CIWS Data Distribution Service

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FAA NextGen 2012-2025 Transformational Programs

ADS-B: Automatic Dependent Surveillance-Broadcast  NVS: NAS Voice Switch
SWIM: System Wide Information Management  CSS-Wx: Common Support Services -- Weather  CATMT: Collaborative Air Traffic Management Technologies
FAA Programs Across the NAS

National Airspace System 2009 SV-1

Blue Boxes: Air Traffic Automation Systems
Purple Boxes: Weather Systems
FAA Weather System Transformation

Examples of Autonomous Weather Systems

WARP
- Display Component
- Processing Component
- Weather Data I/O Component
- General Data I/O Component
- Physical Network Component

ITWS
- Display Component
- Processing Component
- Weather Data I/O Component
- General Data I/O Component
- Physical Network Component

CIWS
- Display Component
- Processing Component
- Weather Data I/O Component
- General Data I/O Component
- Physical Network Component

CIWS Data Distribution Service

NextGen Transformation

Weather System Axis Transformation

TBD

NWP

CSS-Wx

SWIM

FTI
High-Level Architecture

NWS Network
- Satellite
- MADIS
- HRRR
- NWS NNEW Protocol Bus

External Users
- NWP
- NEXRAD, TDWR, CANRAD, ASR-9/11
  (via pub/sub brokers at ARTCCs, TRACONs)

DataStore
- HRRR, MADIS, Satellite
- Satellite
- NEXRAD

NWP
- NWP Input Products
  (via pub/sub brokers at ARTCCs, TRACONs)

CSS-Wx
- NWP Output Products

Gateway
- XML Gateway

FTI Network
- FAA Gateway
- SWIM Nodes

Command Center

ARTCCs (20+)

TRACONS

Large/Small ATCTs

(2) - Salt Lake City, Atlanta

NWS: NationalWeatherService
HRRR: HighRes Rapid Refresh
MADIS: MetAssimDataIngest
ARTCC: AirRouteTrafficControlCenter
ASR: AirportSurveillanceRadar
TRACON: Terminal Radar Approach Control
ATCT: Airport Traffic Control Tower
Outline

- Background
- SWIM Program Overview
- CIWS Data Distribution Service (CDDS) Implementation
- CDDS Current And Future Subscribers
What Is SWIM?
System Wide Information Management

• Motivation:
  – Facilitate data sharing and ensure interoperability between FAA systems
  – Reduce time to establish new interfaces
  – Increase common situational awareness

• Development Plan:
  – Segment 1
    • Implement a Service-Oriented Architecture (SOA) in the NAS
    • Identify industry standards, best practices and COTS products for use by NAS programs
    • Establish governance policies, processes, and metrics
  – Segment 2
    • Implement enterprise messaging service for NAS programs (NEMS)
FAA Service-Oriented Architecture

Service Registry

- Publish Services
  - WSDL

- Discover Services
  - WSDL

Service Producer

- Exchange Messages
  - SOAP or JMS

Service Consumer

WSDL: Web Service Definition Language
SOAP: Originally defined as Simple Object Access Protocol
## The SWIM Segment 1 Programs

- **Segment 1 (FY09-FY15): Seven SWIM Implementing Programs**

<table>
<thead>
<tr>
<th>Logo</th>
<th>Program</th>
<th>Description</th>
<th>Category</th>
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<td>En Route Automation Modernization</td>
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<td>Terminal Data Distribution System</td>
<td>Flight and Flow Management</td>
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<td>TFM</td>
<td>Traffic Flow Management</td>
<td>Flight and Flow Management</td>
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</tbody>
</table>

- **Goal:** Create SWIM-Compliant Net-Centric Services to access existing FAA data
What Does It Mean To Be “SWIM-Compliant”

- SWIM-approved COTS products must be used and a security solution must be provided
  - Apache Service Mix, Apache Camel, Apache CXF, Active MQ
  - Segment 2 programs may use non-Apache products

- SWIM services must be registered in the NAS Service Registry/Repository and must follow the Service Lifecycle Management Process:

  - Proposed
  - Approved for SWIM Service
  - Definition
  - Development
  - Verification
  - In Service Decision
  - Production

- Share lessons-learned via monthly meetings
  - COTS WG, Architecture WG, TIMs, Apache User Forums
SWIM Will Encourage Data And Service Standards

- Data Exchange Models developed jointly with FAA, DoD, NOAA, Eurocontrol

<table>
<thead>
<tr>
<th>AIXM</th>
<th>WXXM</th>
<th>FIXM</th>
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</thead>
<tbody>
<tr>
<td>Aeronautical Data</td>
<td>Weather Data</td>
<td>Flight Data</td>
</tr>
</tbody>
</table>

- Service standards provide access to data of all types using spatial/temporal queries
  - OGC Web Coverage Service – Gridded data access
  - OGC Web Feature Service – Non-gridded data access

Common Foundations (XML, ISO 19139, GML)
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Corridor Integrated Weather System Operational Prototype Architecture

Data Ingest Gateways

- Lightning
- Weather Radar (>150)
- Satellites
- CIWS Product Generation Engine

- TDWR
- NEXRAD Level II
- Canadian
- NEXRAD Level III (via WARP)
- LLWAS
- ASOS
- AWOS
- Surface Weather
- Numerical Models

CIWS Product Dissemination

- CIWS Data Distribution Service (CDDS) at FAA Technical Center
- External & Research Users
- FAA Internet Gateway

CIWS Product Generation

- CIWS Product Generation
- CIWS Product Dissemination

- CIWS Website
- Decision Support Tools
- Dedicated Displays
- CIWS Origin Server
- CIWS Data Distribution Service (CDDS) at FAA Technical Center
- FAA Internet Gateway
CIWS Products

**Gridded**
- Precipitation Mosaic
- Precipitation Forecast
- Winter Precipitation Mosaic
- Winter Precipitation Forecast
- Echo Tops Mosaic
- Echo Tops Forecast
- Satellite Mosaic

**Non-gridded**
- Echo Tops tags
- Storm Growth and Decay
- Storm Motion
- 30, 60 and 120 min Forecasts Accuracy Scores

*For each forecast type (Precipitation, Winter Precipitation, and Echo Tops), contours and scores are provided (Precipitation shown below):*
What is CDDS?

