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Summary of the

OGC Web Services, Phase 9 (OWS-9)

Interoperability Testbed

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Abstract:

This report summarizes the results of OGC Web Services Initiative, Phase 9 (OWS-9).

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What is OWS-9

OGC is the only international organization that brings industry players together to help organizations manage risks and difficulties that relate to communication about real-world location and mobility. The OGC combines rapid prototyping, standards development, coordination with other standards organizations, and aggressive standards marketing to address users' challenging integration problems.

Over the last 18 years, the OGC's private sector, government and academic members have developed a unique and proven process that **saves everyone time and money** while creating new business opportunities and driving innovation. The Interoperability Program plans and conducts plugfests, pilots and the annual OGC Web Services (OWS) testbed.

This report summarizes the results of OGC Web Services Initiative, Phase 9 (OWS-9). ***OWS-9 sponsorship totaled $2.80 million USD and attracted an in-kind contribution of 3 times that amount.*** The ten OWS-9 sponsors from the US, Canada and Europe who shared the costs and contributed the requirements have missions ranging from environmental management and civil government mapping to maintaining common operating pictures in disaster zones and battlefields. Working on specific interoperability problems detailed in the sponsors' use cases and scenarios, the 45 industry participants in OWS-9 have delivered extraordinary value in the following areas:

- **Aviation**: The Aviation world gets modern, web-accessible Aeronautical Information Services that can adapt as technology changes.
- **Cross-Community Interoperability (CCI):** Communities sharing spatial data get a better location search capability, improved ability to track data's origins, real-time fusion of data from multiple sensors, and a standard for a Global Gazetteer capable of real-time translation of spatial semantics.
- **Security and Services Interoperability (SSI):** Communities sharing spatial data get recommendations for Security Management, a way to automate the creation of implementable data schemas from abstract models, easier use of OGC Web Services, methods for more efficient design of architectures, and a standard that helps users manage large spatial databases that are being edited by intermittently-connected mobile device users.
- **OGC Web Services (OWS) innovations:** For everyone, new OGC compliance tests and improved interoperability for mobile device apps that use OGC standards in providing location services.

- **Compliance & Interoperability Testing & Evaluation (CITE):** Software implementers now have more tests to run against their implementations. Software consumers, especially governments who are increasingly favoring solutions that use open international standards, now have more mechanisms to guarantee that a software is correctly implementing OGC standards.

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Summary of OGC Web Services Initiative, Phase 9 (OWS-9)

1 Overview

The OGC Web Services, Phase 9 (OWS-9) Testbed was an initiative of OGC's Interoperability Program to collaboratively extend and demonstrate OGC's baseline for geospatial interoperability. The majority of work for OWS-9 was conducted from May to December 2012, with the following outcomes:

- **60** Software Components (servers, clients, tools and other applications) were implemented and participated in interoperability testing.

- **28** Engineering Reports (ERs) were written. The OWS-9 ERs were either technical specifications or reports regarding testing and analysis. Several CRs were also developed as recommendations for changes to existing standards, and have been entered into OGC's public process for reporting such requests here: http://www.opengeospatial.org/standards/cr

  The OWS-9 ERs have also been posted to the OGC Standards Program Pending Documents list for consideration in the consensus process. The Engineering reports have been approved for public release, accessible on the web here: http://www.opengeospatial.org/standards/per

- **55** organizations participated in some aspect of OWS-9. Roles for organizations in OWS-9 included sponsors, participants and architects. Additionally there were many organizations that were observers of OWS-9.

- **10** sponsoring organizations defined requirements for OWS-9. The sponsors' requirements were captured in a set of RFQ/CFP documents that were released by OGC seeking organizations that wished to participate in OWS-9.

The OWS-9 Testbed concluded with a well-attended demonstration on Tuesday January 17 during the OGC Technical Committee meeting, in Redlands California (check out quick blog about the event at *www.opengeospatial.org/**blog**/1775)* .The demonstration lasted 2.5 hours and included an overview of the testbed and the work areas (threads), as well as quick demonstrations of 3 scenarios (Aviation, SSI/CCI/Mobile cross-thread, and geonames). The agenda for the event can be downloaded here https://portal.opengeospatial.org/files/?artifact_id=5175. An exhibit followed the demonstration, where the OWS-9 participating organizations had the opportunity to provide in-depth descriptions to their specific contributions to OWS-9 to the sponsors and other TC attendees. The feedback about the exhibit from attendees and exhibitors alike was very positive.

2 Organizations in OWS-9

2.1 Sponsoring Organizations

OWS-9 was sponsored by the following organizations:

- US National Geospatial Intelligence Agency (NGA)
- US Geological Survey (USGS)
- US Army Geospatial Center (AGC)
- US Federal Aviation Administration (FAA)
- EUROCONTROL
- US National Aeronautics & Space Administration (NASA)
- UK Defence Science & Technology Laboratory (DSTL)
- Lockheed Martin Corporation (also providing thread architect)
- GeoConnections/Natural Resources Canada
- GeoViqua/CREAF/European Commission (EC)

2.2 OWS-9 IP Team

The IP Team is an engineering and management team to oversee and coordinate an OGC Interoperability Initiatives. The IP Team facilitates architectural discussions, synopsizes technology threads, and supports the specification editorial process. The IP Team is comprised of OGC staff and representatives from member organizations. The OWS-9 IP Team was as follows:

- Interoperability Program Executive Director: George Percivall, OGC
- Initiative Director: Dr. Nadine Alameh, OGC
- Thread Architects
  - Aviation: Johannes Echterhoff, Igsi
  - Cross-Community Interoperability: Dr. Luis Bermudez, OGC
  - OWS Innovations: Dr. Raj Singh, OGC
  - Compliance Testing: Dr. Luis Bermudez, OGC
  - Security and Service Interoperability: Jennifer Harne, Lockheed Martin Corporation
- IT and Demonstration Support: Greg Buehler, OGC; Mark Buehler, OGC

2.3 Complete List of Participating Organizations

The following organizations played one or more roles in OWS-9 as participants (responded to the RFQ/CFP and provided in-kind contributions).

