


Geodatabase and Web-GIS as decision support system for precision agriculture: Theory and Application

=Part II Web GIS Technology=

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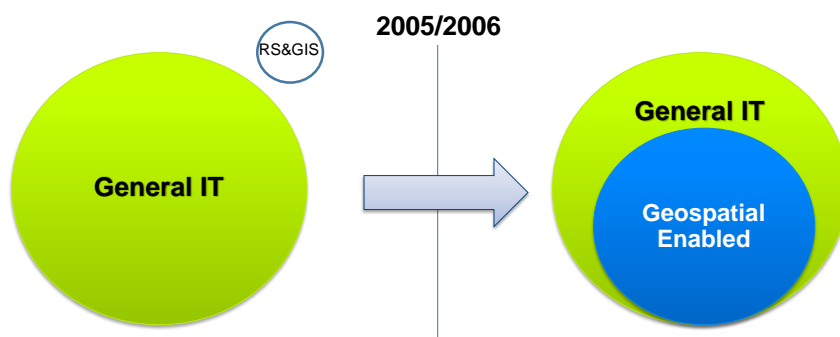
Background

- Geoinformatics
 - The art, science or technology dealing with the acquisition, storage, processing production, presentation and dissemination of geo-information
- Branch of Geoinformatics
 - Cartography, Geodesy, GIS, GPS, RS, Photogrammetry etc
- Technology
 - Database Management System, Grid or Cloud Computing, GPU computing, Networking, WWW, Web Services etc.
 - LBS (Location Based Services), Car Navigation, 3D GIS, Augmented Reality (AR) world, Web Mapping etc.

Background (2)

- It has been used as a powerful tools for decision makers such as Environmental monitoring, urban planning, Disaster prevention and business purpose.
- The potential of Geoinformatics has not been fully realized in the sense that data accessibility, integrity and collaborating with other departments.
- Internet make it “open“ for accessing
 - Only usual Web browser, user can access data from anywhere
- Establishing a scheme to share and integrate geo-spatial information.
 - Contribute for the use of Geoinformatics in the society

Geospatially-Enabled IT



- Public Accessing and Collaborating with other departments
- Fully utilization of geospatial data

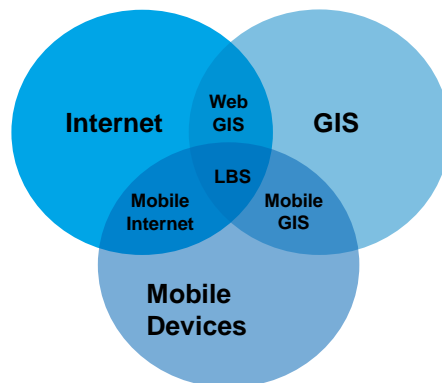
Why Mapping on the Internet?

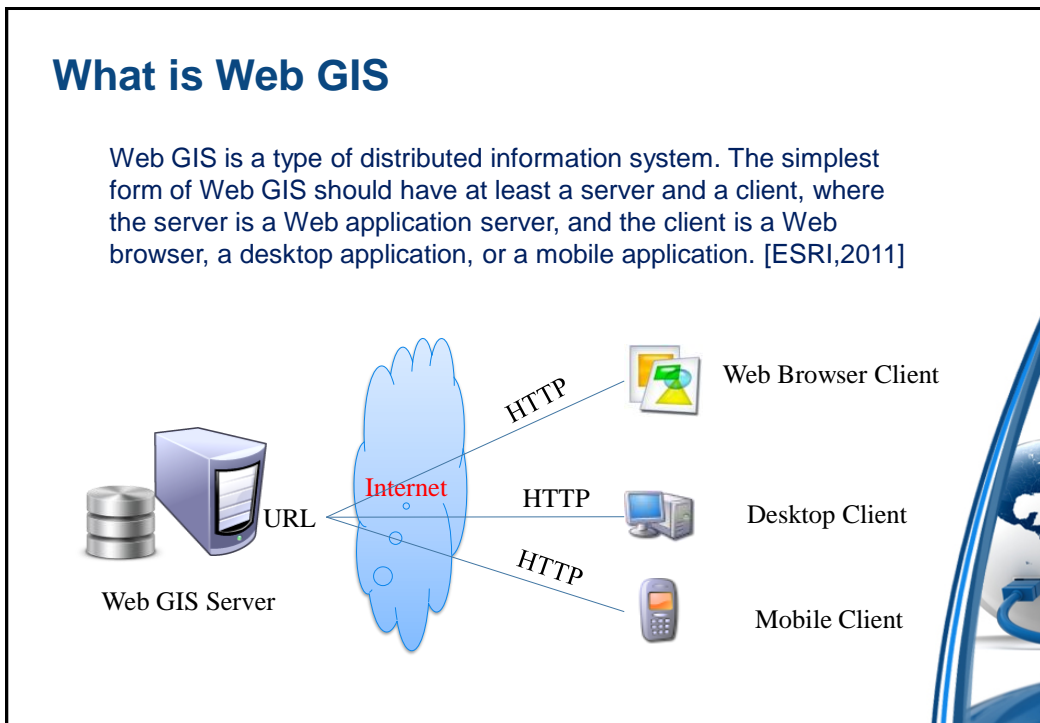
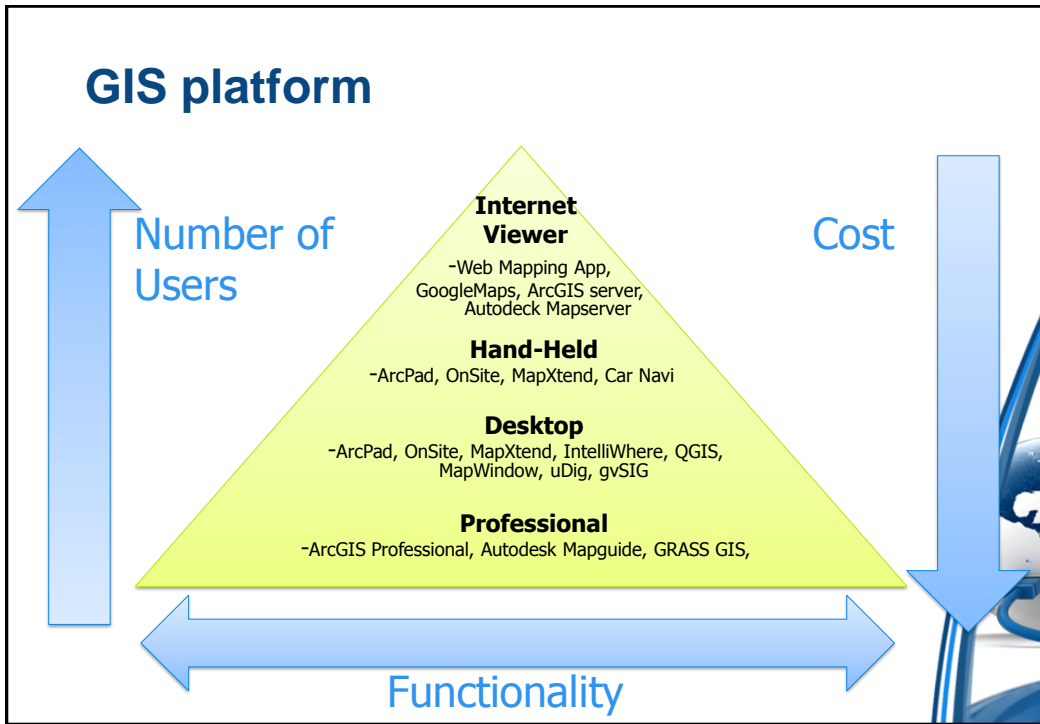
Ideal environment for collaboration and distribution of spatial information.



GIS in different platform

- Web GIS on Mobile as LBS





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 functions

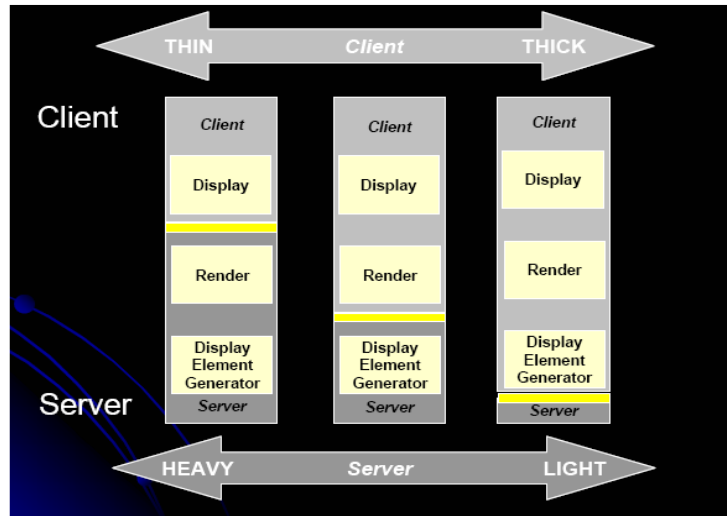
Complexity



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

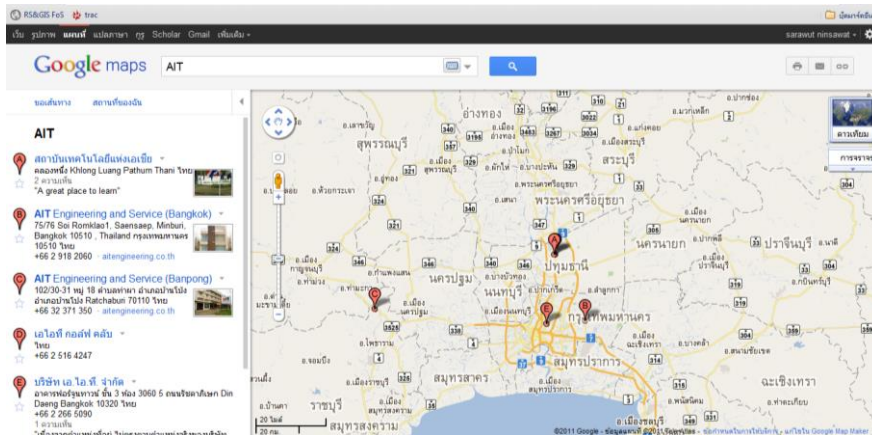
Fundamental Architectures



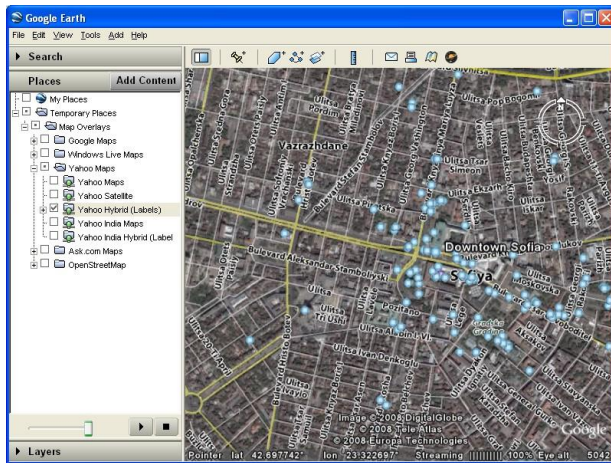
Basic Web GIS



- Red Dot Fever
- The basic purpose of mapping is
 - “To identify the location of Area/Features of Interest”

