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OGC Sensor Web Standards Show GeoINT Potential

Power of specifications showcased in staged dirty bomb scenario.

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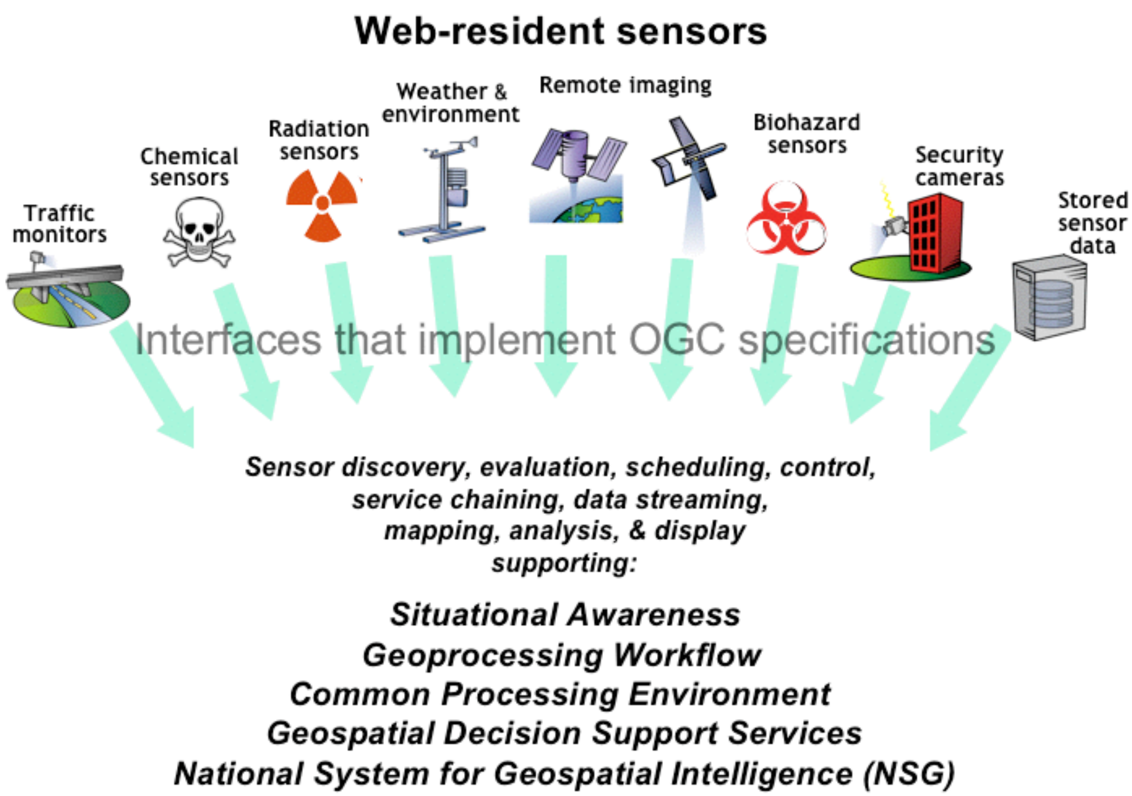
On December 7 and 8, 2006, an invited group of civilian disaster managers and military geointelligence officials witnessed a demonstration of open geospatial standards prepared by members of the Open Geospatial Consortium, Inc. (OGC). The OGC's fourth annual OGC Web services testbed activity (OWS-4) began in June, and culminated in this demonstration at an emergency operations center (EOC) in the New York/New Jersey metropolitan area.

OWS-4 involved development and testing of Sensor Web Enablement (SWE) specifications [link sidebar 2], as well as specifications for geospatial digital rights management (GeoDRM), computer-aided design/GIS/BIM (building information modeling) integration, location-based services, and conformance and interoperability testing. The specifications were implemented mainly in commercial off-the-shelf software. More than 65 participating vendors, integrators, and research organizations [link sidebar 4]used these implementations to meet the application requirements of OWS-4's fictional, but complex, disaster scenario.

Sensor Webs' Role in OWS-4

In the test scenario, a bomb containing highly toxic radioactive material explodes as a container is being unloaded at a wharf in the New York City area. Workers are injured, and a wind-borne plume of radioactivity begins to expand northeast across the metropolitan region. Teams of disaster managers and first responders spring into action to confine radioactive material, organize an evacuation, and treat and decontaminate victims.

