Introduction to WEB-GIS

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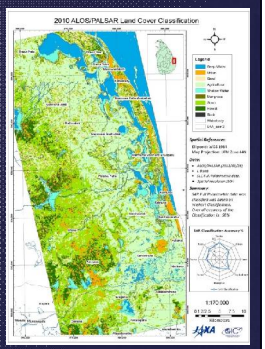
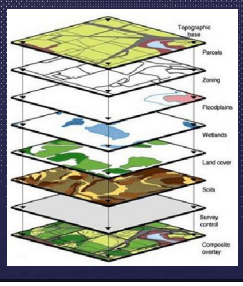
Geographic Information Systems

- "Mapping" is inventory and presentation of spatial data.
- GIS means "Geographical Information System"
  - Its called that because there is information behind the map.





GIS vs CAD

Difference between mapping software or CAD and GIS:

CAD

- Mapping 2D or 3D geospatial data

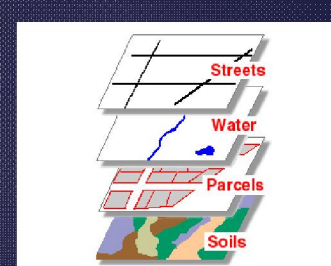
GIS

- Three levels of GIS applications:
  - Inventory (What is there?)
  - Analysis (Answering questions)
    - Shortest distance
  - Modeling (Making predictions)

CAD stands for Computer-Aided Design

A GIS is a software system that connects map layers with tables of information.

Location	None—everyone should pay same	Vary by Family size	Vary by health behaviors	Vary by income	Other	Other: Combination
Orlando	27%	6%	15%	41%	17%	Not mixed
Baton Rouge	6%	5%	27%	44%	8%	Not mixed
Memphis	15%	3%	15%	55%	14%	Not mixed
Charlotte	17%	1%	27%	37%	27%	Not mixed
Jackson	26%	4%	19%	35%	13%	Not mixed
Denver	16%	4%	16%	57%	8%	Not mixed
Los Angeles	20%	4%	11%	51%	13%	Not mixed
Providence	20%	3%	27%	45%	6%	Not mixed
Indianapolis	16%	4%	29%	47%	5%	Not mixed
Detroit	17%	7%	7%	69%	7%	Not mixed
Phoenix	26%	2%	12%	52%	8%	Not mixed
Des Moines	17%	4%	16%	62%	3%	Not mixed
Philadelphia	8%	5%	7%	70%	10%	Not mixed
Billings	12%	7%	29%	44%	8%	Not mixed
Fargo	6%	1%	11%	21%	--	61%
Little Rock	17%	5%	6%	11%	--	67%
Tucson	18%	0%	18%	50%	13%	Not mixed
Sioux Falls	13%	3%	23%	10%	--	52%
Salt Lake City	9%	4%	23%	59%	6%	Not mixed

