Web Services for Mapping

Tutorial

Dr. Emmanuel Stefanakis
Assistant Professor
Harokopio University of Athens – Dept. of Geography
estef@hua.gr
http://www.dbnet.ece.ntua.gr/~stefanak/
Overview

- Tutorial Description
- Tutorial Schedule
- Tutorial Outline

This tutorial is also available at:

http://www.dbnet.ece.ntua.gr/~stefanak/WebServMap_Stefanakis.pdf
As geographic/map data sources expand and the demand to have access to them increases, the Web Mapping Services have been grown rapidly during the last years.

The Web services specifications for mapping come from the Open Geospatial Consortium (OGC) and have been implemented by commercial and open source map server software systems.

The scope of this tutorial is to present the web services for sharing and accessing geographic/map data on the Web.
Tutorial Schedule

Sunday, June 8th, 2008 ...

at 16:00 – 19:00...

• Part I: Theory
  - (duration ~ 1h 30 min)

• Part II: Practice
  - (duration ~ 1h 30 min)
Tutorial Outline

- **Part I: Theory**
  1. Publishing Maps on the Web
  2. XML-based languages for Geography and Mapping
  3. Web Services for Mapping

- **Part II: Practice**
  4. Mapping Servers/Services on the Web
  5. Spatial Data Infrastructures (SDI)
  6. The Heraklion SDI Web Services
Part I: Theory

1. Publishing Maps on the Web
   - Static Maps
   - Interactive Maps
     - Extending the client
     - Extending the server

2. XML-based languages for Geography and Mapping
3. Web Services for Mapping
Web Mapping

- Web ...
  - A common means of publishing maps

- Web maps ...
  - Million of people use web maps daily
  - Few of them know how they are actually generated
Web Mapping

- Publishing Maps on the Web ...
- Two approaches ...
  - **Static maps**
    - Apply the basic web resources
  - **Interactive maps**
    - Enriched functionality by extending
      - The **client side** functionality
      - The **server side** functionality
Static Maps

- Basic web publishing ...
  - distribute scanned maps (as images)
Static Maps

- Clickable maps ...
- Images may have “sensitive areas”...
Static Maps

- Clickable maps ...
  - HTML capabilities ...
    - Insert an image:
      ```html
      <img src="pages.gif" width="384" height="245" alt="site map">
      ```

- Define clickable regions within an image:
  ```html
  <map name="sitemap">
    <area shape="circle" coords="186,44,45" href="Overview.html" alt="Getting Started">
    ...
  </map>
  ```
Static Maps

- Clickable maps ...
  - Define clickable regions within an image
    - Geometry types supported in HTML...
      - Rectangle
        - rect: left-x, top-y, right-x, bottom-y
      - Circle
        - circle: center-x, center-y, radius
      - Polygon
        - poly: x1,y1, x2,y2, ... xn,yn
Static Maps

- Clickable maps ...

```html
<html>
<title>Harokopio University</title>
<h1>HAROKOPIO UNIVERSITY</h1>
<p>Click on the image to see the buildings</p>
<p>
<img src="HUA.jpg" width="729" height="526" usemap="#HUAMap">

<map name="HUAMap">
  <area href="central.jpg" shape="polygon" coords="285,228,293,288,420,283,423,228">
  <area href="geo.jpg" shape="rect" coords="153, 292, 255, 403">
</map>

</p>
</html>
```
Interactive Maps

- Extending **client side** functionality
  - Plugins
    - Make the web browser capable to read and process additional formats
Interactive Maps

- Extending client side functionality
  - Plugins – SVG Viewer
    - eg., http://www.adobe.com/svg/
Interactive Maps

- Extending **client side** functionality
  - Plugins – SVG Viewer
13th Floor, West Tower, San Jose

Mouse over a room to show occupant information.
Click on a room to freeze the information.

Name: Chase Myer  Email: CMyer  Phone Number: 408-555-1212  Other Info: Adobe Studio Human Resources
Interactive Maps

- Extending **client side** functionality
  - **Java + JavaScript**
    - The functionality varies ...
      - from very simple button interactivity
      - to a sophisticated mapping environment
**Example Applets:**

Election results in the city of Bonn
http://www.ais.fraunhofer.de/and/java/iris/app/elect/indexm.html

Overijssel (NL) demographic information
http://www.ais.fraunhofer.de/and/java/iris/app/elect/indexm.html
Interactive Maps

- Extending **server side** functionality
  - **Common Gateway Interface (CGI)**
  - e.g., http://carto.server.gr?doThis&parameter1&parameter2

![Diagram of Interactive Maps]
Interactive Maps

- Extending **server side** functionality
  - **Common Gateway Interface (CGI)**

  ```
  http://wms.jpl.nasa.gov/wms.cgi
  ?request=GetMap
  &service=WMS
  &version=1.1.1
  &srs=EPSG:4326
  &format=image/jpeg
  &styles=
  &bbox=-180,-90,180,90
  &width=600
  &height=300
  &layers=global_mosaic
  ```
Interactive Maps

- Extending server side functionality
Interactive Maps

- Extending...
  - both server & client side functionality
  e.g., ESRI Arc/IMS
Interactive Maps
Interactive Maps

http://earth.google.com/
Part I: Theory

1. Publishing Maps on the Web

2. XML-based languages for Geography and Mapping
   - GML – Geography Markup Language
   - SVG – Scalable Vector Graphics
   - KML – Keyhole Markup Language

3. Web Services for Mapping
XML

XML...

- eXtensible Markup Language
- Developed by the World Wide Web Consortium (W3C)

Nowadays...

- XML is widely used for describing and exchanging data
What is so **advantageous** about XML...

- **It is portable**
  - it utilizes unicode
- **It is platform independent**
- **It is human readable**
  - it is a pure and editable text
- **It is extensible**
  - extra info can be added to a format without breaking applications based on previous versions
- **It is well supported**
  - A large number of off-the-self tools for processing XML exist
XML

- XML...
  - Has been built to support traditional applications (office and banking)

- What about applications involving non-traditional data?
  - Other formats ... based on XML have been proposed
  - E.g.,
    - **GML** (Geography Markup Language) for transport and storage of geo-information
    - **CML** (Chemical Markup Language) for managing molecular information
Geographic Applications

- **XML** ...
  - has been adopted widely in geography
  - It is already a standard for geo-data sharing

- **Main formats** ...
  - **GML**
    - Geography Markup Language
  - **SVG**
    - Scalable Vector Graphics
  - **KML**
    - Keyhole Markup Language
An **XML-based** encoding standard

- for transport and storage of geo-information
- including both spatial and non-spatial features

Developed by ...

- the Open Geospatial Consortium – **OGC**
  
  { 270 companies, government agencies and universities }

http://www.opengeospatial.org/
Geography Markup Language (GML)

http://www.opengeospatial.org/
Geography Markup Language (GML)

- **GML versions ...**
  - Initial release: GML specification
    - based on DTD; not used anymore
  - Feb. 2000: GML2 specification
    - based on XMLSchema
  - Current (since 2003): **GML3** specification
    - based on XMLSchema; includes spatial relationships, 3D geometry, and time
GML represents the content...

- An important distinction should be made between...
  - geographic data encoded in GML (the content) and
  - their visualization (the presentation)

- Similarly to ...
  - XML and HTML
  - XML is helping the Web to clearly separate content from presentation
  - GML will do the same in the world of geography!
Geography Markup Language (GML)

- **GML is** **Text**...
  - Like XML encoding...
    - GML represents geo-info in the form of text
  - Some year ago...
    - This might be censurable
  - Today...
    - This is desirable!
  - Text has advantages
    - Easy to inspect / Easy to change
  - Text formats for geography...
    - have been employed in the past (e.g., SAIF, VRML)
What is so different about GML?

