ICAO Workshop: AIXM / XML / GML Lima, Peru

WXXM Current Status

Presented By: Alfred Moosakhanian and Aaron Braeckel

FAA, NextGen Wx Systems

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Overview

- **WXXM / IWXXM Background**
- **Planned Testing & Demonstrations**
- **FAA Implementation**
- **WXXM / IWXXM AIXM Usage**
- **WXXM / IWXXM Details**
- **Summary**

TAC and XML

Traditional Alphanumeric Codes (TAC) – METAR, TAF, SIGMET, …

Useful for:

- **Human readability (pilots, flight briefers, …)**
- **Machine readability (visualization, storage, weather model integration, …)**

TAC has primarily addressed human-readability. Parsing TAC with software is time-consuming and imperfect due to human-readable text, variations from standard, and other issues

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XML aids machine-readability and can readily be transformed to many other forms.

XML schema can be used to check message structure to ensure correctness – especially useful for data producers

WXXM Evolution

- **IWXXM & WXXM are key to:**
  - Data centric concepts and applications
  - Support to NextGen, SESAR and ICAO SWIM Concepts
- **Supporting Organizations**
  - The World Meteorological Organization (WMO) establishes the basis for global MET/Wx information exchange
  - ICAO establishes the basis for Meteorological Service for International Air Navigation (ICAO Annex 3)
  - Open Geospatial Consortium (OGC) provides the forum for establishing open standards for exchanges of geospatial referenced information
  - FAA and EUROCONTROL develop encoding for exchanging Next- generation aviation weather products

IWXXM Regulation

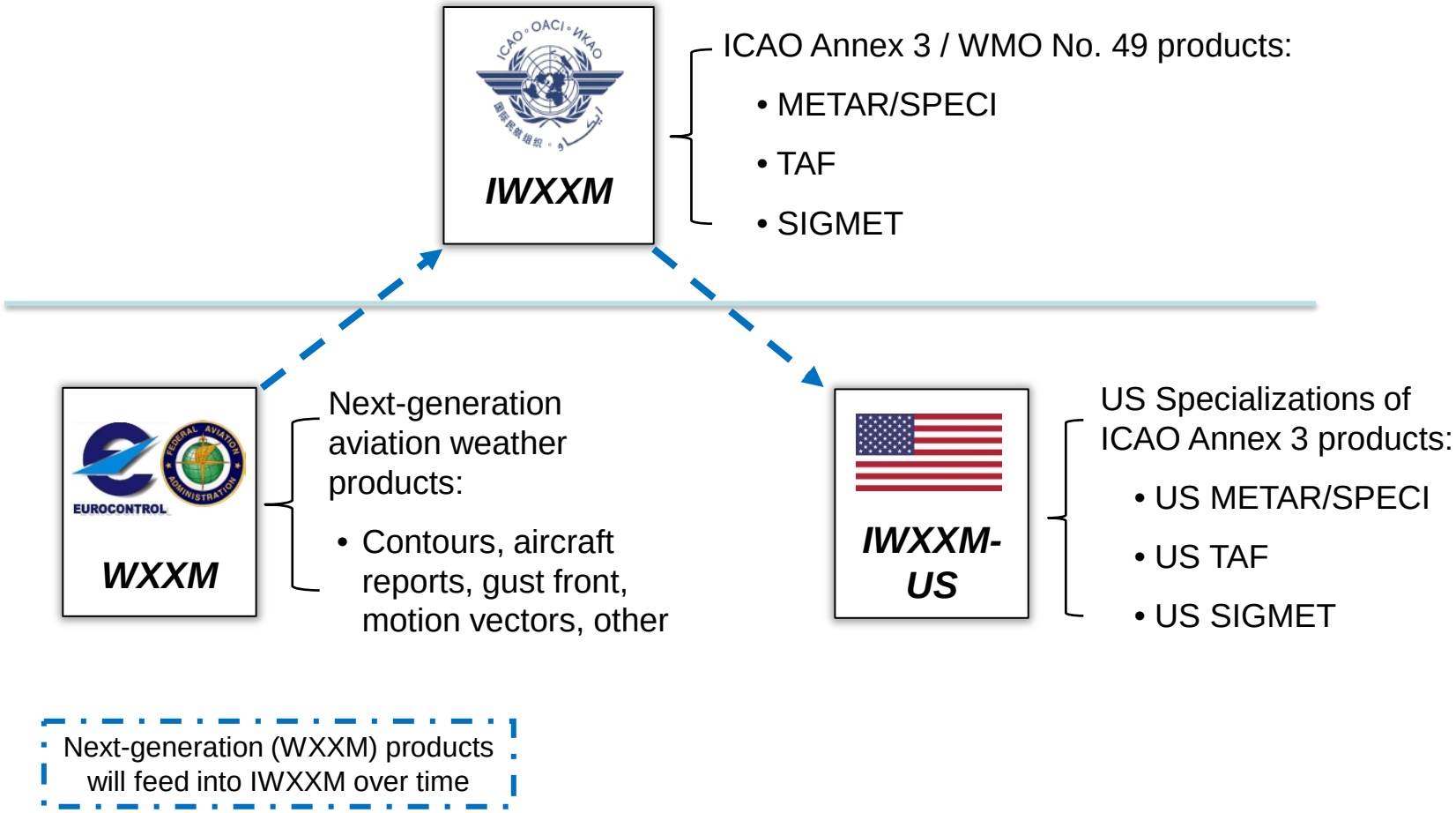
ICAO Responsibility:

