



# Sensor Standards Frameworks Meeting A Variety of Business Needs

NIST Hosted Sensor Standards Harmonization Meeting  
21 June 2006

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# Present Situation

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- Variety of open consensus standards emerging from international and industry SDO's
    - IEEE, ISO, OASIS, OGC
  - National consensus standards
    - ANSI
  - Proprietary open interfaces
- 
- All produced in response to a range of business needs
  - Some adopted, some in development
  - Address and interoperate across different layers of the IT stack
  - Unique, complimentary and potentially overlapping capabilities
  - All need further trial, testing and validation under a greater range of business cases to determine value and applicability

# Sensor Standards Framework

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- Three Viewpoints:
  - Enterprise Viewpoint – use cases / scenarios / policies
  - Information Viewpoint – semantics, models, and relationships
  - Services Viewpoint – moving data through and open distributed network
- Frameworks (profiles) exist for different Communities of Interest, Business processes
  - Draw from a broader universe of standards
  - Provide consistent acquisition / development guidance for that community

# At Our Last Meeting...



- **Common Set of Use Cases** – important resource to drive our work.
- **Information Sharing** policies
- **Joint Testbeds** to assist and accelerate harmonization work
- **SDOs collaborate** on advancement of sensor and related standards based frameworks needed to meet mission needs.
- **Joint Interoperability Demonstrations**
- **Gap analysis:**
  - Consistent, accurate methodology for defining “location” in content objects of EDXL payload (OGC standards may offer the solution)
  - Based on results from joint testbed activities, affirm standards capability and identify gaps for further work (e.g. prioritization/tasking of sensors/actuators)

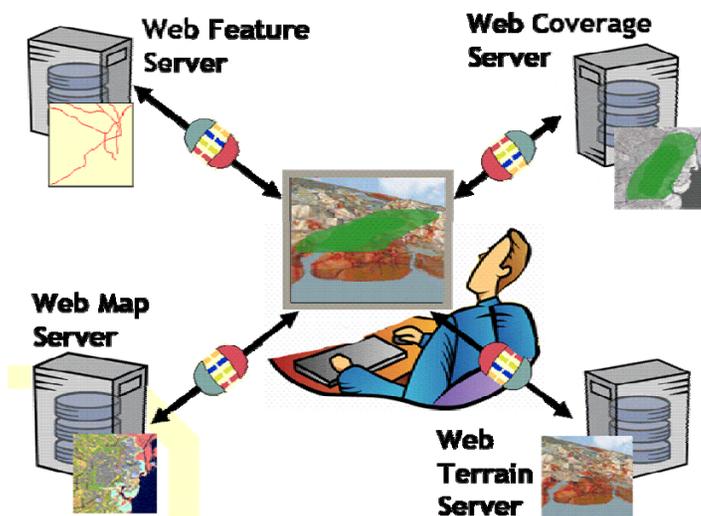


# Sensor Web

# Fully Compatible with & Builds On The OGC / ISO Open Standards Framework for Enterprise GeoServices



Just as http:// is the dial tone of the World Wide Web, and html / xml are the standard encodings, **the spatial web** is enabled by OGC and ISO standards, such as...



- Web Map Service (OGC & ISO)
- Style Layer Descriptor (OGC)
- Feature Model & GML (OGC & ISO)
- Web Feature Service (OGC)
- Web Terrain Service (OGC)
- Web Coverage Service (OGC)
- Web Map Context (OGC)
- Catalogue (OGC)
- Metadata (ISO 19115 & OGC)

Data related to Homeland Security, D&I is geospatial (e.g., vector, raster, gridded, and metadata) in nature – can be managed through OGC/ISO based web services in a Net Centric context.

# Builds on OGC Open Location Services

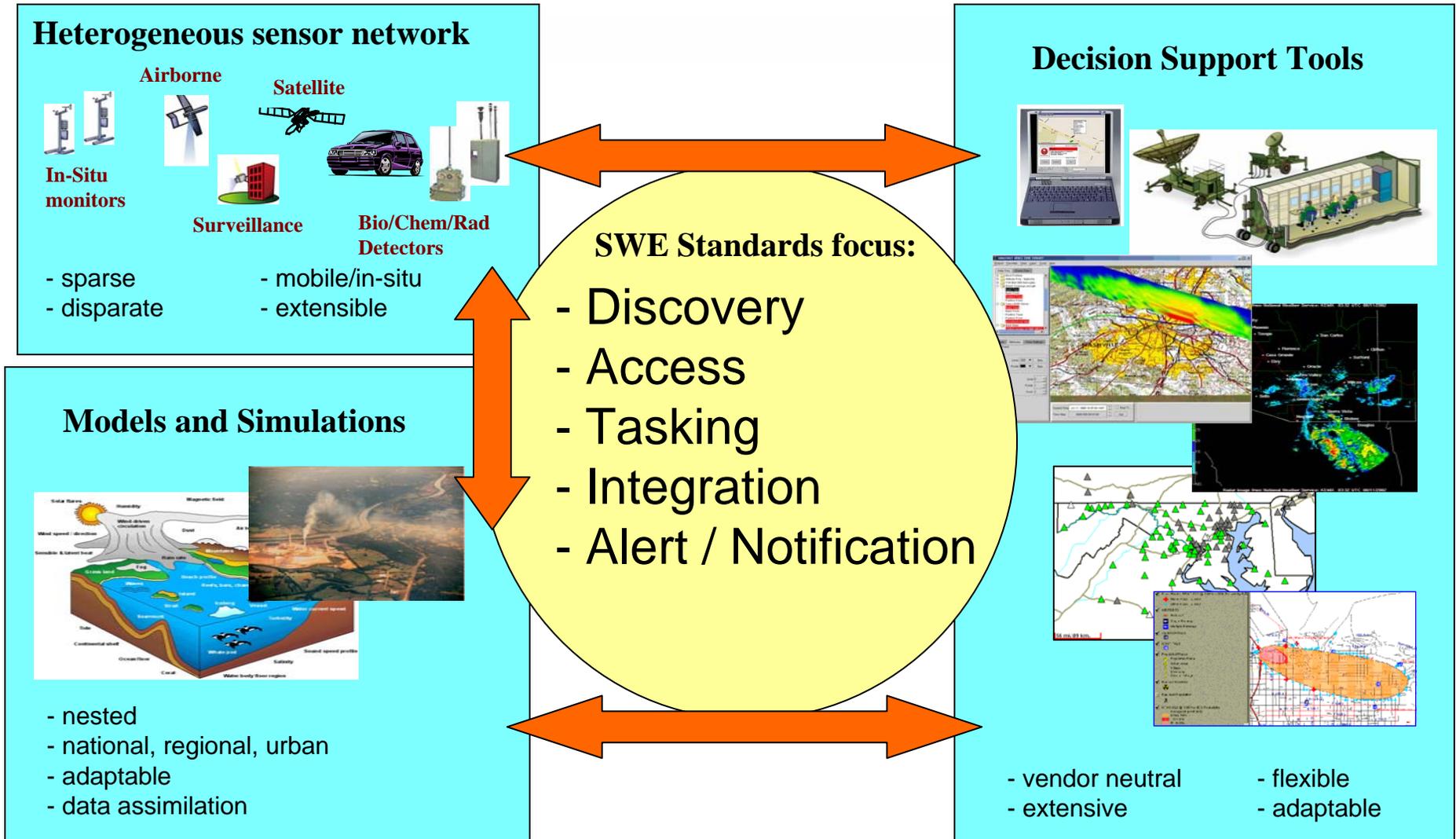


- Includes location-based emergency services, location-based information services, location responsive instant-messaging systems and other services.
- OGC's Open Location Services (OpenLS) specification provides standards framework consistent with both telephony standards and geospatial standards.
- So, geospatial applications can be easily developed and integrated across a range of location-aware mobile devices and networks.



# Sensor Web Enablement (SWE)

Based on OGC, OASIS, IEEE, ISO, IEC



# SWE Goals

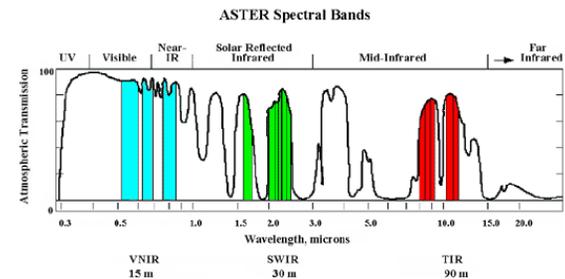
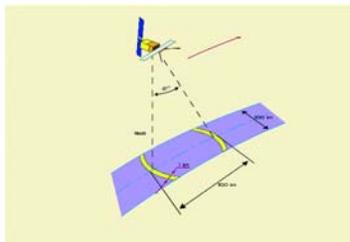


- Quickly **discover sensors** (secure or public) that can meet my needs – and **learn about what they can do** (location, observables, quality, ability to task)
- **Obtain sensor information** in a standard encoding that is understandable by the user and by software
- Readily **access sensor observations** in a common manner, and in a form specific to my needs
- **Task sensors**, when possible, to meet my specific needs
- Request and **receive alerts / notification** when a sensor measures a particular phenomenon, or completes a requested task

# OGC Sensor Web Enablement



- Sensor Web Enablement Framework - Schema
  - **SensorML** – models and schema for describing sensor characteristics (geolocation, response)



- **Observation & Measurement** – models and schema for encoding sensor observations

# OGC Sensor Web Enablement

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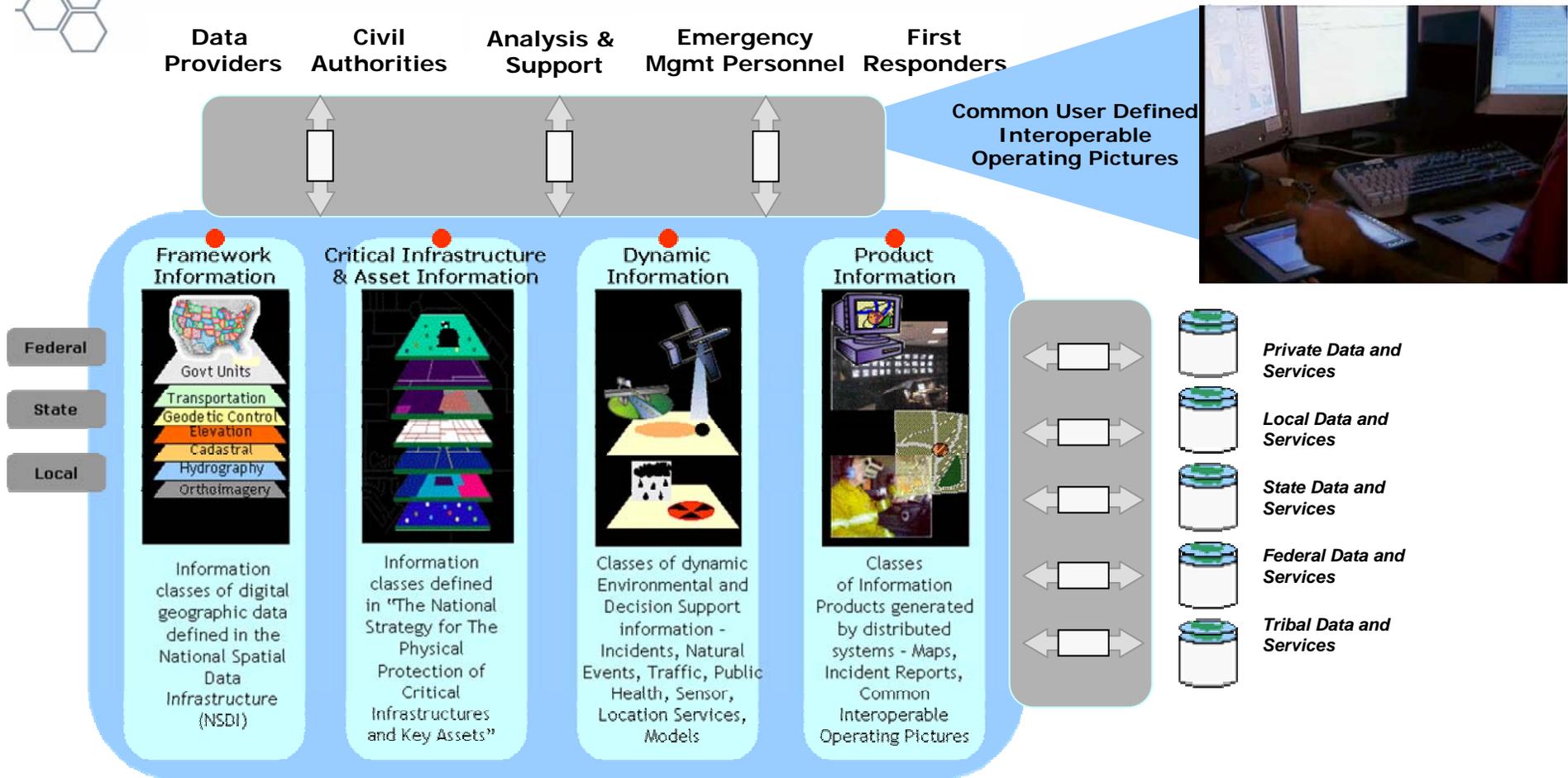
- **Sensor Web Enablement Framework – Services**
  - **Sensor Observation Service** – access sensor information (SensorML) and sensor observations (O&M)
  - **Sensor Planning Service** – task sensors or sensor systems
  - **Web Alert Service** – asynchronous notification of sensor events (tasks, observation of phenomena)
  - **Sensor Registries** – discovery of sensors and sensor data