- There are already...
  - Many encoding standards for GI
    - COGIF, SAIF, DLG, SDTS
- Why GML?
  - A simple text based encoding
  - Based on a common model of geography
    - OGC Abstract Specification
    - Developed and agreed by the vast majority of all GIS vendors
  - GML is based on XML
Geography Markup Language (GML)

- GML is based on XML (advantage...)
  - XML provides a method to verify data integrity
    - XMLSchema or DTD
  - XML can be read and edited using a simple text editor
    - Also several XML editors exist (e.g., XML Spy)
  - A large number of XML languages already available
    - e.g., XML-QL, XSL
  - XML is easy to transform
    - using XSLT or any programming language (Java, C++)
  - XML is a widely adopted public standard
    - A wide variety of commercial/free ware tools for XML exist
    - This leads to an open (geographic) information
Geography Markup Language (GML)

- **GML Encodes Geographic Features**
  - GML is based on...
    - The OGC abstract model of geography
  - Feature = Entity
    - A list of properties and geometry
  - Feature Property
    - Usual Name / type / value description
  - Feature Geometry
    - Basic building blocks
      - points, lines, curves, surfaces and polygons
    - Current version
      - 3D geometry / topological relationships / Time
Geography Markup Language (GML)

- GML Encodes Geographic Features
  - GML encoding allows ... 
    - Quite complex features
  - A feature can be ... 
    - Composed of other features
  - Example...
    - A Railway Station (RS)
      - is a single feature
      - composed of other features
      - Platforms
      - Ticket halls
      - Bus and taxi ways
      - Cafeterias and restaurants
Geography Markup Language (GML)

- GML Encodes Geographic Features
  - Same applies to geometry
    - A geometrically complex feature
    - composed of many geometric elements
      - Points / Line strings / Polygons
      - Example...

Complex geometry

- element 1
- element 2 (hole)
- element 3
- element 4
**Geography Markup Language (GML)**

- **GML Encodes Feature Geometry**

  ```xml
  <MiddleSchool ID ="1451">
    <extentOf>
      <Polygon srsName="epsg:27354">
        <outerBoundaryIs>
          <LinearRing>
            <coordinates>
              491888.99,5458045.99 491904.72,5458044.91 491888.99,5458045.99 491904.72,5458044.91
              491908.42,5458064.58 491924.61,5458064.33 491908.42,5458064.58 491924.61,5458064.33
              491925.62,5458079.59 491977.66,5458120.36 491925.62,5458079.59 491977.66,5458120.36
            </coordinates>
          </LinearRing>
        </outerBoundaryIs>
      </Polygon>
    </extentOf>
  </MiddleSchool>
  ```
Geography Markup Language (GML)

- **GML Encodes Feature Properties**

```xml
<MiddleSchool ID="145l">
    <description>Balmoral Middle School</description>
    <NumStudents>987</NumStudents>
    <NumFloors>3</NumFloors>
    <extentOf>
        <Polygon srsName="epsg:27354">
            <outerBoundaryIs>
                <LinearRing>
                    <coordinates>...
                    </coordinates>
                </LinearRing>
            </outerBoundaryIs>
        </Polygon>
    </extentOf>
</MiddleSchool>
```

Properties (other than geometry)
Geography Markup Language (GML)

- **GML Feature Collections**
  - GML2, GML3 are based on XML1.0
  - XML1.0 uses ...
    - A feature collection as the basis of its document
  - Feature Collection is ...
    - A collection of features
      - Together with an envelop (it bounds features)
    - A collection of properties
      - They apply to the feature collection
    - An optional list of Spatial Ref. System Definitions
  - A Feature Collection ...
    - Can contain other Feature Collections
Geography Markup Language (GML)

- **GML Encodes Spatial Ref. Systems**
  - **GML3 incorporates** ...
    - An extensible earth based Spatial Ref. System
    - The main Projection and Geocentric Ref. Systems in use
  - **The encoding scheme allows for** ...
    - User defined units and Ref. System parameters
  - **Future versions of GML will provide** ...
    - More flexible encodings to handle local coordinate systems (e.g., mile logging)
Geography Markup Language (GML)

- GML Encodes Spatial Ref. Systems
  - Although optional ... it is very valuable...
    - Clients can validate Server SRS
      - SRS description is an XML document
    - Client can handle data from different Servers
      - GML services that transform GML data from one SRS to another are required
  - Server (web site) can accommodate (store)
    - any number of SRS definitions and related data
Geography Markup Language (GML)

**Schemas** for Spatial Data

- A schema defines
  - The characteristics of a class of objects
- In XML
  - A schema defines how data is **marked up**
- GML3.0 is compliant with
  - XML Schema Candidate Recommendation
  - Published by OGC (2003)
Geography Markup Language (GML)

- **GML Base Schemas**
  - Three base schemas
    - Geometry Schema (geometry.xsd)
      - Replaces the DTD of GML1.0
    - Feature Schema (feature.xsd)
      - It supports feature collections (as feature types)
      - It includes common properties
        - fid (identifier)
        - name
        - description
  - XLink Schema
    - Provides Xlink attributes
    - Supports linking functionality
Geography Markup Language (GML)

- GML Base Schemas
  - Base schemas as packages
Geography Markup Language (GML)

- **GML – Geometry Schema**
  - It includes type definitions for ...
    - Abstract geometry elements
      - (multi) point / line / polygon
    - Complex type definitions
      - For the underlying geometry types
  - It includes ...
    - The structures described in the OGC Abstract Specification (Topic 1: Feature Geometry)
Geography Markup Language (GML)

- GML
- Geometry Schema (UML)
Geography Markup Language (GML)

- **GML – Feature Schema**
  - Uses ...
    - The `<include>` element
      `<include schemaLocation="geometry.xsd"/>
    - To bring in GML geometry constructs
  - Hence ...
    - GML geometry constructs are available in defining feature types
Geography Markup Language (GML)

- GML
  - Feature
  - Schema (UML)
Geography Markup Language (GML)

GML Application Schemas

- The development of a schema for a ...
  - Particular domain (e.g., forestry)
  - Jurisdiction (e.g., France)
  - Information community
- Incorporates the base GML schemas ...
  - Geometry schema
  - Feature schema
  - Xlink schema
Geography Markup Language (GML)

- **Rules for GML Application Schema**
  - Defines its own (new) feature types
    - They must be sub-typed from GML types
  - Defines new geometry properties
    - They must be sub-typed from GML types
  - Declares a target namespace
    - A mechanism to keep element names distinct
  - Imports schemas
    - The only means whereby GML constructs are brought in for use
Geography Markup Language (GML)

- Rules for GML Application Schema
  - Imports schemas
    - `<import>`
  - `<include>`

Diagram:
- `foo` namespace
- `schema-A`
- `Feature`
- `gml` namespace
- `Geometry`
- `<import>`
- `<include>`
The Cambridge Example (Appl. Schema)

- One Feature Collection
  - CityModel
    - String property
      - dateCreated (value: ‘Nov 2000’) 
    - Geometry property
      - boundedBy (the bounding box) [expressed in an SRS]
  - Two features (containment relationship: ‘cityMember’)
    - RiverType
      - name: ‘Cam’, description: ‘The River that runs…’
      - geometry: centerLineOf [bounding box SRS]
    - RoadType
      - geometry: linearGeometry [bounding box SRS]
Geography Markup Language (GML)

- The Cambridge Example (Appl. Schema)

(UML)
Making Maps with GML

- How to make a map with GML data?
  - GML represents the content...
  - Therefore...
    - GML data must be styled into a suitable graphical presentation
  - Map styling...
    - The process of transforming GML data into the geometry of a visual presentation
  - A similar process is applied...
    - When an XML document is transformed to a presentation format, such as HTML
    - ... using tools like XSLT (XML Transformation Language)
Making Maps with GML

- **Map styling**...
  - The target of GML Map Styling can be of any format
  - Usually, an XML graphical format is chosen
    - Such as SVG, VML, KML or X3D

- **Graphical rendering**...
  - The process of transforming the graphical representation of Map Styling process into a viewable image
Making Maps with GML

Graphical Rendering Engine

Map Styling Engine

Map Style Library

GML Data

Performed on either the client or the server
Making Maps with GML

- **Graphical renders...**
  - There are a variety available
  - They support the different XML graphical formats
  - They are ...
    - Either ... native to the web browser
      - E.g., Internet Explorer built in VML processor
    - Or ... distributed as plug-ins for many browsers
      - E.g., Adobe SVG Viewer
    - Or ... stand alone viewers
      - E.g., Java Applet SVG viewer, Google Earth
Making Maps with GML

- Making a Map with XSLT and SVG ...
  - (Galdos Systems Inc)
Making Maps with GML

- Map Style Editor ...
  - (Galdos Systems Inc)
Making Maps with GML

- **StruMap DNF Viewer**
  - Displays Map files in GML
  - DNF (Digital National Framework) from **Ordnance Survey, U.K.**
  - The viewer supports ...
    - The display of features using appropriate symbols
    - Zoom-in/-out utilities
    - Display of attribute values assigned to features
    - Selection of themes to be displayed
    - Measuring distances/coordinate values
Making Maps with GML

- StruMap DNF Viewer
Making Maps with GML

- StruMap DNF Viewer (theme selector)
Making Maps with GML

- StruMap DNF Viewer (identifying features)
Making Maps with GML

- Many other options, e.g.,...
  - Convert GML to KML
  - Visualize the result in Google Earth
Making Maps with GML