The response is facilitated by information flowing from many different sources [link sidebar 1]through Web services that implement OGC's standard open interfaces and encodings. OGC's SWE specifications make it possible to find and control online sensors as diverse as radiation counters, anemometers, security cameras, and National Aeronautics and Space Administration (NASA) imaging satellites. The OGC specifications for open interfaces that make this possible are interoperable with the consortium's adopted specifications that enable such functions as access to map images, and raster and vector data and services. The demonstration also showed the value of interoperability between these Sensor Web capabilities and new, not-yet-adopted specifications for BIM, GeoDRM, and service chaining.



OWS-4 showed how diverse kinds of sensors can be found on the Web, evaluated, and controlled, sometimes in a completely automated fashion, to support a wide range of geointelligence and disaster management activities.

Sensor Web Enablement

Sensors have been deployed on the Web for various purposes for more than a decade. OGC's SWE effort is driven by the obvious need for a set of open standards that would enable "on the fly" discovery of sensors, sensor systems, and sensor webs; the goal is "loosely coupled" sensor webs. With a comprehensive set of specifications for sensor system interfaces and encodings, it is possible for vendors and integrators to provide sensor systems that can be deployed, with appropriate authentication and security, for multiple and perhaps unpredicted purposes.

Just as text and image information becomes more valuable when multiple users can access it, online sensors become more valuable when they can be made available to more users. For example, a security camera at an oil depot in a seaport might ordinarily be accessible only to security guards at the depot, but it would have more value if — under certain circumstances — it could also be accessed without delay by disaster managers, first responders, or government security agencies with jurisdiction at the seaport.

The Disaster Unfolds

At the beginning of the scenario, a radiation sensor whose Web interface implements OGC's SWE specifications triggers an alert that automatically sets several processes in motion. Other sensors in the vicinity are immediately and automatically polled. A server managed by the EOC alerts the EOC operator and automatically prepares a report, including a map display of sensors reporting high radioactivity. This automated process involves "service chaining" of multiple online services that publish, find, access, or process sensor locations and other geospatial data. The EOC crisis manager immediately notifies local fire and police departments, as well as the appropriate federal and state authorities.

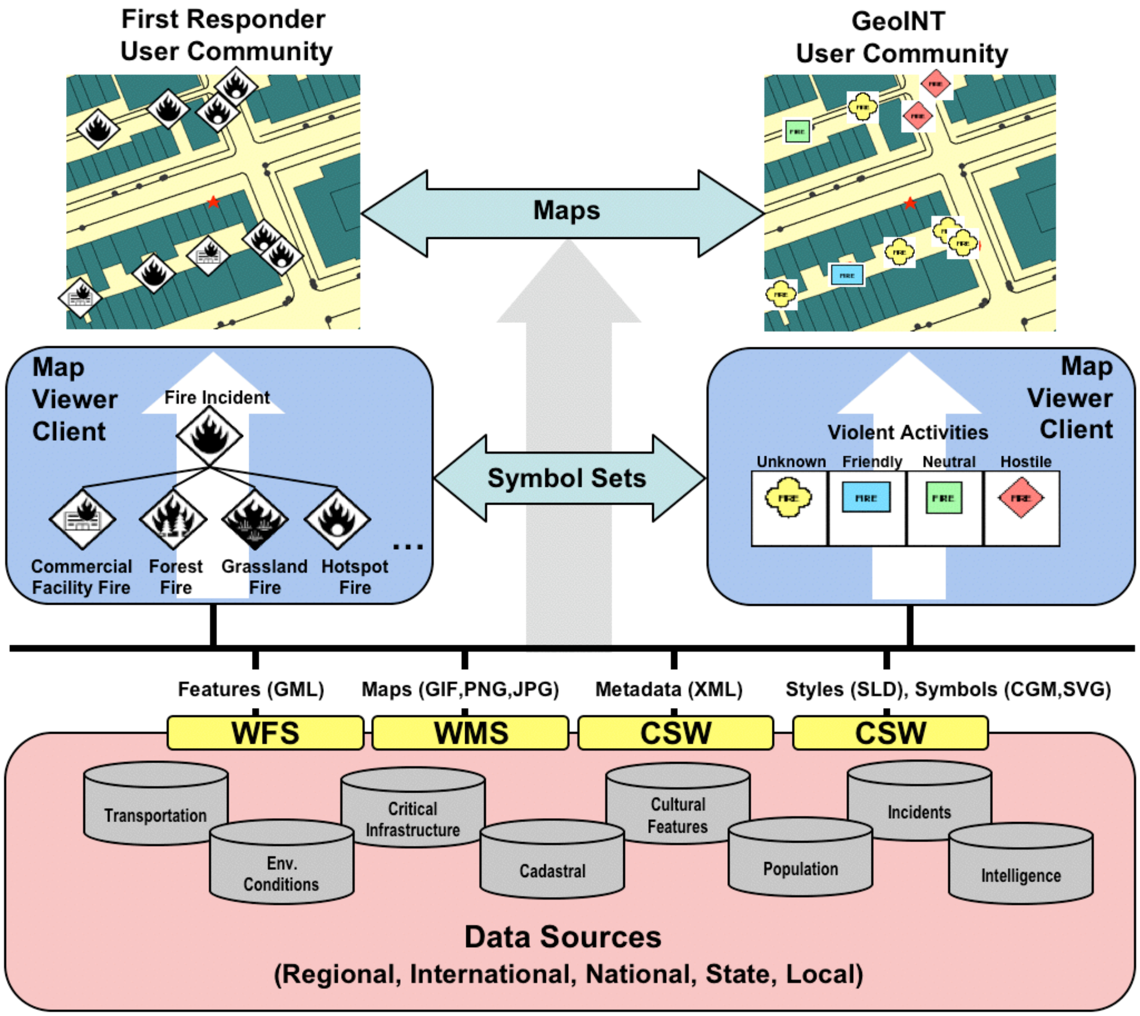
Online catalogs of sensors, each conforming to the OpenGIS Catalog Services Implementation Specification, provide the means for the EOC operator to determine the location and other features of various online sensors. The sensor data and metadata can be immediately found, accessed, and displayed on a map, because the sensors' owners have registered the metadata in the catalogs and provided interfaces that implement the open SWE specifications.

