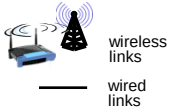
Introduction to Internet technology

What's the Internet: "nuts and bolts" view

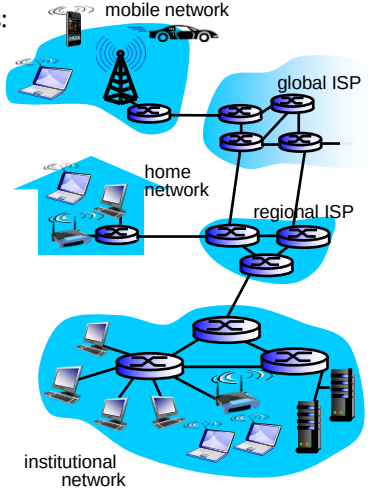
millions of connected computing devices:

- *hosts = end systems*
- running *network apps*



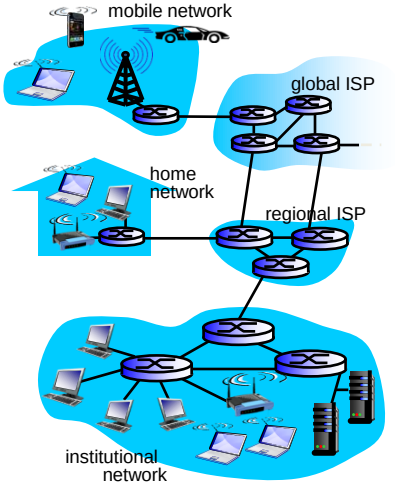
- *Communication links*
  - fiber, copper, radio, satellite
  - transmission rate: *bandwidth*

- *Packet switches:* forward packets (chunks of data)
  - *routers* and *switches*



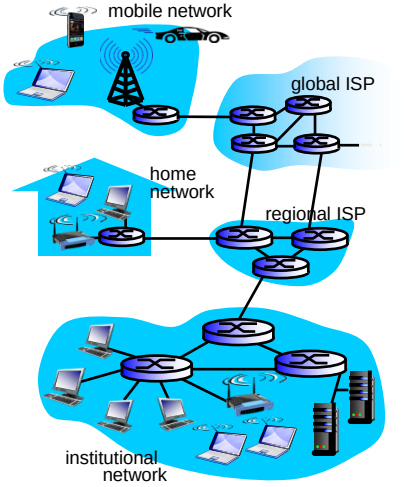
What's the Internet: "nuts and bolts" view

- *Internet:* "network of networks"
  - Interconnected ISPs
- *protocols* control sending, receiving of msgs
  - e.g., TCP, IP, HTTP, Skype, 802.11
- *Internet standards*
  - RFC: Request for comments
  - IETF: Internet Engineering Task Force



What's the Internet: a service view

- *Infrastructure that provides services to applications:*
  - Web, VoIP, email, games, e-commerce, social nets, …
- *provides programming interface to apps*
  - hooks that allow sending and receiving app programs to "connect" to Internet
  - provides service options, analogous to postal service



What's a protocol?

human protocols:

- "what's the time?"
- "I have a question"
- introductions

… specific msgs sent

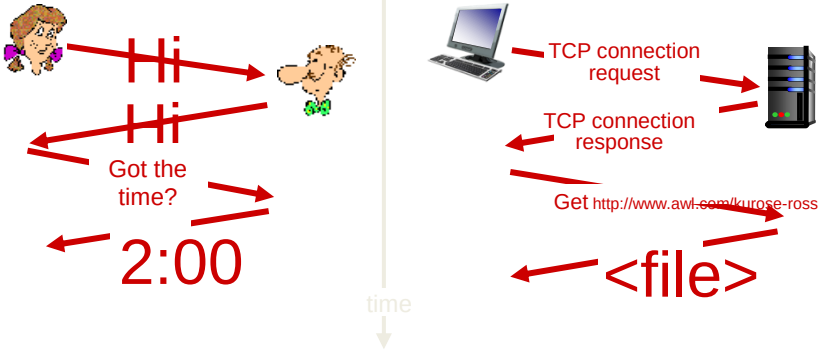
… specific actions taken when msgs received, or other events

network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

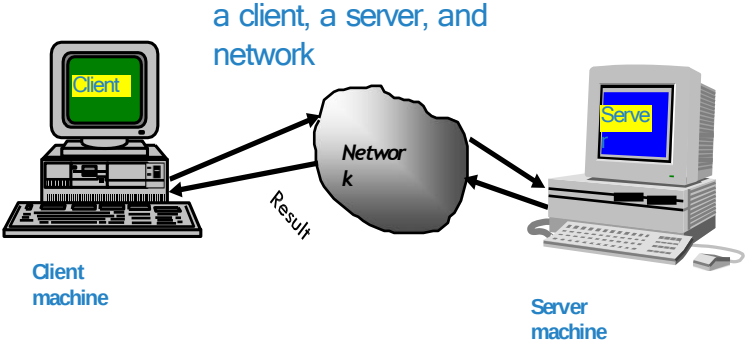
a human protocol and a computer network protocol:



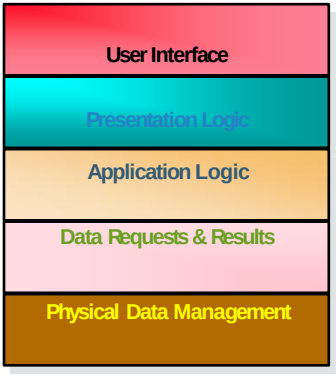
Client-Server System

A simple definition of CS is

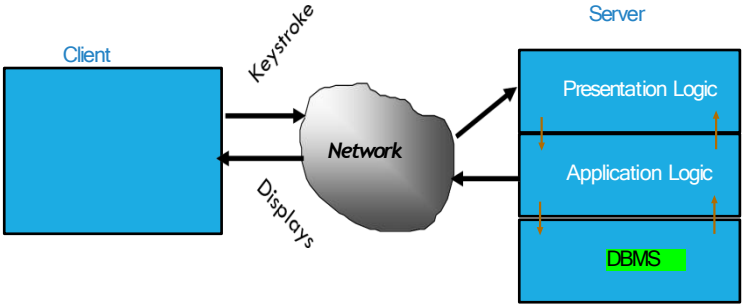
" server software accepts requests for data from client software and returns the results to the client"



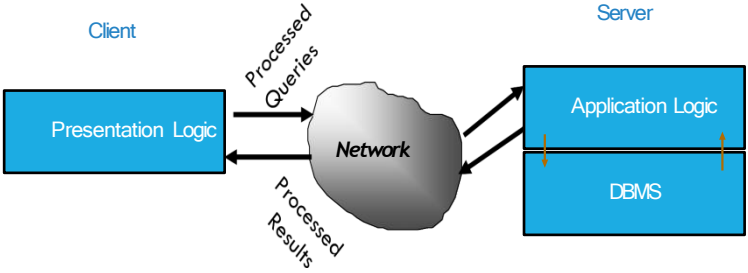
Application Tasks



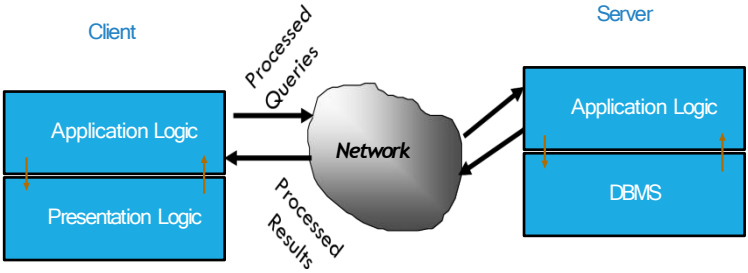
Client (dumb) – Server Model



True Client-Server Model



Distributed Client-Server Model



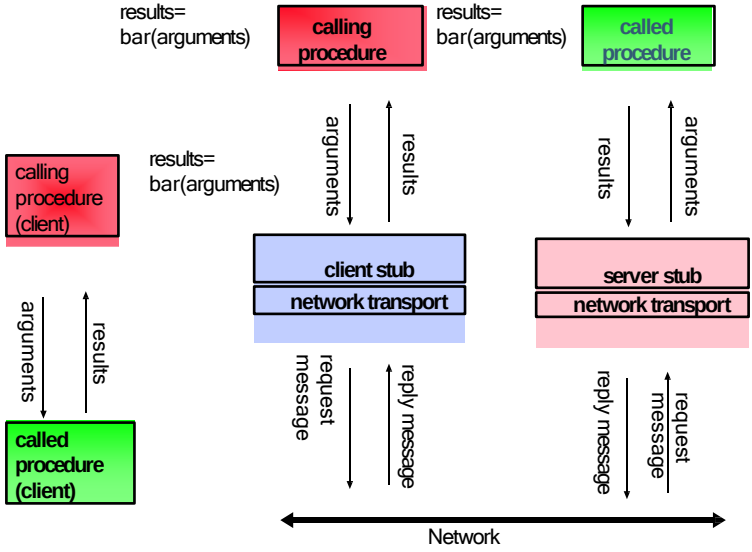
CHARACTERISTICS OF A CLIENT

- ✓ Arbitrary application program
- ✓ Can also perform other computations
- ✓ Invoked directly by user
- ✓ Runs locally on user's computer
- ✓ Actively initiates contact with a server