- Convert GML to KML ...
  - **OGR Simple Feature Library (OSGeo)**
    - a C++ open source library

  e.g.,
  ogr2ogr -f "KML" .\infocharta\municipalities.kml
            .\infocharta\municipalities.gml
            -s_srs "epsg:2100"
            -t_srs "epsg:4326"

  ogr2ogr -f "KML" .\infocharta\towns.kml
            .\infocharta\towns.gml
            -s_srs "epsg:2100"
            -t_srs "epsg:4326"
Making Maps with GML

- Convert GML to KML ...
Scalable Vector Graphics (SVG)

- **SVG** ...
  - language for describing...
    - two-dimensional graphics and
    - graphical applications
  - it is based on the XML standard
    - emphasis on the visualization
  - it describes...
    - Content + Map Symbols + ...
Scalable Vector Graphics (SVG)

- A **W3C** standard (current version 1.1)...
  - [http://www.w3.org/Graphics/SVG/](http://www.w3.org/Graphics/SVG/)

- **SVG Document Type Declaration (DTD)**
  
  ```xml
  <!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN" "http://www.w3.org/Graphics/SVG/1.1/DTD/svg11.dtd">
  ```
Scalable Vector Graphics (SVG)

Table of Contents

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- Copyright notice

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Scalable Vector Graphics (SVG)
Scalable Vector Graphics (SVG)
Scalable Vector Graphics (SVG)

```xml
<?xml version="1.0" standalone="no"?>
<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN" "http://www.w3.org/Graphics/SVG/1.1/DTD/svg11.dtd">
<svg width="100%" height="100%" version="1.1" xmlns="http://www.w3.org/2000/svg">
  <a xlink:href="parthenon.jpg">
    <polygon points="408,238 560,195 578,260 430,306" style="fill:red; stroke:blue; stroke-width:1"/>
  </a>
</svg>
```
Scalable Vector Graphics (SVG)

- An SVG document can be created...
  - from scratch in a text editor
  - using an SVG editor
  - as an output of another program
    - e.g., ArcGIS, Adobe Illustrator, etc.

- An SVG file can be viewed ...
  - in a Web browser, if an appropriate plugin is loaded
    - e.g., Adobe SVG Viewer - http://www.adobe.com/svg
Keyhole Markup Language (KML)

- KML ...
  - format to display geographic data in an Earth browser,
    - such as Google Earth, Google Maps, and Google Maps for mobile
  - to be adopted by OGC
  - it is based on the XML standard
    - emphasis on the visualization
  - it describes...
    - Content + Map Symbols + View point + ...
Keyhole Markup Language (KML)

- A KML file can be created ...
  - with the Google Earth user interface, or
  - from scratch ...
    - use an XML or simple text editor to enter "raw" KML

- KMZ...
  - KML files and their related images (if any) can be compressed using the ZIP format into KMZ archives
Keyhole Markup Language (KML)

- How to share KML and KMZ files...
  - you can e-mail them,
  - host them locally for sharing within a private internet, or
  - host them publicly on a web server

- Earth browsers ...
  - such as Google Earth can display KML files
    - Just as web browsers display HTML files
Keyhole Markup Language (KML)

- KML Specifications...
Keyhole Markup Language (KML)

- **KML Samples...**
  [http://code.google.com/apis/kml/documentation/KML_Samples.kml](http://code.google.com/apis/kml/documentation/KML_Samples.kml)
<kml xmlns="http://earth.google.com/kml/2.0">
  <Placemark>
    <name>Simple placemark</name>
    <description>Attached to the ground. Intelligently places itself at the height of the underlying terrain.</description>
    <Point>
      <coordinates>-122.0822035425683, 37.4228990140251, 0</coordinates>
    </Point>
  </Placemark>
</kml>
Keyhole Markup Language (KML)

Content + Map Symbols + View point + ...

```
<name>Placemarks</name>
<open>1</open>
<description>These are just some of the different kinds of placemarks with which you can mark your favorite places</description>
<LookAt>
  <longitude>-122.0839597145766</longitude>
  <latitude>37.4222904525232</latitude>
  <range>500.6566641072245</range>
  <tilt>40.5575073395506</tilt>
  <heading>-148.4122922628044</heading>
  <altitude>0</altitude>
</LookAt>
<Placemark>
  <name>Simple placemark</name>
  <description>Attached to the ground. Intelligently places itself at the height of the underlying terrain.</description>
  <Point>
    <coordinates>-122.0822035425683,37.42228990140251,0</coordinates>
  </Point>
</Placemark>
```
Part I: Theory

1. Publishing Maps on the Web
2. XML-based languages for Geography and Mapping

3. Web Services for Mapping
   - OGC Specifications
     - WMS – Web Map Service
     - WFS – Web Feature Service
Web Services

- Definition...
  - ... any service that is available over the Internet
  - ... uses a standardized XML messaging system
  - ... it isn’t tied to one operating system or programming language

(E. Cerami, 2005)
Web Services

- **HTTP**
  - Internet transfer protocol

- **XML**
  - Communication language

- **Coupling {HTTP + XML}**
  - allows the Internet to act as a communication network between applications
  - ... not just a service for sharing web applications
Web Services

- **Significance...**
  - Interoperability...
    - between applications, which were developed independently

- **Web services standards ...**
  {XML-RCP, UDDI, WSDL, SOAP ...}
  - Independent of ...
    - Programming languages
    - Operating systems
    - Platforms
Web Services for Mapping

- **Web Services...**
  - Provide a standardized method ...
    - of communicating between web-accessible applications
  - This is especially important ...
    - to mapping applications that use the Internet to share data
Web Services for Mapping

- Mapping web services ...
  - use similar approaches and follow some common communication protocols
  - however,
    - they are maintained independent of the web services in general
  - hence,
    - they are different from the general services a web developer may be familiar with
Web Services for Mapping

- All about ...
  - Sharing geo-information through maps
- They fill two roles...
  1. Accessing remote data sources as **consumer**
  2. Serving up or sharing data as a **provider**
Web Services for Mapping

- **Easy to use...**
  - They don’t require to know
    - a bunch of details about how requests are made or sent
  - Accessing a remote server ...
    - Requires some specific knowledge about the data source
      - Data layers, data format
  - **Sharing your own data ...**
    - Requires a few additions to the application so that others can access the data
Web Services for Mapping
OGC Specifications

- Open Geospatial Consortium
  
  [http://opengeospatial.org](http://opengeospatial.org)

  - Develops the specifications
    
    { WMS, WFS, WCS, WMC, SLD, GML }
  
  - Focus on the specifications for sharing data
OGC Specifications

- Requests sent via URL...
  - parameters are included in the URL after a question mark (?), each separated by ampersands (&)
    - eg., “GET” method
    - Example URL:
      http://atlas.gc.ca/cgi-bin/atlaswms_en?
      REQUEST=GetCapabilities

- Response can be ...
  - an XML document (GetCapabilities, GetFeature) or
  - an image (GetMap)
OGC Specifications

- Requests sent via URL...
  - Typical requests ...
    - GetCapabilities
      - What do you offer ?
    - GetMap
      - Give me the map as an image
    - GetFeatures
      - Give me the map features (as objects)
    - GetFeatureInfo
      - Give me the attribute values of a feature
OGC Specifications

- Web Map Service (WMS)
  - provides a way to send map images over the Web
  - GetMap request ...
    - Requesting a map from remote sources that have a WMS available
    - a set of parameters and options must be defined (regarding the map content and look)
OGC Specifications

- **Web Map Service (WMS)**

  ![Web Map Service (WMS)](http://wms.jpl.nasa.gov)

  - This is the home site of the WMS Global Mosaic, a high resolution global image mosaic of the earth, produced from more than 80,000 individual Landsat7 scenes. Each scene requires more than 50MB of storage, or about one standard CD. These images have been collected during 1986-2013. The highest resolution image has a ground pixel resolution of 15 meters, or 0.5 feet. The mosaic contains all nine spectral bands of the Landsat7 ETM+ instrument. Together with the associated Web Map Service Server, the mosaic is known as the WMS Global Mosaic.

  - The base dataset can be downloaded from the Earthdata site. A mirror download site is available at Tableau.

