"Enabling Information Sharing thru Common Services"

Highlights of the

Open Geospatial Consortium (OGC)

Web Services Testbed Phase 8 (OWS-8)

Presented To: AT Info Exchange Conference

Presented By: Nadine Alameh, Ph.D.

Date: 08/31/2011

EUROCONTROL

Federal Aviation Administration

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

August 30, 2011 - September 1, 2011
NOAA Science Center & Auditorium
Silver Spring, Maryland

Agenda

- **What is the Open Geospatial Consortium (OGC)?**
    - Why are we here today?

- **What is the OGC Web Services Testbed Phase 8 (OWS-8)?**
    - Themes, schedule, participants, deliverables
    - Highlights of the Aviation thread
    - Mini-demo

- **How can you get more information?**
    - Booth (OGC and OGC members)
    - Technical reports and video demos
    - Aviation Domain Working Group

- **What's next?**
    - OWS-9 planning initiated – Participate!

What is the OGC?

The Open Geospatial Consortium (OGC) is a non-profit, international voluntary consensus standards organization that is leading the development, promotion and harmonization of standards for geospatial and location based services.

- Over 416 member organizations (industry, government, academia) (January 2011) http://www.opengeospatial.org/ogc/members
- 30+ adopted OGC Standards (some are ISO Standards) http://www.opengeospatial.org/standards
- Several hundred software products, implementing OGC Standards http://www.opengeospatial.org/resource/products
- Broad user community worldwide, many policy positions for NSDI based on OGC standards
- Cooperation with other standards organizations and foundations, e.g. ISO, W3C, OMG, etc http://www.opengeospatial.org/ogc/alliancepartners

Why are we here today?

Geography Markup Language – ISO 19136

Why are we here today?

- **OGC Interoperability Program (IP)**
  - Global, innovative, rapid-prototyping process to develop, test, validate and demonstrate new standards

- **FAA and Eurocontrol sponsors of 3 OWS initiatives to-date**
  - Validation and advancement of AIXM and WXXM
  - Delivery of Aeronautical and Weather information on-demand via OGC Web Services
  - Increased uptake by industry
  - Delivery of Standards-based Commercial Off-The-Shelf (SCOTS) products

- **Outcomes**
  - Changes to AIXM/WXXM
  - Changes to relevant OGC/ISO standards
  - Best practices/guidance to industry
  - SCOTS products on the market

Aviation Initiatives

Aviation in OGC Web Services Testbed 6 OWS-6

- http://www.opengeospatial.org/pub/www/ows6/index.html
- Public Engineering Reports http://www.opengeospatial.org/standards/per
- Outcomes: Aviation Clients; Event Arch; Change Requests to AIXM and Web Services

Aviation in OGC Web Services Testbed 7 OWS-7

- http://www.opengeospatial.org/pub/www/ows7/index.html
- Public Engineering Reports: http://www.opengeospatial.org/standards/per
- Outcomes: SCOTS, Open source validator, Portrayal, More Change Requests

Special Activity Airspace (SAA) Pilot

- http://www.opengeospatial.org/pub/www/saa/index.html
- (soon-to-be) Public Engineering Report
- Outcomes: using OGC services for SAA data dissemination, integration of static and dynamic info
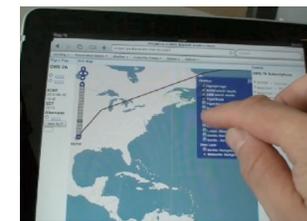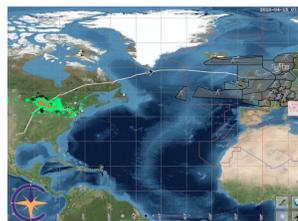
What is OWS-8?

Sensor / Observation Fusion

Observation Fusion: Coverages

Web Coverage Service 2.0: EO App Profile, WPS/WCPS, Compliance Tests

Observation Fusion: Motion

Moving Objects in Motion Imagery: Detecting & tracking objects, and setting bookmarks

Feature Fusion / Portrayal

Gsync

Geodata Bulk Transfer with Synchronization: Content management across SDI

CCI: Mediation

Cross-Community Interoperability: Semantic mediation across heterogeneous data models

CCI: Schema

Schema Automation: UML-GML enhancements, Schematron support for SWE (O&M) schema

CCI: Portrayal

Portrayal Enhancements: Registries for symbols and rules (incl. DGIWG), FPS with SE + KML

Aviation / Weather

Aviation: Architecture

AIXM 5.1: Metadata, GML Profile, Performance

Aviation: Portrayal

FPS, SLD: ICAO symbol libraries for AIXM, WXXM

Aviation: Events

Digital NOTAM: Events spec, AIXM event schema, validation

Aviation: Security

Authoritative AIXM Services: Authentication (PDP), Authorization (PIP), Gatekeeper (PEP)

Aviation: Weather

WXXM 1.1: WCS conversion, probabilistic TAF, distributed UoM

Kickoff meeting
• March 9-11 2011

Final Demo – OGC TC Colorado
• Sep 22 2011

Final delivery (reports & demos)
• Sep 30 2011

OWS-8 Aviation Participants

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LUCIAD
high performance visualization

FREQUENTIS

JACOBS UNIVERSITY

EOX

Atos

LISAsoft
Linking IT

COMSOFT

carmenta
geospatial innovations

ENVITIA
World Class Spatial Information Technologies

galdos
systems inc

IDS
INGEGNERIA DEI SISTEMI

ATMOSPHERE

LA TROBE UNIVERSITY

Snowflake software

iGSI

ifgi

NATIONAL WEATHER SERVICE

GEORGE MASON UNIVERSITY

der Bundeswehr
Universität München

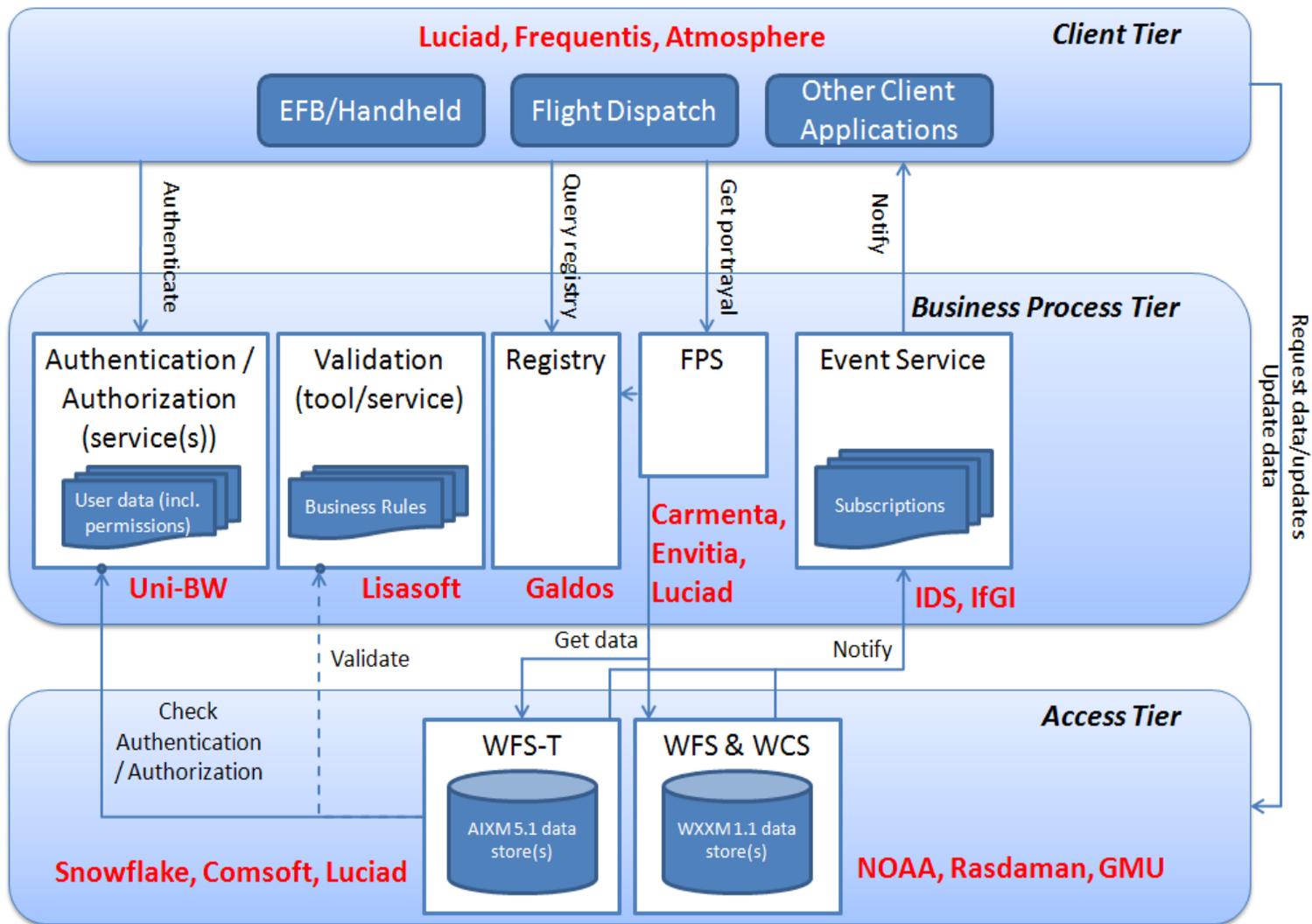Applied Informatics /
Cooperative Systems
AICOS