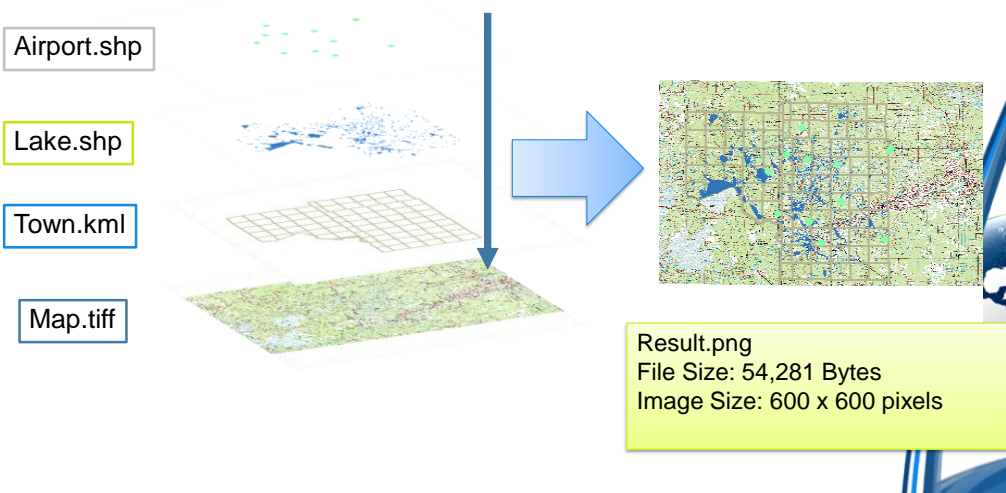


Large dataset



- For one meter resolution remote sensing image
 - 6 MB per sq km.
- India's area
 - 3 million sq km.
 - Require space around 17 TB
- Limitation of Mobile device
 - Processing
 - Ram
 - Storage

Image Map Rendering



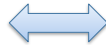
Mapping Applications

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).

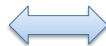
Mapping applications

On Web Server



Access via Web Browser Client

On Local machine

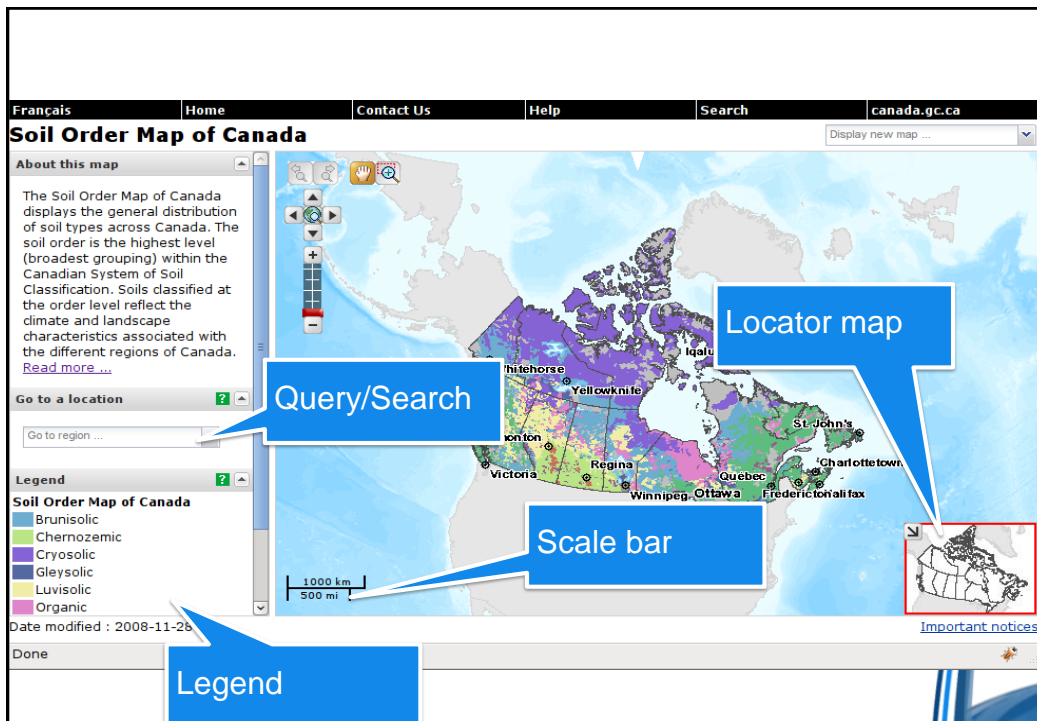


Desktop Application Client

The screenshot shows a web-based mapping application interface. The main map area displays a street map with a blue highlighted area labeled "5 Acres Per Unit Residential". Several callouts point to specific interface elements:

- Layers Control:** Points to the "Layers" panel on the left, which lists various map layers like "Basemap", "Flood Zone", "Creeks", "Rivers", "River Trail", "City_Boundary", "400 Scale Grid", "Transportation", "Roads", "Railroad", "Community", "Parks_points", "Parks", "Cadastral", and "Parcels".
- Zoom Control:** Points to the zoom controls in the top toolbar.
- Pan Control:** Points to the pan controls in the top toolbar.
- Map Display:** Points to the main map area.
- Processing task:** Points to the "Create a Buffer" dialog box on the right, which includes settings for "Buffer settings", "Distance around features", "Layers to include in the buffer", "Name for the resulting buffer layer", "Merge buffer areas", "Fill style", and "Border style".
- Attribute query:** Points to the "Properties" panel at the bottom left, which shows details for the selected feature: "Name", "GPID: 552.000000", "GP: SP", "GP_CLASS: Residential", and "GP_DESC: 5 Acres Per Unit Residential".

At the bottom of the interface, there is a status bar showing coordinates (X: 1969052.879314, Y: 636491.372683 (Meter)), "1 feature selected", scale (1: 14,368), and map size (32 x 47 (km)). The interface is 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

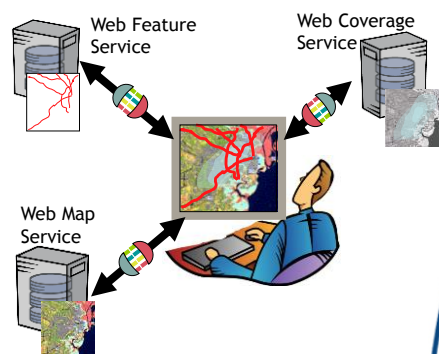


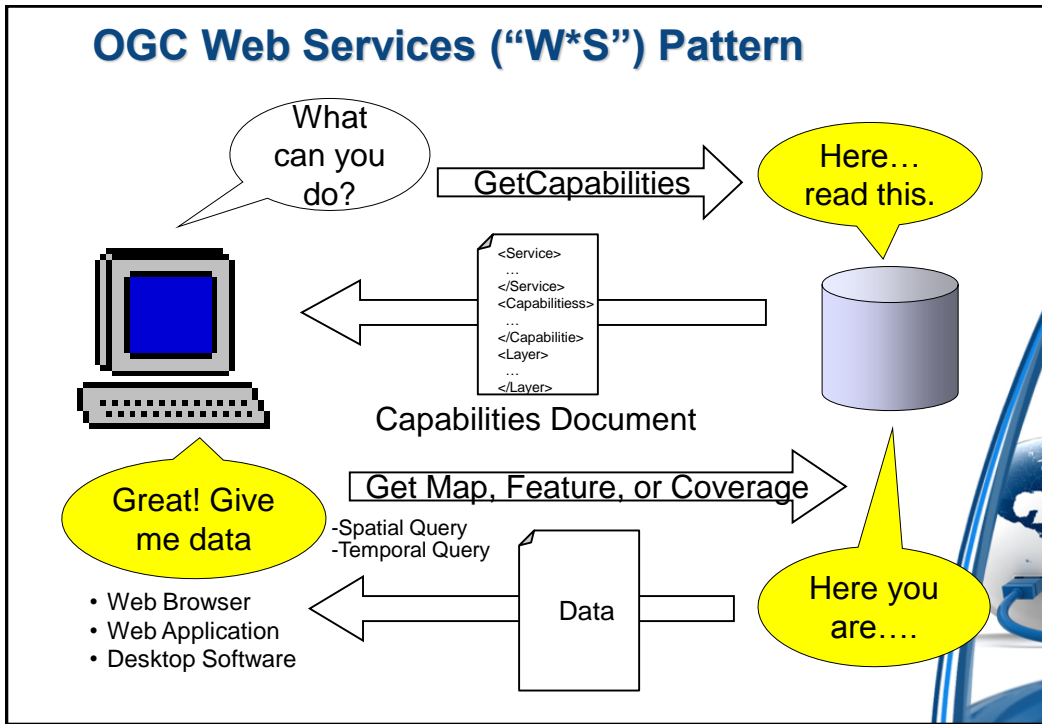
File-based Data Sharing

- Consider about “Time-critical applications” scenario
 - Major tsunami bearing down on the Southeast Asia Coast
 - As Chief Information Officer (CIO) you are required to put together a web site for citizens with things like tsunami shelter, route map and other map information
 - You don’t have those data, what do you do?
 - Tell your boss, “Sorry, I can’t do that”
 - Or Get on the phone/Internet and try to 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