# OGC Sensor Web Enablement

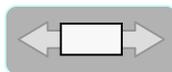


- Reaching out to the broader standards / IT community
  - **TransducerML** – XML protocol for streaming data clusters from transducers (sensors, transmitters, actuators)
  - **Common Alert Protocol (CAP)** – developed by international emergency management community (OASIS) for XML publishing of events
  - **IEEE P1451** – provides “plug-n-play” capabilities for sensors; looking at complimentary interaction between 1451, SensorML, and the SWE Framework

# Common Geospatial Interoperability Framework Multi-source Access and Integration (Homeland Security)



**Information Architecture:**  
Models, Transforms, Application Schemas and Dictionaries



**Service Architecture:**  
Standards, Certified Services for Accessing, Processing, Presenting Information

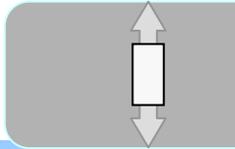


*Geospatial Interoperability Framework development is a key focus of ongoing OGC Testbeds to meet cross-organizational enterprise challenges.*

# Common Geospatial Interoperability Framework Multi-source Access and Integration (Homeland Security)



Data Providers    Civil Author



Framework Information



Information classes of digital geographic data defined in the National Spatial Data Infrastructure (NSDI)

Federal

State

Local

Critical & Asse

In  
clas  
in "r  
Stra  
Pr  
Infr  
and



Processing, Presenting Information



Information Architecture  
Models, Transforms, Ap  
Schemas and Dictionaries



*Geospatial Interoperability Framework development is a key focus of ongoing OGC Testbeds to meet cross-organizational enterprise challenges.*

# Addresses HLS and DOD Enterprise Needs

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- A taxonomy of well known - reusable service interfaces
  - Build once - use many
  - Enforces a finite number of interfaces that clients have to support
  - Avoids an incomprehensible babble of service interfaces
- Separation of interface elements that must be hard coded from those that can be configured at run time
  - Supported format types
  - Data content
  - Area of coverage
  - Optional features
- Configurable properties can be **discovered and negotiated at run time.**



# Rapid Prototyping To Mature / Standards in Context

# OGC Sensor Web Enablement - Background

SensorML initiated at Univ. of Alabama

2000



OGC Web Services Testbed 1.1

- Sponsors: EPA, NASA, DOD
- Specs: SOS, O&M, SensorML
- Demo: NYC Terrorist
- Sensors: weather stations, water quality

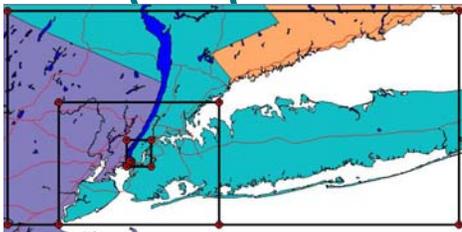
2002

• Specs advanced through independent R&D efforts in Germany, Australia, Canada and US

- Sensor Web Work Group established
- Specs: SOS, O&M, SensorML, SPS, WNS, SAS
- Sensors: Wide Variety

2003-4

2001



OGC Web Services Testbed 1.2

- Sponsors: EPA, General Dynamics, NASA, DOD
- Specs: SOS, O&M, SensorML, SPS, WNS
- Demo: Terrorist, Hazardous Spill and Tornado
- Sensors: weather stations, wind profiler, video, UAV, stream gauges

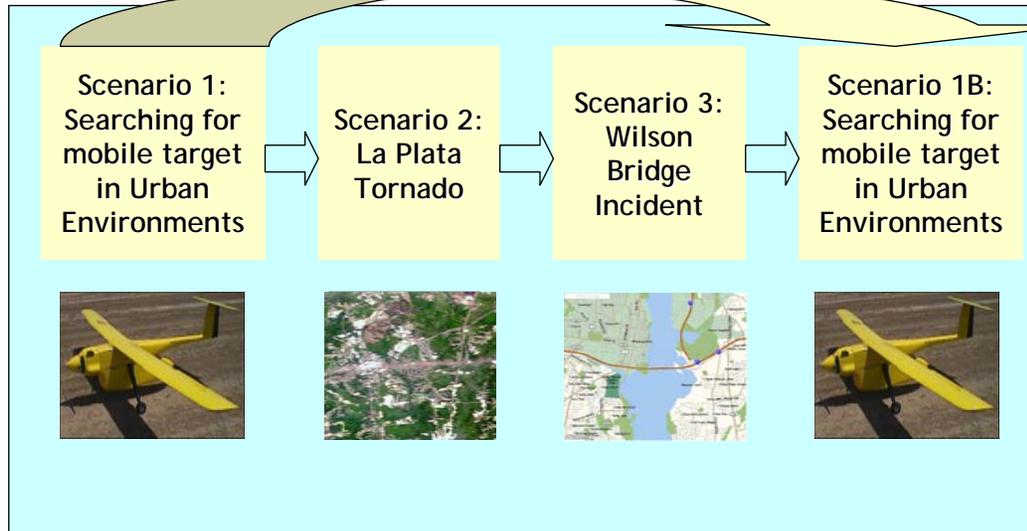


2005-6

- OWS4 Testbed Matures Specs as an Enterprise Framework
- Formal collaboration with IEEE, OASIS
- Specs: TransducerML, integration with Location Based Services
- Sensors: Wide Variety
- SWE Standards to be introduced to OGC's Technical Committee for consideration as Adopted OGC standards



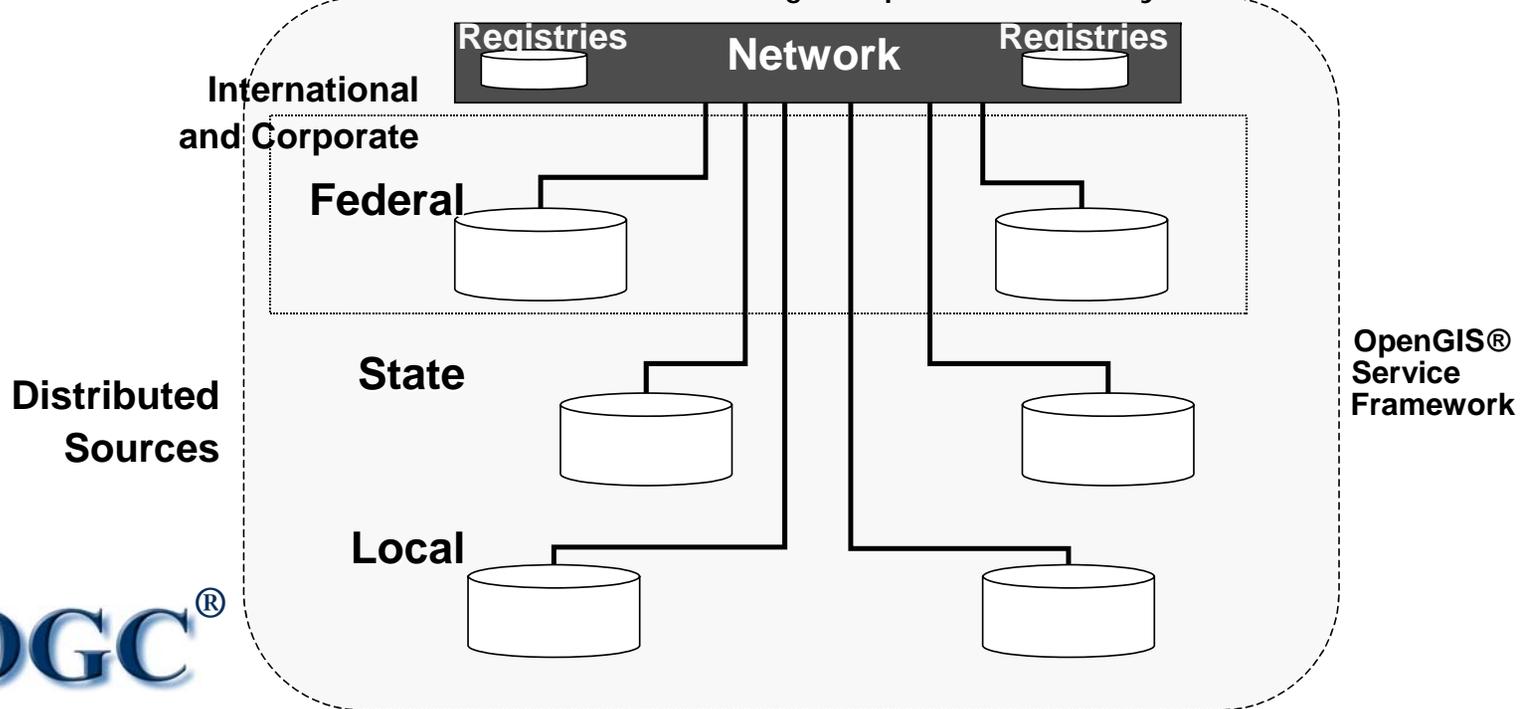
Tasking      Collection      Processing      Dissemination      Analysis



EOC Must Respond to Dynamic Events Happening Simultaneously

...

**Emergency Operations Center**  
Detection, Planning, Response, Recovery



# A Scenario from OGC Web Services 2 Testbed

Special Thanks to GeoData Systems



Tasking      Collection      Processing      Dissemination      Analysis

Scenario 1:  
Searching for  
mobile target  
in Urban  
Environments



Scenario 2:  
La Plata  
Tornado



Scenario 3:  
Wilson  
Bridge  
Incident



Scenario 1B:  
Searching for  
mobile target  
in Urban  
Environments



**Emergency Operations Center**

Detection, Planning, Response, Recovery



# OGC Web Services 3 Testbed

## The Scenario



An Emergency Response Center in Southern California receives notification of a fire in the hills east of San Diego. It threatens to breach an industrial storage facility near some inhabited regions.

Recognizing the risk that the resulting plume may contain toxic components in addition to the particulates and combustion products typical of a wildland fire, the professionals act quickly to find and deploy resources to track the plume and evaluate its composition, as well as to support the response effort.

### The Actors:

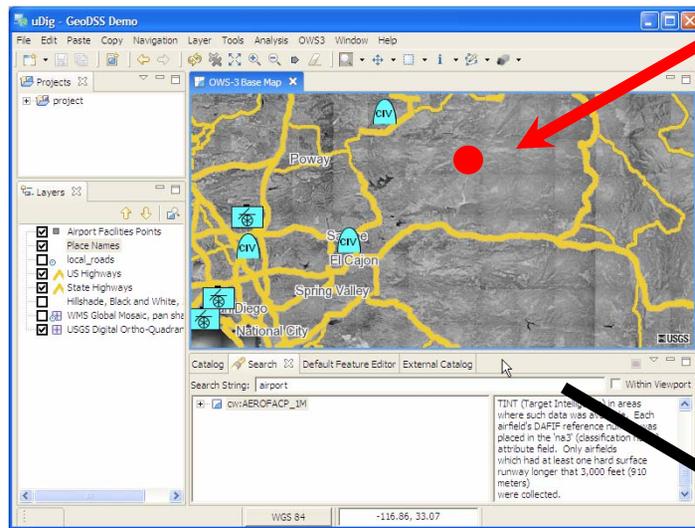
- NG1 = National Guard #1 at ERC - Refrations
- FS1 = Forest Service #1 at ERC - Intergraph
- NG2 = National Guard #2 at ERC - UAH
- FS2 = Forest Service #1 at ERC - York
- EMT = Emergency Response Team - Skyline

# Scene 1

## Alert / Notification. Establish Common Operational Picture

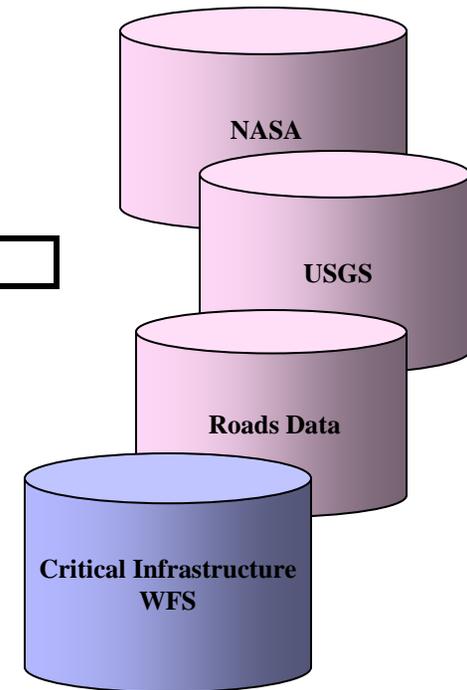
Alert arrives: probable fire in Pine Hills area

National Guard builds framework map from various interoperable data sources ...



