Sensor to Internet

A Complete Workflow from Pixels to the Web with On-Demand Geoprocessing
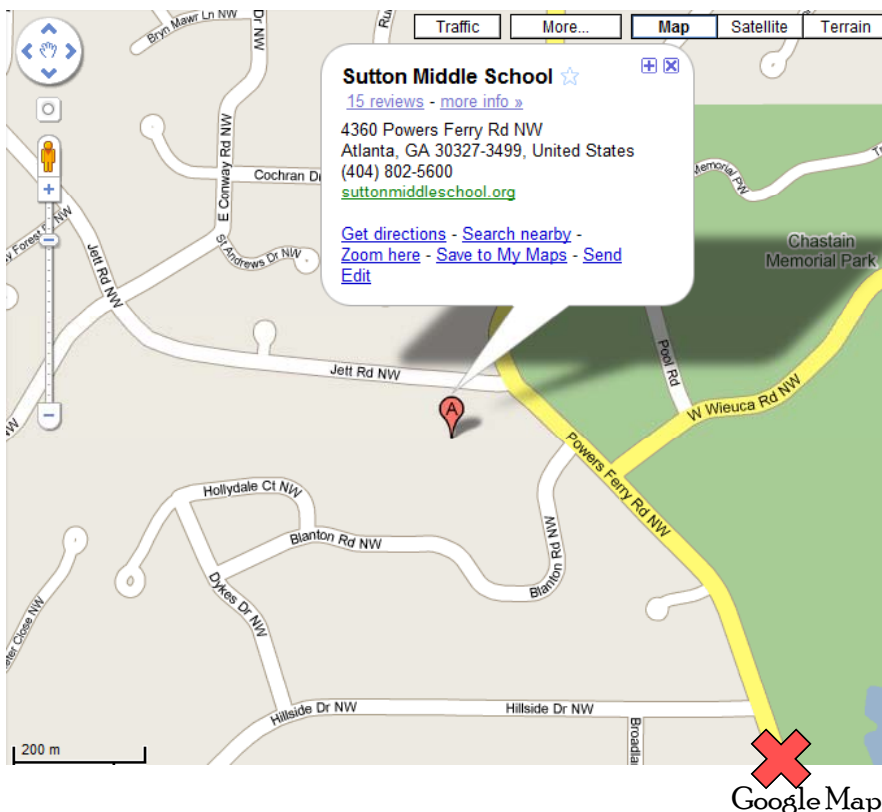
Brad Skelton

ERDAS - Photogrammetric Week 2007

**erdas**
The Earth to Business Company

- when it has to be *right*   **Leica** Geosystems

Where is the ball game?

Sutton Middle School ☆
15 reviews - more info »
4360 Powers Ferry Rd NW
Atlanta, GA 30327-3499, United States
(404) 802-5600
suttonmiddleschool.org

Get directions - Search nearby -
Zoom here - Save to My Maps - Send
Edit

Google Map

- **Sometimes a map is not enough**

- **It can easily be out of date or incomplete**

erdas / The Earth to Business Company

Imagery solves everyday problems...
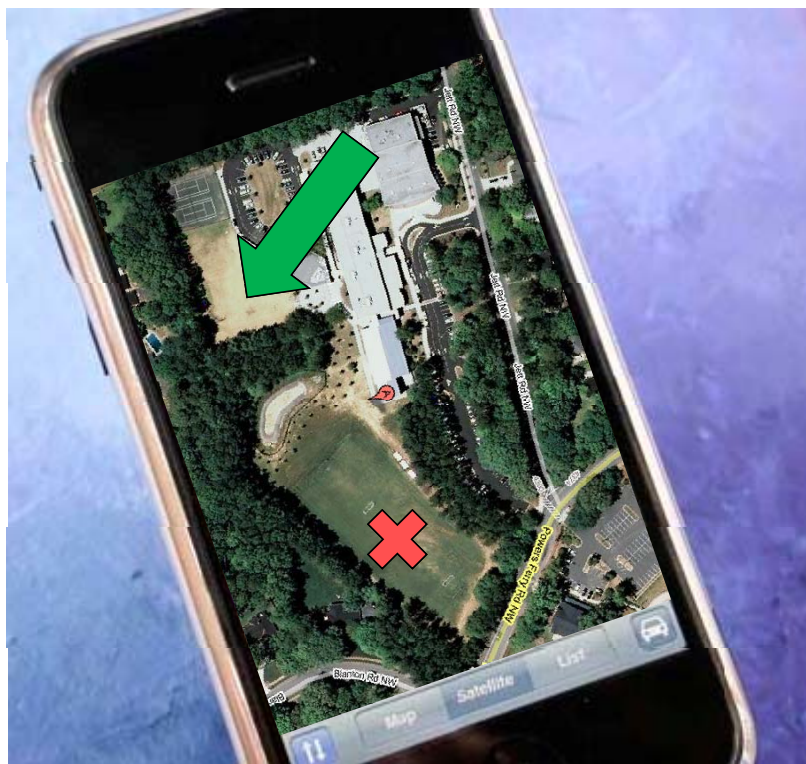
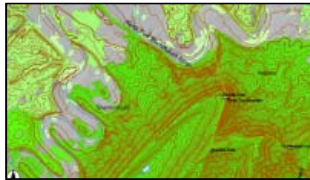The correct field was "Hidden" behind the school and not visible from the main road.
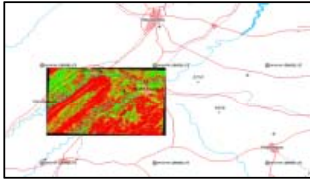
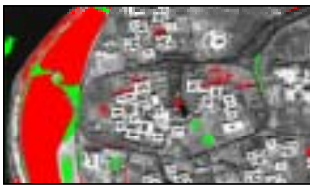Google Map

So What is behind this?

Imagery can be used for so much more...

Landcover Mapping

Mobility Analysis

Change Detection

Feature Extraction

- Emergency Response

- Mission Planning

- Environmental Monitoring

- City Planning

- Cadastral Mapping

...And it has been, but...

Departments in large organizations have tended to work in their own "silos", segmenting the work and access to the data.