Tsunami Disaster Mapping for Indian Ocean Coastal Regions

DM Solutions Group

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

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

Legend Disaster Info Viewer Help

Map Legend

Disaster Info

- Earthquake Epicenter [info]
 - 9.0, 2004/12/26 00:58:53 UTC
- Recent Earthquakes [info]
 - 5.0 - 6.0
 - 6.0 - 7.0
 - 7.0 - 8.0
 - >8.0
- Fault Lines [info]
- Points of Interest [info]
 - Click then a point on the map for more information

Political

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

www.demis.nl

0 370 740 1110 1480 1850 km

Redraw Map

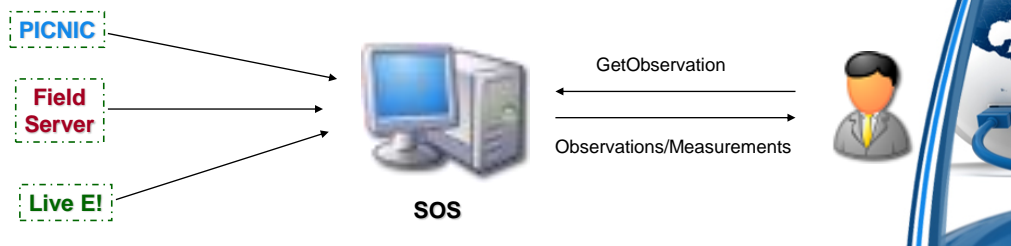
WMS : Indian Ocean Tsunami 2004



Ownership : 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



Sensor Observation Service (SOS)

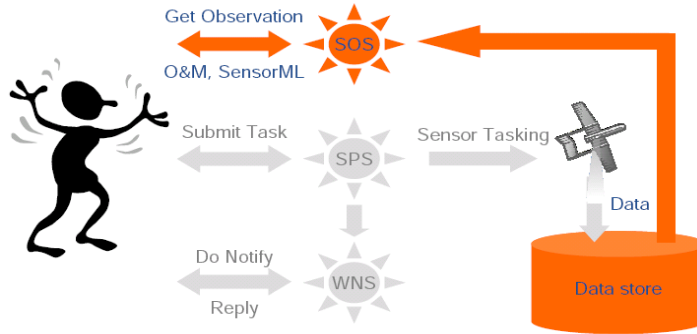
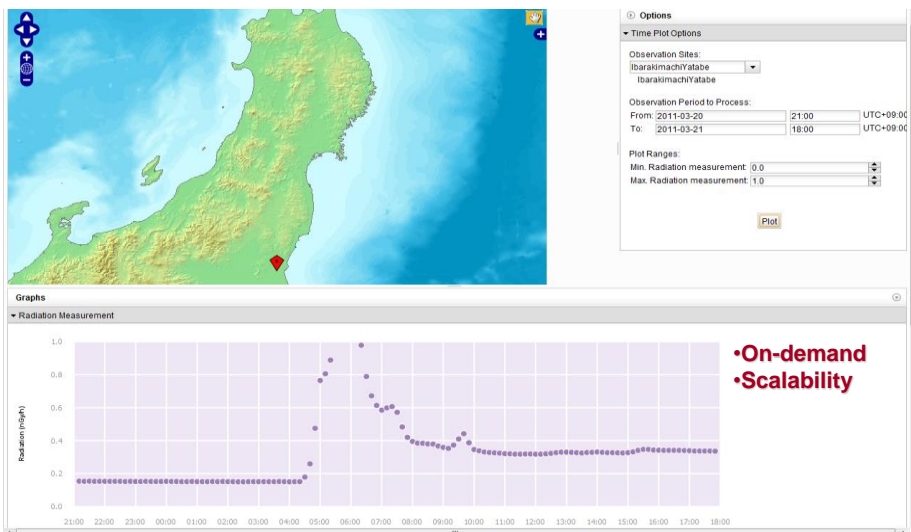


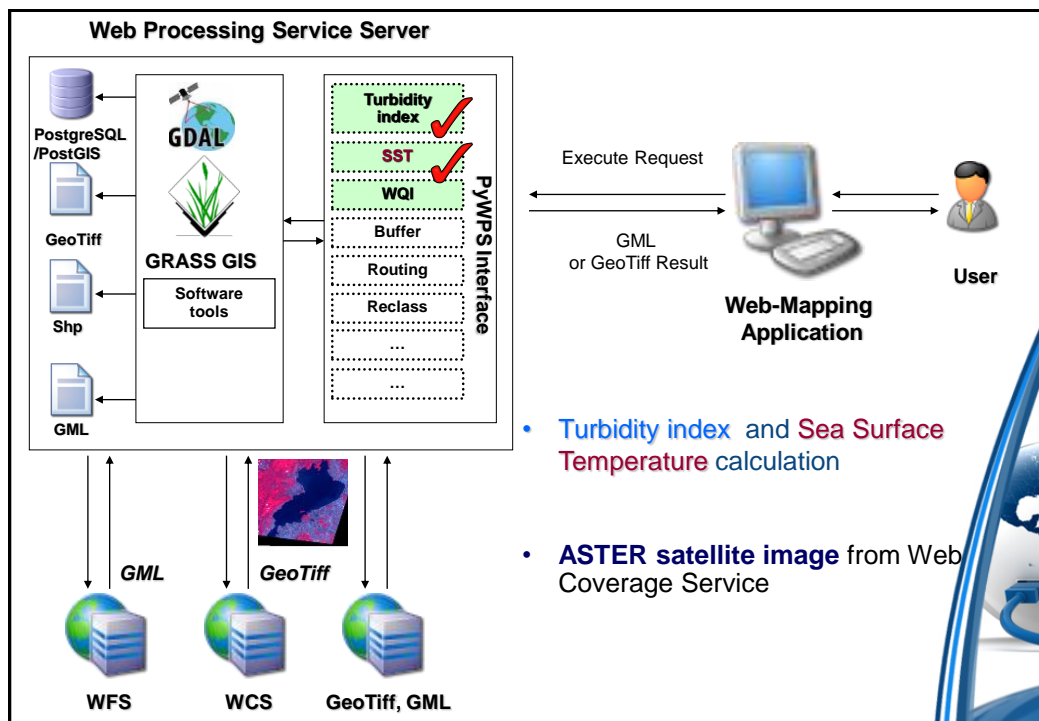
Figure from <http://52north.org>

SOS for Radiation monitoring sites around North Ibaraki region

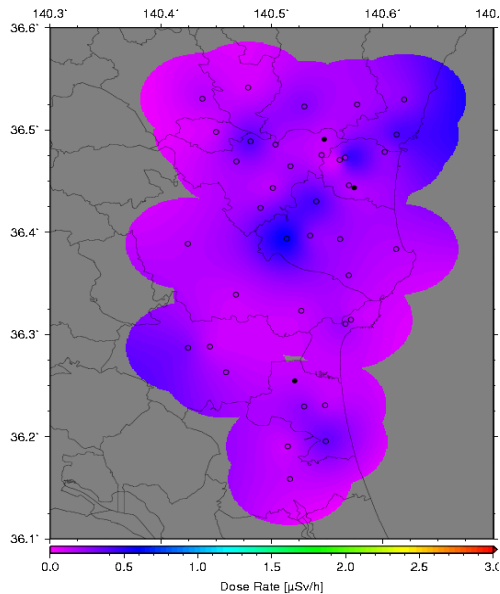


Web Processing Service (WPS)

- **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



Spatial distribution of Radiations

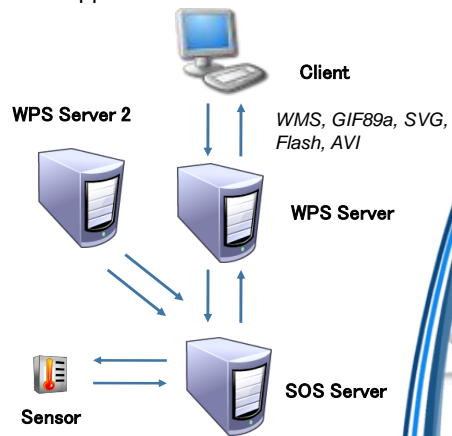


• Legacy code from :Y.Ishihara (RISE/NAOJ)

• Data source : CSV

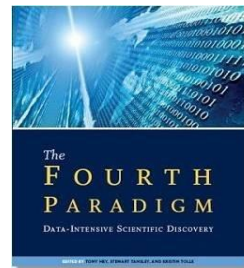
• Preprocess

• New Approach : WPS + SOS

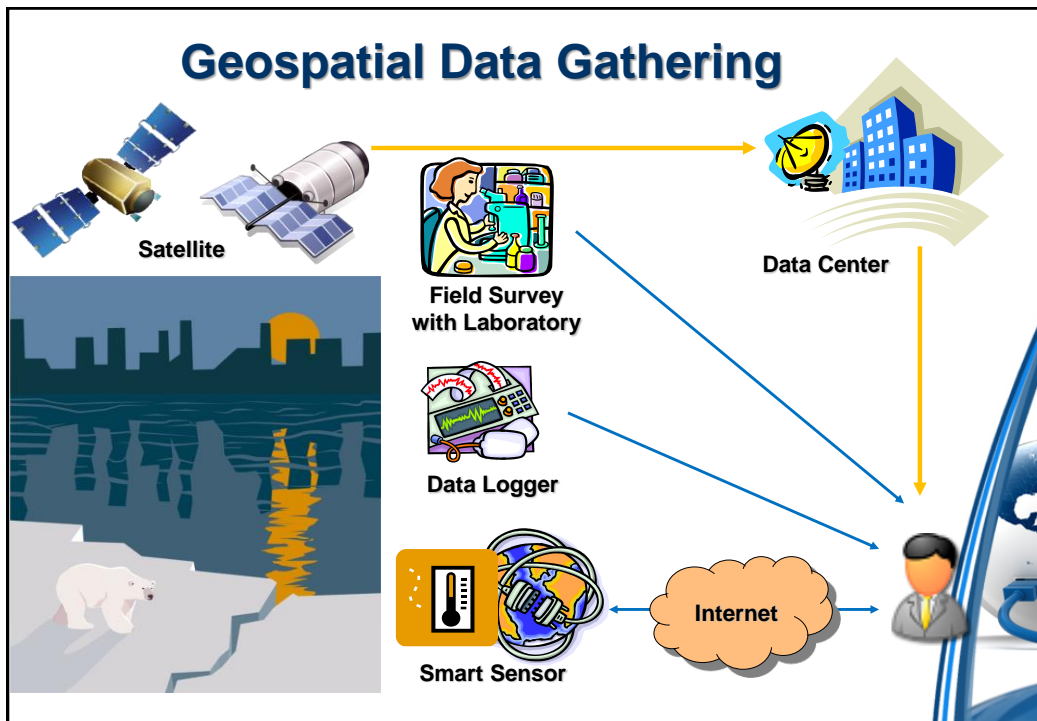


Fourth Research Paradigm : eScience

1. Thousand years ago – **Experimental Science**
 - Description of natural phenomena
2. Last few hundred years – **Theoretical Science**
 - Newton's Laws, Maxwell's Equations etc.
3. Last few decades – **Computational Science**
 - Simulation of complex phenomena
4. Today – **Data-Intensive Science**
 - Scientist works with data sets from many different sources
 - Data captured and generated by instruments, sensor networks and simulations
 - eScience is the set of tools and technologies to support data federation and collaboration
 - For analysis and data sharing
 - For data visualization and exploration
 - For scholarly communication and dissemination

