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OGC® OWS-9 Web Feature Service Temporality Extension Engineering Report

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Abstract

This document is a deliverable of the OGC Web Services (OWS) Initiative - Phase 9 (OWS-9). This Engineering Report summarizes the OWS-9 activity regarding the extension of the Web Feature Service (WFS) and Filter Encoding (FE) standards to support dynamic feature data.

Specifically this document describes the result work performed in OWS-9 on the WFS Temporality Extension. The technical specification including background is discussed and defined in the OGC Discussion Paper 12-027r1. This document gives a summary about issues, lessons learned, recommendations, accomplishments and benefits for the Aviation Architecture. It also gives an outlook on future work items and change requests.

Keywords

ogcdoc, ows9, ows-9, wfs, fe, aviation, temporality

What is OGC Web Services 9 (OWS-9)?

OWS-9 builds on the outcomes of prior OGC interoperability initiatives and is organized around the following threads:

- **Aviation**: Develop and demonstrate the use of the Aeronautical Information Exchange Model (AIXM) and the Weather Exchange Model (WXXM) in an OGC Web Services environment, focusing on support for several Single European Sky ATM Research (SESAR) project requirements as well as FAA (US Federal Aviation Administration) Aeronautical Information Management (AIM) and Aircraft Access to SWIM (System Wide Information Management) (AAtS) requirements.

- **Cross-Community Interoperability (CCI)**: Build on the CCI work accomplished in OWS–8 by increasing interoperability within communities sharing geospatial data, focusing on semantic mediation, query results delivery, data provenance and quality and Single Point of Entry Global Gazetteer.

- **Security and Services Interoperability (SSI)**: Investigate 5 main activities: Security Management, OGC Geography Markup Language (GML) Encoding Standard Application Schema UGAS (UML to GML Application Schema) Updates, Web Services Façade, Reference Architecture Profiling, and Bulk Data Transfer.

- **OWS Innovations**: Explore topics that represent either new areas of work for the Consortium (such as GPS and Mobile Applications), a desire for new approaches to

existing technologies to solve new challenges (such as the OGC Web Coverage Service (WCS) work), or some combination of the two.

- **Compliance & Interoperability Testing & Evaluation (CITE)**: Develop a suite of compliance test scripts for testing and validation of products with interfaces implementing the following OGC standards: Web Map Service (WMS) 1.3 Interface Standard, Web Feature Service (WFS) 2.0 Interface Standard, Geography Markup Language (GML) 3.2.1 Encoding Standard, OWS Context 1.0 (candidate encoding standard), Sensor Web Enablement (SWE) standards, Web Coverage Service for Earth Observation (WCS-EO) 1.0 Interface Standard, and TEAM (Test, Evaluation, And Measurement) Engine Capabilities.

The OWS-9 sponsors are: AGC (Army Geospatial Center, US Army Corps of Engineers), CREAF-GeoViQua-EC, EUROCONTROL, FAA (US Federal Aviation Administration), GeoConnections - Natural Resources Canada, Lockheed Martin Corporation, NASA (US National Aeronautics and Space Administration), NGA (US National Geospatial-Intelligence Agency), USGS (US Geological Survey), UK DSTL (UK MoD Defence Science and Technology Laboratory).

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Contents

Page

OGC® OWS-9 WFS Temporality Extension Engineering Report

1 Introduction

1.1 Scope

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1.2 Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

Name	Organization
Timo Thomas	COMSOFT GmbH, Germany

1.3 Revision history

Date	Release	Editor	Primary clauses modified	Description
2012-11-23	Draft	Timo Thomas	all	First initial draft of the report.

1.4 Foreword

This document is a deliverable of the OGC Web Services (OWS) Initiative - Phase 9 (OWS-9). Its contents cover the summary of the work carried out regarding the Web Feature Service Temporality Extension, which resulted in OGC Discussion Paper 12-027r1.

2 References

The following documents are referenced in this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

OWS-9 Engineering Reports:

- OGC 12-147, OWS-9 Aviation Architecture Engineering Report
- OGC 11-093r2, OGC® OWS-8 Aviation Architecture ER (2011-09-30)
- OGC 11-073r2, OGC® OWS-8 Aviation: Guidance for Retrieving AIXM 5.1 data via an OGC WFS 2.0 (2011-11-04)
- OGC 10-131r1, OGC® OWS-7 Aviation – AIXM Assessment Report (2010-08-18)

Other OGC Documents:

- OGC 12-027r2, WFS Temporality Extension
- ISO/DIS 19142 and OGC 04-094, OpenGIS® Web Feature Service 2.0 Interface Standard (2010-11-02)
- ISO/DIS 19143 and OGC 09-026r1, OpenGIS® Filter Encoding 2.0 Encoding Standard (2010-11-22)

Aviation specific documents:

- AIXM 5 Temporality Model 1.0 (2010-09-15)

3 Conventions and abbreviated terms

AIXM	Aeronautical Information Exchange Model
DNOTAM	Digital NOTAM
ES	Event Service

GML	Geography Markup Language
HTTP	Hypertext Transfer Protocol
NOTAM	Notice to Airmen
OGC	Open Geospatial Consortium
OWS-9	OWS Testbed Phase 9
UUID	Universally Unique Identifier
UML	Unified Modeling Language
WFS	Web Feature Service
XML	Extensible Markup Language
XPath	XML Path Language

4 Executive Summary

The Aeronautical Information Exchange Model (AIXM) is designed to enable the management and distribution of Aeronautical Information Services (AIS) data in digital format. The newest version of this model, AIXM 5.1, is based on GML 3.2 and features an exhaustive temporality model loosely based on the GML Dynamic Feature Model.