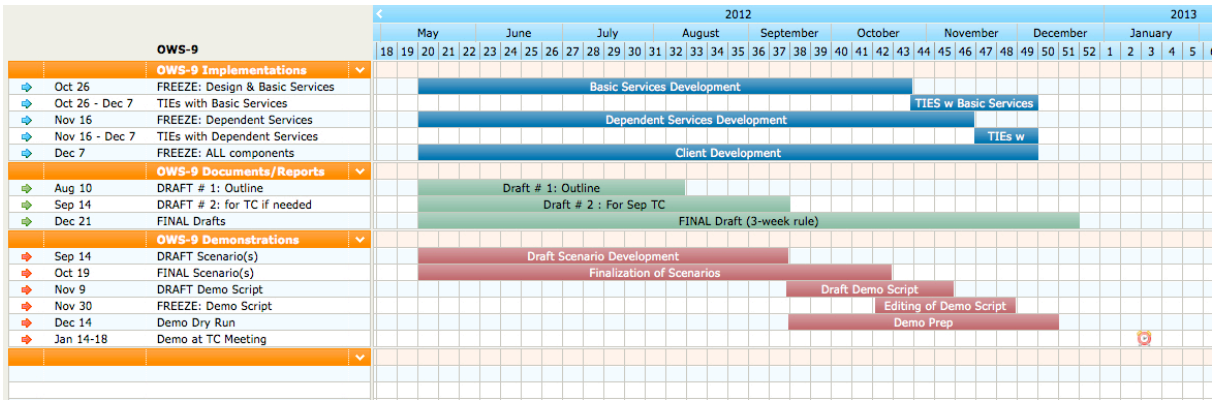
- 52North
- Atmosphere
- Botts Innovative Research
- Compusult
- Comsoft
- Consiglio Nazionale delle Ricerche (CNR)
- con terra
- CREAF
- CubeWerx
- DevelopmentSeed
- Envitia
- EOX
- European Union Satellite Center (EUSC)
- Galdos Systems
- GIS.FCU
- GMU
- Harris Corporation
- Ingegneria Dei Sistemi (IDS)
- Institute for Geoinformatics (ifgi)
- interactive instruments
- Intergraph
- International Geospatial Services Institute (iGSI)
- Latlon
- LISAsoft
- Luciad
- Meteorological Environmental Earth Observation (MEEO)
- OpenDAP
- Opengeo
- rasdaman
- Secure Dimensions
- Snowflake
- Speed Squared
- Terradue
- Terrapixel
- The Carbon Project
- The PYXIS Innovation
- TriaGnoSys

3 Schedule

The OWS-9 followed the following general schedule

Date	Milestone
11 February 2012	RFQ/CFP Released
6 April 2012	Responses due
14-16 May 2012	Kickoff at GMU Fairfax VA
14 September 2012	Interim milestone: draft reports and implementations
21 December 2012	Final reports and components due
17 January 2013	Demonstration at OGC TC meeting

A detailed execution schedule is captured below



After the Kickoff Meeting, design, development and testing of OWS-9 components was conducted in a distributed fashion supported by the collaborative development resources of telecoms, a web portal, twiki, web collaboration tools, and e-mail.

The SOW milestones had various deliverables specific to each participant. A limited number of ERs were extended beyond this schedule, as the inputs needed for the work were not available as anticipated. See ER table for more information.

4 Engineering Reports

The following reports were presented and voted on for public release at the January 2013 TC.

- 12-156 OWS-9 Reference Architecture Profile (RAP) Advisor as ER
- 12-105 OWS-9 - OWS Context Evaluation IP ER
- 12-104 OWS-9 ER – Cross Community Interoperability (CCI) - Single Point of Entry Global Gazetteer
- 12-133 OWS-9 Web Services Facade ER
- 12-152r1 OWS-9 Compliance and Interoperability Testing Initiative (CITE) Help Guide
- 12-162r1(WCS) 2.0 Core and Extensions Reference Implementation and Conformance Testing
- 12-145 OWS-9 Aviation Metadata & Provenance ER
- 12-147 OWS-9 Aviation Architecture ER
- 12-146 OWS-9 Web Feature Service (WFS) Temporality Extension ER
- 12-151 OWS-9 Aviation Portrayal
- 12-027r2 OGC Web Feature Service (WFS) Temporality Extension
- 12-163 OWS-9 Data Transmission Management ER
- 12-094 OWS-9 Aviation ATM Information Reference Model (AIRM) Derivation
- 12-119r1 OGC Mobile Apps ER: : Definition, Requirements, and Information Architecture
- 12-159 OWS-9 Cross Community Interoperability (CCI) Conflation with Provenance ER
- 12-097 OWS-9 Bulk Data Transfer – GML Streaming Engineering Report
- 12-093 OWS-9 SSI UML-to-GML-Application-Schema automation (UGAS) ER
- 12-154 OWS-9 GMLJP2 for (National Imagery Transfer Format (NITF) ER
- 12-103r3 OWS-9 Cross Community Interoperability (CCI) Semantic Mediation
- 12-096 OWS-9 Use of SWE Common Data and SensorML for GPS Messaging
- 12-118 OWS-9 - Security Engineering Report
- 12-139 OWS-9 Security and Services Interoperability (SSI): Security Rules Service ER
- 12-157r1 OWS-9 ER - OWS Innovations - Map Tiling Methods Harmonization
- 12-158 OWS-9 Report on Aviation Performance Study ER

