IMPLEMENTING WEB GIS SOLUTIONS
USING OPEN SOURCE SOFTWARE

Karsten Vennemann

TERRA GIS
TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS
Seattle

Talk Overview

Why and What	*What is Open Source (GIS)?* *Why use it ?*
Overview of Web GIS	*Components of a Web GIS* *What is out there ?*
Some Foundations	*OGR, GDAL, PROJ4, GeoTools*
Web GIS Engines	*MapServer* *GeoServer*
Frameworks	*Mapbender, MapFish, Cartaro* *Open Layers 2 + 3, Leaflet, D3, CesiumJS*
Extending GIS Capabilities	*Spatial Data Storage Solutions* *Additional Tools*
Resources	*How can you build your own ?* *...5 simple steps*

Application Components

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What is Open Source (GIS)?

Open source 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)

Open Source ≠ Open Standards

While most open source geospatial software is built on the standards of the Open Geospatial Consortium (OGC) the term "Open Source" it 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

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

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Why use it ? General and incomplete listing

- **User is in control**
  - **Pick you favorite operating system: supports many operating systems: Windows-Linux-Solaris-…**
  - **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**

- **High performance, high quality, high interoperability**
  - **distributed programming effort, highly modular…**
  - **System heterogeneity - less prone to hacker attacks and viruses**
  - **Interoperable – very advanced support of OGC open standards**

- **Exceptional Support - Commercial and non commercial**
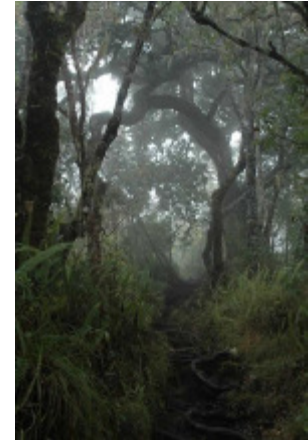 - **Mailing lists, user groups, Conferences, IRC channels**
  - **Fast response times for bug fixes**
    typically tracked on the web accessible and open to everybody to report or fix a bug
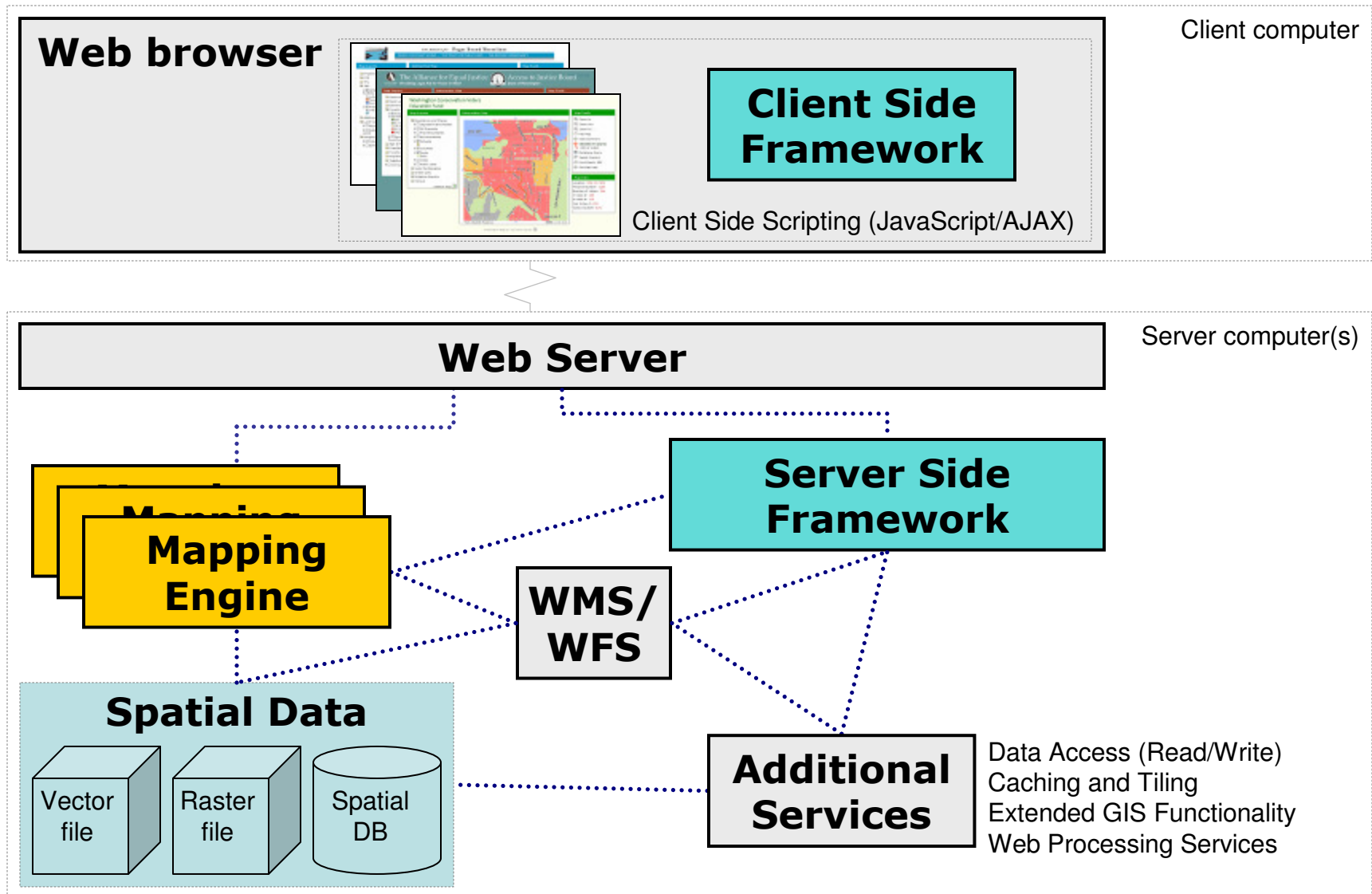
- **It is free**

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What is out there ?