Photogrammetry Department

Remote Sensing Department
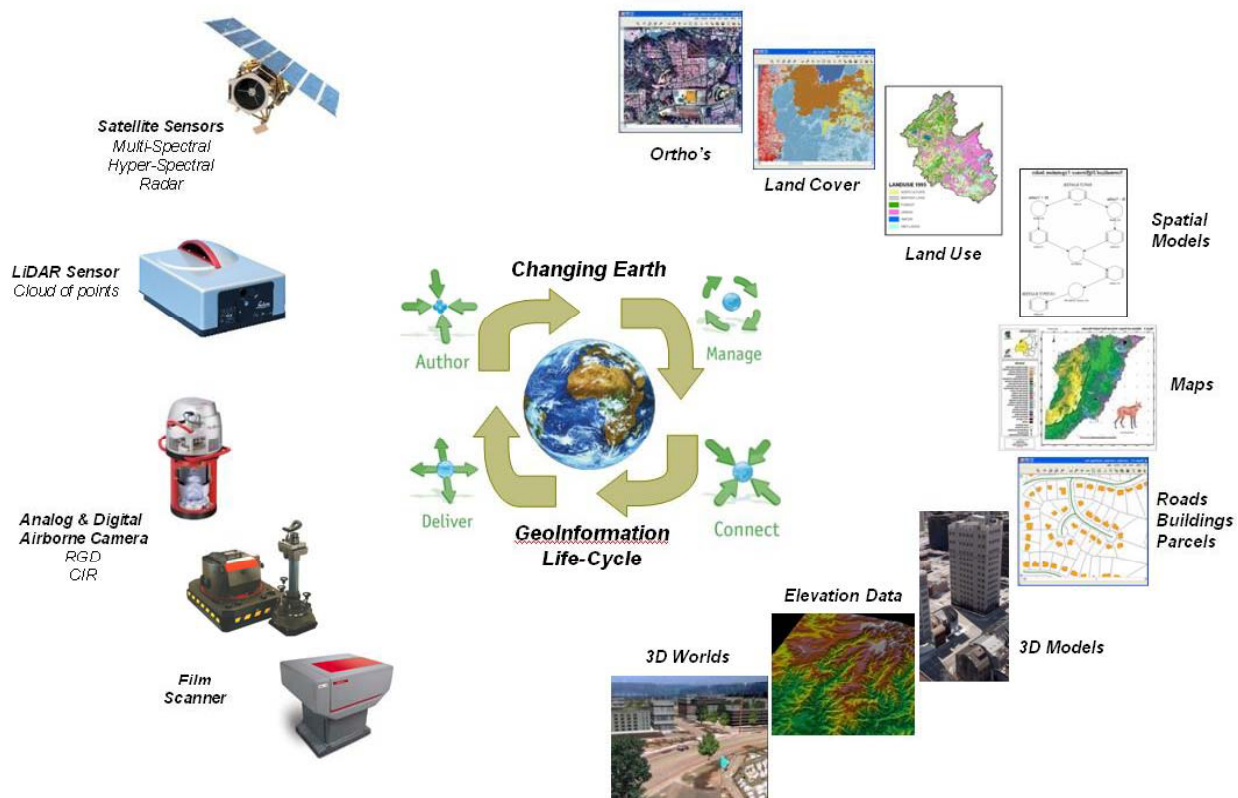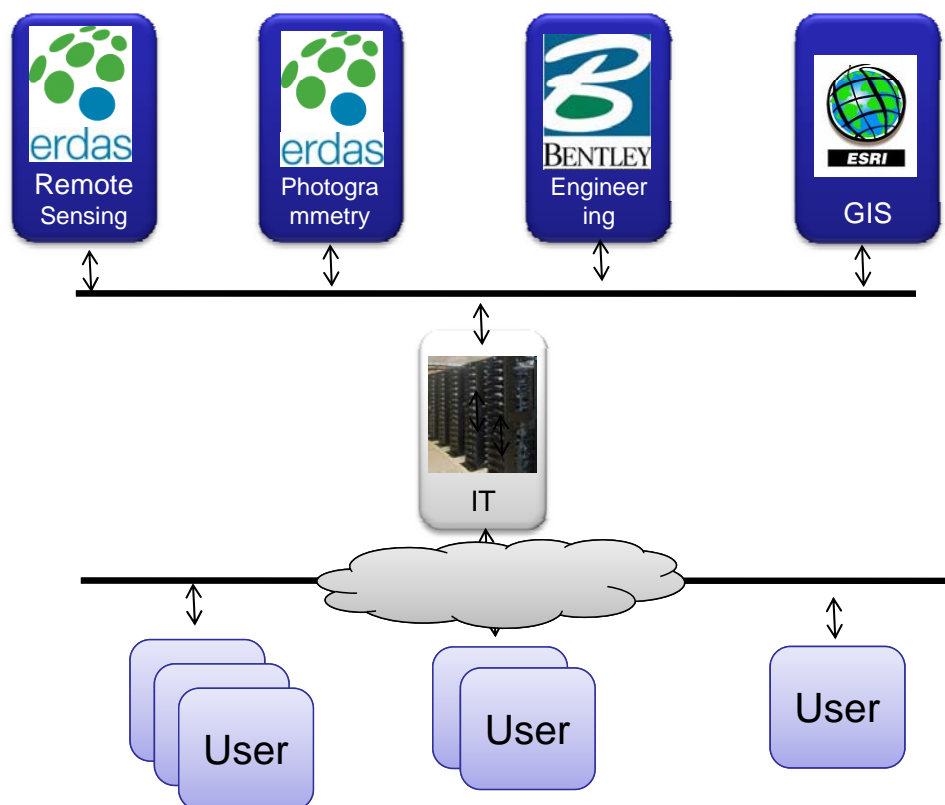
GIS Department

Engineering Department

IT Department

GeoInformation Life-Cycle

Integrate the Flow of Information

A Spatial Data Infrastructure

A Spatial Data Infrastructure is the relevant base collection of technologies, interoperable data modeling, policies and institutional arrangements that *facilitate the availability and access to spatial data*.

- Provides a basis for spatial data discovery, evaluation, and application for users throughout the organization
- Is more than a single data set or database; an SDI hosts geosptial data and attributes, it should provide
  - **sufficient documentation** (metadata)
  - **a means to discover, visualize, and evaluate the data** (Catalogues and Web Mapping)
  - **some method to provide access to the geographic data** (Un-portrayed data)

GEOSS connects Observations to Decisions
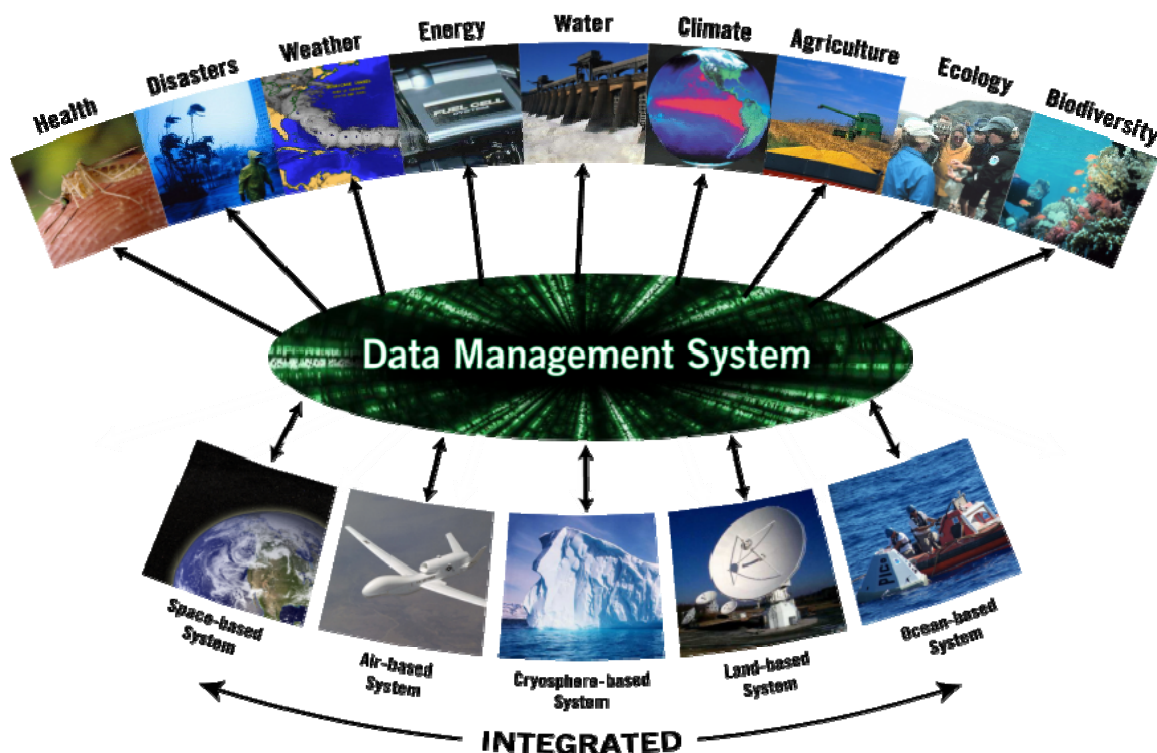
Global Earth Observation System of Systems

- GEO was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries

- GEO is constructing GEOSS on the basis of a 10-Year Implementation Plan for the period 2005 to 2015. The Plan defines a vision statement for GEOSS and the nine "Societal Benefit Areas" of disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity.

- This 'system of systems' will proactively link together existing and planned observing systems around the world and support the development of new systems where gaps currently exist.

- It will promote common technical standards for Earth Models, Sensor Web, and Web Services, so that data from the thousands of different instruments can be combined into coherent datasets.

Systems Like This Must Have ...

- Tools for acquiring and/or creating the data…

  Author

- A means of organizing and accessing the data and services available…

  Manage

- A means of connecting to and communicating with the system…

  Connect

- A means of effectively delivering the data to the user...

