Article for September 2006 Geoinformatics

GEOSS to Benefit from "Service Chaining" Based on OGC® Standards

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At a series of demonstrations being held around the world, scientists in many disciplines are discovering exciting new capabilities for publishing, discovering and accessing not only geospatial data, but also online geospatial services that can be "linked together" to process the data.

The "Global Earth Observation System of Systems" (GEOSS) effort was begun at the 2003 Earth Observation Summit (EOS) to serve a wide range of social needs. Sixty-one countries and 40 international organizations, including the Open Geospatial Consortium, Inc. (OGC), are now involved in GEOSS.

"The User and the GEOSS Architecture V Workshop" at IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2006 in Denver, Colorado, July 29, is the fifth in a series of nine international GEOSS Architecture workshops. The goal of the workshops is to provide opportunities for different communities of GEOSS users to interact with information technologists in exploring the benefits and challenges of the emerging GEOSS.

During each workshop, participants demonstrate an OGC standards-based networking application, such as monitoring forest fire smoke dispersion. These demonstrations are supported by the OGC as part of the GEOSS Web Services network. The Denver demo was lead by Liping Di of George Mason University and Rudy Husar of Washington University, St. Louis. Demonstration components and data were provided by Unidata/UCAR, NOAA/NCDC NASA, IMAA/CNR, CIESIN, EPA and others.

The four previous "The User and the GEOSS Architecture" Workshops were held in Seoul, Korea; Tshwane (Pretoria), South Africa; Beijing, China; and Corsica, France. Three others are planned:

- Sept 25-26 in Goa, India at the ISPRS Comm IV (International Society for Photogrammetry and Remote Sensing - Commission IV) conference. OGC demo to be managed by University College of London.

- October 28-29 in Cairo, Egypt at the Sixth AARSE (African Association of Remote Sensing of the Environment) conference. OGC demo to be managed by Council for Scientific and Industrial Research (CSIR) of South Africa.

- November 8 in Santiago, Chile at the 9th International Conference of the Global Spatial Data Infrastructure. GEOSS demo to be managed by the Center for International Earth Science Information Network (CIESIN).

The workshops provide an informal environment in which to exchange ideas and make recommendations to the GEO committees formulating GEOSS as the committees move forward with implementation.

GEOSS has a mission to provide societal benefit in nine areas. Two of these, air quality and climate change, were highlighted at the Denver workshop, and most of the scientists present at the Denver workshop work in these two areas.

A Forest Fire Smoke Use Case

The Denver GEOSS demo involved a scenario that required near real-time data access, browsing, and analysis of distributed air quality data from satellite and surface sensors. The scenario was based on an actual smoke incursion on June 26-30, 2006 from Manitoba to the U.S.

The pattern of air pollution is determined by the combined effects of emission sources and by the interaction of transport, transformation and removal processes. The contribution of the various factors can be examined by a set of relatively simple analysis tools.

Air quality is monitored by a variety of sensors at the Earth's surface and from satellites. The data are accessible from a large array of distributed providers, but they are in different formats and use different access procedures. The demonstration showed how the different formats and access procedures no longer need prevent scientists and others from being able to easily discover and use the data – live and archived – from these sensors.

The analyst in the scenario first accesses air quality images, including surface visibility and meteorological conditions observed from the U.S. Environmental Protection Agency's AirNow sensors and a surface meteorological network. Political boundaries and weather observation data from the satellite-borne MODIS (the MODerate Resolution Imaging Spectroradiometer) also need to be accessed.

The analyst uses a catalog that implements the OpenGIS® Catalog Services interface standard to search the published air quality images for the specific date and geographic coverage. When the analyst finds there is no such data product registered and available, the analyst creates such a product through a geo-processing model and registers the model as a virtual product in the catalog.

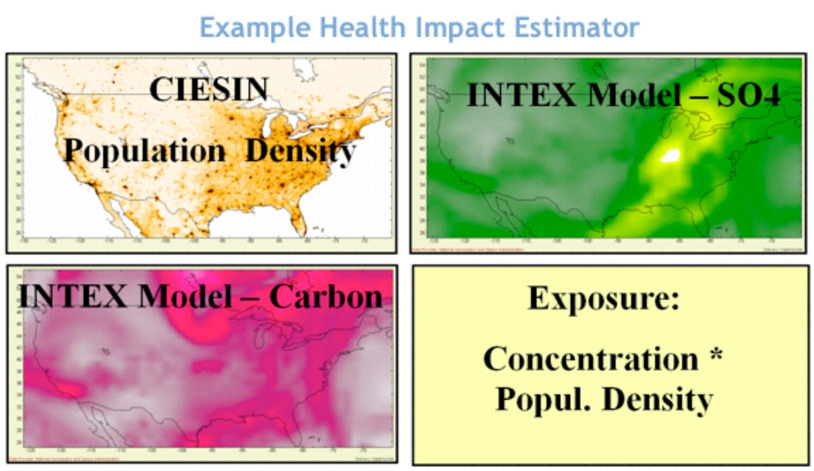


Figure 1: Data for air quality analyses comes from many sources.

