Applying Semantic Web Technologies in Service-Oriented Architectures

24 August 2015

Semantic Web for Air Transportation (SWAT)

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Making location count.

Introduction

- ## Intro to OGC
  - Cross Community Interoperability (CCI) Threads
  - Aviation Threads

- ## Testbed 9 (OWS-9): Semantic Mediation

- ## Testbed 10: Ontology

- ## Testbed 11: Symbology

- ## Future Work

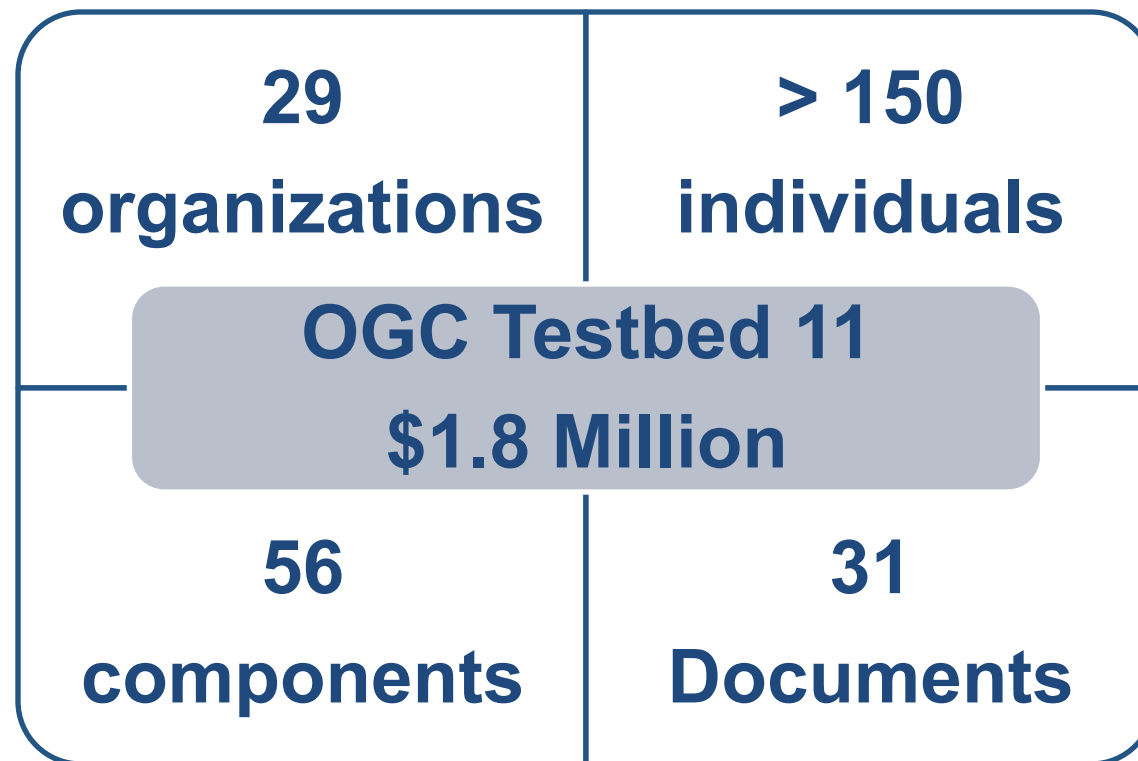**OGC**®

OGC's Approach for Advancing Interoperability

- **_Interoperability Program_ (IP)** - a global, innovative, hands-on rapid prototyping and testing program designed to unite users and industry in accelerating interface development and validation, and the delivery of interoperability to the market

- **_Standards Program_ –Consensus standards process similar to other Industry consortia (World Wide Web Consortium, OMA etc.).**

- **_Compliance Testing and Certification Program_** - allows organizations that implement an OGC standard to test their implementations with the mandatory elements of that standard

- **_Communications and Outreach Program_ –education and training, encourage take up of OGC specifications, business development, communications programs**
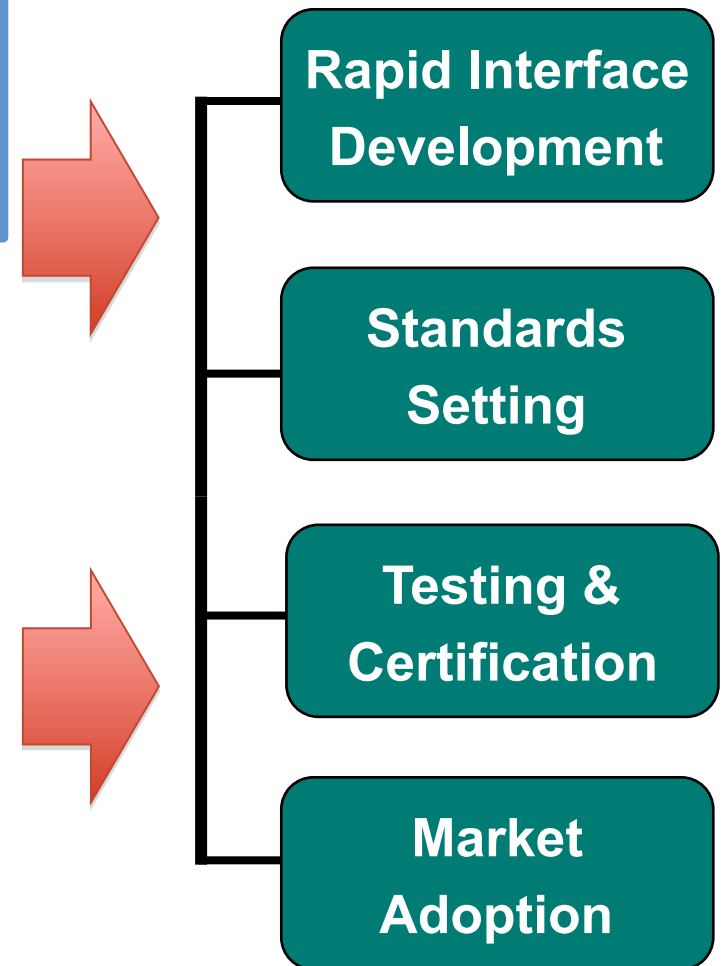
Rapid Interface Development

Standards Setting

Testing & Certification

Market Adoption

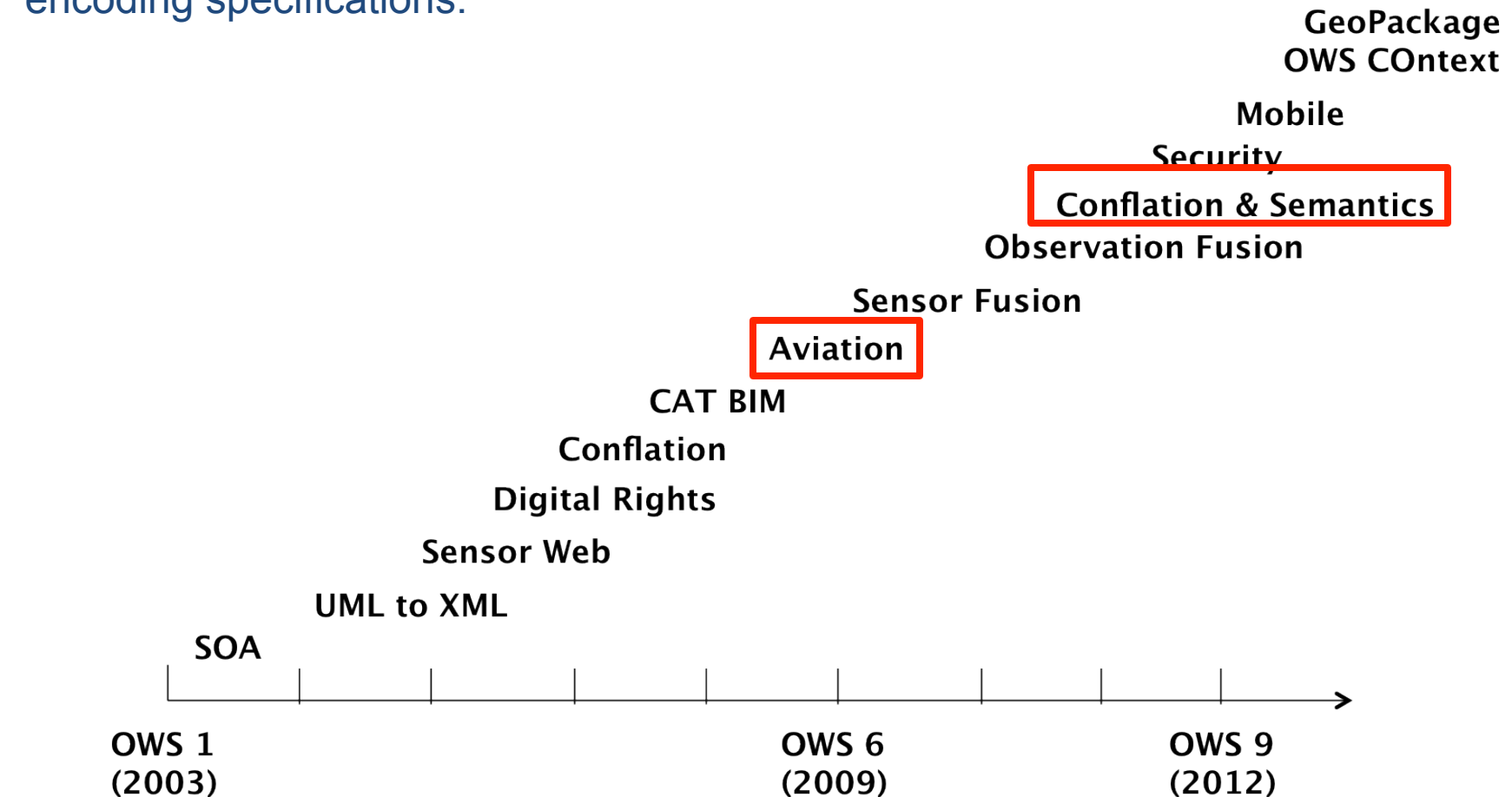**OGC**®

OGC Testbed Projects

OGC Testbeds provide an environment for collaborative, fast-paced, multi-vendor rapid prototyping efforts to define, design, develop, and test candidate interface and encoding specifications.