- Aviation regulation and requirements

WMO Responsibility:

- Weather regulation and technical implementation

Wx Standards Correlation



IWXXM and WXXM

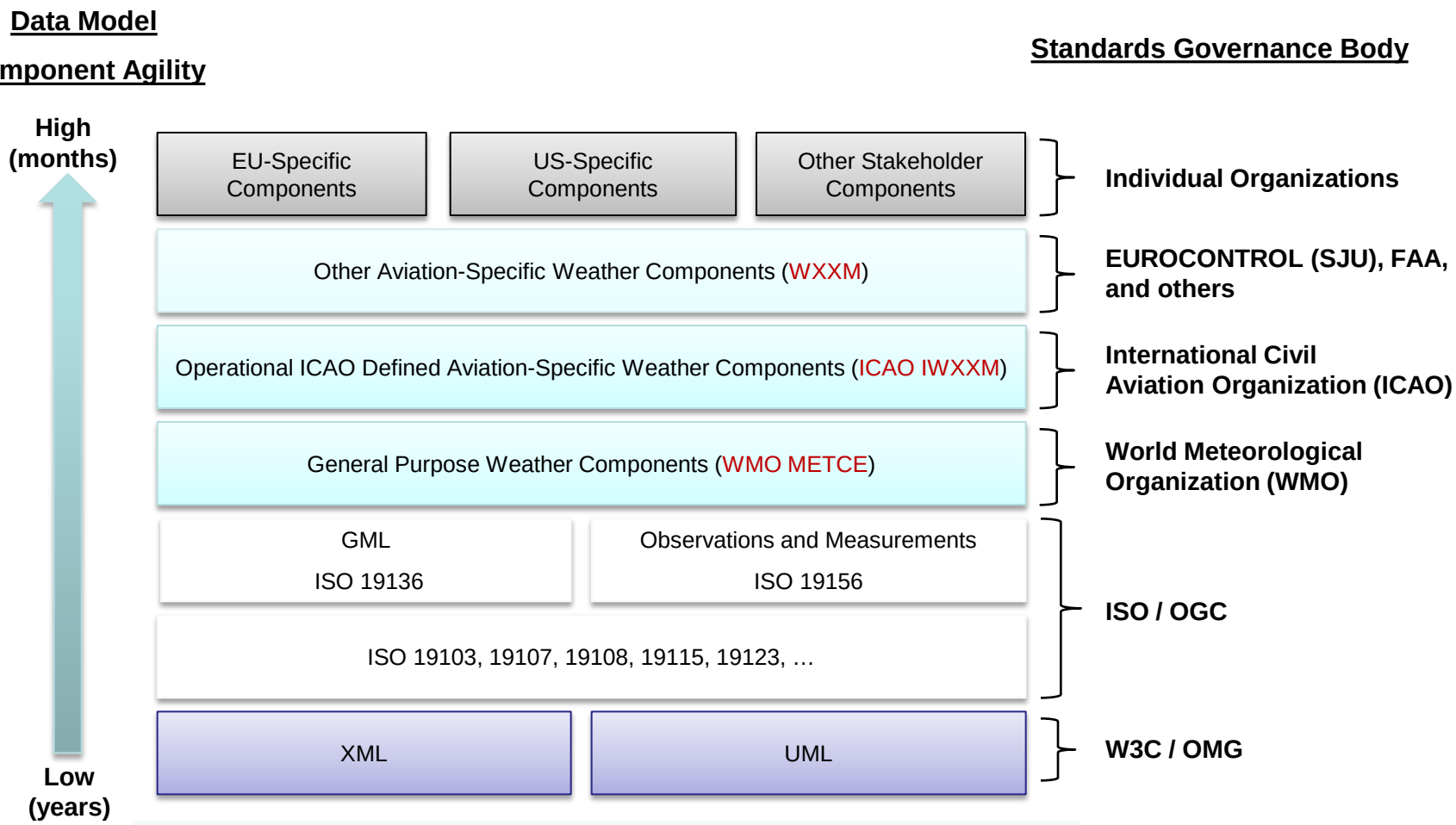
IWXXM

- Authoritative and official XML representations of ICAO Annex 3 products
- Managed by ICAO and WMO
- Strong support for validating whether messages are formatted correctly
- Updated on roughly the same time scale as ICAO Annex 3 (currently 3 years, changing to 2 year)

WXXM

- Next-generation aviation and weather data representations
- Managed by Eurocontrol, FAA, and other partners
- Many products and data types beyond ICAO Annex 3
- General purpose, reusable data types (aerial report, profile, trajectory, area forecast, point forecast, etc.)
- Open/extensible content policy

Wx Data Models



Descriptions of US and International weather data models are available at

https://wiki.ucar.edu/display/CSSWX/Weather+Data+Models

ICAO Products in WXXM

WXXM has implemented ICAO products before they were incorporated officially into IWXXM (in some cases several years prior)

For example:

WXXM 2.0 – AIRMET, VA Advisory, SigWx

Products in WXXM should be considered deprecated and should no longer be used when they become available in an official form in IWXXM

ICAO Annex 3

APPENDIX 3. TECHNICAL SPECIFICATIONS RELATED TO METEOROLOGICAL OBSERVATIONS AND REPORTS

(See Chapter 4 of this Annex.)

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2. GENERAL CRITERIA RELATED TO METEOROLOGICAL REPORTS