For those who have not closely followed the development of Web services, this is a rather remarkable development. With open geoprocessing service interface standards -- OGC Web Services (OWS) -- based on the open standards of the Web, many things are possible that were barely dreamed of just a few years ago.

It is now possible for owners of geospatial data, data streams, data schemas, and Web services (online processing capabilities) to register these resources in a standard way using an online catalog. The catalog is designed with open interfaces so any developer can write software to access the resources registered in it. Not only is it possible to access a Web Service from a Web-based application, but one can string together a series of Web Services (which may be running on different computers around the world) to perform a series of operations on data.

In the GEOSS demo, the system converts the analyst's model to an executable workflow using the OASIS standard called BPEL (Business Process Execution Language for Web Services) by automatically plugging in real services and data based on the user's specification. The system and the Web services it has marshaled then execute the workflow to generate the geospatial information product on demand.

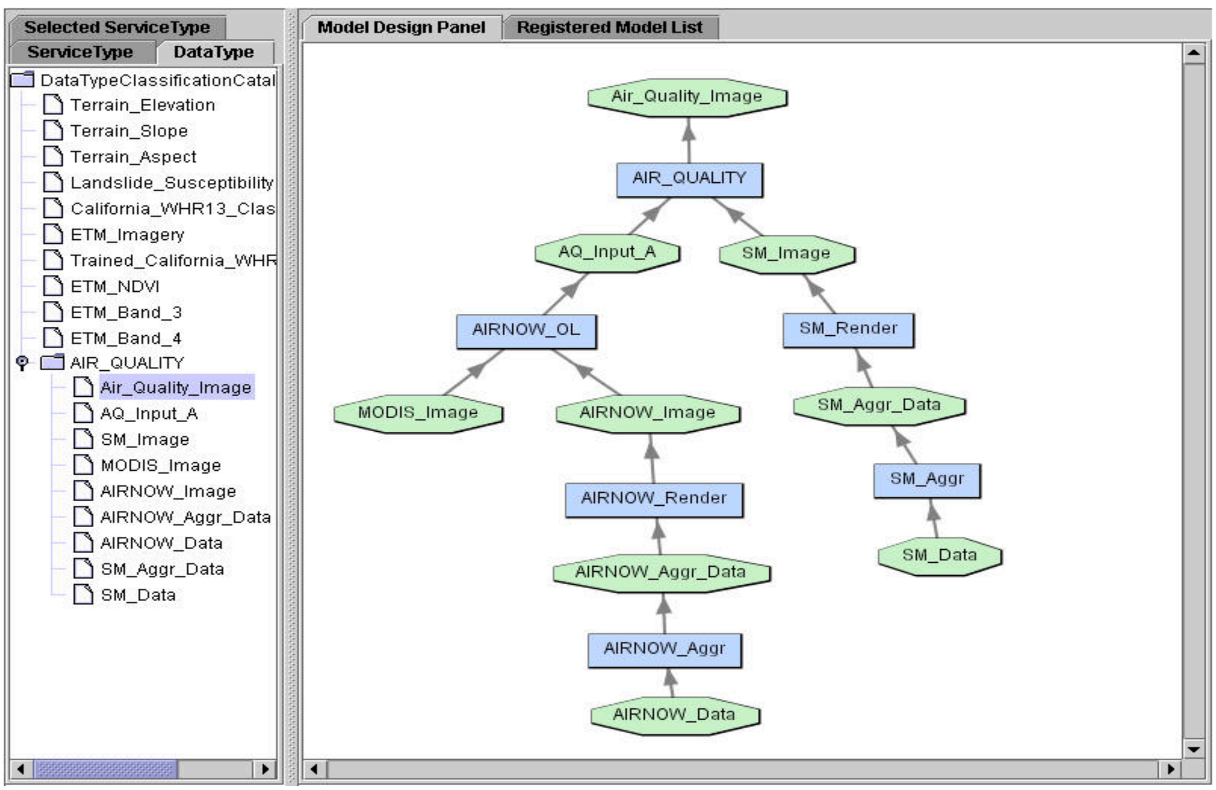


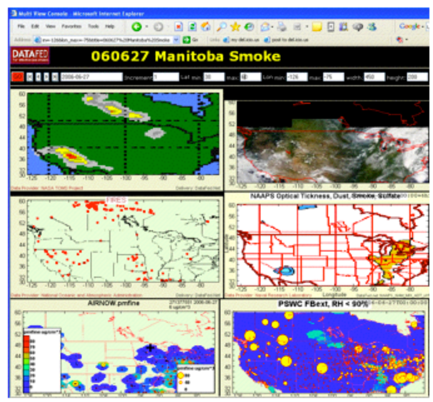
Figure 2: Analyst creates a new image by "chaining" services from multiple sources.

The analyst retrieves the air quality image from a server with an interface that implements the OpenGIS Web Coverage Service (WCS) Implementation Specification.

The analyst identifies the location of high pollution levels and runs the back-trajectories for those locations. Air mass back-trajectories are overlaid on top of emission density maps to see if the air resided over high pollutant emission regions. Based on satellite and model data, the analyst examines possible emissions from major fires or from dust storms. Given the location of high pollution values, forward trajectories are calculated to see the transport direction of the polluted air. Model forecasts are also consulted.

