# Enabling Information Sharing thru Common Services

## Distribution of WXXM data in the NAS using OGC data access services

Presented To: Services Session

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Date:     August 31, 2011

**Federal Aviation Administration**

**EUROCONTROL**

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

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

# Introduction

- ## This talk covers

  - High-level architecture concepts for distribution of weather data in the NAS, based on R&D conducted by the NNEW and SWIM programs

  - Exercising the architecture concepts using an OGC Web Feature Service (WFS) to disseminate WXXM data

# Agenda

- Architectural Background

- Distribution of WXXM data using the NNEW Web Feature Service Reference Implementation (WFSRI)
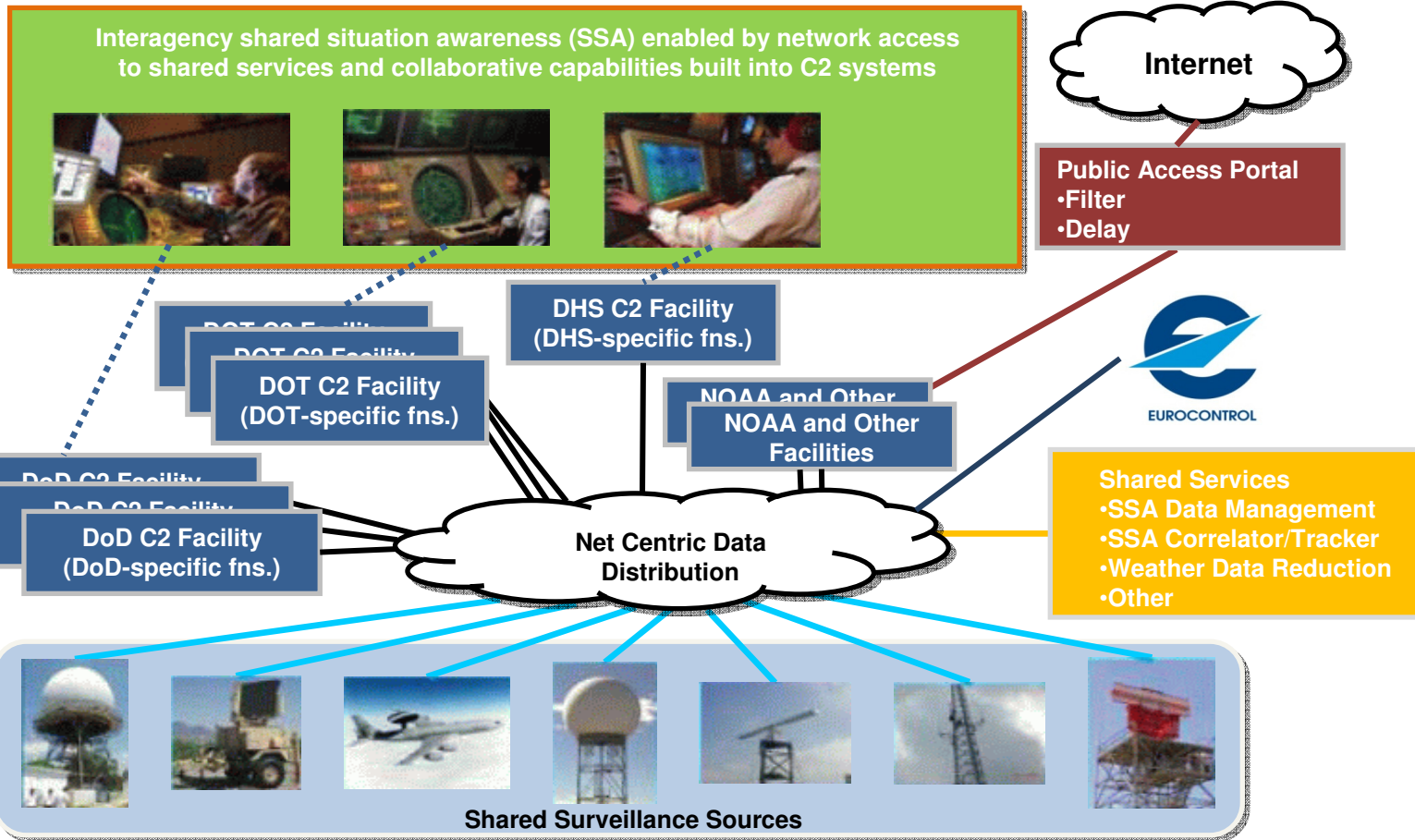
- Summary

# JPDO Integrated Surveillance Concept of Operations

Interagency shared situation awareness (SSA) enabled by network access to shared services and collaborative capabilities built into C2 systems

Internet

Public Access Portal
•Filter
•Delay

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DHS C2 Facility
(DHS-specific fns.)

DOT C2 Facility
DOT C2 Facility
DOT C2 Facility
(DOT-specific fns.)

NOAA and Other
NOAA and Other
Facilities

DoD C2 Facility
DoD C2 Facility
DoD C2 Facility
(DoD-specific fns.)