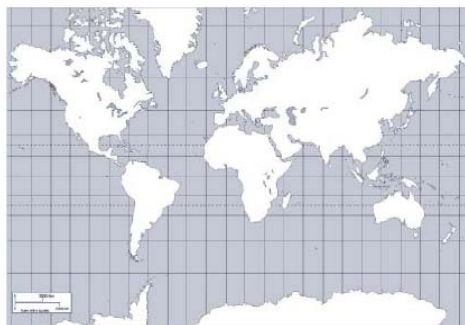 Deliver

OGC and ISO Geospatial Standards

- OGC
  - Coordinate Transformation
  - Observation & Measurements (O&M)
  - Sensor Model Language (SensorML)
  - Sensor Observation Service (SOS)
  - Sensor Planning Service (SPS)
  - Transducer Markup Language (TML)
  - Web Coverage Service (WCS)
  - Web Processing Service (WPS)
  - Web Feature Service (WFS)
- ISO
  - ISO 19130 – sensor and data models for imagery and gridded data
  - ISO 19115 – schema required for describing geospatial data and services

Coordinate Transformation Services

- Provides a common framework for relating geospatial data
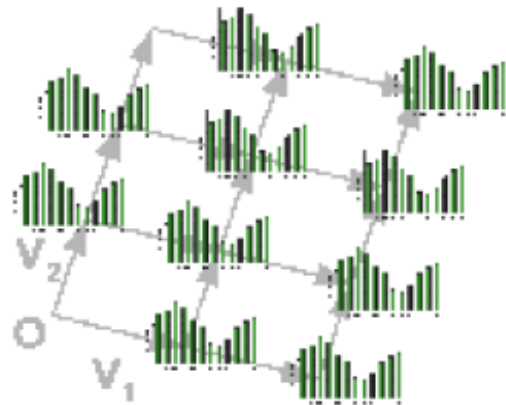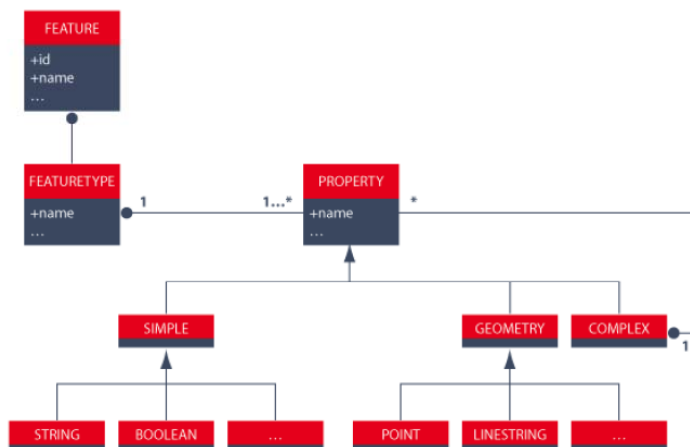- EPSG system is the most well know authority

OGP

Web Mapping Service (WMS)

- Defines a means of specifying the components of a map and how to style them (SLD)
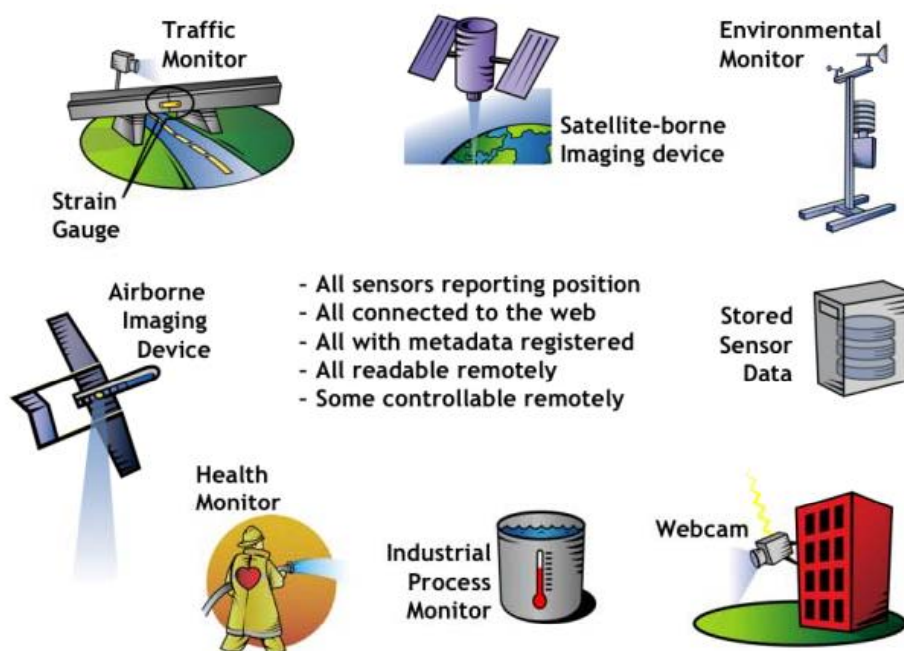- Defines the mechanism for requestiong and delivering the map as a Web Graphic (JPG, PNG)

Web Feature & Coverage Services (WFS, WCS)

- Features are named collections of properties, most commonly a geometry and attributes (GML)
- Coverages are collections of regularly spaced measures or obvservations, most commonly images. (GeoTIFF, etc)
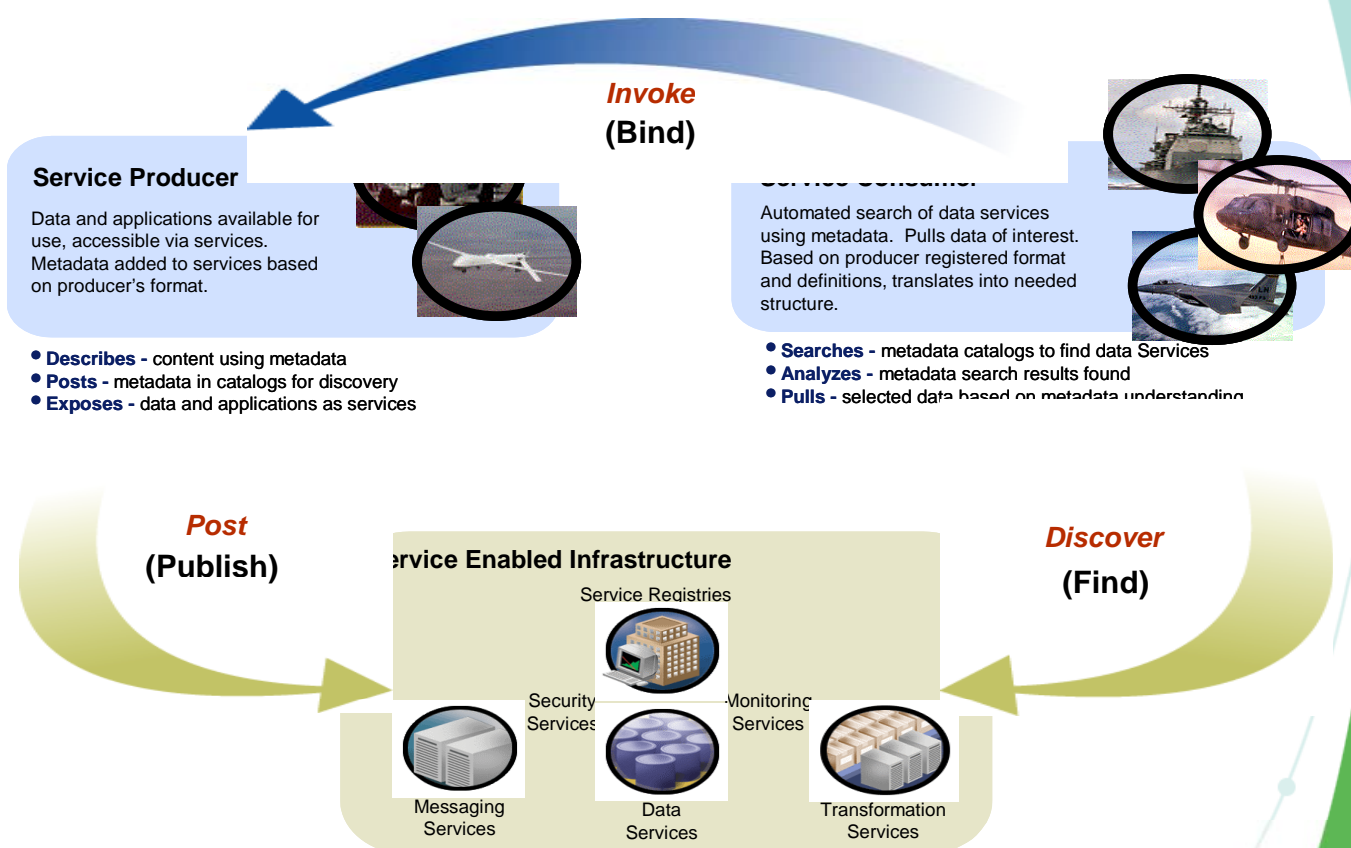
Sensor Web Enablement (SWE)

Traffic Monitor

Strain Gauge

Airborne Imaging Device

Health Monitor

Industrial Process Monitor

Satellite-borne Imaging device

Environmental Monitor

Stored Sensor Data

Webcam

- All sensors reporting position
- All connected to the web
- All with metadata registered
- All readable remotely
- Some controllable remotely

The "Publish-Find-Bind" Model

Invoke
(Bind)

Service Producer

Data and applications available for use, accessible via services. Metadata added to services based on producer's format.

- **Describes -** content using metadata
- **Posts -** metadata in catalogs for discovery
- **Exposes -** data and applications as services

Service Consumer

Automated search of data services using metadata. Pulls data of interest. Based on producer registered format and definitions, translates into needed structure.