  - WMS The WMS Map Service (WMS) server providing access to the WMS Global Mosaic and other datasets is accessible via this base URL: http://wms.jpl.nasa.gov/wms.cgi. The WMS server capabilities, an XML encapsulated document describing the datasets and the server are can be retrieved via a **Capabilities Request**.
OGC Specifications

- Web Map Service (WMS)
  - GetCapabilities request ...

  http://wms.jpl.nasa.gov/wms.cgi?
  request=GetCapabilities

  - What do you offer ??
OGC Specifications

- Web Map Service (WMS)
  - GetCapabilities request ...

```xml
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<!DOCTYPE WMT_MS_Capabilities [View Source for full doctype... ]>
  <WMT_MS_Capabilities version="1.1.1">
    <Service>
      <Name>OGC:WMS</Name>
      <Title>JPL Global Imagery Service</Title>
      <Abstract>WMS Server maintained by JPL, worldwide satellite imagery.</Abstract>
      <Keywords>
      </Keywords>
      <ContactInformation>
        <Fees>none</Fees>
      </ContactInformation>
      <AccessConstraints>Server is load limited</AccessConstraints>
    </Service>
    <Capability>
      <Request>
        <GetTileService>
          <Format;text/xml</Format>
        </GetTileService>
      </Request>
    </Capability>
  </WMT_MS_Capabilities>
```
OGC Specifications

- Web Map Service (WMS)
  - GetCapabilities request ...
OGC Specifications

- **Web Map Service (WMS)**
  - GetMap request ...

  ```
  http://wms.jpl.nasa.gov/wms.cgi?
  request=GetMap
  &service=WMS
  &version=1.1.1
  &srs=EPSG:4326
  &format=image/jpeg
  &styles=
  &bbox=-180,-90,180,90
  &width=600
  &height=300
  &layers=global_mosaic
  ```
OGC Specifications

- **Web Map Service (WMS)**
  - GetMap request ...

  http://wms.jpl.nasa.gov/wms.cgi?
  request=GetMap
  &service=WMS
  &version=1.1.1
  &srs=EPSG:4326
  &format=image/jpeg
  &styles=
  &bbox=23,37.5,25,38.5
  &width=600
  &height=300
  &layers=global_mosaic
OGC Specifications

- Web Feature Service (WFS)
  - the actual **feature data** is returned to the client (in GML)

- WMS (vs) WFS
  - WMS returns a map image
  - WFS returns geographic features (geometries and thematic data)
OGC Specifications

- Web Feature Service (WFS)
  http://map.ns.ec.gc.ca/envdat/map.aspx
  ?service=WFS
  &version=1.0.0
  &request=GetCapabilities

- What do you offer ????
OGC Specifications

- Web Feature Service (WFS)

```xml
<?xml version="1.0" encoding="ISO-8859-1" ?>
<WFS_Capabilities version="1.0.0" updateSequence="0" xmlns="http://www.opengis.net/wfs"
<Service>
  <Name>MapServer WFS</Name>
  <Title>Newfoundland and Labrador Water Quality Stations</Title>
  <Abstract>ENVIRODAT is a repository of water quality information including chemical, physical, biological, and selected hydrometric data which are stored for surface, groundwater, wastewater, precipitation and various other water types</Abstract>
</Service>

<FeatureType>
  <Name>envirodat</Name>
  <Title>ENVIRODAT - Atlantic Region Water Quality Chemistry Database</Title>
  <SRS>EPSG:4326</SRS>
  <LatLongBoundingBox minx="-64.6622" miny="46.7594" maxx="-52.6808" maxy="55.2333" />
  <MetadataURL type="FGDC" format="TXT">http://geodiscover.cgdi.ca/gdp/search?language=en&action=entrySummary&entryType=productCollection&entryId=14413&entryLang=en</MetadataURL>
</FeatureType>
```
OGC Specifications

- The Web Feature Service (WFS)...
  - GetFeature request

http://localhost/cgi-bin/mapserv.exe?
map=/ms4w/apps/ITE/htdocs/WFS/infocharta.map&
SERVICE=WFS&VERSION=1.0.0&
REQUEST=GetFeature&
typename=odiko_irakliou
OGC Specifications

- The Web Feature Service (WFS)...
  - GetFeature request
Part II: Practice

4. Mapping Servers/Services on the Web
   - ICEDS Server
   - GeoNames Web Service
   - Google Earth’s Technology

5. Spatial Data Infrastructures (SDI)
6. The Heraklion SDI Web Services
ICEDS Server

- ICEDS...
  - Integrated CEOS European Data Server
  - CEOS...
    - Committee on Earth Observing Satellites

- Motivation / Data Sources...
  - CEOS Landsat and SRTM Project (CLASP)
  - NASA has provided to UN ...
    - SRTM (Shuttle Radar Topographer Mapper) and 3 sets of orthorectified Landsat scenes
  - The UN wish...
    - to maximise access to these data to all of its agencies
ICEDS Server

- Web Service...
  - Developed by...
    - University College London – Dept. of Geomatics Eng.
    - ESYS plc
  - Funded by...
    - British National Space Center (BNSC)

- Functionality...
  - On-line access to...
    - a global SRTM Digital Elevation Model
    - Landsat satellite imagery for Africa and Europe
    - Other information layers

http://iceds.ge.ucl.ac.uk/
Welcome to the Integrated CEOS European Data Server (ICEDS)

A demonstration service provided by University College London and ESYS plc, funded by the British National Space Centre, serving global and continental-scale, full-resolution geographic information, particularly for Europe and Africa.

Introduction

ESYS plc and the Department of Geomatic Engineering at University College London (UCL) have been funded by the British National Space Centre (BNSC) to develop a web GIS service to serve global geographic data derived from remote sensing datasets. Funding was provided as part of the BNSC International Co-operation Programme 2 (ICP-2).

Particular aims of the project have been to:

1. use Open Geospatial Consortium (OGC, formerly OpenGIS Consortium) technologies for map and data serving;
2. serve datasets for Europe and Africa, particularly Landsat TM and Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) data;
3. provide a website giving access to the served data;
4. provide software scripts, etc., and a document reporting the data processing and software set-up methods developed during the project.

ICEDS Web GIS service

There are three methods for accessing the ICEDS service:

1. through a Web interface, allowing you to browse the datasets held on ICEDS and served through Web Map Services (WMS, OGC map portrayal service);
ICEDS Server

- RAID Server
  - 1.7TB capacity; dual Athlon MP 2400+ processors; 1 Gb of RAM
- Mandrake Linux 9
- Apache Web Server
  - Tomcat servlet container
- UMN MapServer (ver 4.4.1) (OSGeo)
- Ionic RedSpider web mapping s/w
  - Commercial package
ICEDS Server

- Purely OGC-based services
  - Hence separation of client and server(s)
- ICEDS client ...
  - based on Ionic’s GAF client
  - HTML + Javascript only
- Good browser compatibility...
  - PC & Mac IE, Mozilla/Firefox/Seamonkey, Mac Safari
ICEDS Server

- Typical WMS request

http://iceds.ge.ucl.ac.uk/cgi-bin/icedswms?
VERSION=1.1.1&
REQUEST=GetMap&
SRS=EPSG:4326&
BBOX=-30,35,112.86,65&
WIDTH=600&HEIGHT=420&
LAYERS=LANDSAT5&
FORMAT=image/jpeg&BGCOLOR=0xffffff&
TRANSPARENT=TRUE&
EXCEPTIONS=application/vnd.ogc.se_inimage
Landsat images

Nighttime lights
Natural Hazards (earthquakes, Volcanos, plates)

Clouds (custom/current weather)
ICEDS Server & GE

- Add ICEDS layers to Google Earth

Add > Image Overlay > WMS Layer
Earthquakes, Volcanos and Plate Boundaries
The gazetteer tool
GeoNames Web Service

- Feature Density Map ...
  - bright parts
    - high density areas (lot of features per km²)
  - dark parts
    - regions with no or only few features
The GeoNames database ...