Each data set is accessed through a variety of interfaces based on OGC standards. Service chaining is executed at multiple servers to demonstrate the interoperability that such chaining requires.

In the demonstration, after finding, accessing and analyzing the data, the analyst estimates the current and predicted health impact of air pollution on the human population, calculating from the surface concentration of pollutants and from population density. When the forecast exposure exceeds a threshold, the manager issues an ‘air pollution advisory’ or warning. The Air Quality Image created as a result of the chained services can be combined with other OGC web service accessible data to complete the analysis.



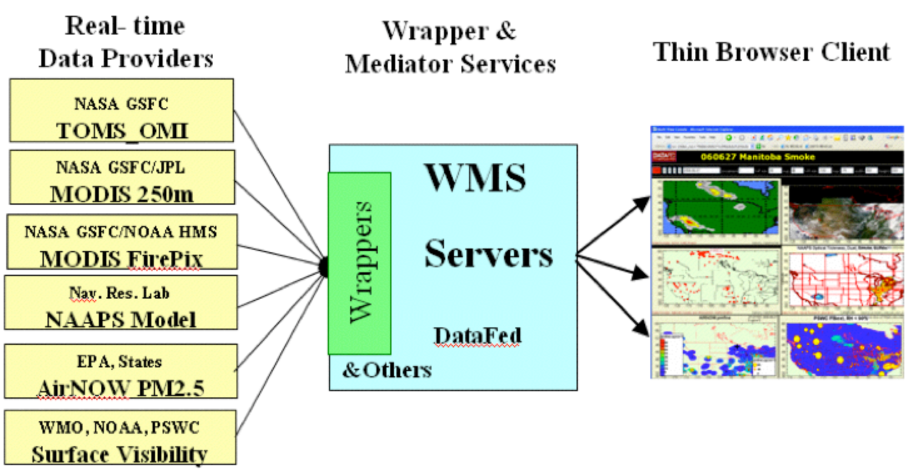


Figure 3: Data from many sources can be automatically accessed and combined.

Workflow automation using standards-based geospatial web services will provide a new level of productivity in addressing the societal benefit areas of GEOSS. The easy, quick access to data results in a dramatic reduction in effort and time for the projects. The ability to share the workflow scripts amongst peers enables collaboration. The agile, flexible workflow allows evaluation of different approaches for pragmatic decision making.

Conclusion

The Denver GEOSS Architecture Demo showed how interoperability of Web services from different providers implementing OGC Web Services standards enables chaining of services in automated workflows. Through open standards in a distributed processing environment, scientists can quickly find and evaluate many different data sets and processing approaches. Such an open Web services approach provides an agile environment to serve scientific collaboration in all the scientific communities that use geospatial data.

This streamlined approach to finding, accessing and analyzing data also serves environmental managers and others who must deliver the results of their analyses to officials and to the public. Scientists are nearly unanimous in their concerns about global warming and its accompanying dangers, such as severe weather events and associated forest fires, floods, etc. Clearly, the need for GEOSS rises with the rise in the temperature of the planet.