Various interoperability test-beds at OGC, in particular OWS-7 and OWS-8, have applied OGC's WFS 2.0 and FES 2.0 standards on AIXM 5 data. Though it could be demonstrated that a basic interoperability is possible, it turned out that some key requirements could not be fulfilled.

After OWS-8, work on an extension to the WFS specification started to overcome these shortcomings. This work was continued and intensified in OWS-9, resulting in the WFS Temporality Extension Discussion Paper, OGC document 12-027r2. It summarized the observations made and showed that these requirements are not specific to AIXM 5, but more generally apply to any data model featuring temporality.

5 Accomplishments

By creating the WFS TE Discussion Paper, the following accomplishments were made.

5.1 Identification of use cases for aviation

A total of 8 use cases where identified out of different areas of application, including but not limited to visualization, decision support, AIP publication, NOTAM communication and data replication.

5.2 Mapping of use cases to WFS operations and FES filters

Where possible, the identified use cases where mapped to WFS operations and FES filters.

5.3 Problem analysis, categorization and generalization

A problem analysis revealed two key unfulfilled requirements:

1. The ability to filter time slices using FES filters
2. The ability to generate SNAPSHOT time slices

5.4 Identification of AIXM TM specifics compared to the general GML Dynamic Feature Model

AIXM 5.1 temporality model is loosely based on the GML Dynamic Feature Model. A detailed comparison of both models was undertaken.

5.5 Conceptual design of the extension

An extension of WFS/FES was designed. This process included discussion with interested parties from other perspectives (e.g. clients) and performance considerations like required bandwidth and minimum latency.

5.6 Model creation and generation of a physical representation

A model of the extension was created and embedded in the existing UML model of WFS/FES. A physical model (XML Schema) was then generated out of the UML model using existing transformation tools.

5.7 Documentation

A detailed documentation of all introduced elements and the overall concept was created.

5.8 Proof that all use cases are covered and example creation

For each of the identified use cases mentioned above it was tested whether it is covered by the created extension. For each, an example query was created.

5.9 Implementation

Parts of the extension were implemented on server side in the Web Feature Service of CADAS-AIMDB, COMSOFT's AIXM 5.1 database. These were in particular:

- SNAPSHOT generation

- PropertyExclusion projection clause

6 Demo scenarios and tested Temporality Extension use cases

Two scenarios where created and demonstrated:

- Retrieve the state of a runway at a specific point in time (SNAPSHOT generation)
- Retrieve all airports fulfilling specific constraints at a point in time in the future (BASELINE filtering)

As there were no client implementations available, COMSOFT created a thin client for the purposes of the demo.

7 Implementation results

No specific observations were made during the implementation of the Temporality Extension. The implemented parts are ready to be used in future test beds.

8 Future work items

Future work items directly related to the work on the specification can be found in the discussion paper. Items relevant for future test beds are listed below.

8.1 Implementation and tests

A more complete implementation should be provided to allow further testing. It should especially include a client and advanced functionality such as the evaluation of properties with schedules.

8.2 Handling of long-term data

Future test beds should include long-term aspects of handling of AIXM 5.1 data, including long histories of permanent and temporary changes. This would more reflect real-world scenarios and would emphasis the importance of the Temporality Extension.

8.3 Compatibility

In the course of maturation of the extension, further effort should be invested in the compatibility of the extension with the existing WFS standard, e.g. regarding join queries.

Regarding the compatibility with AIXM, future test beds should include transactional operations in their focus covering the complete life time of features (commissioning, permanent changes, temporary changes, corrections, cancelations, decommissioning).

8.4 Property exclusion

The test bed revealed that the introduced projection clause for excluding properties is also useful for other domains and areas of application, like event services [see OWS-9 Archtiecture Engineering Report]. As it isn't directly related to the temporality issues, the PropertyExclusion projection clause should be separated from the Temporality Extension and given its own namespace.

9 Benefits for the Aviation Architecture

Existing test beds for the Aviation domain focused on the general processing of AIXM data so far. The history of features played only a minor role. Sample data mainly consisted of one time slice per feature (the commissioning) and temporary changes (DNOTAMs). Permanent changes were barely used, as were corrections and cancelations of data. In these simple scenarios, exchanging features with the full history of time slices was not a problem.

A key design element of the AIXM TM is that it never forgets. For long-running productive systems, the amount of time slices of a feature can grow to great numbers. Efficient retrieval of a set of time slices of interest will then become a key requirement. The WFS Temporality Extension paves the way for these use cases in an efficient and convenient manner.

Another key functionality developed is the generation of SNAPSHOT time slices, which represent the complete state of a feature at a given point in time. This relieves clients from implementing the complex AIXM TM algorithm and also saves bandwidth. It enables "thin" clients, which do not need to have a full understanding of the AIXM Temporality Model to successfully interact with an AIXM 5.1 data store through the WFS. Support for recurring changes of data on a regular basis, called "properties with schedules" in AIXM TM terminology, is also included, as are constraints based on the value of a property in the future, which are important for decision support applications.

