

Enabling Information Sharing thru Common Services

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

Presented To: Services Session

Presented By: Oliver Newell

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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**

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



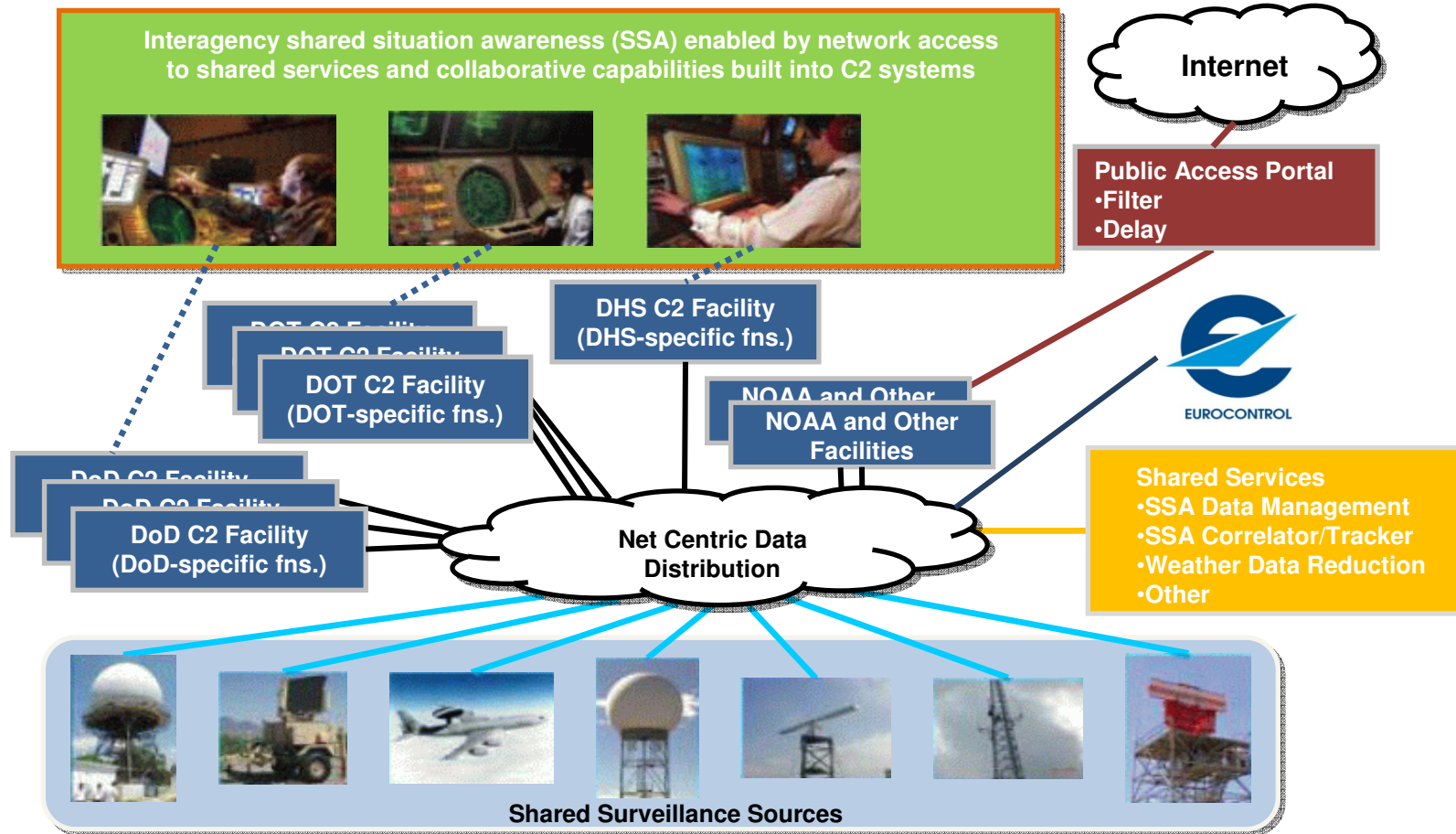
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- Architectural Background
- Distribution of WXXM data using the NNEW Web Feature Service Reference Implementation (WFSRI)
- Summary

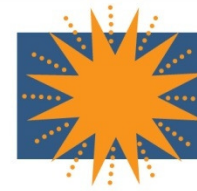
JPDO Integrated Surveillance Concept of Operations



