Federation of Earth Science Information Partners

MAKING DATA MATTER

The ESIP Federation's Long Experience In the Development and Deployment of Web Services

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The ESIP Federation's Efforts in Web Services

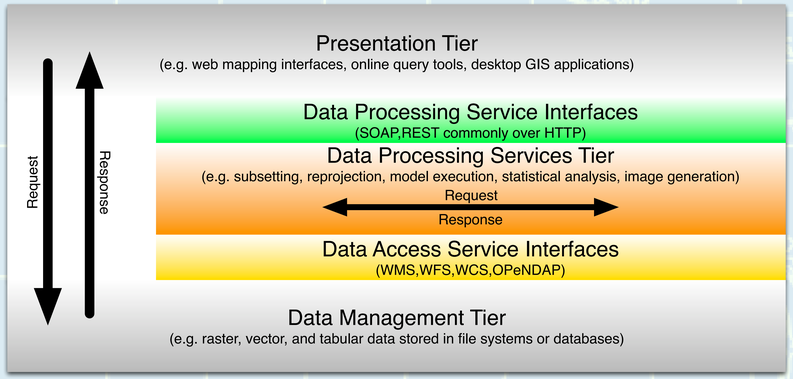
Throughout its near 10-year history, the Federation of Earth Science Information Partners (ESIP Federation) has endeavored to facilitate the discovery, access and use of Earth Science data products through the development and deployment of standards-based web services. These efforts have focussed in several areas, including:

- data and service discovery through the use of standard data and service metadata formats (FGDC, ISO 19115, WSDL, SERF, DIF) and catalog services (CSW, Z39.50, UDDI)
- data delivery, as images (WMS), as raster/vector data products (WFS, WCS), or as structured data (OPeNDAP)
- data processing, statistical analysis, and modeling through services callable through both SOAP and REST interfaces
- service chaining to allow for the definition of multi-step data processing chains using BPEL and SciFlow
- user interface development based upon web standards (HTML, CSS, JavaScript) and advanced interface development models based upon those standards (AJAX)

These efforts have resulted in a large number of standards-based systems and products that individual and groups of Federation members have developed in support of multiple end-user communities, with these communities including researchers, educators, decision-makers, and the general public.

This poster presents only a sample of the types of web services, and applications based upon those services, that have been developed by several Federation member organizations.

A Generic Services Oriented Architecture Model



This model illustrates an architecture in which there is a logical separation between data storage, data processing, and presentation. Communication between these separate tiers is accomplished through the use of a limited set of standard interfaces. This separation yields a high degree of flexibility in how the resources within each tier are combined in response to the requirements of a specific application.

For example, many applications may need access to a multi-TB imagery collection for use in their client interfaces. If that collection were published as an OGC Web Map Service (WMS), any client application that could submit a WMS request (in the form of a simple URL) to that service to obtain an image (map) for a specified region, in a specified format, and of a specific pixel resolution. In this specific example, a partial list of client applications that can make use of a WMS service includes Google Earth, ArcGIS, uDig, QGIS, and any web application that places the WMS request URL into the <img> HTML tag. In this instance, the deployment of a single standard services enables the use of this large data set in a broad range of client applications without having to modify how the data are stored or accessed in response to the needs of each client's needs.

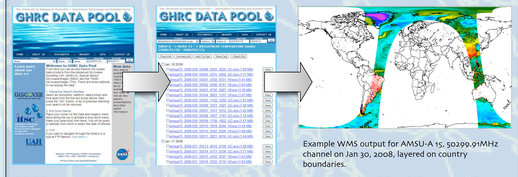
A second example highlights the 'component' nature of this architecture in the reuse and chaining of data processing services. If, for example, a reprojection SOAP service were developed for the processing of image data provided as a result of a WCS request, that reprojection service could be reused in multiple applications, either as a stand-alone service request originating in the Presentation Tier, or as part of a chain of service calls executed within the Data Processing Services Tier.

A Sampling of ESIP Federation Services and Applications Based upon those Services

NASA's Global Change Master Directory includes a variety of climate related portals that are enabled through the use of DIF and SERF documents to facilitate the discovery and access of data and services through these portals.

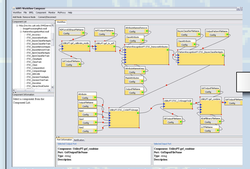
Specialized keyword hierarchies have also been developed within the GCMD for optimized discovery of climate-related data.

The Information Technology and Systems Center at the University of Alabama, Huntsville has developed numerous OGC WMS and WFS services for use in a variety of application environments, including hydrologic remote sensing and hurricane tracking.

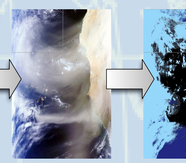


Example WMS output for AMSU-A 15, 50299.91MHz channel on Jan 30, 2008, layered on country boundaries.

SOAP web service interfaces have been added to the ADaM mining toolkit omponents. This has allowed the services to be orchestrated into solutions involving distributed resources by remote users, using BPEL standardized workflow definitions. The functionality is being used across multiple projects and science researchers.