Net Centric Data Distribution

Shared Services
•SSA Data Management
•SSA Correlator/Tracker
•Weather Data Reduction
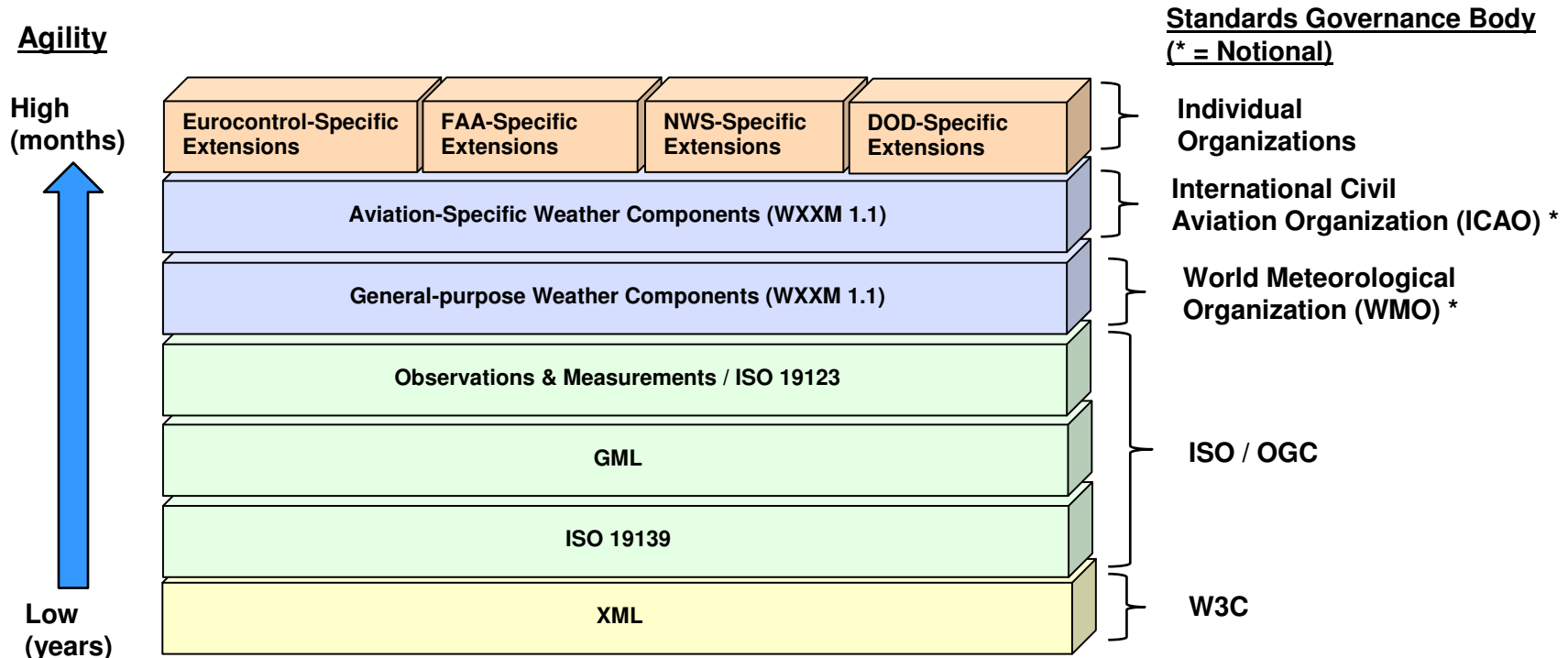•Other

Shared Surveillance Sources

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# Interoperability via WXXM
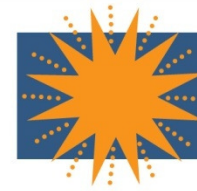
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**WXXM 1.1 Data Model (Collaborative effort among _Eurocontrol, FAA, NWS, DoD, NOAA_)**

Agility

Standards Governance Body
(* = Notional)

High
(months)

| | | | | |
|---|---|---|---|---|
| Eurocontrol-Specific Extensions | FAA-Specific Extensions | NWS-Specific Extensions | DOD-Specific Extensions | Individual Organizations |

Aviation-Specific Weather Components (WXXM 1.1) — International Civil Aviation Organization (ICAO) *

General-purpose Weather Components (WXXM 1.1) — World Meteorological Organization (WMO) *

Observations & Measurements / ISO 19123

GML — ISO / OGC

ISO 19139

XML — W3C

Low
(years)

- **Composable, extensible data model balances standardization with the need for individual communities to innovate over time**
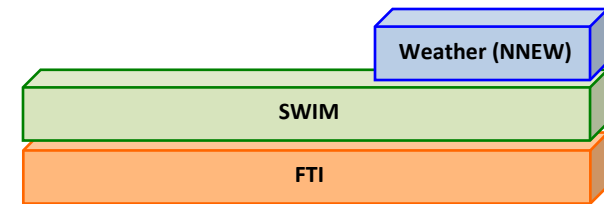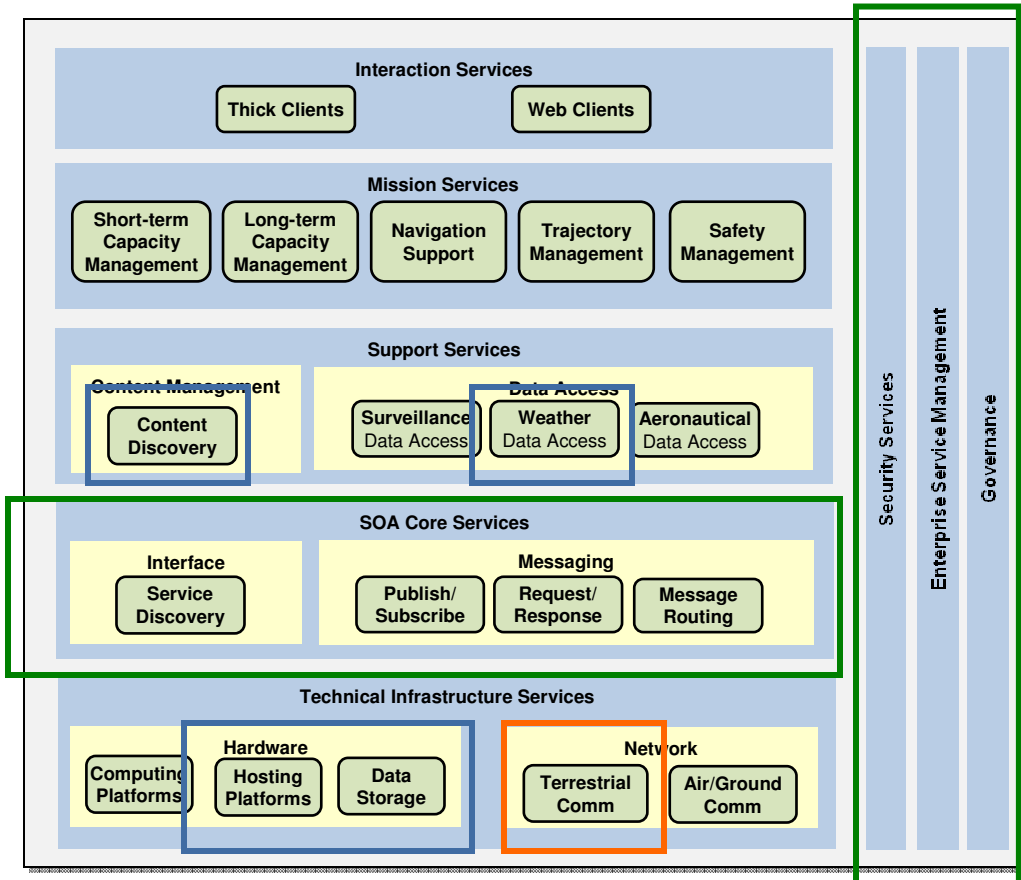- **_What is the vision for distributing this data within the NAS?_**

