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Summary of the OGC Web Services, Phase 7 (OWS-7) Interoperability Testbed

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Preface

OGC Web Services (OWS) testbeds are part of OGC's Interoperability Program, a global, hands-on and collaborative prototyping program designed to rapidly develop, test and deliver proven candidate specifications into OGC's Specification Program, where they are formalized for public release. In OGC's Interoperability Initiatives, international teams of technology providers work together to solve specific geoprocessing interoperability problems posed by the Initiative's sponsoring organizations. OGC Interoperability Initiatives include test beds, pilot projects, interoperability experiments and interoperability support services - all designed to encourage rapid development, testing, validation and adoption of OGC standards.

This report summarizes the results of OGC Web Services Initiative, Phase 7 (OWS-7). The content of the OWS-7 initiative are organized around the following three threads:

- **Sensor Fusion Enablement (SFE)** – this thread builds on the OGC Sensor Web Enablement (SWE) framework of standards, focusing on integrating the SWE interfaces and encodings with workflow and web processing services to perform dynamic sensor tracking and notification, and motion video change detection. The SFE thread also continued work on the interoperability of SWE and Common CBRN (Chemical, Biological, Radiological and Nuclear) Sensor Interfaces (CCSI).
- **Feature and Decision Fusion (FDF)** – this thread builds on OWS-6 Geoprocessing Workflow and Decision Support Services work, to advance common interfaces for information cataloguing and sharing, feature and statistical analysis, synchronization of multiple geospatial databases, Web Processing Services (WPS) profiles, and the Integrated Client.
- **Aviation** – this thread continued development and demonstration of the Aeronautical Information Exchange Model (AIXM) and the Weather Information Exchange Model (WXXM) in an OGC Web Services environment, to provide applications and tools that support Airline Operations Centers and Flight Dispatch applications. Such applications provide information for representing a Common Operating Picture; supporting flight planning (including General Aviation) and preparation (MET and AIM); calculating weight and balance; estimating fuel requirements; in-flight emergency response; etc. The primary focus in OWS-7 Aviation was on ground usage of the information, although provision of information packages to the crew, on the ground and in the air, were also of interest.

Suggested additions, changes, and comments on this draft report are welcome and encouraged. Such suggestions may be submitted by email message or by making suggested changes in an edited copy of this document (keep Revision Tracking enabled).

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Summary of OGC Web Services Initiative, Phase 7 (OWS-7)

1 Overview

The OGC Web Services, Phase 7 (OWS-7) Testbed was an initiative of OGC's Interoperability Program to collaboratively extend and demonstrate OGC's baseline for geospatial interoperability. The main execution of OWS-7 was conducted from January to June 2010, with the following outcomes:

- **38 Components** were implemented and participated in interoperability testing. Components were developed in 3 activity threads.
- **21 Engineering Reports (ERs)** were written. The OWS-7 ERs were either technical specifications or reports regarding testing and analysis. The OWS-7 ERs have been posted to the OGC Specification Program Pending Documents list for consideration in the consensus process. Most of these have now been approved as Public Engineering Reports (PERs), accessible on the web here:
 - <http://www.opengeospatial.org/standards/per>
- **24 Demonstrations** of OWS-7 components, many of which were shown during the OWS-7 Technical Review held in Silver Spring, Maryland USA on 17 June 2010, and the later webinars. The demonstrations with a voice-over explaining the content are now released as multi-media products via the web here:
 - <http://www.opengeospatial.org/pub/www/ows7/>
- **41 organizations** participated in some aspect of OWS-7. Roles for organizations in OWS-7 included sponsors, participants and architects. Additionally there were many organizations that were observers of OWS-7.
- **10 sponsoring organizations** defined requirements for OWS-7. 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-7.
- Major **technical achievements** of OWS-7 include the following
 - Geosynchronization architecture and practice completed and documented for adoption as both OGC and ISO standards.
 - Tested the use of Atom (IT industry standard for syndication) as container for OWS Context documents
 - Tested the use of OGC Web Processing Services (WPS) for motion video change detection, for sensor tracking and notification, and for feature & statistical analysis.
 - Initial development of an approach for Authoritative Data Source Directory (ADSD), capable of cataloguing and querying a wide range of geospatial and nonspatial multimedia object types for use in feature analysis, information sharing, and decision support. This was based on OGC Catalogue Services for the Web (CSW), eBRIM Profile.
 - Development of tracking and notification service, for use in motion video change detection.
 - Full implementation of WFS 2.0 for aviation, using commercial software.