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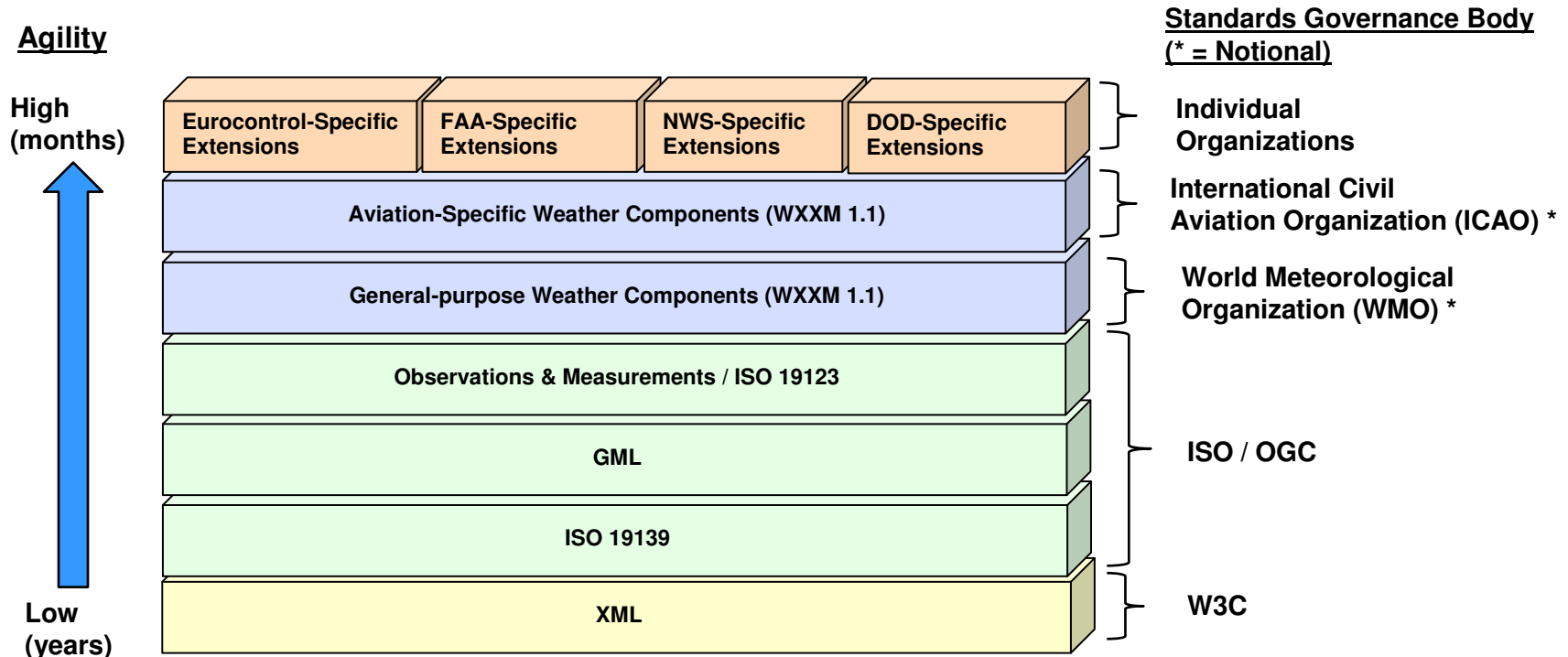


Interoperability via WXXM



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WXXM 1.1 Data Model (Collaborative effort among Eurocontrol, FAA, NWS, DoD, NOAA)



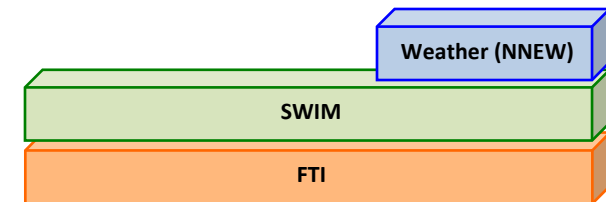
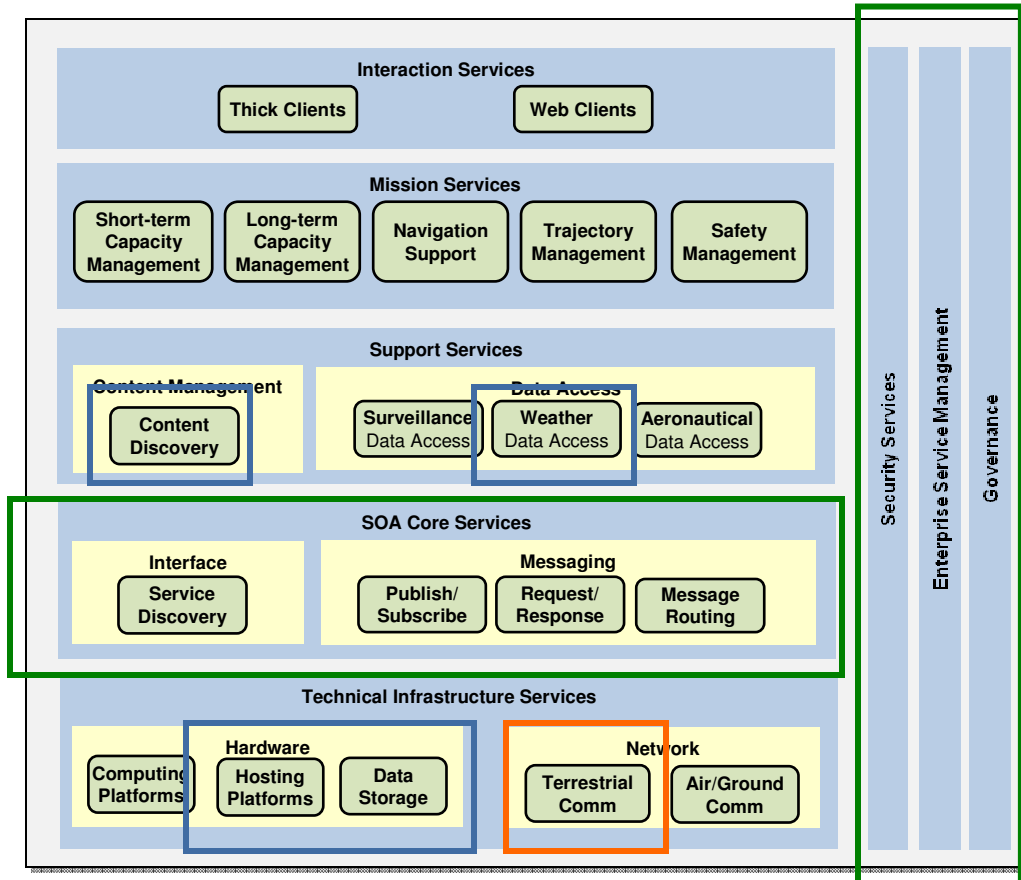
- Composable, extensible data model balances standardization with the need for individual communities to innovate over time
- *What is the vision for distributing this data within the NAS?*