2.1 Format of meteorological reports

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2.1.3 **Recommendation.**— *METAR and SPECI should be disseminated, under bilateral agreements between States in a position to do so, in ~~the WMO BUFR code~~digital form, in addition to the dissemination of the METAR and SPECI in accordance with 2.1.2.*

~~*Note. — The BUFR code form is contained in WMO Publication No. 306,* Manual on Codes, *Volume I.2, Part B — Binary Codes.*~~

2.1.4 METAR and SPECI if disseminated in digital form shall be formatted in accordance with a globally interoperable information exchange model and shall use extensible markup language (XML)/geography markup language (GML).

2.1.5 METAR and SPECI if disseminated in digital form shall be accompanied by the appropriate metadata.

Note.— Guidance on the information exchange model, XML/GML and the metadata profile is provided in the Manual on the Digital Exchange of Aeronautical Meteorological Information *(Doc 10003).*

IWXXM Timeline

IWXXM 2.0 Release Candidate 1 – March 2016

- Initial version for 2016 operational assessment
- New products: VA Advisory, TC Advisory, AIRMET
- Feedback by April 2016

IWXXM 2.0 – May 2016

- Final release prior to Nov 2016 operational implementation

Operational Implementation – May 2016 to Nov 2016

- ICAO member states implement IWXXM in operational systems

IWXXM 3.0 and beyond

- Releases made as needed to support upcoming ICAO Annex 3 Amendments (new products, modifications to ICAO Annex 3 rules, etc.)