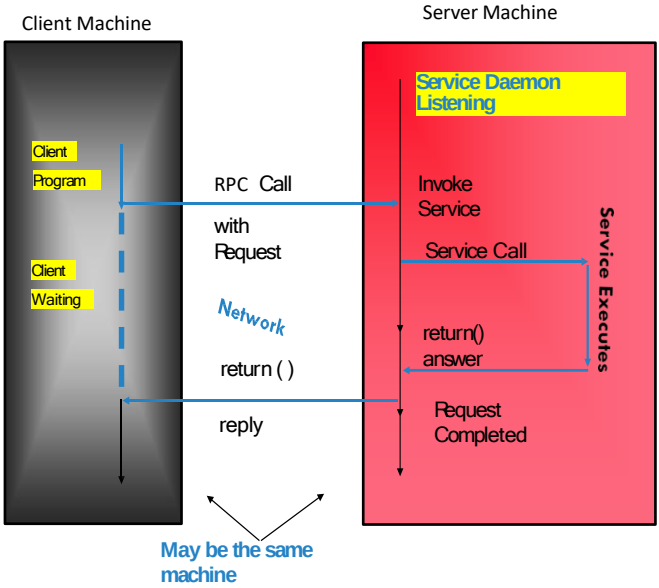
CHARACTERISTICS OF A SERVER

- ✓ Special-purpose, privileged program
- ✓ Dedicated to providing one service
- ✓ Can handle multiple remote clients simultaneously
- ✓ Invoked automatically when system boots
- ✓ Executes forever
- ✓ Needs powerful computer and operating system
- ✓ Waits passively for client contact
- ✓ Accepts requests from arbitrary clients