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# NextGen Standards and Programs 'Stack'

# Key Challenge – Efficient use of Network Bandwidth
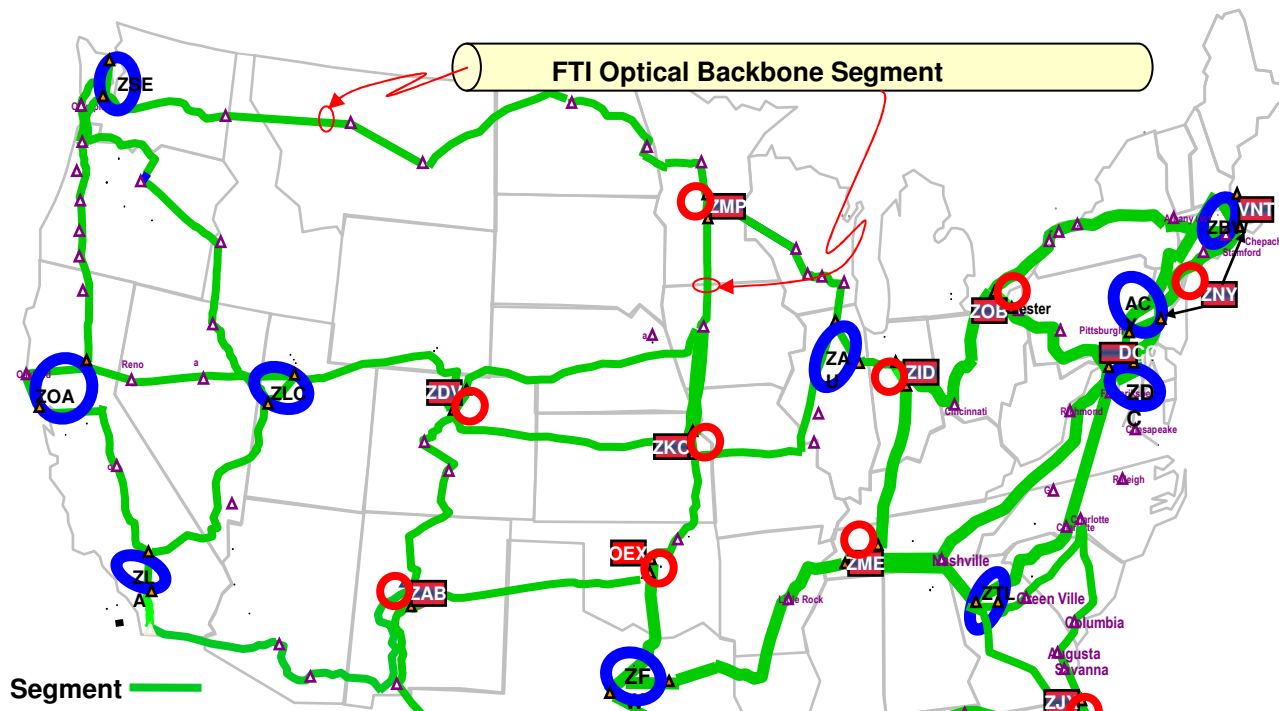


- Weather data can be large in size when compared with typical surveillance data
- 1000's of users – many getting the same or similar data
- FTI not (currently) encouraging use of multicast protocols at network layer due to management complexity
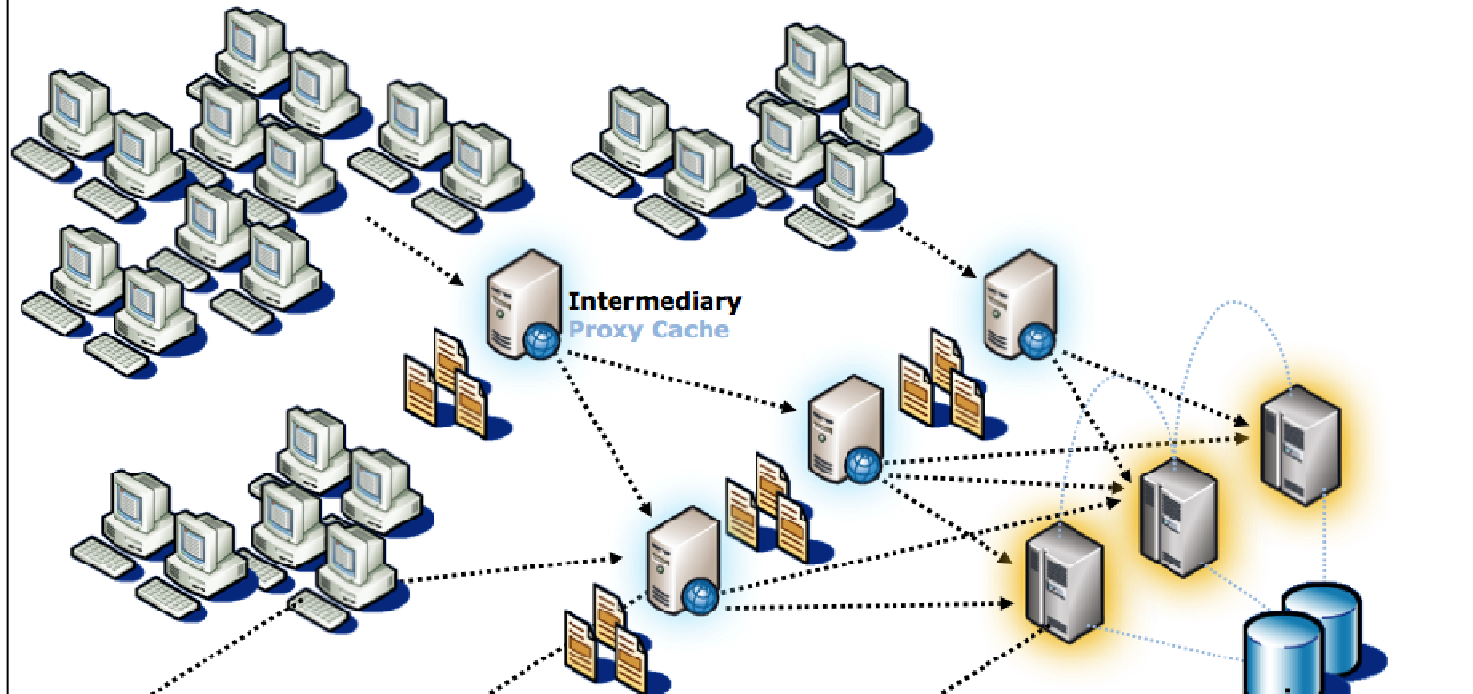
# It's Not a Brand-New Problem…