... saves sharable context document

```
<Map>
  <More Info>
    <abc>
      def
    </abc>
  </More Info>
</Map>
```



# CAP Message from Sensor Alert Service



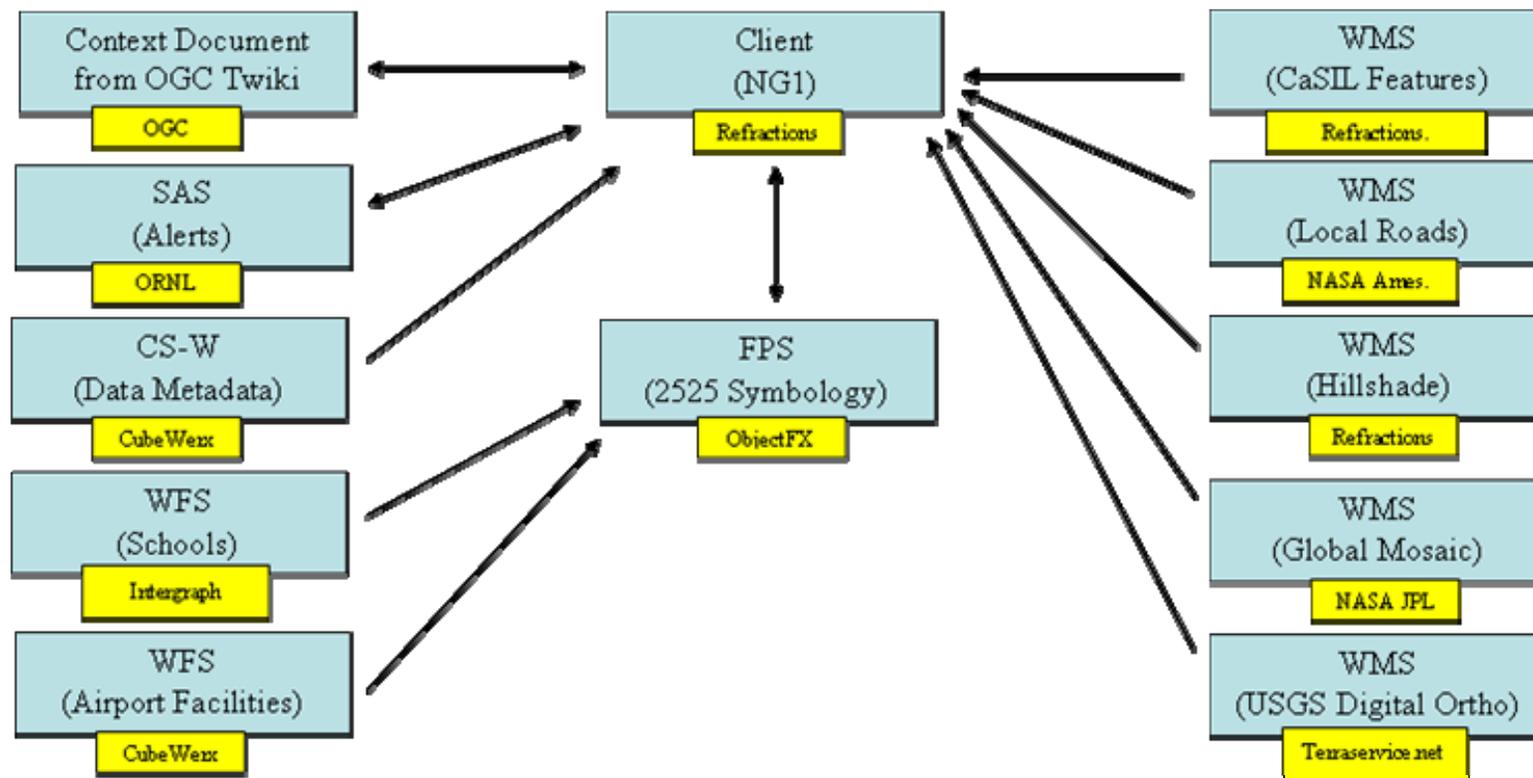
The screenshot shows the uDig - GeoDSS Demo application window. The title bar reads "uDig - GeoDSS Demo". The menu bar includes "File", "Paste", "Copy", "Layer", "Analysis", "OWS3", "Window", and "Help". The toolbar contains icons for file operations and navigation. The main window has a tab labeled "External Catalog" and a sub-tab "SAS CAP Message Subscriber (Pushlet)". The main content area displays a CAP message with the following details:

```
Sender Name : 3eTI Chemical Detection Center
urgency : Immediate
scope : Restricted
sender : cap-alerts@sas.3eti.net
identifier : system.acada-sensor-1.1129751545660
parameter : HD-conc=9.1
mimeType : text/xml
restriction : Classified
uri : http://sas.3eti.net/sml?fid=system.acada-sensor-1#HD-conc
headline : HAZARDOUS CHEMICAL RELEASE
polygon : -116.81600,32.86200 -116.81600,33.26200 -116.41600,32.86200 -116.41600,33.26200 -
116.81600,32.86200
msgType : Alert
size : 99
status : Actual
category : Security
severity : Severe
description : Chemical agent HD was detected
event : Chemical agent release
contact : mpriest@3eti.com
areaDesc : 3eTI Headerquarters
instruction : Stay indoors
resourceDesc : SensorML Document
sent : 2005-10-19T19:57:59.175Z
expires : 2005-10-19T19:58:23.175Z
```

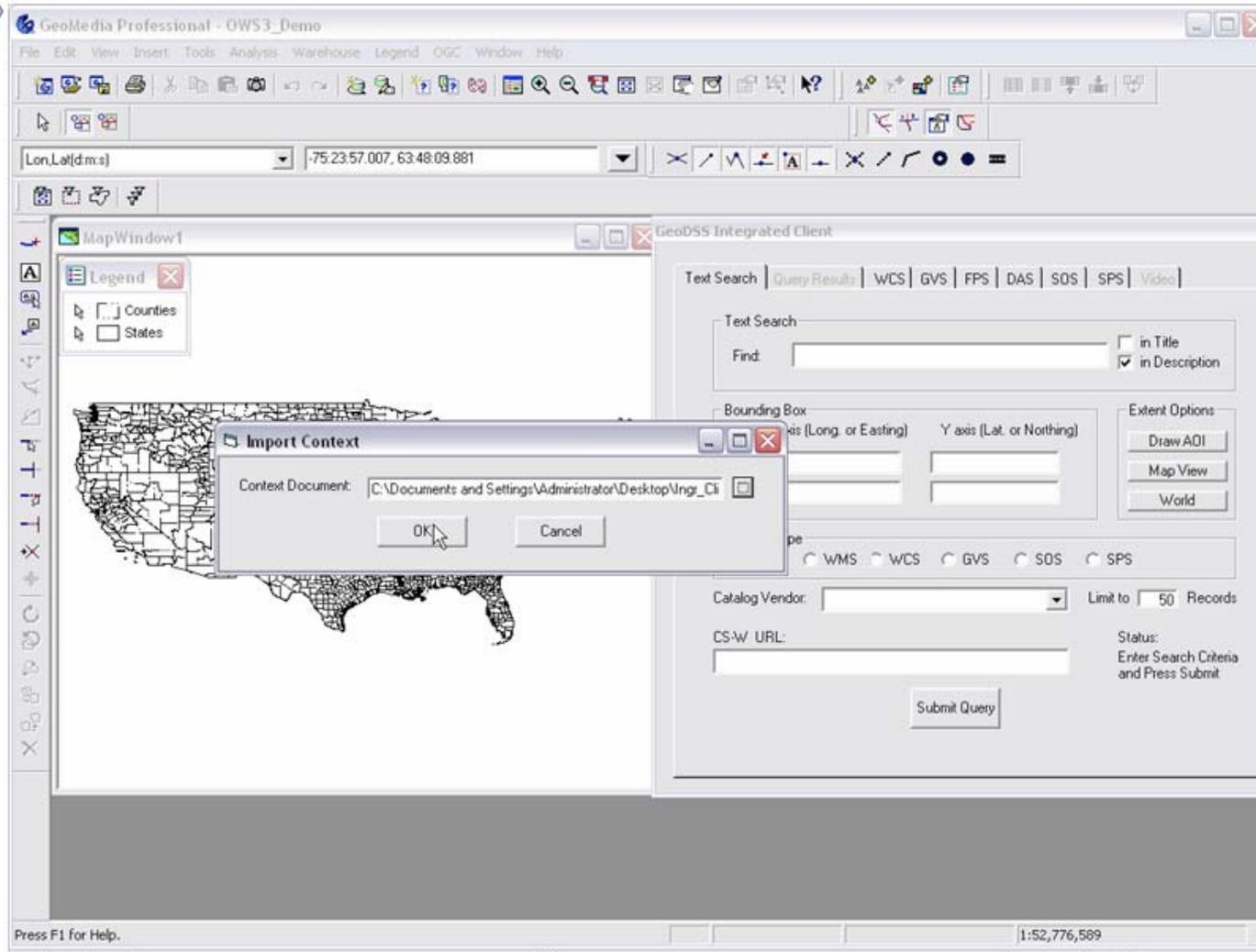
Cap Alert Message



# National Guard builds Context Document



# Forest Service imports Context document

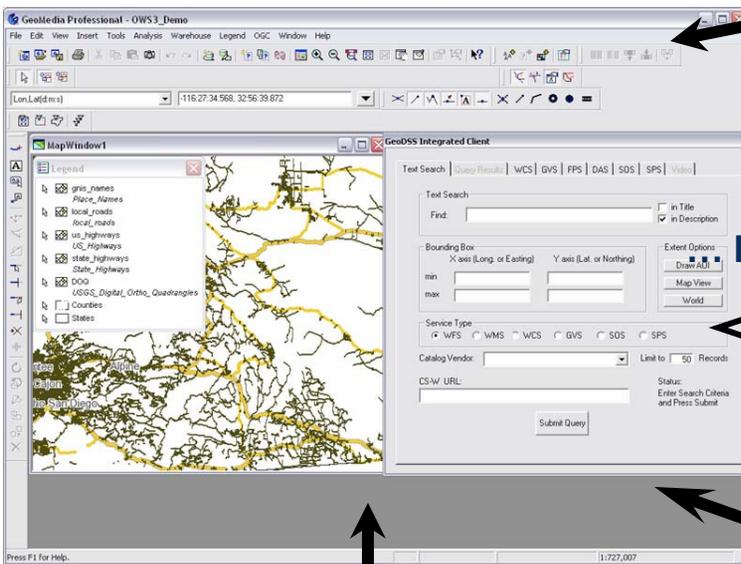


# Scene 1

## Establish Common Operational Picture

Forest Service reads context document ...

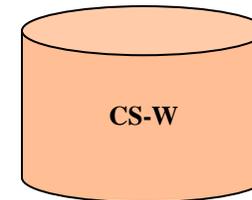
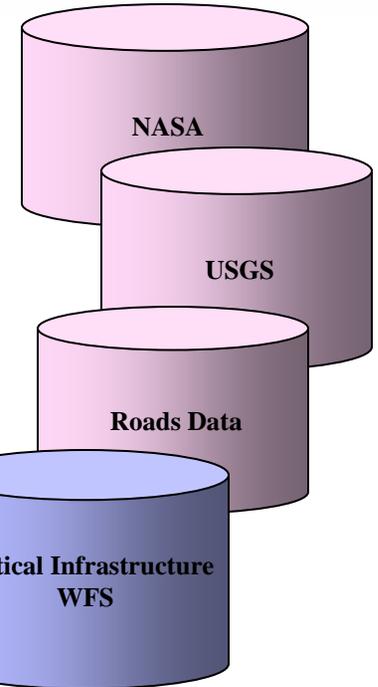
```
<Map>
  <More Info>
    <abc>
      def
    </abc>
  </More Info>
</Map>
```



loads data to present same view

... queries symbol catalog

...and translates using Data Aggregation Service

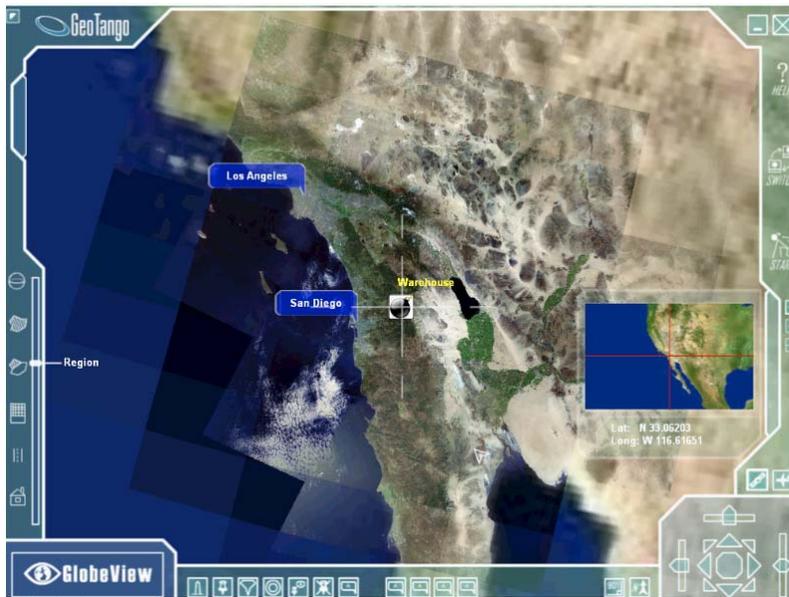


# Scene 1



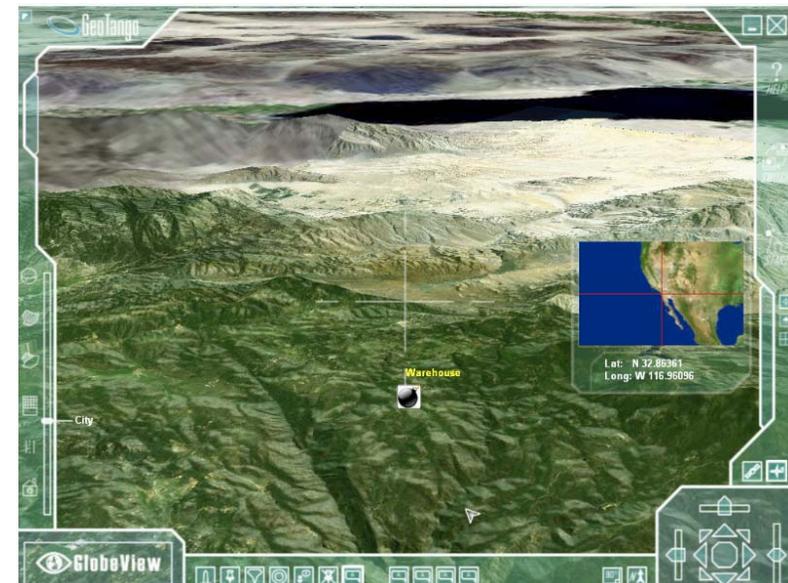
## Establish Common Operational Picture ...