RPC Look and Feel like Local Calls

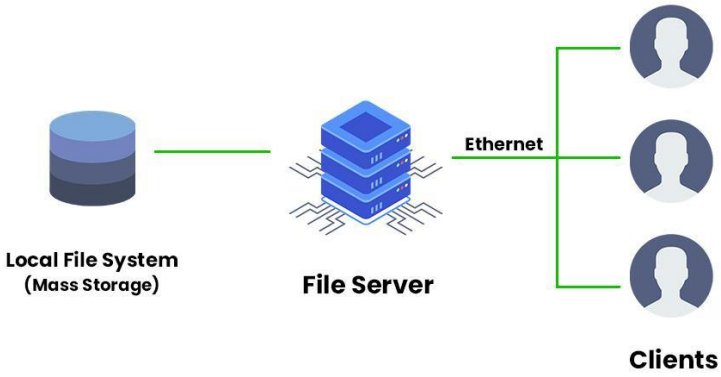


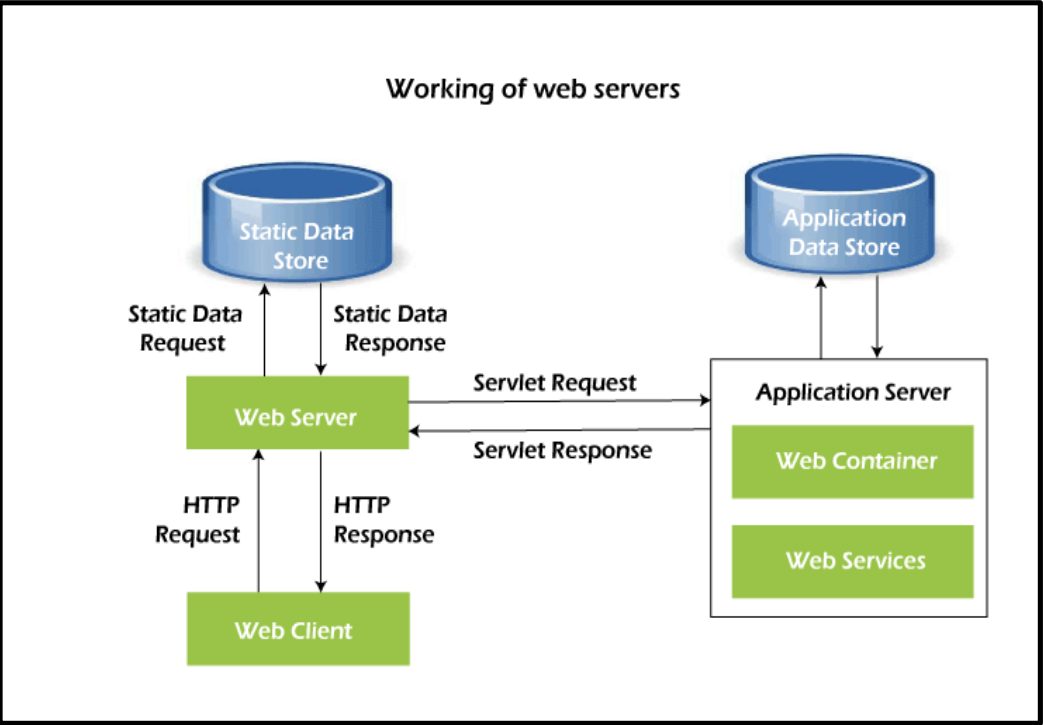
Flow Control in a Sychronous RPC

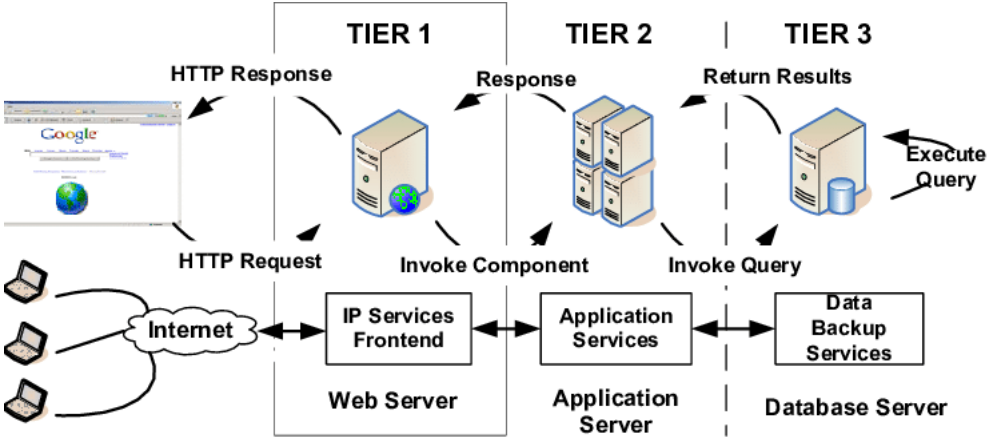


CATEGORIES OF SERVERS

FILE SERVER

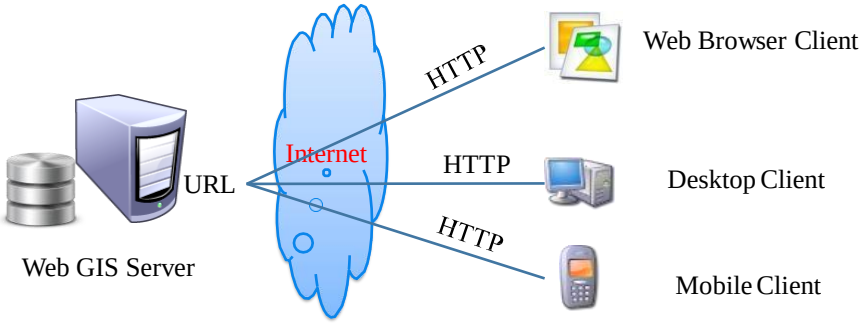

Ethernet
Local File System
(Mass Storage)
File Server
Clients


Working of web servers
Static Data Store
Application Data Store
Static Data Request
Static Data Response
Servlet Request
Servlet Response
Web Server
Application Server
Web Container
Web Services
HTTP Request
HTTP Response
Web Client


TIER 1
TIER 2
TIER 3
HTTP Response
Response
Return Results
Execute Query
HTTP Request
Invoke Component
Invoke Query
Internet
IP Services Frontend
Application Services
Data Backup Services
Web Server
Application Server
Database Server

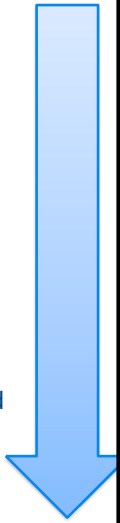
What is Web GIS

Web GIS is a type of distributed information system. The simplest form of Web GIS should have at least a server and a client, where the server is a Web application server, and the client is a Web browser, a desktop application, or a mobile application. [ESRI,2011]



Web GIS functions

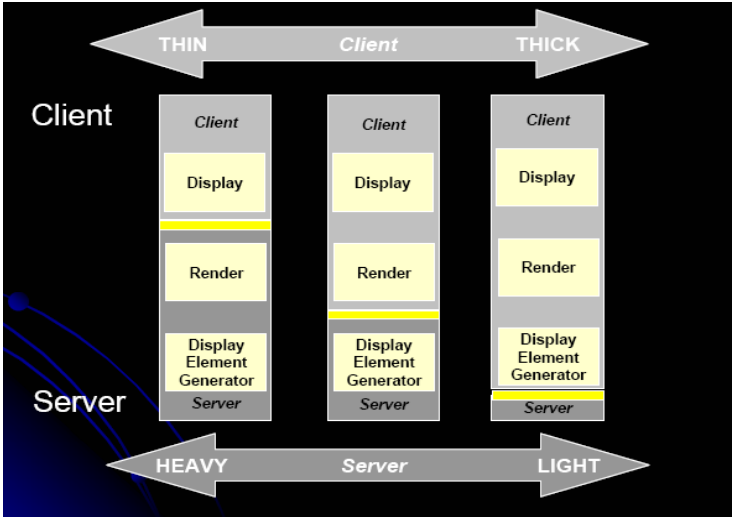
- Web Mapping (Visualization)
  - It is a common and important functions of Web GIS.
- Query
  - Asks for information about features display in the map.
  - Point-based queries on map data is a common task.
- Collecting/Editing geospatial information
  - Allow down-to-top information flow
  - Crowdsourcing – up-to-date information
- Dissemination of geospatial information
  - Wide distribution of information
  - Seamless : No need to know servers, Dynamic Link to Server, No Need to Copy Huge Dataset
- Analysis
  - Provide analytical funcations