- CIWS Data Distribution Service
- Provides CIWS products as web services
- Uses
  - CSS-Wx NetCDF/WXXM Data Model Definitions
  - CSS-Wx OGC WCS/WFS Data Services
  - SWIM Messaging Infrastructure
  - SWIM Security Guidelines
  - SWIM Service Repository
- First SWIM Program to have an Operational Capability
CDDS Data And Service Definitions

- Gridded data is converted from an internal CIWS format to the CSS-Wx-specified NetCDF format
- CDDS then uses the CSS-Wx Web Coverage Service Reference Implementation (WCSRI) software

- Non-gridded data is converted from an internal CIWS format to the CSS-Wx-specified WXXM format
- CDDS then uses the CSS-Wx Web Feature Service Reference Implementation (WFSRI) software
WCS
Filtered Data Access Model

1. Request: “Subscribe to product X in region Y”
2. Reply: Dynamic Subscription Topic Id #1
3. Pub/Sub Connection Request: “Subscribe to Topic Id #1”
4. Real-Time Metadata Updates
5. HTTP Data Download Request: Subsetted Data File Cache
6. HTTP Server

Web Coverage Service
- Request/Reply
- ‘Single-Shot’ Data Request Manager
- Subscription Data Request Manager
- Data Subsetting Filter
- Real-Time Data Store
- Subscription Topic Creation
- Data Subsetting Filter – Topic #1
- Data Subsetting Filter – Topic #2
- ... Data Subsetting Filter – Topic #<N>
- Dynamic Subscription ‘Topics’
- Real-Time Data Updates

Real-Time Weather Data Access Client

Web Coverage Service
From CIWS Data Gateway
### SOAP Service Properties

**Implementation of:** CDDS WCS Gridded Weather Products  
**Version:** 1.0  
**Keywords:** CIWS, Gridded Data Sets, Weather, VIL Mosaic, VIL Forecast, Echo Tops Mosaic, Echo Tops Forecast, Satellite Mosaic, CIWS Data Distribution Service, CDDS, CIWS, WCS, Web Coverage Service, OGC, WS-N, Aviation Weather, Precipitation Mosaic, Precipitation Forecast, CONUS, Pub/Sub, Request/Reply  
**Document:** cdds-wcs-endpoints.wsdl (Advanced View)

### Environments

**Environment:** Unspecified (Download WSDL)  
**Endpoints:**

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<td>clone</td>
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**Add Endpoint**

**Operations**

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<thead>
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<th>Description</th>
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</tr>
</tbody>
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Traffic Flow Manager TSD
Playbook Routes & CIWS

Shows some flights and Playbook Routes for “DFW-Bypass-3” as red dashed lines

CIWS Winter Precip Added In Nov 2011
NEMS Data-flows: Non-NAS Producer

Non-NAS Producer

Distributes data received from non-NAS Producers to NAS Systems

VPN Tunnel

External DMZ

Untrusted NEMS Node

Non-NAS facing tier receives data from non-NAS Producers

Distributes data received from non-NAS Producers to NAS Systems

Internal NAS NEMS Node

NAS Consumer

External DMZ

Trusted NEMS Node

NEMS Data-flows: Non-NAS Producer

Lincoln Laboratory Air Traffic Control Workshop 2012
C2WS Data Distribution Service - 22
CAK 12/11/12
Large subsets for large number of weather data products very CPU-intensive
CDDS Dynamic Resource Provisioning
“Cloud Computing”

- Investigating cloud and virtual technologies
  - Additional compute nodes to be configured as virtual machines
  - Use VMware vCloud to enable dynamic resource provisioning based on demand

- Can provision services elastically
  - If demand for services exceeds a threshold, can reconfigure the number of services without human intervention
    - Can create/destroy additional VMs dynamically
    - Can balance work load using new servers automatically
    - In the event of a hardware failure, can transfer services to other virtual machines automatically
CDDS Subscribers

• Traffic Flow Management System (TFMS) now uses CIWS data on their Traffic Situation Displays (TSDs) operationally across the NAS
  – 20 ARTCCs, over 60 TRACONs/Terminals

• Time-Based Flow Management program (TBFM) to add CIWS to their PGUI displays in September 2013 via SWIM NEMS

• FAA Tech Center display team (NWP Displays/Mobile Apps)

• Possible Future Clients
  – DHS-Customs and Border Protection Secure Border Initiative
  – DoD ERSA (accessing internally now; may transition to CDDS)
  – NASA Dynamic Weather Routing Demonstration
Summary

• Seven Segment 1 programs have collaborated together to help the FAA understand how best to create and govern net-centric services

• CDDS is the first operational SWIM capability and demonstrates that weather products can be distributed through the NAS using standardized data models and data services

• Going forward with SWIM Segment 2 (2011-2017), CDDS will be an early adopter of SWIM’s new messaging solution (NEMS)
  – CDDS publishes data to SWIM messaging nodes
  – SWIM messaging nodes communicate with consumers (TBFM)
  – SWIM handles security and monitoring inside the NAS