- **Searches -** metadata catalogs to find data Services
- **Analyzes -** metadata search results found
- **Pulls -** selected data based on metadata understanding

Post
(Publish)

Discover
(Find)

Service Enabled Infrastructure

Service Registries

Security Services

Monitoring Services

Messaging Services

Data Services

Transformation Services

Catalog Service (CSW)

- Manage the discovery of services and data
- Support well known metadata standards (ISO 19115, eBRIM)
- Support common language for expressing search criteria
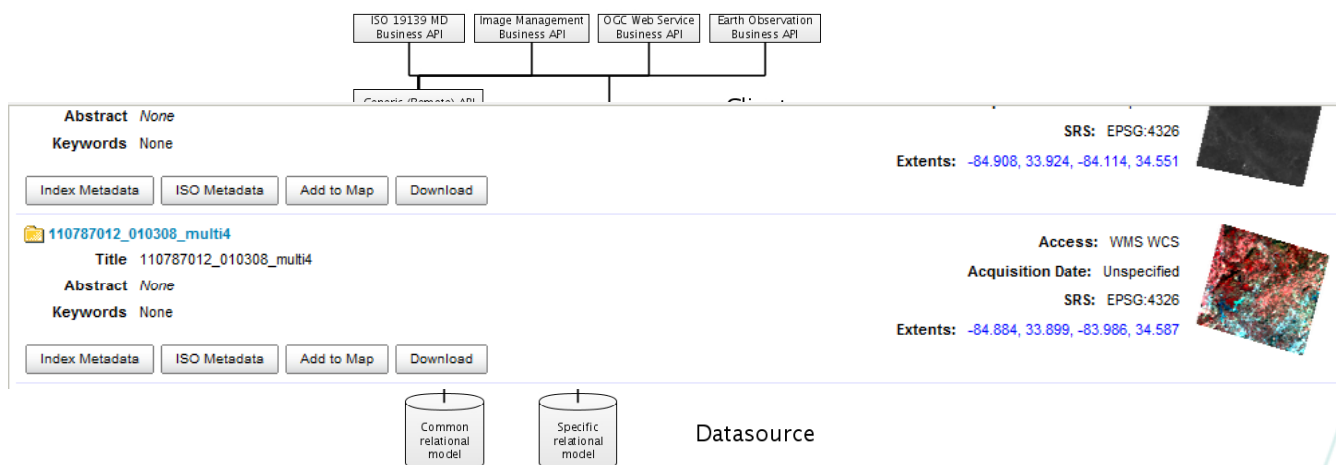
Sometimes You Need Speed

- This highest interoperability with the broadest range clients is achieved using Web Graphics (WMS) or TIFF (WCS)

- Two possible techniques to improve performance are tiled delivery formats (OTDF) or wavelet compressions (ECW, JP2)
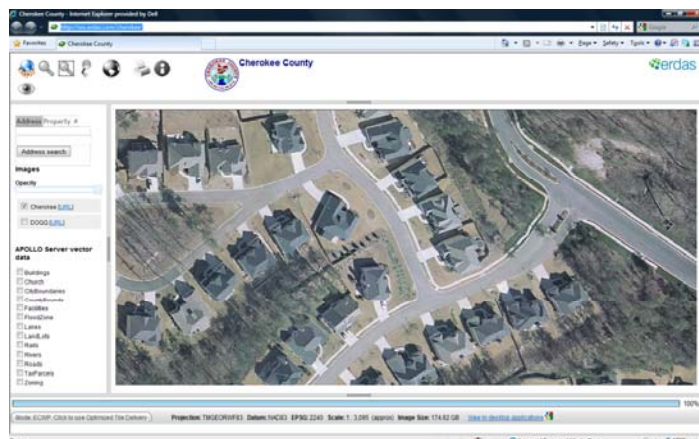
Autonomous Persistent Mapping
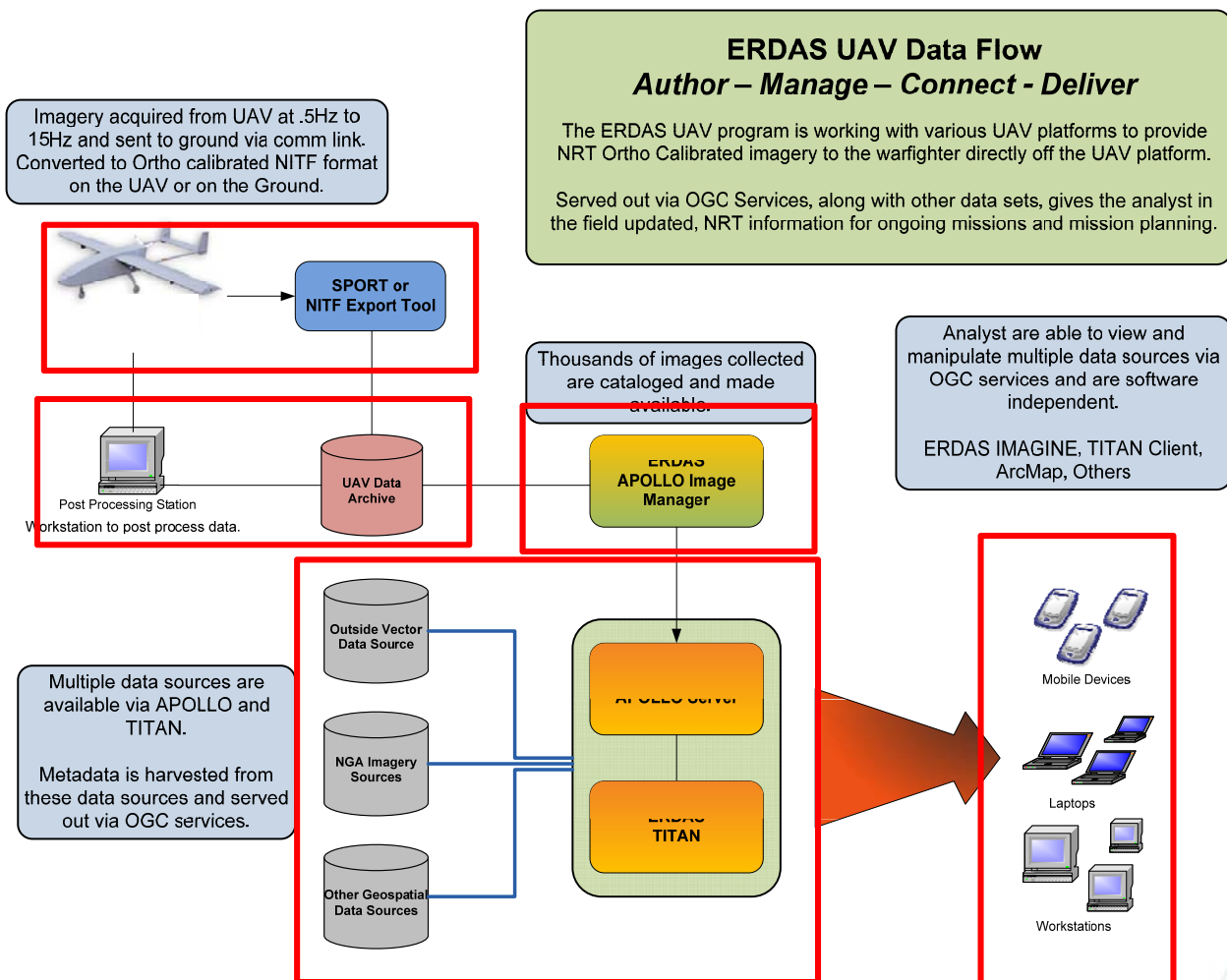## Empire Challenge '08 – TEC SpeckEye

Key Objectives

- Build a solution for two different UAVs
- Conduct Autonomous Collections via OGC Services (SWE)
- Process Imagery to a high degree of GeoSpatial Precision
  - Processed to Mapping Standards
  - On-the-Bird Processing
  - Near Real-time Downlink
- Serve resulting data to a broad range of users using OGC

ERDAS UAV Data Flow
Author – Manage – Connect - Deliver

The ERDAS UAV program is working with various UAV platforms to provide NRT Ortho Calibrated imagery to the warfighter directly off the UAV platform.

Served out via OGC Services, along with other data sets, gives the analyst in the field updated, NRT information for ongoing missions and mission planning.

Imagery acquired from UAV at .5Hz to 15Hz and sent to ground via comm link. Converted to Ortho calibrated NITF format on the UAV or on the Ground.

SPORT or NITF Export Tool

Thousands of images collected are cataloged and made available.

Analyst are able to view and manipulate multiple data sources via OGC services and are software independent.

ERDAS IMAGINE, TITAN Client, ArcMap, Others

Post Processing Station
Workstation to post process data.

UAV Data Archive

ERDAS APOLLO Image Manager

Outside Vector Data Source

Multiple data sources are available via APOLLO and TITAN.