29 organizations	**> 150** individuals
56 components	**31** Documents

OGC Testbed 11
$1.8 Million

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OGC Testbed Projects

OGC Testbeds provide an environment for collaborative, fast-paced, multi-vendor rapid prototyping efforts to define, design, develop, and test candidate interface and encoding specifications.

GeoPackage
OWS COntext

Mobile
Security
Conflation & Semantics
Observation Fusion
Sensor Fusion
Aviation
CAT BIM
Conflation
Digital Rights
Sensor Web
UML to XML
SOA

OWS 1
(2003)

OWS 6
(2009)

OWS 9
(2012)

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OWS-9 CCI Aviation

- Challenge

  - Demonstrate the querying of Aviation data through user terminology from the Pilots' Glossary (e.g. High Speed Taxiway -> aixm:Taxiway)

- Semantic Mediation Requirements

  - Implement user friendly interfaces that are based on understood concepts (glossary)

  - Interface with web services based on OGC standards and offering data modelled on the Aeronautical Information Exchange Model (AIXM)

  - Experimental application of the FAA Air Transportation Information Ontology

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OWS-9 CCI Aviation Client

- Pilots terminology
  - Using **Air Transportation Information Ontology**
    - **Includes** Pilot Controller Glossary for the JPAMS project (air traffic control procedures)

PILOT/CONTROLLER GLOSSARY

PURPOSE

a. This Glossary was compiled to promote a common understanding of the terms used in the Air Traffic Control system. It includes those terms which are intended for pilot/controller communications. Those terms most frequently used in pilot/controller communications are printed in **bold italics**. The definitions are primarily defined in an operational sense applicable to both users and operators of the National Airspace System. Use of the Glossary will preclude any misunderstandings concerning the system's design, function, and purpose.

b. Because of the international nature of flying, terms used in the Lexicon, published by the International Civil Aviation Organization (ICAO), are included when they differ from FAA definitions. These terms are followed by "[ICAO]." For the reader's convenience, there are also cross references to related terms in other parts of the Glossary and to other documents, such as the Code of Federal Regulations (CFR) and the Aeronautical Information Manual (AIM).

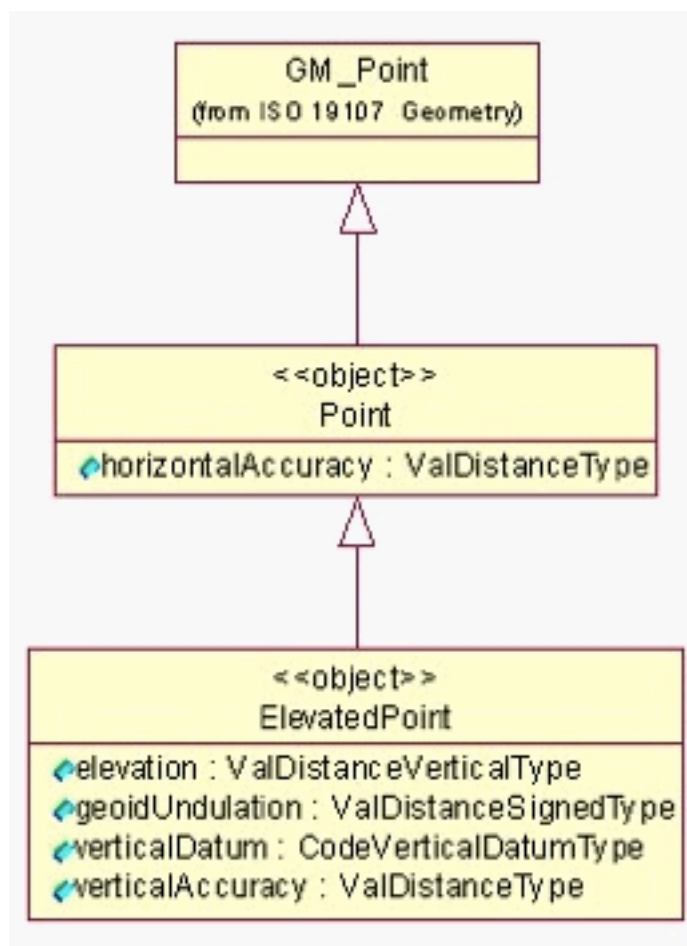**c.** This Glossary will be revised, as necessary, to maintain a common understanding of the system.

EXPLANATION OF CHANGES

a. Terms Added:
PROTECTED SEGMENT

b. Terms Deleted:
OMEGA

c. Editorial/format changes were made where necessary. Revision bars were not used due to the insignificant nature of the changes.
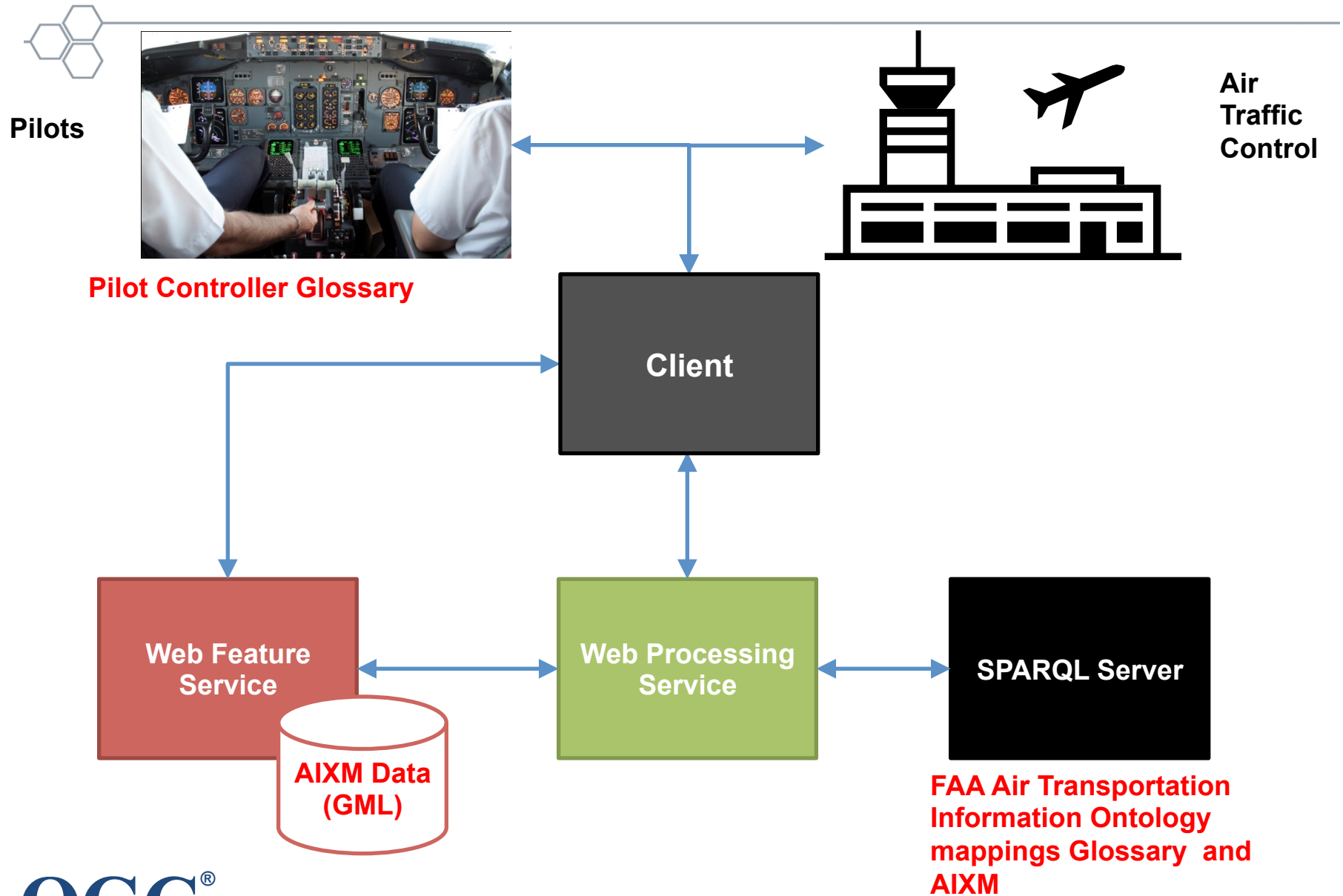
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AIXM features

GM_Point
(from ISO 19107 Geometry)

<<object>>
Point
- horizontalAccuracy : ValDistanceType

<<object>>
ElevatedPoint
- elevation : ValDistanceVerticalType
- geoidUndulation : ValDistanceSignedType
- verticalDatum : CodeVerticalDatumType
- verticalAccuracy : ValDistanceType