NextGen Standards and Programs 'Stack'



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NextGen Enterprise Architecture System View 4 (SV-4)

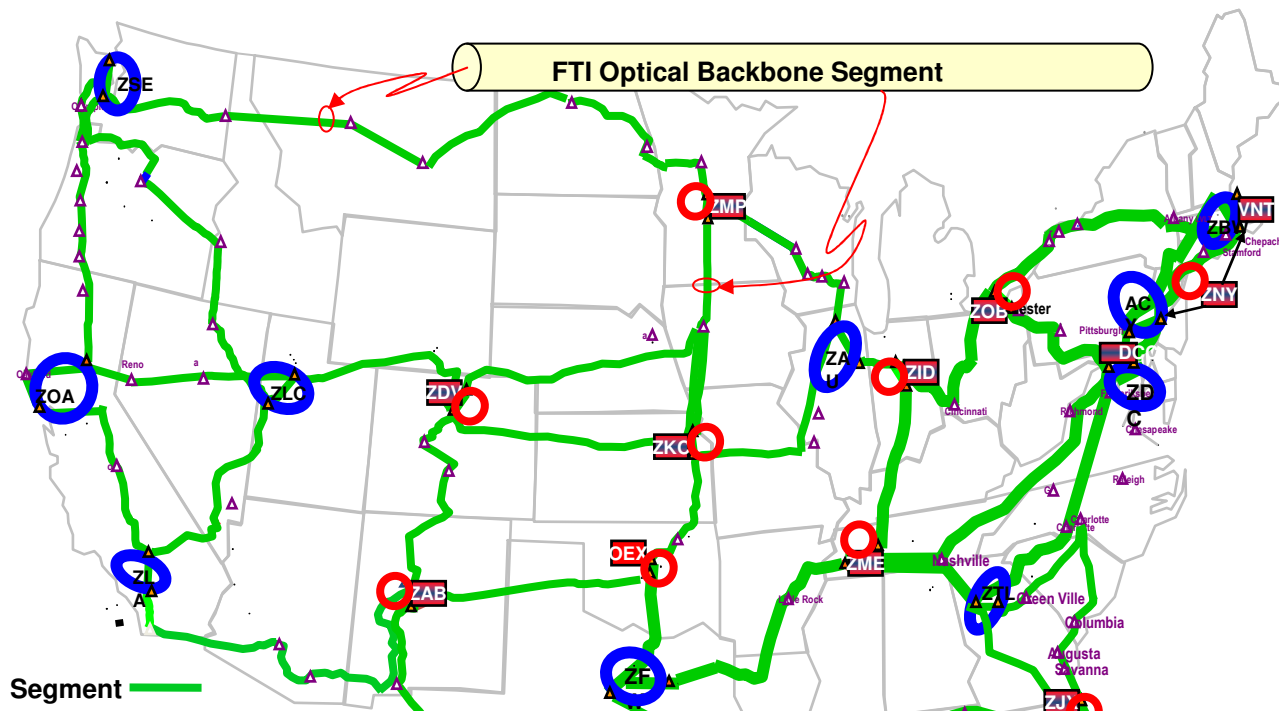


Weather Data Dissemination Supporting
Infrastructure Programs

Key Challenge – Efficient use of Network Bandwidth



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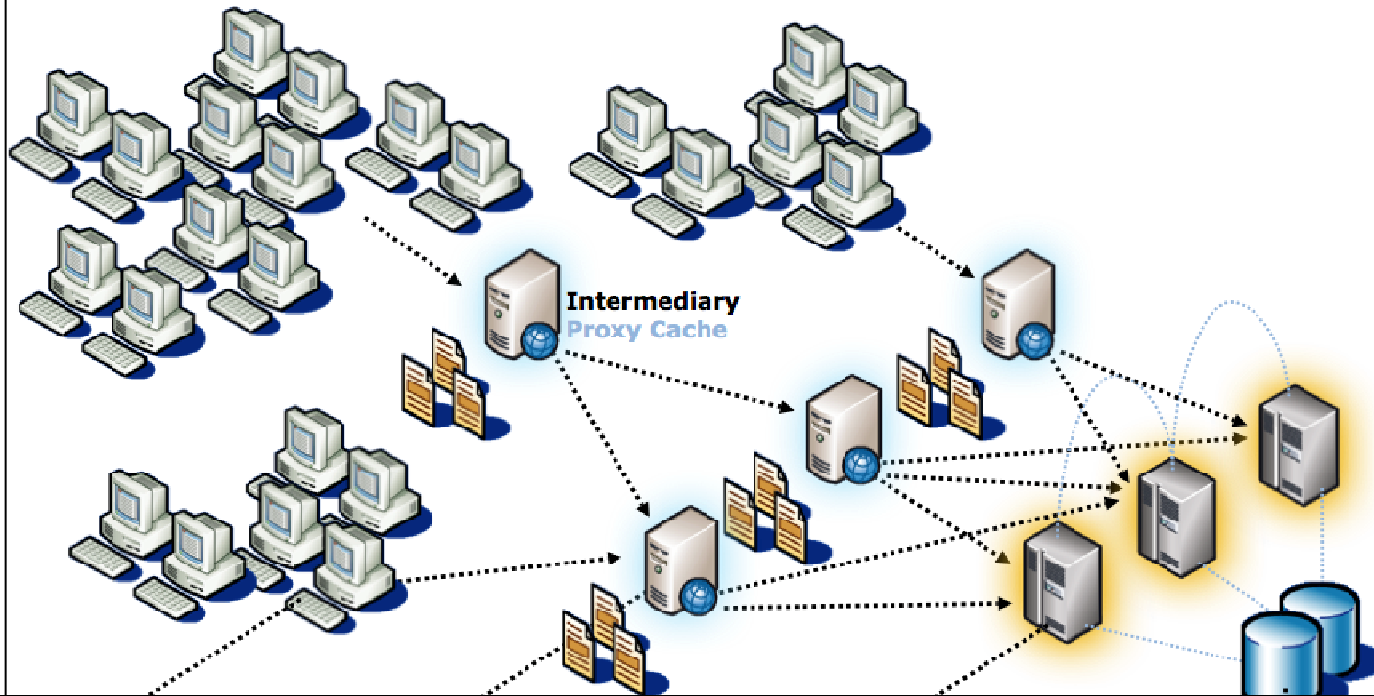
- Weather data can be large in size when compared with typical surveillance data
- 1000's of users – many getting the same or similar data
- FTI not (currently) encouraging use of multicast protocols at network layer due to management complexity