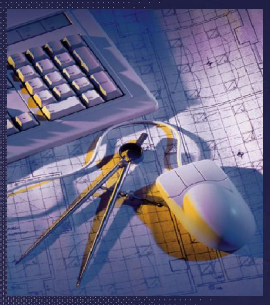


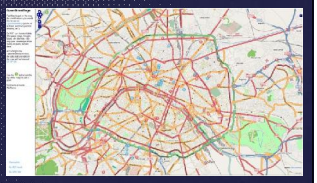
GIS MAP

Image: ESRI course Learning ArcGIS Desktop 2007

Importance of Geographic Data

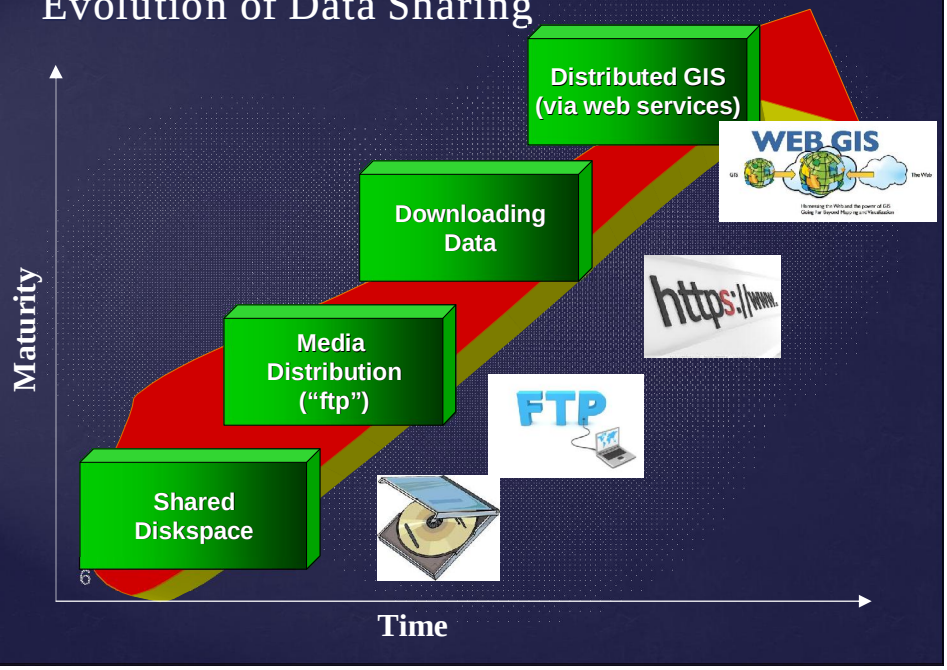
- GIS is different than most applications
- Word processing, Spreadsheets… are entirely dependent on input of YOUR data
- GIS users nearly always require reference map data (e.g., streets, boundaries) that are maintained by others
- As GIS users, we rely heavily on "external" data sources





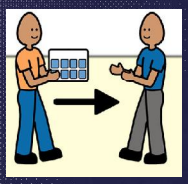
Data has to be shared

Evolution of Data Sharing



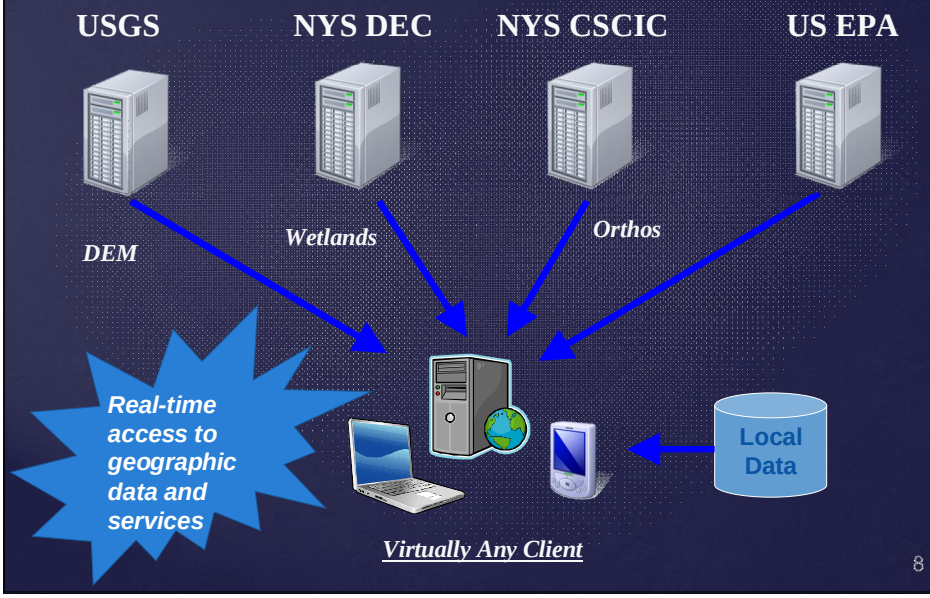
Issues with typical/traditional Data Sharing Methods

- **Getting all the data**
- **Vintage**
- **Format**
- **Coordinate System/Projection**
- **Media Compatibility**
- **File Size**
- **Bandwidth**
- **Metadata Distribution**



Typically requires data manipulation prior to use (reformatting, reprojecting, clipping, etc.)

Distributed GIS Model



Mashup

- An application that combines data from multiple sources
- Referred to as “content aggregation”
- Combines similar types of data (e.g., maps,) from different systems/services
- Term originated from music industry when a new song was made from several existing tracks

Distributed GIS Advantages

- **Format is irrelevant**
- **Guarantees latest data**
- **No media involved**
- **Size is irrelevant (only requested data needed)**
- **Software independent**

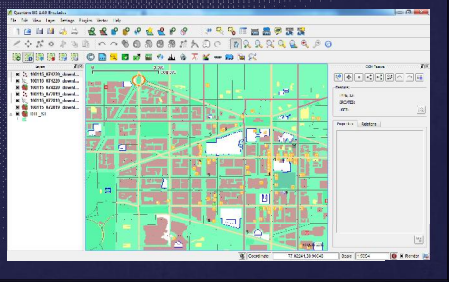
Distributed GIS Advantages

- **Device independent (PC, phone)**
- **Saves Time!**
- **Data security**
  - **Only view data**
  - **Download data**
  - **Data upload and editing**

Distributed GIS Advantages

- Desktop software's also support WMS
  - QGIS
  - ArcGIS

  - Advantages
    - Carryout advance GIS operations on the data.
    - Use as source data for GIS analysis.
    - Easy to search and access data.