WXXM Timeline

WXXM 2.1 Release – as needed

- No specific timeline at present, but typically minor releases (2.x) are performed on an annual basis
- Released as bug fixes or new products are required

IWXXM 3.0 – as needed

- No specific timeline at present, but typically major releases are performed every 2-3 years

WXXM 2.0 Change List (Apr 2015)

- Updated to utilize IWXXM design approach
- Observations and Measurements v2
- Utilizes GML standards for representing units of measure (UCUM)
- Schemas and content hosted on wxxm.aero
- Changed namespace to “http://www.wxxm.aero/wxxm/2.0”
- Removed deprecated ICAO Annex 3 products that are authoritatively represented in IWXXM
- Improved general-purpose coverage products
- Removed regional content, such as PIREP
- Additional ICAO Annex 3 products
- Fixed a number of schema issues

IWXXM 2.0 Change List (forthcoming)

- New products (VA Advisory, TC Advisory, AIRMET)
- Training materials
- Incorporate AIXM for aeronautical referencing
- Online web validator
- Additional examples
- XML Schema 1.1 version
- Test status for reports for evaluation purposes
- Enhanced metadata for associating TAC terms and XML terms
- GML Profile
- Simplification
- Other fixes and improvements

Exchange of MET Information

- **Today:**
  - ICAO Global exchange of OPMET products (METARs/SPECIs, TAFs and SIGMETs) is primarily via the Aeronautical Fixed Telecommunications Network (AFTN)
  - OPMET products are encoded in Traditional Alphnumeric Code (TAC)
- **Future:**
  - IWXXM (XML/GML) encoding increases the message volume beyond the AFTN capacity
  - XML exchange of OPMET products will transition to the ATS Message Handling System (AMHS)

IWXXM Implementation

- **Managed by New Meteorology Panel (MET/P)**
  - Resulted from recommendations of the 2014 ICAO MET Divisional meeting
- **Technical work under MET/P Working Group for Meteorological Information Exchange (WG-MIE)**
  - Key Tasks:
    - 2016 - AMHS Transition: Develop test objectives and criteria for validating the capability of the ATS Message Handling System (AMHS) to support IWXXM compliant data exchange

      Note: Global testing will be managed by the ICAO Comm Panel; State Bi-Lateral testing may also be pursued
    - 2018 – Annex 3: Expand IWXXM exchange for additional required products
    - 2022 – Annex 3 & PANS-MET: Introduce the meteorological component of SWIM, i.e. move toward WCS/WFS/WMS

AMHS Testing

- **Key Objectives**
  - Evaluate concepts and procedures for 2016 implementation (should exchange)
    - Engage with OPMET organizations; increase awareness of coming changes
    - Involve organizations responsible for producing, consuming and translating TAC/XML encoded OPMET information
    - Engage Operational Users to validate that XML exchange meets their needs
  - Verify XML/GML exchange concepts and AMHS capabilities
  - Identify limitations in the IWXXM model
  - Track and feed limitations to IWXXM developers

Global SWIM Demonstrations

- **NextGen**
  - Mini Global II Demonstration
    - Demonstrate global exchange of AXIM, IWXXM and FIXM through complex ATM scenarios
      - International Partner Participation
      - Multiple border crossings & ANSP/FIR border coordination
    - Evaluate SWIM maturity/interoperability and identify potential benefits
  - Demo scheduled for Mar-Apr 2016