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OWS-8 Aviation Architecture

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

Client Tier

Luciad, Frequentis, Atmosphere

EFB/Handheld   Flight Dispatch   Other Client Applications

Authenticate   Query registry   Get portrayal   Notify

Request data/updates   Update data

Business Process Tier

Authentication / Authorization (service(s))
User data (incl. permissions)
Uni-BW

Validation (tool/service)
Business Rules
Lisasoft

Registry
Galdos

FPS
Carmenta, Envitia, Luciad

Event Service
Subscriptions
IDS, IfGI

Validate   Get data   Notify

Check Authentication / Authorization

Access Tier

WFS-T
AIXM 5.1 data store(s)

WFS & WCS
WXXM 1.1 data store(s)

Snowflake, Comsoft, Luciad   **NOAA, Rasdaman, GMU**

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11 Engineering Reports!

| Report	OGC Doc #	Editor(s)
OWS-8 Aviation Arch	11-093	Johannes Echterhoff (iGSI)
OWS-8 Aviation Auth Data Source Arch	11-086	Jan Herrmann (Tech U of Munchen)
OWS-8 WFS Guidance for AIXM	11-073	Debbie Wilson (Snowflake)
OWS-8 AIXM Compression Benchmarking	11-097	Jerome Jansou (AtoS), Thibault Dacla (Atmosphere)
OWS-8 ICAO Guidance for SLD	11-089	Daniel Tagesson (Carmenta)
OWS-8 WXXM and Weather	11-072	Torab Torabi (La Trobe University)
OWS-8 WXXM Audit Results	11-091	David Burggraf (Galdos)
OWS-8 Report on Digital NOTAM Event Spec	11-092	Johannes Echterhoff (iGSI), Matthes Rieke (IfGI)
OWS-8 AIXM 5.1 Metadata	11-061	David Burggraf (Galdos)
OWS-8 Domain Modeling Cookbook	11-107	Jim Groffen (Lisasoft)
OWS-8 Digital NOTAM Refactoring Report	11-106	Jim Groffen (Lisasoft)

Approach
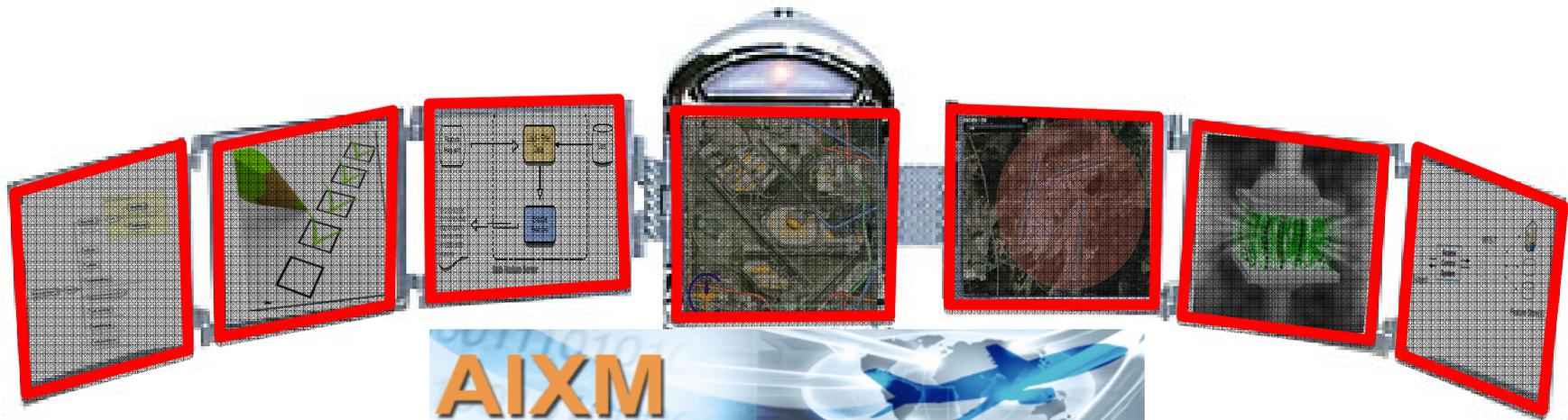
AIXM
Aeronautical Information Exchange Model

Standards-based data model and exchange format that can satisfy the aeronautical information exchange requirements for current and future aeronautical information applications; Models temporality

Accommodates ICAO standards and recommendations: Accommodates industry requirements: ARINC 424/EUROCAE ED-99/ RTCA DO-272

- Uses XML and GML
- Is modular and extensible
- Supports current and future AIM IS requirements

Digital AIPs, automated charting and pubs, integrated digital NOTAMs, Aerodrome mapping databases and apps
Situational displays, etc

- Schema refactoring
- Validation
- WFS Guidance
- Portrayal
- Digital NOTAMs
- Compression
- Auth Data Source

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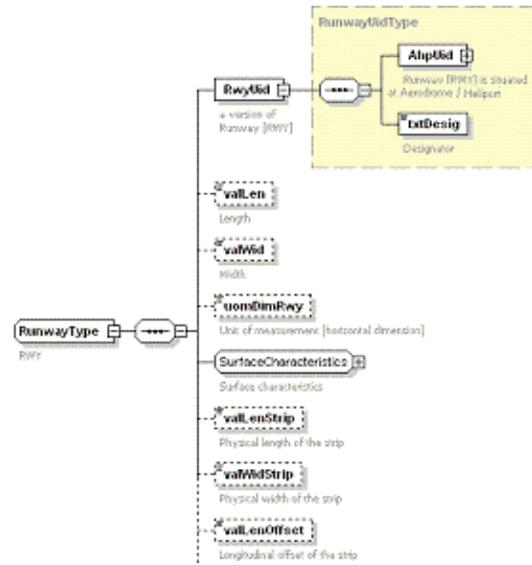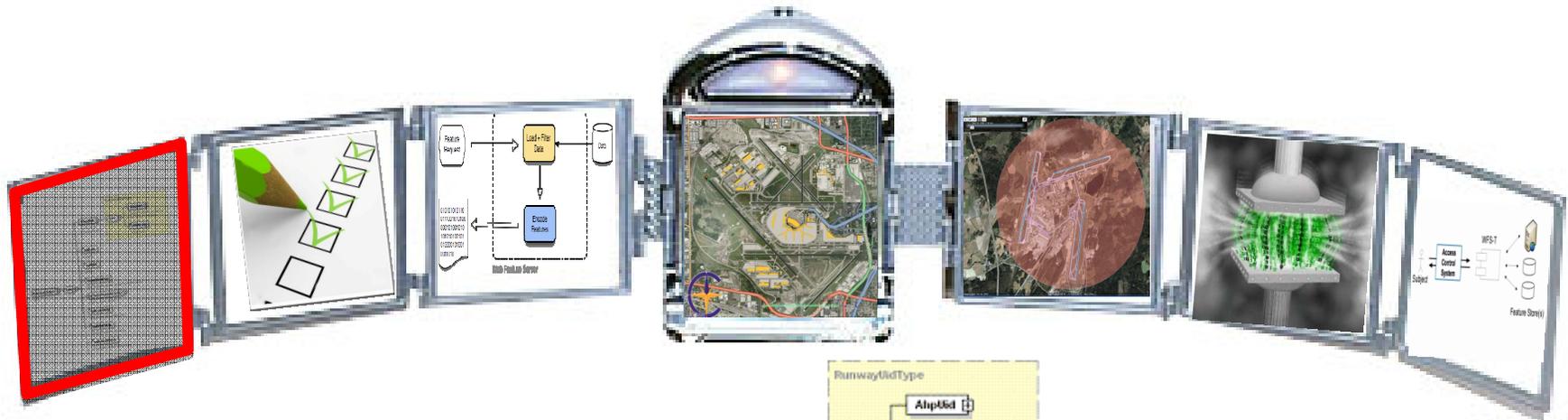
- **Schema refactoring**
- Validation
- WFS Guidance
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Refactoring of AIXM - DNES

- The value of formal information modelling
  - Share information across a "universe of discourse" (ISO 19101)

- Conceptual Domain Modelling vs. Physical Domain Modelling
  - Capture concepts, allow for their reuse
    - standardize the definition of a mountain so we all know what we are talking about
  - Map concepts to useful systems
    - my system tells me where mountains are so I don't fly into them

- Develop General Cookbook – Apply to DNES
  - Modeling practices
  - Model hiegene
  - Sustainable model management

Slide provided by Jim Groffen (Lisasoft), Rob Atkinson (CSIRO), Cameron Shorter (Lisasoft)

Modeling Tools

- ## HollowWorld
  - Templates for domain models
  - ISO Harmonized Model

- ## FullMoon
  - Conformance Checking
  - Generate Application Schema

Standards Conformance ▸	Assign Sequence Number
Generate PSM ▸	Generate Package Dependencies Diagram
Import PSM ▸	Run Conformance Tests
Concept/Impl. Mapping ▸	Generate Class Diagram
Version Management ▸	Generate Class Context Diagram
Model Registry ▸	Clean Duplicate Tagged Values
Controlled Vocabularies ▸	Validate Mapping Model
Excel Import/Export ▸	
Model Driven Software Developement ▸	
System Meta Data ▸	
Export Model To SGXML	
Convert UML Model	
Generate Model Documentation	
Set Predefined Location	
Get Element GUID	
About	

- ## SolidGround
  - Model authoring tools
  - Plug-in for Enterprise Architect
  - Many helpers

DNES Modeling Recommendations

- Separation of implementations details from the conceptual model
  - Line between conceptual and physical models has become blurred

- Improve packaging and dependency relations
  - To support extension of the model by others
  - Allows the model use other models more easily too
  - E.G. Temporality classes currently have to be the supermodel for most concepts

- Incorporation into SolidGround model management practices – the Model Registry

- Recommendation: FullMoon
  - Improve conformance of the model
  - Ensure formal notation of the UML so a physical model (XSD) can be generated