A whole lot !

More than 250 project entries on
http://opensourcegis.org/

Selection of some of the
most advanced and popular Web GIS components

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Schematic View Interoperable Web GIS

Web browser

Client computer

Client Side Framework

Client Side Scripting (JavaScript/AJAX)

Web Server

Server computer(s)

Mapping Engine

Server Side Framework

WMS/ WFS

Spatial Data

Vector file

Raster file

Spatial DB

Additional Services

Data Access (Read/Write)
Caching and Tiling
Extended GIS Functionality
Web Processing Services

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Relations of Web GIS Components
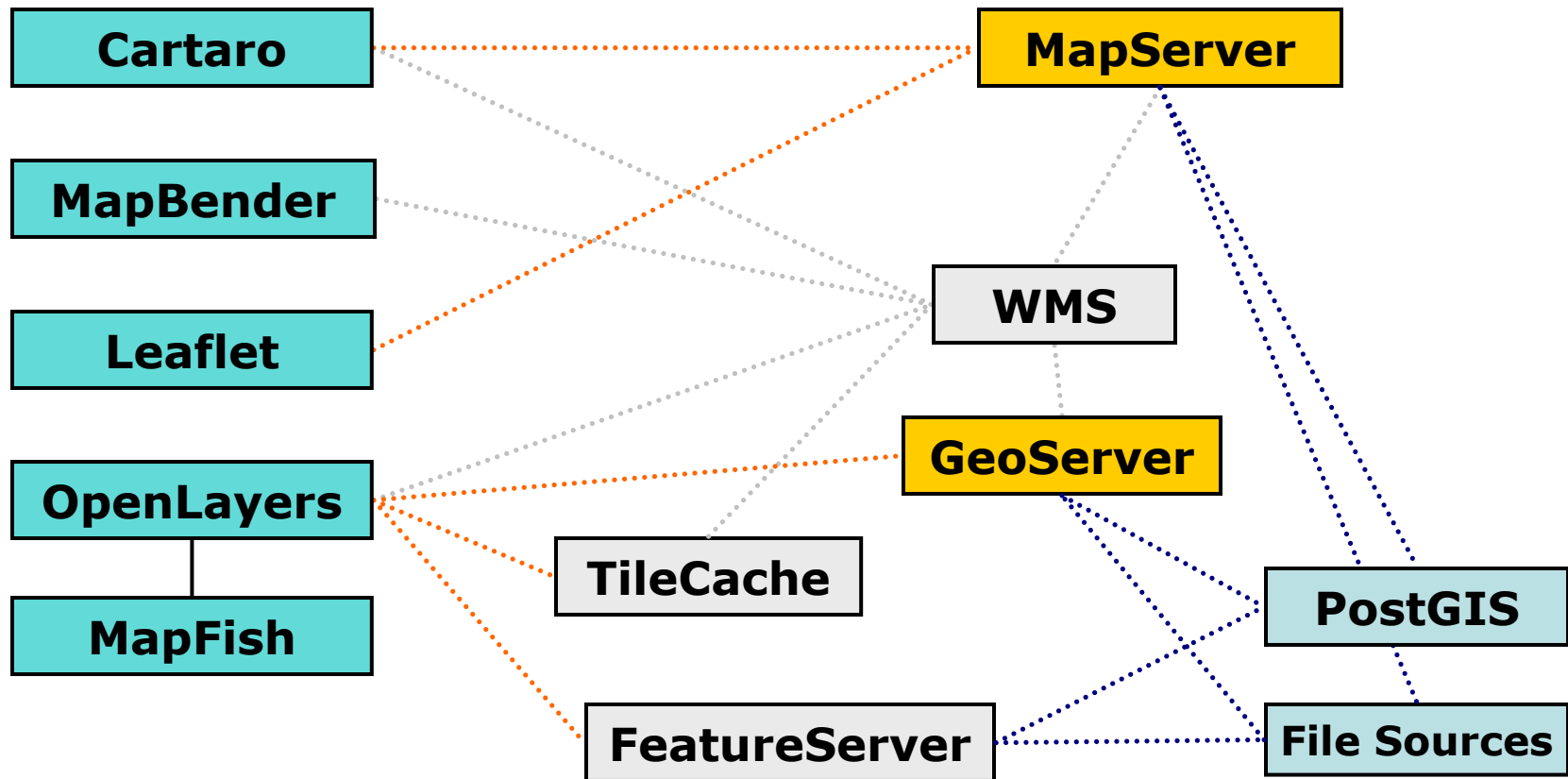
Modified from "The State of Open Source GIS", Paul Ramsey, Sep. 2007, formerly Refractions Research, Victoria, BC, Canada

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Some Foundations (Tools)

A few libraries that are the foundation of many
Open Source and commercial Geospatial Software Packages

- ## GDAL (Raster) and OGR (Vector)
  Geospatial Data Abstraction Library / OpenGIS Simple Features Reference Implementation