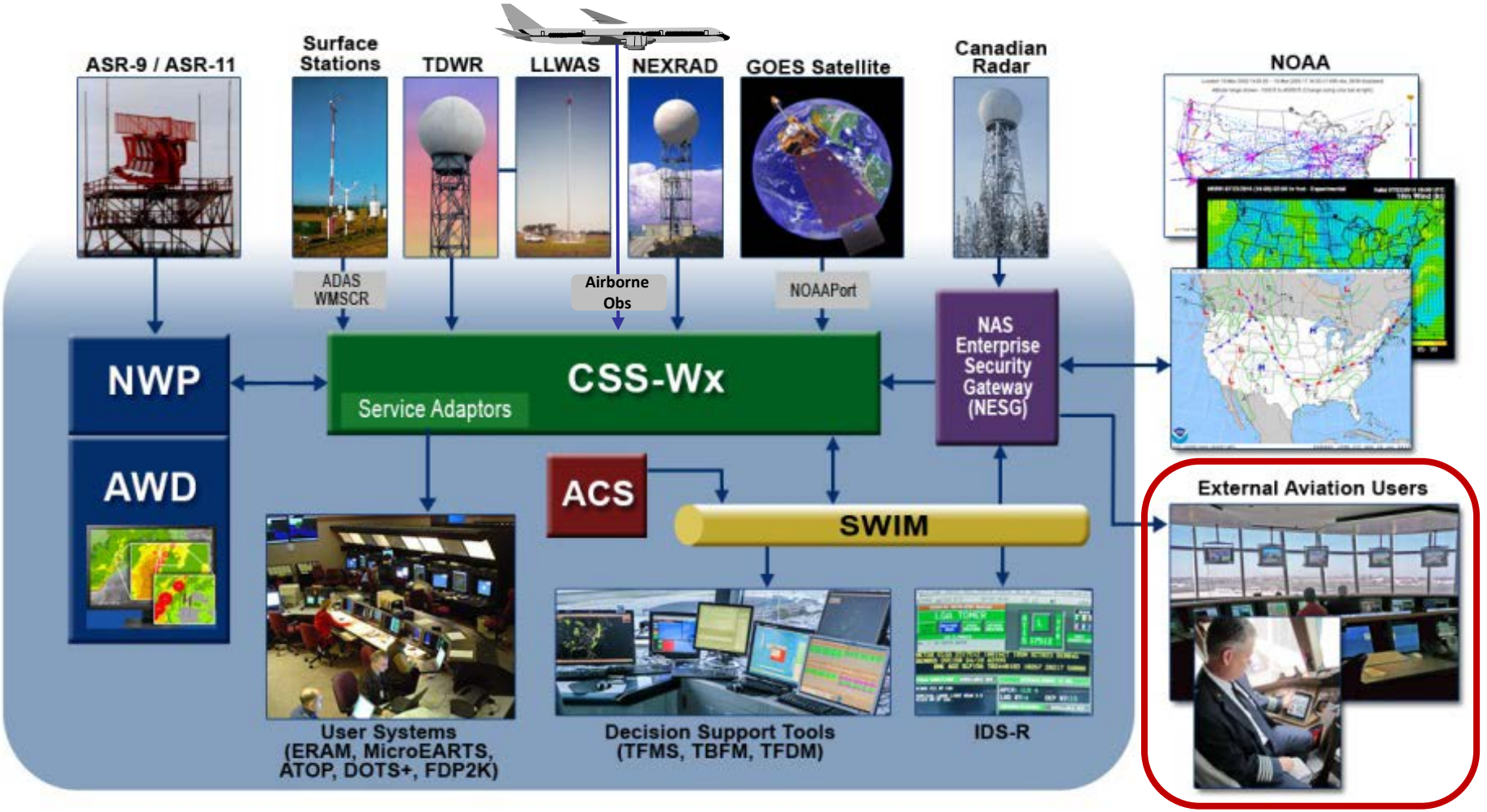
    https://www.faa.gov/nextgen/update/collaboration/international/
- **SESAR**
  - SESAR Master Class 2015
    - Demonstrate providing and consuming SWIM Services in a Non-Operational environment
    - Includes developers and providers of SWIM-enabled ATM applications, information services and infrastructure
    - Compete for “Best in Class” for SWIM compliant services and applications

    http://www.sesarju.eu/swim-masterclass-2015

FAA NextGen Wx Systems

- **NextGen weather systems are being fielded to support FAA ATM and evolving NextGen capabilities**
  - Weather products generated in OGC format
  - SOA Web Services publishing weather information
- **Contracts have been awarded for:**
  - NextGen Weather Processor (NWP)
  - Common Support Services – Weather (CSS-Wx)

NextGen Weather Architecture



CSS-Wx Data Access Services

- **Ingests weather sensor and processor data as well as other NOAA data (e.g. Satellite, models) for FAA**
- **Makes weather data available through Web Services**
- **Adheres to international standards for handling and representing geospatial data**

Web Coverage Service	Web Feature Service	Web Map Service
• Filters and transforms large gridded dataset • NetCDF format	• Filters and transforms non-gridded data sets • WXXM 2.0 XML format	• Renders weather data as single large image or sets of tiled images for display • JPEG, PNG, GIF, KML format