The following Engineering Reports were not ready for voting in January 2013, and will be voted on during the March 2013 TC meeting

- 12-144 OWS-9 Aviation Registry ER
- 12-095 OWS-9 Coverage Access (OPeNDAP) Study ER
- 12-160 OWS 9 Data Quality and Web Mapping Engineering Report
- 12-155 OWS-9 Innovations WCS For LIDAR ER
- 13-011 OWS-9 Summary Report

5 Development Threads

The development of the OWS-9 initiative was organized around the following 5 threads:

1) Aviation – Building Blocks for Interoperable ATM Information Management
2) Cross-Community Interoperability (CCI) – Where Data and Knowledge Converge
3) Security and Service Interoperability (SSI) – Advances in Service Access and Data Distribution
4) OWS Innovation (OI) – Revolutionary Interoperability Experiments
5) Compliance Testing (CITE) – Compliant Bytes

An introduction to each of these threads and subthreads is presented below, followed by a listing of the components and ERs developed in each thread.

5.1 Aviation

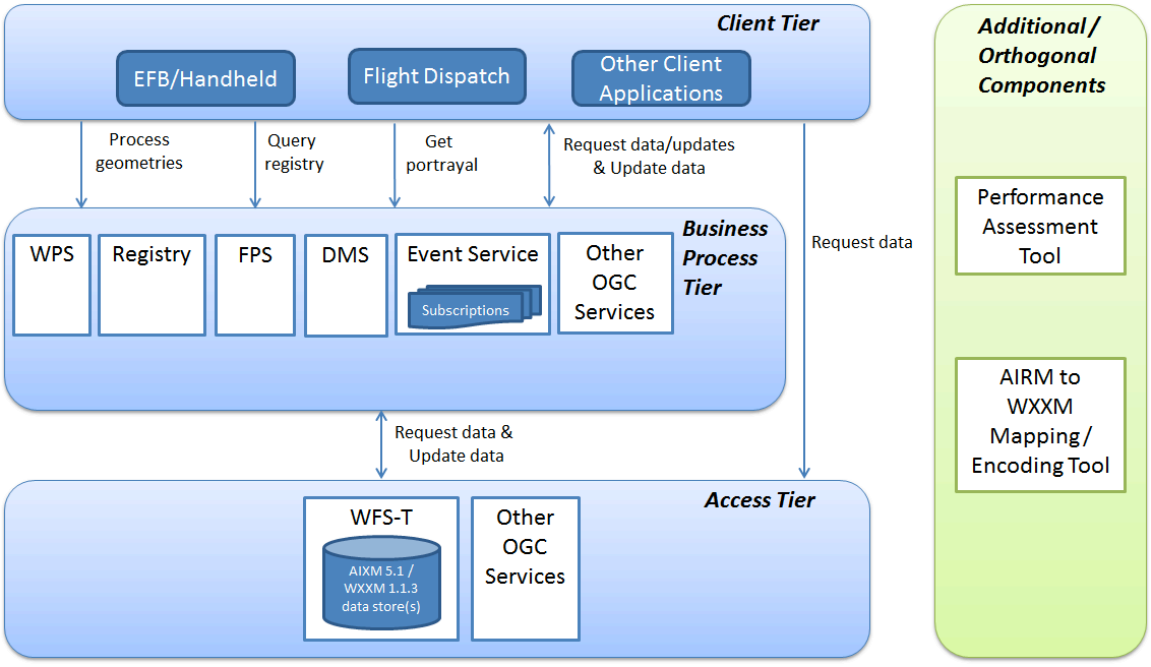
Sponsors: FAA (AIM, NNEW, SWIM), EUROCONTROL

Participants: 14 organizations

Tasks:

- **Advancing the Aviation Architecture:**
  - Investigating functionality to support improved retrieval of aeronautical and weather information via Web Feature Service and Event Service
  - Exploring the representation and efficient management of metadata – including data provenance
  - Developing support for efficient communication between Aviation services and clients located on an aircraft
  - Pursuing work in the areas of discovery as well as interoperable styling and portrayal
  - Integrating functionality to perform geometry processing via Web Processing Service
- **Advancing system stability and compliancy:**
  - Testing and analyzing the performance and endurance of critical data provisioning services – Web Feature Service and Event Service
  - Advancing the Temporality Extension support in Web Feature Services serving aeronautical information
- **Advancing modeling tool support:**
  - Investigation and development of conceptual modeling and mapping tool support.

OWS-9 Aviation Architecture Diagram:



OWS-9 Aviation had nine main work areas:

- AIRM (to WXXM) Derivation
- Data Provision
- Data Transmission Management
- Discovery
- Geometry Processing
- Metadata Use
- Performance Study

- Portrayal
- Temporality Extension

Significant Results Achieved in these work areas:

- **AIRM (to WXXM) Derivation**
  - Simple transformation and mapping rules for generating implementation schema from the SESAR ATM Information Reference Model (AIRM) were developed.
  - The AIRM was successfully transformed and GML/JSON application schema encodings were automatically generated, including code list dictionaries and feature catalogues.
  - Existing UML to GML Application Schema (UGAS) software was applied to ensure a consistent schema generation result.
- **Data Provision**
  - Implemented and tested advanced filtering functionality to:
    - Selectively retrieve metadata
    - Have an Event Service provide Digital NOTAMs at a specific update rate
    - Simplify spatial filtering based upon the spatial extent of AIXM features, using AIXM features as geometry operands directly and supporting spatial queries of AIXM features that do not provide their spatial context themselves (but via other features)
    - Simplify common filtering tasks through use of the WFS Stored Query mechanism and addition of a similar mechanism to the Event Service (Stored Filter)
    - Take into account the actual shape of an airspace – 2.5D instead of 2D only - when calculating the spatial relationship (e.g. intersection) to other features
- **Data Transmission Management**
  - Concepts from Aircraft Access to SWIM (AAtS) were analyzed, especially the Data Management Service (DMS), as well as related technologies.
  - The first version of a modular service specification supporting DMS requirements and interoperable DMS systems was defined.
  - DMS prototypes have been implemented and tested – both clients and services.
  - Communication between a client and OGC web services via a DMS was demonstrated.
- **Discovery**
  - The “Cataloging ISO Metadata (CIM) Registry Package” (an OGC Discussion Paper) was implemented and tested.
  - A capability for harvesting ISO compliant service and dataset metadata from a number of OGC Web Service types was established.
  - A capability was created for CSW-ebRIM to harvest full OGC WFS metadata.
  - References to OWS-9 Aviation web services were added to the SESAR Registry Demonstrator.
  - A “SESAR-compliant” OGC CSW-ebRIM Registry was implemented.
  - A gap analysis between OGC Catalogue Service and SESAR Registry requirements was performed.
- **Geometry Processing**
  - A number of WPS profiles were developed to serve common Aviation processing tasks (intersection of two AIXM features, spatial relationship of AIXM features, calculating the geometry of an AIXM feature).
  - WPS components supporting these profiles were implemented as proof of concept.
  - The components were demonstrated based upon real-world use cases (for example the intersection of a flight route with airspaces).

- **Metadata Use**
  - ISO service metadata (encoded in ISO 19139) was created from OWS Capabilities documents (via automated scripts) and made accessible.
  - Metadata guidelines from the OGC Aviation Domain Working Group and NNEW were compared, resulting in a number of proposals to enhance and harmonize the metadata guidelines and standards.
  - Means to efficiently retrieve metadata from a CSW-ebRIM registry were investigated, for example using the proposed CSW-ebRIM 2.0 'view' parameter.
  - A number of metadata transfer options were investigated: via the SOAP message header, the SOAP message body, and the dataset payload body (for GML based data).

- **Performance Study**
  - A general approach to assess the performance of Aviation data provision services (WFS and Event Service) was designed.
  - Test models for a number of (operational) use cases from the Aviation domain were developed, implemented, executed against OWS-9 Aviation service components and the results documented.

- **Portrayal**
  - A workflow to generate ePIB airport maps based upon an OGC standards-based architecture was designed, implemented and demonstrated.
  - OGC service components used in the demonstration of the workflow were re-used without any modification:
    - OGC WFS was used to deliver airport feature data relevant for creation of the airport maps,
    - OGC FPS was used for rendering the airport map and the Digital NOTAM events
    - OGC CSW/WRS was used to identify and query the WFS data sources that provide relevant feature data and to retrieve styling information
    - Custom business logic was isolated in an OGC WPS
  - The client to invoke the workflow is portal-based, demonstrating the approach of using light wrapper services to mediate OGC services.

- **Temporality Extension**
  - The first version of a "Temporality Extension" specification that adds rich query functionality to WFS/FES, tailored to the AIXM Temporality Model, was finished. The specification can also be used to manage Dynamic Feature Data in general and thus is applicable to other domains as well.
  - A prototypical implementation of the service was created and tested.
  - An OGC Discussion Paper was written to document the specification, paving the way towards a normative OGC document and thus eventually conformance testing and certification.

Significant results of OWS-9 Aviation (general accomplishments, and encompassing multiple work areas):

- The compliance of OWS-9 Aviation service components with FAA SWIM Compliance requirements was analyzed.
- Multiple AIXM data sets were validated, transformed, corrected and loaded to support testing and demonstration.
- Functionality to simplify the retrieval of AIXM data was designed and tested.
- Styling information as well as (ISO encoded) dataset and service metadata was harvested, transformed and loaded to a CSW-ebRIM Registry to support discovery use cases.
- The feasibility of performing Aviation processing tasks in a web based fashion via WPS was demonstrated. This work can lead to a web based processing toolbox for the Aviation domain.
- The first version of a DMS specification supporting Data Transmission (to Aircraft) Management requirements was created.

- Client software was developed to demonstrate map-centric displays with intuitive user interfaces, supporting interactions with OWS-9 Aviation services such as WFS, Event Service and DMS.

Significant results regarding the various software components developed in OWS-9 Aviation:

- **Web Feature Service**
  - Data was loaded, validated, transformed and corrected from multiple sources into 2 WFSs (one for North America and one for Middle-Northern Europe).
  - WFS query capabilities were exercised to support calculation of airspace extents in full 2.5D, including composite airspaces (unions, intersections and subtractions), altitude queries including calculation of extents of non-spatial feature types (for runways, taxiways and aprons), and spatial filtering of non-spatial feature types.
- **Registry Service**
  - The OWS-9 Aviation Registry was used to host resources shared between multiple OGC services (e.g. ISO data and service metadata, styling information, etc)
  - The efficient retrieval of metadata was also exercised using the Aviation Registry by designing queries to retrieve only the relevant excerpts of the metadata needed by client applications.
  - OWS-9 Aviation Web Services were also registered in the SESAR Registry Demonstrator.
- **Event Service**
  - Compared to the Event Services (ES) used in the previous OGC test beds, major improvements have been implemented during OWS-9, particularly features supporting Advanced filtering functionality, such as Event Service Update Intervals, Stored Filters, AIXM Features as Geometry Operands, Spatial Filtering of Non-spatial Features, Simple Altitude Queries as well as Selective Metadata Retrieval.
- **Web Processing Service**
  - Web Processing Service profiles were implemented to support Electronic Pre-Flight Information Briefing (ePIB) generation and geometry processing, including calculation of topological relations between two AIXM 5.1 features.
- **Data Management Service**
  - OWS-9 Aviation introduced a new component: a Data Management Service (DMS) that included a set of functionalities to provide reliable and efficient management of communications between aircraft and services located on the ground. The DMS provided:
    - DMS service discovery to find and set the processing options used by the DMS to manage communications between the aircraft and dispatch client.
    - DMS basic pass-through, which handled the forwarding of request/response and notifications between the aircraft client and OGC web services.
    - Reliable messaging functionality to handle potential communication breaks.
    - Data compression and expansion to improve the use of scarce network / data link resources.
    - Data filtering to remove irrelevant data and thus further reduce the size of data that needs to be communicated via wireless data links.
    - Dispatch synchronization to ensure that the dispatcher is aware of the information the aircraft client received.
    - Provenance tracking to support the aircraft client in identifying the provenance (source, potential processing steps, etc) of data received from ground services.
    - Validation to support the aircraft client in identifying the validity of incoming data and to potentially prevent the delivery of invalid data altogether, thus saving network resources.

- Prioritization to expedite the delivery of important information to the aircraft.

- **Feature Portrayal Service**
  - Airport maps were generated, based upon AIXM feature data retrieved from WFS and styling information retrieved from the Registry, to support Digitally Enhanced Pre-Flight Information Bulletin (ePIB) use cases.
- **Aviation Clients**
  - Aviation clients were implemented to provide map-centric displays with intuitive user interface giving access to data from entities such as WFS, ES, and the DMS.
  - The continuing evolution of these clients provided a rich set of capabilities and features that helped to demonstrate the OWS-9 Aviation scenario and to perform testing and integration with a wide variety of service components.
- **Performance Assessment Tool**
  - A tool was created to assess the performance and endurance of Web Feature Service and Event Service for (simulated) operational situations.
- **AIRM to WXXM Mapping / Encoding Tool**
  - Developed a simple, re-usable process for transforming AIRM packages into an ISO compliant Application Schema model and encoding.
  - Leveraged existing, industry standard software for generating implementation schemas ensuring that the resultant implementation schemas adhere to the ISO 19109/ISO 19136 rules and increase consistency.
  - Demonstrated that the tools are highly configurable enabling the transformation and mapping rules to be extended to meet requirements for different ATM exchange models without needing software development.

Aviation Deliverable Engineering Reports:

12-147	OWS-9 Aviation Architecture ER
12-163	OWS-9 Data Transmission Management ER
12-158	OWS-9 Report on Aviation Performance Study ER
12-151	OWS-9 Portrayal ER
12-144	OWS-9 Registry ER
12-146	OWS-9 Temporality Extension ER
12-027r2	WFS Temporality Extension for Aviation
12-094	OWS-9 AIRM Derivation ER
12-145	OWS-9 Metadata and Provenance ER

5.2 Cross-Community Interoperability (CCI)

Sponsors: NGA, USGS, UK DSTL, FAA, GeoConnections/Natural Resources Canada, GeoViqua/CREAF/EC, Army Geospatial Center

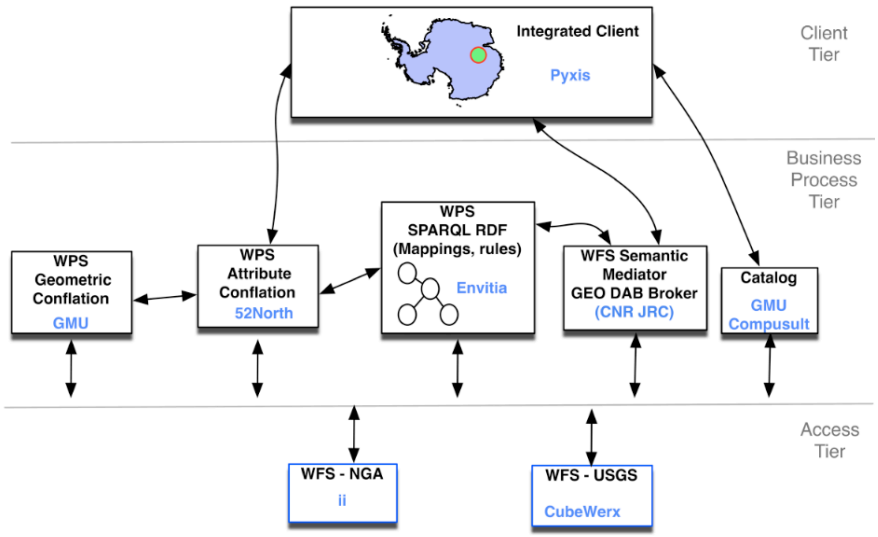
Participants: 14 organizations

Tasks:

- **Semantic mediation:**
  - Advancement of semantic mediation approaches to query and discover data, which have been described using different metadata models, including non-traditional OGC metadata models.
  - Advancement of semantic mediation approaches to query and discover data, which have been described using different data models, including non-traditional OGC data models.

- **Query Results Delivery**
  - Advancement of using Security to filter and route query results.
  - Advancement of using OWS-Context for results delivery.
- **Data Provenance and Quality:**
  - Advancement of using a web based data processing facility for managing and visualizing provenance and quality of data.
  - Advancement of managing data provenance in OGC Web Services.
- **Single Point of Entry Global Gazetteer (SPEGG)**
  - Advancement of semantic mediation approaches to provide a Single Point of Entry Global Gazetteer.