Security cameras (whose Web interfaces implement SWE specifications) near the scene of the explosion are immediately accessible, and the operator takes control of those that allow remote control, because the SWE standards address video camera control parameters.

The operator also accesses NASA's Earth Observation-1 (EO-1) satellite ground system, instructing the satellite through an open interface to provide images of the New York/New Jersey area over the next several days. The acquisition request was accepted by the EO-1 planning systems, and the image was acquired on December 8 during the OWS-4 demonstration.

Using information from NASA's satellites, commercial data providers, and Web-resident wind sensors, a radioactivity dispersion plume is calculated. The current and predicted direction of the radiation plume are used to determine the site for a temporary hospital to treat the radiation victims. Web-based integration of live sensor data in computer simulation and modeling, supported by open standards, is a high priority for several of the OWS-4 sponsors [link sidebar 3].

The use of Web-resident sensors with Geospatial Decision Support Services (GeoDSS) was also a key objective of OWS-4. Disaster managers want a decision maker at a single workstation to be able to find and identify sensors — and other geospatial resources — located anywhere. That individual should be able to access the resources, bring them into an operational context, and integrate them with other resources to support the decision process. Live sensor data is a key requirement to giving such decision makers heightened situational awareness, which they can share with responders on the ground. Access and integration of data from multiple sources — irrespective of the technology or developer of the sensors or servers — is critical to decision making in a distributed services environment.



OGC specifications make it possible for data to be portrayed using symbol sets appropriate to a particular set of users. Both data and symbols can be Web-resident resources.

The sensor resources must be brought into multiple operational contexts. OGC standards, such as the OpenGIS Style Layer Descriptor Implementation Specification used in the OWS-4 demo, showed how software and services running on different devices can tailor data "portrayal" for the user of the device. An open source Geography Markup Language viewer client implementing these specifications was one of the software components demonstrated.

Standards Enable Integration

Geointelligence involves more than the exploitation and analysis of satellite and aerial imagery. Many other kinds of sensors also address the need to describe, assess, and visually depict geographically referenced features and activities. OGC's SWE specifications have been carefully designed to provide open interfaces for describing and remotely using — via the Web — everything from thermometers to the most complex "steerable" imaging satellites. Metadata for any kind of sensor, or sensor data store, can be registered in standards-based catalogs to enable quick, fine-grained discovery. The schemas for describing both sensor devices and data enable automated processing of virtually every kind of sensor input.

The OWS-4 demo shows that many capabilities that were previously only feasible on a limited scale, using "tightly coupled" components, are now possible and practical with distributed, heterogenous, "loosely coupled" components. Service-oriented architectures for sensor systems, and the geointelligence systems that use them, are much cheaper to implement and require less project management (and less coordination among users) than previous systems do. The primary requirement for all is that they put their resources on the Internet and make them discoverable and accessible through catalogs, open schemas, and interfaces.