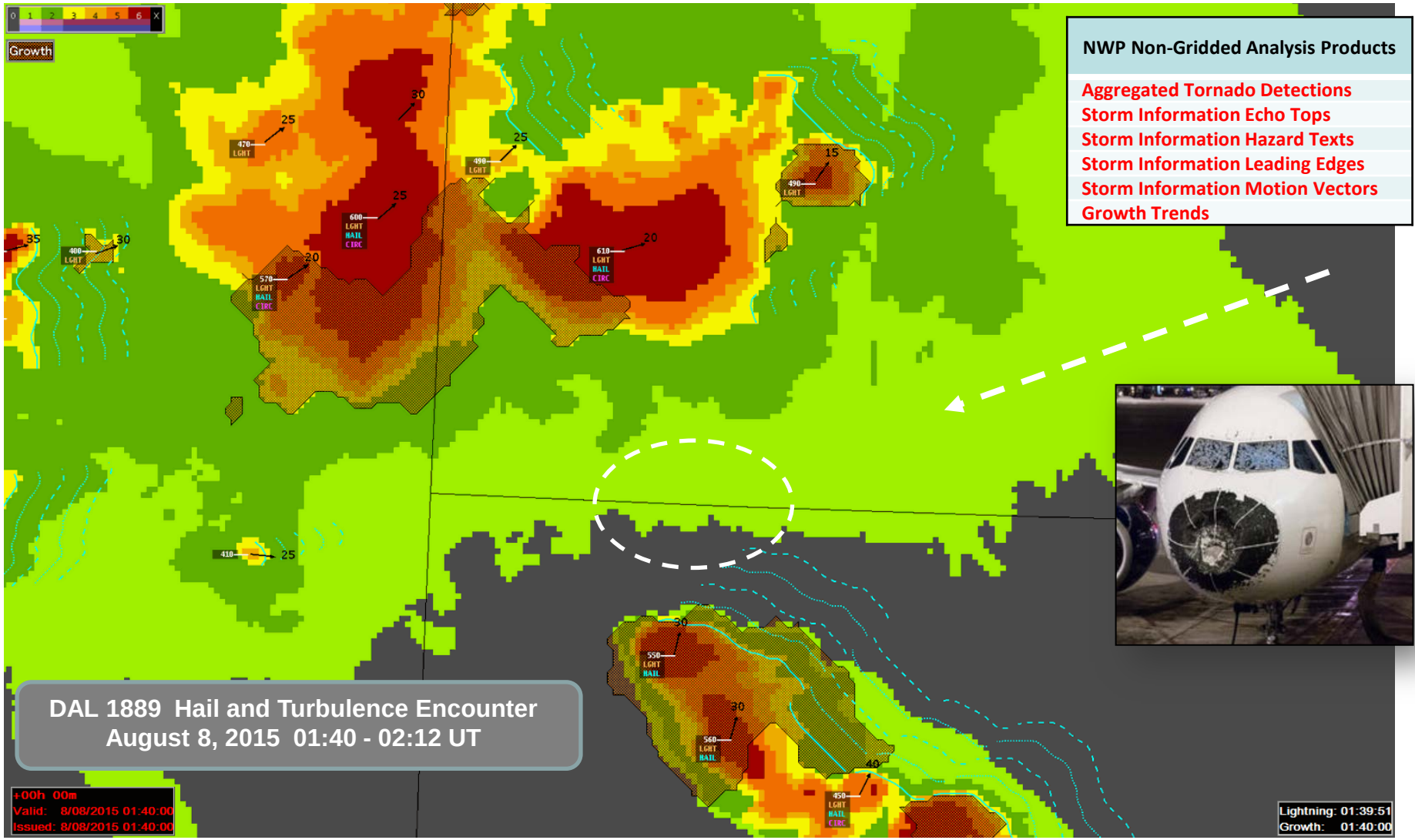
NWP WXXM Products

NWP Non-Gridded Analysis Products
Precipitation (VIL) Forecast Accuracy
Echo Tops Forecast Accuracy
Aggregated Lightning Flashes
Aggregated Tornado Detections
Storm Information Echo Tops
Storm Information Hazard Texts
Storm Information Leading Edges
Storm Information Motion Vectors
Storm Information Precipitation Cells
Precipitation (VIL) Contours
Echo Tops Contours
Fronts
Growth Trends
Wind Profiles
Convective WAF Mosaic Polygons
Jet Stream
Airport Status Summary

NWP Non-Gridded Prediction Products
Forecast Confidence
Precipitation (VIL) Forecast Contours
Echo Tops Forecast Contours
Fronts Forecast
Convective WAF Forecast Polygons