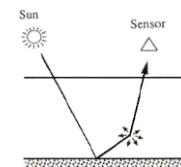
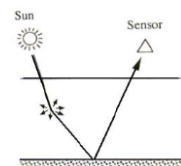


Jim Gray on eScience: a transformed scientific method



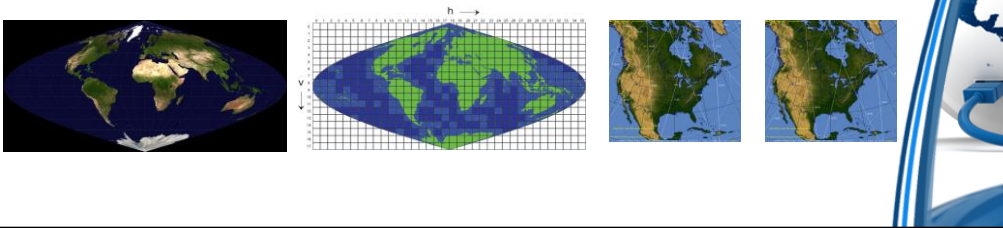
Satellite RS & Ground-based

- Benefit of satellite RS:
 - Cheap and rapid over large geographic area
 - Regional coverage and broadly spectral resolution
 - Continuous acquisition of data
 - Archive of historical data
- Limitation of satellite RS:
 - Interference of atmospheric gaseous and particles
 - Absorbing (H_2O , O_3 etc.) and Scattering (mainly by aerosol particles such as dust, ash and smoke)
 - Not direct sample of the phenomenon.
- Ground-based observation:
 - Direct sample of the phenomenon is possible
 - Real-time or Near Real-time observation
 - High temporal resolution
 - Expensive for wide area observation
- Data Federation, Cal/Val (Calibration/Validation)

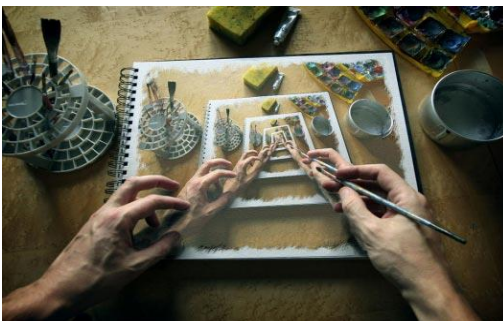


Research Needs

- Lack of comprehensive framework with ease of use to the end-users.
- Huge amount of effort from user such as
 - Prepare, analyze and process both of datasets to achieve final results.
 - High requirement of user skills and sufficient computer support system.



Satellite Field Integrator (SFI)



- Design to reduce the onerous tasks of
 - Data gathering
 - Manipulating
 - Processing
- Supports heterogeneous data formats in both remote sensing and sensor observation data
- Scalability to handle the increasing number of datasets currently available
- Offers a robust, on-demand processing service

Lake Rotorua monitoring

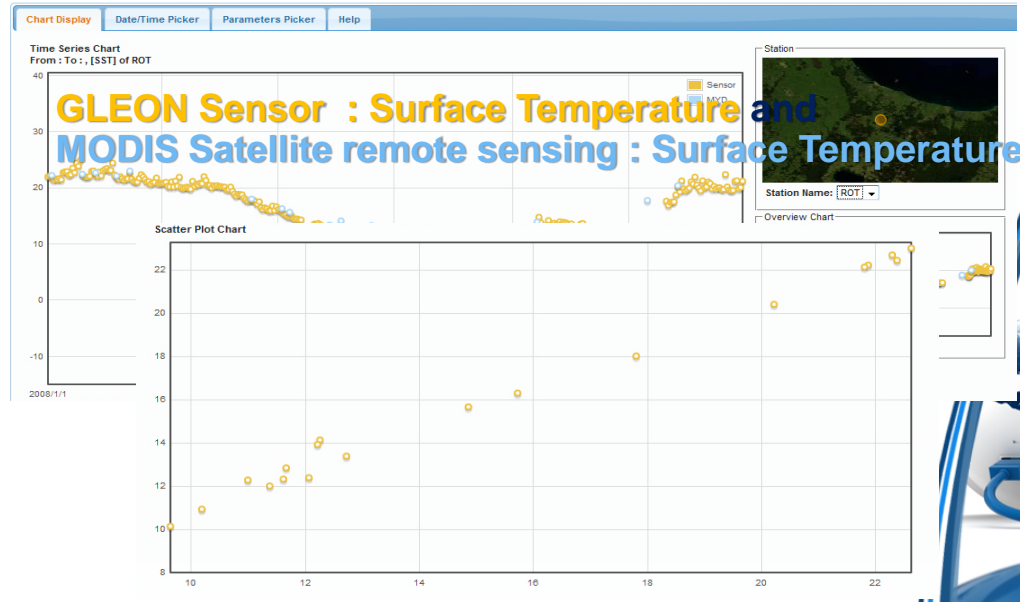
- Global Lake Ecological Observatory Network (GLEON)
- Pacific Rim Application and Grid Middleware Assembly (PRAGMA)
- Monitor and improve of lake health
- Since 2007-07-13 every 15 minutes

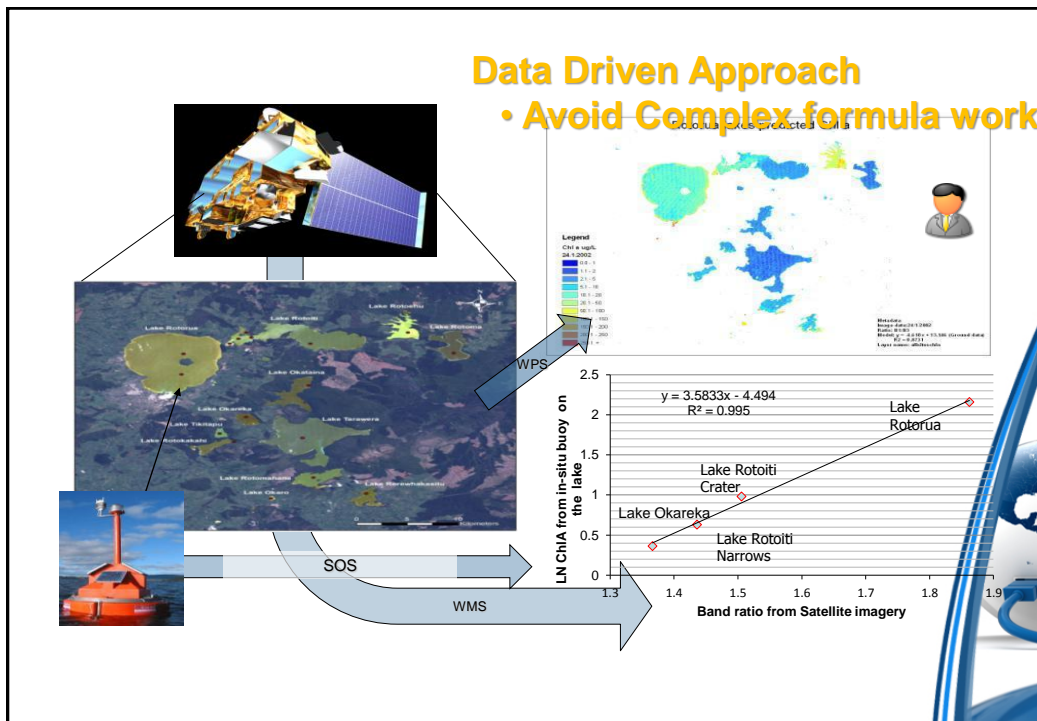


Sensors	Make/model	Depths
Water temperature	Apprise TempLine	0.5 - 20.5 every 2m
Dissolved oxygen	D-opto	0.5, 20
Chlorophyll	Seapoint/Trios	1
Phycocyanin	Trios	1
Climate	Vaisala WXT510	n/a