National Guard and Forest Service use their Sensor Web (SWE) clients to view Area of Interest from high-altitude ...



“Forest Service” SWE Client

... and zoomed-in perspectives

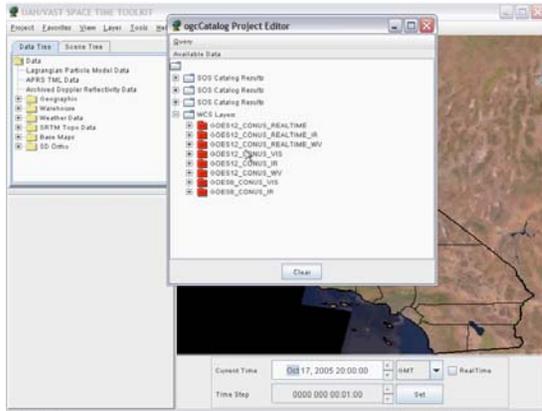


# Scene 2

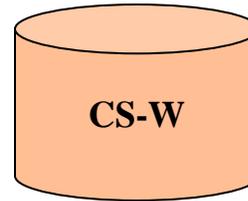
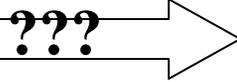
## Prepare to Deploy - Identify Resources



Web Cam

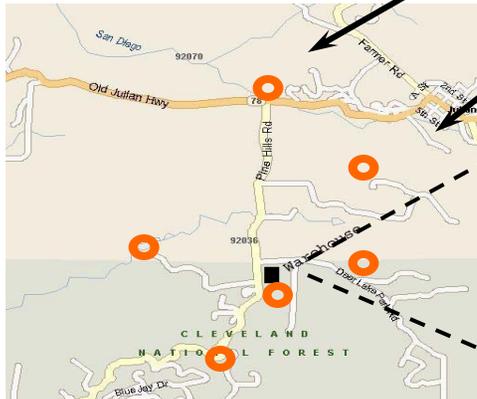


Query for  
sensor  
systems

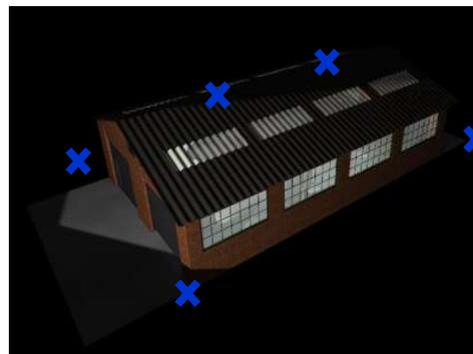


UAV-Based Cameras  
and Scanners

Proprietary Maps



Smoke / Heat Detectors



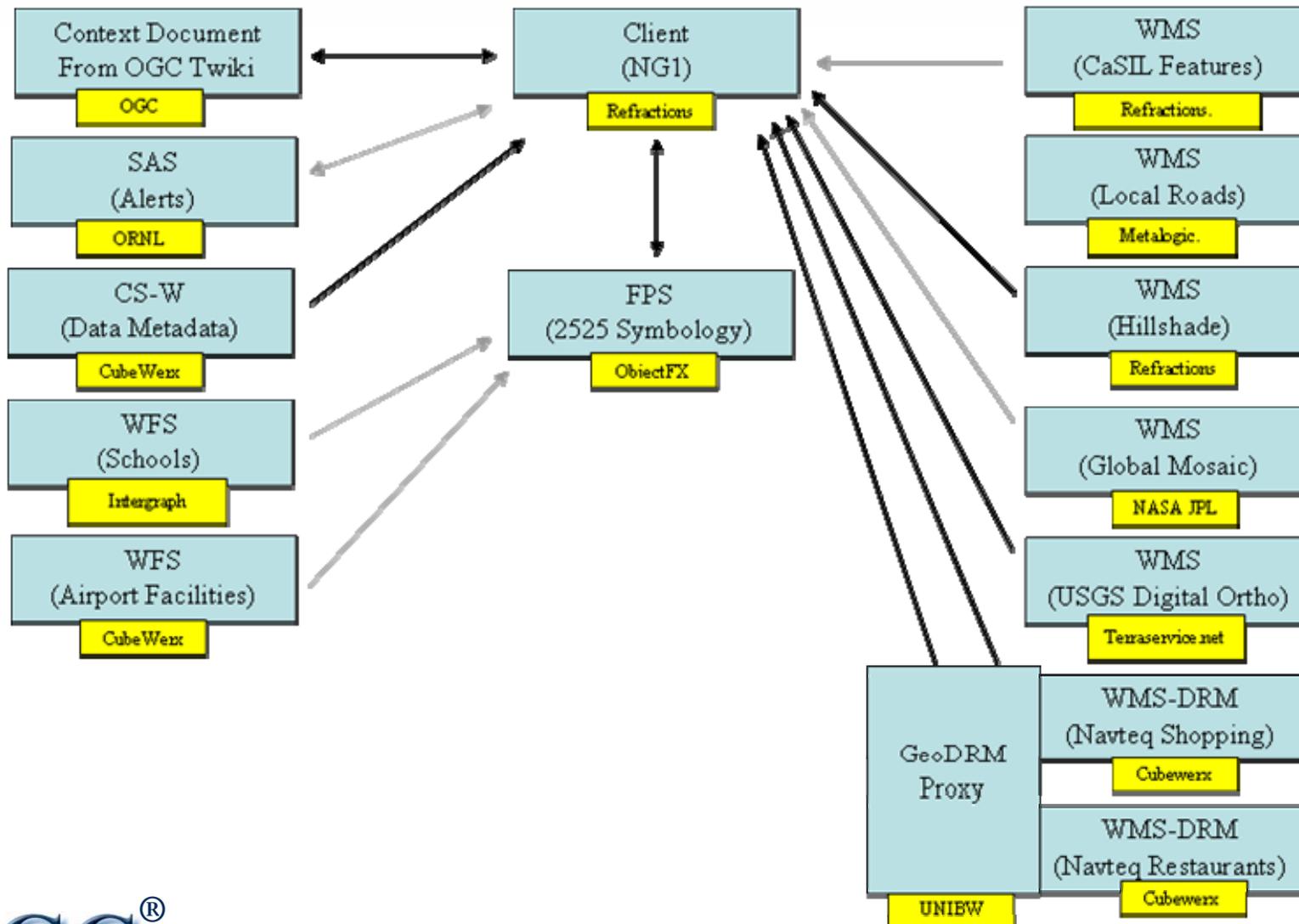
Airborne Toxin Sensors



Mobile Video Unit



# National Guard adding data from GeoDRM





University of Federal Armed Forces, Munich: OWS3.GeoDRM Demo - Mozilla Firefox Beta 1

File Edit View Go Bookmarks Tools Help

der Bundeswehr  
**Universität München**

# OWS3 Demo - WMS

Demo > Terms and Conditions Management Console

Welcome!  
Your user name / session ID is: **ng1**

Below you can see the Terms Of Use that apply to the different layers of the WMS:

License Name	Layers	Status
Navteq License	<ul style="list-style-type: none"><li>• RESTRNTS:Navteq</li><li>• SHOPPING:Navteq</li></ul>	<p>You did NOT agree to this license.</p>  <p><a href="#">Click here to read the license.</a></p>

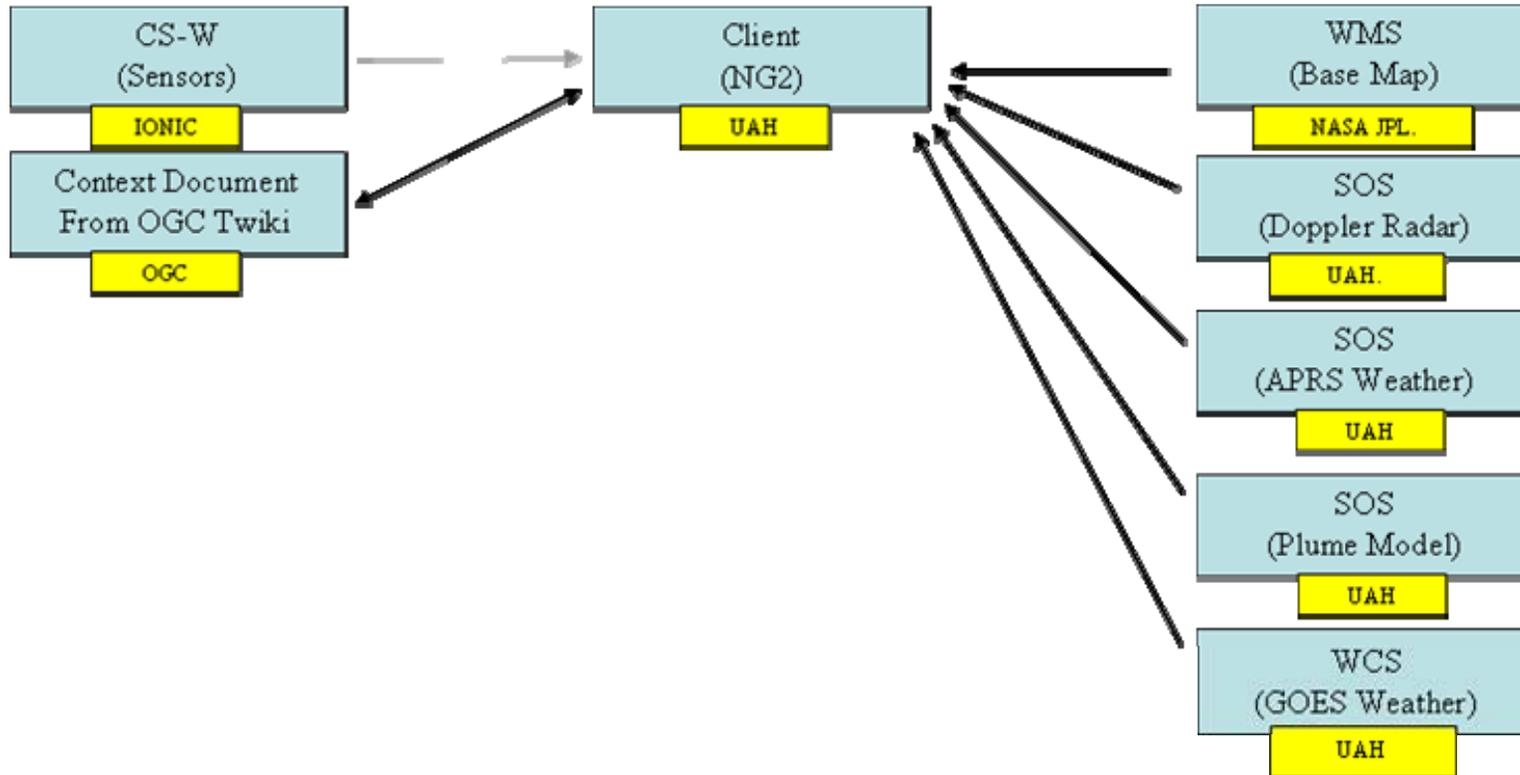
Terms of use not agreed exception



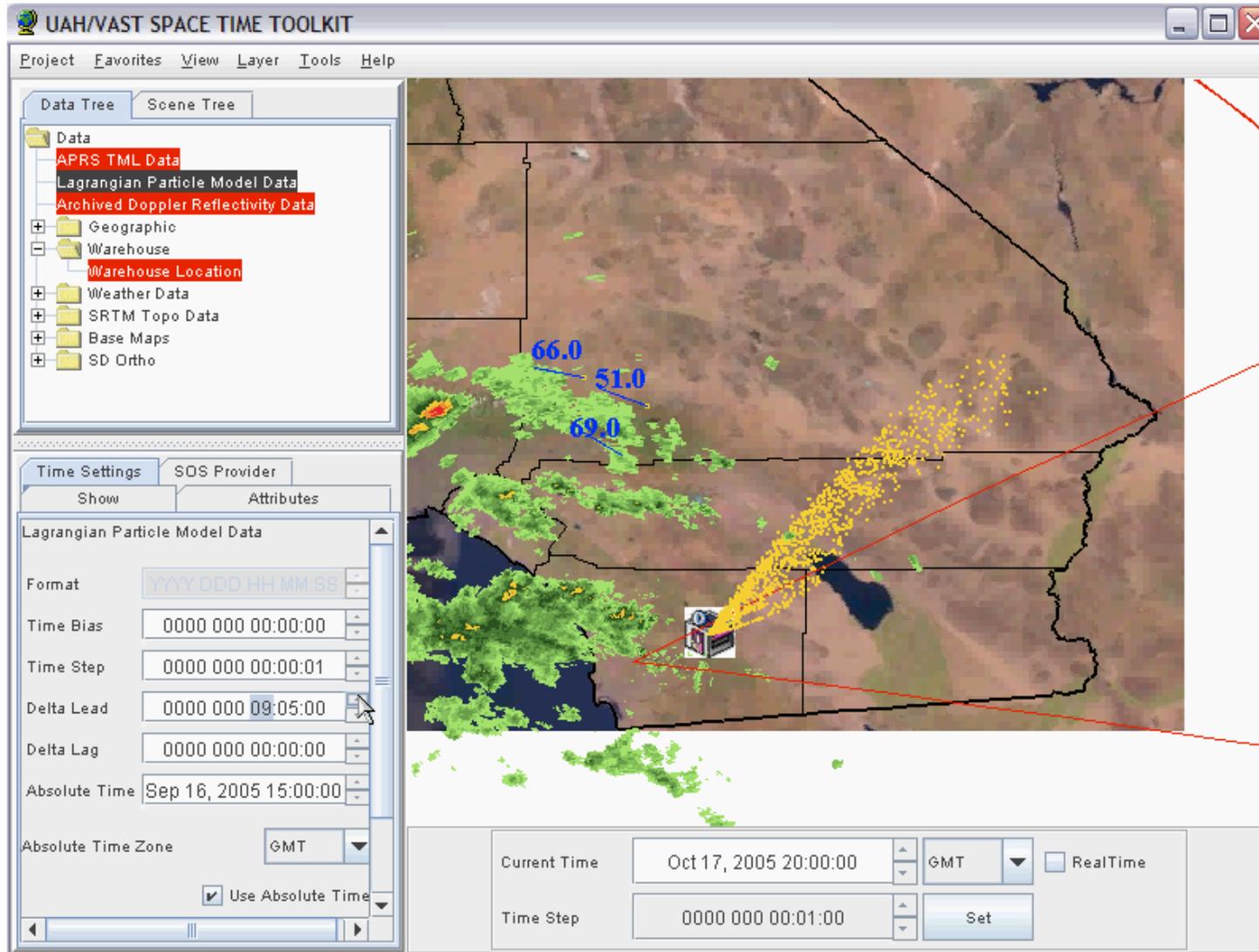
de.ubm.ows3.server.exceptions.DisclaimerNotAgreedException: RESTRNTS:Navteq