  - Tools for reading, writing and processing of
    raster and vector data sets -> <u>formats</u>
  - Important base for many Desktop GIS systems e.g. ArcGIS
  - OGR extends Mapserver formats
    Oracle Spatial, ESRI Geodatabase (MDB), TIGER, MapInfo…

- ## PROJ4 is a library for cartographic projection routines

  - stand alone projection utility "proj"
  - libraries for more than 2500 projections (e.g. EPSG list)

- ## GeoTools is an open source Java GIS toolkit is a library for cartographic projection routines
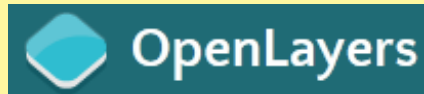
  - Similar usage as OGR and GDAL for Java based projects
  - Udig and GeoServer are based on GeoTools

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🔹 **Web GIS Frameworks**

Client Side

JavaScript/Ajax Libraries

*OpenLayers
JavaScript API*

*Leaflet
JavaScript API*

*D3
JavaScript API*

Cesium

Client-Server Side

*JavaScript/Ajax Libraries
Server Side Scripts, Database*

*Mapbender 2.X + 3
    PHP, JavaScript, PostGIS*

*MapFish
    Python (Pylons),
    Java Script
    (ExtJS) and OpenLayers*

*Cartaro
    PHP, JavaScript
    Drupal CMS*

OpenLayers

Object-oriented JavaScript library version 2+ 3

- OL 2.X   using Prototype.js and Rico library)

- OL 3   using Google's Closure Tools (compiler+ library)

Lets you add maps to any web page by embedding OpenLayer.js

- no server-side dependencies

- Easily reusable component similar to Google Maps and BING Web Mapping APIs

Input Formats

- Bing, Open Street map, Google Maps, WMS, Vector layers, GeoRSS, WFS, KML

Standard Tools

- Google Like zoom bar, standard functions like zoom in/out pan

Clustering example

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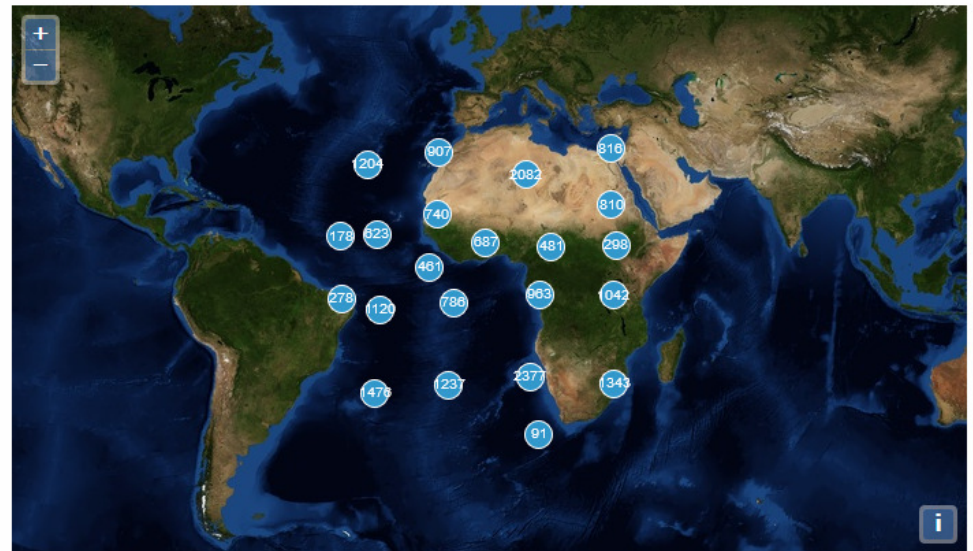
D3.js   Data-Driven Documents

- D3.js is a JavaScript library for manipulating documents based on data

- supports many kinds of visualizations (e.g. charts) based on a combination of HTML, SVG and CSS

- Mapping capabilities interesting alternative in browser visualization of geographic and non geographic objects.

- TopoJSON format is an extension of GeoJSON
  topology - eliminating redundancy in data

- D3 and Leaflet can be combined (TopoJSON is available in Leaflet via D3)

Mike Bostock examples
Globe projections transitions example

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- a lightweight JS Library about 33KB size works efficiently on desktop + mobile platforms

- many functions
  but lacking the more advanced 'GIS' features
  OpenLayers 2.X + OL 3 caters to.

- good choice if (download) speed is the main objective, compatibility with mobile devices is important and if more advanced "GIS" features are not needed

- Can be extended with large collection number of plugins

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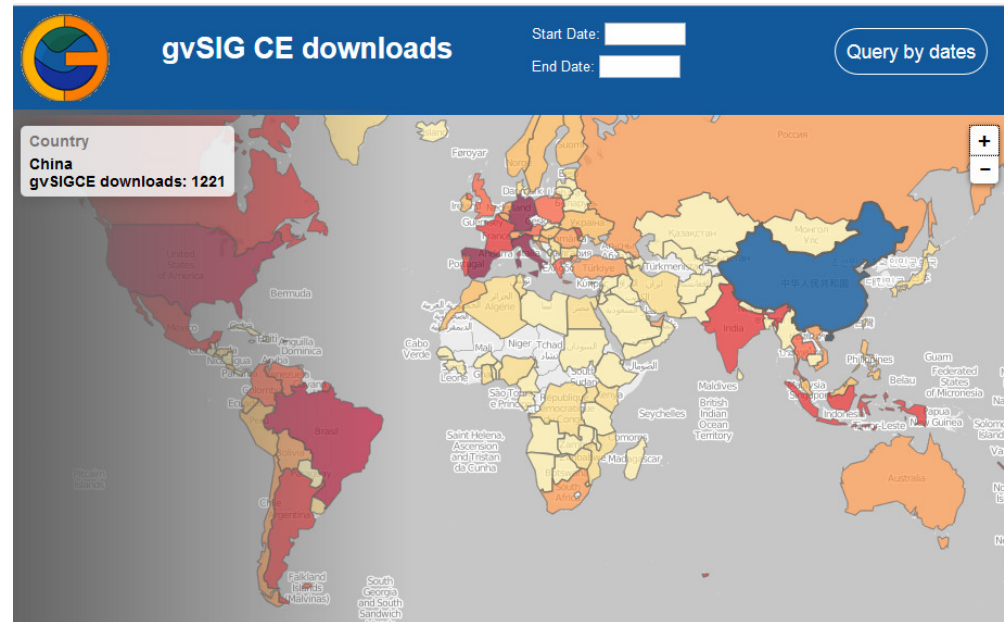
Cesiumjs