CCI Diagram:



Cross-Community Interoperability Significant Results:

- ✧ Built on the progress made in OWS-8 by improving interoperability between communities sharing geospatial data through advances in semantic mediation approaches for data discovery, access and use of heterogeneous data models and heterogeneous metadata models.
- ✧ Demonstrated that OGC standards can successfully support semantic mediation
- ✧ Exercised the WFS-G to publish the USGS and NGA gazetteers
- ✧ Demonstrated a single point of entry to both gazetteers in 2 ways: by using a cascading WFS-G as a channel to both WFS-Gs, and by setting up a cascading WFS-G with Semantic mediation capabilities that provided support for rich semantic searches to both WFS-Gs
- ✧ Demonstrated the use of Semantic Mediation in the aviation domain by dynamically linking glossary terms to WFS endpoints.
- ✧ Successfully configured and exercised the CNR/JRC GEO Discovery and Access Broker (DAB) for mediating between NGA TDS and USGS TNM data
- ✧ Successfully demonstrated the use of WPS to support conflation of data, both geometric and attribute conflation.
- ✧ Advanced and demonstrated sharing via GML of provenance data generated when conflating data sources
- ✧ Advanced metadata mappings between NMF 2.1, FGDC, ISO 19115 and OSM
- ✧ Evaluated and provided recommendations for capturing provenance using ISO 19115 and NMF 2.1.
- ✧ Exercised the SPARQL standard by setting up a SPARQL server, wrapped in a WPS, to publish the Knowledge Base of semantic mappings

- ✧ Incorporated Volunteered Geographic Information (VGI) by setting up a WFS for publishing user generated content from Twitter, Open Street Map and Ushahidi, and a WPS for Geocoding and Geoparsing that information
- ✧ Exercised and advanced OWS Context for sharing information across components (clients and catalogs)
- ✧ Secured needed services and data using PEPs developed in the SSI thread
- ✧ Successfully demonstrated the concept of a Single Point of Entry Gazetteer by exercising the CCI architecture and semantic mediation capabilities

Cross-Community Interoperability Deliverable Engineering Reports:

12-104	OWS-9 Single Point of Entry Global Gazetteer ER
12-103r3	OWS-9 Semantic Mediation ER
12-159	OWS-9 Conflation with Provenance ER
12-105	OWS-9 Context Evaluation ER

5.3 Security and Service Interoperability (SSI)

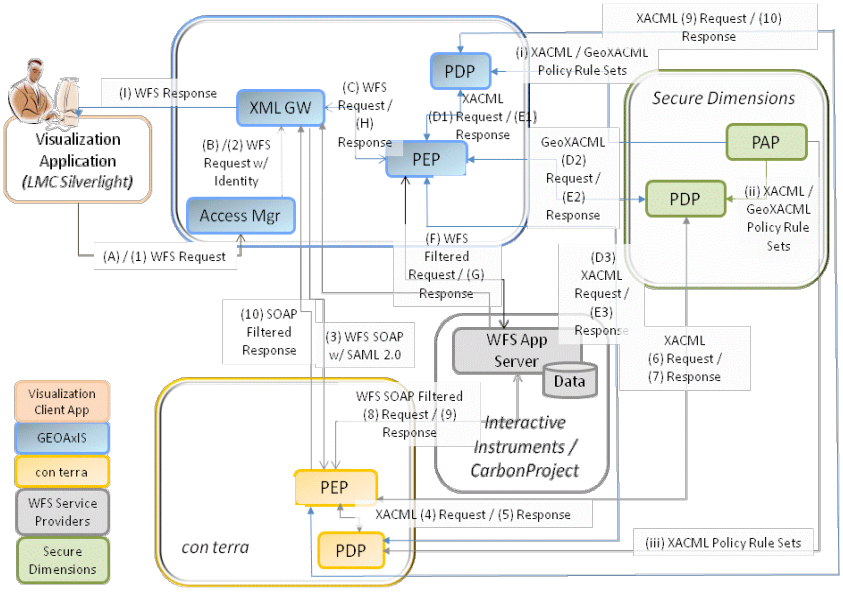
Sponsors: NGA, Lockheed Martin

Participants: 7 organizations

Tasks:

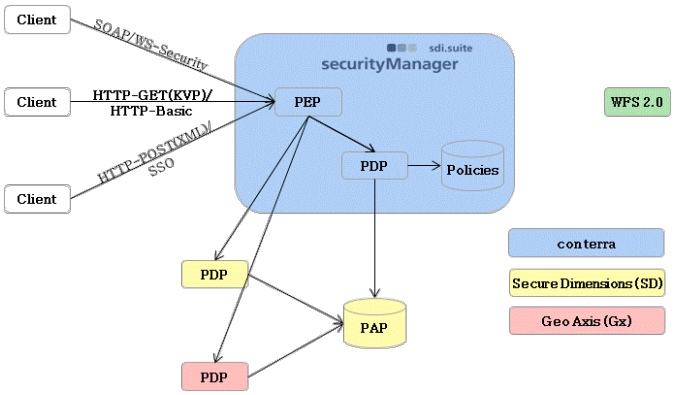
- **Security Management:** Building on and extending the OWS-6 Security thread, basing solutions WS-Federation for Web service (SOA) transactions, including role-based and attribute-based authentication and authorization rules indicating where a user and SOA Consumer is authorized access to particular services or particular data content.
- **GML Application Schema UGAS updates:** Building on the OWS-9 Schema Automation activity for improved schema automation supporting SWE common 2.0 with an open source UML-to-GML Application Schema (UGAS) tool. Add - UML to JSON capabilities.
- **Web Services Façade:** Building a tool for web service developers to implement as a façade to the service capable of translating a request from one binding format into a binding format which is supported by that OWS service
- **Reference Architecture Profiling:** Prototyping a web-based interface for profiling the OGC Reference Architecture based on user input and domain requirements.
- **Bulk Data Transfer:** Building upon the OWS-9 GeoSync activity investigating data transfer, and exploring streaming solutions, and real time data updates to be usable on in conjunction with any device, while ensuring data integrity and precision.