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AIXM features

name	TextNameType
locationIndicatorICAO	CodeICAOType
designatorIATA	
type	
certifiedICAO	CodeYesNoType
privateUse	CodeYesNoType
controlType	CodeMilitaryOperationsType
fieldElevation	ValDistanceVerticalType
fieldElevationAccuracy	ValDistanceVerticalType

```
<aixm:name>QUEEN OF THE VALLEY HOSPITAL</aixm:name>
<aixm:type>HP</aixm:type>
<aixm:certifiedICAO>NO</aixm:certifiedICAO>
<aixm:privateUse>YES</aixm:privateUse>
<aixm:controlType>CIVIL</aixm:controlType>
<aixm:fieldElevation uom="FT">49</aixm:fieldElevation>
<aixm:windDirectionIndicator>YES</aixm:windDirectionIndicator>
<aixm:abandoned>NO</aixm:abandoned>
```

OWS-9 CCI Aviation Architecture

Pilots

Pilot Controller Glossary

Air Traffic Control

Client

Web Feature Service

AIXM Data (GML)

Web Processing Service

SPARQL Server

FAA Air Transportation Information Ontology mappings Glossary and AIXM

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WPS SPARQL Server provides mappings

```xml
<wps:Execute service="WPS" version="1.0.0" xmlns:wps="http://www.opengis.net/wps/1.0.0"
xmlns:ows="http://www.opengis.net/ows/1.1" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/1.0.0
 http://schemas.opengis.net/wps/1.0.0/wpsExecute_request.xsd">
 <ows:Identifier>com.envitia.ows9.cciaviation.CCIAviationProcess</ows:Identifier>
 <wps:DataInputs>
   <wps:Input>
     <ows:Identifier>query</ows:Identifier>
     <wps:Data>
       <wps:LiteralData>High Speed Taxiway</wps:LiteralData>
     </wps:Data>
   </wps:Input>
 </wps:DataInputs>
 <wps:ResponseForm>
   <wps:ResponseDocument storeExecuteResponse="false" lineage="false" status="false">
     <wps:Output>
       <ows:Identifier>result</ows:Identifier>
       <ows:Title>result</ows:Title>
       <ows:Abstract>result</ows:Abstract>
     </wps:Output>
   </wps:ResponseDocument>
 </wps:ResponseForm>
```

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WPS responds AIXM features from a WFS

```
<ns:ProcessOutputs>
    <ns:Output>
    <ns1:Identifier
    xmlns:ns1="http://www.opengis.net/ows/1.1">result</ns1:Identifier>
    <ns1:Title xmlns:ns1="http://www.opengis.net/ows/1.1">result</ns1:Title>
    <ns:Data>
        <ns:LiteralData dataType="xs:string">
            <![CDATA[

                http://demo.snowflakesoftware.com/AIXM51_WFS2/GOPublisherWFS?
                service=wfs&acceptversions=2.0.0&request=GetFeature&maxfeatures=10&
                typenames=aixm:TaxiwayElement#http://demo.snowflakesoftware.com/
                AIXM51_WFS2/GOPublisherWFS?service=wfs&acceptversions=2.0.0&request
                =GetFeature&maxfeatures=10&typenames=aixm:Taxiway

            ]]>
        </ns:LiteralData>
    </ns:Data>
    </ns:Output>
</ns:ProcessOutputs>
```
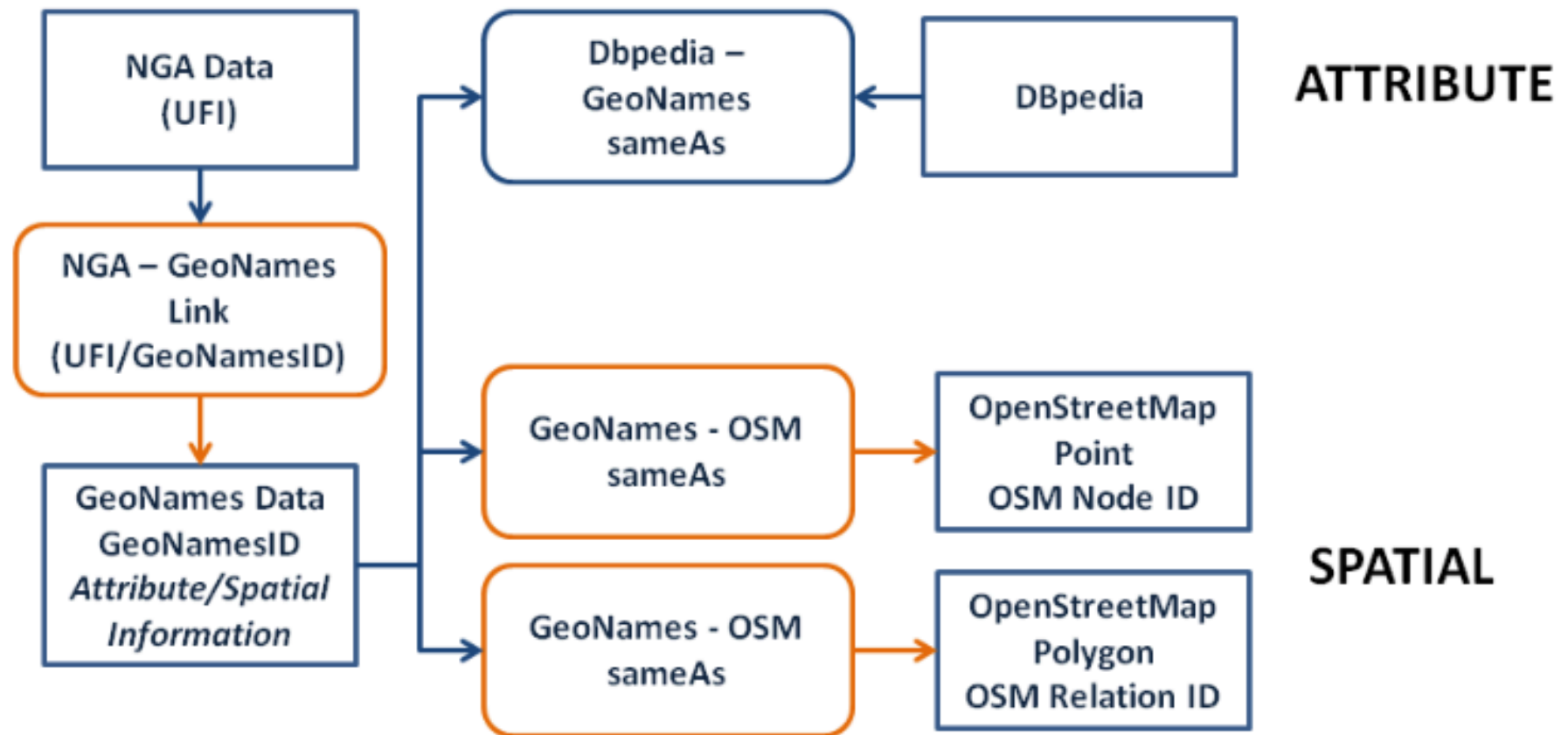
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Search interface

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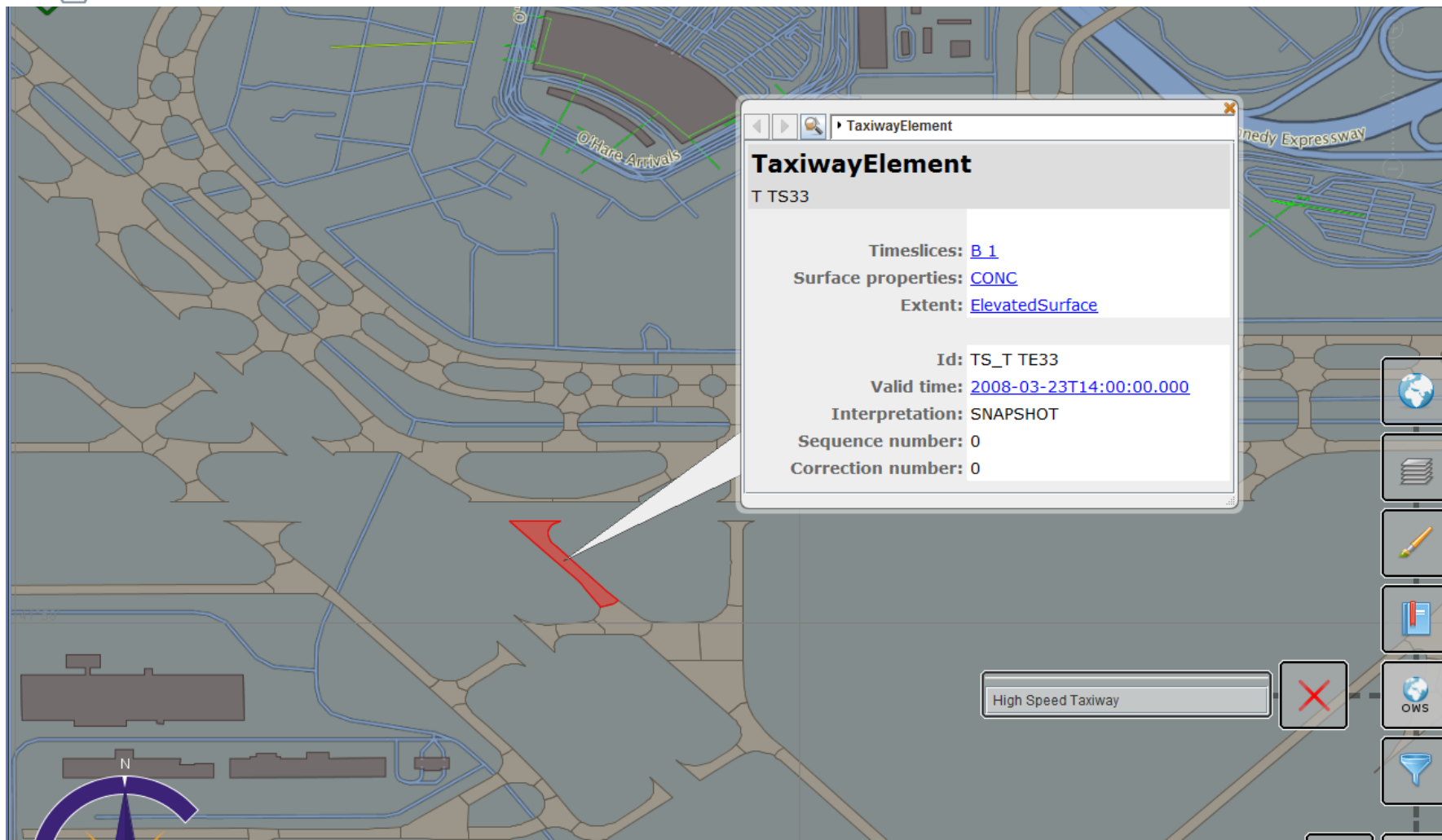
Search Interface