Cesium is a JS library enabling 2D maps +3D Globe visualizations , using WebGL , Apache 2 lic

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Cesiumjs
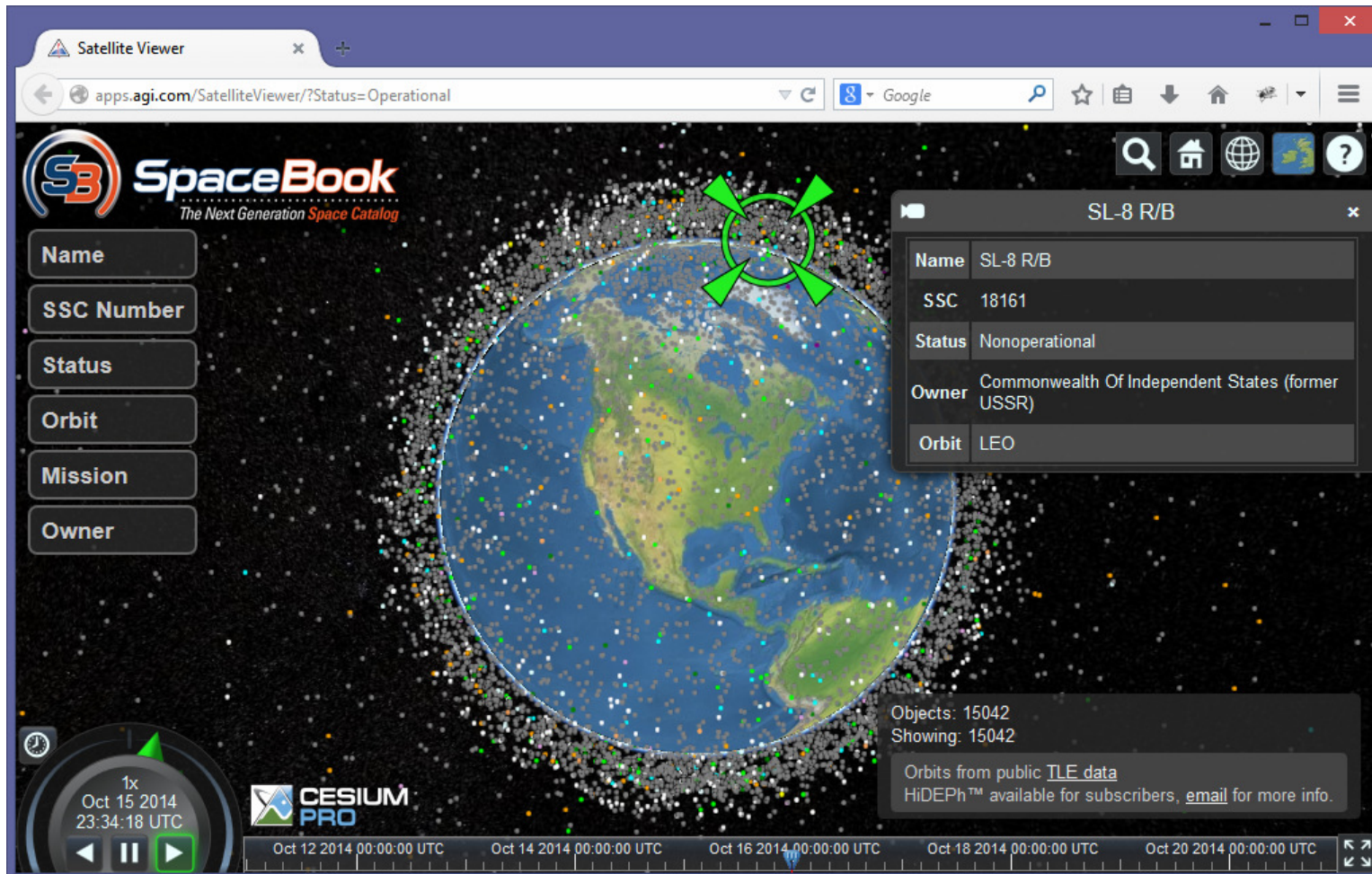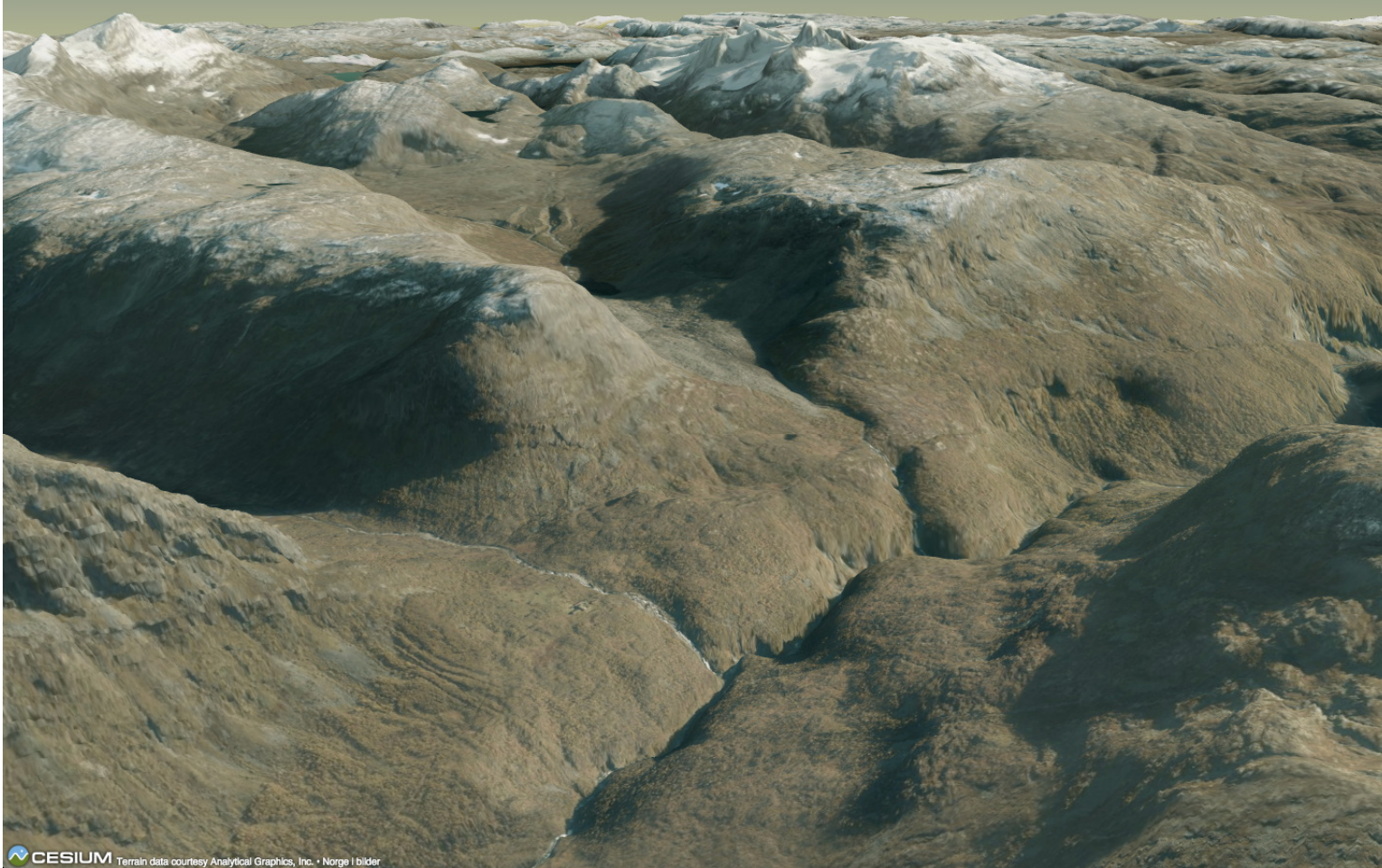
Jotunheimen Norway - rendered with 10 m elevation data from the Norwegian Mapping Authority
Credit Bjørn Sandvik