Done

# 3.1 National Guard - SWE predicting plume



# Display Plume



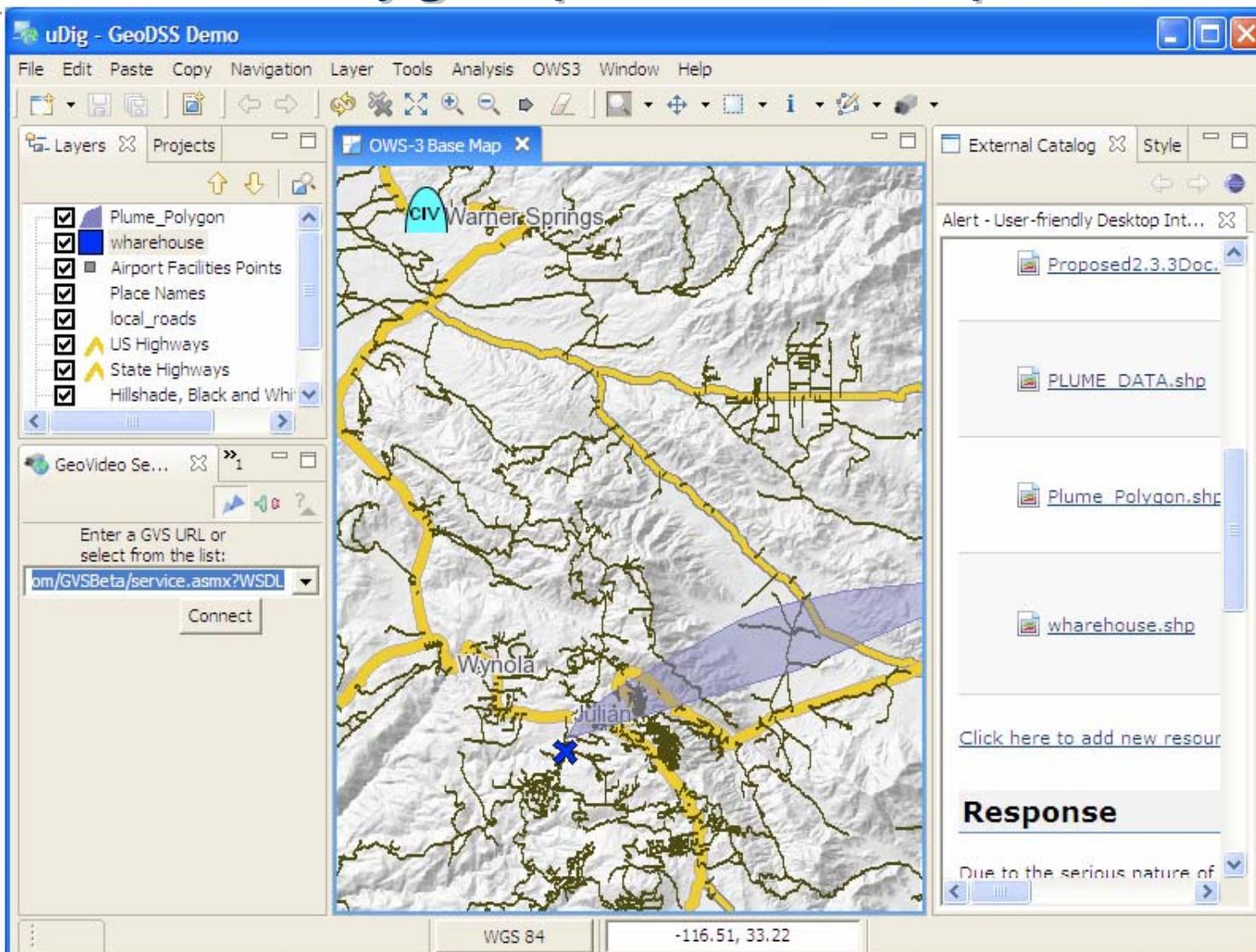
# Polygon Plume and population centers



The screenshot displays the uDig - GeoDSS Demo application. The interface includes a menu bar (File, Edit, Paste, Copy, Navigation, Layer, Tools, Analysis, OWS3, Window, Help), a toolbar, and several panels:

- Layers Panel:** Lists various map layers such as Local Roads, State Highways, local\_roads, US Highways, State Highways, Hillshade, Black and White, WMS Global Mosaic, pan, and USGS Digital Ortho-Quadrangle.
- Search Panel:** Contains a search box with the text 'shop' and a list of results including 'SHOPPING:Navteq'. Below the search results, there is a URL: '0&SERVICE=WMS#SHOPPING:Navteq' and a description: 'Description: WMT-compliant cascading map server by CubeWerx Inc.'
- External Catalog Panel:** Shows a list of XML files: 'alert.xml', 'basemap.xml', 'nq1aoi2.xml', and 'nq1deployment.xml'.
- Main Map Window:** Displays a topographic map with a yellow polygon plume and a green polygon. A blue 'X' marker is visible on the map.
- Status Bar:** Shows the coordinate system 'WGS 84', coordinates '-116.58, 33.03', and active layers '[Local Roads, State Highways]'. The USGS logo is also present in the bottom right corner of the map area.

# Polygon plume on map



# TML Camera in warehouse

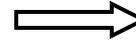
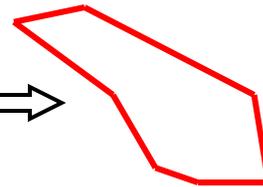
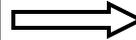


# Scene 3

## Plan Deployment



### Analysis



Sensor Client detects plume,  
develops polygon representation ...

... for viewing in DSS Client  
... to develop evacuation areas  
... and avoidance zones for ERT

### Tasking



# Deploy and Track Emergency Responders

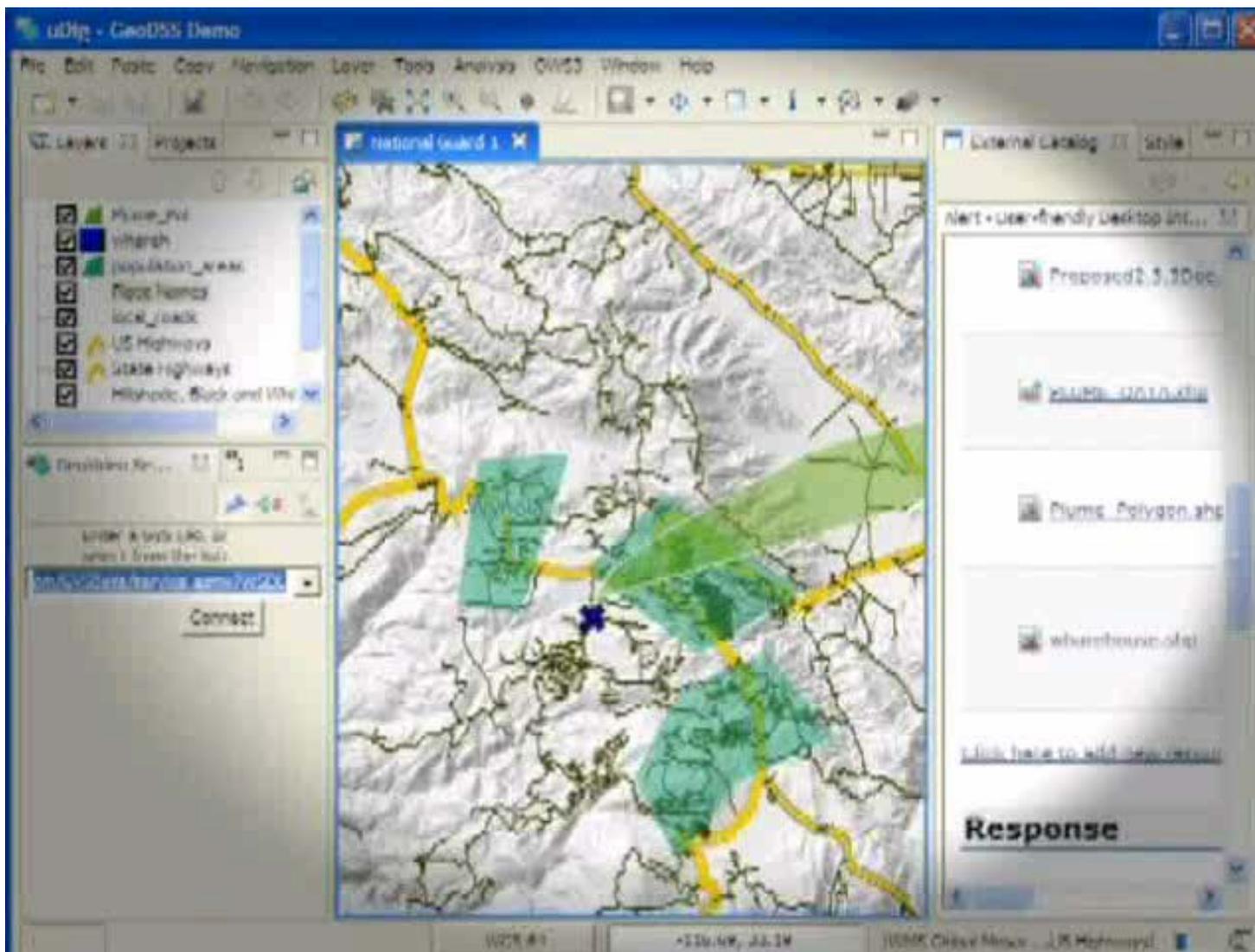


The screenshot shows the uDig - GeoDSS Demo application interface. The main window displays a map titled "OWS-3 Base Map" with several cyan circular markers labeled "CIV" scattered across a terrain map. A red dashed line indicates a path or route on the map. The interface includes a menu bar (File, Edit, Paste, Copy, Navigation, Layer, Tools, Analysis, OWS3, Window, Help), a toolbar, and a Layers panel on the left. The Layers panel lists various layers with checkboxes: road\_selection, Camera Location, Plume\_Polygon, warehouse, Airport Facilities Points, Place Names, local\_roads, and US Highways. Below the Layers panel is a GeoVideo Sequence panel with a table of events.

ID	Description	Loc
6	take dog to therapy	http
7	road rip after	http
8	off to therapist	http
9	off to movie	http
10	left theatre	http
11	to lulu's happy hour	http
12	take dog to therapy	http
13	take dog to therapy	http
14	take dog to therapy	http
15	visit the Dalai Lama	http
16	road trip	mm
17	to grandma's house	mm
18	chasing tornadoes	mm
19	road trip before	mm
20	take dog to therapy	mm

At the bottom of the application, there is a status bar with the text "Select a different layer and try again", the coordinate system "WGS 84", and the coordinates "-116.55, 32.57". To the right of the map is a "GeoVideo View" window showing a live video feed of a road. The video player interface includes a progress bar and a timestamp "Playing: 301 K bits/second 03:04".

# Deploy and Track Emergency Responders



# Deploy and Track Emergency Responders



The screenshot displays the uDig - GeoDSS Demo application. The interface includes a menu bar (File, Edit, Paste, Copy, Navigation, Layer, Tools, Analysis, OWS3, Window, Help), a toolbar, and several panels:

- Layers Panel:** Lists various data layers such as Camera Location, schoolsa, Plume\_Pol, whareh, population\_areas, Place Names, local\_roads, and US Highways.
- Projects Panel:** Shows the current project name, "National Guard 1".
- Map View:** Displays a topographic map of Wynola, TN, with a blue 'X' and a red dot marking specific locations. A green shaded area is visible on the map.
- GeoVideo Se... Panel:** Contains a table of video tracks and a video player window.