Testbed 10

- Linking
- Point conflation
- Core Ontology

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Gazetteer Linking Concept

NGA Data (UFI) → NGA – GeoNames Link (UFI/GeoNamesID) → GeoNames Data GeoNamesID *Attribute/Spatial Information*

Dbpedia – GeoNames sameAs ← DBpedia

ATTRIBUTE

GeoNames - OSM sameAs → OpenStreetMap Point OSM Node ID

GeoNames - OSM sameAs → OpenStreetMap Polygon OSM Relation ID

SPATIAL

NGA UFI	-569498
GeoNames ID	http://sws.geonames.org/6076211/
Dbpedia Link	http://live.dbpedia.org/page/Moncton
OSM Point	http://linkedgeodata.org/triplify/node204466183
OSM Boundary	http://linkedgeodata.org/page/triplify/relation1109568

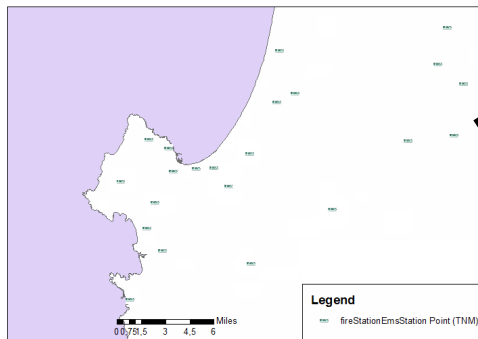— **Existing**
— **Need to Create**

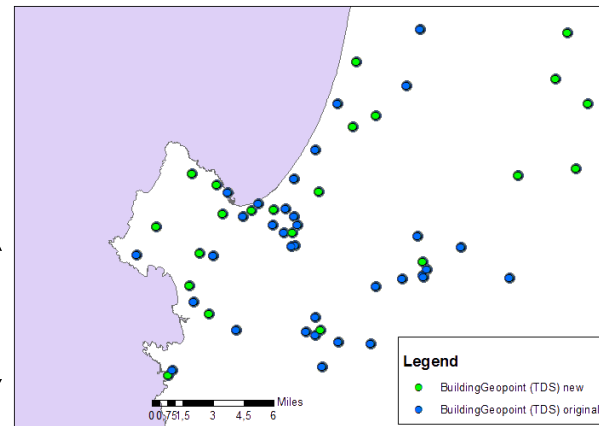# Point conflation in the Monterey area

Example scenario: Add all (non-duplicate) firestations from TNM to TDS
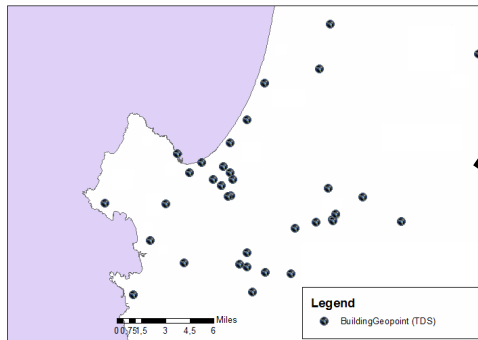
TDS

TNM

Attribute mappings (TNM->TDS)

address -> address
name->
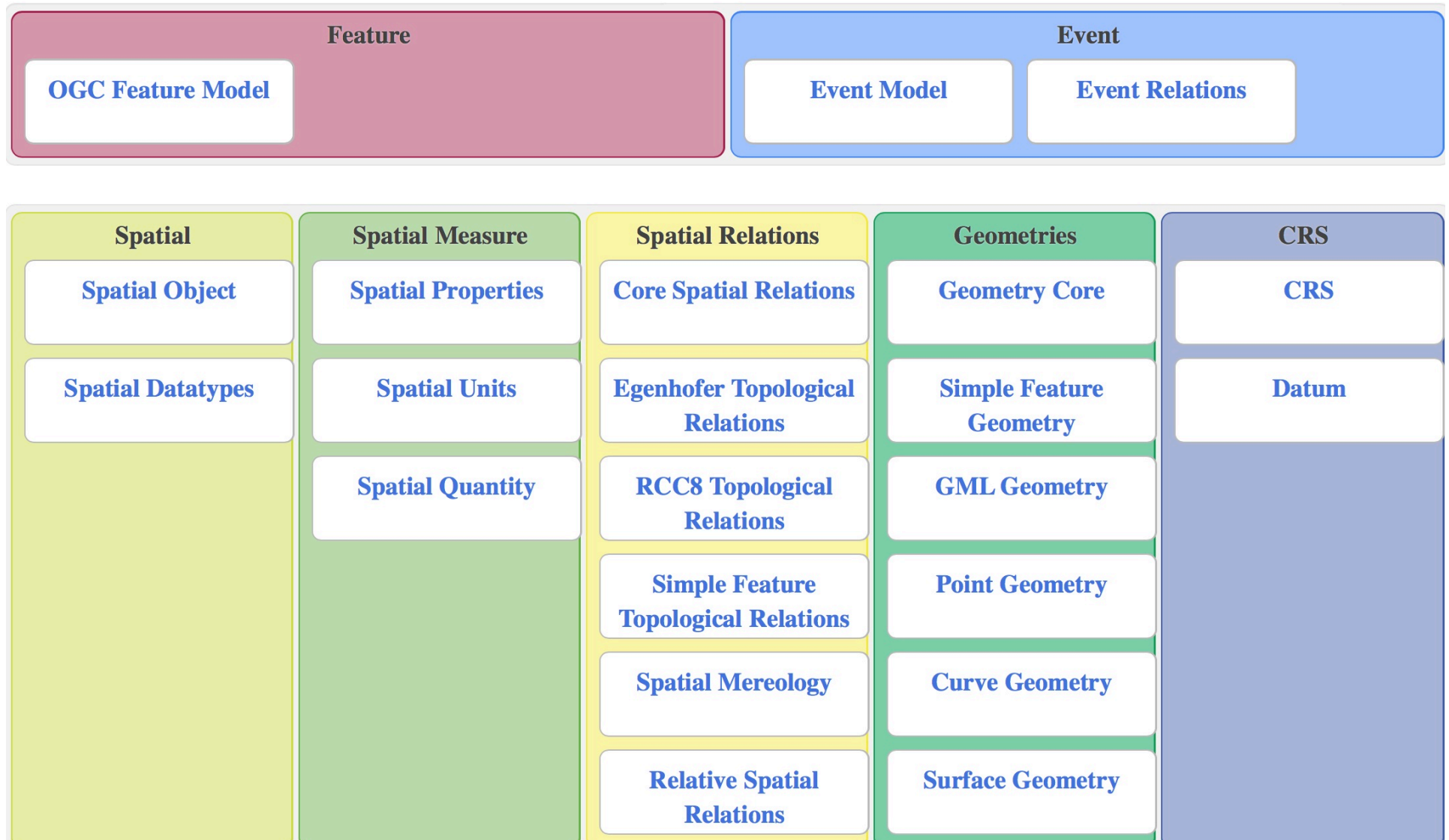geoNameCollection.memberGeoName.fullName