NWP Non-Gridded Terminal Products
Microburst TRACON Map
ATIS Panel Message
Gust Front TRACON Map
Gust Front Estimated Time of Impact
Configured Alerts
Tornado Alert
Airport Lightning Warning
Storm Information Motion Vectors (ASR)
Storm Information Leading Edges (ASR)
Storm Information Hazard Texts (ASR)
Runway Configuration
AP Status
Terminal Weather Information for Pilots

NWP Product Examples



WXXM / IWXXM Use of Aeronautical Information (AIXM)

Traditional METAR, SIGMET, and other ICAO Annex 3 products reference aeronautical information with identifiers (i.e., ‘KDEN’)

This referencing approach makes it difficult for consumers to consistently interpret the locations for meteorological conditions

WXXM and IWXXM address this by including explicit latitude and longitude boundaries of meteorological conditions along with ICAO identifiers – these can be ignored if a consumer has a better source of information but they are very useful for those without such sources

Weather Use of Aeronautical Information

A very small set of aeronautical information is needed in WXXM and IWXXM:

- Airport/Heliport
- Airspace
- Airspace volume
- Runway
- Runway direction
- Unit

IWXXM 2.0 and WXXM 2.0 use AIXM definitions for these terms, but do not require everything that is available in AIXM

AIXM Wx Profile

A “profile” of AIXM was created which is identical to AIXM 5.1 but excludes AIXM information that is not needed in the weather community

https://ext.eurocontrol.int//aixmwiki_public/bin/view/Profiles/AIXM_WX

The current version of the AIXM Wx profile is 5.1a. A new 5.1b version will be released to address technical issues with AIXM 5.1’s use of GML

Examples

```
<aixm:Unit gml:id="YUCC-WMO" xmlns:aixm="http://www.aixm.aero/schema/5.1"
<aixm:AirportHeliport gml:id="YUDO-aerodrome" xmlns:aixm="http://www.aixm.aero/schema/5.1"
<aixm:AirspaceVolume gml:id="vacav1" xmlns:aixm="http://www.aixm.aero/schema/5.1"
  <aixm:upperLimit uom="FL">250</aixm:upperLimit>
  <aixm:upperLimitReference>STD</aixm:upperLimitReference>
  <aixm:lowerLimit uom="FL">300</aixm:lowerLimit>
  <aixm:lowerLimitReference>STD</aixm:lowerLimitReference>
  <aixm:horizontalProjection>
    <aixm:Surface gml:id="s1">
      <gml:patches>
        <gml:PolygonPatch>
          <gml:exterior>
            <gml:LinearRing>
              <gml:posList>54.00 159.30 54.00 161.00 53.00 159.45
                54.00 159.30</gml:posList>
            </gml:LinearRing>
          </gml:exterior>
        </gml:PolygonPatch>
      </gml:patches>
    </aixm:Surface>
  </aixm:horizontalProjection>
</aixm:AirspaceVolume>
```

TAC Parsing Challenges

External References

- Aerodrome ('KDEN'), waypoints, etc.

Typographic

- "AU" instead of "UA", "N23 E1175",
- Capital "O" instead of 0, ...