- is available for download free of charge
- It contains ...
  - over 8 million geographical names
  - consists of 6.5 million unique features
    - whereof 2.2 million populated places and
    - 1.8 million alternate names.
- All features are categorized ...
  - into 9 feature classes
  - further subcategorized into 645 feature codes

http://www.geonames.org/
GeoNames Web Service

http://www.geonames.org/
GeoNames Web Service
GeoNames Web Service

The 9 categories
GeoNames Web Service

![GeoNames Web Service Demo](image)

### GeoNames Home | Postal Codes | Download | Webservice | About

<table>
<thead>
<tr>
<th>Name</th>
<th>Country</th>
<th>Feature class</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vouliagmeni</td>
<td>Greece</td>
<td>populated place</td>
<td>N 37° 49' 0&quot;</td>
<td>E 23° 47' 0&quot;</td>
</tr>
<tr>
<td>Ormos Vouliagmeni</td>
<td>Greece</td>
<td>bay</td>
<td>N 37° 48' 0&quot;</td>
<td>E 23° 47' 0&quot;</td>
</tr>
<tr>
<td>Limni Vouliagmeni</td>
<td>Greece</td>
<td>lake</td>
<td>N 38° 2' 0&quot;</td>
<td>E 22° 53' 0&quot;</td>
</tr>
<tr>
<td>Vouliagmeni Milos</td>
<td>Greece</td>
<td>populated place</td>
<td>N 37° 50' 0&quot;</td>
<td>E 21° 36' 0&quot;</td>
</tr>
<tr>
<td>Grecotel Vouliagmeni Suites</td>
<td>Greece</td>
<td>hotel</td>
<td>N 37° 58' 23&quot;</td>
<td>E 23° 47' 36&quot;</td>
</tr>
</tbody>
</table>
GeoNames Web Service
# GeoNames Web Service

![GeoNames Web Service](http://www.geonames.org/postalcodesearch.html?query=Bonn, Germany)

The GeoNames Web Service is a tool for searching and retrieving geographic information. It provides a database of cities, countries, and other geographical features worldwide. This screenshot shows the GeoNames home page with a search for postal codes in Germany. The example search is for Bonn, Germany, which returns various postal codes along with their respective country, Admin1, Admin2, and Admin3 information.

<table>
<thead>
<tr>
<th>Place</th>
<th>Code</th>
<th>Country</th>
<th>Admin1</th>
<th>Admin2</th>
<th>Admin3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bonn</td>
<td>53113</td>
<td>Deutschland</td>
<td>Nordrhein-Westfalen</td>
<td>Köln, Kreisfreie Stadt Bonn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.723/7.107</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bonn</td>
<td>53175</td>
<td>Deutschland</td>
<td>Nordrhein-Westfalen</td>
<td>Köln, Kreisfreie Stadt Bonn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.698/7.142</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bonn</td>
<td>53111</td>
<td>Deutschland</td>
<td>Nordrhein-Westfalen</td>
<td>Köln, Kreisfreie Stadt Bonn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.735/7.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bonn</td>
<td>53115</td>
<td>Deutschland</td>
<td>Nordrhein-Westfalen</td>
<td>Köln, Kreisfreie Stadt Bonn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.727/7.085</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Bonn</td>
<td>53121</td>
<td>Deutschland</td>
<td>Nordrhein-Westfalen</td>
<td>Köln, Kreisfreie Stadt Bonn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.732/7.058</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GeoNames Web Service

http://ws.geonames.org/findNearbyPlaceName?
lat=37.82&lng=23.78
GeoNames Web Service

http://ws.geonames.org/gtopo30?
lat=37.82&lng=23.78

http://ws.geonames.org/timezone?
lat=37.82&lng=23.78
Google Earth's technology

- Explore Google Earth Database...
Google Earth's technology

- Google Earth provides ...
  - images/photographs cover the entire globe
  - taken sometime during the last three years
    - updated on a rolling basis
  - resolution varies from place to place
    - allows the user to see major geographic features and man-made development (towns and major roads)
    - for most of the major cities in US, Canada, Western Europe, and UK the resolution is high
      - 15cm to 1m (details for buildings, cars, humans)
Google Earth's technology

- The coordinate system used ... 
  - the standard **WGS84 datum**
- All images / photographs ... 
  - are geo-referenced to this system
- All terrain data / GIS data ... 
  - also stored and represented in this datum
Google Earth’s Database

- Data provided by Google Earth ...
  - is mainly retrieved from Google Maps and
  - several satellite and aerial datasets
    - including private Keyhole images
    - DTM by NASA’s Shuttle Radar Topography Mission

- Google Maps ...
  - is a Web map server maintained by Google
    - such as Mapquest or Yahoo!Maps
  - provides ...
    - high-resolution satellite imagery and aerial photography
    - International street-level datasets
    - many other map-based services
Google Earth Client

- Google Earth Client ...
  - a 3D visualization of
    - the earth
    - ... and more
  - integrates, organizes and publishes location data on Google Maps
Google Earth Client

http://earth.google.com/
Google SketchUp is software that you can use to create, modify and share 3D models. It's easier to learn than other 3D modeling programs, which is why so many people are already using it.

We designed SketchUp's simplified toolset, guided drawing system and clean look-and-feel to help you concentrate on two things: getting your work done as efficiently as possible, and having fun while you're doing it.

» Learn more about Google SketchUp (Free)
Google Maps API

- Allows Google Maps + user data
  - being integrated into web-based applications
  - viewed by any user, regardless of their client software
Google Maps API

- API ...
  - Application Programming Interface
  - A source code interface that an...
    - operating system,
    - library or
    - service
  ...
  ... provides to support requests made by computer programs
Google Maps API

- Google Maps API
  - created by Google
  - to facilitate developers integrating Google Maps into their web sites with their own data points
  - It is a free service
    - currently does not contain ads,
    - Google reserveS the right to display ads in the future
Google Maps API

- Lets you embed Google Maps ...
  - in web pages
  - with JavaScript
- Provides a number of utilities for
  - manipulating maps
  - adding content to the map
    - through a variety of services
Google Maps API

- **Mapping Mashups...**
  1. the Google Map API along with others
  2. the Web 2.0 technologies
  ... lead to an expansion of the so-called mapping mashups

- **Mashup is...**
  - a website or Web application that
    - uses content from more than one source to create a completely new Web service
Google Maps API

- Mapping Mashups...
Google Maps API

- The full Google Maps ...
  - can be embedded on an external web site
- Start by creating an API Key
  - it will be bound to the web site and directory
- Creating the map interface involves...
  - adding the Google JavaScript code to the web page, and
  - using Javascript functions to add points / objects to the map
Google Maps API
<html>

<script src="http://maps.google.com/maps?file=api&amp;v=2&amp;key=ABQIAAAAAtNxdreQp4EAvf3ECF28WHhSubFl71VHwydoYiEmf3h21QVKzHBT4QGIPZ6akBuhlNZZG6MXdRn3psHw" type="text/javascript"></script>

<script type="text/javascript">

    function load() {
        var map = new GMap(document.getElementById("map"));
        map.centerAndZoom(new GPoint(23.708211, 37.961252), 3);
        map.setMapType(G_MAP_TYPE);

        var point = new GPoint(23.708211, 37.961252);
        var marker = new GMarker(point);
        map.addOverlay(marker);
    }

</script>

<body onload="load()" onunload="GUnload()">

    <h1>HAROKOPIO UNIVERSITY</h1>
    <div id="map" style="width: 450px; height: 350px"></div>

</body>

</html>
Google Earth API

What is the Google Earth API?

The Google Earth Plug-in and its JavaScript API let you embed Google Earth, a true 3D digital globe, into your web pages. Using the API you can draw markers and lines, drape images over the terrain, add 3D models, or load KML files, allowing you to build sophisticated 3D map applications. If you have an existing Maps API site, you can 3D-enable your page with as little as one line of code.

The Google Earth Plugin instance could not be created. Try installing again.

Get the Google Earth Plugin now

3D Google Maps in your browser

Supported browsers currently include Firefox 2.x, IE6, and IE7, all on Windows. Learn more »

Google I/O: May 28-29
Join us for Google’s largest developer event

How do I start?

1. Check out some Google Earth Plug-in examples.
2. Sign up for a Google Maps API key.
3. Read the Google Earth API Developer’s Guide.
4. Review the Google Earth API.

Learn more about the Google Earth API
Google Earth API

What is the Google Earth API?