- Schema refactoring
- **Validation**
- WFS Guidance
- Portrayal
- Digital NOTAMs
- Compression
- Auth Data Source

Validation of DNES

- Goals
  - Review of the conceptual aspects of DNOTAM design and usage rules
  - Creation of a Schematron rule set for testing DNOTAMs against the rules of the DNES

- Initial findings
  - Description of geometry encoding needs revision (to align with the GML profile for AIXM guidelines)
  - Specification not clear on how XML doc containing a DNOTAM event is structured (message required? One event per message? Etc)
  - Imprecision regarding documentation of static data availability
  - Need to improve specification of conformance targets to better identify for which entity a given statement is normative
  - Need to explicitly state identifier requirement
  - Need consistent path notation in mapping of event data template items to the relevant AIXM properties

DNES – Validation Tool

Validation tool

- XML Schema and Schematron validation
- Automated testing and reporting
- Preconfigured for Digital NOTAM
- Test WFS or local files

Schematron rules developed for

- Published SAA – activation;
- Published SAA – creation;
- Aerodrome closure;
- Runway closure;
- Navaid unserviceable;
- Other Event (partly)

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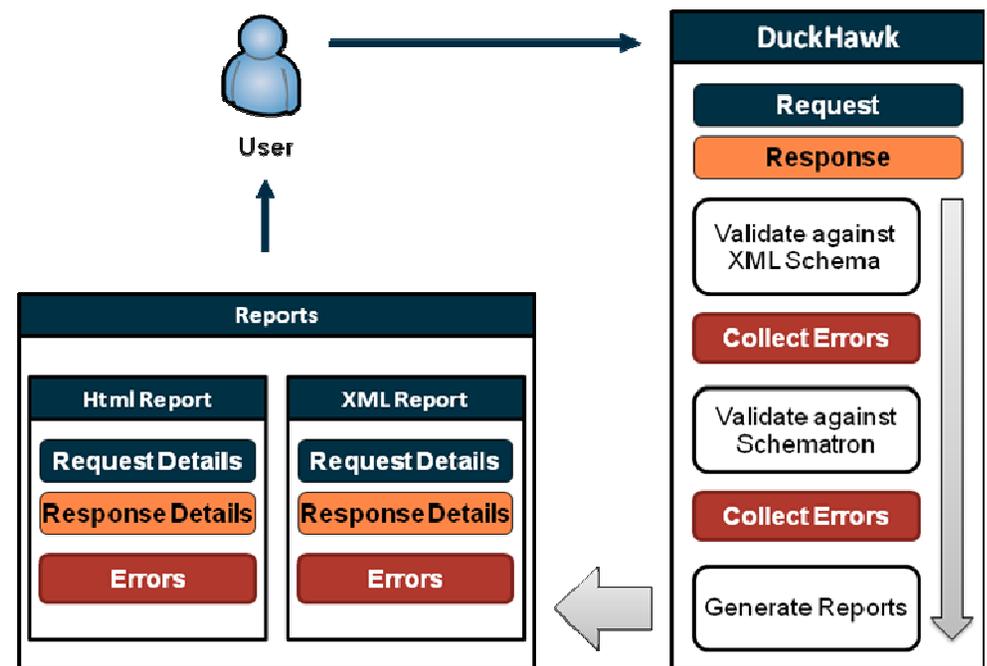
WXXS Schema Compliance

- Manual and automated scan

- W3C XML Schema Part 1: Structures
- ISO 19136:2007 (GML 3.2.1)
    - Clause 7.1: GML model and syntax
    - Clause 21: Rules for GML Application schemas
    - Annex A.1: Abstract test suite for GML application schemas

- Results
    - No critical compliance issues uncovered
    - Identified 43 issues, of various kinds:
        - Element substitutions
        - GML naming violations
        - GML property types
        - Duplicated (anonymous) types
        - Circular schema dependencies
        - Spurious import/include statements
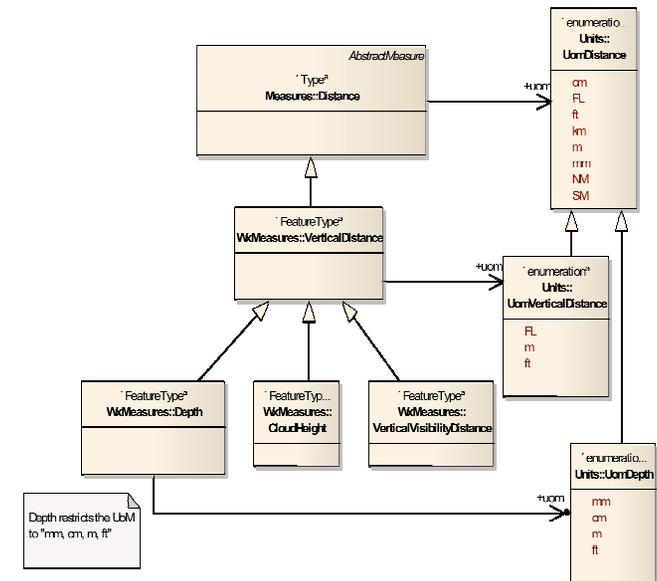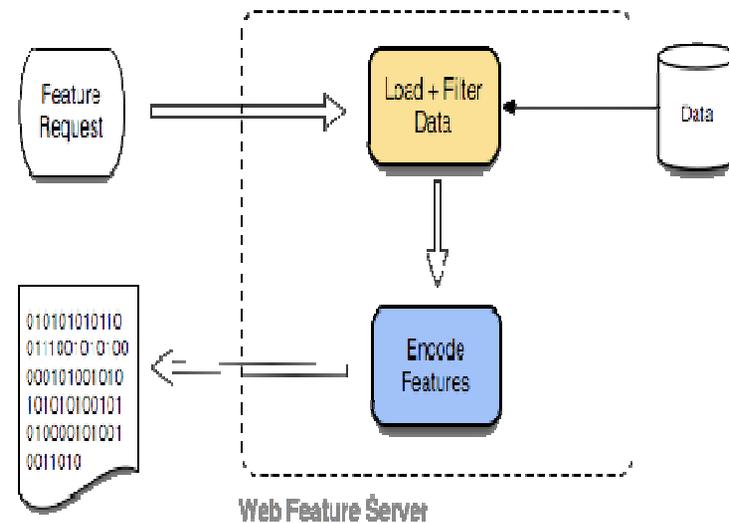
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- Schema refactoring
- Validation
- **WFS Guidance**
- Portrayal
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WFS Guidance Report

- To be submitted as an OGC Best Practice Paper

  Provide guidance to enable consistent implementation and use of OGC WFS 2.0 specification for retrieving AIXM 5.1

  Capture best practice for using WFS 2.0 to handle AIXM 5 data in operational environment

Chapter	Information
1. **Overview of WFS 2.0 Specification**	Introduction to the WFS specification
2. **Configuring WFS to serve AIXM 5.1**	Configuring GetCapabilities, support for filter capabilities, referencing related resources, encoding feature references, handling reverse associations, ensuring gml:id uniqueness
3. **Retrieving AIXM 5.1 using WFS 2.0**	Improvements for effective retrieval (returning subset of timeslices within a feature), introducing new filter function "evaluateDuring", retrieving SNAPSHOTs
4. **Aviation clients use cases**	Based on real-world flight planning and dispatch use cases

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Key Outcomes

Specification	Outcome	Recommendation
WFS 2.0	• Recommendations for which service bindings such be supported is essential for interoperability and lower cost for client development	• HTTP POST should be supported, • HTTP GET (KVP) should be supported • More investigation and experience needed with SOAP
	• Advanced query parameters (XPath Accessor functions, join queries) are required but still unproven	• Investigate applicability in OWS-9
	• Need improved support for retrieving Dynamic Features via WFS	• Develop and test proposed improvements to WFS/FE 2.0 specification
AIXM 5.1/ GML 3.2.1	• Need to better align AIXM 5 Temporality and GML Dynamic Feature Model • Maintaining reverse associations in an AIXM extension leads to several open issues	• Mature Dynamic Feature Model with aim to submit as ISO 19100 specification (alongside moving objects model) • More work on reverse associations
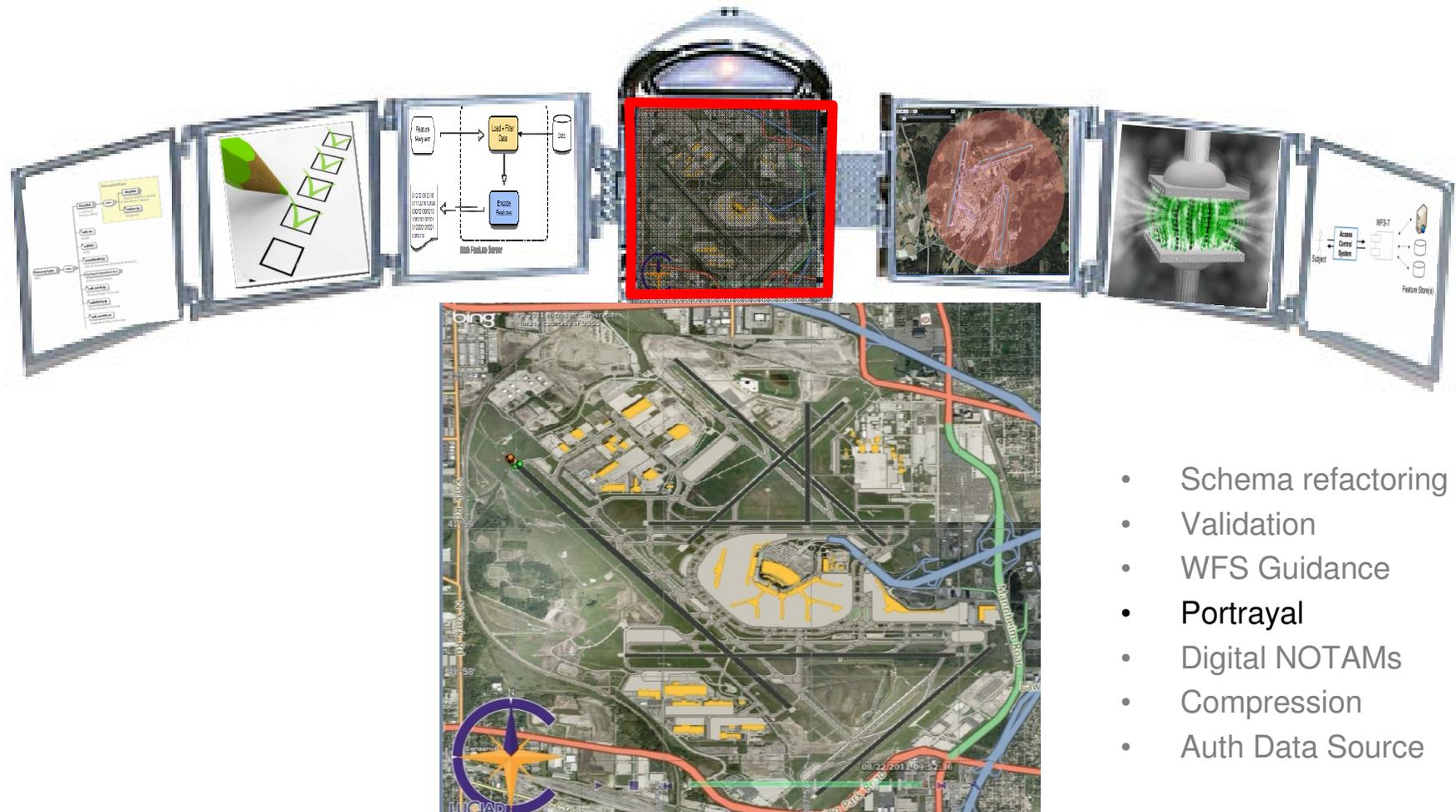
Slide provided by Debbie Wilson (Snowflake) with input from Timo Thomas (Comsoft), Jeroen Dries (Luciad) and Ulrich Berthold (Comsoft)