OWS-9 Web Security Architecture:

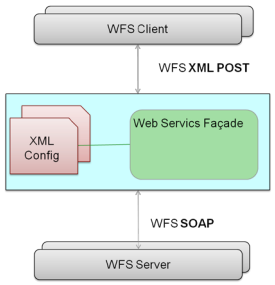


Security Sub-thread Significant Results

- ✧ Prototyped Web Service with thin client GUI for GeoXACML 1.0 and XACML 2.0 policy management
- ✧ Prototyped Web Services that transforms XACML 2.0 to XACML 3.0 policies and GeoXACML 1.0 to XACML 3.0 plus GeoXACML 1.0 geospatial extension
- ✧ Prototyped GeoXACML 1.0 and XACML 2.0 compliant policy decision Web Service
- ✧ Supported the CCI thread by providing an Apache2 web server enforcement module for OGC CSW 2.0.2 and WFS 1.1.0 and 2.0.0, and by exercising the GeoXACML 1.0 and XACML 2.0 compliant policy decision Web Service
- ✧ Demonstrated that query results from an OGC Catalog Service can be tailored based on an analyst authorization rights to certain data holdings
- ✧ Demonstrated interoperability between vendors supporting different WS-Security policies

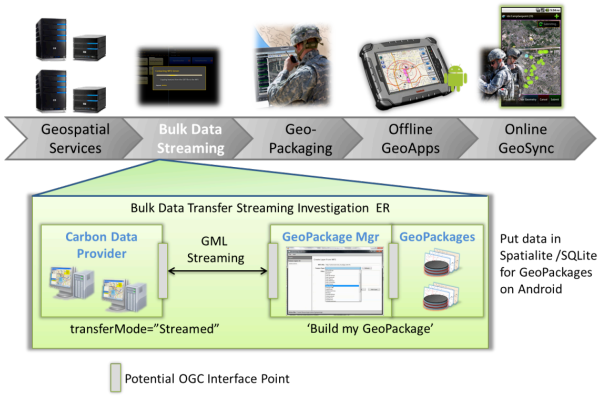


Web Service Façade Significant Results



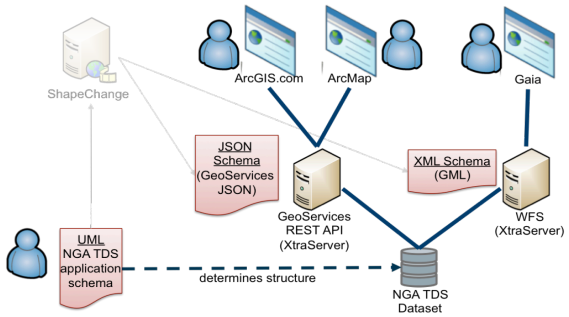
- Supported the translation of protocols for web services
  - This tool provides the capability to translate service requests between different service bindings. For example if a client (visualization tool) supports only KVP bindings but the service to be accessed is a SOAP based service the Façade tool will translate the KVP request to a SOAP request. This would allow access to the data. The Façade tool will then convert the response back to KVP so that the client can interpret.
  - Implemented WFS Post to SOAP.
  - Released open source code configurable to any service (WMS, WCS, WPS, etc) and any protocol (REST, SOAP, KVP, JSON, etc)
  - This tool is intended to support the ability for analysis to discover and make use of multiple services that may not have been available to them before thus increasing analytic capabilities.

Bulk Data Transfer Significant Results



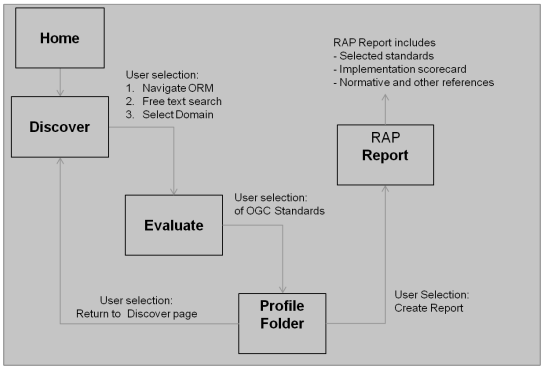
- Exercised GML streaming to provide large amounts of data to desktop and mobile apps
- Demonstrated the support of GML streaming in existing WFS implementation
  - Mobile application development of the emerging OGC GeoSynchronization Service was enhanced adding capabilities to support GML Streaming as well as the new proposed OGC GeoPackage standard.
  - Early performance results of GML Streaming were very encouraging.
- Used SQLite/SpatiaLite (Geopackage) on mobile apps for off-line online access and update

UGAS/SWE Common Updates Significant Results



- Advanced the state-of-the-art UGAS tool to support
  - Encoding rules for JSON considering GeoServices JSON and GeoJSON
    - Added new functionality for automating UML to JSON encoding
  - Generation of SWE Common data component templates from UML
    - Added new capabilities supporting Sensor Web Enablement 2.0