Advantage of Web GIS over desktop GIS

- Global accessible
  - Web remove the constraint of distance
- A large number of user
  - Desktop GIS is used by only one users at a time, while Web GIS can be used by dozens or hundreds of user simultaneously.
  - Proven collaboration environment
- Better cross-platform capability
- Low cost as averaged by the number of users
  - Investment on server-side to support many users
- Makes spatial data accessible to non-technical people
  - User expect Web GIS as easy as using a regular web site
- Unified Update
  - Simplifies software and application code versioning and upgrades
- Diverse application
  - Broad user needs drive the innovative applications

Fundamental Architectures



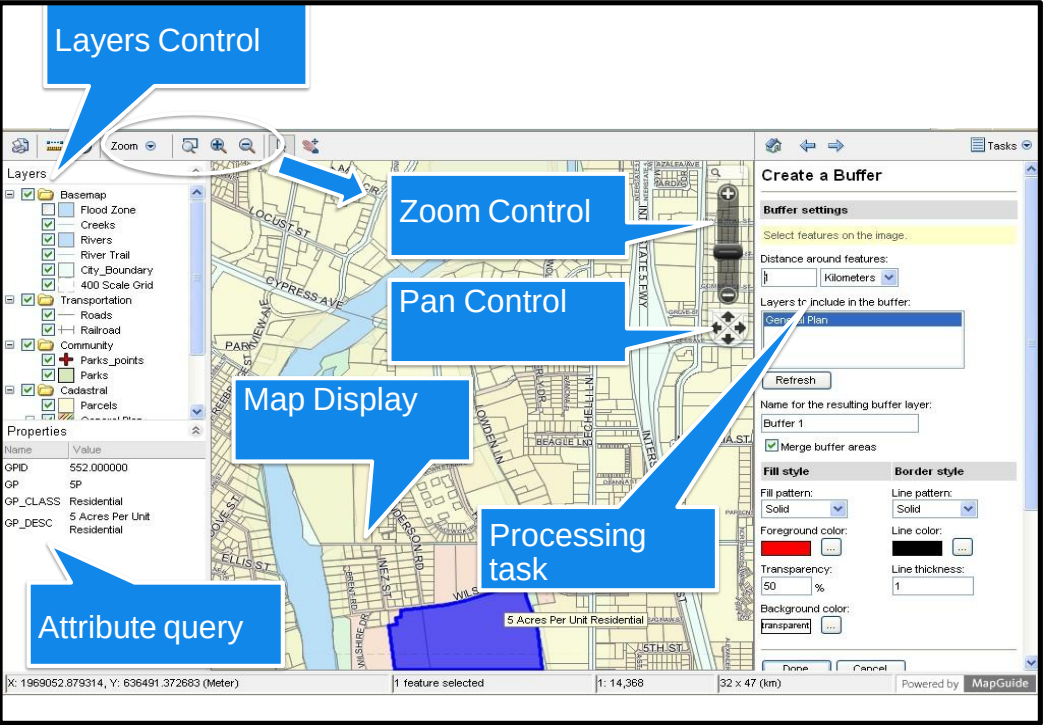
Mapping Applications

A mapping application is a web component/page (HTML, PHP, JavaScript etc.) that handles requests/responses to and from the mapping server.

Typical functionality includes handling navigation panning/zooming, layer management, attribute queries and advanced processing tasks (buffer, distance calculations, etc).

Mapping applications

On Web Server		Access via Web Browser Client
On Local machine		Desktop Application Client


Layers Control
Zoom Control
Pan Control
Map Display
Processing task
Attribute query
Zoom
Tasks
Layers
Basemap
Flood Zone
Creeks
Rivers
River Trail
City_Boundary
400 Scale Grid
Transportation
Roads
Railroad
Community
Parks_points
Parks
Cadastral
Parcels
Properties
Name
Value
GPID
552.000000
GP
5P
GP_CLASS
Residential
GP_DESC
5 Acres Per Unit Residential
Create a Buffer
Buffer settings
Select features on the image.
Distance around features:
1
Kilometers
Layers to include in the buffer:
General Plan
Refresh
Name for the resulting buffer layer:
Buffer 1
Merge buffer areas
Fill style
Border style
Fill pattern:
Solid
Line pattern:
Solid
Foreground color:
Line color:
Transparency:
50
%
Line thickness:
1
Background color:
Transparent
Done
Cancel
5 Acres Per Unit Residential
X: 1969052.879314, Y: 636491.372683 (Meter)
1 feature selected
1: 14,368
32 x 47 (km)
Powered by MapGuide

Extensible Mapping Applications:

Thousand lines of code are written to perform a fruitful Mapping applications. Extensible Mapping Application tools helps developer to easily perform a common task (layer control, zoom-to-extent, query etc.) and allow them to customize the functionalities as well.