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Web GIS Engines

- MapServer (C)

- GeoServer (Java)

- Mapnik (C++)

- Map Guide Open Source (C++)

                    + "Fusion" by DM Solutions

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MapServer

Originally developed at the University of Minnesota (UMN), short "MapServer"

- one of the most mature open source projects
- written in C

Main Focus

- rendering spatial data
- development environment for spatially-enabled internet applications

Map output

- CGI mapserv (Linux) and mapserv.exe (windows)
- MapScript API available for Python, PHP, Perl, and Java
- Map/Layer configuration text file .map

Formats

- In: PostGIS, Oracle Spatial ArcSDE, WMS, GDAL and OGR formats
- Out: GIF, JPG, PNG, all GDAL formats, WFS and WMS

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GeoServer

Main supporter The Open Planning Project (TOPP)

- newer development than Mapserver)

- written in Java, built on top of Geotools (like Udig)

Main Focus

- rendering images, <u>serving and editing</u> spatial data

More differences to Mapserver

- configuration web-based Graphical user interface (stored as xml)

- transactional capabilities, support for shared editing

Formats

- PostGIS, Shapefile, ArcSDE, DB2, Oracle
  (soon VPF, MySQL, MapInfo, WFS)

- JPG, GIF, PNG, SVG, KML/KMZ, GML, Shapefile, GeoJSON, GeoRSS

- WFS , WMS and KML output

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GeoServer

Logged in as admin. Logout

Welcome

Welcome

This GeoServer belongs to The ancient geographes INC.

About & Status
- Server Status
- GeoServer Logs
- Contact Information
- About GeoServer

Data
- Layer Preview
- Workspaces
- Stores
- Layers
- Layer Groups
- Styles

Services
- WCS
- WFS
- WMS

Settings
- Global
- JAI
- Coverage Access

Tile Caching
- Tile Layers
- Caching Defaults
- Gridsets
- Disk Quota

Security
- Settings
- Authentication
- Passwords
- Users, Groups, Roles
- Data
- Services

Demos

139 Layers   Add layers
29 Stores   Add stores
8 Workspaces   Create workspaces

ⓘ Strong cryptography available

This GeoServer instance is running version **2.4.0**. For more information please contact the administrator.