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Google I/O: May 28-29

Join us for Google’s largest developer event

Featured Video

Learn more about the Google Earth API
<script src="http://www.google.com/jsapi?key=ABQIABAAS5E150zA4PeDTEMLy-sXFfRSsTL4W1gkhMZ0ZK_kHjwHeQuOD4xTdBlxhkZWuzyYTVelkwYHpb17ZQ"></script>
<

googles load("earth", "1");
var ge = null;

function init() {
  google.earth.createInstance("map3d", initCallback, failureCallback);
}

function initCallback(object) {
  ge = object;
  ge.getWindow().setVisibility(true);
  var cam = ge.getView().getAsCamera(ge.HEIGHT_ABSOLUTE);
  cam.setAltitude(12000000);
  ge.getView().setAbstractView(cam);
  ge.getNavigationControl().setVisibility(true);
  document.getElementById('geplugin_version').innerHTML = ge.getPluginVersion();
}

function failureCallback(object) {
}
</script>
Google Earth Plugin / Interactive Samples

Camera control
- Move camera
- Move camera with mouse
- Tilt view

Place marks and geometry
- Create Place mark
- Create Screen Overlay
- Create Screen Overlay Frame
- Create Line String
- Line String style
- Create Polygon

Run code

```javascript
var placemark = ge.createPlacemark('');
placemark.setName('placemark' + counter);
ge.getFeatures().appendChild(placemark);

// Create style map for placemark
var normal = ge.createIcon('');
normal.url = 'http://maps.google.com/mapfiles/kml/paddle/red-circle.png';
var iconNormal = ge.createStyle('');
iconNormal.getIconStyle().setIcon(normal);
var highlight = ge.createIcon('');
highlight.url = 'http://maps.google.com/mapfiles/kml/paddle/red-circle-highlight.png';
```

http://www.google.com/earth/plugin/examples/samples
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.1">
  <Document>
    <name>HOTEL PRESIDENT</name>
    <description><![CDATA[how to reach your hotel from]]></description>
    <NetworkLink>
      <Url>
        <name>HOTEL PRESIDENT</name>
        <href>http://maps.google.com/maps/ms?ie=UTF8&amp;hl=en&amp;om=1&amp;msa=0&amp;msid=115683686283263188475.000001129c50cc7778752&amp;output=kml</href>
      </Url>
    </NetworkLink>
  </Document>
</kml>
Part II: Practice

4. Mapping Servers/Services on the Web

5. Spatial Data Infrastructures (SDI)
   - Architecture
   - Components
   - Initiatives (INSPIRE)

6. The Heraklion SDI Web Services
Spatial Data Infrastructures (SDI)

- SDI’s are frameworks of...
  - policies,
  - institutional arrangements,
  - data,
  - services,
  - technologies, and
  - people

- with a common scope...
  - to promote the **accessibility** and **usability** of
    geospatial content (data and services)
Spatial Data Infrastructures (SDI)

- SDI’s are built at...
  - regional
  - national or
  - international level

- The participating organizations have agreed on the adoption of common...
  - vocabularies,
  - practices,
  - standards,
  - technical specifications and
  - operational components
Spatial Data Infrastructures (SDI)

- SDI is NOT a simple data repository...
- An SDI hosts...
  - geographic content (data and services)
  - sufficient description of this content (metadata)
  - effective methods to discover and evaluate this content (data catalogs)
  - tools to visualize the data (web mapping)
  - services and software tools to support specific application domains
Spatial Data Infrastructures (SDI)

- A three-tier architecture...

1. **Users and Applications** (top layer)
2. **Discovery & retrieval services** (middle layer)
3. **Geospatial data** (bottom layer)
Spatial Data Infrastructures (SDI)

- The development of an SDI ...
  - supported by a set of sophisticated (1) software systems and tools and
  - must be compatible with a series of (2) standards and specifications

...in order to assure the interoperability between repositories with geospatial content
Spatial Data Infrastructures (SDI)

(1) Software Systems & Tools...

- **Commercial GIS packages** ...
  - may support the development of high quality SDIs

- **Open Source** Geospatial software ...
  - is now able to address the needs of geoscientists and professionals (OSGeo)
Spatial Data Infrastructures (SDI)

(2) Geospatial standards/specifications

- the Open Geospatial Consortium (OGC)
- the World Wide Web Consortium (W3C)
- the International Organization for Standardization (ISO)

... have already developed rich standards and specifications to support the interoperability between repositories with geospatial content
Spatial Data Infrastructures (SDI)

- SDI supports ...
  - many users (web clients)
  - many providers (web servers)
Spatial Data Infrastructures (SDI)

- SDI data/metadata/catalog services
Spatial Data Infrastructures (SDI)

“SDI Initiatives”

- any national, regional, and international programs and projects
- “working to improve access to available spatial data, promote its reuse, and ensure that additional investment in spatial information collection and management results in an ever growing, readily available and useable pool of spatial information”
Spatial Data Infrastructures (SDI)

http://www.ec-gis.org/inspire/
Spatial Data Infrastructures (SDI)

- **The need for the INSPIRE initiative**
  - The general situation on spatial information in Europe is one of fragmentation of datasets and sources, gaps in availability, lack of harmonisation between datasets at different geographical scales and duplication of information collection. **These problems make it difficult to identify, access and use data that is available.**

- **The INSPIRE Concept**
  - **INSPIRE is ambitious.** The initiative intends to trigger the creation of a European spatial information infrastructure that delivers to the users integrated spatial information services. **These services should allow the users to identify and access spatial or geographical information from a wide range of sources,** from the local level to the global level, in an inter-operable way for a variety of uses. The target users of INSPIRE include policy-makers, planners and managers at European, national and local level and the citizens and their organisations. Possible services are the visualisation of information layers, overlay of information from different sources, spatial and temporal analysis, etc.
Part II: Practice

4. Mapping Servers/Services on the Web
5. Spatial Data Infrastructures (SDI)

6. The Heraklion SDI Web Services
   - SDI Architecture and Software Systems
   - The WMS, WFS, WCS and KML Servers
   - The Web Client Application
   - The Mashups
   - The Web Catalog Server
The Heraklion SDI

- A regional SDI...
  - has recently been developed for the Heraklion Prefecture in Crete, Greece
  - using merely...
    - Geographic Free and Open Source Software (GeoFOSS)

http://heraklion-sdi.dynalias.net/coastatlas/index-en.html
Heraklion SDI

- This SDI is ...
  - compatible with the geospatial standards and specifications introduced by the Open Geospatial Consortium (OGC), and
  - serves the geospatial content through widely accepted web services (e.g., WMS, WFS, WCS and CSW)

http://heraklion-sdi.dynalias.net/coastatlas/index-en.html
## Heraklion SDI

- **Public Datasets ...**

<table>
<thead>
<tr>
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</tr>
</thead>
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<tr>
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<td>Shapefile</td>
<td>dhm_diamer_irakliou</td>
</tr>
<tr>
<td>Urban Areas (outlines)</td>
<td>Shapefile</td>
<td>bua_irakliou</td>
</tr>
<tr>
<td>Towns and Villages (points)</td>
<td>Shapefile</td>
<td>oikismoi_irakliou</td>
</tr>
<tr>
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<td>odiko_irakliou</td>
</tr>
<tr>
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<td>build_egsa</td>
</tr>
<tr>
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</tr>
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<td>Shapefile</td>
<td>limnes_irakliou</td>
</tr>
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<td>Shapefile</td>
<td>geo_N_Herakleio</td>
</tr>
<tr>
<td>Archaeological spots (points)</td>
<td>Shapefile</td>
<td>archaiologia_N_Herakleio</td>
</tr>
<tr>
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<td>dem</td>
</tr>
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</tr>
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<td>hr_ortho</td>
</tr>
</tbody>
</table>
Architecture & Software Systems

- The architecture...

- Desktop Client: QuantumGIS, GoogleEarth
- Web Client: OpenLayers
- Direct Access
- WMS: PNG, KML
- WFS: GML, SHP
- WCS: GeoTIFF
- CSW: ISO19115/19139
- Map Server: UMN MapServer
- Catalog Server: GeoNetwork
- Geo-Databases: Postgresql/PostGIS
- File System: Vector and Raster Data (shapefiles - satellite images)
Architecture & Software Systems

- The geospatial layers of the SDI are served using ...
  - Services: WMS, WFS, WCS
  - Languages: GML, KML
  - Standards: ISO19115/139

- They are visualized via ...
  - a web application (web client)
  - a desktop GIS / GE (desktop client)
Welcome to the Open Source Geospatial Foundation Website

The Open Source Geospatial Foundation has been created to support and build the highest-quality open source geospatial software. The foundation’s goal is to encourage the use and collaborative development of community-led projects. The website serves as a portal for users and developers to share their ideas and contribute to project development. As the Open Source Geospatial Foundation grows and changes, so will this website. Please check back often and sign up to the mailing lists to monitor developments. To get involved, check out the Getting Started page.

Steve Lime is the lead developer of MapServer, a leading web mapping package. At the FOSS4G 2007 conference, Steve was honored with the Sol Katz GFOSS Award for 2007. Read more...

Tom Krizidis is a participant at OSGeo.org and an employee of Environment Canada. Tom is primarily a user of MapServer (and underlying packages) and mapshader and also supports OSS specifications for open source projects. Read more...

http://www.osgeo.org/
OSGeo...
- The Open Source Geospatial Foundation...
- has been created to support and build the highest-quality open source geospatial software
- The foundation's goal is....
- to encourage the use and collaborative development of community-led projects

http://www.osgeo.org/
Software Systems...

- *QuantumGIS* (http://www.qgis.org) in the role of the Desktop Client.
Software Systems... (cont’)

- *Postgresql/PostGIS* (http://www.postgis.org) in the role of the Spatial Database Server.
Architecture & Software Systems

The architecture...