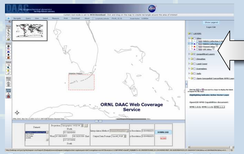
Mining Workflow Composer showing Bayes classification workflow



True Color MODIS showing dust blown off the coast of Africa

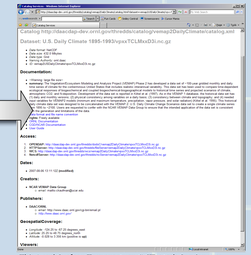
Result of Bayes classification using MWS to generate thematic map detailing dust

ORNL DAAC provides a number of data services in areas of data access, metadata archive and search, and data visualizations. Although they are mostly developed for internal tools hosted at ORNL DAAC, these services are standards-based and hence can be easily consumed by external processes.

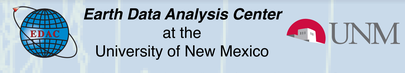


The ORNL DAAC WebGIS includes a number of land cover, biophysical, elevation, and geopolitical layers, as well as access to other relevant Open Geospatial Consortium (OGC) layers. The system utilizes the following OpenGIS protocols specified by OGC for data exchange between a browser client and the WebGIS Server: Web Map Service (v. 1.1.1), Web Coverage Service (v.1.0.0).

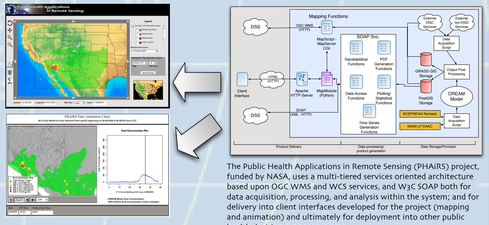
The Unidata "Thematic Realtime Environmental Distributed Data Services" project is a catalog middleware project to bridge the gap between data providers and data users. THREDDS Data Server (TDS) combines catalogs with OPeNDAP (DAP 2.0) and OGC Web Coverage Service (WCS 1.0), along with bulk file download and NetCDF subset services. The TDS instance at ORNL DAAC provides these data services for a subset of ORNL DAAC data collections. The TDS catalog includes datasets local to the TDS Server as well as externally-linked datasets from an OPeNDAP Hyrax Server.



This Land Surface Temperature (LST) Web Service was constructed to facilitate easy inter-comparison of datasets from various satellite and ground sources. MODIS/Terra LST (MOD11A2) and other pre-made subsets based on particular field locations are made available through a W3C SOAP Service. The service is consumed by a visualization application (SPEC) to compare with other data sources, including field measurements from AmeriFlux and NOAA Climate Reference Network field sites.



The Earth Data Analysis Center (EDAC) at the University of New Mexico provides a host of web services in support of the diverse application development and service activities it supports. These include OGC WMS and WFS, W3C SOAP services, and metadata search capabilities based upon the Z39.50 standard.



The Public Health Applications in Remote Sensing (PHAIRS) project, funded by NASA, uses a multi-tiered services oriented architecture based upon OGC WMS and WCS services, and W3C SOAP both for data acquisition, processing, and analysis within the system; and for delivery into client interfaces developed for the project (mapping and animation) and ultimately for deployment into other public health decision support systems.

As a partner in New Mexico's NSF funded EPSCoR program, EDAC has developed time-enabled OGC WMS services for remote sensing derived ET data, ET Tower data, and hydrologic model outputs that have been successfully deployed into a variety of client applications, including Google Earth.

Deciphering the "Alphabet Soup" of Services and Standards

AJAX - Asynchronous JavaScript and XML - http://en.wikipedia.org/wiki/Ajax_(programming)
BPEL - Business Process Execution Language for Web Services - http://www.ibm.com/developerworks/library/specification/ws-bpel/
CSS - Cascading Style Sheets - http://www.w3.org/Style/CSS/
CSW - OpenGIS Catalogue Service Implementation Specification - http://www.opengeospatial.org/standards/cat
DIF - Directory Interchange Format - http://gcmd.nasa.gov/User/difguide/difman.html
FGDC - FGDC Content Standard for Digital Geospatial Metadata - http://www.fgdc.gov/standards/standards_publications/
HTML/XHTML - Hypertext Markup Language - http://www.w3.org/MarkUp/
ISO 19115 - ISO Standard for Geographic Information Metadata - http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=26020
JavaScript aka ECMAScript - Scripting language commonly used in web applications - http://en.wikipedia.org/wiki/JavaScript
OPeNDAP - Open-source Project for a Network Data Access Protocol - http://www.opendap.org/
REST - Representational State Transfer - http://en.wikipedia.org/wiki/Representational_State_Transfer
SciFlow - A workflow toolkit developed as part of NASA's GENESIS Project - http://esto.nasa.gov/conferences/estc2004/papers/a1p1.pdf
SERF - Service Entry Resource Format - http://gcmd.nasa.gov/User/serfguide/
SOAP - Simple Object Access Protocol - http://www.w3.org/TR/soap12-part1/
UDDI - Universal Description, Discovery, and Integration - http://uddi.xml.org/
WCS - OpenGIS Web Coverage Service - http://www.opengeospatial.org/standards/wcs
WFS - OpenGIS Web Feature Service - http://www.opengeospatial.org/standards/wfs
WMS - OPenGIS Web Map Service - http://www.opengeospatial.org/standards/wms
WSDL - Web Services Description Language - http://www.w3.org/TR/wsdl
Z39.50 - Client-Server protocol for remote database search and retrieval - http://en.wikipedia.org/wiki/Z39.50

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