Fixed attribute value:
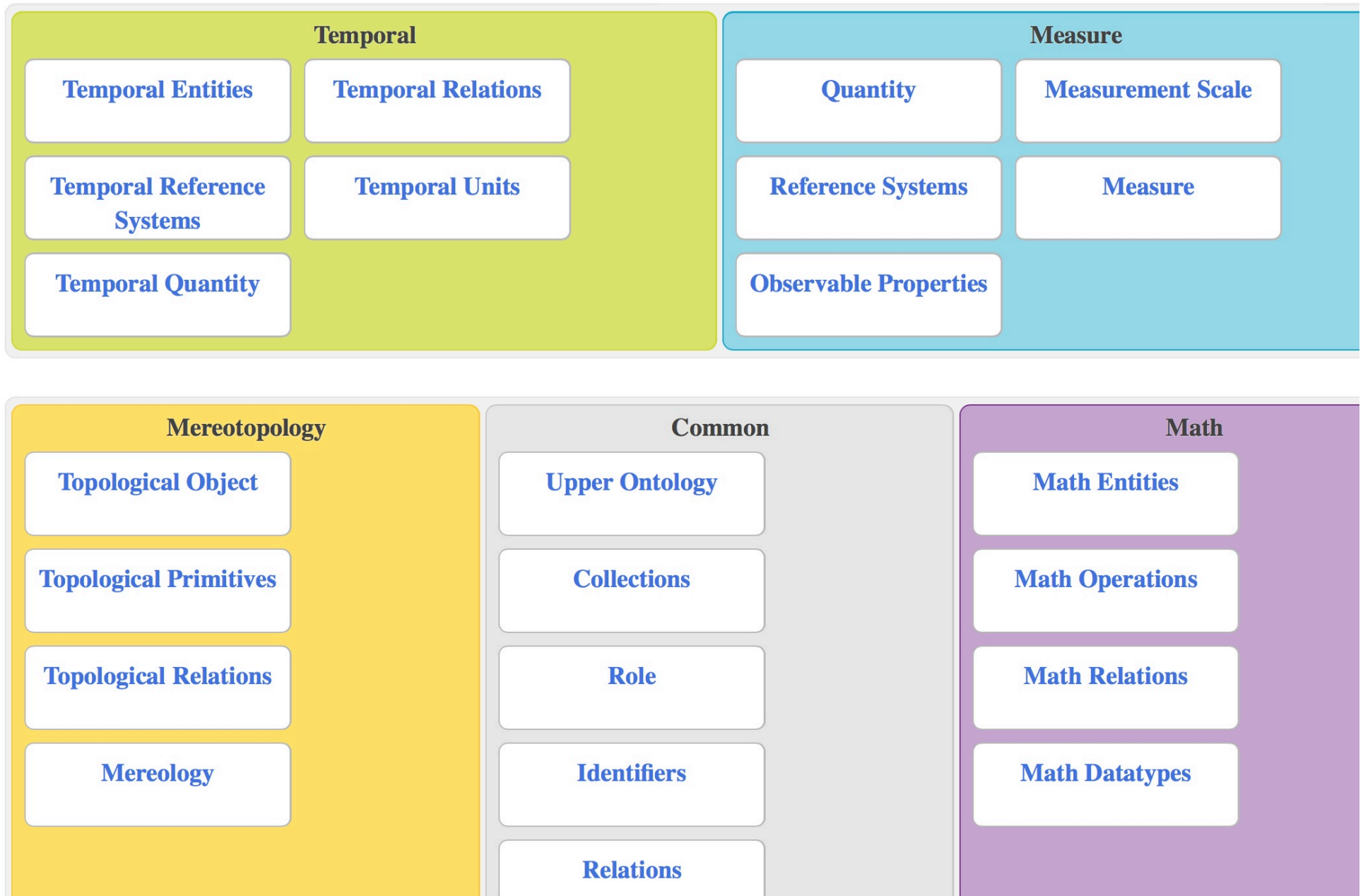featureFunction-1->"firefighting"
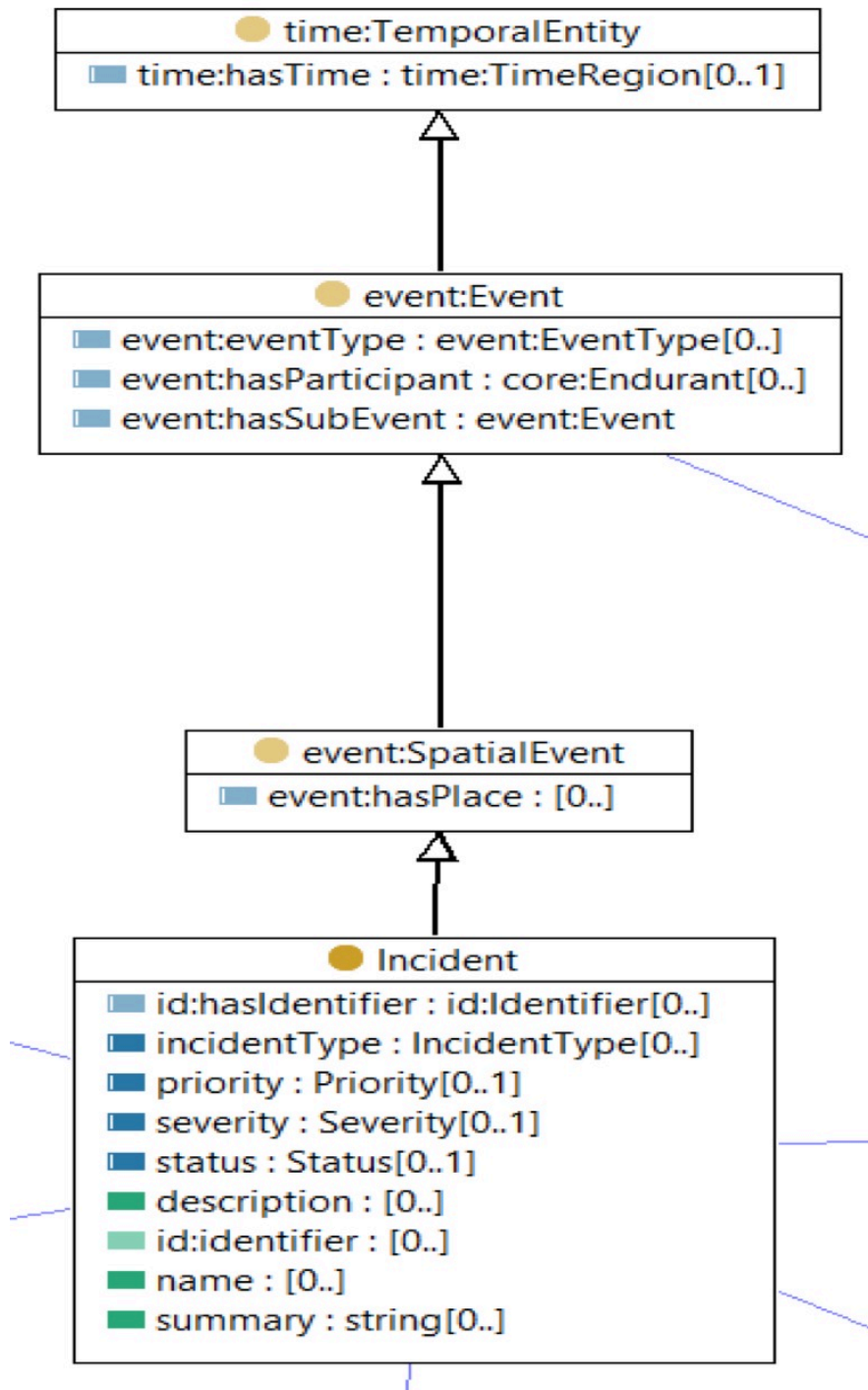
Testbed 10 - Geospatial Ontology

http://ows10.usersmarts.com/ows10/ontologies/
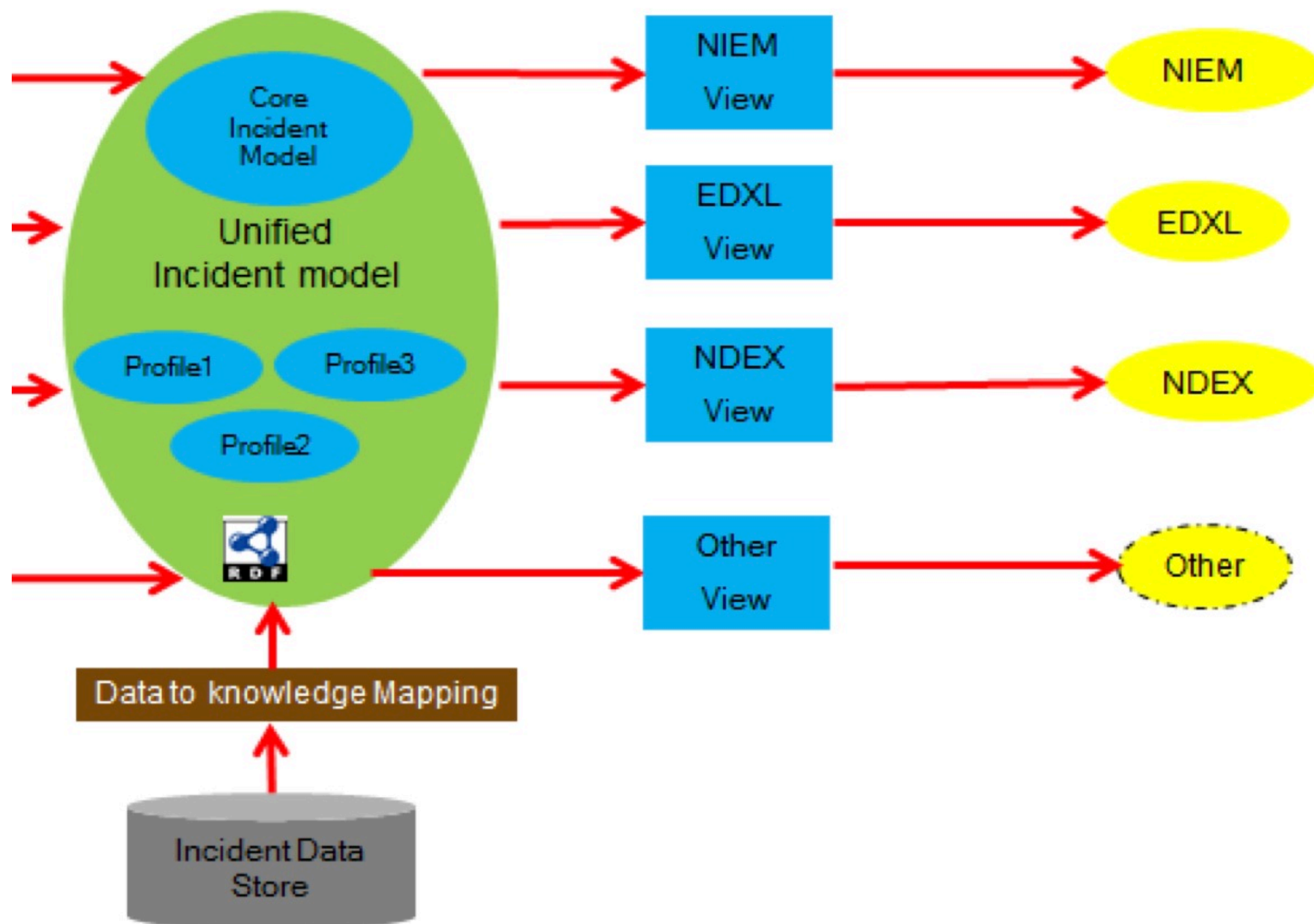
Feature