Figure from <http://www.lernz.co.nz/gallery/lakerotorua.html>

GLEON Sensor and MODIS : SST



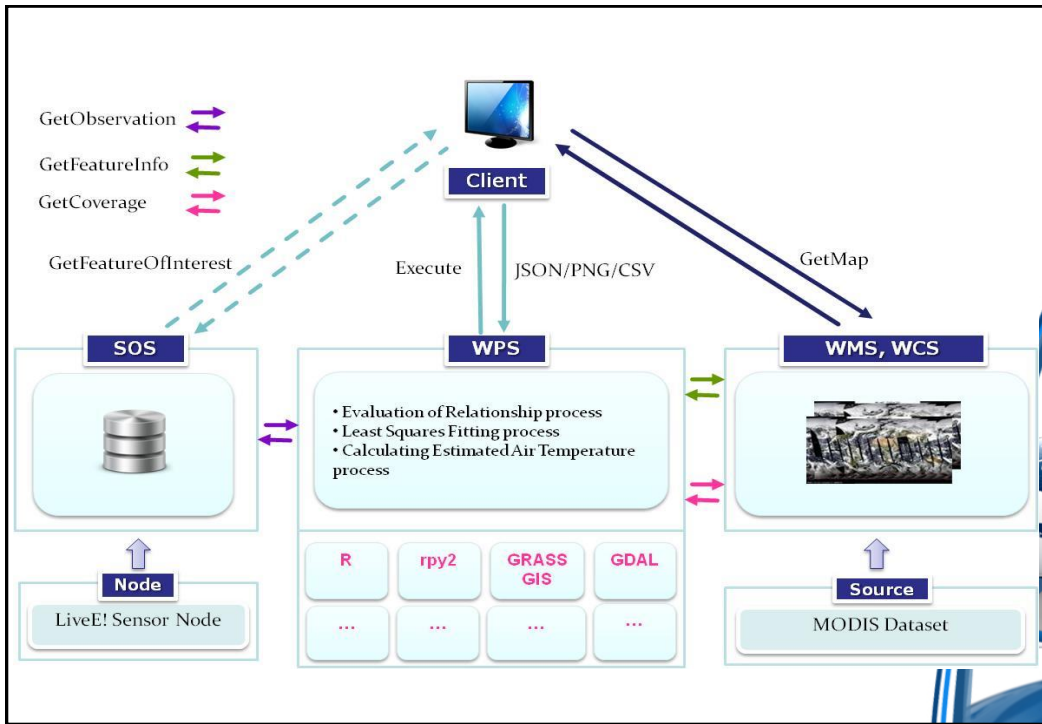


Air Temperature

- Air temperature near the Earth's surface
 - Key variable for several environmental models.
- In most case, Spatial interpolation from sample point of meteorological station is carried out
 - Based on Land use, Elevation etc.
 - Uncertainly interpolation : Limited density of station

MODIS Land Surface Temperature

- Derived from Two Thermal infrared band channel
- Not a true indication of “ambient air temperature”
- However, there is a strong correlation between LST and air temperature
 - Evaluation of a correlation between the measured air temperature from meteorological station and LST can estimated air temperature.



ESAT Map Application

MOD11A1 LST vs Air Temperature

MOD11A1 LST vs Air Temperature

MOD11A1 LST vs Air Temperature

Observation Sites:
 Mizushima Industrial School Data Center Pedagogio Child Museum Kasumi live-datacenter

Observation Period to Process:
 From: 2006-01-01 To: 2008-05-01
 UTC+09:00 UTC+09:00

Plot Ranges:
 Mini Air Temperature: 0.0
 Max Air Temperature: 35.0

QA Filter:
 Data QA: 0.0

Processing Air Temperature Map Parameter:
 Scene: h29v05
 Process Date: 2006-05-01
 WMS Preview:

Air Temp. Map

Scatter plot & Evaluation equation

Estimated Air Temperature = 0.97 MOD11A1 - 0.6249
 Coefficient of determination (R²): 0.8928
 Estimated Air Temperature: 9.21, Measured Air Temperature: 9.0917

Estimated Air Temperature = 0.9004 MOD11A1 - 0.9118
 Coefficient of determination (R²): 0.9033
 Estimated Air Temperature: 9.89, Measured Air Temperature: 10.4636

Gross Primary Productivity

MOD17 GPP

$$\text{GPP} = \text{FPAR} \times \text{LUE}$$

Light, Tree



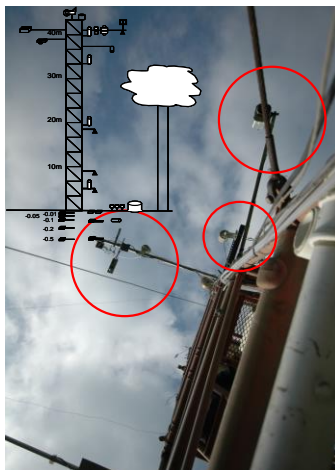
Min (Temperature)
Water availability

GPP : Gross primary productivity

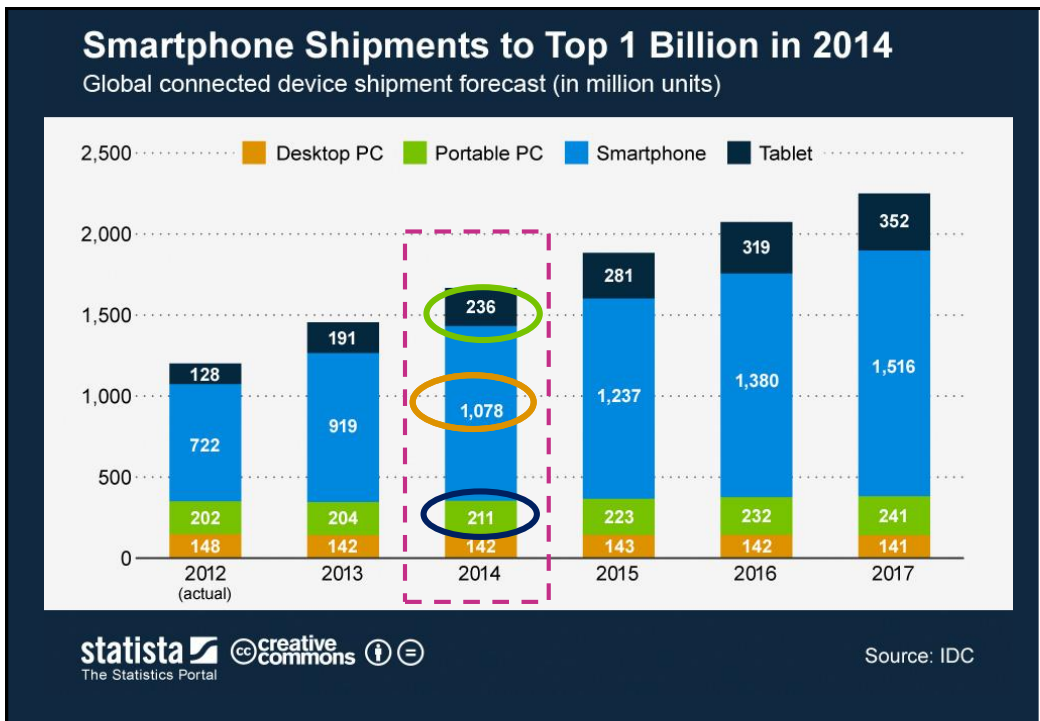
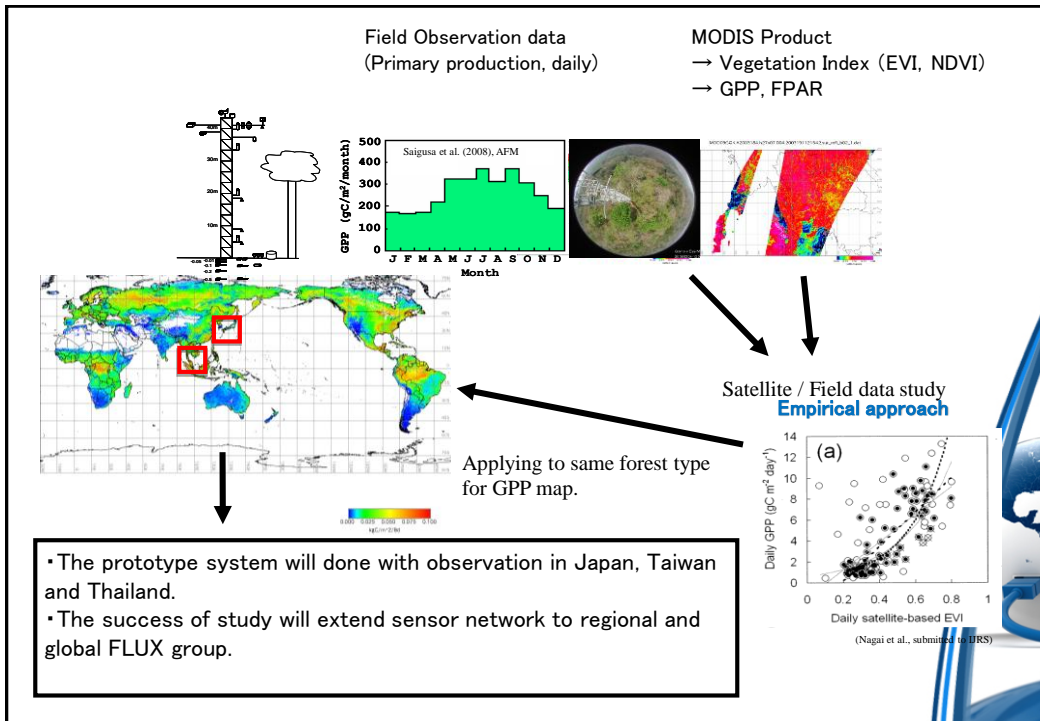
FPAR : Fraction of absorbed photosynthetically active radiation

LUE : Empirical light use efficiency factor (gCMJ-1)

Flux tower



Sakaerat (SKR), Thailand
- Tropical seasonal evergreen forest

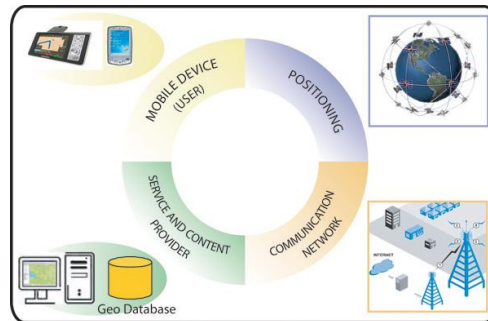


Location-based services (LBS)

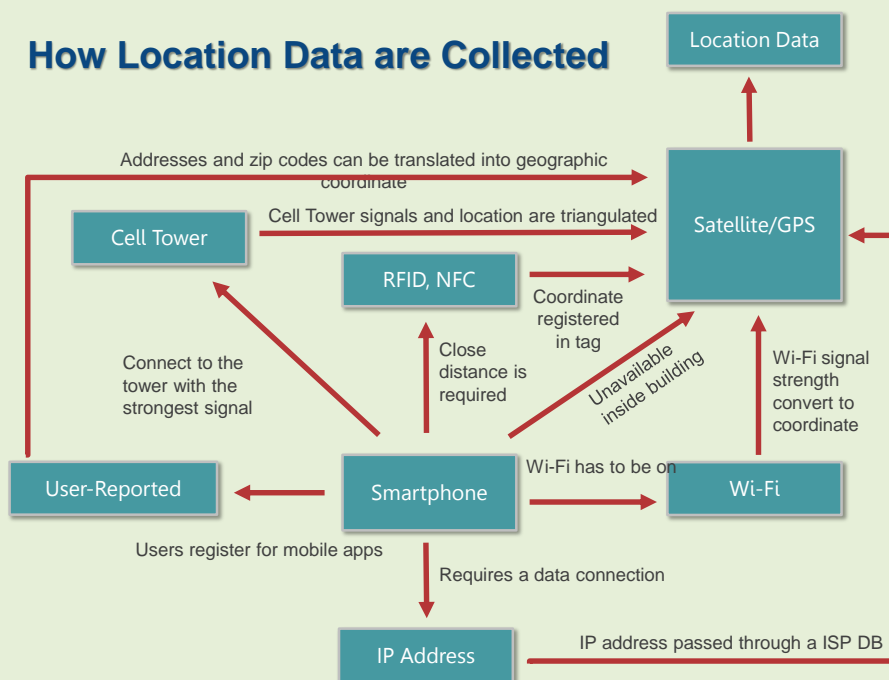
LBSs are information services accessible with mobile devices through the mobile network and utilizing the ability to make use of the location of the mobile device. (Virrantaus et al. 2001)

Components of LBS

1. Mobile Devices
2. Positioning Component
- Global Positioning System (GPS)
3. Communication Network
4. Service and Data Provider



How Location Data are Collected





เมนูหลัก ค้นหาข้อมูล
นปก.สาขาลำปาง

ผลการค้นหาท่อประปา

จำนวน 830 รายการ
ความยาวรวม 246,254 ม.