ID	Description	Loc
17	to grandma's house	mm:
18	chasing tornadoes	mm:
19	road trip before	mm:
20	take dog to therapy	mm:
21	take dog to therapy	mm:
22	road rip after	mm:
23	off to therapist	mm:
24	off to movie	mm:
25	left theatre	mm:
26	to lulu's happy hour	mm:
27	take dog to therapy	mm:
28	take dog to therapy	mm:
29	take dog to therapy	mm:
30	visit the Dalai Lama	mm:

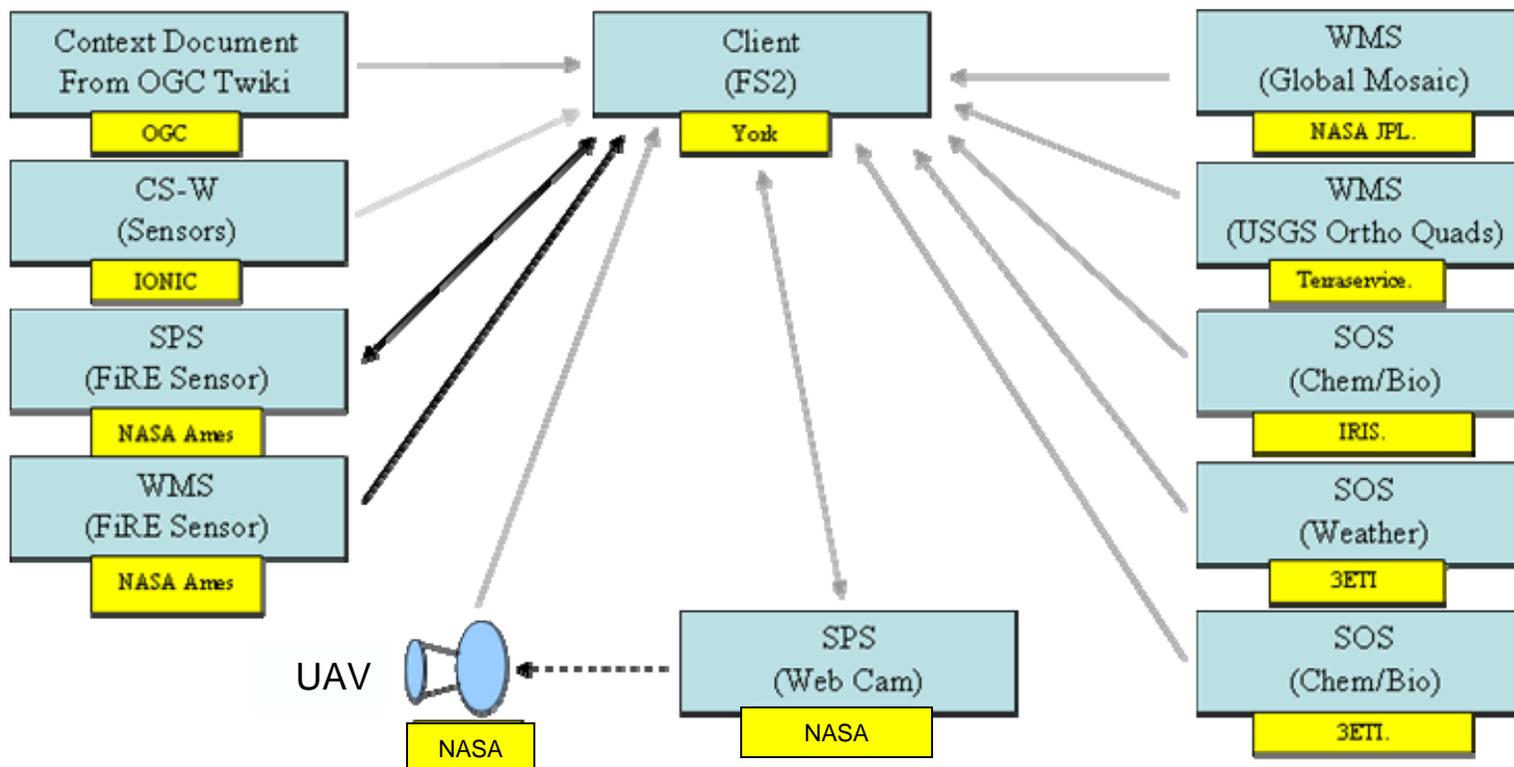
The video player window shows a video titled "Playlist: Playlist2" with a duration of 00:19. The status bar at the bottom indicates the coordinate system as WGS 84 and the current location as -116.60, 33.20.

# Sensor Planning Service for NASA UAV



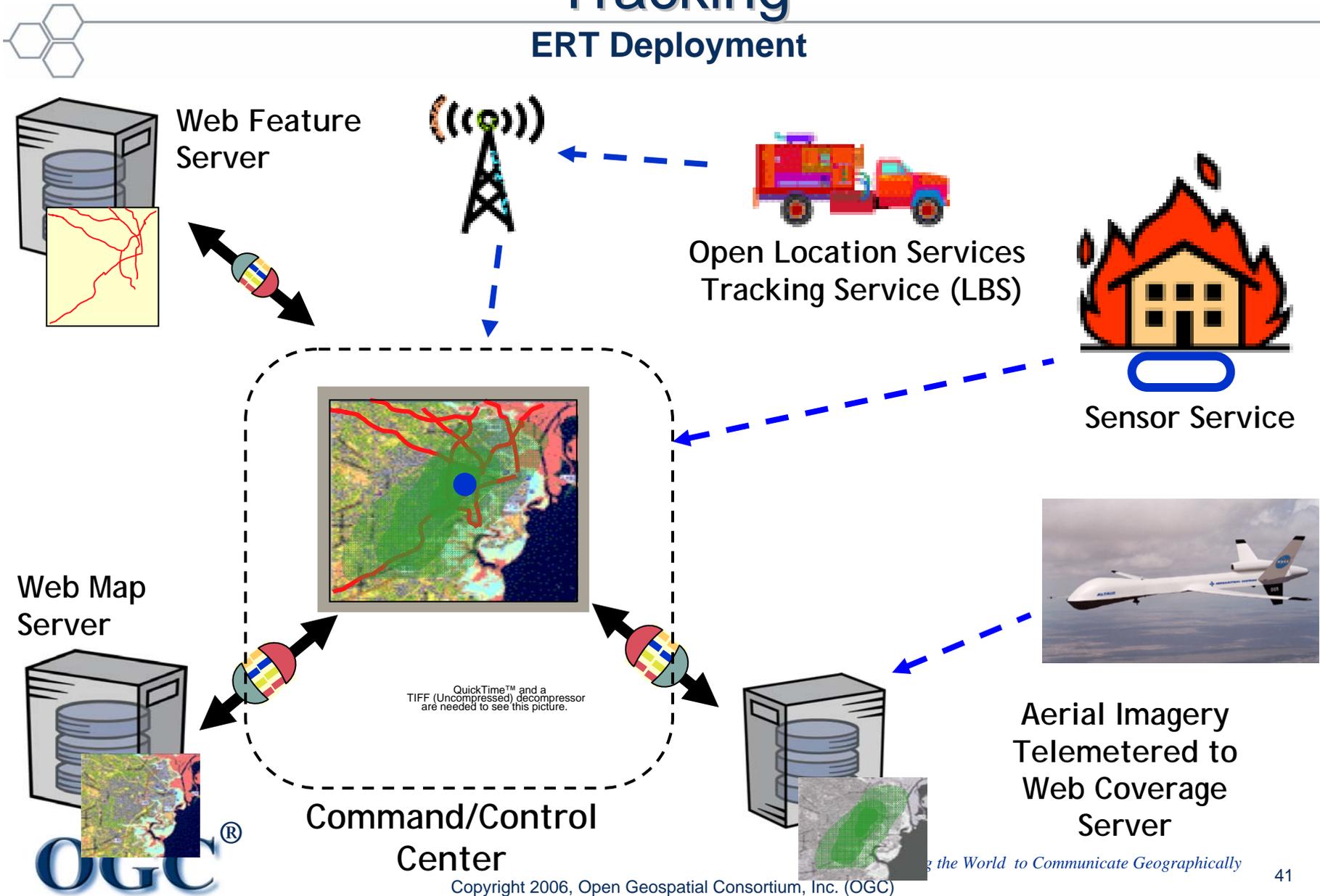
The screenshot shows a web browser window titled "QControl". The interface includes a "File" menu at the top left. Below the menu, there is a "Server" field containing "sgqtss.arc.nasa.gov" and a "Port" field containing "1039", with a "Connect" button to the right. Below this, there are two tabs: "Server Options" and "Task Options". The "Task Options" tab is active, showing an "ID" field with the value "20051019114830068-135896" and a "Get Info" button. Below the ID field, there are four time-related fields: "Status" (a dropdown menu set to "In operation"), "Earliest Collection Time" (2005-10-19T23:10:10), "Latest Collection Time" (2005-10-19T23:20:10), and "Scheduled Event Time" (2005-10-19T23:18:38). At the bottom of this section are "Set" and "Remove" buttons. The footer of the interface features the NASA logo and "National Aeronautics and Space Administration" on the left, and the Ames Research Center logo on the right.