Metadata is harvested from these data sources and served out via OGC services.

NGA Imagery Sources

APOLLO Server

ERDAS TITAN

Other Geospatial Data Sources

Mobile Devices

Laptops

Workstations

First Flight Success

Take it Beyond
Delivery of Data

What about Processing as a Service?

- Just collecting processing and disseminating data is not enough
- The Web Processing Service (WPS) defines a framework for exposing and requesting general processes to be run as a service.
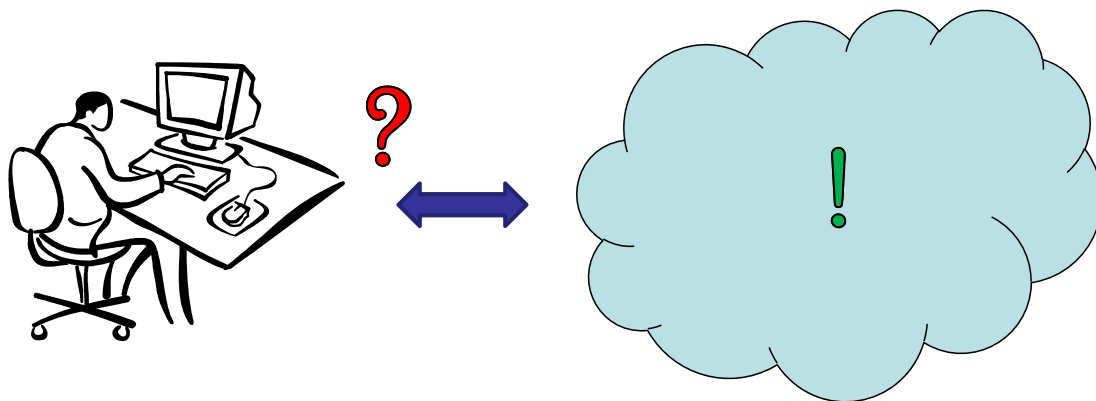
Description of a Processing Service

- A processing service is a "black box"
- It is described by its inputs and outputs (Describe)
- They can be discovered and run (Get Capabilities, Execute)
- Client applications can chain them together

Input 1 → | Input 2 → | Input 3 → **Processing Service** → Output
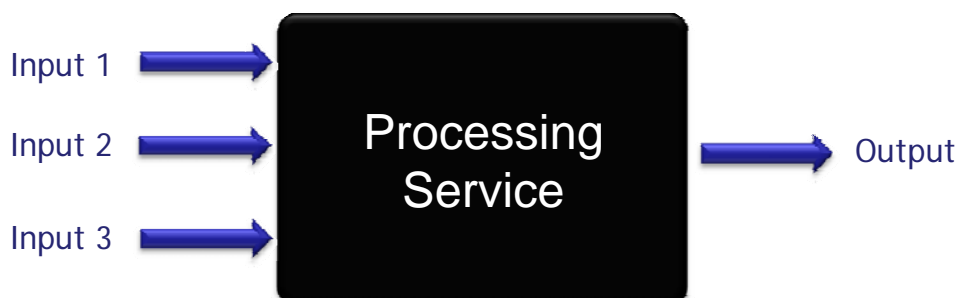
Imaging Services ...?

- Geolocation
- Reprojection
- Land Cover Classification
- Ice Mapping
- Crop Monitoring
- Urban Mapping
- Disaster Monitoring
- Bathymetry
- Mobility Analysis
- Change Detection
- Building Extraction
- Subsidence Mapping

- Environment Monitoring
- Feature Extraction/Detection
- Crop Production Estimation
- Biodiversity Characterization
- Road Extraction
- Elevation Extraction
- Urban and Regional Planning
- Defense Mapping
- Wetlands Mapping
- City Modeling
- Target Mapping

Spatial Modeling

```
integer incount;
integer outcount;
incount = numlayers (f1);
outcount = arg9;

set aoi arg12;
float raster tempout;
float matrix cov [incount, incount];

cov = covariance (f1);
tmpmtx = eigenmatrix (cov);
eig = eigenmatrix (cov) [1, 1: incount, outcount];

 transmtx = mattrans (eig); if(arg11) {
tempout = linearcomb (f1, transmtx);
out = ((tempout - global min(tempout))/(global
max(tempout)
      - global min(tempout))) * 255;
 }
 else {
   out = linearcomb (f1, transmtx);
 }
 quit;
```
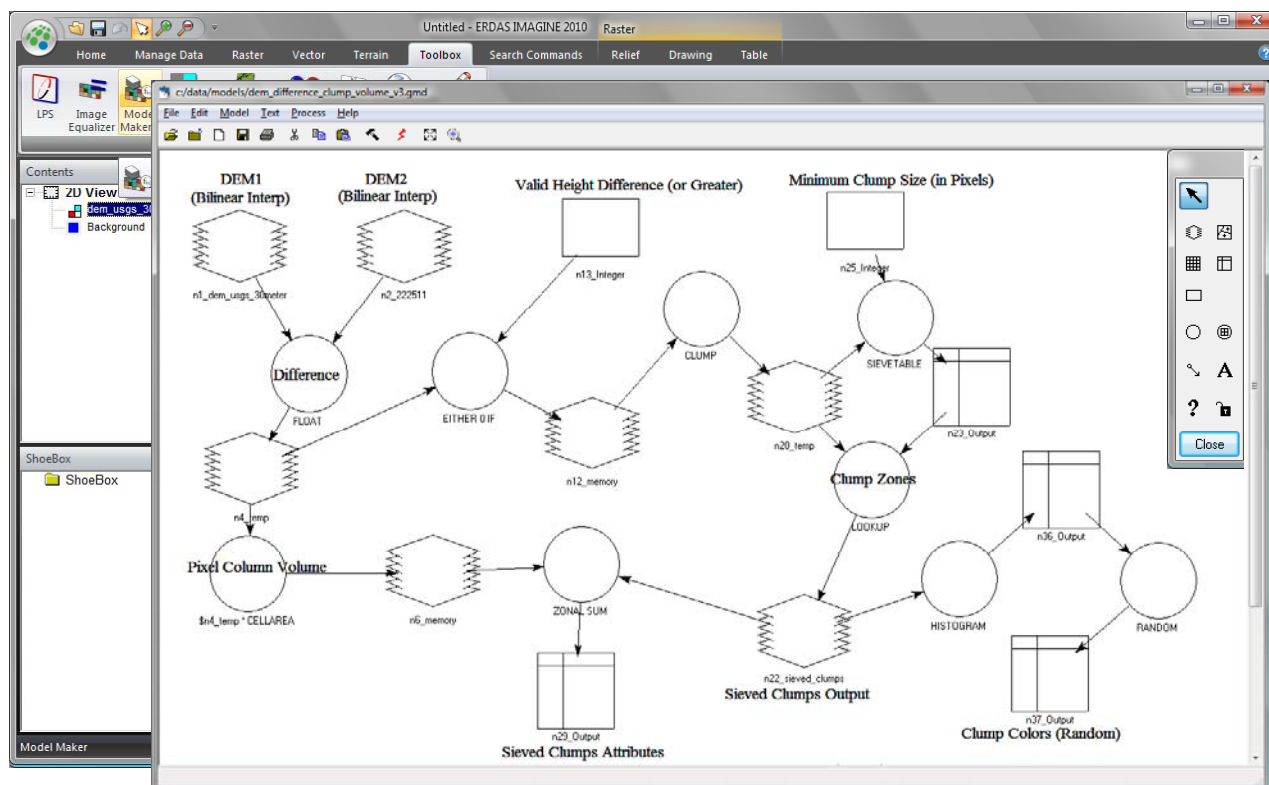

Spatial Model Script

Coverage Data

Modeling Engine
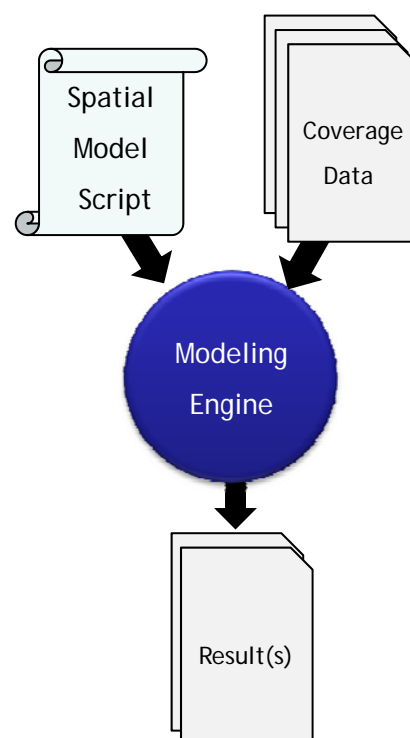
Result(s)