OGC Feature Model

Event

Event Model

Event Relations

Spatial

Spatial Object

Spatial Datatypes

Spatial Measure

Spatial Properties

Spatial Units

Spatial Quantity

Spatial Relations

Core Spatial Relations

Egenhofer Topological Relations

RCC8 Topological Relations

Simple Feature Topological Relations

Spatial Mereology

Relative Spatial Relations

Geometries

Geometry Core

Simple Feature Geometry

GML Geometry

Point Geometry

Curve Geometry

Surface Geometry

CRS

CRS

Datum

Testbed 10 - Geospatial Ontology

Temporal

- Temporal Entities
- Temporal Relations
- Temporal Reference Systems
- Temporal Units
- Temporal Quantity

Measure

- Quantity
- Measurement Scale
- Reference Systems
- Measure
- Observable Properties

Mereotopology

- Topological Object
- Topological Primitives
- Topological Relations
- Mereology

Common

- Upper Ontology
- Collections
- Role
- Identifiers
- Relations

Math

- Math Entities
- Math Operations
- Math Relations
- Math Datatypes

Ontology Example

time:TemporalEntity
- time:hasTime : time:TimeRegion[0..1]

event:Event
- event:eventType : event:EventType[0..]
- event:hasParticipant : core:Endurant[0..]
- event:hasSubEvent : event:Event

event:SpatialEvent
- event:hasPlace : [0..]

Incident
- id:hasIdentifier : id:Identifier[0..]
- incidentType : IncidentType[0..]
- priority : Priority[0..1]
- severity : Severity[0..1]
- status : Status[0..1]
- description : [0..]
- id:identifier : [0..]
- name : [0..]
- summary : string[0..]

Testbed 11

- Linking
- Symbology mediation
- Semantics of Business Vocabulary and Rules

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Linking with the National Map

Geographic names refer to hydrographic features

Hydrographic features follow the land elevation

Land Cover
Structures
Boundaries
Hydrography
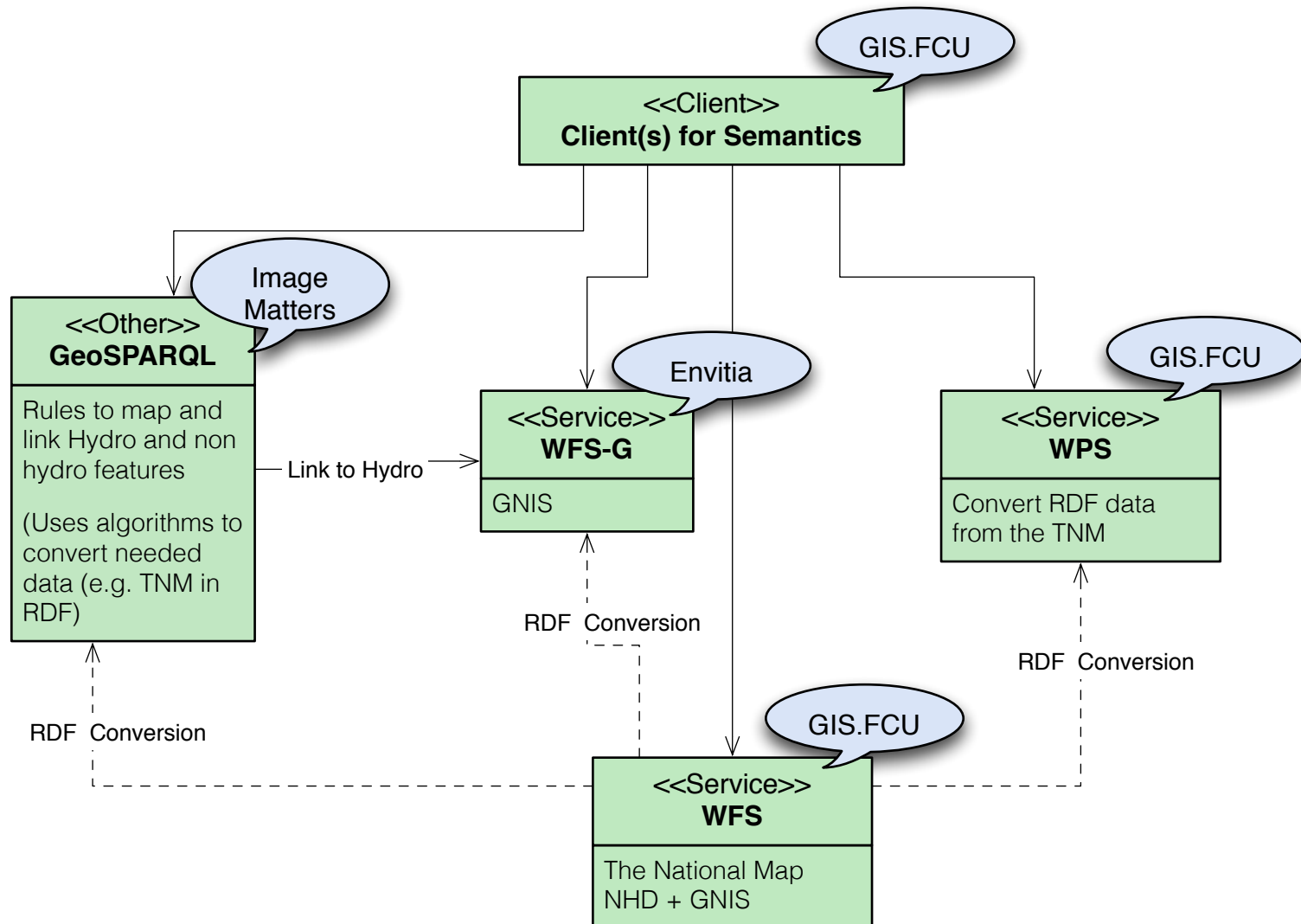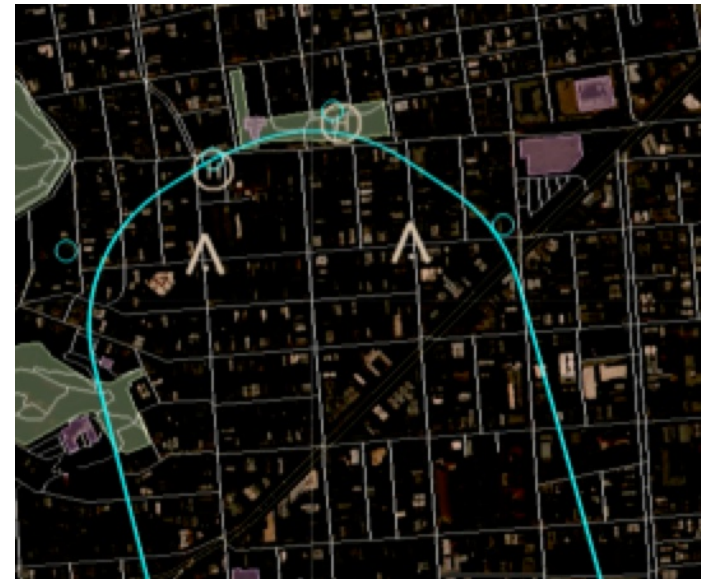Geographic Names
Transportation
Elevation
Orthoimagery
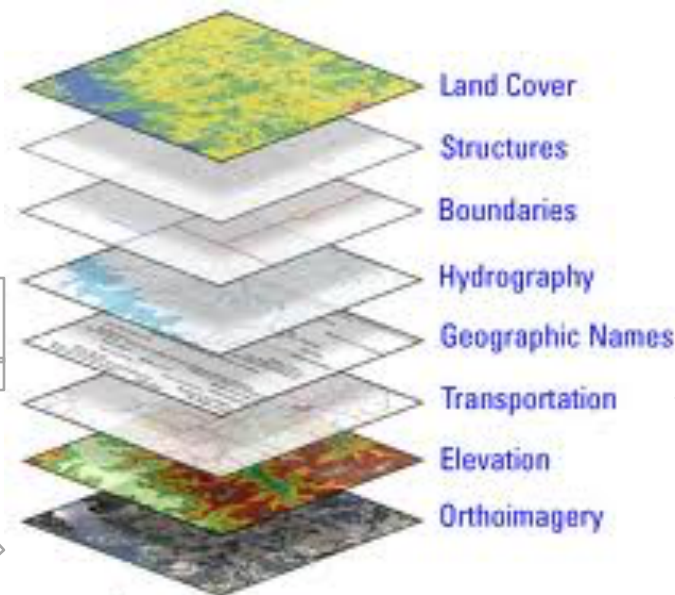
The National Map