ปีที่ทำวท่อ : 2556
ชนิด : PVC
ขนาด : 100 มม.
เลขที่สัญญา : นปก.สป. 4/2556
บริเวณที่ทำวท่อ : ถนนลำปาง-ห้างฉัตร ตอนดงสัน
ดิน-ขามแดง ต.บ่อแก้ว อ.เมือง

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ข้อมูลทั่วไป แผนที่ที่ดู

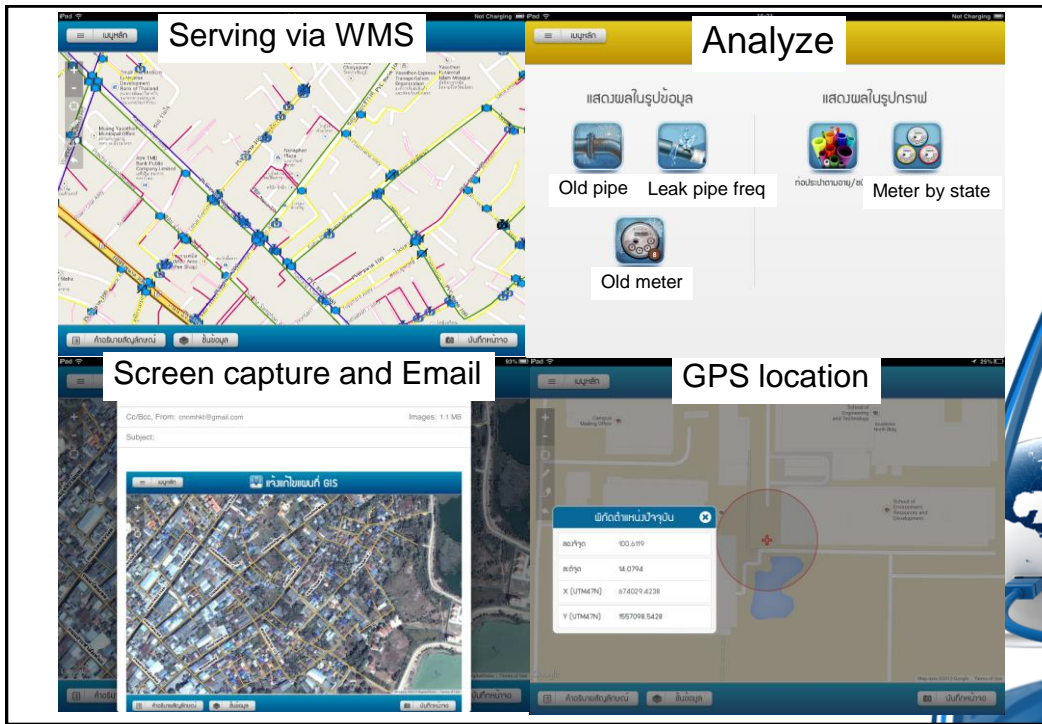
Provide powerful functionaliti Smart PWA mobile application on

- Asset management
- Pipeline Risk Identification
- Water Consumption Analysis
- Billing Analysis

Android

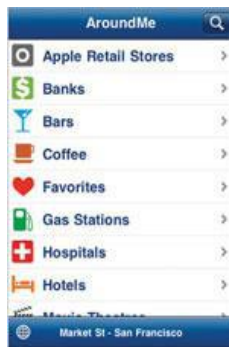
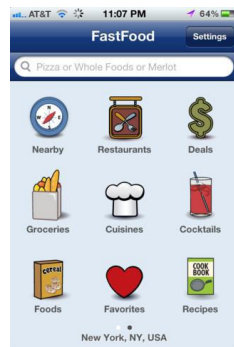
Available on the
App Store

กรมประปาส่วนภูมิภาค
Provincial Waterworks Authority



Location-based services

- Applications of LBS
 - Information service



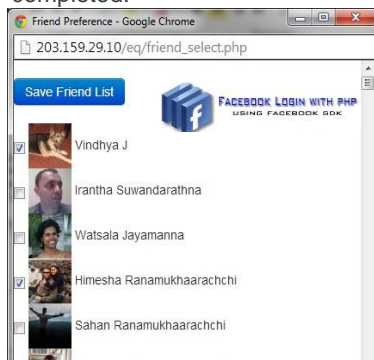
Location-based services

- Location-based Social Networks

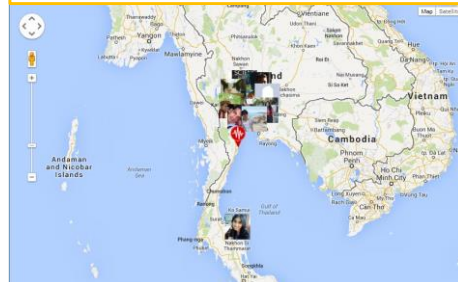


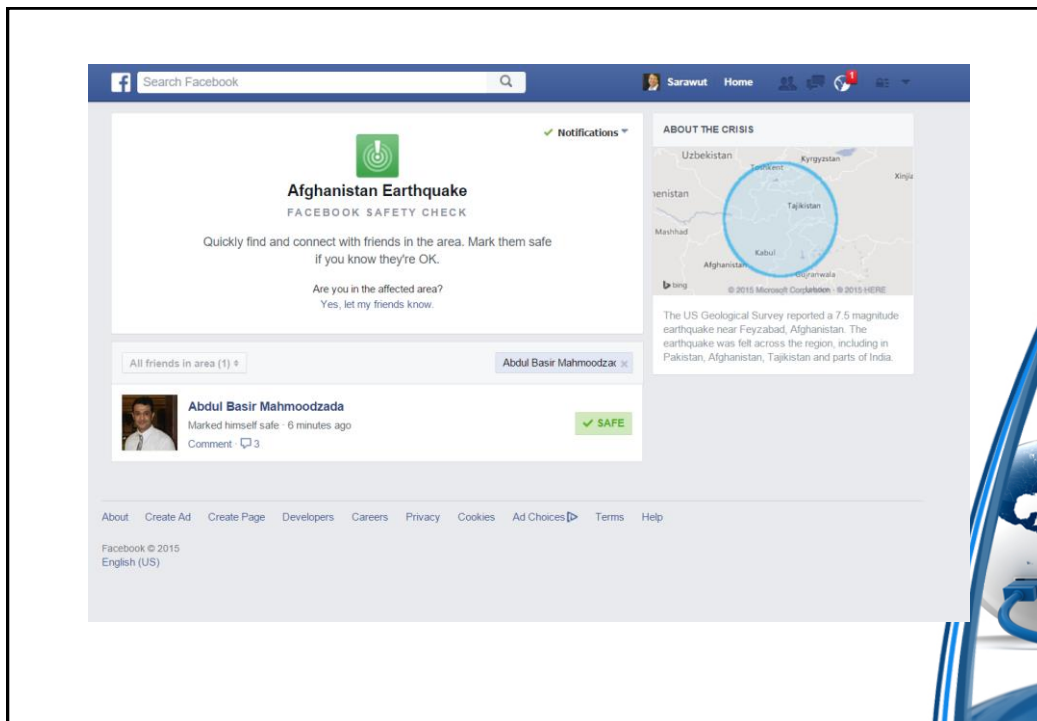
Integrating Social Network to Disseminate Disaster Information Based on User Preferences and Location Information

- User login with Facebook account (Single Sign-On)
- Select type of disaster and level for notification
- Notification based on users including check ins, hometown, current town etc.
- User can select concerned friends from the list which are linked with FB account.
- Spatial analysis of large friend network and spread location must be rapidly completed.



Email notification contains a link to visualize the location information of the earthquake and the locations of the affected friends.





What is Augmented Reality (AR)?

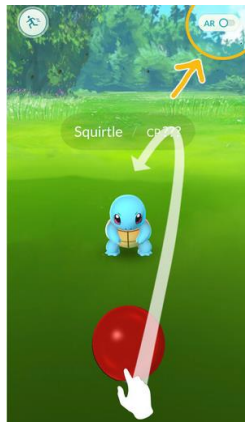
Augmented Reality (AR) is the technology which can direct or indirect real-time represent contents in a view of physical with real world environment via a camera of a device such as smartphone, tablet and computer.

- Combines real-world environments and virtual reality
- Real-world environments can interact with virtual objects.
- Virtual objects will respond to real-world physical actions.