## Scalable Web Caching Architecture



Intermediary Proxy Cache

- **To this concept, we would like to add:**
  - Spatial filtering operations relevant to aviation weather
  - Support for publish/subscribe message exchanges
  - *Common interface semantics for real-time and archived data*
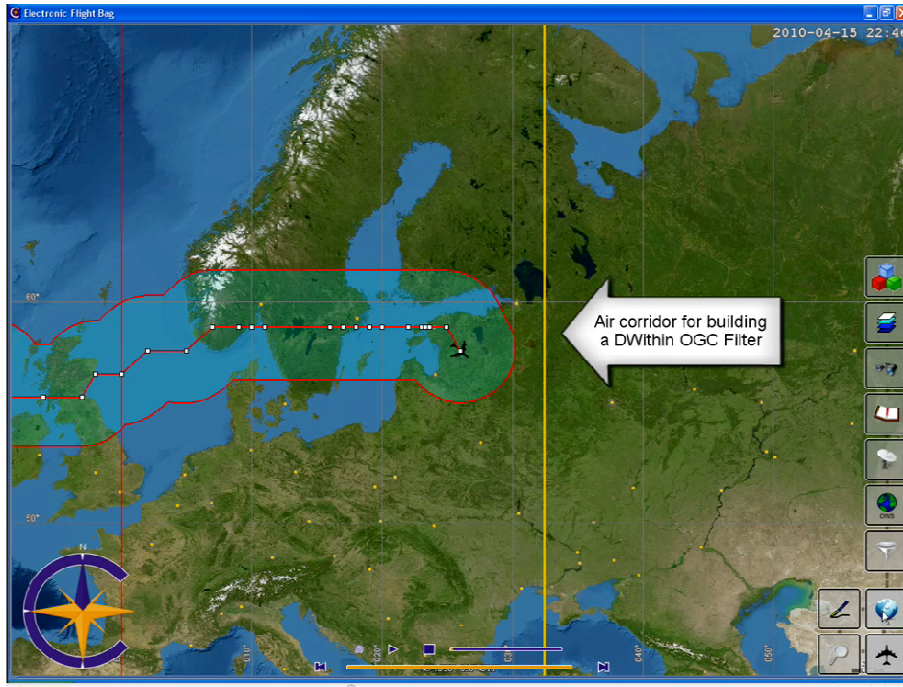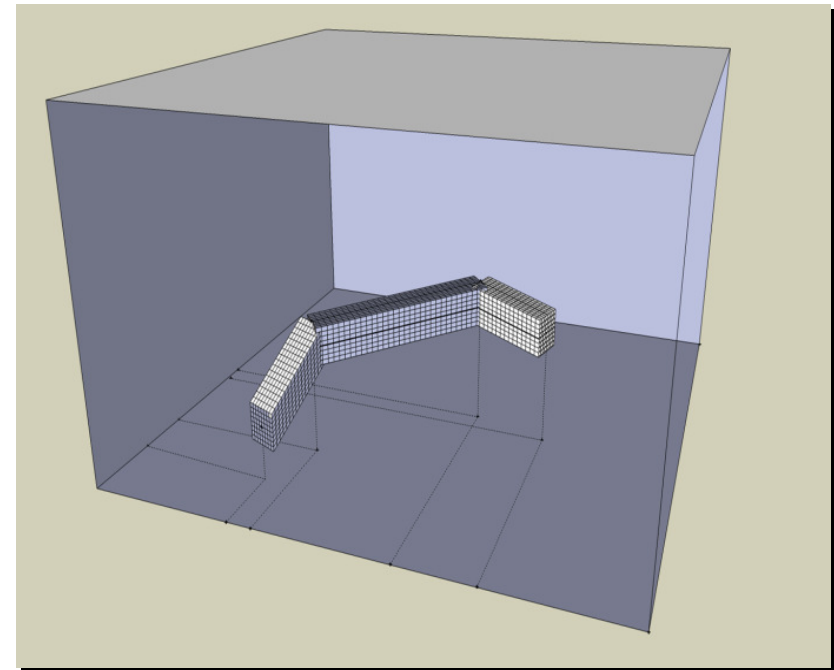
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# OGC Data Access Services



**International standards for access to data of all types using spatial/temporal queries**
• Web Coverage Service – Gridded data access
• Web Feature Service – Non-gridded data access



2 spatial dimensions + time



3 spatial dimensions + time  (4-D Cube)