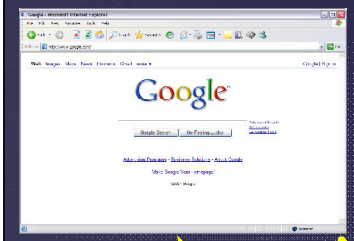
Distributed GIS Disadvantages

- **Dependent on server availability**
- **Dependent on internet availability**
- **Users need to be aware of web service**

Service Oriented Architecture

- Architecture that is based on integrating "loosely coupled", interoperable services
- Loosely coupled means NOT physically bound or compiled like an EXE or DLL
- These services can be invoked and consumed remotely over a network
- Data and messages are exchanged between clients and services

Basic Web Page Operation



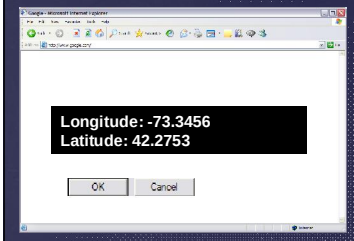
Web Server
(Listening for requests)

Request

Response
(HTML document)

Web Service Operation

Client



Web Server
(Listening for requests)

1. Creates XML Request

2. Request sent to web service

3. Receives request and parses XML

4. Calls the function

5. Creates response XML with results

6. Response sent to client

7. Receives response and parses

Types of Geospatial Web Services

- Map/Data Oriented Services
  - Map Services (Image)
  - Feature Services (Vector)
  - Coverage Services (Grid)
- Task Oriented Services
  - Routing Services
  - Geoprocessing Services

Map Services

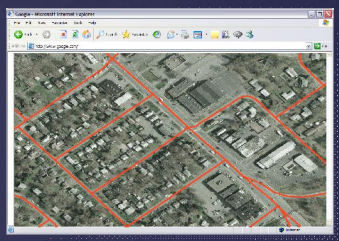
- Client requests a map from a server for a specified geographic extent
- Map Server renders the requested map internally and converts to an image file (e.g., JPG, PNG, GIF) and returns the map image to the client for display
- Fast map display is possible.

99% of current activity's in Web GIS Map/Image Serving

"Google Map" made way for WebGIS popularity

Map Service Operation

Client



Web Server/Map Server

1. Creates XML Request

2. Request sent to web service

3. Receives request and parses XML

4. Calls the map server to request map

5. Map Server generates map as image file

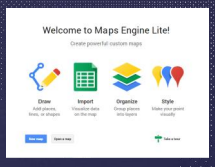
6. Creates response XML with image file

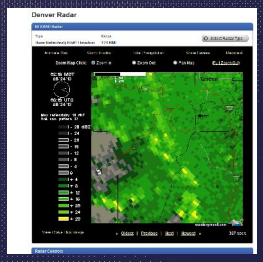
7. Response sent to client

8. Receives response, parses to extract image and updates map

Sample site

- http://www.wunderground.com/radar/map.asp
- http://maps.eyesontheforest.or.id/
- https://mapsengine.google.com/map





Need for standardization

- Every one was creating own standards
  - Google maps
  - Bing Maps
  - USGS
- Make universal data sharing possible.
- Overcome technical chalengers.
- Make way for rapid development in WebGIS.