Virtual Reality

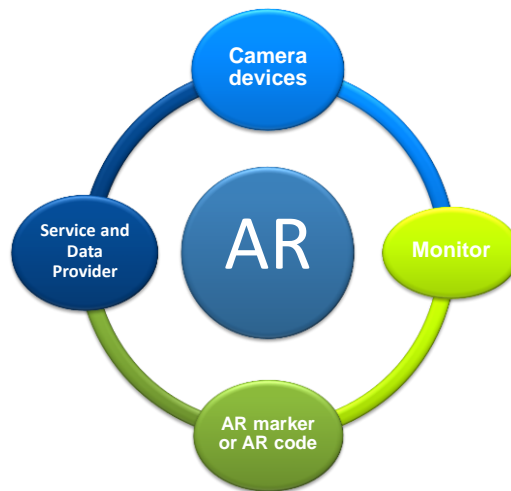


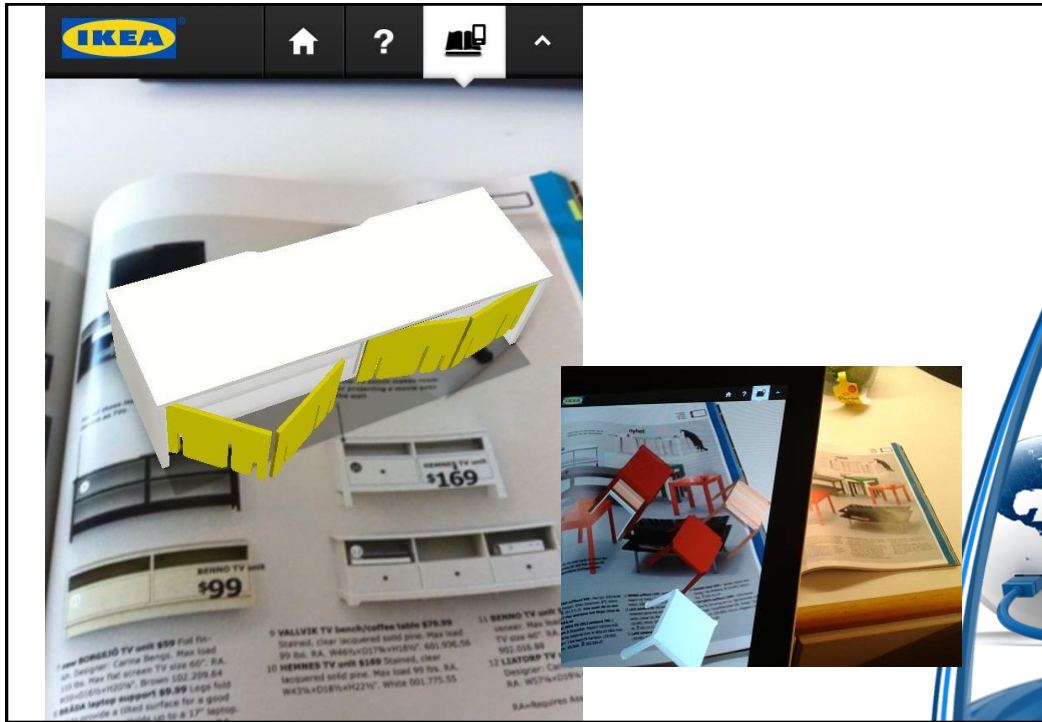
Augmented Reality






AR Components







Google Glass: Mom Mode

Device






Is that vomit?



Alternate route to soccer game, via Starbucks

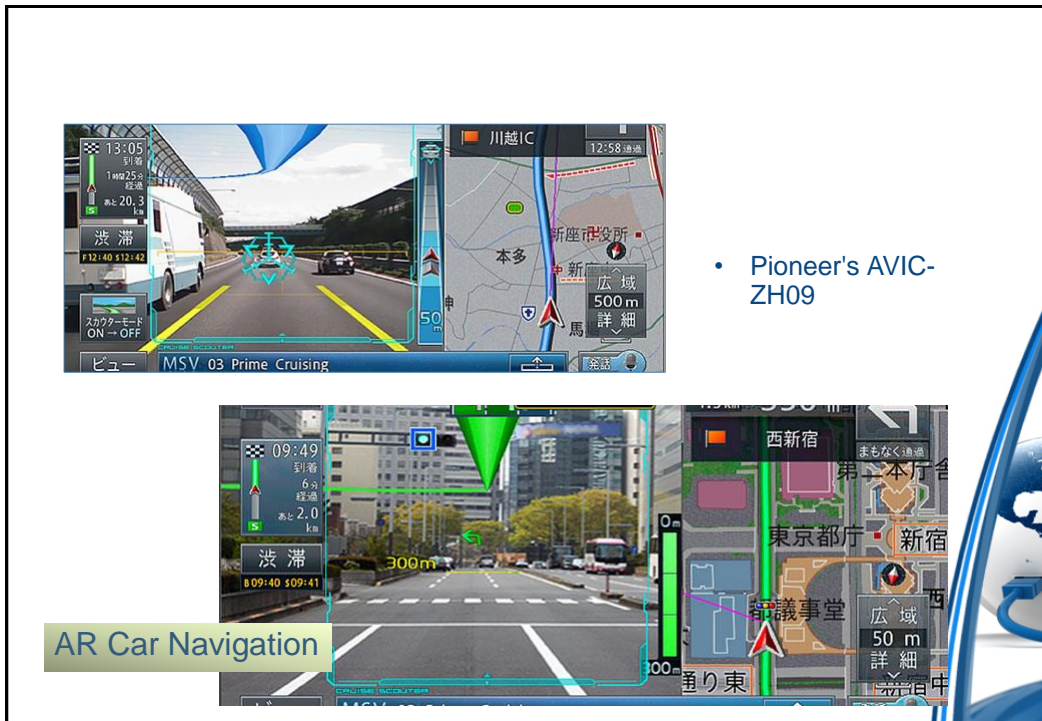


Post to Facebook?

Google AR Glasses

<http://www.youtube.com/watch?v=9c6W4CCU9M4>

nickmom
Every night at 10pm ET



AR Car Navigation

• Pioneer's AVIC-ZH09

Using Mobile Augmented Reality for Urban Design



Courtesy from "Using Mobile Augmented Reality for Urban Design by Mark Billingham, Gun Lee, HIT Lab NZ, University of Canterbury"

Using Mobile Augmented Reality for Urban Design



Before/after earth quake at Christchurch/NZ

AR for underground



Courtesy from "Using Mobile Augmented Reality for Urban Design by Mark Billingham, Gun Lee, HIT Lab NZ, University of Canterbury"

LBS & AR Technology for Historical Tourism on iOS Platform

Temple popup in AR View

Augmented POI
-Title
-Thumbnail
-Distance

Surrounded POI (GPS, Compass)

3D model in AR View

- The developed application can be utilized as the tourist assistance in historical place to augment the knowledge of tourists and to make impression of users by the new technologies.
- Several advantages as described followings
 - Mobility
 - Easily maintenance
 - Multi-language supports

Description information

Info by Image recognition

IndoorNavi: Hybrid Indoor Navigation System based on WiFi and NFC Positioning Techniques

Specifying the current location:

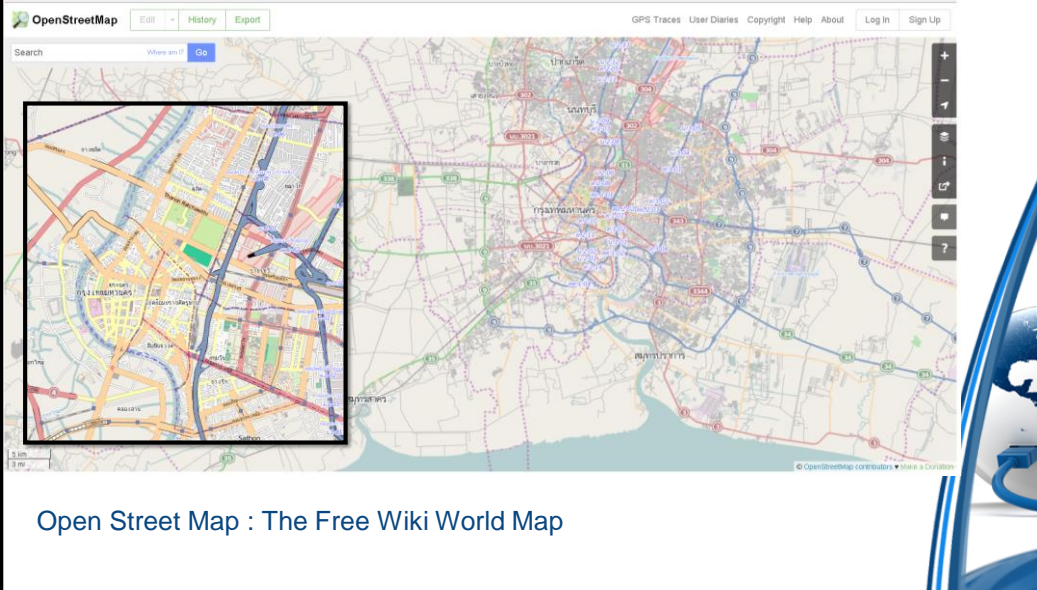
Waiting 5 secs WiFi Scanning

Touching the NFC

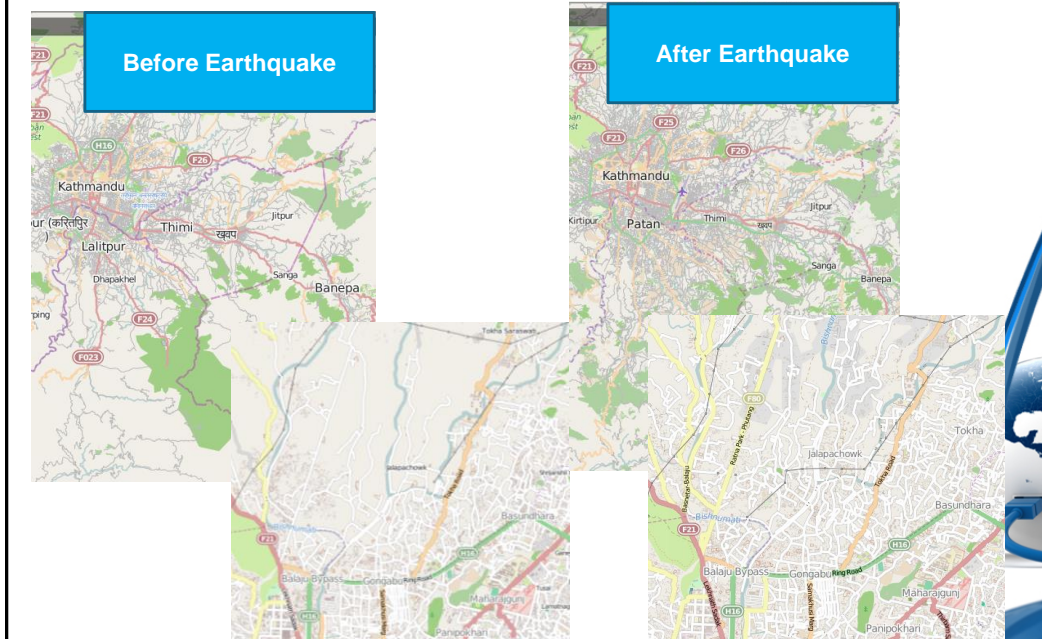
- Indoor Navigation
- AR sign direction

C. Sirirattanapol, S. Ninsawat and N. K. Tripathi, M. Nagai (in press). IndoorNavi: The Hybrid Indoor Navigation System based on WiFi and NFC Positioning Techniques. *International Journal of Geoinformatics*.