- **OGC data access services not historically focused on continuous real-time data delivery**
- **NNEW is extending WCS/WFS to include publish/subscribe capability**
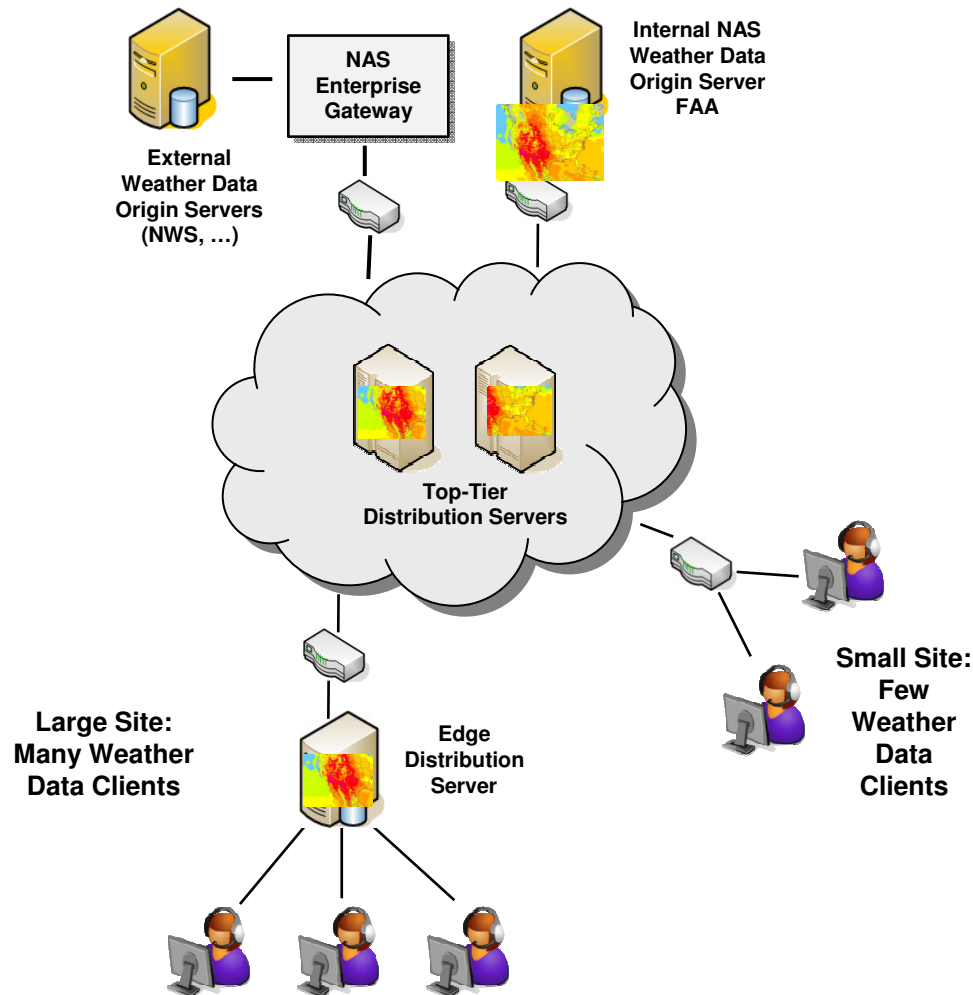  - **Goal is to standardize the extensions within OGC (Pub/Sub Working Group)**

# Service-Oriented Weather Content Delivery Network



- **Content Delivery Network (CDN) for Weather Data**
  - *Origin Servers*
  - *Distribution Servers*
  - *Common Interfaces at all Server Tiers (OGC WFS, WCS, WMS)*
  - *Leverages and extends SWIM-compliant Pub/Sub Messaging*

- **Top-Tier distribution servers isolate origin servers from demands of multiple distributed clients**

- **Edge distribution servers isolate network and top-tier servers from demands of *many* clients at a single location (e.g., large TRACON facility)**

- **Actual deployed distribution server topology can grow or shrink over time based on changing user demand and underlying network capability**

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# Roles of the NNEW Service Reference Implementations

- Proof-of-concept platform used to exercise the core OGC specifications and extensions against NNEW requirements

- Build on top of the SWIM software stack - provide lesson's learned

- Technology transfer from R&D to NNEW implementation phase (Government Furnished Information)

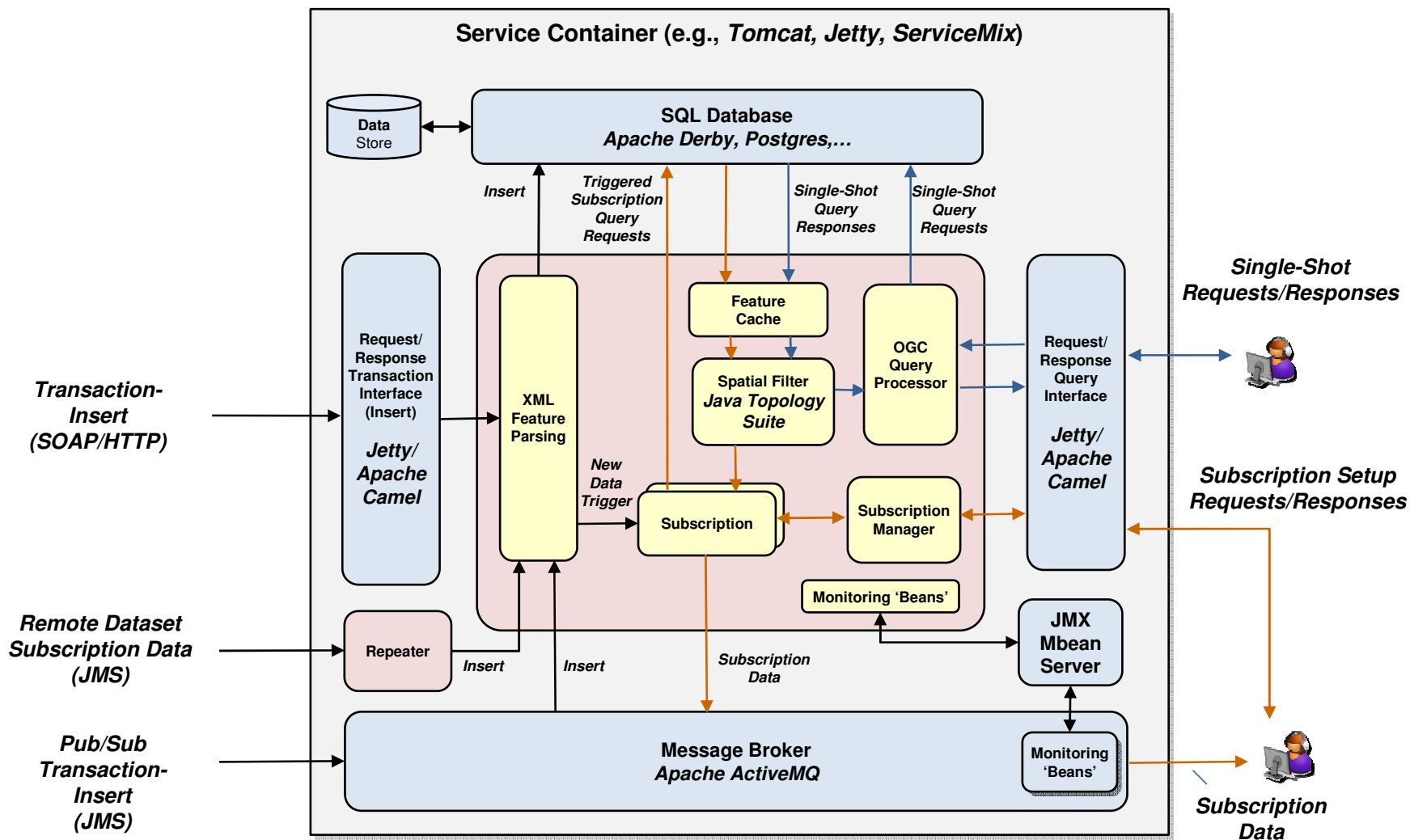# WFSRI Block Diagram

# WFSRI Installation Verification/ Performance Measurement



Sample program capable of simulating a variety of products at a number of different spatial densities