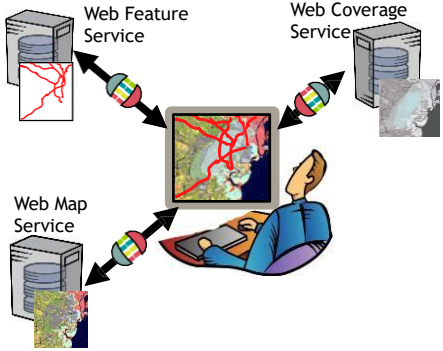
- ESRI WebADF/JavaScript API
- Google Maps API /ArcGIS JS Extension
- Google Earth API
- Bing Maps API /ArcGIS JS Extension
- Bing Maps Silverlight API (Microsoft)
- Flex (Adobe) / ArcGIS Extension
- Yahoo Maps API
- OpenLayers API
- ArcGIS for iPhone API

File-based Data Sharing

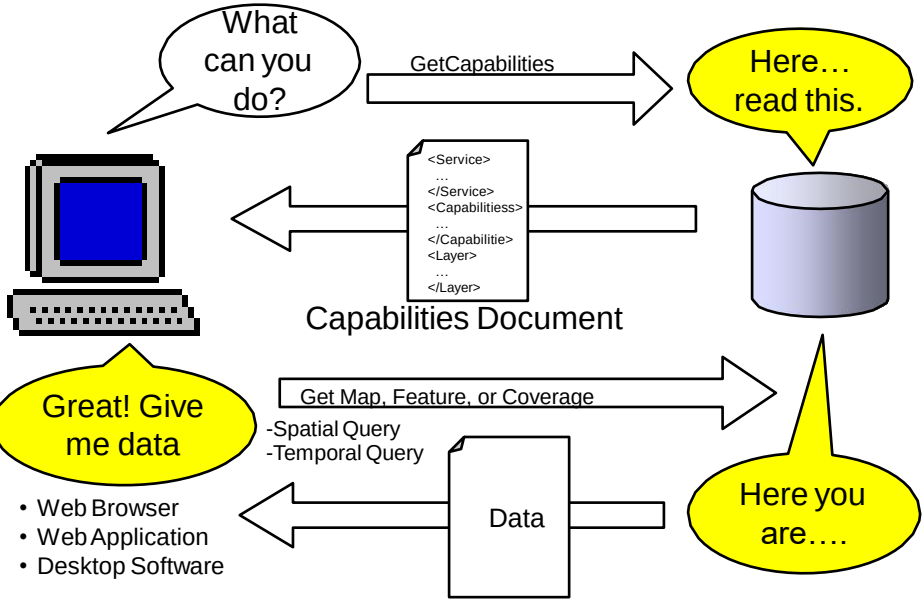
- Consider about “Time-critical applications” scenario
  - Download the data
- Results
  - Slow and High Cost
  - Data are not up-to-date
  - Redundancy
  - Ownership, License

OGC Web Services (OWS)

- OGC Web Services (OWS) specification
  - Exchange geospatial data and functionalities as web service
  - Rich query interface
  - Self Described
  - On-demand
  - Interoperability
  - Reusability
  - Scalability



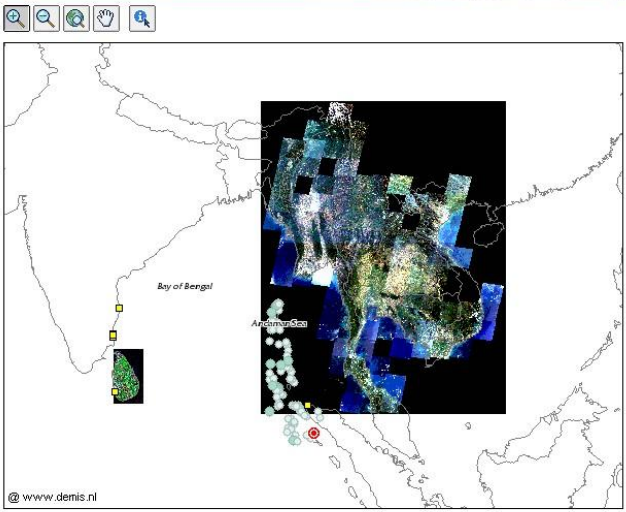
OGC Web Services ("W*S") Pattern



Tsunami Disaster Mapping for Indian Ocean Coastal Regions

DM Solutions Group

M9.0
2004/12/26 00:58:53 UTC



0 370 740 1110 1480 1850 km

Select a Map... Select a Country...