Spatial Modeling Service in WPS
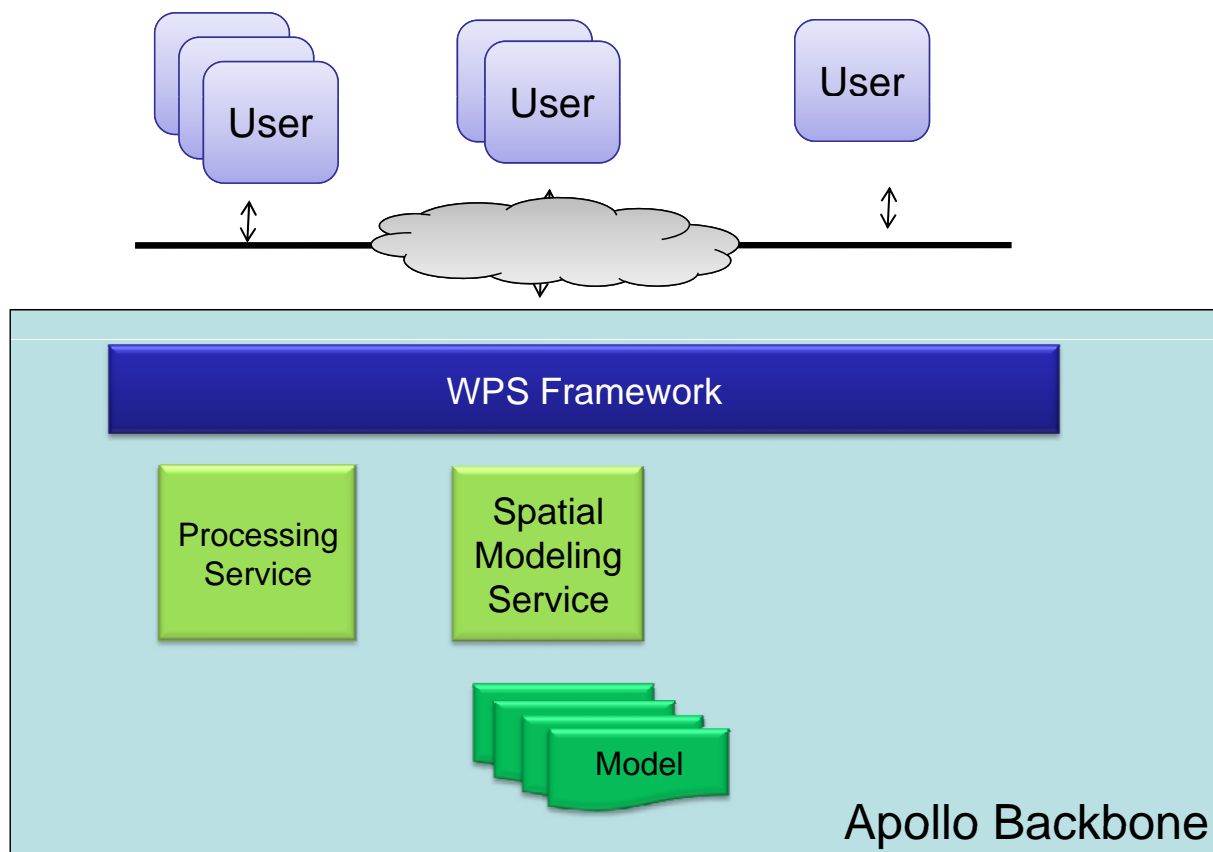
Create a Model

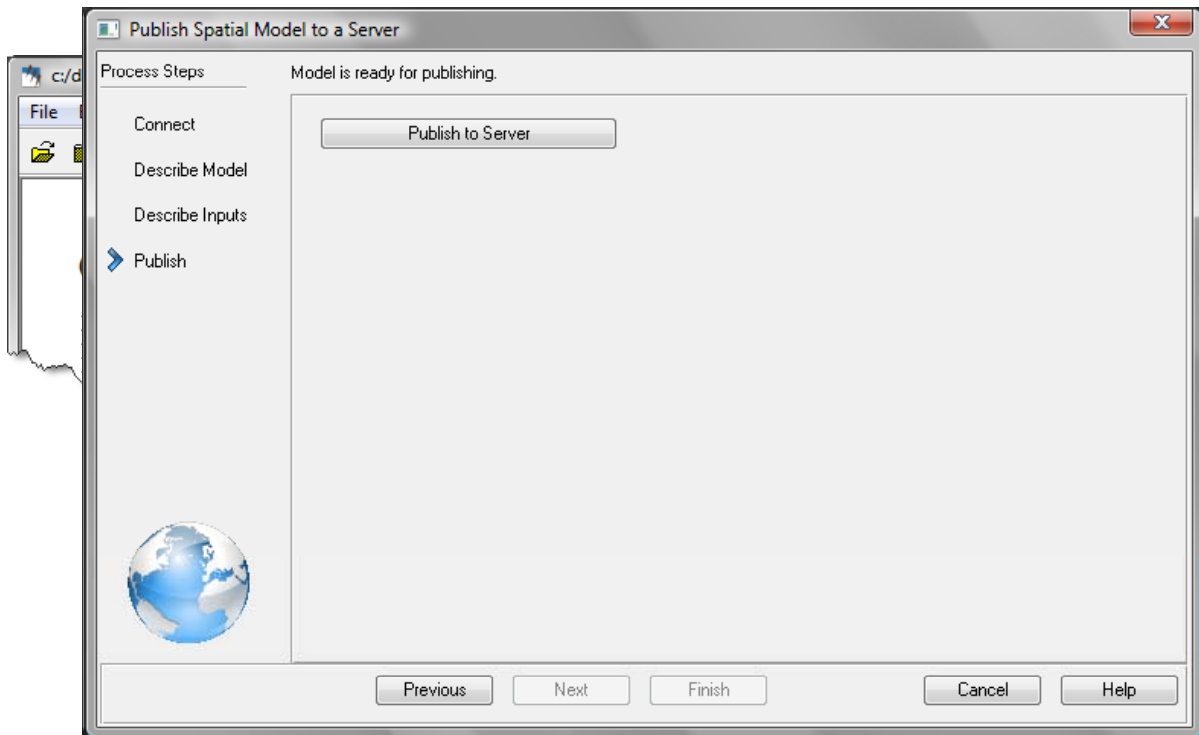# Check the Model Results..
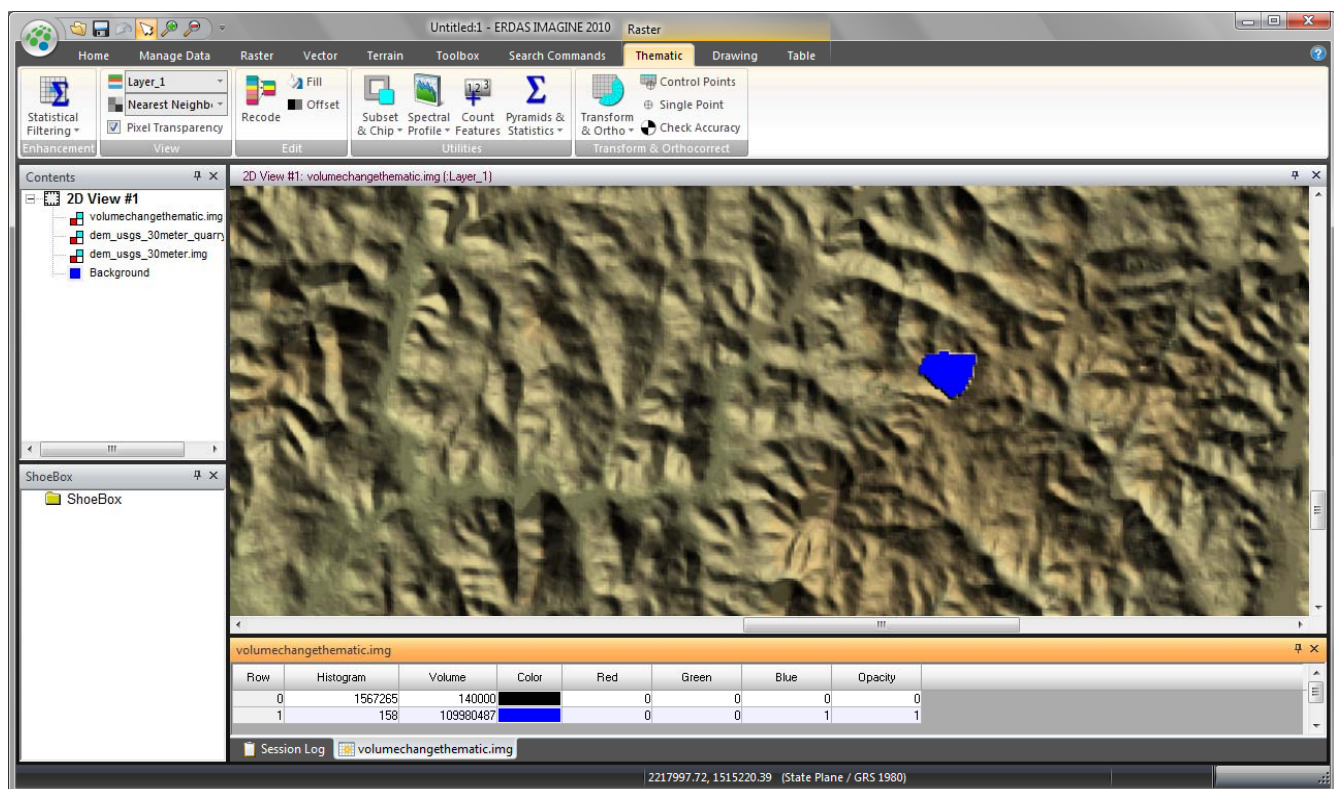
Model Metadata to be Published