**SamplePublisher**

Simulator

Sample Core

(Cmd-Line Interface & I/O)

Test Files

Transaction-Insert (SOAP)

Transaction-Insert (JMS)

**Web Feature Service Reference Implementation**

WFSRI Core

Message Broker

GetFeature (SOAP)

Subscription Control/Setup (SOAP)

Subscribe (JMS)

**SampleReqReply**

Sample Core

**SampleSubscriber**

Sample Core
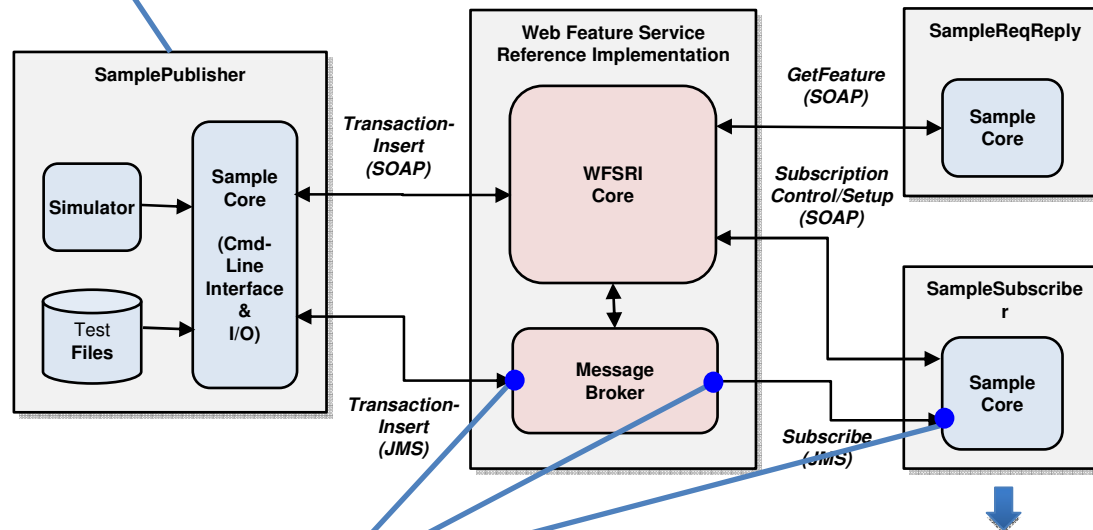
- Data flow instrumented to enabled creation of timing trace at end receiver
- HTTP, JMS headers used (similar to HTTP 'Via' header in principle)

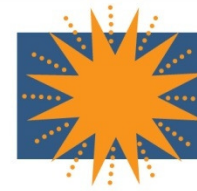| Hostname | AppName | After | Timestamp(ms) | DeltaTime |
|---|---|---|---|---|
| sampson.local | WFS | Recv | 1314164845047 | |
| localhost | WFS | Proc | 1314164845455 | ( 408 ms ) |
| localhost | WFS | Zip | 1314164845469 | ( 14 ms ) |
| sampson.local | WFSClientApp | Recv | 1314164845471 | ( 2 ms ) |
| sampson.local | WFSClientApp | Unzip | 1314164845481 | ( 10 ms ) |

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# Simulated Storm Contours (Dense Scenario – NW Filter)
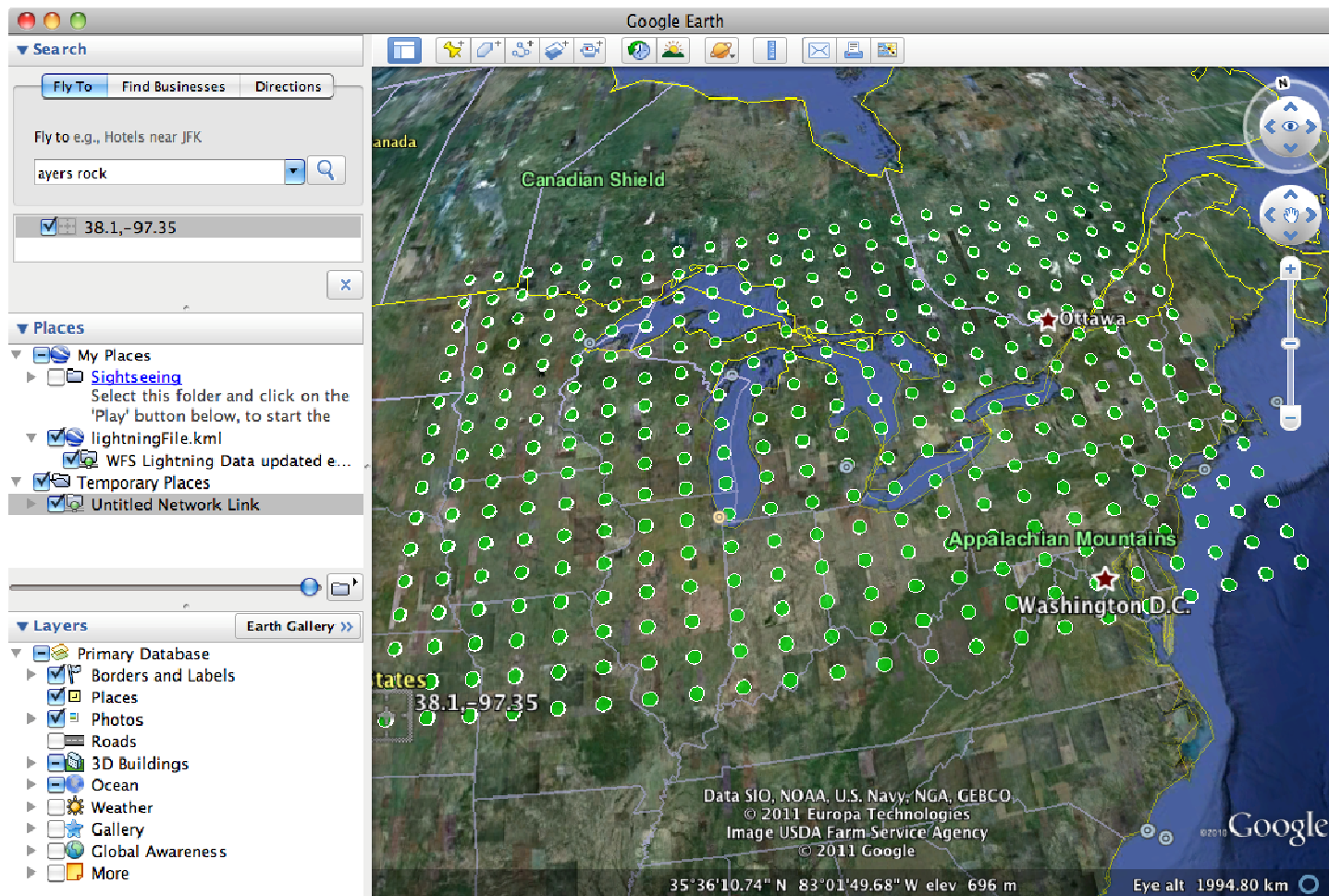
# WFSRI Installation Verification/ Performance Measurement