- Desktop Client
  QuantumGIS, GoogleEarth
- Web Client
  OpenLayers

- Direct Access
- WMS
  PNG, KML
- WFS
  GML, SHP
- WCS
  GeoTIFF
- CSW
  ISO19115/19139

- Map Server
  UMN MapServer
- Catalog Server
  GeoNetwork

- Geo-Databases
  Postgresql/PostGIS
- File System
  Vector and Raster Data
  (shapefiles - satellite images)
Heraklion SDI

The Geo-Databases...

SDI Public Layers

<table>
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<tr>
<td>Towns and Villages (points)</td>
<td>Shapefile</td>
<td>oikismoi iraklion</td>
</tr>
<tr>
<td>Road Network (lines)</td>
<td>Shapefile</td>
<td>odko iraklion</td>
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<td>Orthophoto Map (raster)</td>
<td>GeoTiff</td>
<td>hr_ortho</td>
</tr>
</tbody>
</table>

GeoTiff (Raster) -> File System

Shapefiles (Vector) -> GDAL/OGR

PostgreSQL/PostGIS
Architecture & Software Systems

- The architecture...

- Desktop Client
  - QuantumGIS, GoogleEarth

- Web Client
  - OpenLayers

- Direct Access
- Interfaces
  - WMS PNG,KML
  - WFS GML, SHP
  - WCS GeoTIFF
  - CSW ISO19115/19139

- Map Server
  - UMN MapServer

- Catalog Server
  - GeoNetwork

- Geo-Databases
  - Postgresql/PostGIS

- File System
  - Vector and Raster Data
    (shapefiles - satellite images)
Heraklion SDI

- The middle layer...
  - provides the **Direct Access Interface**
    - to the geospatial content that resides in the spatial database server
  - The Direct Access Interface ...
    - may support effectively...
      - the querying and
      - the analysis
      ... of the geospatial content using SQL statements
Heraklion SDI

- The Direct Access Interface...
  - Example queries...
- **Table of Municipalities: “dhmoi_irakliou” (type: multi_polygon)**

```sql
SELECT gid, NAMF_EN, POP_01, AsText(the_geom)
FROM dhmoi_irakliou;
```

<table>
<thead>
<tr>
<th>gid (identifier)</th>
<th>NAMF_EN (municipality name)</th>
<th>POP_01 (population in 2001)</th>
<th>the_geom (geometry column)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Municipality Of Irakleio</td>
<td>137711</td>
<td>MULTIPOLYGON(...)</td>
</tr>
<tr>
<td>2</td>
<td>Municipality Of Agia Varvara</td>
<td>5310</td>
<td>MULTIPOLYGON(...)</td>
</tr>
<tr>
<td>3</td>
<td>Municipality Of Arkalochori</td>
<td>10897</td>
<td>MULTIPOLYGON(...)</td>
</tr>
<tr>
<td>4</td>
<td>Municipality Of Archanes</td>
<td>4548</td>
<td>MULTIPOLYGON(...)</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

26 rows

- **Table of Cities/Villages: “oikismoi_irakliou” (type: point)**

```sql
SELECT gid, NAMEENG, POP01, AsText(the_geom)
FROM oikismoi_irakliou;
```

<table>
<thead>
<tr>
<th>gid (identifier)</th>
<th>NAMEENG (city/village name)</th>
<th>POP01 (population in 2001)</th>
<th>the_geom (geometry column)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agia Pelagia</td>
<td>553</td>
<td>POINT(592221 3918593)</td>
</tr>
<tr>
<td>2</td>
<td>Paralia Fodele</td>
<td>99</td>
<td>POINT(586237 3917962)</td>
</tr>
<tr>
<td>3</td>
<td>Achlada</td>
<td>119</td>
<td>POINT(589949 3917093)</td>
</tr>
<tr>
<td>4</td>
<td>Fodele</td>
<td>540</td>
<td>POINT(586850 3915575)</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

400 rows

- **Table of Road Network: “odiko_irakliou” (type: multi_linestring)**

```sql
SELECT gid, SPEED, EU_CODE, AsText(the_geom)
FROM odiko_irakliou;
```

<table>
<thead>
<tr>
<th>gid (identifier)</th>
<th>SPEED (speed limit)</th>
<th>EU_CODE (E75 for national roads)</th>
<th>the_geom (geometry column)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>E75</td>
<td>MULTILINESTRING(...)</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>E75</td>
<td>MULTILINESTRING(...)</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>E75</td>
<td>MULTILINESTRING(...)</td>
</tr>
<tr>
<td>4</td>
<td>70</td>
<td>E75</td>
<td>MULTILINESTRING(...)</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

12228 rows
**Query 1: Find how many cities there are per municipality.**

**SQL Statement**

```
SELECT r.NAMF_EN as Municipality,
       count(m.the_geom) as Number
FROM dhmoi_irakliou AS r,
     oikismoi_irakliou AS m
WHERE intersects(r.the_geom, m.the_geom)
GROUP BY r.NAMF_EN
ORDER BY number_of_cities DESC;
```

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipality Of Viannos</td>
<td>46</td>
</tr>
<tr>
<td>Municipality Of Arkalochori</td>
<td>40</td>
</tr>
<tr>
<td>Municipality Of Asterousia</td>
<td>28</td>
</tr>
<tr>
<td>Municipality Of Gortyna</td>
<td>26</td>
</tr>
<tr>
<td>Municipality Of Kasteelli</td>
<td>24</td>
</tr>
</tbody>
</table>

**Query 2: What is the length of roads fully contained within each municipality? Report only the 5 largest.**

**SQL Statement**

```
SELECT m.NAMF_EN as Municipality,
       sum(length(r.the_geom))/1000 as Roads_km
FROM odiko_irakliou AS r,
     dhmoi_irakliou AS m
WHERE r.the_geom && m.the_geom
     AND contains(m.the_geom,r.the_geom)
GROUP BY m.NAMF_EN
ORDER BY roads_km DESC
LIMIT 5;
```

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Roads_km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipality Of Irakleio</td>
<td>595.440</td>
</tr>
<tr>
<td>Municipality Of Gazi</td>
<td>200.706</td>
</tr>
<tr>
<td>Municipality Of Arkalochori</td>
<td>147.853</td>
</tr>
<tr>
<td>Municipality Of Asterousia</td>
<td>146.120</td>
</tr>
<tr>
<td>Municipality Of Viannos</td>
<td>137.159</td>
</tr>
</tbody>
</table>
Query 3: Find the road segments intersected by the municipality of Arkalochori.

**SQL Statement**
```
CREATE TABLE "ark_roads"
  (gid serial PRIMARY KEY,"id" int4);
SELECT AddGeometryColumn('','ark_roads','the_geom','2100','MULTILINESTRING',2);
INSERT INTO ark_roads(id, the_geom)
SELECT r.gid, r.the_geom
FROM odiko_irakliou AS r,
  dhmoi_irakliou AS m
WHERE r.the_geom && m.the_geom
AND intersects(m.the_geom,r.the_geom)
AND m.NAMF_EN =
  'Municipality Of Arkalochori';
```

Query 4: Find the neighbors (with a common border) of the municipality of Arkalochori.

**SQL Statement**
```
CREATE TABLE "ark_neigh"
  (gid serial PRIMARY KEY,"id" int4);
SELECT AddGeometryColumn('','ark_neigh','the_geom','2100','MULTIPOLYGON',2);
INSERT INTO ark_neigh (id, the_geom)
SELECT n.gid, n.the_geom
FROM dhmoi_irakliou as m,
  dhmoi_irakliou as n
WHERE m.NAMF_EN =
  'Municipality Of Arkalochori'
AND Touches(m.the_geom, n.the_geom);
```
Heraklion SDI

- The Web page...

http://heraklion-sdi.dynalias.net/coastatlas/index-en.html
The architecture...

- **Desktop Client**: QuantumGIS, GoogleEarth
- **Web Client**: OpenLayers

**Interfaces**
- **Direct Access**
  - **WMS**: PNG, KML
  - **WFS**: GML, SHP
  - **WCS**: GeoTIFF
  - **CSW**: ISO19115/19139

**Servers**
- **Map Server**: UMN MapServer
- **Catalog Server**: GeoNetwork

**Databases**
- **Geo-Databases**: Postgresql/PostGIS
- **File System**: Vector and Raster Data (shapefiles - satellite images)
Heraklion SDI

- The Web Map Service (WMS)...