Reference Architecture Profiling (RAP) Significant Results



- Prototyped a web interface that recommends OGC standards and ORM sections that are relevant to a system development; such that a community of interest can derive and build a profile of suitable OGC standards to meet their specific needs
  - The tool provides not only a list of applicable standards but also identifies standards dependencies, compliance test availability, reference implementation availability as well as a listing of commercial implementations. This capability will support development of standards compliant system/program implementations facilitating a better customer experience.
  - Functionality of this tool was exercised using the DNI Content Discovery and Retrieval Standard requirements as a use case.
- More information at rap.opengeospatial.org

SSI Engineering Reports:

12-156	OWS-9 Reference Architecture Profiler ER
12-118	OWS-9 Security ER
12-093	OWS-9 SSI UGAS ER
12-139	OWS-9 Security Rules Service ER
12-097	OWS-9 Bulk Data Transfer ER
12-133	OWS-9 Facade ER

5.4 OWS Innovations

Sponsors: NGA, NASA, UK DSTL

Participants: 16 organizations

Tasks:

- **Geospatial Mobile Applications:** further understand the requirements for developing standards-based geospatially-enabled mobile applications, and to advance, test and prototype the emerging GeoPackage format, a simple structure to support data downloaded and cached onto a then disconnected mobile device that can collect data in a disconnected environment and synchronize the new data to master databases upon reconnection to the Internet.
- **Web Mapping:** Evaluate diverse, competing and sometimes complementary raster data tiling schemes that now exist in the marketplace, including WMTS, Tile Map Service (OSGeo), MBTiles, TileCache (MetaCarta), and various others. Recommend alignement.
- **Coverage Access and Data Quality:** Explore NITF, LIDAR, and DAP/OPeNDAP, and investigate their re-implementation in an OWS environment with a focus on the Web Coverage Service 2.0 standard.
- **GPS Study:** Investigate and prototype the capabilities of OGC standards to support GPS data product and message requirements to include definition of a new one-size-fits-all Variable Message Format (VMF) message capable of supporting all potential GPS ephemeris/data**.**

OWS Innovations Significant Results:

- ✧ Positive findings on the fitness of OGC standards for the mobile environment
  - ✧ Enabling Mobile Applications for OGC web services is a relatively new concept within OGC and this effort tried to scope out the issues including certification requirements etc.
  - ✧ This effort supports the on-line on-demand at least from the perspective of defining how OGC can look to respond to the Mobile App requirement.
  - ✧ Advanced and tested the Geopackage format - a single file format for mobile (vectors, image tiles)
    - ✧ GeoPackage provides the container for vector, raster (imagery/terrain) data for use in mobile devices in a disconnected or limited connection environment. This effort supported not only the on-line on demand vision but also the ability for field user collected information to be uploaded thus supplementing an analyst's knowledge and understanding of the situation.
    - ✧ Several Mobile Apps were developed in support of GeoPackage.
- ✧ Positive findings on the usability of WCS
  - ✧ Successfully demonstrated NITF, LiDAR data served via WCS
    - ✧ Enhanced WCS support for LiDAR derived data (gridded only) as a first step in getting this capability added to the WCS standard
    - ✧ Demonstrated how GMLJP2 can support the requirements of NITF
    - ✧ Demonstrated the ability to enable a WCS with JPIP streaming for GMLJP2
  - ✧ Supported advanced integration of JPIP streaming with WCS
  - ✧ Demonstrated that scientific raster formats can be supported by WCS
- ✧ Positive findings on the use of SWE to support GPS
  - ✧ SWE found suitable for distributed post-processing
- ✧ Positive findings on WMS
  - ✧ Wrote and implemented a simpler WMTS profile
  - ✧ Showed support for data quality measures with WMS extensions

OWS Innovations Engineering Reports:

12-119	OWS-9 Mobile Apps ER
12-157	OWS-9 Map Tiling Methods Harmonization ER
12-160	OWS-9 Data Quality for Web Mapping ER
12-096	OWS-9 GPS Study ER
12-154	OWS-9 GMLJP2 for NITF ER
12-155	OWS-9 WCS for LIDAR ER
12-095	OWS-9 Coverage Access ER

5.5 Compliance Testing

Sponsors: NGA, OGC

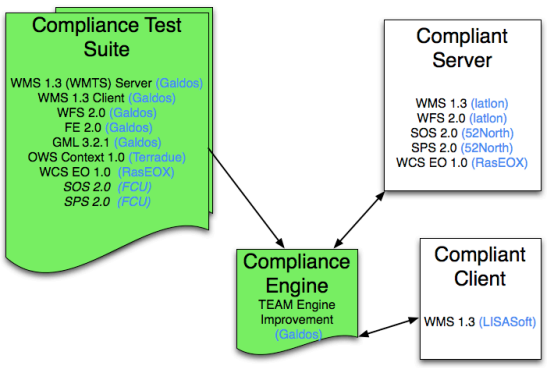
Participants: 7 organizations

Tasks:

- Develop/update a suite of compliance test scripts for testing and validation of products with interfaces implementating the OGC specifications listed below.
  - WMS 1.3 Server (FE)
  - WMS 1.3 Client
  - WFS 2.0
  - GML 3.2.1- Application schemas and instances
  - OWS Context 1.0
  - SOS 2.0
  - SPS 2.0
  - WCS 2.0
  - WCS –EO 1.0
- Upgrade the TEAM Engine Capabilities:
  - TEAM Engine was mavenized to allow developers to better integrate TEAM Engine in their own environments
  - TEAM Engine was improved to support Junit tests, and to enable other testing languages
  - TEAM Engine was improved to test instances and application schemas (GML 3.2.1) to help communities test against profiles of standards

CITE Significant Results:

- All goals for this thread have been achieved with impressive cooperation amongst participants and the community



CITE Engineering Reports:

12-152	OWS-9 CITE Help Guide ER
12-162r1	OWS-9 WCS Conformance Testing ER