- Schema refactoring
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- **Portrayal**
- Digital NOTAMs
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Portrayal

- Identify Portrayal issues and technical risks in the practical implementation of an OGC Standards based AIXM/ICAO Aviation Information System
  - OGC Styled Layer Descriptor (SLD)
  - OGC Symbology Encoding (SE)
  - OGC Feature Portrayal Service (FPS)

- Identify potential changes to the standards, models and methods by which the technical issues and risks can be addressed

- Most complex lines (controlled airspaces, FIR/UIR, etc) and fills (graphic fills) can be visualized using SLD/SE

147	Unpaved runway	

Portrayal: The Challenges

- **ICAO Symbology is Complex!**
  - Graduated fading boundaries
  - Complex line styles
  - Many inter-woven business rules and dependencies

- **AIXM Model is Complex!**
  - Relational model
    - Model tends to specify uni-directional relationships between features and their component features
    - Need WFS 2.0 resolve and resolveDepth parameters of a GetFeature to ensure that all GML content required for portrayal is returned by a query result
  - Hierarchical data
    - Allow different styles to be applied to nested children based on the children's properties
    - Change request to SE Symbolizer and Rule for styling of nested objects
  - Temporality!

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Styling not covered by ICAO

- Proposed styling
    - Closed surfaces
      ManoeuveringAreaAvailability>operationalStatus set to OTHER, LIMITED or CLOSED