- Name of the model
- Category for the model
- Full Description of the model
- The inputs and outputs
- For each input and output define
  - Input or output
  - Type: raster, a number, a color, etc
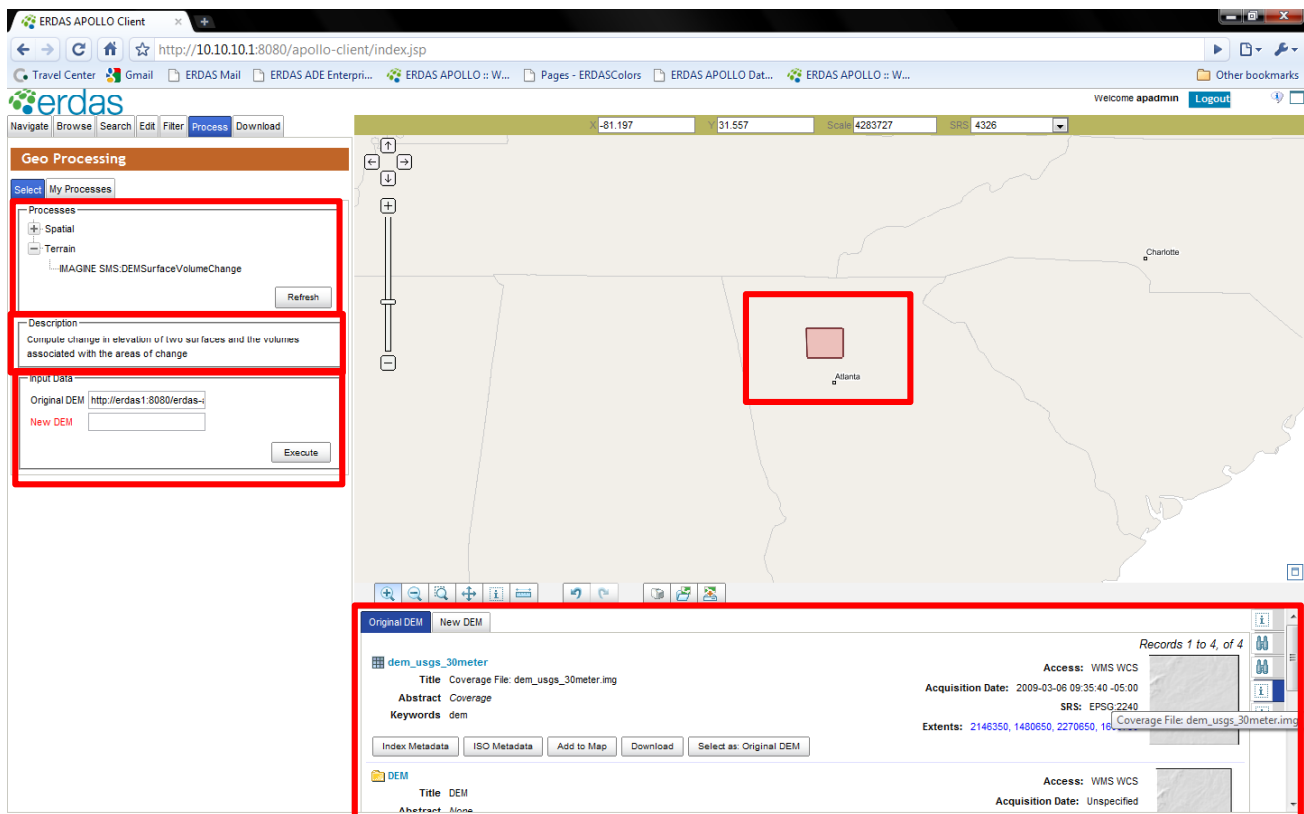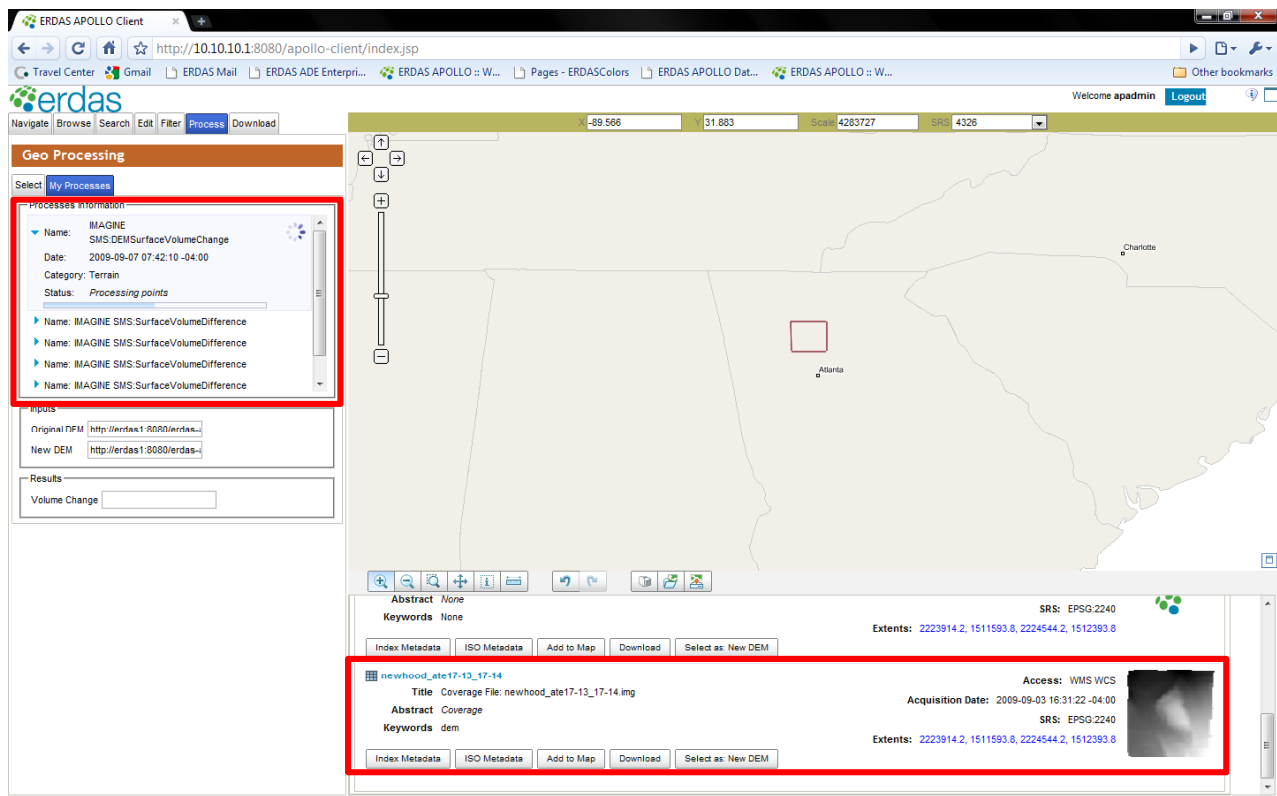 - Constraints

Publish the Model...