It's Not a Brand-New Problem...



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Scalable Web Caching Architecture



- 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*

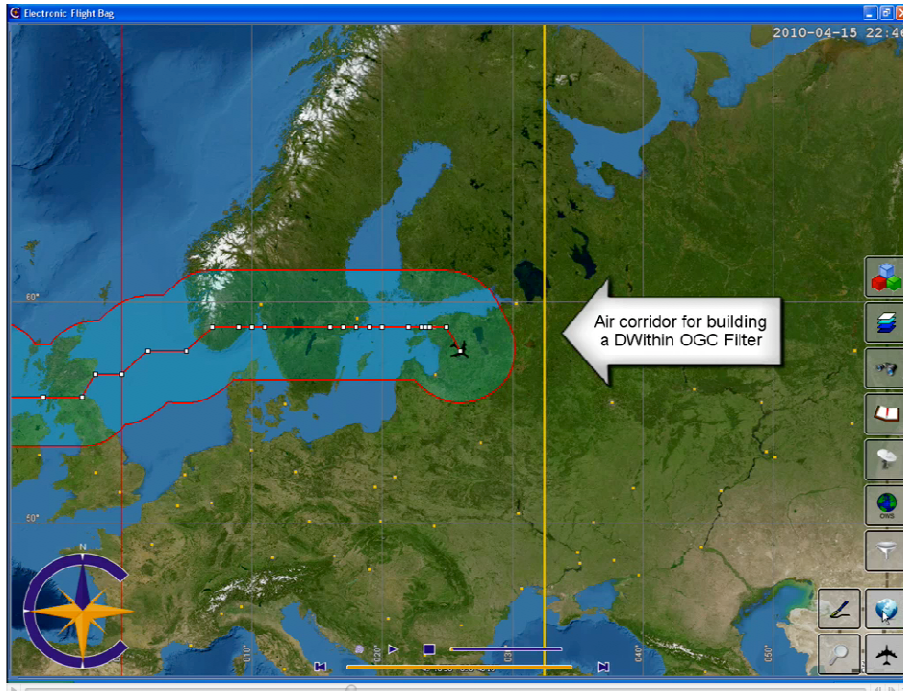
OGC Data Access Services



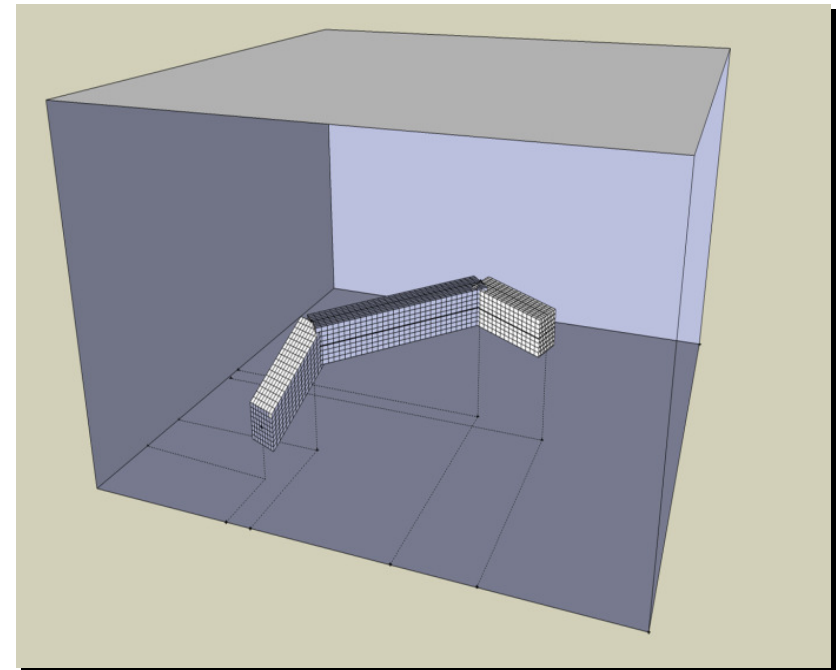
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International standards for access to data of all types using spatial/temporal queries

- Web Coverage Service – Gridded data access
- Web Feature Service – Non-gridded data access