    - Unserviceable features (e.g. Navaids)
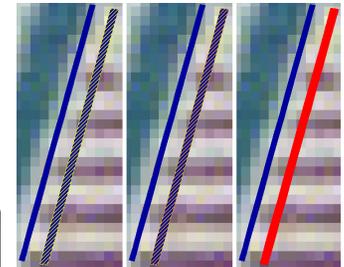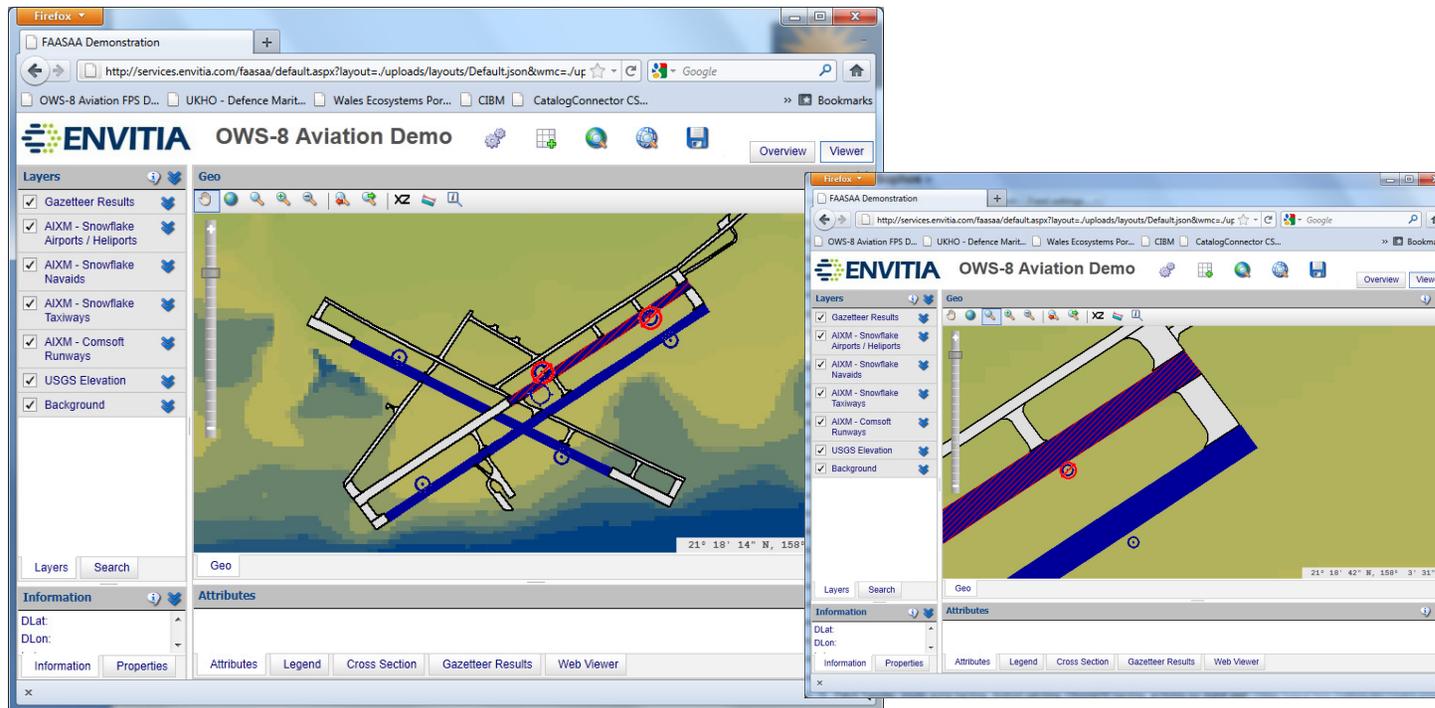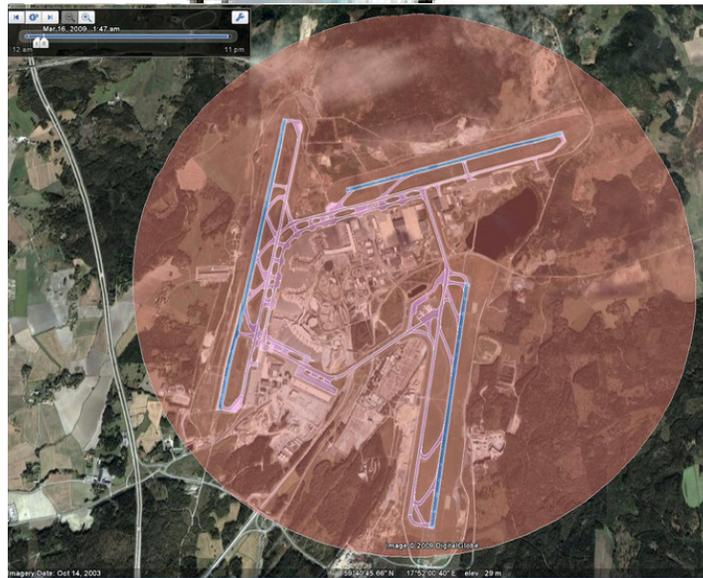
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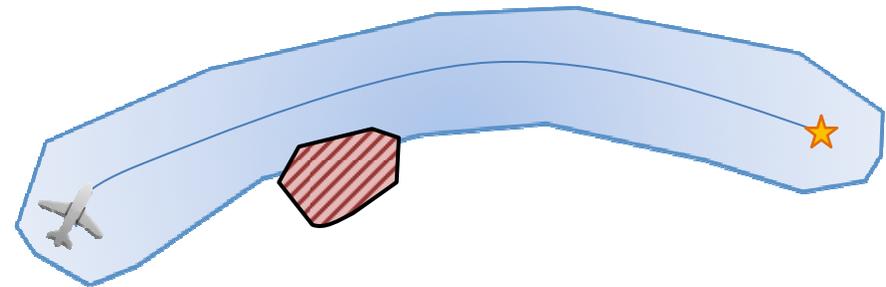- Portrayal
- **Digital NOTAMs**
- Compression
- Auth Data Source
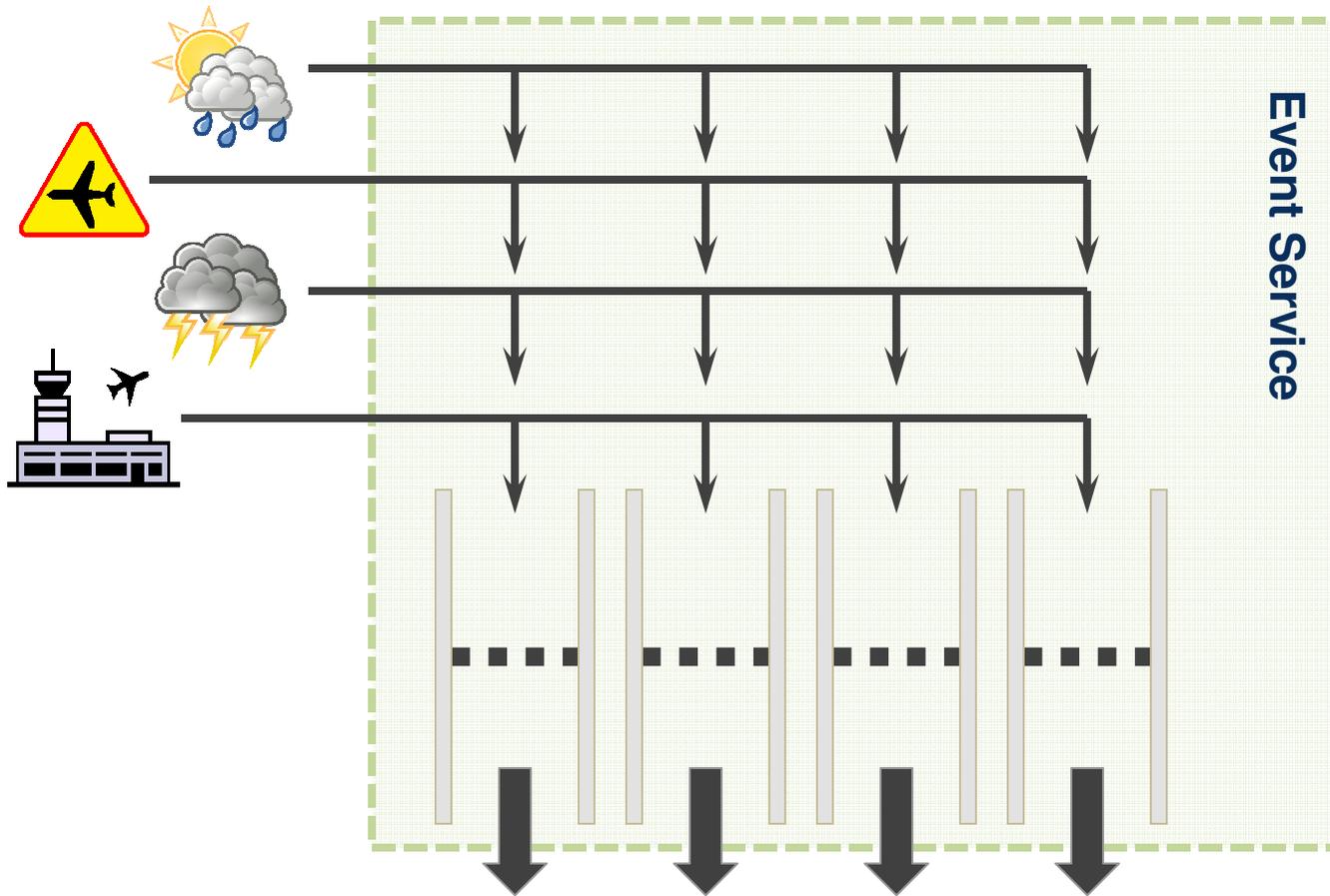
Event Service
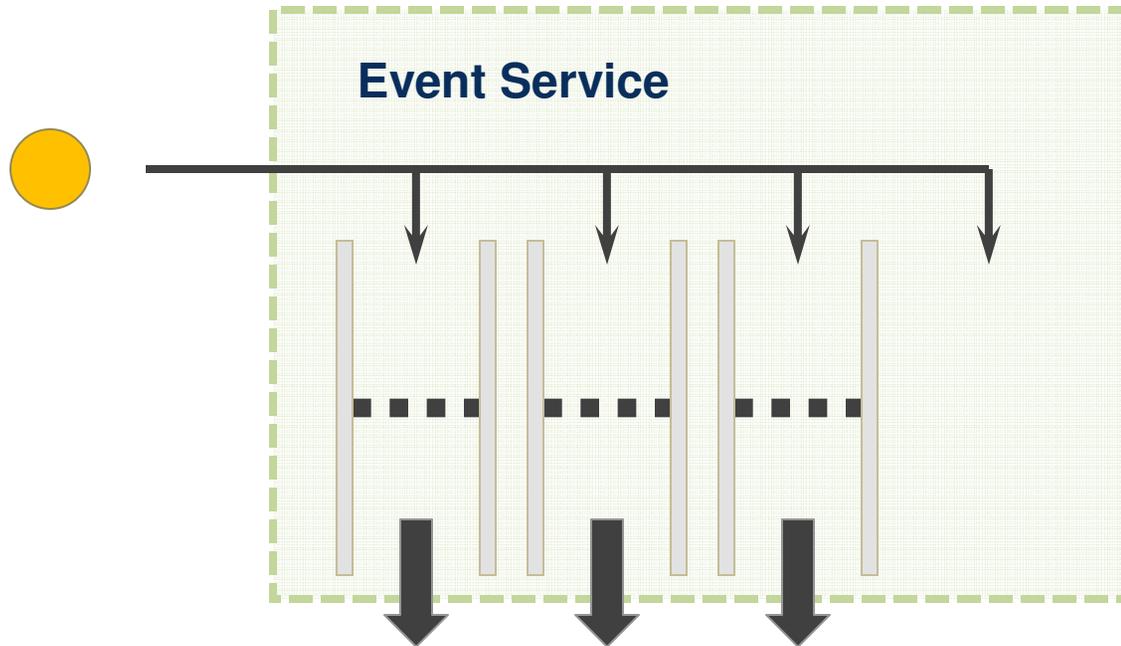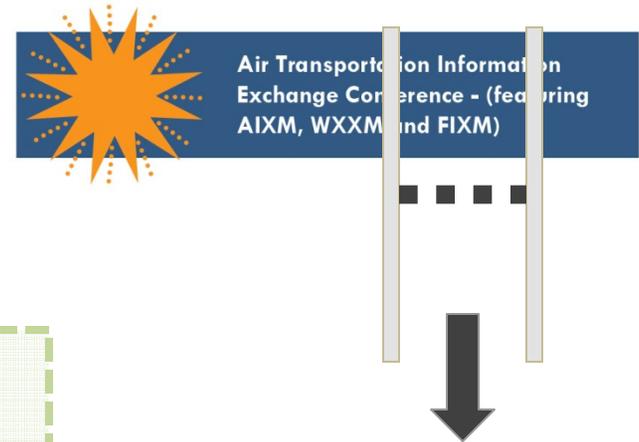
- The Event Service is a standalone Publish/Subscribe Broker service with sophisticated filter and processing capabilities

- The Event Service is not an OGC standard but the **PubSub SWG at OGC** is working on a **standard that enables publish/subscribe support for all OGC Web Services** in a well-defined manner
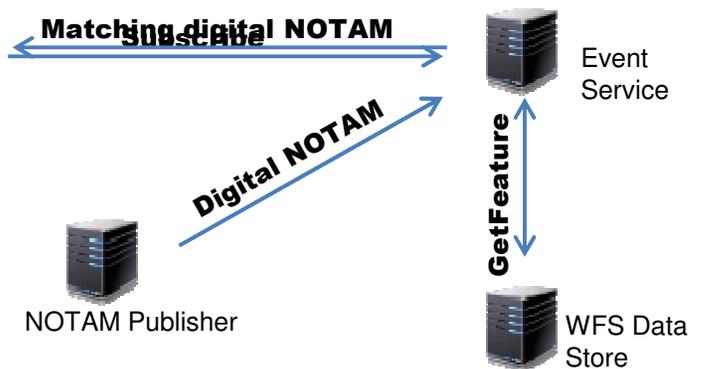
Slide provided by Thomas Everding (Ifgi), Johannes Echterhoff (IGSI) and Matthes Rieke (Ifgi)

Enrichment of thin Digital NOTAM Events

- ## Spatial flight route buffer example

|		
1.	Client → Event Service	*Subscribe for flight route using buffer of 500 nautical miles*
2.	NOTAM Publisher → Event Service	*Thin digital NOTAM for activating a previously published SAA*
3.	**Event Service → WFS Data Store**	*Pull unchanged information (**enrichment**) using GetFeature request for Airspace feature*
4.	Event Service → Client	*Push matching originally received (**unchanged**) NOTAM to clients*

Communication

Visualization

Matching digital NOTAM

Subscribe

Client

Digital NOTAM

NOTAM Publisher

GetFeature

Event Service

WFS Data Store

Slide provided by Johannes Echterhof (IGSI) and Matthes Rieke (Ifgi)