- Improved event architecture for aviation notices (NOTAM, METAR), with support for AIXM 5.1 and WXXM 1.1 in a single event service.

2 Organizations in OWS-7

2.1 Sponsoring Organizations

OWS-7 was sponsored by the following organizations:

- US National Geospatial-Intelligence Agency (NGA)
- US Federal Aviation Administration (FAA)
- EUROCONTROL
- US Army Geospatial Center
- US Geological Survey (USGS)
- US Joint Program Executive Office – Chemical and Biological Defense (JPEO-CBD)
- BAE Systems – Network Systems
- Lockheed Martin – Information Systems and Global Services
- PCI Geomatics
- EADS – Defence and Communications Systems

2.2 OWS-7 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, synthesizes technology threads, and supports the specification editorial process. The IP Team is comprised of OGC staff and representatives from member organizations. The OWS-7 IP Team was as follows:

- Interoperability Program Executive Director: George Percivall, OGC
- Initiative Director: David Arctur, OGC
- Thread Architects
 - Sensor Fusion Enablement: Shayne Urbanowski and Daniel Pittman, Lockheed Martin
 - Feature and Decision Fusion: Raj Singh, OGC
 - Aviation: Nadine Alameh, OGC
- Demo Capture: Greg Buehler, OGC; Mark Buehler, OGC

2.3 Complete List of Organizations

The following organizations played one or more roles in OWS-7 as sponsors, participants and/or architects. Additionally there were many organizations that were observers of OWS-7.

52North	Compusult	FAA	iGSI	NGA
AGC	Comsoft	Feng Chia	Interactive	Northrop Grumman
Alticode	con terra	University GIS	Instruments	Information Systems
Atmosphere, Systèmes et Services	CubeWerx	Research Center	Intergraph	Planet9
BAE Systems	EADS-DCS	FortiusOne	JPEO-CBD	PCI Geomatics
Botts Innovative Research	Envitia	Frequentis	lat-lon	Snowflake
Carbon Project	ERDAS	Galdos	LISAsoft	UAB-CREAF
	ESRI	GMU CSISS	Lockheed Martin	USGS
	EURO- CONTROL	IfGI, Muenster	Luciad	University of the Bundeswehr
			Meteo France	

3 Schedule

The OWS-7 Testbed Execution Phase was preceded by a Concept Development Phase.

OWS-7 Concept Development Phase:

- Sponsor Meetings June – December 2009
- Fusion RFI Workshop 26-27 August 2009
- RFQ development July – October 2009
- Bidders Conference 10 November 2009
- RFQ response period 28 October – 1 December 2009
- Participant Selection – Phase 1 December 2009

OWS-7 Execution Phase:

- Kickoff Meeting 19-21 January 2010, GMU, Fairfax VA
- Interim Milestone 26 March 2010
- Implementation Milestone 21 May 2010
- OWS-7 Demonstrations 17 June 2010, TC Meeting, Silver Spring MD
- Final Delivery 30 June 2010
- OWS-7 Demo web release 30 July 20
- Specification Program review of ERs June 2010, TC Meeting, Silver Spring MD, and September 2010, TC Meeting, Toulouse France
- Decision Fusion RFI Workshop 10-11 August 2010
- OWS-7 Webinar, Asia/Pacific 20 August 2010
- OWS-7 Webinar, N.America/Europe 8 September 2010

After the Kickoff Meeting, design, development and testing of OWS-7 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 particular to the 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 Development Threads

The development of the OWS-7 initiative was organized around the following 3 threads:

- 1) Sensor Fusion Enablement (SFE)
- 2) Feature and Decision Fusion (FDF)
- 3) Aviation

An introduction to these 3 threads is described below, followed by a listing of the components and ERs developed in each thread.

4.1 Sensor Fusion Enablement (SFE)

The SFE Thread builds on the OGC Sensor Web Enablement (SWE) framework of standards that has achieved a degree of maturity through previous OWS interoperability initiatives and deployments worldwide. SFE focused on integrating the SWE interfaces and encodings with workflow and web processing services to perform sensor

fusion. SFE continued the development of interoperability of SWE and Common CBRN (Chemical, Biological, Radiological, Nuclear) Sensor Interface (CCSI).