OGC and Open Web Mapping

- The Open Geospatial Consortium (OGC) was founded in 1994
- An international consortium of 346 organizations that lead the development of open standards and specifications to enable the interoperability of geospatial and location based services
- They have developed a series of open standards for geospatial web services such as:
  - Geography Markup Language (GML)
  - Web Mapping Services (WMS)
  - Web Feature Services (WFS)
  - Web Coverage Services (WCS)
- Referrred to as “OpenGIS®” standards

OGC®
Open Geospatial Consortium, Inc.
"Making location count"

OGC Web Services (OWS)

- Web Map Service (WMS)
  - Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc) that can be displayed in a browser application.
- Web Feature Service (WFS)
  - The WFS operations support INSERT, UPDATE, DELETE, LOCK, QUERY and DISCOVERY operations on geographic features using HTTP as the distributed computing platform. It is the function of a web feature service, in its interaction with the data storage system used to persistently store features, to ensure that changes to data are consistent.
- Web Coverage Service (WCS)
  - The OpenGIS® Web Coverage Service Interface Standard (WCS) defines a standard interface and operations that enables interoperable access to geospatial "coverages" [http://www.opengeospatial.org/ogc/glossary/c]. The term "grid coverages" typically refers to content such as satellite images, digital aerial photos, digital elevation data, and other phenomena represented by values at each measurement point.

Web Mapping Services (WMS)

- WMS is the OGC specification for implementing a map (image) service
- Does not allow for cached map services
- WMS provides 3 functions for clients to access functionality
- Two functions are mandatory to be implemented, the third function is optional
- This results in two general “types” of WMS Services
  - Basic
  - Queryable

Web Mapping Services (WMS)

Basic WMS Service

Every WMS service MUST support the following two functions:

- GetCapabilities – Describes the capabilities and available layers
- GetMap – Generates a map image based on input parameters

Queryable WMS Service

The following function is optional for WMS services:

- GetFeatureInfo – Gets the attributes for a specified feature

http://www.opengeospatial.org/standards/wms

What can be done with a WMS service?

- Each client application (e.g., ArcView, MapInfo, Google Earth, etc.) handles WMS services differently
- However, generally the following functions are available:
  - Map Display and navigation
  - Zoom to layer
  - Layer Control
  - Identify feature (only with Queryable Map services)
- Anything else is not available
  - No feature selection
  - No geoprocessing
  - No attribute table/browser display
  - Menus/Buttons are greyed out and disabled

Open WEB-GIS components

Map Servers

http://mapserver.org/

Rendering spatial data (maps, images, and vector data) for the web

- Minnesota MapServer
- GeoServer

http://geoserver.org

Map Viewer

It provides a data model and web based interfaces for displaying, navigating and querying OGC compliant map services

- Mapbender
- OpenLayers

*www.**mapbender**.org/*

***openlayers**.org/*

WebGIS using open source tools

Example: The following WebGIS application was developed using GeoServer & OpenLayers

Open Web GIS solutions

GeoNode

- GeoNode is a web-based application and platform for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI).

geonode.org/

GeoNetwork opensource

- GeoNetwork is a catalog application to manage spatially referenced resources. It provides powerful metadata editing and search functions as well as an embedded interactive web map viewer. It is currently used in numerous Spatial Data Infrastructure initiatives across the world.

http://geonetwork-opensource.org/

Core components

- Upload Vector & Raster data
- Metadata support.
- Create Maps
- Print maps as pdf

- Up- and downloading data, graphics, documents, pdf files
- Online editing of metadata
- Scheduled harvesting and synchronization of metadata
- Support for OGC-CSW 2.0.2 ISO Profile, OAI-PMH, Z39.50 protocols.

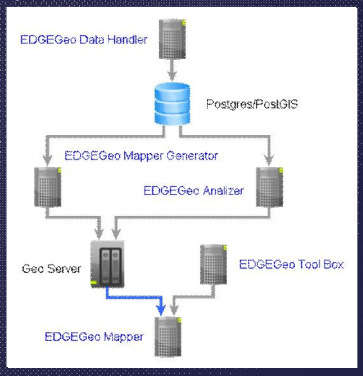
Web Server

Map Viewer

GeoEDGE

Compilation of Free Open source Web GIS resources Powerful tool that support

- Map services
- GIS spatial operations
- Map display
- Advance Spatial analysis
- Automatic Geocoding
- Geo reference map views
- Interactive multi user digitizing



Web Processing Services

Web Processing Service

- The OpenGIS® Web Processing Service (WPS) Interface Standard provides rules for standardizing how inputs and outputs (requests and responses) for geospatial processing services, such as polygon overlay.
- The standard also defines how a client can request the execution of a process, and how the output from the process is handled. It defines an interface that facilitates the publishing of geospatial processes and clients' discovery of and binding to those processes. The data required by the WPS can be delivered across a network or they can be available at the server.

WPS

Advantages

- GIS Operation online
- No need of GIS applications
- Easy to use
- No need of GIS knowledge
- Can be done on any device (mobile / pc)

Disadvantages

- Need powerful server

Thank You