Dynamic Filters
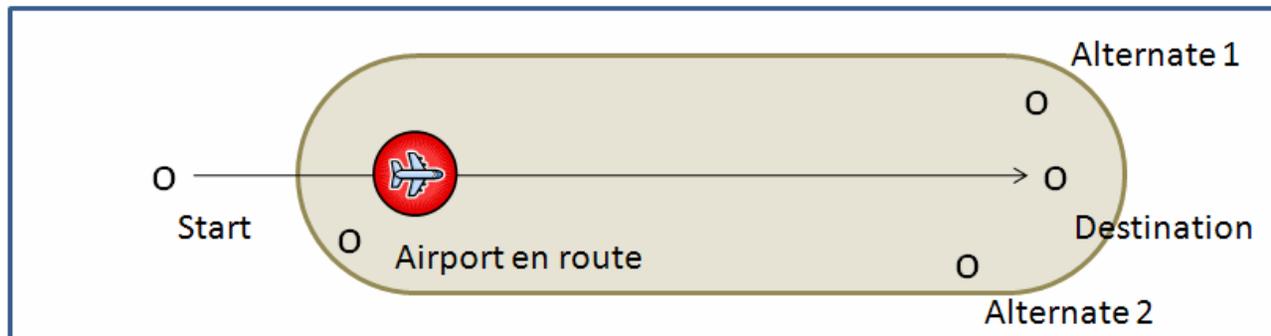
buffer around flight path updated with aircraft position
•no longer transmit events from passed locations to aircraft
• more accurate filtering
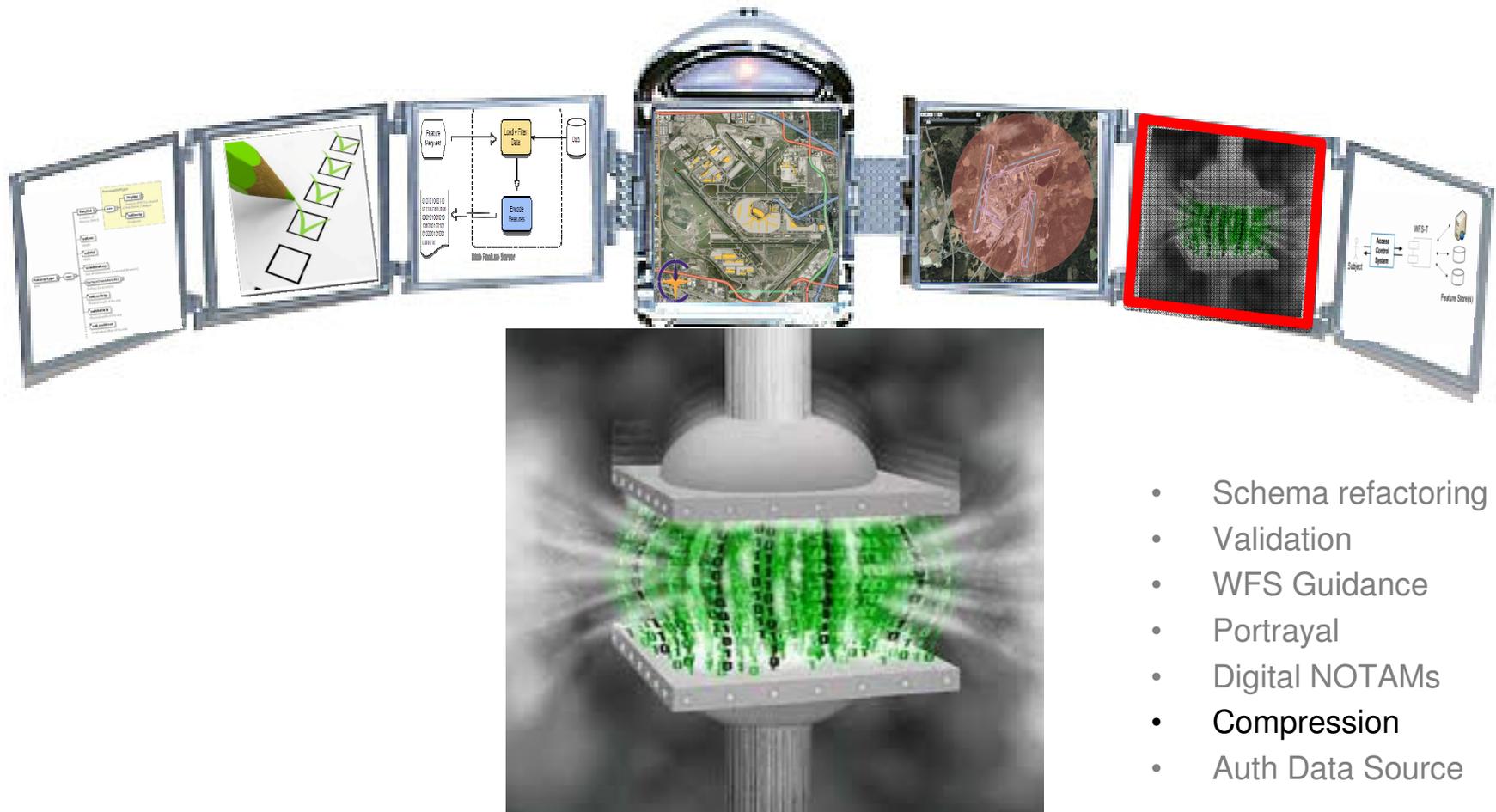
- Schema refactoring
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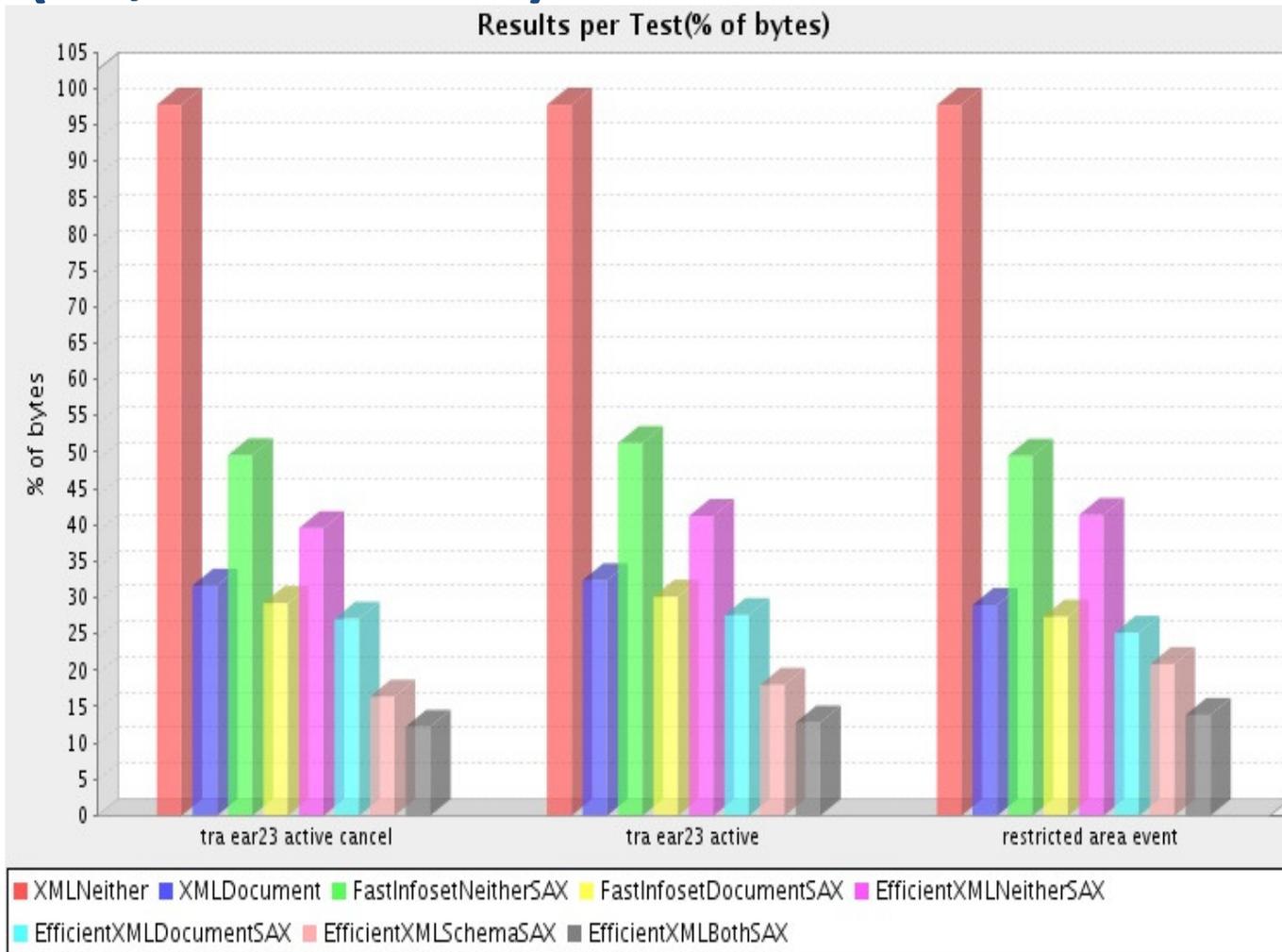- Digital NOTAMs
- **Compression**
- Auth Data Source

Compression Platform presentation

- The OWS-8 AIXM Compression Benchmark platform is based on the W3C EXI Platform, and uses the following libraries :
  - Japex 1.2.2 with slight modifications (for memory consumption measures)
  - Fast Info Set 1.2.9
  - Excificient 0.7 (Siemens open source EXI impl.)
  - CubeWerks CWXML 4.0.5 (C candidate)

- Focus on:
  - Compaction performance of candidates (encoding), with various configurations
  - Memory footprint (encode / decode)
  - CPU consumption (encode / decode)

- For input, 4 families of AIXM files cleaned (no comments, indenting,…)
  - A first family made of 3 DNOTAMs (resp. 4441, 4537 and 6986 bytes)
  - A second family made of AIXM file between 10kB and 1MB
  - A third family of files between 1MB and 20MB
  - A fourth family of technical files (hand made to focus on specific points)