Service Capabilities

WCS
  1.0.0
  1.1.0
  1.1.1
  1.1
WFS
  1.0.0
  1.1.0
  2.0.0
WMS
  1.1.1
  1.3.0
TMS
  1.0.0
WMS-C
  1.1.1
WMTS
  1.0.0

MapFish

Main supporter "Camptocamp"

Widgets and plugins oriented architecture

MapFish Client - JavaScript framework – two parts

- mapping part OpenLayers

- user interface (GUI widgets) ExtJs + GeoExt library

MapFish Server

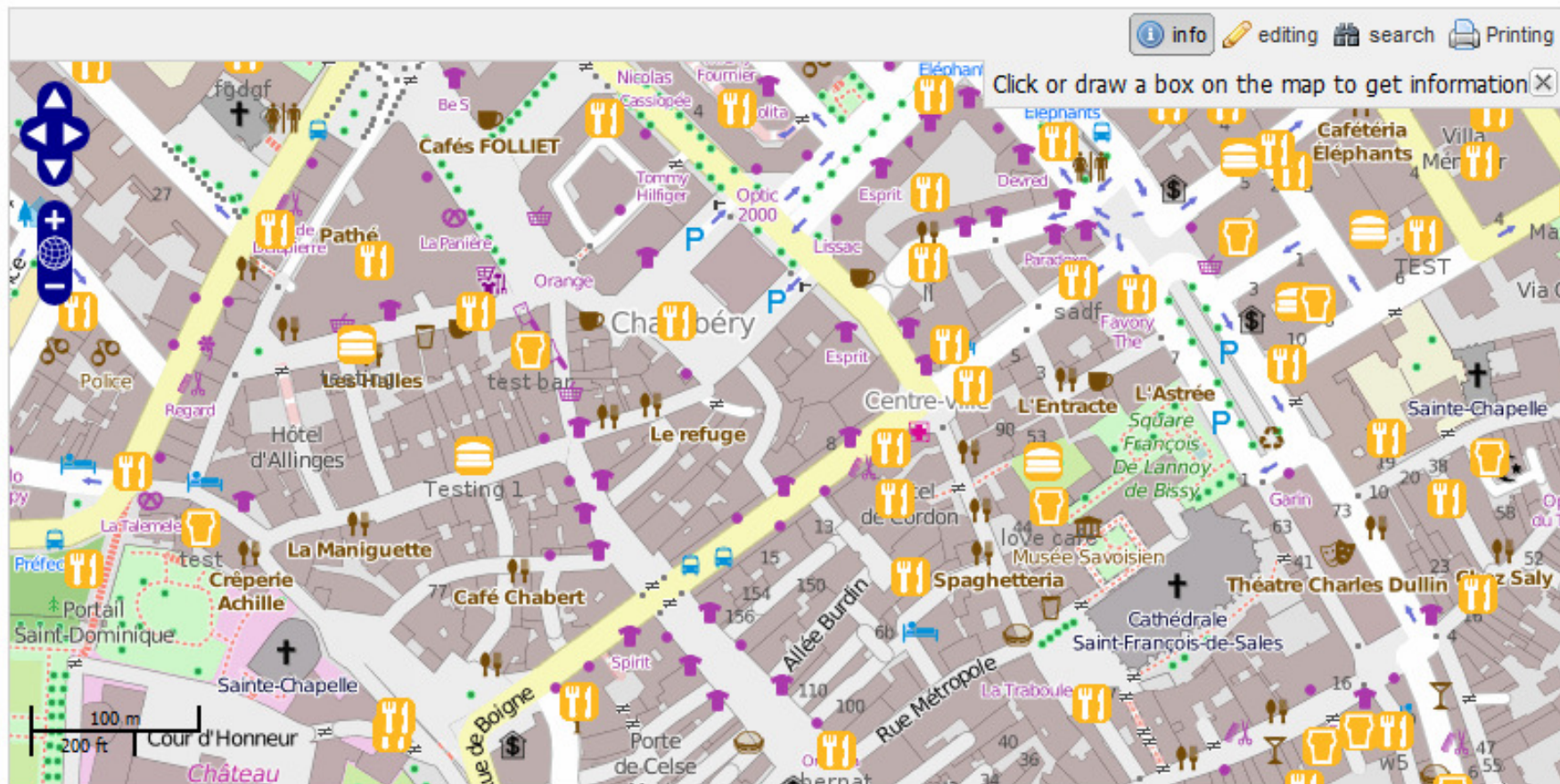- MapFish Server is a Python framework (based on Pylons)

Main Focus - Adding server side framework to OpenLayers

- Advanced UI components: layer tree…

- Server-side services: authentication, query…

- Server-side processing: routing, editing…

- Print Module (Java based and independent)

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MapFish

Map Fish demo

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Mapbender

Main supporter "WhereGroup"

Comprehensive Client - Server framework

- implemented in PHP, JavaScript and XML

- Management Database MySQL or PostgreSQL

Functionality

- displaying, navigating, editing and querying spatial data and maps

- map services authorization services (OWS proxy functionality)