Legend | Disaster Info | Viewer Help

Map Legend

Disaster Info

- [x] **Earthquake Epicenter** [info]
  - 9.0, 2004/12/26 00:58:53 UTC
- [x] **Recent Earthquakes** [info]
  - 5.0 - 6.0
  - 6.0 - 7.0
  - 7.0 - 8.0
  - >8.0
- [ ] **Fault Lines** [info]
- [x] **Points of Interest** [info]

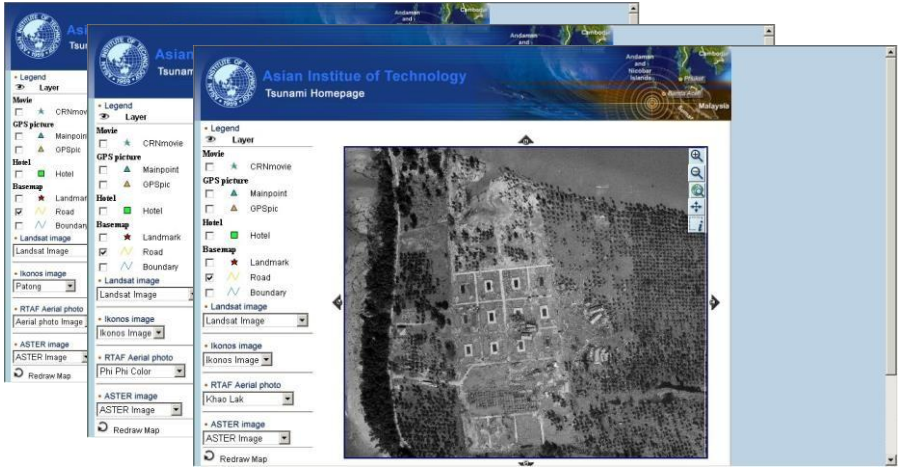
Click then a point on the map for more information

Political

- [ ] **World Cities** [info]
- [x] **World Oceans Labels** [info]
- [x] **Political Borders** [info]
- [x] **Coastlines** [info]
- [ ] **Political Land Mass** [info]

Redraw Map

WMS : Indian Ocean Tsunami 2004



Source: GISTDA&RTAF

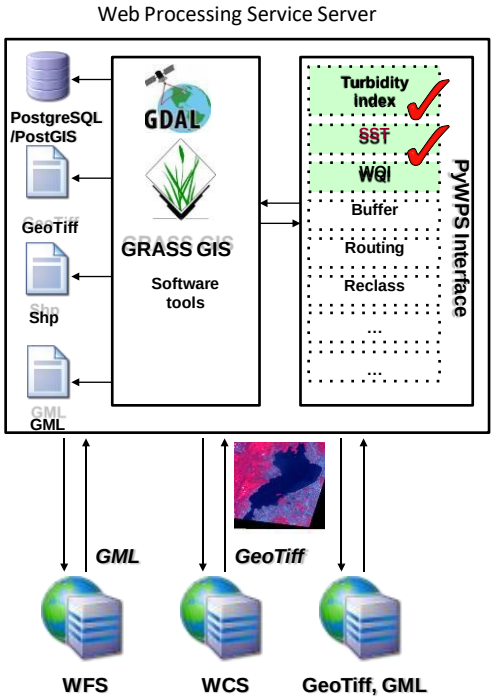
Sensor Web Enablement (SWE)

- Different real-time acquisition system
  - Different makers , Different architecture
  - No standards
- Sensor Observation Service (SOS)
  - Accessing observation from various type sensor system in a common manner
  - Compliance testing of standard web service with heterogeneous system