D-NOTAM compression (13,4% for best)

Results per Test(% of bytes)

Legend:
- XMLNeither
- XMLDocument
- FastInfosetNeitherSAX
- FastInfosetDocumentSAX
- EfficientXMLNeitherSAX
- EfficientXMLDocumentSAX
- EfficientXMLSchemaSAX
- EfficientXMLBothSAX

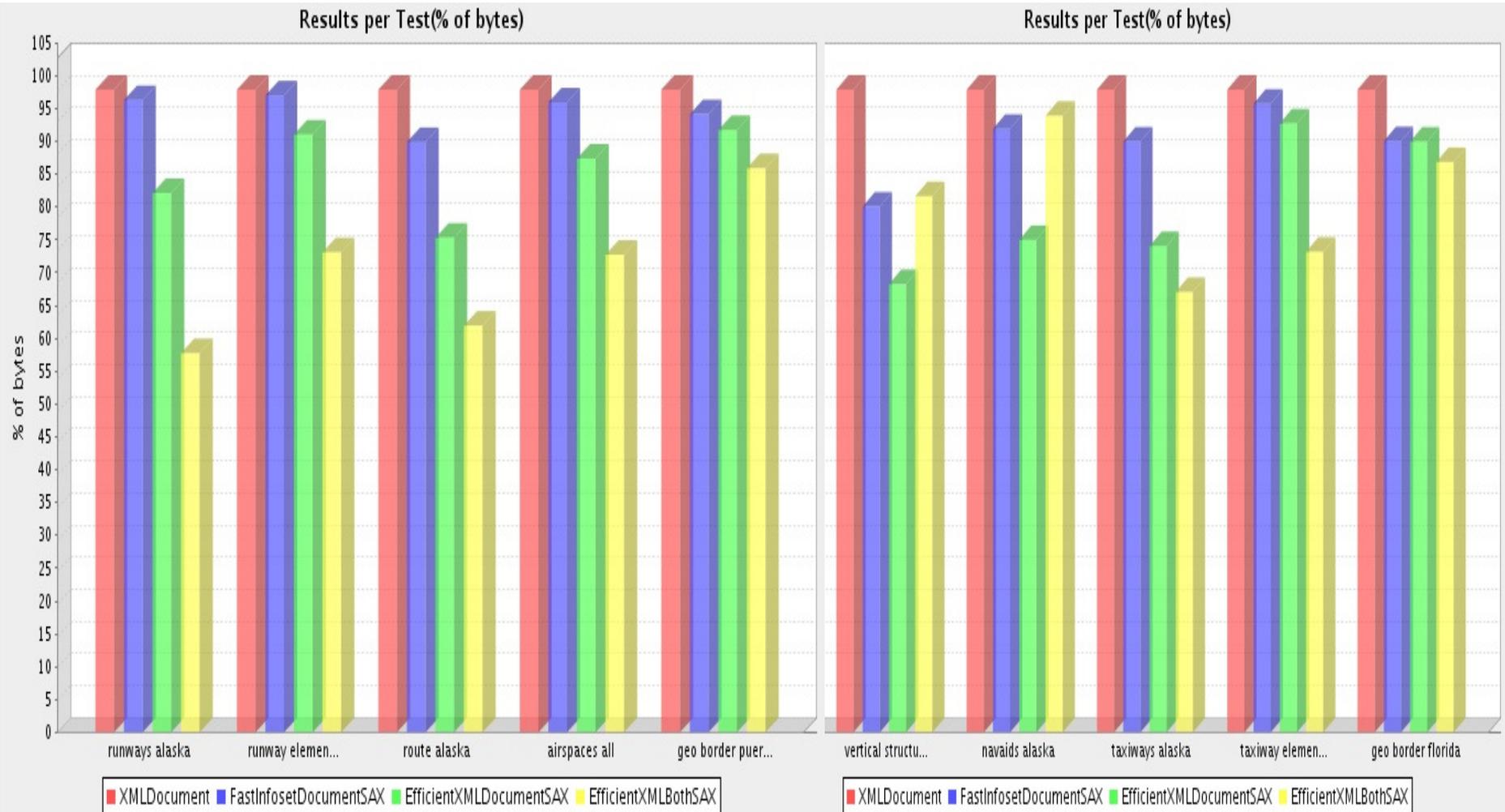Categories: tra ear23 active cancel, tra ear23 active, restricted area event

Candidates :

- SAX (JAXP), so no compression

- SAX with deflate level 9 (post treat. through zlib)

- FI without deflate

- FI with deflate lev 9 (as post treat.)

- EXI without schema nor deflate

- EXI without schema but with integrated deflate

- EXI with schema but without deflate

- EXI with both schema and deflate

Family 2 compression

GZIP level impact on compression for large files (3rd fam.)
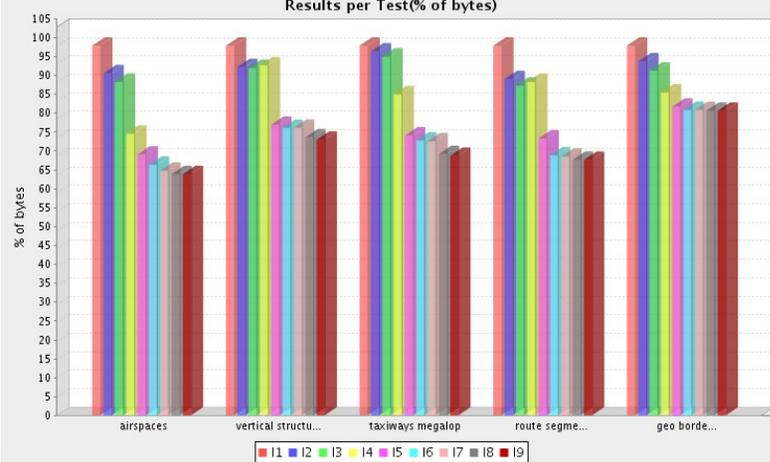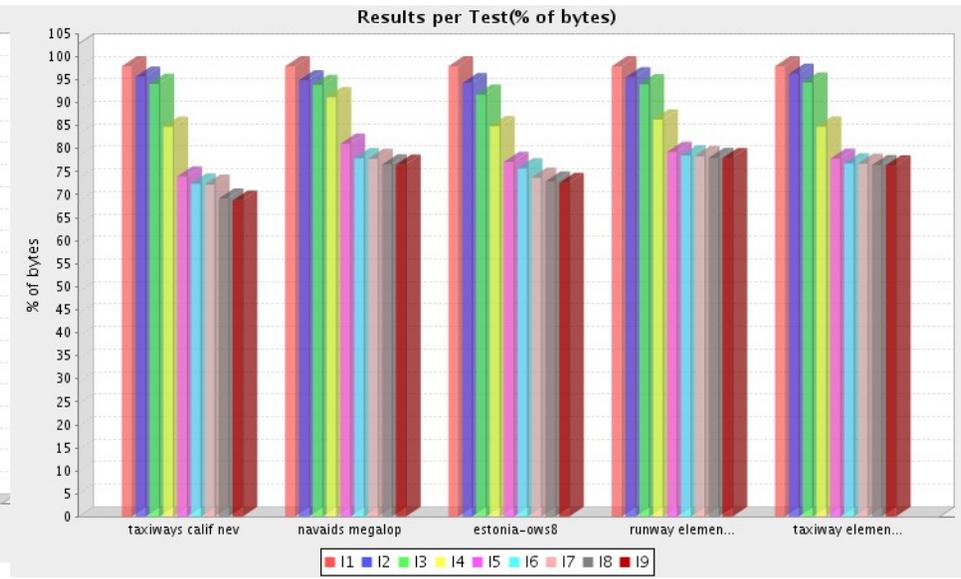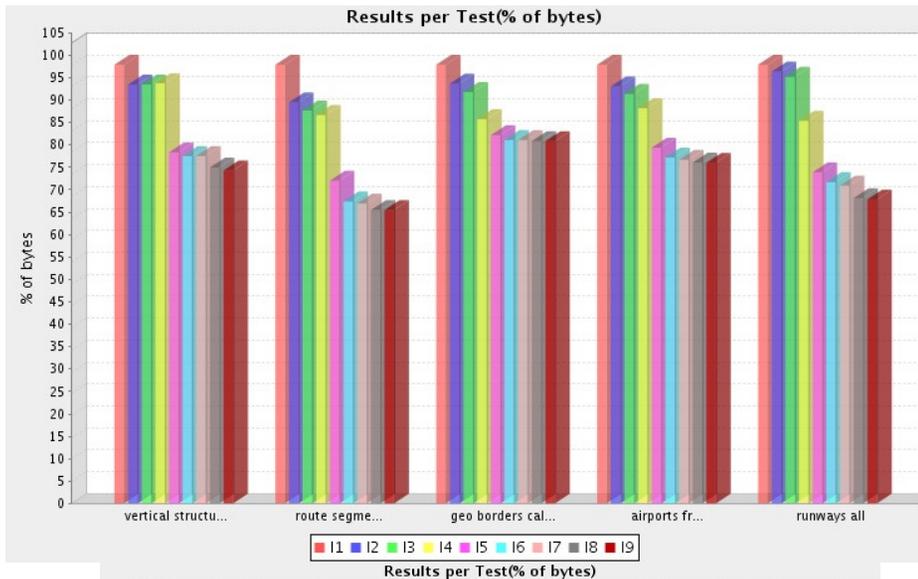

In most cases level 5-6 is enough

Conclusion

- EXI is the best way to compress D-NOTAM for datalink, even if compression is slow (but on the server side a priori).

  - D-NOTAM weighs less than 1KB once compressed (good for ACCARS or ATN, and spans a single satellite time slot).