2 spatial dimensions + time



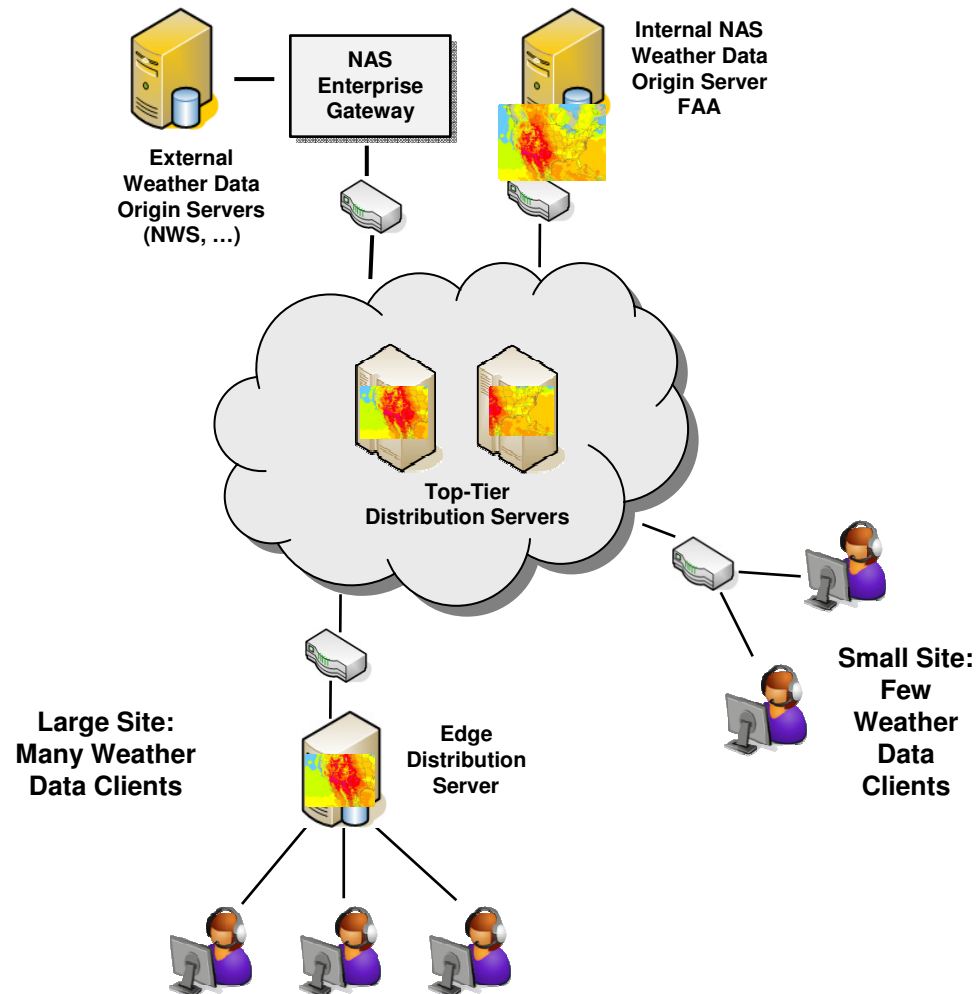
3 spatial dimensions + time (4-D Cube)

- 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



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- **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**

Agenda



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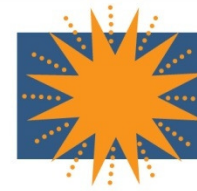
Roles of the NNEW Service Reference Implementations



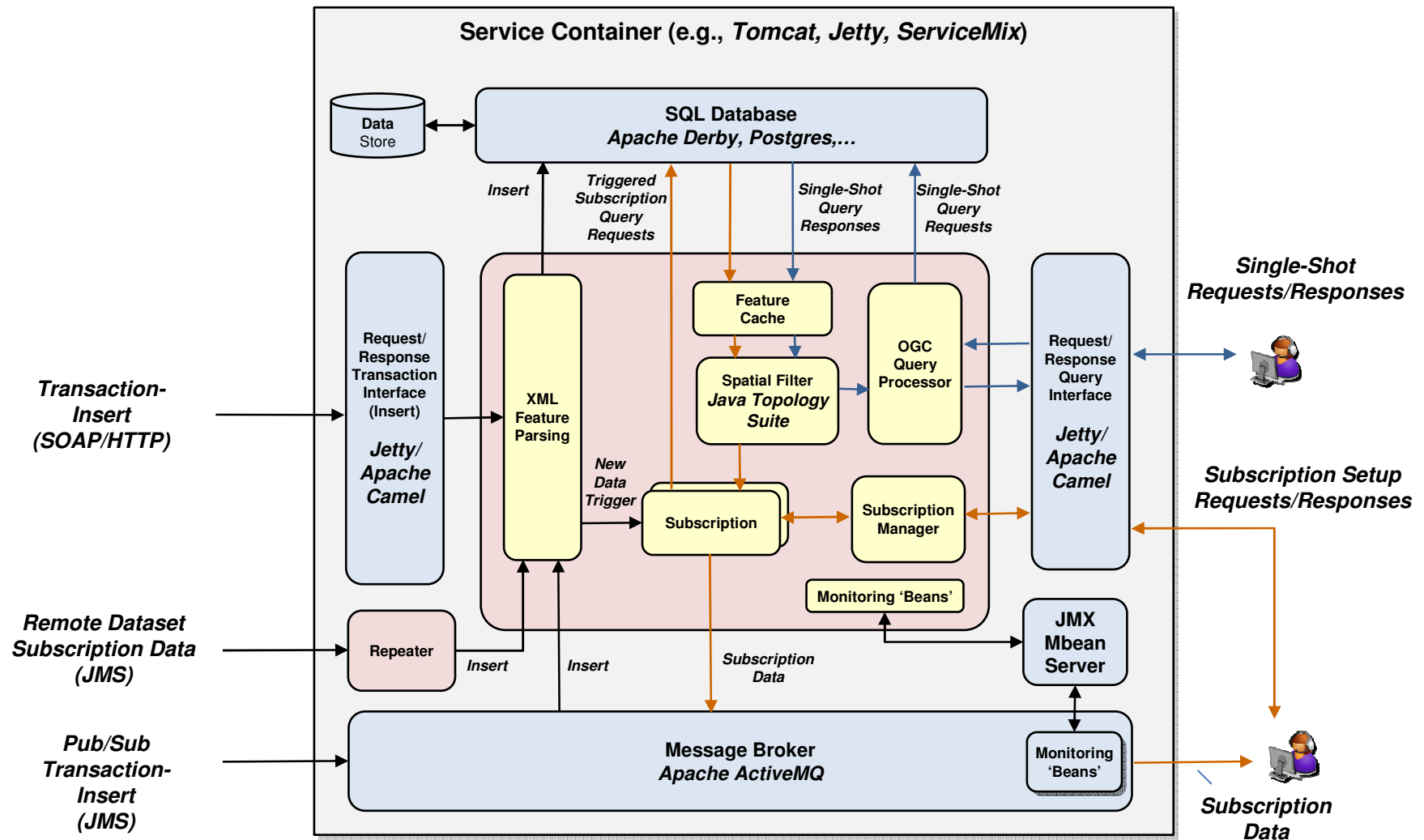
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- Proof-of-concept platform used to exercise the core OGC specifications and extensions against NNEW requirements
- Build on top of the SWIM software stack - provide lesson's learned
- Technology transfer from R&D to NNEW implementation phase (Government Furnished Information)