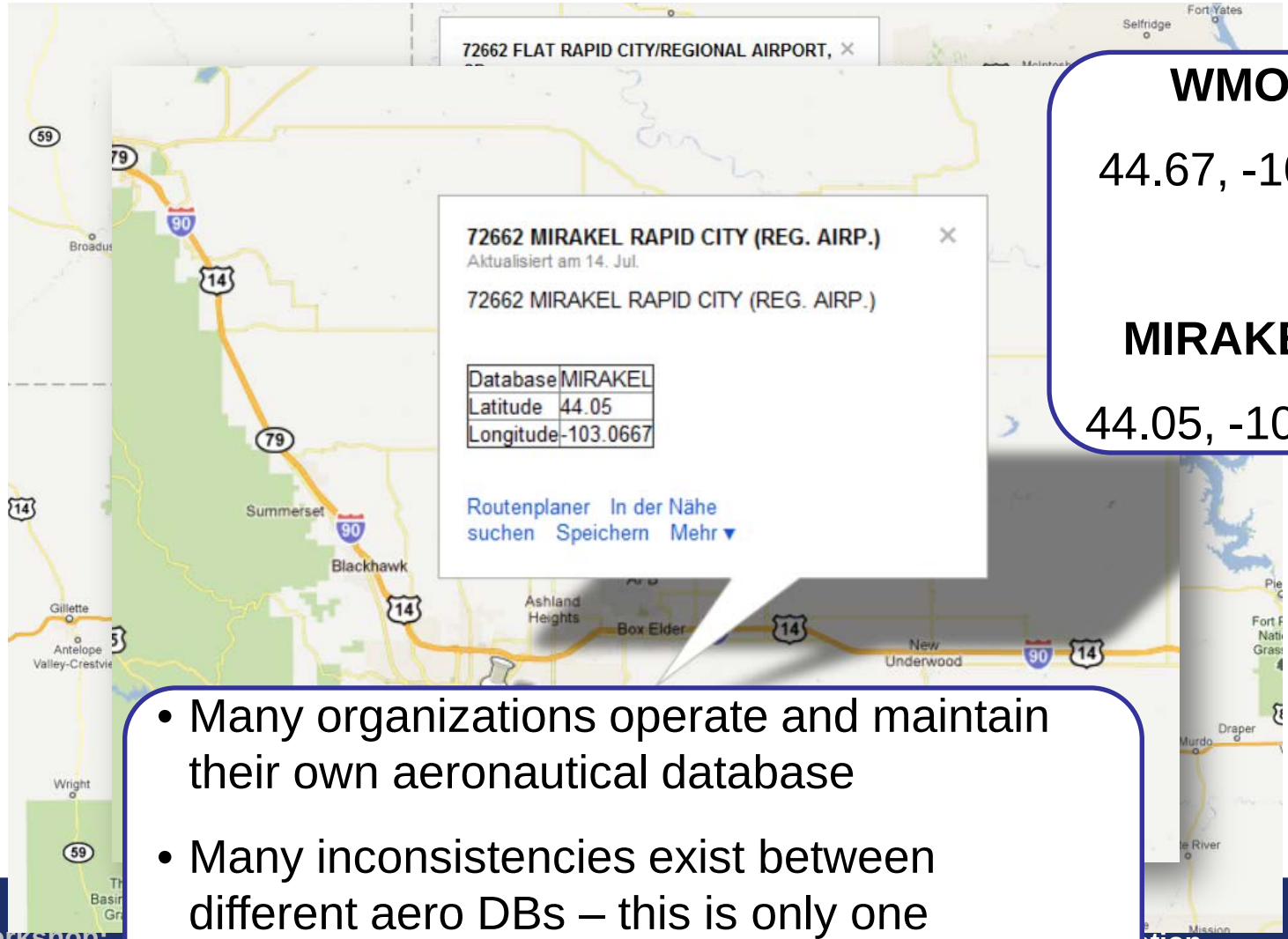
Human language

- SIGMET 1 VALIDO 140019/140600 UTC - FIR SCCI - POR JET STREAM ENTRE LAT 49/54S CON NUCLEO A LOS 35MFT…

"Other" cases

- PIREP: /TB MDT WIFE SAYS SVR

Station Location Consistency



WMO:

44.67, -103.2

MIRAKEL:

44.05, -103.07

- Many organizations operate and maintain their own aeronautical database
- Many inconsistencies exist between different aero DBs – this is only one example

Summary

- **IWXXM 1.1 & WXXM 2.0 released**
  - ICAO testing of IWXXM through collaboration between the ICAO MET and Comm Panels
  - Updates planned
- **IWXXM and WXXM are starting to be integrated into operational systems now and increasingly so in the next 2-3 years**
  - United States use through FAA CSS-Wx and NWP, and NOAA NextGen IT Services
  - International demonstrations in operational contexts (NextGen/SESAR)
- **November 2016: IWXXM will become a recommended practice for ICAO member states**

References

International and US Data Model Descriptions:

https://wiki.ucar.edu/display/CSSWX/Weather+Data+Models

Contact Information

Alfred Moosakhanian, FAA

Program Manager

FAA NextGen Weather Systems

+1 (202) 267-0792

alfred.moosakhanian@faa.gov

Aaron Braeckel, NCAR

WXXM and IWXXM Developer

braeckel@ucar.edu