# Forest Service Client Tasks NASA SPS

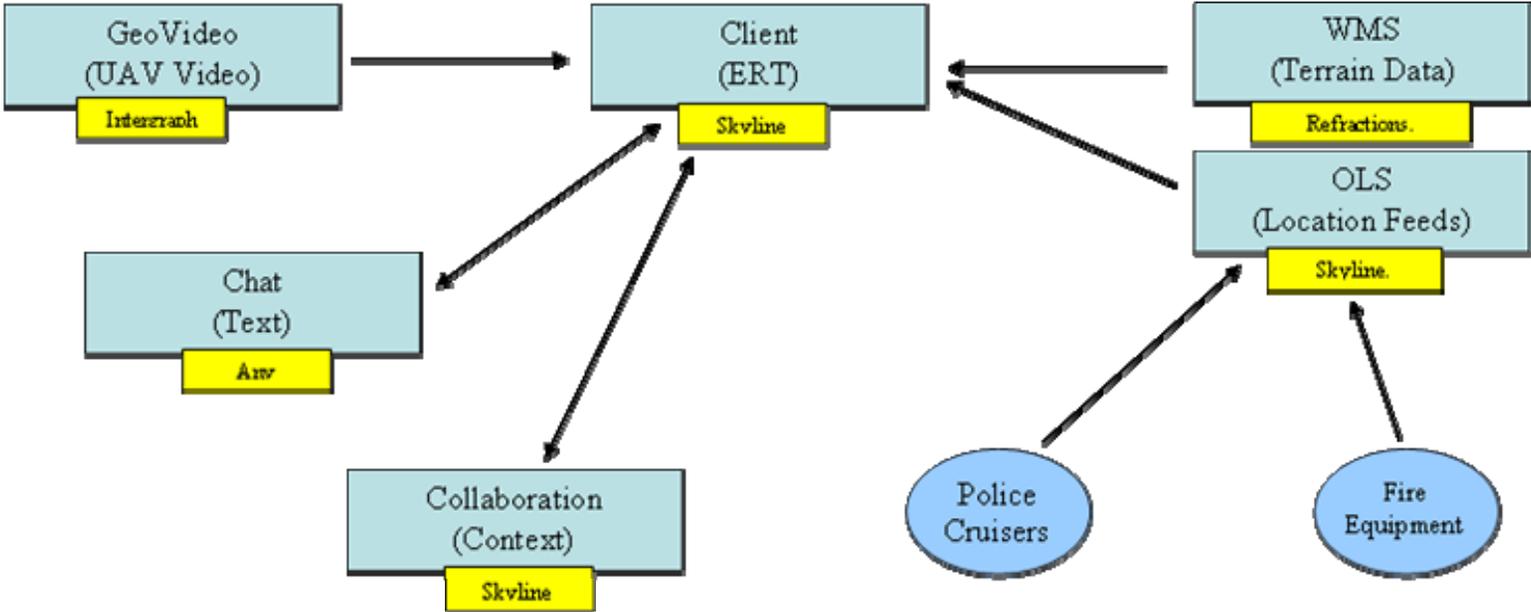


# Scene 4 Integration of Open Services For Tracking

## ERT Deployment



# 4.1 Emergency Response Team



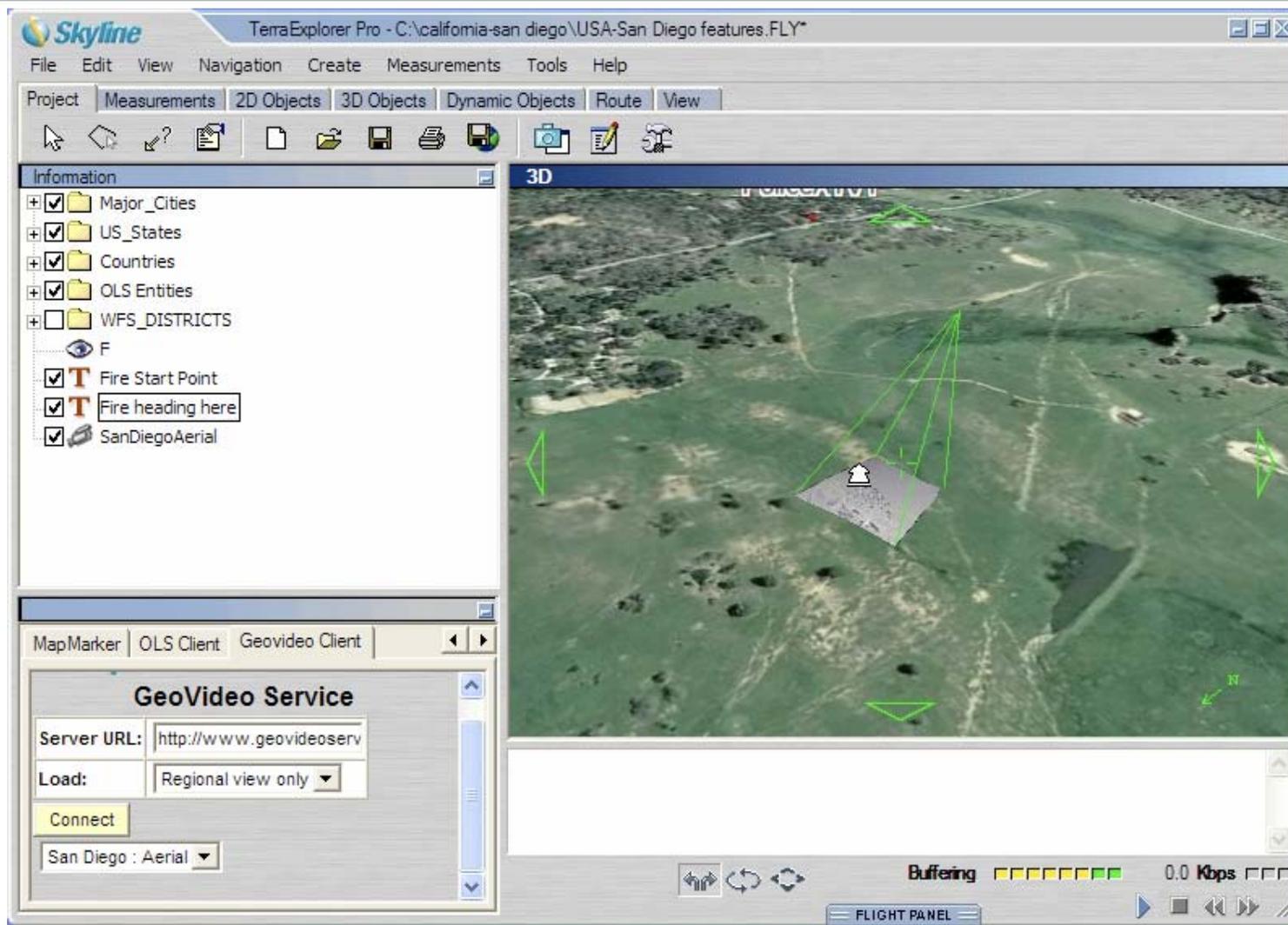
# Tracking service and terrain view



The screenshot displays the Skyline TerraExplorer Pro software interface. The main window title is "TerraExplorer Pro - C:\california-san diego\USA-San Diego features.FLY". The interface includes a menu bar (File, Edit, View, Navigation, Create, Measurements, Tools, Help) and a toolbar with various icons. On the left, the "Information" panel shows a tree view with folders like Major\_Cities, US\_States, Countries, OLS Entities, and WFS\_DISTRICTS, and a list of features including "Fire Start Point" and "Fire heading here". The central 3D view shows a terrain map with a red "Fire Start Point" label and a white arrow pointing to it. A "PoliceCruiser1" label is visible in the upper right of the 3D view. The bottom left panel shows a 2D map view with a "US Map" tab and a "MapMarker" tab, displaying a map of the Julian area with a white arrow pointing to a location. The bottom right panel shows a "FLIGHT PANEL" with a "Buffering" progress bar and a "0.0 Kbps" speed indicator.



# UAV Video over Terrain



# NG continues to monitor after situation is secured



uDig - GeoDSS Demo

File Edit Paste Copy Navigation Layer Tools Analysis OWS3 Window Help

Layers Projects

- Camera Location
- schoolsa
- Plume\_Pol
- whareh
- population\_areas
- Place Names
- local\_roads
- US Highways

GeoVideo Se... >>1

ID	Description	Loc
17	to grandma's house	mm:
18	chasing tornadoes	mm:
19	road trip before	mm:
20	take dog to therapy	mm:
21	take dog to therapy	mm:
22	road rip after	mm:
23	off to therapist	mm:
24	off to movie	mm:
25	left theatre	mm:
26	to lulu's happy hour	mm:
27	take dog to therapy	mm:
28	take dog to therapy	mm:
29	take dog to therapy	mm:
30	visit the Dalai Lama	mm:

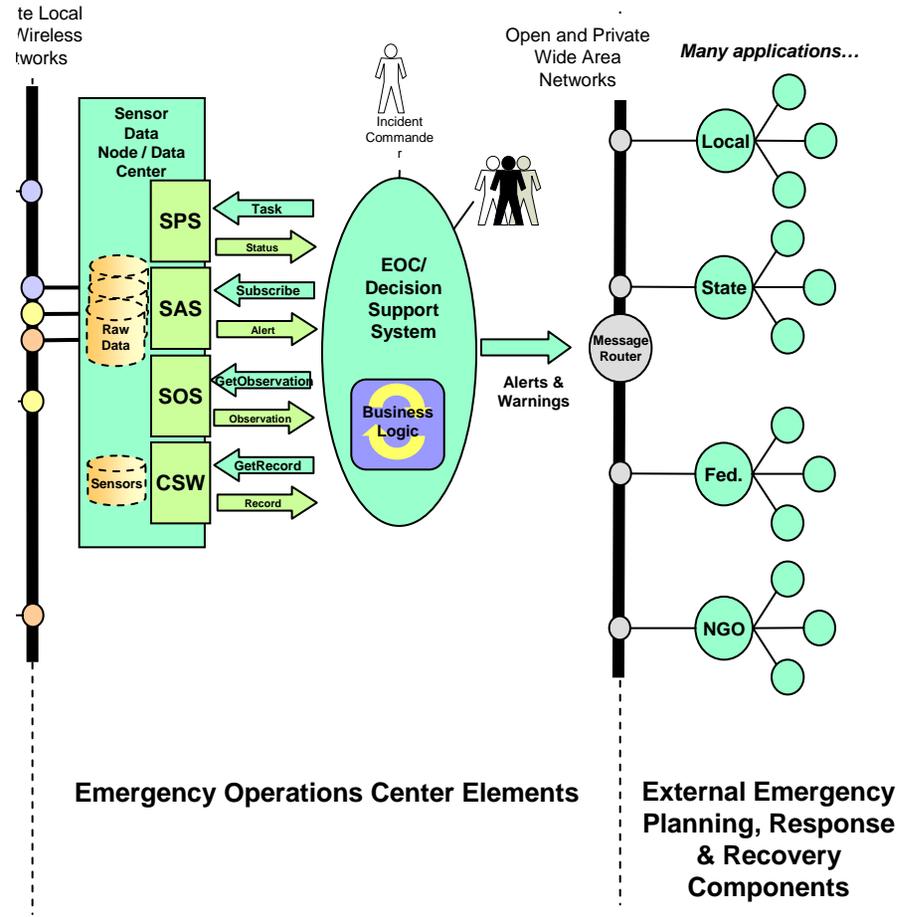
WGS 84 -116.60, 33.20

GeoVideo View >>2

Playlist: Playlist2 00:19

Review UAV over location - note red dot

# SensorNet





# What's Next?

# Since our Last Meeting

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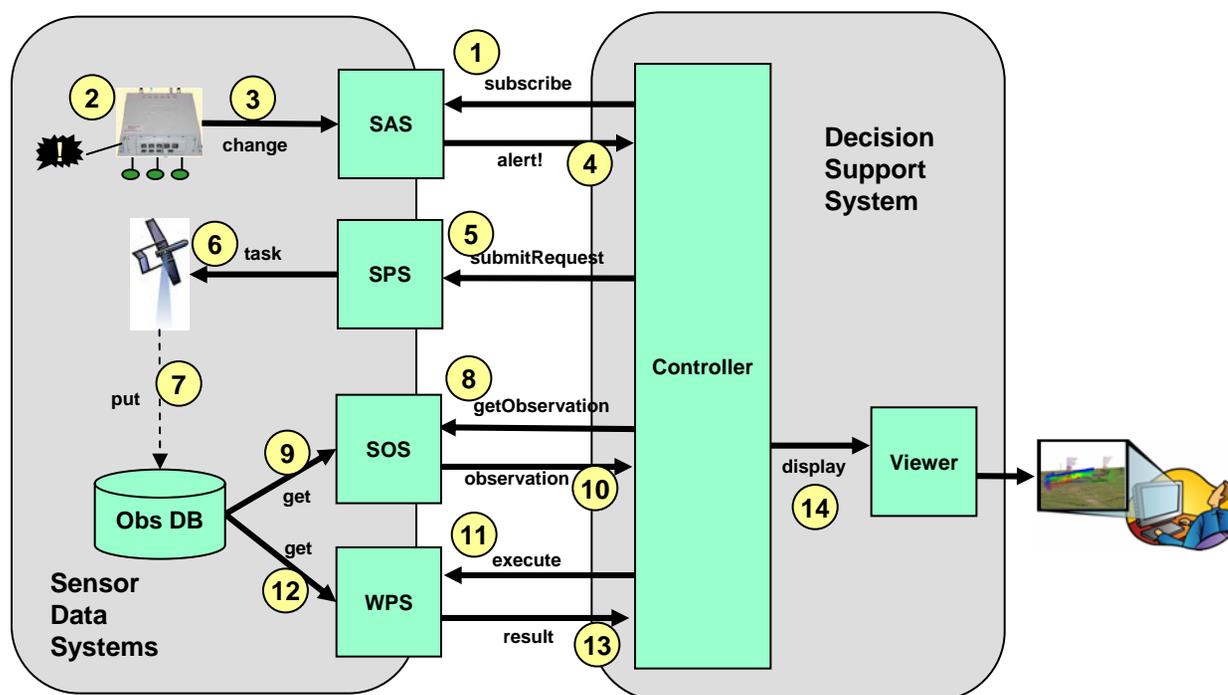


- We held several teleconferences to identify possible joint sponsorship of requirements for harmonization tasks to be addressed in OWS4
- OGC formalized a MOU with OASIS for improved coordination between our organizations
- We developed and released a Request for Quotation / Call For Participation in OWS4
  - OASIS, IEEE involved in RFQ definition
- OGC participated in recent OASIS TC meeting, with indications of interest in participation in a joint testbed
- We held a successful Kick Off event for OWS4, with substantial SWE requirements
  - IEEE requirements formalized
  - Opportunity to include OASIS (July)

# Alert-driven Processing of Sensor Data



- Seek to automate/shorten the decision loop.
- Focus on:
  - automated sensor management and sensor data processing to produce actionable information for decision makers.

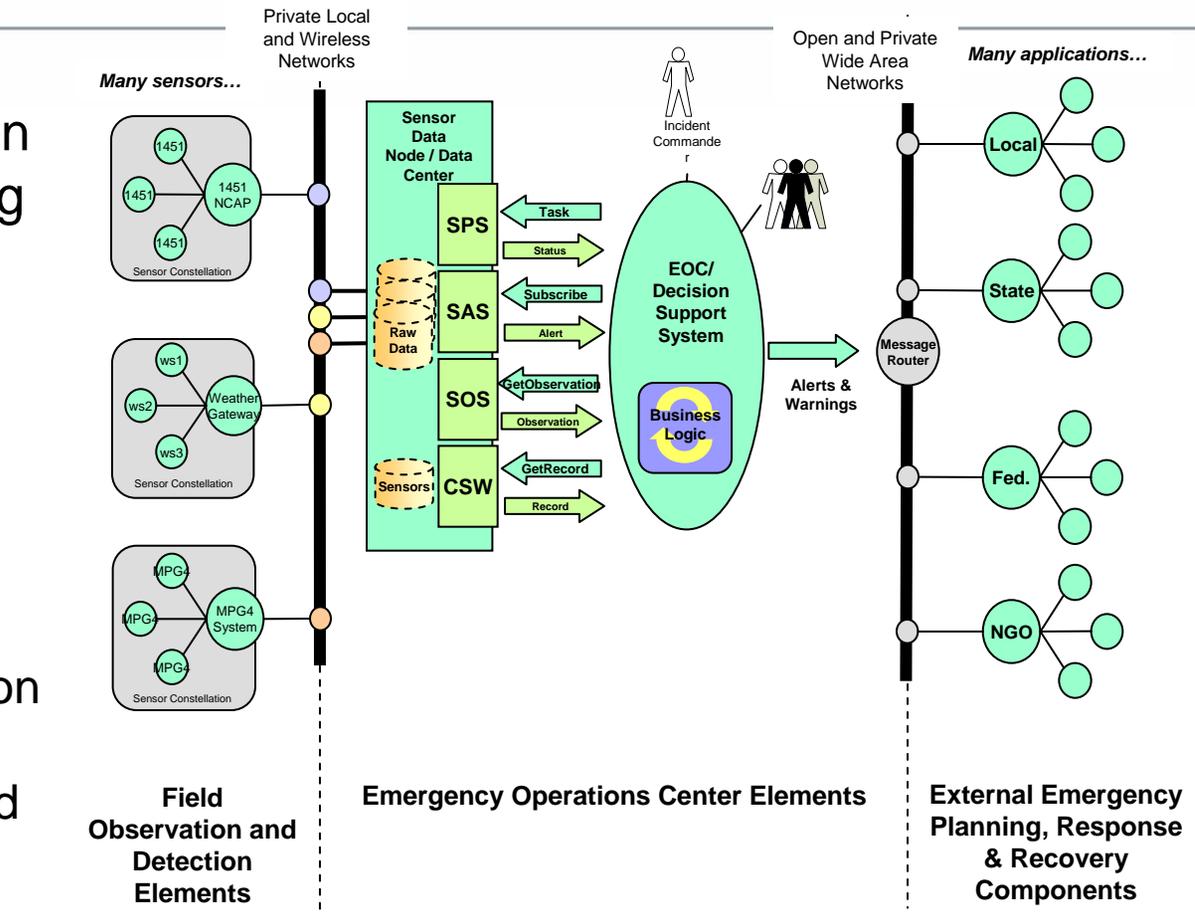


- The approach must be modular and extensible (i.e., not a “point solution”) and align with the scope, activities, requirements and deliverables for the SWE thread of OWS-4.