WFSRI Block Diagram



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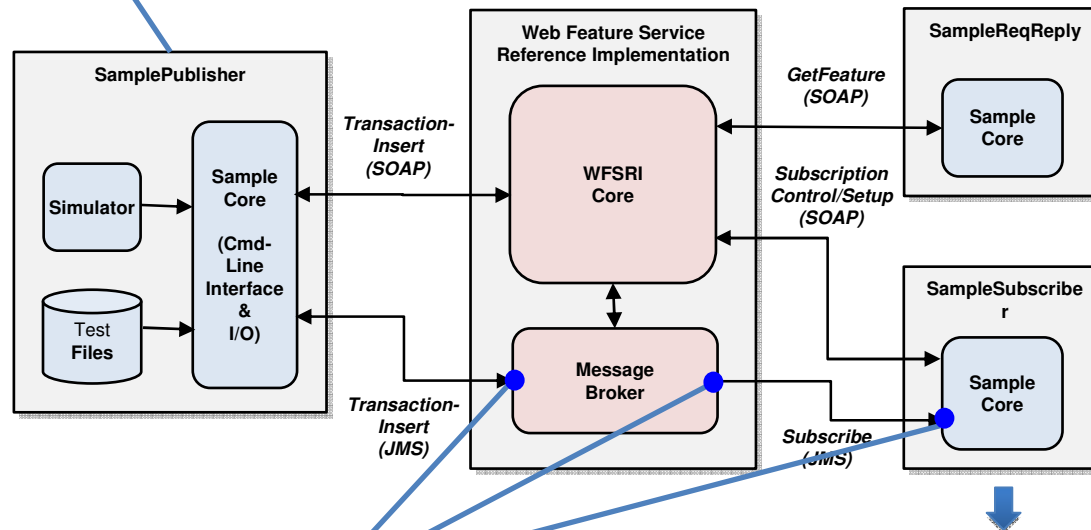