Emphasis for SFE during the OWS testbed was on the following:

- Motion Video Fusion. Geo-location of motion video for display and processing. Change detection of motion video using Web Processing Service with rules.
- Dynamic Sensor Tracking and Notification. Track sensors and notify users based on a geographic Area of Interest (AOI). The sensor and the user may be moving in space and time.
- CCSI-SWE Best Practice. Building on OWS-6, develop an ER to be considered by the OGC Technical Committee as a Best Practice.

SFE Services/Components	Participants
SOS Server for Motion Imagery	52North, Compusult
WPS Server for Change Detection	GMU CSISS
Tracking and Notification Service, including CAP	Compusult, Univ Muenster IfGI
Motion Video Data collection and SOS server	BIRI
SFE Client for motion video	Compusult, BIRI
Catalog Service for Motion Video Sensors and Imagery	Compusult
SOS Client for CCSI toxic sensors	NGIS

SFE Engineering Reports	Participants	OGC Doc #
Dynamic Sensor Notification	iGSI	10-061
Motion Imagery Discovery and Retrieval	GMU CSISS, BIRI	10-087
WPS Motion Video Change Detection	Intergraph	10-036
CCSI-SWE Best Practices	NGIS	10-073

4.2 Feature and Decision Fusion (FDF)

The FDF Thread builds on OWS-6 Geoprocessing Workflow and Decision Support Services work, in particular to advance the state of information cataloguing, Web Processing Services (WPS) profiles, and the Integrated Client. Task areas for FDF in OWS-7 included:

- Schema Automation: Transformation of NGA Application Schema (NAS) from UML to profiles of GML and KML.
- Data Discovery, Organization and Sharing: Use of thematic categories in multi-source data discovery, including augmented metadata for quality of source, and fitness for use. Organize in OWS Context documents—the analyst’s information resource “shoebox”.
- Feature and Statistical Analysis (FSA): WPS profiles for feature fusion, including statistical analysis, vector and topological processing.
- Geosynchronization: Components to support synchronization of geospatial data and updates across a formal or ad hoc Spatial Data Infrastructure (SDI).

- Alerting: Fuse alerts with geospatial analysis using OASIS Common Alerting Protocol (CAP) format.
- Integrated Client: A field-ready client application to support and display sensor information, cataloguing metadata, notification alerts, statistical analyses, and save it all in a Context document.

FDF Services/Components	Participants
ShapeChange UGAS Enhancements	interactive instruments
ShapeChange extension for KML 2.2	interactive instruments
Automation of ISO 19139 compliant metadata from NAS	interactive instruments
Authoritative Data Source Directory services	Compusult, ERDAS
WPS for Feature and Statistical Analysis	Intergraph, 52North
Services for Feature and Statistical Analysis	lat/lon
Geosynchronization service, including CAP	Carbon Project
Geosynchronization client	Carbon Project
“Embedded” Geosynchronization service/client	GIS Center, Feng Chia Univ
“Embedded” WFS-T for geosynchronization with mobile devices	CubeWerx
WFS-T for desktop synchronization	CubeWerx
Integrated Clients	Intergraph, ESRI

FDF Engineering Reports	Participants	OGC Doc #
Schema Automation	interactive instruments	10-088r1
Feature and Statistical Analysis	Univ Muenster IfGI	10-074
Authoritative Data Source Directory	FortiusOne, Envia	10-086
Information Sharing, including OWS Context	Intergraph, LISASoft	10-035r1
Geo-synchronization, including CAP	CubeWerx	10-069
WPS Profiling, with cross-thread coordination	lat/lon	10-059

4.3 Aviation

This thread seeks to further develop and demonstrate the use of the Aeronautical Information Exchange Model (AIXM) and the Weather Information Exchange Model (WXXM) in an OGC Web Services environment.