- management interfaces for user, group and service administration

- Management of WMS and WFS

- User interface configuration and tool stored in data base

Input

- WMS and WFS

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Extending GIS Capabilities
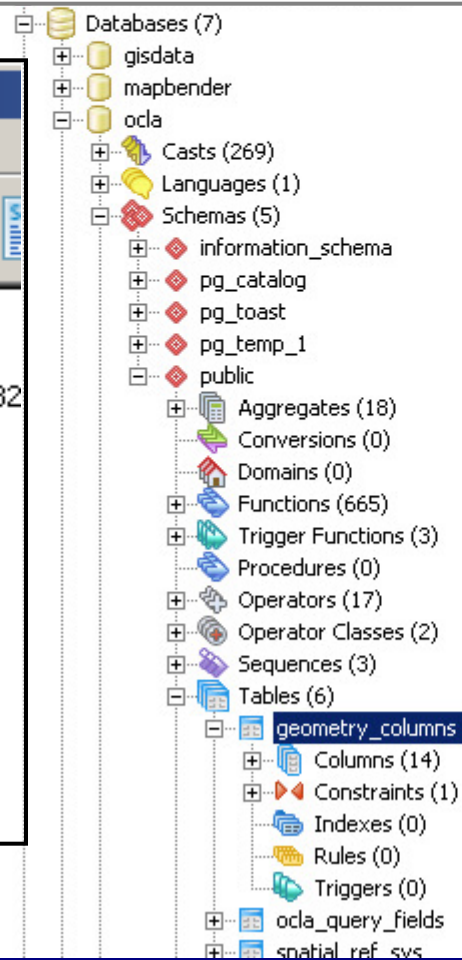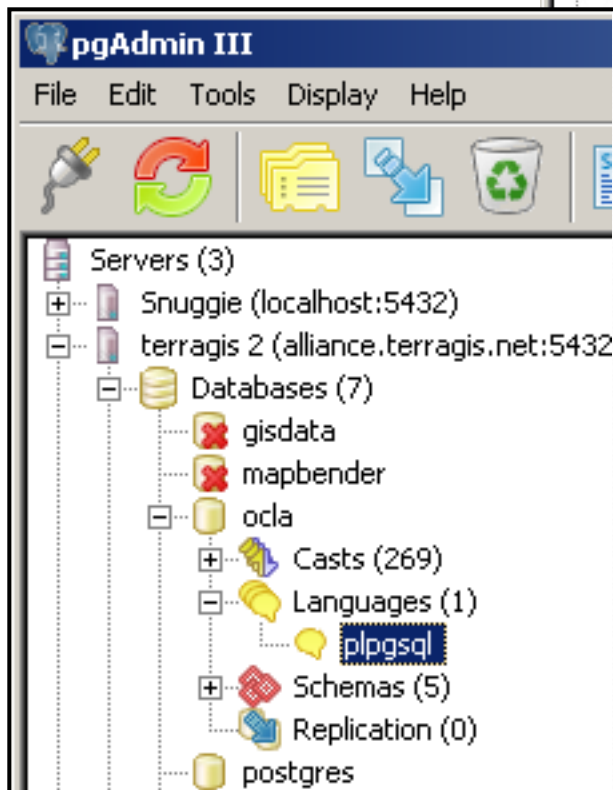# PostGIS – Spatial Database

- PostGIS is an extension for PostgreSQL

- adds support for geographic objects to PostgreSQL

- enables PostgreSQL server to be used as a backend spatial database for GIS

- Spatial operations and analysis simply mean running a (spatial) SQL query in the database

- Similar functions as SDE and much more ….

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PostGIS

PostgreSQL

pgAdmin – GUI base Database administration tool

pgAdmin III

File Edit Tools Display Help

Servers (3)

- Snuggie (localhost:5432)
- terragis 2 (alliance.terragis.net:5432)
  - Databases (7)
    - gisdata
    - mapbender
    - ocla
      - Casts (269)
      - Languages (1)
        - plpgsql
      - Schemas (5)
      - Replication (0)
  - postgres

pgAdmin III

File Edit Tools Display Help

Servers (3)

- Databases (7)
  - gisdata
  - mapbender
  - ocla
    - Casts (269)
    - Languages (1)
    - Schemas (5)
      - information_schema
      - pg_catalog
      - pg_toast
      - pg_temp_1
      - public
        - Aggregates (18)
        - Conversions (0)
        - Domains (0)
        - Functions (665)
        - Trigger Functions (3)
        - Procedures (0)
        - Operators (17)
        - Operator Classes (2)
        - Sequences (3)
        - Tables (6)
          - geometry_columns
            - Columns (14)
            - Constraints (1)
            - Indexes (0)
            - Rules (0)
            - Triggers (0)
          - ocla_query_fields
          - spatial_ref_sys

Property	Value
Name	geometry_columns
OID	16754
Owner	gisdata
ACL	
Primary key	f_table_catalog, f_table_schema, f_
Rows (estimated)	1
Rows (counted)	3
Inherits tables	No
Inherited tables count	0
Has OIDs?	Yes
System table?	No

Properties Statistics Depends on Referenced by

```
-- Table: geometry_columns

-- DROP TABLE geometry_columns;

CREATE TABLE geometry_columns
(
  f_table_catalog varchar(256) NOT NULL,
  f_table_schema varchar(256) NOT NULL,
  f_table_name varchar(256) NOT NULL,
  f_geometry_column varchar(256) NOT NULL,
  coord_dimension int4 NOT NULL,
  srid int4 NOT NULL,
  "type" varchar(30) NOT NULL,
  CONSTRAINT geometry_columns_pk PRIMARY KEY (f_
)
WITH OIDS;
ALTER TABLE geometry_columns OWNER TO gisdata;
```