| Product | Feature Count | XML Size (raw/compressed MB)) | Avg Latency (sec) | Min Latency | Max Latency |
|---|---|---|---|---|---|
| Standard VIL Forecast Contours | 1200 | 1.82/0.13 MB | 0.44 sec | 0.36 | 0.54 |
| Winter VIL Forecast Contours | 4800 | 7.02/0.57 MB | 2.10 sec | 1.60 | 2.50 |
| Storm Motion Vectors | 1600 | 0.97/0.01 MB | 0.33 sec | 0.29 | 0.38 |
| Storm Leading Edges | 1200 | 1.30/0.067 MB | 0.34 sec | 0.29 | 0.36 |

- 'Dense' simulation exceeds feature count of CIWS worst-case weather day
- ~ 2 seconds per distribution node 'hop' for this loading is not considered problematic (forecast data latency requirements are relaxed when compared to their wind-shear alert counterparts)
- Room for improvement remains via a number of optimizations

# WFS, WXXM, and AIXM

## Querying for weather in an Airspace Volume

- WFS issue: no generic GML '2.5-D' data types (2-D shapes plus vertical extent)
- AIXM provides the needed types

```
<AirspaceVolume>
 <upperLimit uom="m">5000</upperLimit>
 <upperLimitReference>STD</upperLimitReference>
 <lowerLimit uom="m">0</lowerLimit>
 <lowerLimitReference>MSL</lowerLimitReference>
 <horizontalProjection>
  <Surface gml:id="SURF">
   <gml:patches>
    <gml:PolygonPatch>
     <gml:exterior>
      <gml:LinearRing>
       <gml:posList dimension="2">
         40.450001 -93.900002
         40.525002 -93.491669
         (additional points....)
         40.450001 -93.900002
       </gml:posList>
      </gml:LinearRing>
     </gml:exterior>
    </gml:PolygonPatch>
   </gml:patches>
  </Surface>
 </horizontalProjection>
</AirspaceVolume>
```

## WFS AIXM Support Example

```
<wfs:WFS_Capabilities>
 ...
 <fes:Spatial_Capabilities>
  <fes:GeometryOperands>
   <fes:GeometryOperand name="gml:Point"/>
   <fes:GeometryOperand name="gml:Curve"/>
   <fes:GeometryOperand name="gml:Polygon"/>
   <fes:GeometryOperand name="gml:Envelope"/>
   <fes:GeometryOperand name="aixm:AirspaceVolume"/>
  </fes:GeometryOperands>
 <fes:SpatialOperators>
 ...
</wfs:WFS_Capabilities>
```

```
<wfs:GetFeature>
 <wfs:Query typeNames="avwx:PIREP">
  <fes:Filter>
   <fes:Within>
    <fes:ValueReference>GEOMETRY</fes:ValueReference>
    <aixm:AirspaceVolume>
     <aixm:upperLimit uom="m">5000</aixm:upperLimit>
     <aixm:upperLimitReference>STD</aixm:upperLimitReference>
     <aixm:lowerLimit uom="m">0</aixm:lowerLimit>
     <aixm:lowerLimitReference>MSL</aixm:lowerLimitReference>
     <horizontalProjection>
     <Surface gml:id="SURF">  …. (details omitted)</Surface>
    <aixm:AirspaceVolume>
   </fes:Within>
  </fes:Filter>
 </wfs:Query>
</wfs:GetFeature>
```
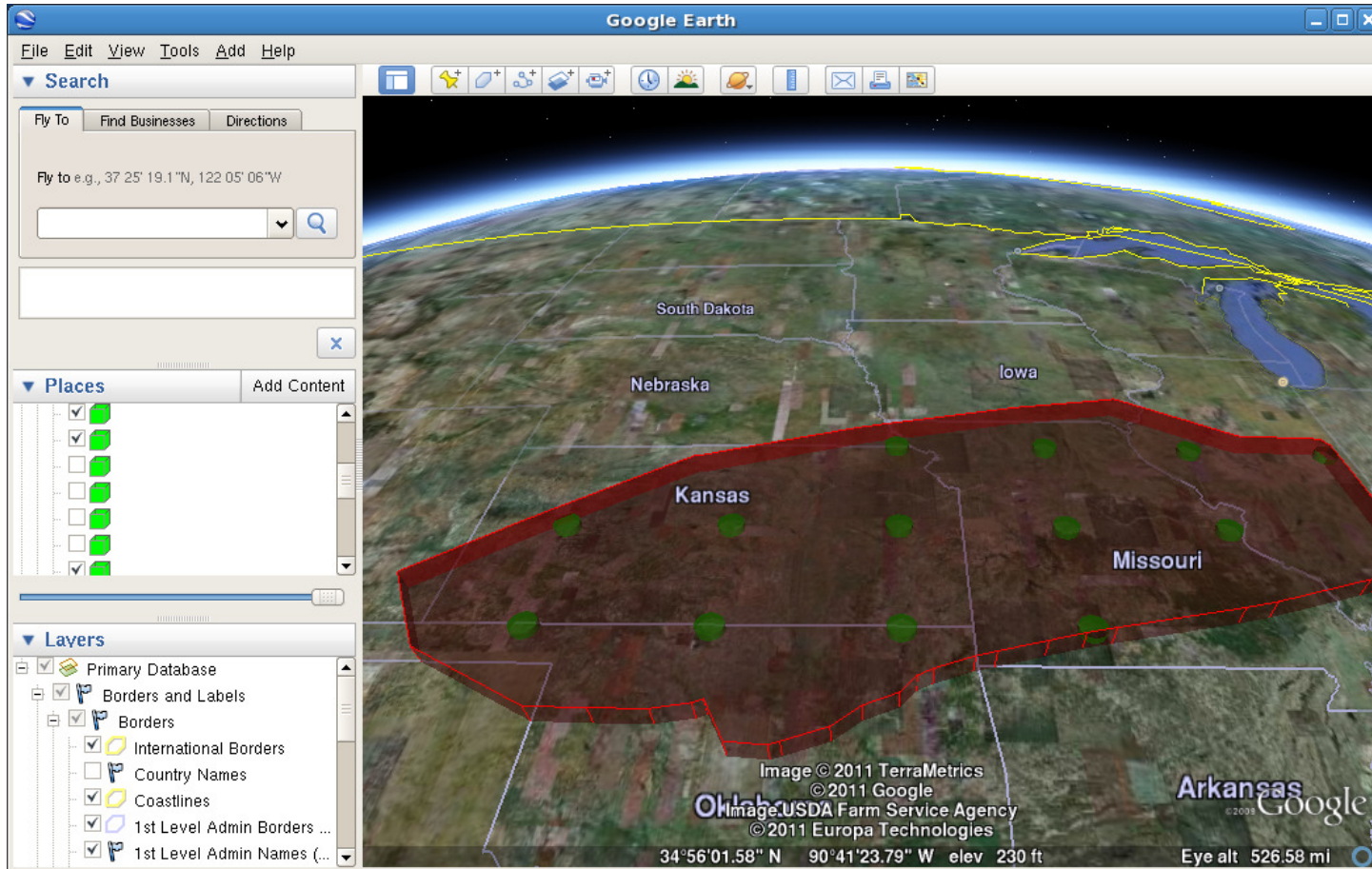
# WFS Weather Contour Query Filtered by AIXM <AirspaceVolume>