Access the Model from a Browser

Multiple Processes can be Run

Some Forestry Models from USFS
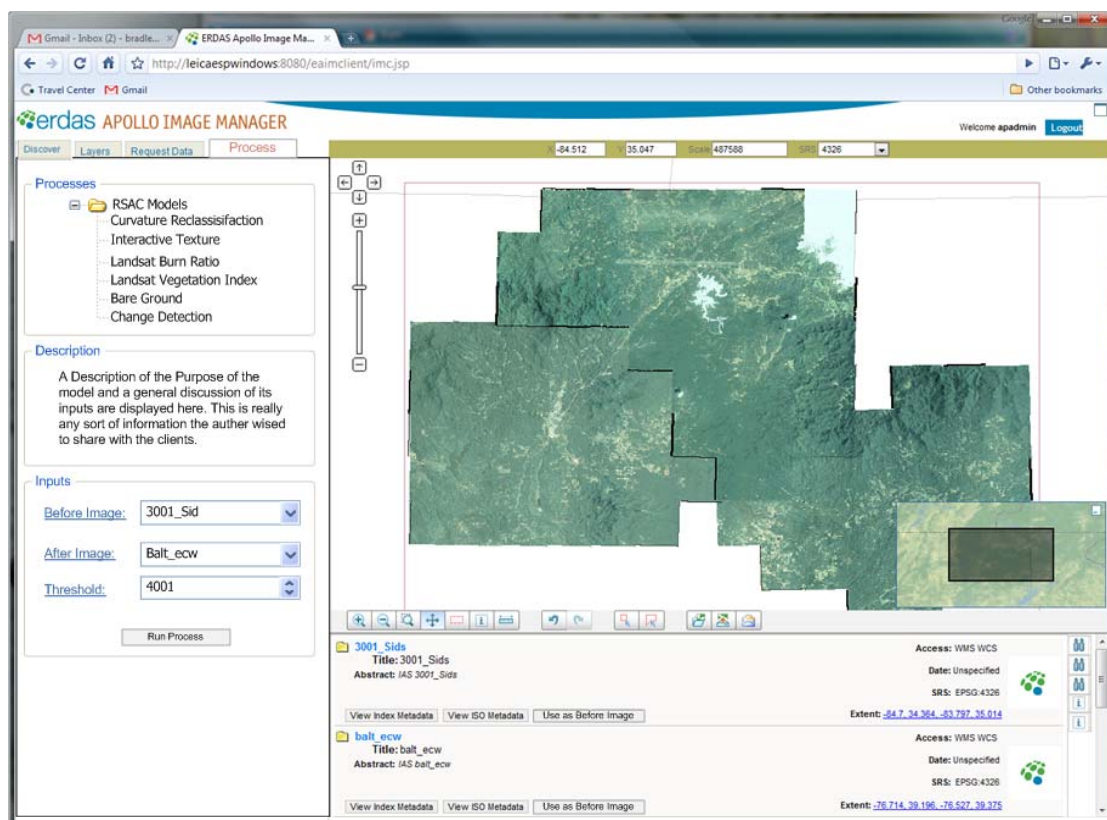
Spatial Modeling Results in TITAN
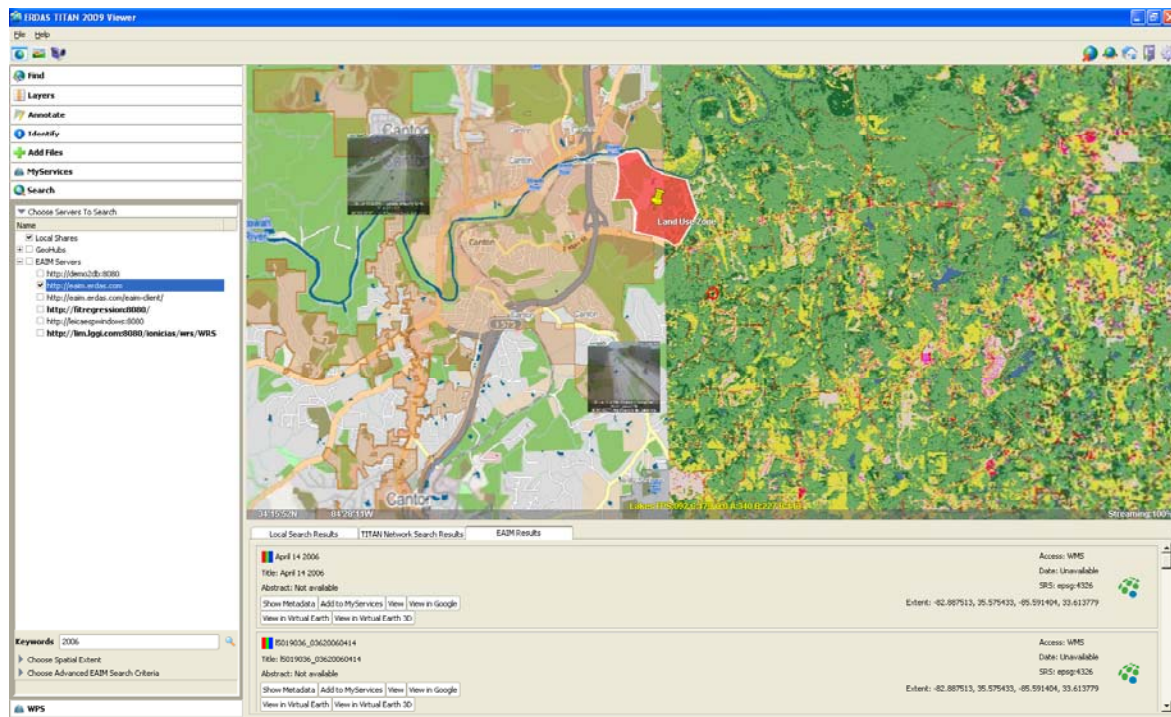
Results can be Viewed in Any WMS Client
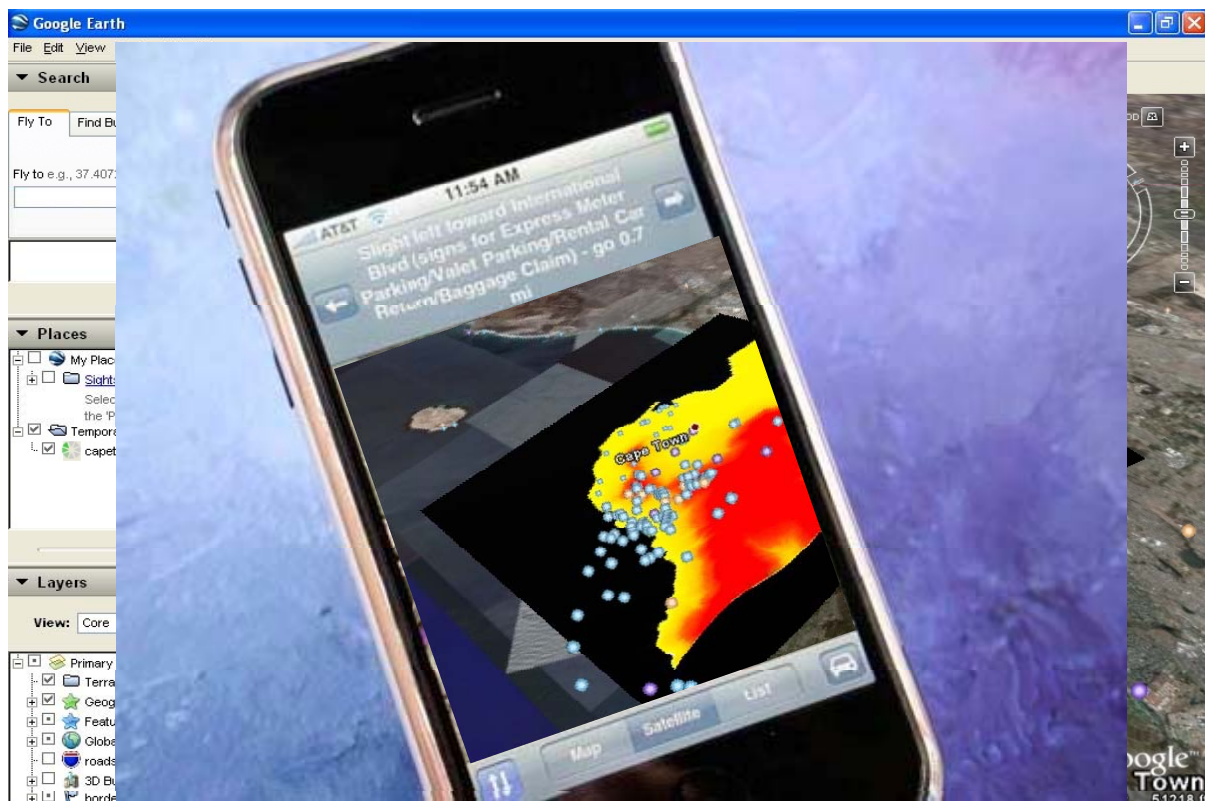
Conclusion

- Geospatial processing will become a mainstream tool in the general enterprise toolbox which will be integrated at many levels throughout the organization.

- Processing as a Service will make the benefits of Remote Sensing and Photogrammetry accessible to the general consumer.

Thank You