Stream gauges and water sampling refer to hydrographic features
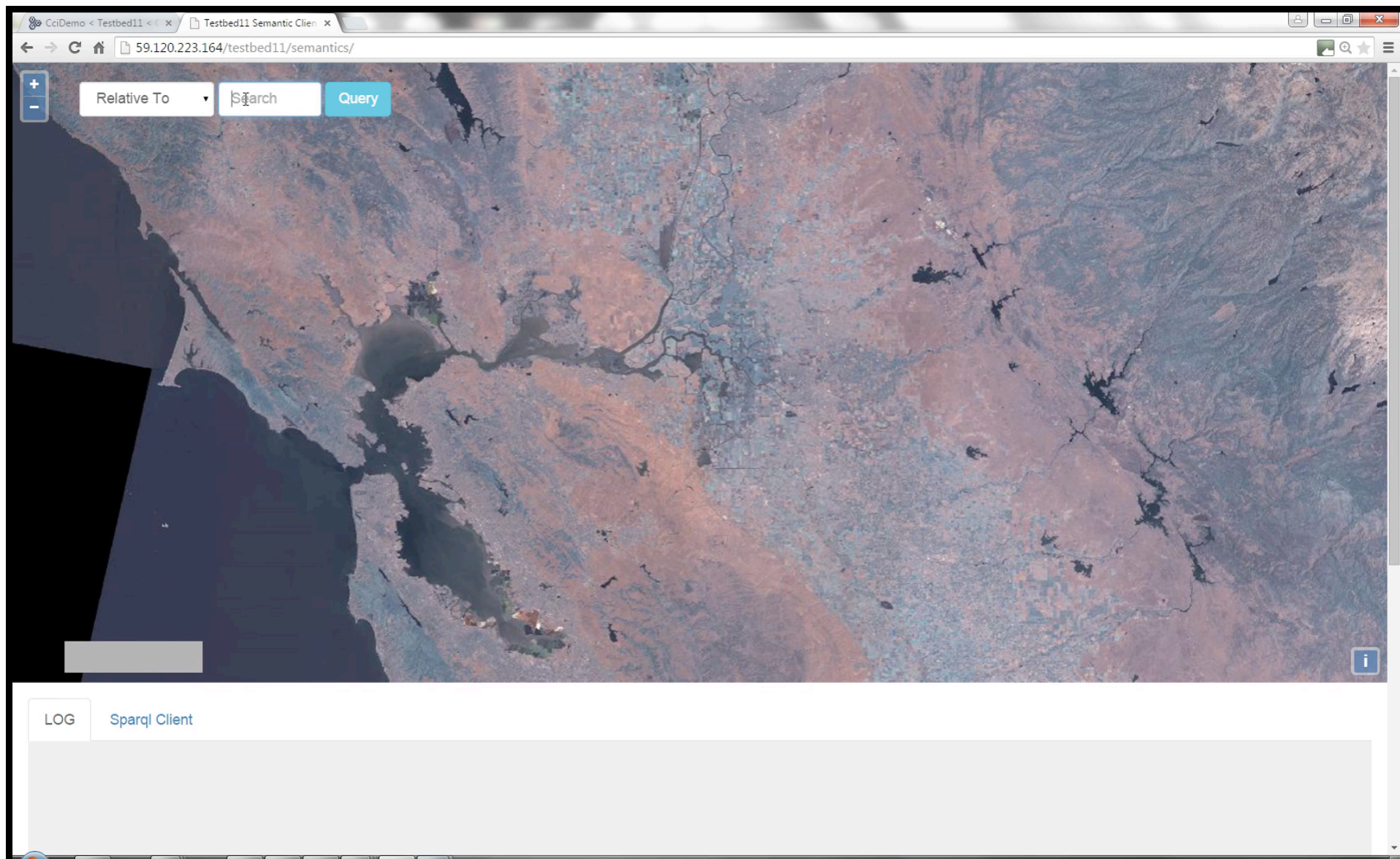
Overview of Components:TNM Hydro & Names

GIS.FCU

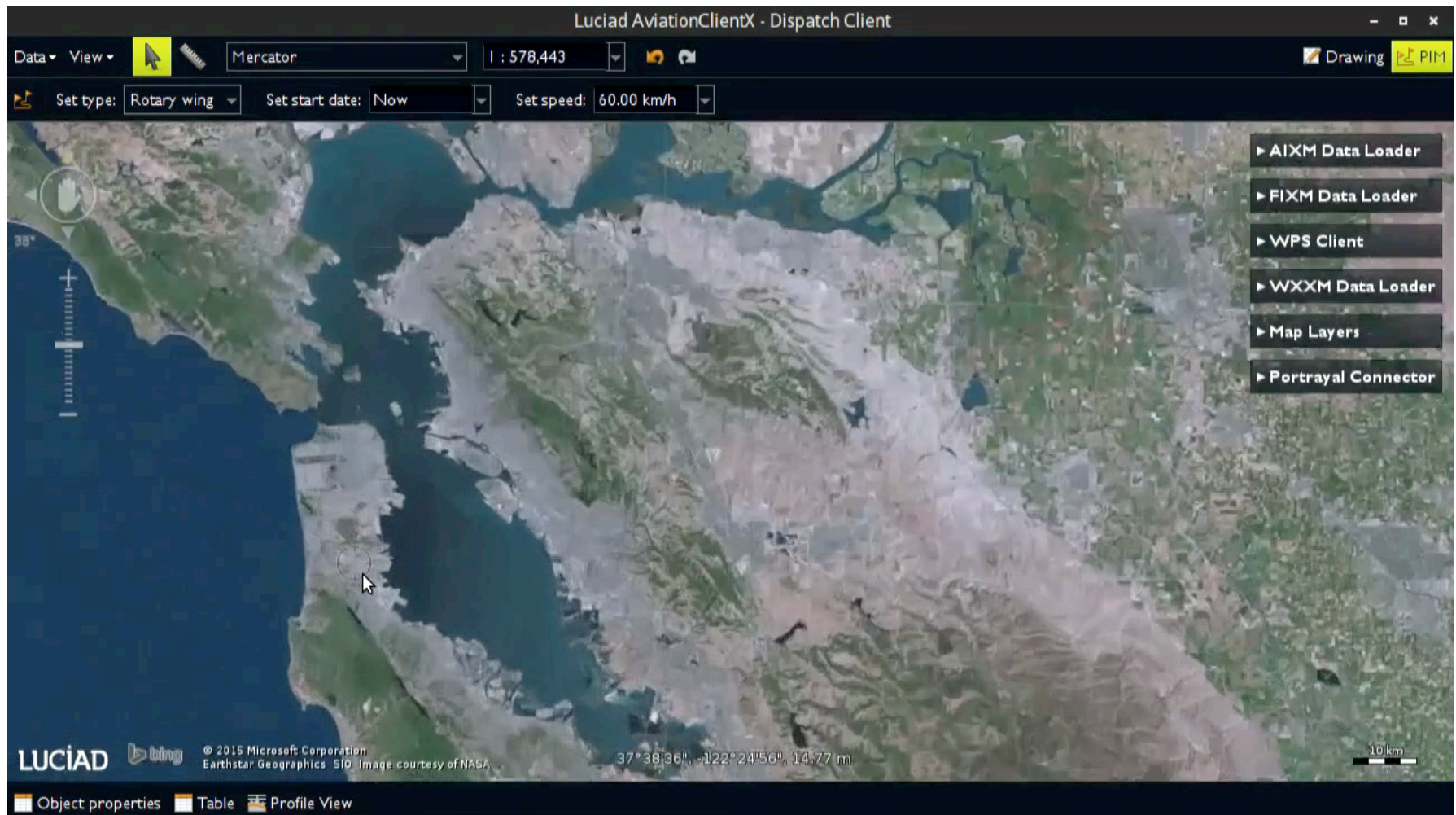**<<Client>>**
Client(s) for Semantics

Image Matters

<<Other>>
GeoSPARQL

Rules to map and link Hydro and non hydro features

(Uses algorithms to convert needed data (e.g. TNM in RDF)

Link to Hydro

Envitia

<<Service>>
WFS-G

GNIS

GIS.FCU

<<Service>>
WPS

Convert RDF data from the TNM

RDF Conversion

RDF Conversion

RDF Conversion

GIS.FCU

<<Service>>
WFS

The National Map NHD + GNIS

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Testbed 11 - Symbology Mediation

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Styled Layer Descriptor / Symbology Encoding

Aviation Client

GeoSPARQL Ontology Service

SLD/SE Producer

AIXM Web Feature Service
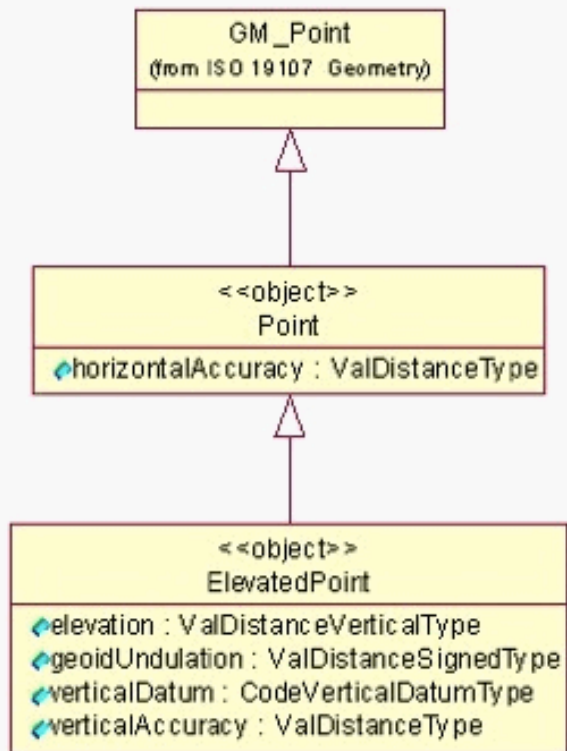
Data Broker

Feature Portrayal Service (FPS)