The OGC is producing an OWS-4 video and making it available to the public in early 2007. In addition to a video describing the demo above, the OWS-4 multimedia product will include complete demonstrations of each of the clients in the scenario. This product will be similar to the OWS-3 demonstration available here: http://www.opengeospatial.org/pub/www/ows3/index.html.

<Sidebar 1>

Sensors Integrated in the SWE Demo Network

- Oak Ridge National Laboratory — Rad Sensor
- ORNL — Sensor Alert Service, Sensor Observation Service
- 3eTI — SOS
- IRIS Corporation and Institut für Geoinformatik (IFGI) Video Sensors/Actuators
- IFGI — Sensor Planning Service
- Smart Sensor Systems Light Sensor (TinyTIM 1451 Bluetooth)
- NASA Earth Observing 1 Hyperion Imagery Sensor
- Vightel — SOS, SAS, SPS
- Environment Sensors (Moisture, AmbTemp, SoilTemp, Solar Voltage/Current)
- Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) Information & Communications Technologies Centre — SAS and SOS
- U.S. National Weather Service Weather Sensors
- Doppler Radar Sensors

- University of Alabama Huntsville (UAH) — SOS, Web Coverage Service (WCS)
- Geostationary Operational Environmental Satellite (GOES) metrological sensor

<Sidebar 2>

The SWE Standards Framework

Two of the new OpenGIS Specifications for SWE are information models and schemas:

- Sensor Model Language (SensorML) is an XML encoding that provides an information model and encodings that enable discovery and tasking of Web-resident sensors, and exploitation of sensor observations.

- TransducerML (TML) is a method and message format for describing information about transducers and transducer systems and capturing, exchanging, and archiving live, historical, and future data received and produced by them.

And two are interface specifications for Web services:

- Sensor Observation Service (SOS) provides access to observations and associated metadata for a sensor or sensor constellation.

- Sensor Planning Service (SPS) enables clients to request collection feasibility and task a sensor system for desired observations.

SWE participants are working on additional candidate specifications:

- Observations and Measurements (O&M) specifies core models and schema for observations.

- Sensor Alert Service (SAS) enables clients to subscribe to alerts based upon sensor observations.

- Web Notification Service (WNS) enables management of dialogue between clients and Web services for long-duration (asynchronous) processes.

- Sensor Registries specifies a universal system for publishing and discovering sensors and sensor observations.

<Sidebar 3>

OWS-4 Sponsors

- BAE Systems (U.S.)
- GeoConnections (Canada)
- Lockheed Martin Corporation (U.S.)
- National Technology Alliance (U.S.)
- NATO C3
- Oak Ridge National Laboratory (U.S.)
- Ordnance Survey (UK)
- TeleAtlas (U.S.)
- U.S. General Services Administration
- U.S. National Aeronautic and Space Administration
- U.S. National Geospatial-Intelligence Agency

<Sidebar 4>

OWS-4 Participants

- 3eTi
- ADI/Thales
- AEC3
- Autodesk
- BAE Systems
- Bentley
- COMCARE
- Compusult
- con terra
- CSIRO-EM
- CSIRO-ICT
- Cubewerx
- deCarta
- Eco-Systems
- ESRI
- FAO (GeoNetwork)
- Fraunhofer
- Galdos
- George Mason University
- General Services Administration
- GeoConnections
- GeoTexel
- Harvard University
- Image Matters
- IndoorLBS
- Interactive Instruments
- Intergraph
- Ionic Software
- Iris (Argon ST)
- ITC

- ITT
- IU Bremen
- Laser-Scan/1Spatial
- Lat/lon
- Lizardtech/Celartem
- Lockheed Martin Corporation
- MAGIC Services Forum
- MapXperts
- NASA
- NATO C3 Agency
- Navteq
- National Technology Alliance
- Northrop Grumman-TASC
- Onuma
- Oracle
- Ordnance Survey
- Oak Ridge National Laboratory
- PCI Geomatics
- Port Authority New York/New Jersey
- Smart Sensors
- Snowflake
- Spacebel
- Spot Image
- Technical University of Munich
- Tele Atlas
- Thirteen/WNET
- TOPP
- Traverse Technologies
- University Alabama Huntsville
- UniBW — AGIS
- University of Bonn
- University of Muenster — IFGI
- University of Potsdam — HPI
- Vightel
- Washington University, StL