- If CPU or RAM is a problem, or complexity of EXI is estimated too high

  - Deflate with a 32KB dictionary made with AIXM (GML,…) schema (XSD files) can be sufficient.

- Fast Info Set is the best way to compress big amounts of data over a fast ground network

Axis of future work :

- Improve deflate post-compression for EXI or check if AgileDelta's original EXI is doing better. Sometime EXI with deflate is doing worst than without…

- Work on AIXM schema to improve compression (maybe identify a subset for DNOTAMs and remove unnecessary data for the pilot (IDs, …))

- Handling of coordinates (special dictionary, dimension guessing, differential storage, work on precision needed depending on feature)
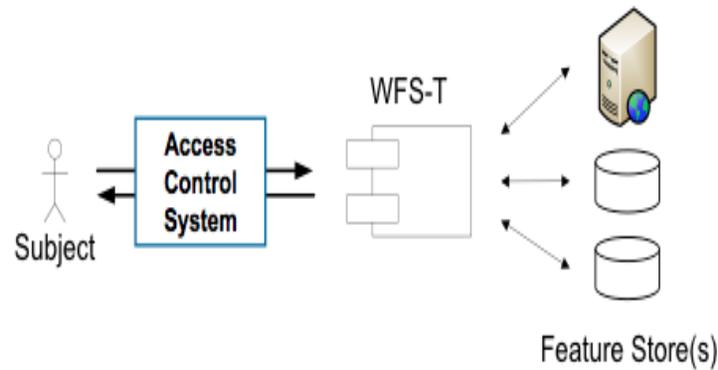
WFS-T

Access
Control
System

Subject

Feature Store(s)

- Schema refactoring
- Validation
- WFS Guidance
- Portrayal
- Digital NOTAMs
- Compression
- **Auth Data Source**

AIXM Auth Data Source Architecture
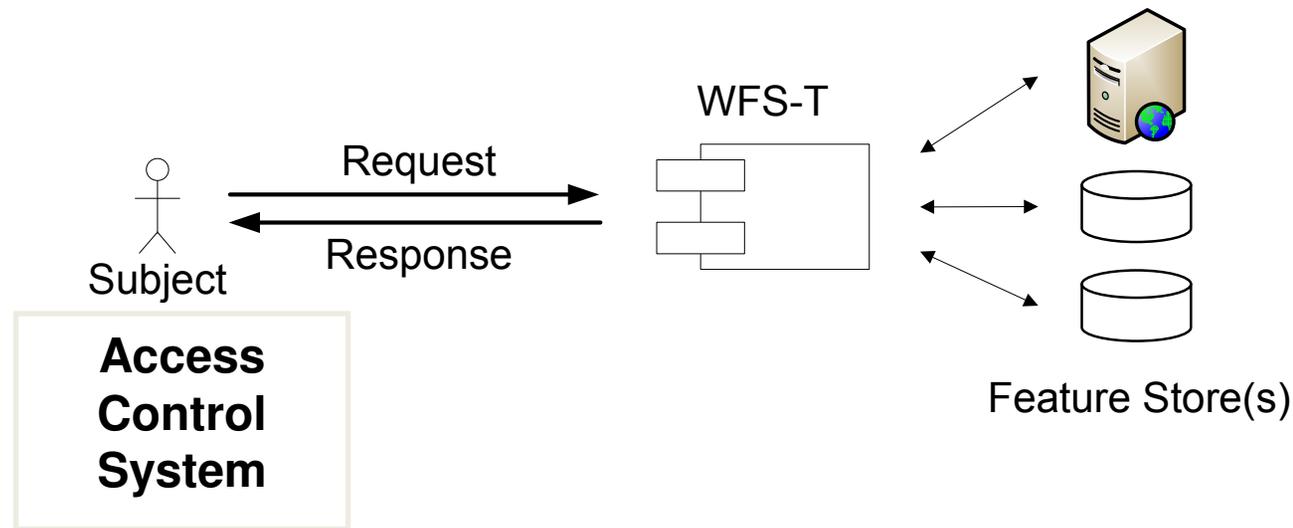
- XACML based Access Control Systems support the enforcement of complex, fine grained rights

- GeoXACML extension of XACML supports geometry and spatial functions

- Examples
    - deny if user interacts with a service on IP 123.123.123.123
    - permit if Alice has activated role xyz and interacts with services of type WFS 2.0
    - permit if GetFeature requests refer to features of type Runway within a certain area
    - permit if the request is a valid (de-)commissioning for features of type RadarSystem

Information Flow
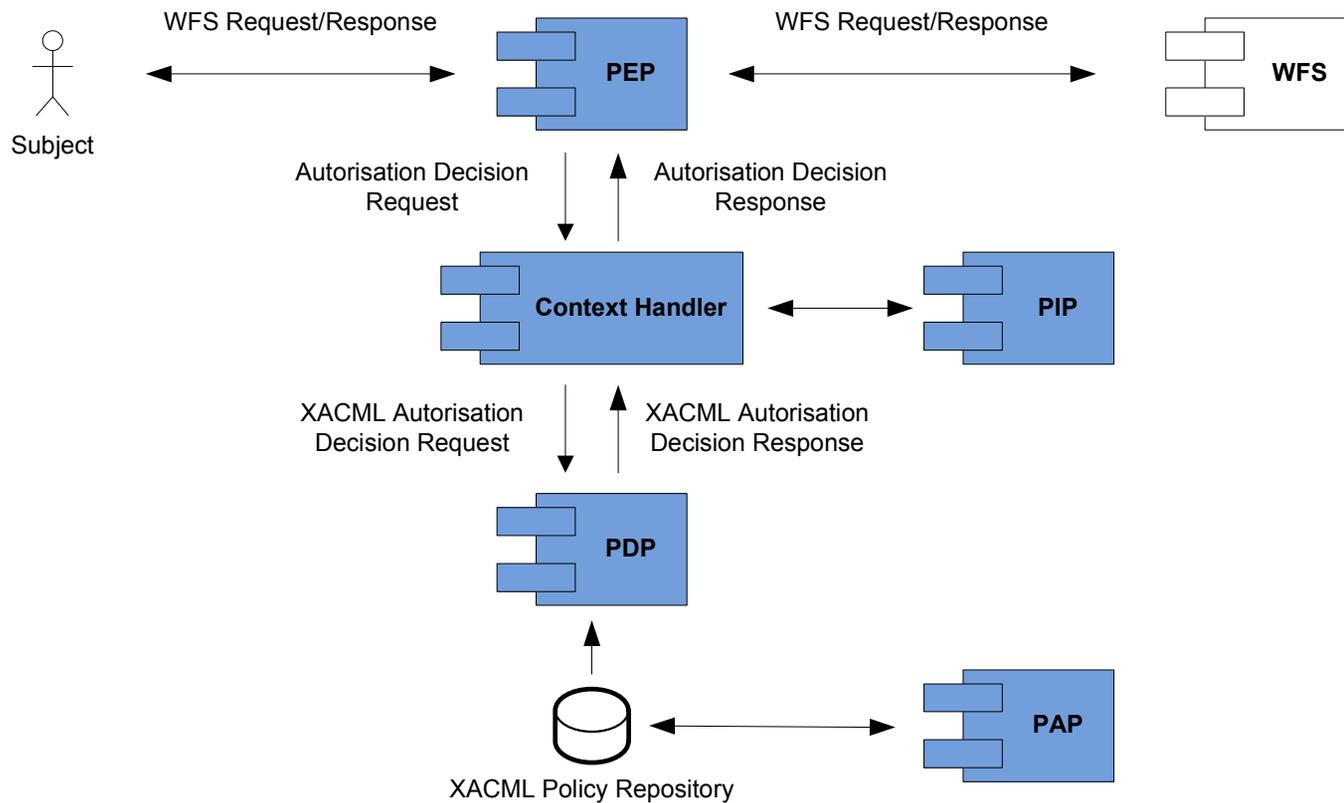
- **Issues**
  - Need to rewrite certain exchanged WFS requests

  - Need to query external information sources (e.g. WFS) to get additional data that is needed to derive an authorization decision

Future Work

- Continuation of the standardization progress of the "XACML v3.0 OGC Web Service Profile"

- Development of an administration service for (Geo)XACML policies supporting complex analysis functions

- Development of a GeoXACML policy life cycle management system

- Performance studies in real environments

- Address security related issues in OWS common

Luciad OGC OWS-8

Aviation Client

For More Information

Visit our booth or our members booths
www.opengeospatial.org

Come to the demo on Sep 22- Boulder Colorado
http://www.opengeospatial.org/event/1109tc

Check out the Public Technical Engineering Reports

Subscribe to the OGC Aviation Domain Working Group Mailing list
http://www.opengeospatial.org/projects/groups/aviationdwg

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Participate!

OWS-9 RFQ (expected)
•January 2012

OWS-9 Kickoff (expected)
•Spring 2012

Air Transportation Information
Exchange Conference - (featuring
AIXM, WXXM and FIXM)

Federal Aviation
Administration
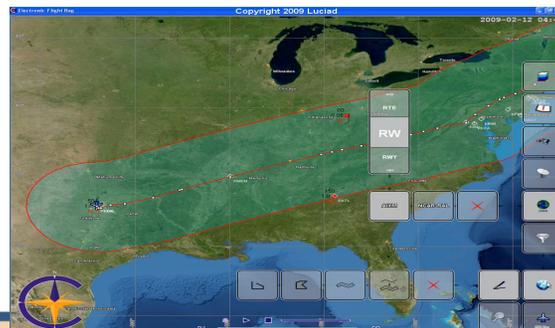
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Thanks again to Participants and Sponsors

Questions & Answers / Feedback