The US Federal Aviation Administration (FAA) and EUROCONTROL have developed AIXM as a global standard for the representation and exchange of aeronautical information. AIXM uses the OGC Geography Markup Language (GML) tailored to the specific requirements for the representation of aeronautical objects, including the temporality feature that allows for time dependent changes affecting AIXM features. FAA and EUROCONTROL are using AIXM as an integral part of their efforts to modernize their aeronautical information procedures and to transition to a net-centric, global aeronautical management capability. More specifically, AIXM is being used in the net-centric System Wide Information Management (SWIM)-related components of the US NextGen and European Union (EU)'s SESAR programs. Indeed, it is expected that the results of the Aviation Thread of OWS-7 will be contributed to both programs with a focus on recommended OGC specifications that can be applied in the definition and implementation of both SWIM environments.

WXXM is also jointly developed by FAA and EUROCONTROL, as a proposed standard for the exchange of aeronautical weather information in the context of a net-centric and global interoperable Air Transport System (ATS). WXXM also uses GML tailored to the specific requirements of aeronautical meteorology and is based on the OGC Observation and Measurement Model. WXXM development is harmonized and coordinated with the World Meteorological Organization (WMO), the organization traditionally responsible for standards in meteorology.

The OWS-7 Aviation Thread investigated and demonstrated the applicability of AIXM and WXXM along with relevant OGC specifications and web services to applications and tools that support Airline Operations Centers and Flight Dispatch applications. Such applications provide information for representing a Common Operating Picture; supporting flight planning (including General Aviation) and preparation (MET and AIM); calculating weight and balance; estimating fuel requirements; in-flight emergency response; etc. The primary focus in OWS-7 was on ground usage of the information, although provision of information packages to the crew, on the ground and in the air, is also of interest.

To support the above goal, the OWS-7 Aviation Thread covered the following tasks:

- Evaluation and advancement of AIXM, in the areas of using and testing new AIXM 5.1 features, developing components/tools for generating, validating, converting, and parsing AIXM, addressing feature metadata requirements and performance constraints, and supporting the portrayal of AIXM information.
- Evaluation and advancement of WXXM, focusing on the incorporation and demonstration new weather concepts such as the 4-D Weather Data Cube, including the impact of such concepts on the Event Notification Architecture, the support for probabilistic events, and the definition and usage of the time model in WXXM.
- Advancement of the Event Notification Architecture developed and exercised in OWS-6 to support multiple sources of events and multiple types of events and data changes (AIXM, WXXM), and to investigate different delivery protocols (push/pull), registration and subscription lifecycle management approaches, and domain/schema-specific matching between events and subscriptions.
- Examination of AIXM/WXXM in the FAA SWIM environment, focusing on investigating approaches for leveraging SWIM Interface Management, Messaging and Security capabilities, as well as enabling Aviation clients to access SWIM services in addition to OGC services.

Aviation Services/Components	Participants
WFS/WFS-T serving AIXM 5.1 including metadata	Snowflake, Comsoft
WS-Notification "push" service with static subscriptions	Comsoft
WFS serving WXXM 1.1 including metadata	MFAA, Snowflake
FPS for AIXM	Envitia
FPS for WXXM	MFAA
Event Architecture components, including Event Service	52North, Galdos
Registry Service for symbols, styles & codelists in AIXM, WXXM	Galdos
Aviation Clients for AIXM, WXXM, SWIM (EFB-full)	Luciad
Aviation Clients for AIXM, WXXM, SWIM (EFB-handheld)	Frequentis
Aviation Clients for WXXM (EFB-handheld)	MFAA
Aviation Clients for AIXM, WXXM, SWIM (Dispatch)	Frequentis
Reusable AIXM handling tools and documentation (UML2AIXM)	LISAsoft
3D Visualization client for airports, airspaces, etc.	Planet9

Aviation Engineering Reports	Participants	OGC Doc #
Aviation Architecture	Univ Muenster IfGI	10-079r3
Event Architecture	iGSI	10-060r1
Aviation AIXM Assessment	Snowflake	10-131
Aviation WXXM Assessment	MFAA/Alticode	10-132
Aviation Portrayal	Envitia	10-127r1
AIXM 5.1 Metadata Change Request	Galdos	10-072
AIXM 5.1 Codelist Change Request	Galdos	10-102
FUSE Integration	Snowflake	10-130

Toward Secure Interconnection of OGC Web Services with SWIM	Univ Bundeswehr	10-155
UML to Schema, Conversion and Validation	LISAsoft	10-137