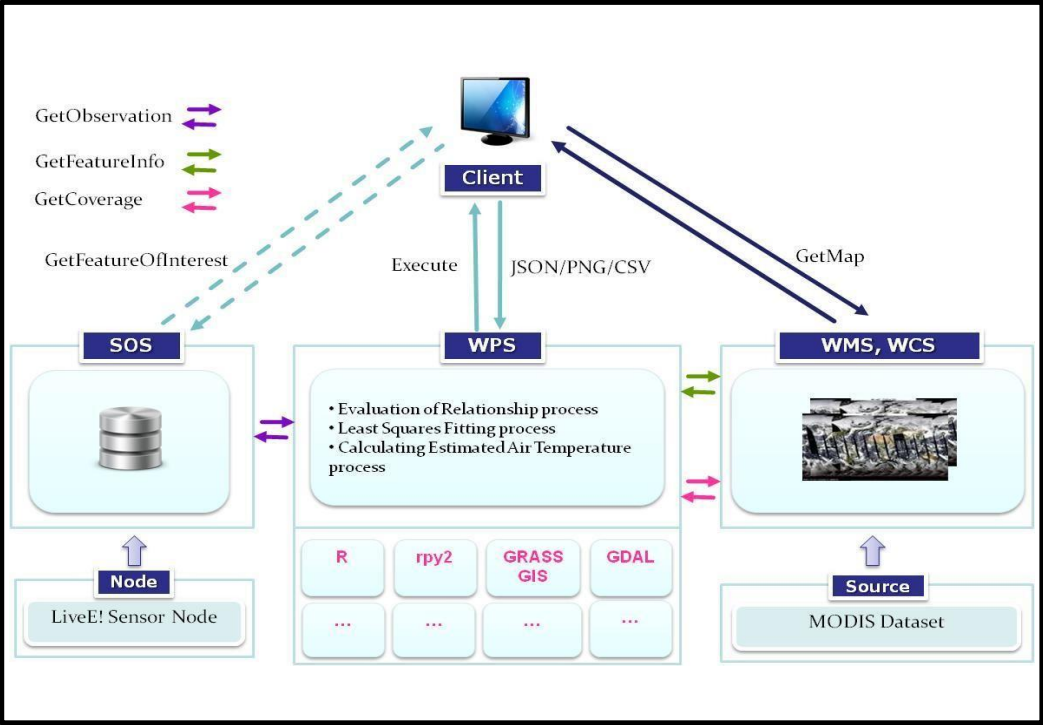
Web Processing Service (WPS)

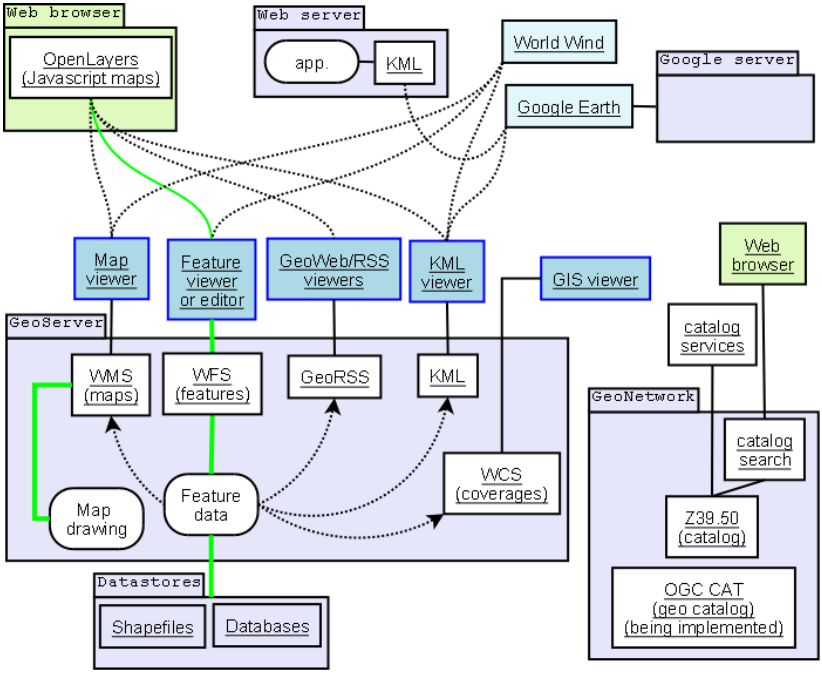
- **Web Processing Service** (WPS)
  - OGC launches a specification as Version 1.0.0
  - Provides client access to **pre-programmed calculations** and/or **computation models** that operate on spatially referenced data
  - The result of request process are available to download for further analysis at user's machine.

- GetCapabilities, DescribeProcess, Execute



- Turbidity index and Sea Surface Temperature calculation
- **satellite image** from Web Coverage Service


GetObservation
GetFeatureInfo
GetCoverage
GetFeatureOfInterest
Client
Execute
JSON/PNG/CSV
GetMap
SOS
WPS
WMS, WCS
• Evaluation of Relationship process
• Least Squares Fitting process
• Calculating Estimated Air Temperature process
R
rpy2
GRASS GIS
GDAL
...
...
...
...
Node
LiveE! Sensor Node
Source
MODIS Dataset


Web browser
OpenLayers (Javascript maps)
Web server
app.
KML
World Wind
Google Earth
Google server
Map viewer
Feature viewer or editor
GeoWeb/RSS viewers
KML viewer
GIS viewer
Web browser
GeoServer
WMS (maps)
WFS (features)
GeoRSS
KML
catalog services
GeoNetwork
catalog search
Map drawing
Feature data
WCS (coverages)
Z39.50 (catalog)
Datastores
Shapefiles
Databases
OGC CAT (geo catalog) (being implemented)