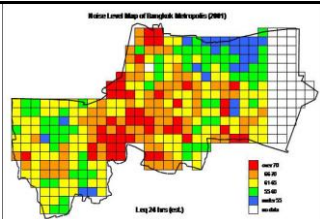
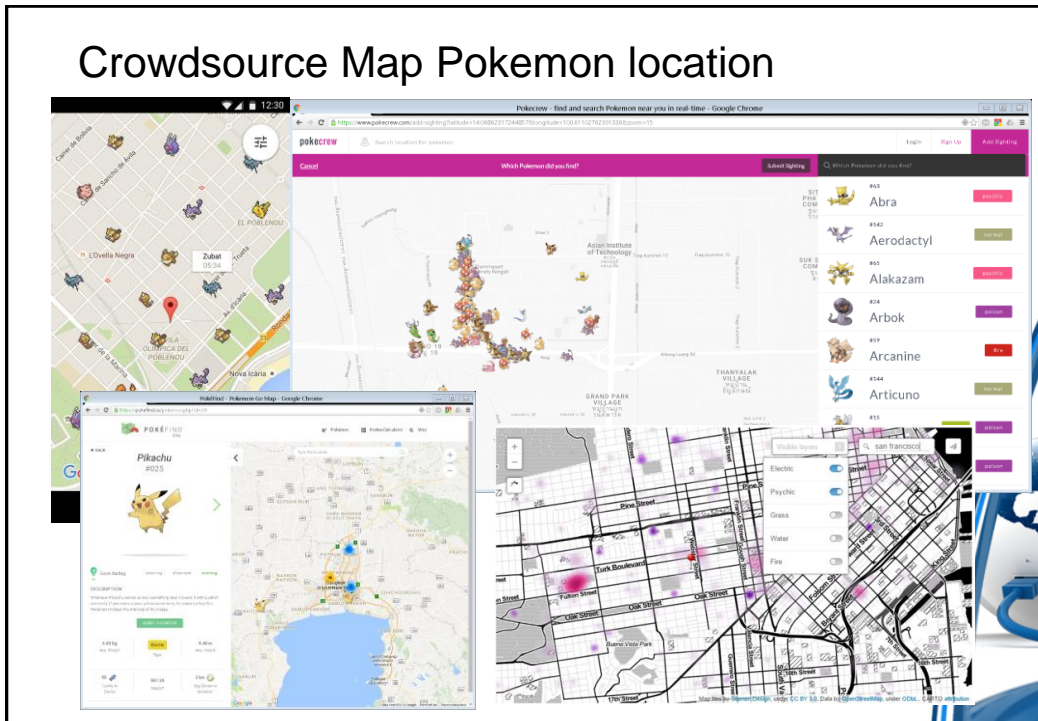
Crowdsourcing



Crowdsourcing



Crowdsource Map Pokemon location



Source : Department of Environmental Quality Promotion (DEQP) (2001).

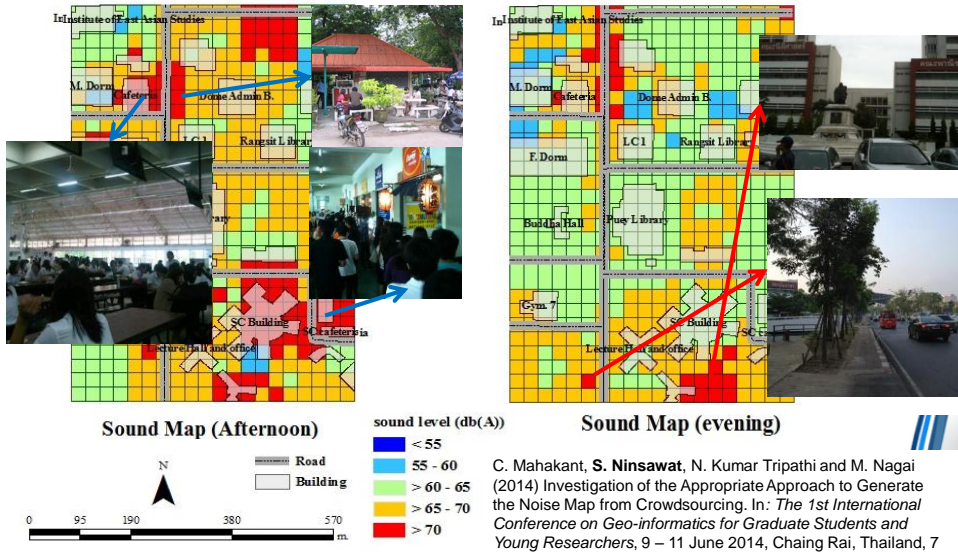
Investigation of the Appropriate Approach to Generate the Noise Level Map from Crowdsourcing

- Noise pollution is the important issue that affects the health problems.
- Latest noise level map in BKK is in 2001.
 - Costly and timely process
- Crowdsourcing for noise pollution is applied to monitor sound levels by using smartphone with
 - Microphone -> Sound level
 - GPS-enables -> Location
 - Clock -> Time

Seven mobile devices were used for collecting data



Sound level map in Thammasat Rangsit campus from crowd sourcing survey



Smart Survey

Supporting tools for regularly field survey tasks. The GPS, camera, mobile network communication of device will facilitate the staff and increasing performance, accuracy of data capturing operation.

Input field data

H1	H2	H3	H4	H5	H6
100	105	101	100.83	102	109
D1	D2	D3	D4	D5	D6
3.5	3	3.25	3.25	3.4	3.75

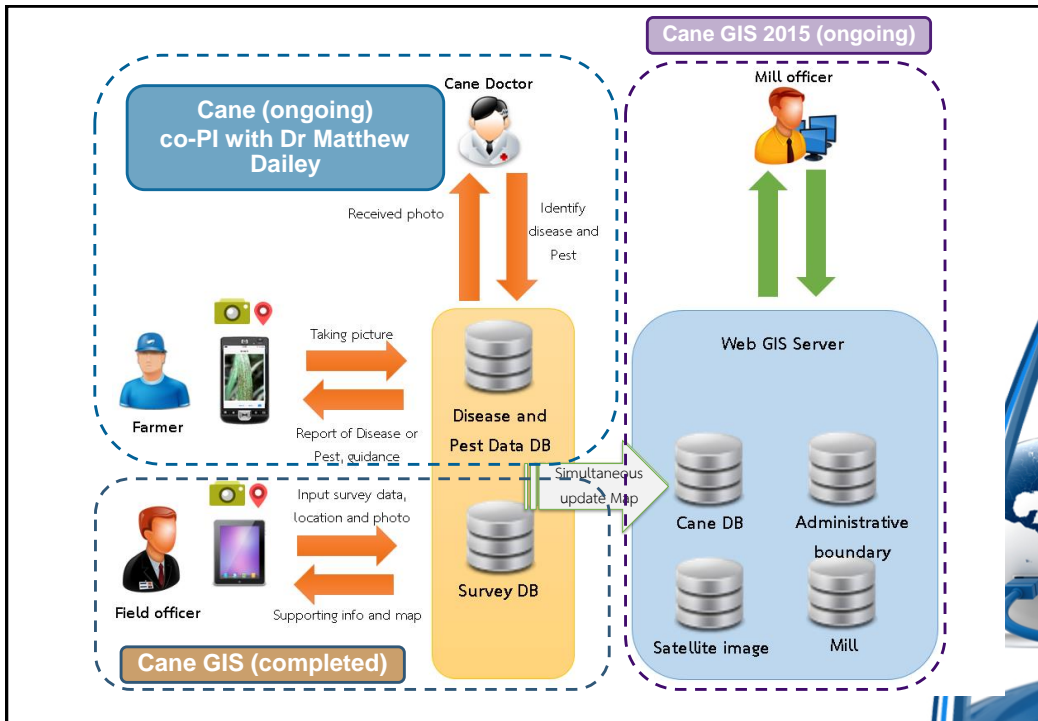
Captured the image using camera

Calculate Yield from input data

Rep ID	Yield	Yield Non Cut
1	102.97	3.36
2	101.97	3.56
3	105.29	3.37
Avg.	103.41	3.43

Registered cane farms within 800m from user location

Nearby Farm:



Crowd sourcing agriculture field data collection system using LBS and AR

Check land parcel and press reserve land parcels to reserve the jobs

Reserve Land Parcels

- 2-AVAILABLE (100.233841684,13.9168180171)
- 7-AVAILABLE (100.194081381,13.9371439899)
- 8-AVAILABLE (100.194470463,13.935820835)
- 9-AVAILABLE (100.195886348,13.9332754627)
- 4-AVAILABLE (100.237118896,13.9155889658)
- 6-AVAILABLE (100.165975269,13.9349310458)

- Paper-based forms are mostly used
 - Inconvenience, time consuming, error prone
- Support the concept of crowd sourcing or VGI
 - Farmer, land owners and local volunteers can afford for data collection process.
 - Assigning different status of jobs availability
- The agriculture fields were always existed in vast area
 - Label or sign of each agriculture plots are not practical available.
- The virtual tag representing the plot location can be augmented in real world environment scene
 - GPS, compass, camera and display screen of smartphone.

Manuscript in topic of "Development of crowd sourcing agriculture field data collection system using Location-Based Services (LBS) and Augmented Reality (AR) technologies" is being submitted to an International Journal of Computers and Electronics in Agriculture

Thank you

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