WFSRI Installation Verification/ Performance Measurement



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



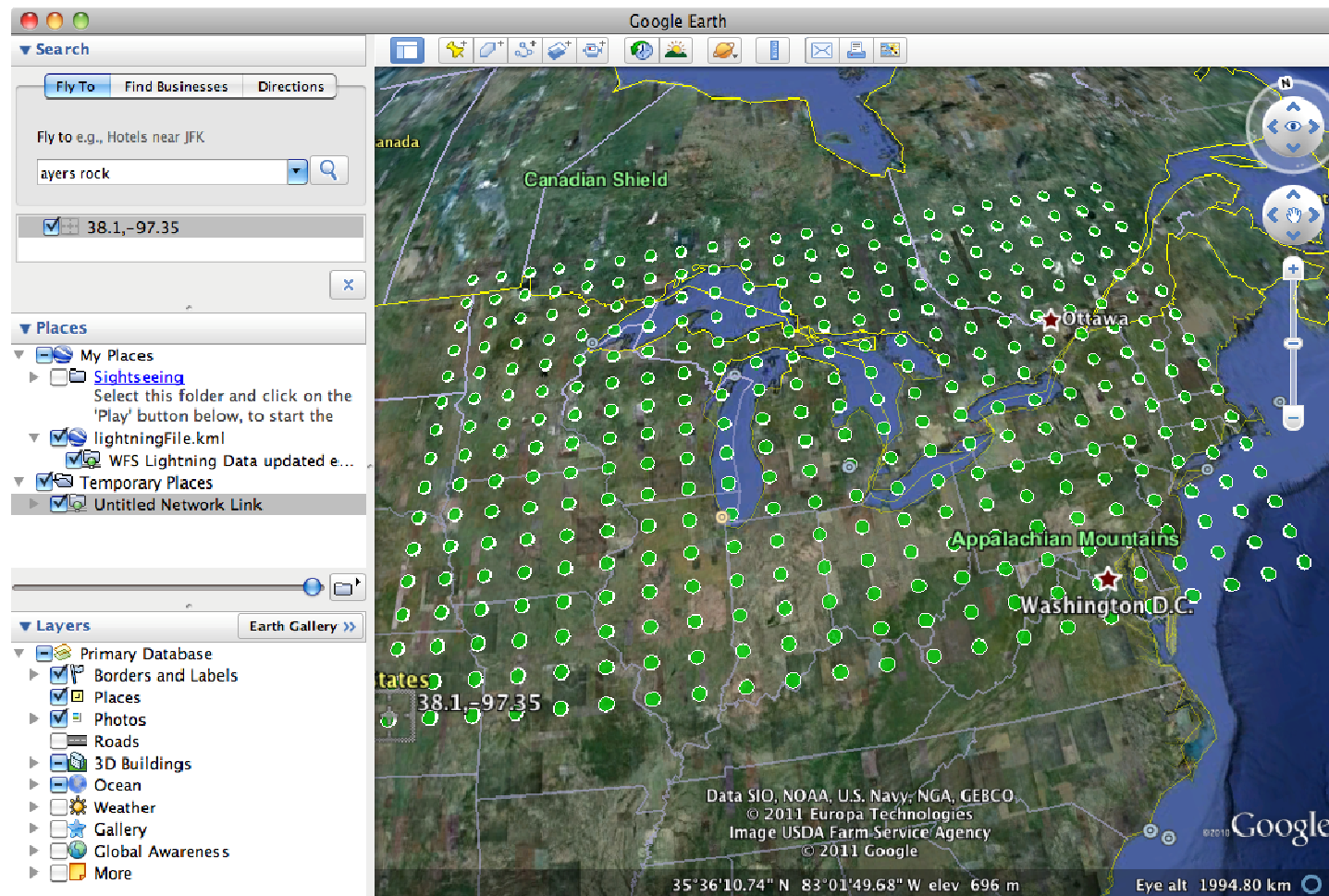
- Data flow instrumented to enabled creation of timing trace at end receiver
- HTTP, JMS headers used (similar to HTTP 'Via' header in principle)

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	WFSClntApp	Recv	1314164845471	(2 ms)
sampson.local	WFSClntApp	Unzip	1314164845481	(10 ms)

Simulated Storm Contours (Dense Scenario – NW Filter)



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WFSRI Installation Verification/ Performance Measurement



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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

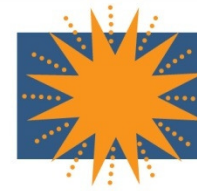
- ‘Dense’ simulation exceeds feature count of CIWS worst-case weather day
- ~ 2 seconds per distribution node ‘hop’ for this loading is not considered problematic (forecast data latency requirements are relaxed when compared to their wind-shear alert counterparts)
- Room for improvement remains via a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



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WFS AIXM Support Example

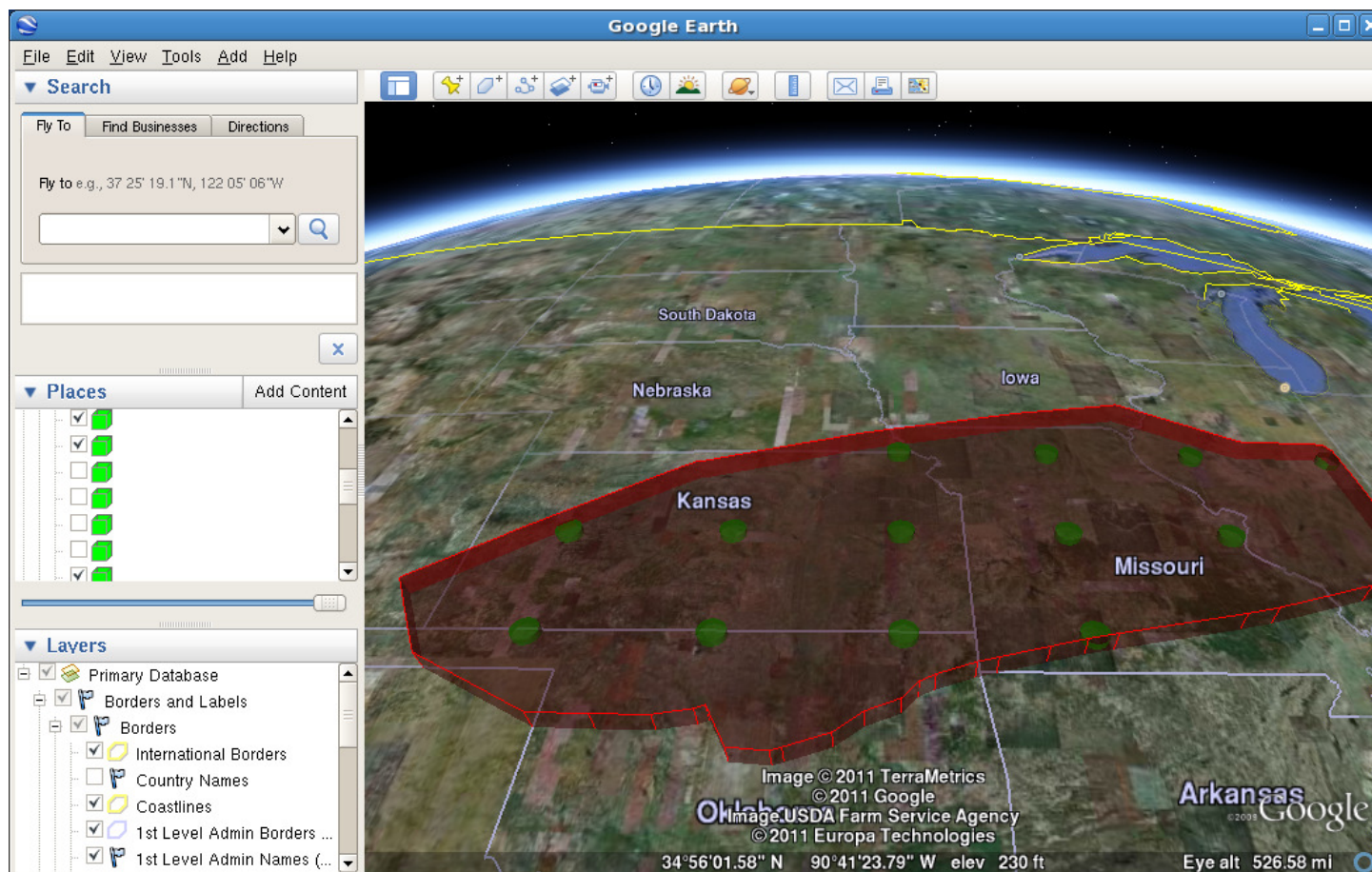
```
<wfs:WFS_Capabilities>
...
  <fes:Spatial_Capabilities>
    <fes:GeometryOperands>
      <fes:GeometryOperand name="gml:Point"/>
      <fes:GeometryOperand name="gml:Curve"/>
      <fes:GeometryOperand name="gml:Polygon"/>
      <fes:GeometryOperand name="gml:Envelope"/>
      <fes:GeometryOperand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