Web Map Server (WMS)

Topography [GetCapabilities]

Topography Layers [ALL] [GetMap]
- Prefecture [GetMap]
- Municipalities [GetMap]
- Municipalities Subdivisions [GetMap]
- Road Network [GetMap]
- Urban Areas [GetMap]
- Towns and Villages [GetMap]
- Lakes [GetMap]
- Heraklion City Buildings [GetMap]
- Airport - Sea Port (POI) [GetMap]

Archaeological Spots and Geology [GetCapabilities]

Archaeological Spots and Geology Layers [ALL] [GetMap]
- Prefecture [GetMap]
- Geology [GetMap]
- Archaeological Spots [GetMap]
The architecture...

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- **Interfaces**:
  - Direct Access: PNG, KML
  - WMS: GML, SHP
  - WFS: GeoTIFF
  - WCS: ISO19115/19139
- **Database**: File System (Vector and Raster Data)
Heraklion SDI

- The Web Map Service (WMS)...
  - maps served as images
    - GetCapabilities request

http://localhost/cgi-bin/mapserv.exe?
map=/ms4w/apps/ITE/htdocs/WMS/infocharta.map&
SERVICE=WMS&
REQUEST=GetCapabilities
Heraklion SDI

- The Web Map Service (WMS)...
  - GetMap request
  
  http://localhost/cgi-bin/mapserv.exe?
  
  map=/ms4w/apps/ITE/htdocs/WMS/infocharta.map&
  SERVICE=WMS&VERSION=1.1.1&
  REQUEST=GetMap&
  LAYERS=odiko_irakliou&
  BBOX=553530,3864020,653540,3925230&
  STYLES=&
  SRS=EPSG:2100&
  WIDTH=500&HEIGHT=306&
  FORMAT=image/png
The architecture...
Heraklion SDI

- The Web Map Service (WMS)...
  - QGIS: Connect to the WMS
Heraklion SDI

- The Web Feature Service (WFS)...
Architecture & Software Systems

- The architecture...

---

**Client applications**
- *Desktop Client*
  - QuantumGIS, GoogleEarth
- *Web Client*
  - OpenLayers

**Interfaces**
- *Direct Access*
- *WMS PNG, KML*
- *WFS GML, SHP*
- *WCS GeoTIFF*
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**Servers**
- *Map Server*
  - UMN MapServer
- *Catalog Server*
  - GeoNetwork

**Databases**
- *Geo-Databases*
  - Postgresql/PostGIS
- *File System*
  - Vector and Raster Data (shapefiles - satellite images)
Heraklion SDI

- The Web Feature Service (WFS)...
  - data served in GML
  - GetCapabilities request

http://localhost/cgi-bin/mapserv.exe?
map=/ms4w/apps/ITE/htdocs/WFS/infocharta.map&
SERVICE=WFS&
VERSION=1.0.0&
REQUEST=GetCapabilities
The Web Feature Service (WFS)...

- GetFeature request

http://localhost/cgi-bin/mapproxy.exe?
map=/ms4w/apps/ITE/htdocs/WFS/infocharta.map&
SERVICE=WFS&VERSION=1.0.0&
REQUEST=GetFeature&
typename=odiko_irakliou
Heraklion SDI

- The Web Feature Service (WFS)...
  - GetFeature request
Architecture & Software Systems

- The architecture...

Client applications
  - Desktop Client
    - QuantumGIS, GoogleEarth
  - Web Client
    - OpenLayers

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Heraklion SDI

- The Web Feature Service (WFS)...
- QGIS: Connect to the WFS
Heraklion SDI

- The Web Coverage Service (WCS)
Architecture & Software Systems

- The architecture...

![Diagram showing architecture and software systems](image-url)
Heraklion SDI

- The KML Server...

KML Layers

Heraklion SDI (all layers) in KML (63MB) and in KMZ (13MB)

Topography...

- Prefecture [KML]
- Municipalities [KML]
- Municipalities Subdivisions [KML]
- Road Network [ALL] [KML]
  - EU175 [KML]
  - non EU175 [KML]
- Urban Areas [KML]
- Towns and Villages [KML]
- Lakes [KML]
- Heraklion City Buildings [KML]
- Airport - Seaport [PC] [KML]

Archaeological Spots and Geology

- Prefecture [KML]
- Archaeological Spots [KML]
- Geology [KML]
Heraklion SDI

- The Web Client Application...
Architecture & Software Systems

- The architecture...

Client applications
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  (shapefiles - satellite images)
Heraklion SDI

- The Web Client Application ...
Heraklion SDI

- The Web Map Service (WMS)...
  - GetFeatureInfo request

```javascript
null
```
Heraklion SDI

- Mashups ...
Heraklion SDI

- Mashups ...

Base Map: Google Satellite
Layers: Municipalities, Road Network, Buildings
Heraklion SDI

- Mashups ...

Base Map: Google Map
Layers: Municipalities, Road Network
Heraklion SDI

- Mashups ...

Base Map: Orthophoto Map
Layers: Municipalities, Towns, Road Network
Heraklion SDI

- Mashups ...

Base Map: ICEDS (WMS)
Layers: Geology, Urban areas, Towns, Lakes
Heraklion SDI

- The Catalog Server ...
  - Heraklion SDI accommodates...
    - a wide digital content of **various types and formats**
      - geospatial data layers
      - satellite images
      - web mapping applications and services
Heraklion SDI

- The Catalog Server ...
  - to make this content accessible on the web and assure its usability,
    - appropriate metadata items must be generated
    - a data catalog server is needed
      - to make the metadata items available on the web
      - support the efficient discovery and evaluation of the SDI content
Architecture & Software Systems

- The architecture...

- Desktop Client
  QuantumGIS, GoogleEarth

- Web Client
  OpenLayers

- Direct Access
  WMS PNG,KML
  WFS GML, SHP
  WCS GeoTIFF
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- Map Server
  UMN MapServer
  Catalog Server
  GeoNetwork

- Geo-Databases
  Postgresql/PostGIS

- File System
  Vector and Raster Data
  (shapefiles - satellite images)
Heraklion SDI

- The Catalog Server ...
  - The content items of the SDI ...
    - have been assigned appropriate metadata items in **XML format**
    - according to the specification of a customized **ISO19139 template**
The Catalog Server ...

- ... then a catalog server has been implemented using GeoNetwork OpenSource Server software ver. 2.1
- The configuration adopted utilizes
  - the PostgreSQL in the role of the DBMS server and
  - the Apache Tomcat v5.5 in the role of the Web Server.
Heraklion SDI

- The Catalog Server ...
Heraklion SDI

- The Catalog Server ...
Heraklion SDI

- The Catalog Server...
Heraklion SDI

- The Catalog Server ...

![Image of the Catalog Server interface]
Heraklion SDI

- The Catalog Server...

**HERAKLION ROAD NETWORK (TRANSPORTATION)**

Abstract: This is the Herakiion Prefecture road network.
Keywords: roads, Heraklion, Crete Island, Greece

<table>
<thead>
<tr>
<th>Identification info</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title</strong></td>
<td>Heraklion Road Network (transportation)</td>
</tr>
<tr>
<td><strong>Date</strong></td>
<td>2008-02-29T12:21:00</td>
</tr>
<tr>
<td><strong>Date type</strong></td>
<td>Publication</td>
</tr>
<tr>
<td><strong>Edition</strong></td>
<td>mapDigital</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This is the Herakiion Prefecture road network.</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>This layer is part of the Herakiion Coast Atlas SDI (PEP Crete 2006-08)</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>completed</td>
</tr>
</tbody>
</table>
## The Catalog Server

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of contact</td>
<td></td>
</tr>
<tr>
<td>Individual name</td>
<td>Emmanuel Stefanakis</td>
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Heraklion SDI

The Catalog Server ...

- Extent
  - Geographic bounding box
    - North bound latitude: 35.5
    - West bound longitude: 24.7
    - East bound longitude: 25.6
    - South bound latitude: 34.9

- Supplemental Information

- Distribution info
  - OnLine resource: KML layer of the Heraklion Coastal SDI
  - OnLine resource: WFS layer of the Heraklion Coastal SDI
  - WMS/Interactive Map: WMS layer of the Heraklion Coastal SDI

- Reference system info
  - Code: HGGR67 (EGSA'87)

- Data quality info
  - Hierarchy level: dataset
  - Statement: TBA
Heraklion SDI

- The Catalog Server ...

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Heraklion SDI

The Catalog Server ...
References

References

Web Services for Mapping

Tutorial

Dr. Emmanuel Stefanakis
Assistant Professor
Harokopio University of Athens – Dept. of Geography
estef@hua.gr

Ευχαριστώ! Thank you!