# Sensor Value Chain for Emergency Response



- Seek to automate/shorten the decision loop, starting from:
  - 1) the receipt of raw observations and alerts originating from sensor systems,
  - 2) the analysis and refinement of these data into actionable information by EOC staff and the Incident Commander and
  - 3) the dissemination of alerts and warnings to external supporting agencies and the public.

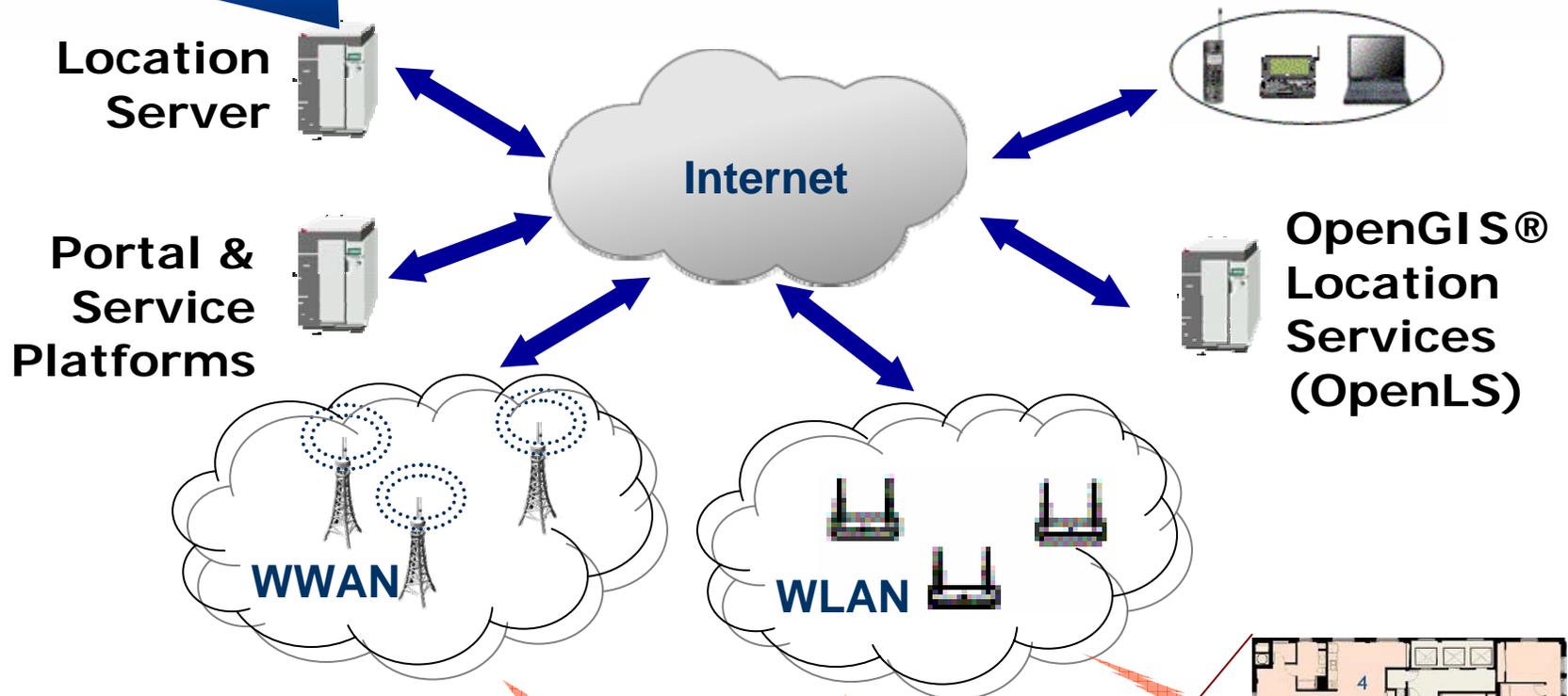


- The approach must be modular and extensible (i.e., not a “point solution”) and align with the scope, activities, requirements and deliverables for the SWE thread of OWS-4.

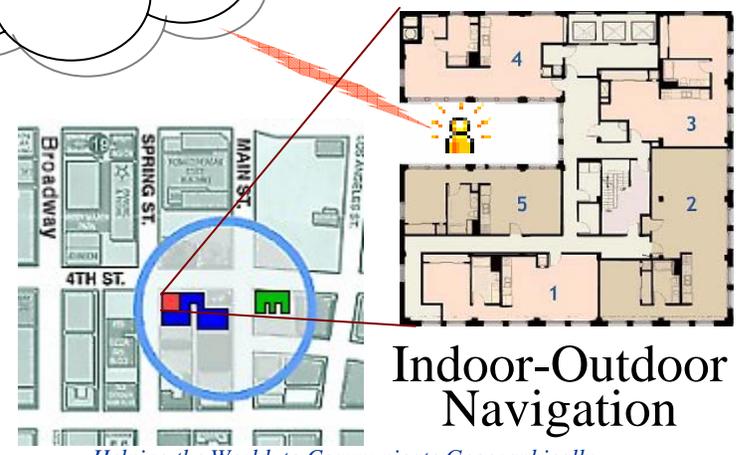
# Indoor-Outdoor Navigation

("Seamless Worlds Experience")

I. Gateway Service available over the Internet (e.g., off-board A-GPS)



II. Gateway Service available on the client (e.g., on-board GPS)



Indoor-Outdoor Navigation

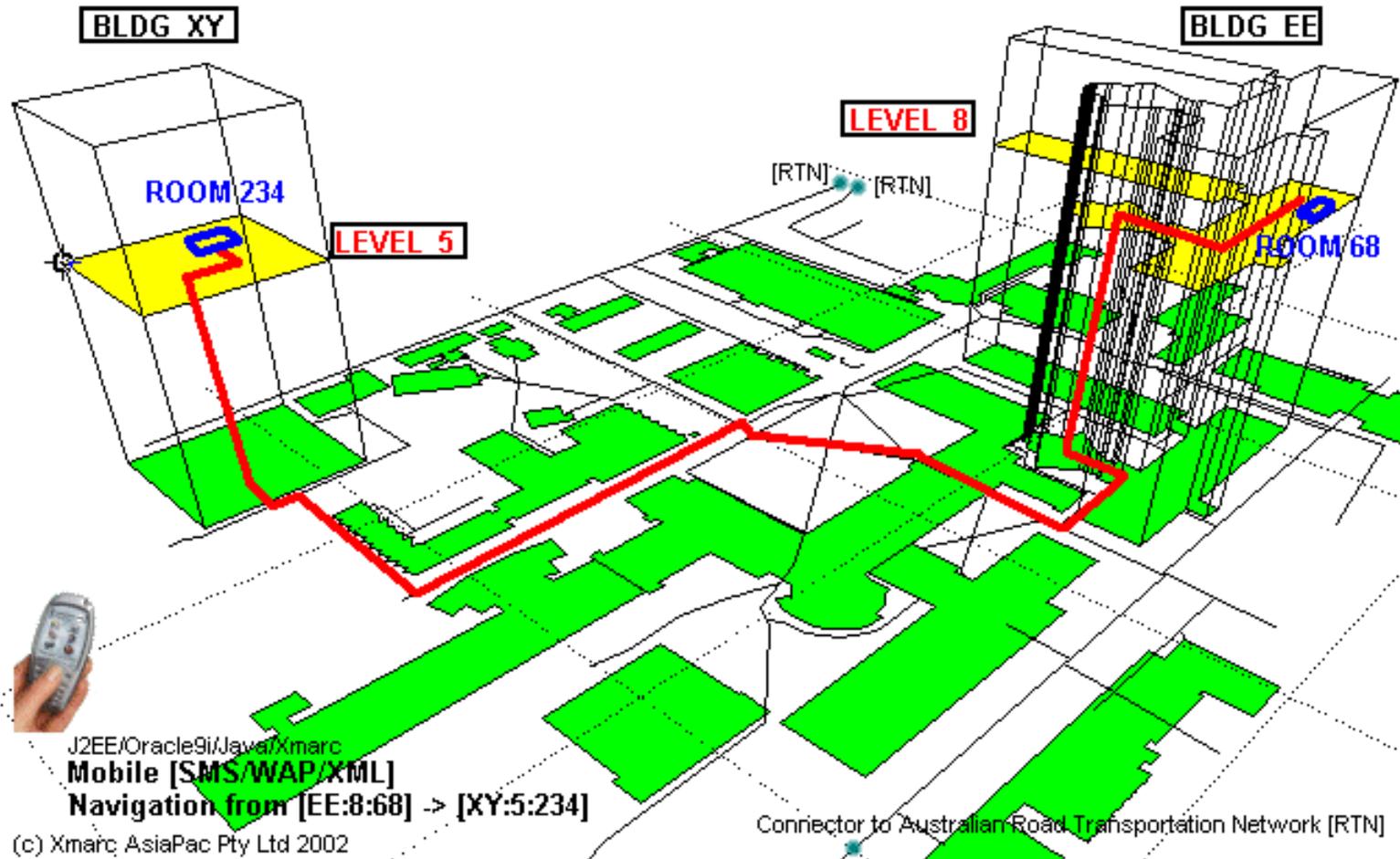


# Multi-Modal Navigation Emphasis

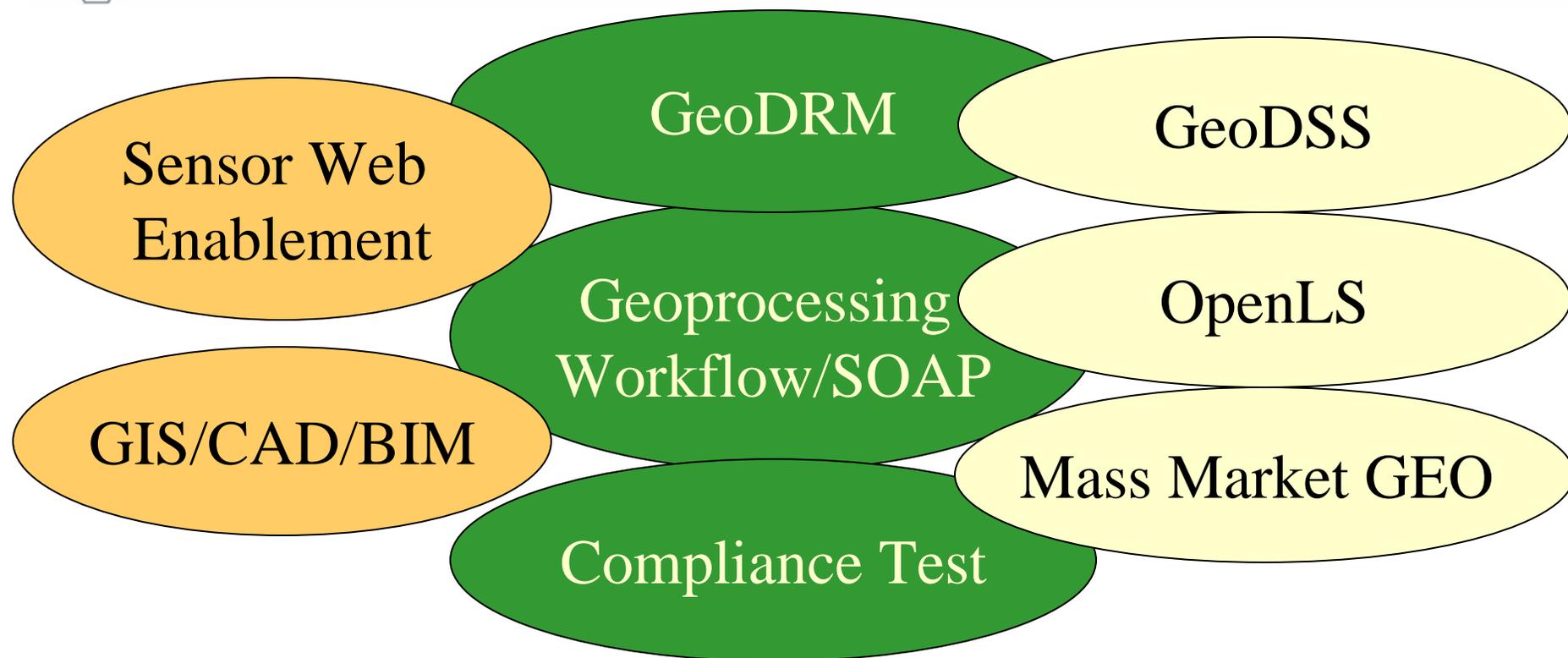


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# OGC Web Services 4 Testbed Threads



SOURCE

INFRASTRUCTURE

USERS

# Other Use Cases - Implementations

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- Ocean Observing
- ITS, Vehicle Integrated Infrastructure
- Weather monitoring / forecasting
- Asset Tracking, Logistics and Security
- HLS, Emergency Management and Response
- Hospitality / Travel
- Health monitoring / surveillance
- Natural Resource / pollution monitoring, assessment and response
- Industrial process management and control
- Consumer location services
- ....

# Parting Thoughts

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- Making progress in addressing joint sensor standards in OWS-4. Still time (through July) to consider expanding joint standards scenarios/tests in OWS-4 OASIS (EDXL-DE), CBRN Data Model, etc.
- Identify, refine and agree on a broad set of use cases from which we advance harmonized standards frameworks or profiles
- Bring in more representatives from the user community to help assess and confirm capabilities

# World Wide Web of Things



“A World Wide Web of Things would enable easy publishing and spontaneous viewing of control-sense-identify information. A Google of Things would interconnect CSI data to enable powerful search and inference.”

Source: Bob Metcalf, Sensors Expo Speech, June 2006  
(Inventor of Ethernet)