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![PostGIS PostgreSQL logo]

pgAdmin III Edit Data - terragis 2 (alliance.terragis.net:5432) - ocla - geometry_columns

	oid	le_ca | vard	table_schem [PK] varchar	f_table_name [PK] varchar	geometry_colum [PK] varchar	d_dimer int4	srid int4	type varchar
1	63153	"	public	wa_counties	the_geom	2	2285	MULTIPOLYGON
2	63206	"	public	wa_counties_we	the_geom	2	2285	MULTIPOLYGON
3	63226	"	public	wa_tracts	the_geom	2	2285	MULTIPOLYGON
*								

PostGIS tables

geometry columns

spatial reference table

pgAdmin III Edit Data - terragis 2 (alliance.terragis.net:5432) - ocla - spatial_ref_sys

	srid [PK] int4	auth_name varchar	auth_srid int4	srtext varchar	proj4text varchar
1614	4324	EPSG	4324	GEOGCS["WGS 72BE",DATUM["WGS_1972_	+proj=longlat +ellps=WGS72 +t
1615	4326	EPSG	4326	GEOGCS["WGS 84",DATUM["WGS_1984",SP	+proj=longlat +ellps=WGS84 +d
1616	4600	EPSG	4600	GEOGCS["Anguilla 1957",DATUM["Anguilla_1	+proj=longlat +ellps=clrk80 +no
1617	4601	EPSG	4601	GEOGCS["Antigua 1943",DATUM["Antigua_1	+proj=longlat +ellps=clrk80 +no
1618	4602	EPSG	4602	GEOGCS["Dominica 1945",DATUM["Dominica	+proj=longlat +ellps=clrk80 +tou
1619	4603	EPSG	4603	GEOGCS["Grenada 1953",DATUM["Grenada_	+proj=longlat +ellps=clrk80 +tou
1620	4604	EPSG	4604	GEOGCS["Montserrat 1958",DATUM["Montse	+proj=longlat +ellps=clrk80 +tou

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PostGIS Functions

■ Spatial SQL

```
Functions (780)
    _st_asgeojson(integer, geography, integer, integer)
    _st_asgeojson(integer, geometry, integer, integer)
    _st_asgml(integer, geography, integer, integer)
    _st_asgml(integer, geometry, integer, integer)
    _st_askml(integer, geography, integer)
    _st_askml(integer, geometry, integer)
    _st_bestsrid(geography, geography)
    _st_bestsrid(geography)
    _st_buffer(geometry, double precision, cstring)
    _st_contains(geometry, geometry)
    _st_containsproperly(geometry, geometry)
    _st_coveredby(geometry, geometry)
    _st_covers(geography, geography)
    _st_covers(geometry, geometry)
    _st_crosses(geometry, geometry)
    _st_dfullywithin(geometry, geometry, double precision)
    _st_distance(geography, geography, double precision, boolean)
    _st_dumppoints(geometry, integer[])
    _st_dwithin(geometry, geometry, double precision)
    _st_dwithin(geography, geography, double precision, boolean)
    _st_equals(geometry, geometry)
    _st_expand(geography, double precision)
    _st_intersects(geometry, geometry)
    _st_linecrossingdirection(geometry, geometry)
    _st_longestline(geometry, geometry)
    _st_maxdistance(geometry, geometry)
```

Extending GIS Capabilities - Additional tools

FeatureServer

middleware for publishing and modifying geospatial data in lots of different formats to the web (RESTful Geographic Feature Service)

- *dynamic capabilities to read geographic features (or collections) with standard HTTP methods from distributed sources (aggregation)*

- *translate geographic features between formats*
  e.g. input shape file and open in Google Earth

TileCache

server software solution with caching and rendering capabilities

- *create your own local disk-based cache of any WMS server*

- *use the resulting map tiles in supporting clients*
  e.g. OpenLayers, Google maps, Virtual Earth, Worldkit

- *create a fast performing slippy style map a la Google Maps*

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Map Tile Caching Server / **engines**

TileCache	www.tilecache.org
TileStache	http://tilestache.org/
GeoWebCache	http://geowebcache.org
MapProxy	tiles, server proxy, security
	http://mapproxy.org
MapCache	www.mapserver.org
TileMill	map styling - http://mapbox.com/tilemill

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■ **But you still have one important question !**

"How can I build my own WEB GIS ? "

simple steps…

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Articles

The State of Open Source GIS,
Version September 2007. By Paul Ramsey, formerly
Refractions Research, Victoria. 49pages

Web Sites

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

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Open source utilities and websites

Simple Feature Library (OGR)		www.gdal.org
Geospatial Data Abstraction Library (GDAL)		www.gdal.org
GeoTools		http://www.geotools.org
PROJ4		http://trac.osgeo.org/proj
MapServer		http://mapserver.org
GeoServer		http://geoserver.org
Mapnik		http://mapnik.org
OpenLayers		www.openlayers.org
Leaflet		http://leafletjs.com
Mapbender		www.mapbender.org
MapFish		http://mapfish.org
Cartaro		http://cartaro.org
Map Guide Open Source		https://mapguide.osgeo.org
PostgreSQL		www.postgresql.org
PostGIS		http://postgis.refractions.net
Django		https://www.djangoproject.com
TileCache		www.tilecache.org

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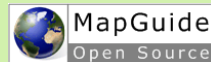
Local GIS user group:

"Cascadia Users of Geospatial Open Source"

www.cugos.org
http://groups.google.com/group/cugos

Monthly meeting every 3rd Wednesday, 5:30 pm

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