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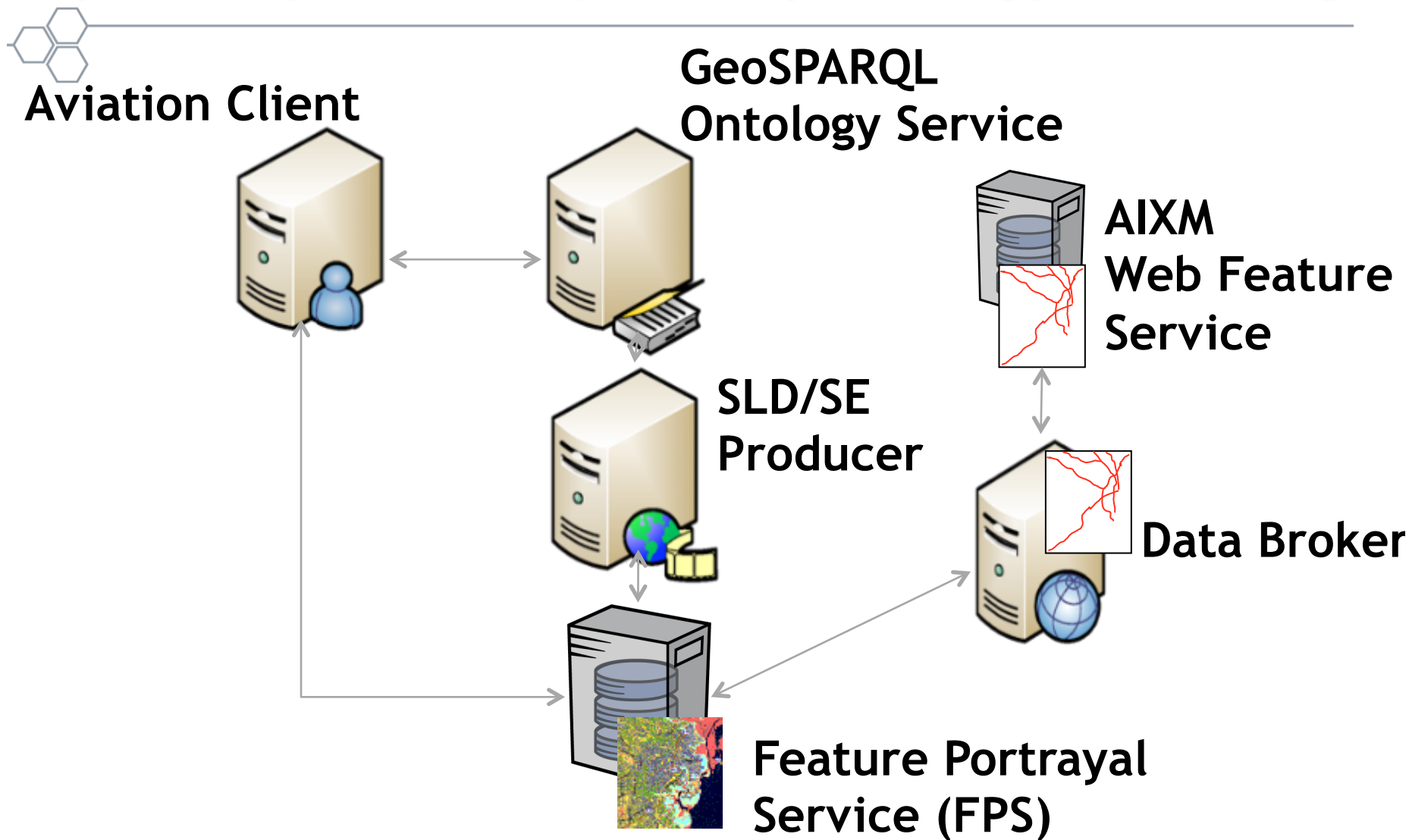
Aviation Symbology Demo

Community models

Application Schemas created extending classes via UML

How can we express (model) and validate this?

ICAO Annex 11: "*If a control zone is located within the lateral limits of a control area, it shall extend upwards from the surface of the earth to at least the lower limit of the control area.*"

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Semantics of Business Vocabulary and Rules (SBVR)

ICAO Annex 11: "*If a control zone is located within the lateral limits of a control area, it shall extend upwards from the surface of the earth to at least the lower limit of the control area.*"

SBVR Text:

NounConcept VerbConcept Name Keyword Other   **B** *I* U A▾ ab▾

Each **Airspace**.type equal to 'CTR' or 'CTR_P' *must have* at least one **AirspaceGeometryComponent**.**AirspaceVolume**.lowerLimit equal to '0' and one **AirspaceGeometryComponent**.**AirspaceVolume**.lowerLimitReference equal to 'SFC'

… and the validation?

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# Solution: SBVR to Schematron

Automatic

Schematron

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Linking Data recommendations from Testbed11

- Registry for managing **unique identifiers** for Linked Data
- Application of URI **aliases** (owl:sameAs)
- **Advertise** future NHD Linked Data Products in Semantic Web Search Engines
- Establish a standard for a GeoSPARQL **Server**

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Web Services Architecture Pattern

Client

Web Feature Service

Web X Service

SPARQL Server

NEW

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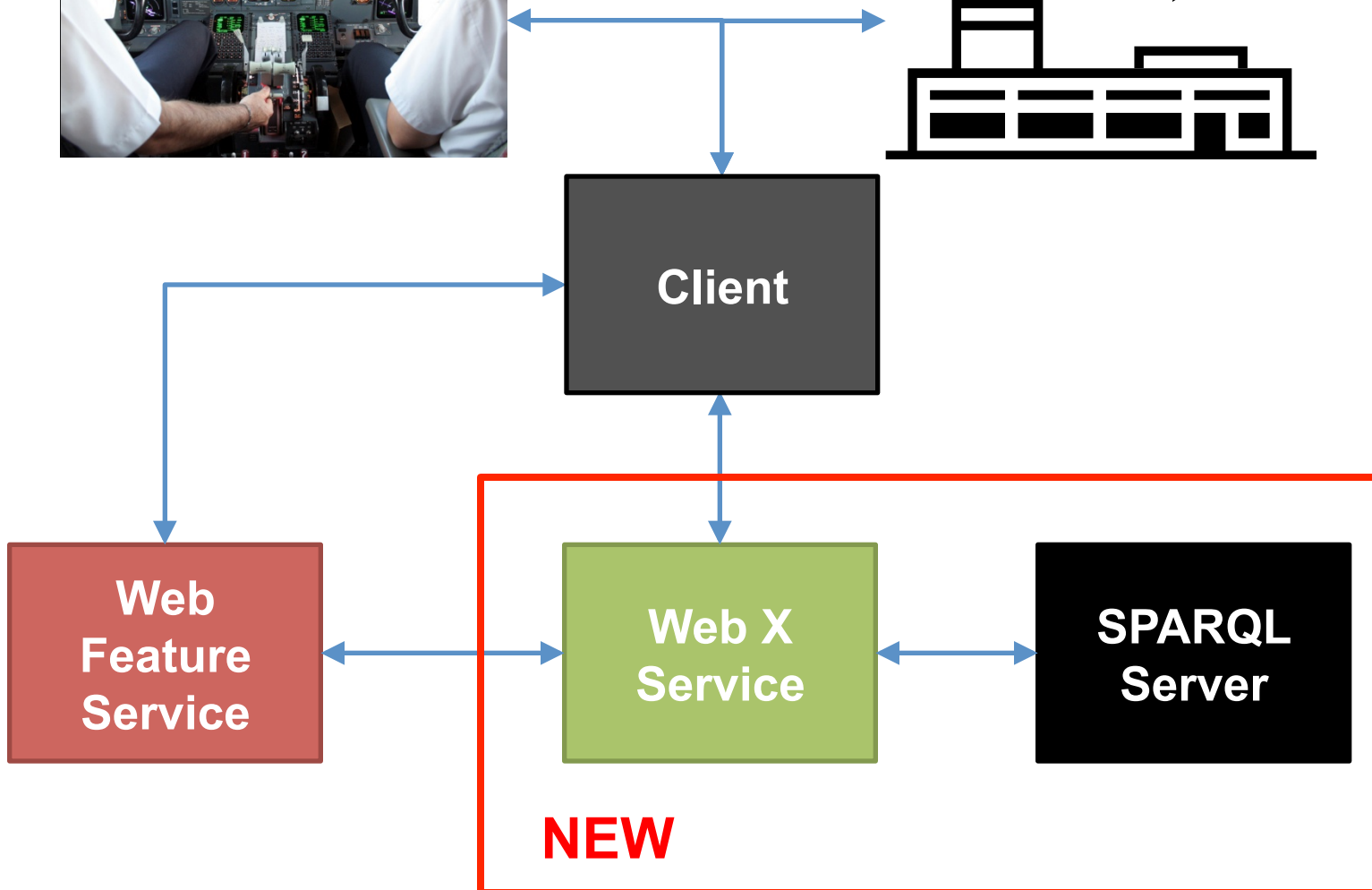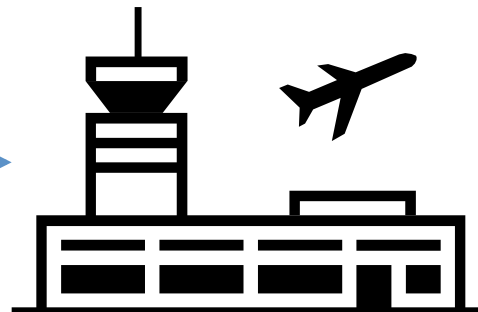
Testbed 12 – ideas for future work

- Standard Server for GeoSPARQL
- Advance use of LinkedData for conflation (trust and provenance)
- Restful architectures and discovery patterns using OGC services and models
- UML semantic modeling (mapping)

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Questions?

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- Charles Chen – charles.chen@skymantics.com

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