GEOSS "System of Systems" Depends on Standards

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How can 61 countries and 40 international organizations bring together their existing and new earth observation hardware and software systems to create a Global Earth Observation "System of Systems" (GEOSS) when the component systems are so different?

Like telephones, fax machines and web servers, the diverse systems in GEOSS will interoperate through published, free, universally adopted interface and encoding standards. The GEOSS 10-Year Implementation Plan and Reference Document (www.earthobservations.org) states:

"The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata and products. GEOSS interoperability will be based on non-proprietary standards, with preference given to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such systems have interfaces to the shared architecture."

"The Group on Earth Observations will establish, within 2 years, a process for reaching, maintaining, and upgrading GEOSS interoperability arrangements, informed by ongoing dialogue with major international programmes and consortia. Attention is drawn to the importance of using existing international standards organizations and institutes as a focal point for the GEOSS interoperability objectives as they relate to and use standards."

Among the standards necessary to build GEOSS are some that are already in use in commercial and non-commercial products, as demonstrated by members of the Open Geospatial Consortium, Inc. (OGC) at the International Geosciences and Remote Sensing Symposium, IGARSS 2005, in Seoul, Korea, in July 2005. The demonstration showed that earth observation data and online services are already accessible using industry standard, open interfaces. The demonstration utilized software components that use OGC Web Services interfaces (described below) in a scenario of damage assessment from the Indian Ocean Tsunami, Dec. 26, 2004.

The scenario began with a George Mason University client accessing a Common Alerting Protocol (CAP) message as a Geography Markup Language (GML) document from an Intergraph server that implemented OGC's OpenGIS Web Feature Server Specification (WFS). Landsat imagery was provided by the NASA-JPL Global Mosaic, which implements the OpenGIS Web Map Server Specification (WMS).

CAP, from OASIS (Organization for the Advancement of Structured Information Standards, an e-business standards organization) is a simple but general format for exchanging all-hazard emergency alerts and public warnings over networks. The OpenGIS GML Specification (all the OpenGIS Specifications are products of the international consensus process managed by OGC) defines a data encoding in Extensible Markup Language (XML, a simple, extensible text format from W3C) — a "namespace" — for geographic data and its attributes. WFS describes data manipulation operations on OGC Simple Features (e.g., points, lines, and polygons) so that servers and clients can communicate at the feature level. WMS provides uniform access by Web clients to maps rendered by map servers on the Internet.

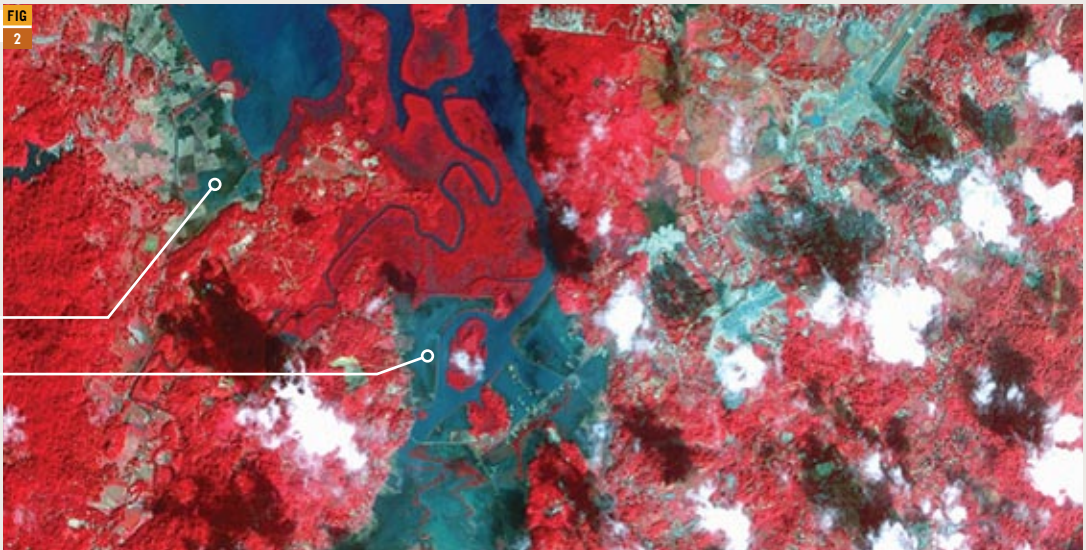

FIGURE 2 *Value-added product showing areas of the Andaman Islands affected and flooded by the tsunami. Image from SPOT Image, Inc.*

The George Mason University client accessed layers of tsunami damage summaries provided by a server that implemented WMS. That server was developed by DM Solutions as part of a project with several East Asian Universities.

Next, imagery was accessed from a Spot Image server — via an interface implementing the OpenGIS Web Coverage Server Specification (WCS) — to see additional detailed damage from the tsunami. (WCS extends the WMS interface to allow access to geospatial "grid coverages" that represent values or properties of geographic locations, rather than simple maps, or pictures.)

A chain of OGC Web services was invoked using standard web service chaining mechanisms to produce a value-added product. See ***Figues 1*** and ***2***. The European Space Agency System Support Environment managed the workflow of accessing the Spot Image WCS and invoking PCI Geomatics' implementation of the OGC Web Coordinate Transformation Service (WCTS) discussion paper (a specification that has not yet been adopted by the OGC membership). (The WCTS provides a standard Web-based way for software to specify and access coordinate transformation services for use on specified spatial data.) OGC specifications can be downloaded from www.opengeospatial.org/specs/?page=specs.

More than 270 products are registered as officially implementing OpenGIS Specifications. (See www.opengeospatial.org/resources/?page=products.) As demand grows for interoperating products like these, more product developers add open interfaces. Many agencies are boosting demand by putting standards requirements in their Requests for Quotes for software procurements. This progress advances the GEOSS vision.

The ad-hoc Group on Earth Observations Architecture sub-group has a plan that includes a task to select standards, but none have been selected yet. Specifications used in the IGARSS 2005 demo are candidates for consideration as part of the technology layer of the GEOSS architecture.

Other standards that are under consideration include CORBA (Common Object Request Broker Architecture), WSDL (Web Services Definition Language), ebXML (electronic business XML), UML (Unified Modeling Language), and ISO/IEC 11179, Information Technology – Metadata Registries.

Remote sensing organizations from many countries have contributed to the development of OpenGIS Specifications, and OGC has worked to harmonize these specifications with evolving internet and World Wide Web standards. Thus, much of OGC's work addresses the needs of the GEOSS community. Regarding the OGC demo during IGARSS, Al Gasiewski, President, IEEE Geoscience and Remote Sensing Society said, "It is encouraging to see such rapid progress in the development of multi-source open web-based software tools designed with the needs of GEOSS users in mind."

However, the work is not finished. Important technical capabilities are still missing and some communities in the Earth observation world have not made their requirements known in OGC or in other relevant standards organizations, so existing and in-progress specifications may not meet their needs. Broad participation by GEOSS communities in standards efforts will be necessary if GEOSS is to succeed, because only by participating in standards efforts can organizations shape standards to suit their needs.

FIGURE 1 *Open interfaces enable web-based "service chaining." Value-added information products are produced by automated procedures involving different data servers and process servers on the web.*