```
<wfs:GetFeature>
  <wfs:Query typeName="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>
          </horizontalProjection>
        </aixm:AirspaceVolume>
      </fes:Within>
    </fes:Filter>
  </wfs:Query>
</wfs:GetFeature>
```

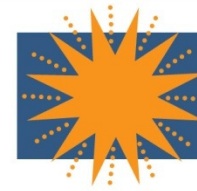
WFS Weather Contour Query Filtered by AIXM <AirspaceVolume>



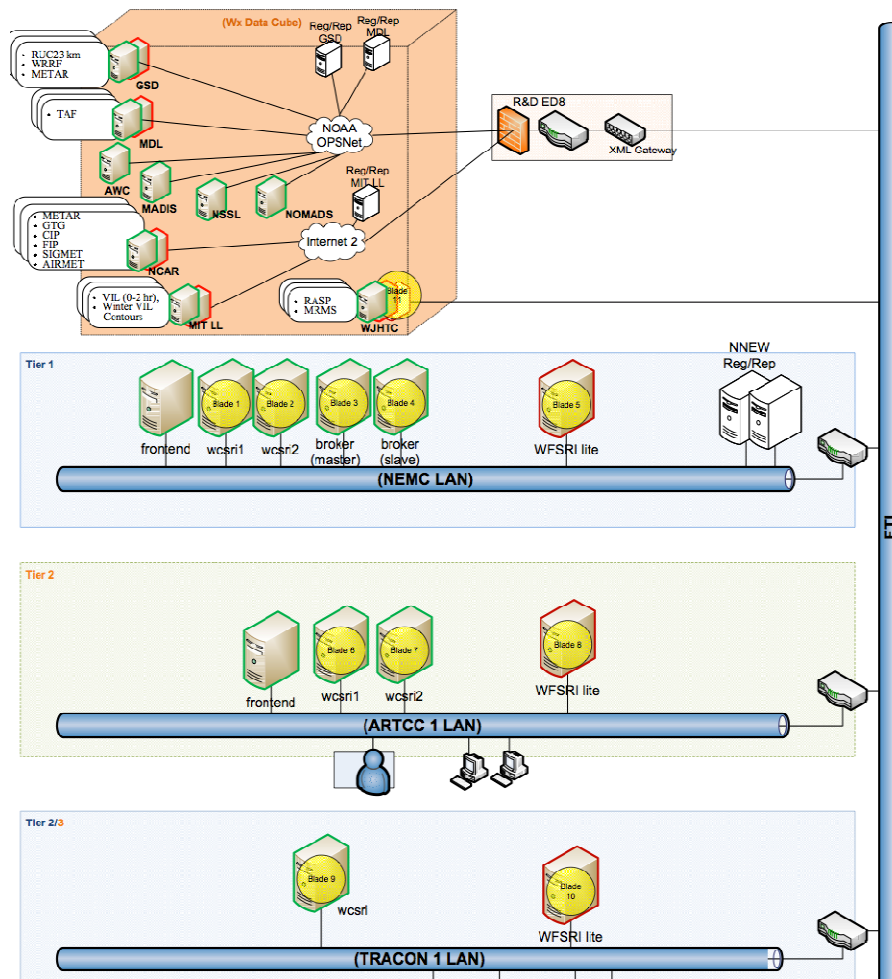
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FAA Tech Center R&D Enclave (Weather Domain Portion)



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- 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

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



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More Information / Contacts



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- WFS/WCS Reference Implementations
 - <https://wiki.ucar.edu/display/NNEWD/Reference+Implementations>
- olivern@LL.mit.edu



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