# FAA Tech Center R&D Enclave (Weather Domain Portion)
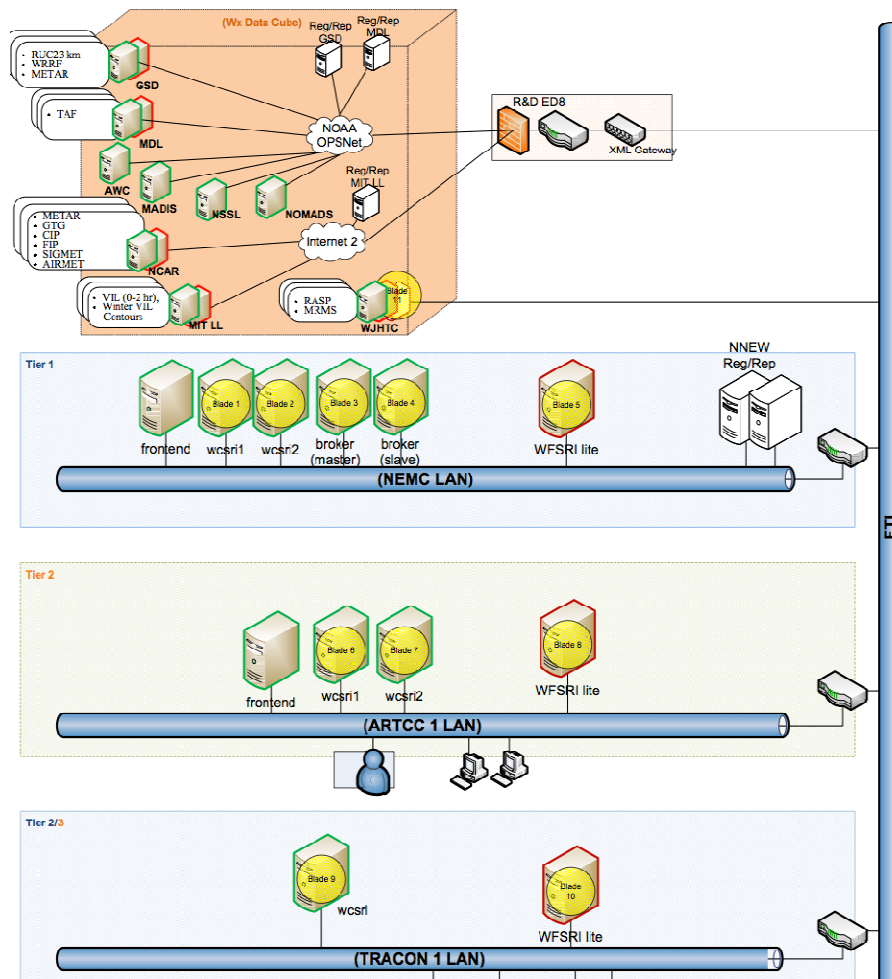
- •Data providers pass variety of weather data products via R&D NAS Enterprise Gateway (NESG)

- •Flexible environment - ability to simulate multiple data distribution tiers

- •Quality-of-Service (QoS) capable routers between tiers

- •WFS/WCS reference implementations currently being deployed and instrumented

- •Focus on performance, documentation of lessons learned

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# Summary

- FAA has a need to efficiently distribute WXXM data in the operational NAS environment

- The OGC WFS interface, augmented with pub/sub extensions and configured in a hub & spoke topology, can be used to help implement this vision

- NNEW WFS Reference Implementation being used to demonstrate feasibility of approach

# Questions & Answers / Feedback

# More Information / Contacts

- WFS/WCS Reference Implementations
  - https://wiki.ucar.edu/display/NNEWD/Reference+Implementations

- olivern@LL.mit.edu