What is the ICAO Meteorological Information Exchange Model (IWXXM)?

B.L. Choy

Hong Kong Observatory, Hong Kong, China

on behalf of WMO TT-AvData (formerly TT-AvXML)

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IWXXM in short

- A data format for reporting aviation weather information in machine readable XML/GML form
- Currently covers 7 TAC products including:
  METAR/SPECI, TAF, AIRMET, SIGMET, Tropical Cyclone Advisory, Volcanic Ash Advisory, Space Weather Advisory
- Original TAC contents are enriched in their IWXXM counterparts with metadata (e.g. projection) and extension
- XML Schema and Schematron enforces report integrity and reporting requirements in ICAO Annex 3

Who makes IWXXM?

- Institution
- Exchange Model
- Documentation
- Web resources

WMO Approval Process

- **WMO Governance** – IWXXM is defined in WMO-No.306 Manual on Codes Volume I.3: Representations derived from data models.
- **Fast Track Amendment Procedure** – Used for amendments that have minor financial or operational implications (e.g. a minor version or patch release). Usually takes six months from the completion of the draft amendment to implementation of the decision.
- **In Session / between Technical Commission Sessions Amendment Procedure** – Used for amendments that have a noticeable financial or operational implications (e.g. a major version release). Usually takes eight months or more to complete.

Resources on Internet

- Wikipedia (https://en.wikipedia.org/wiki/IWXXM) – as landing page
- WMO
  - WISWiki – no longer available. New web resources being planned
  - No.306 Vol. I.3 (https://library.wmo.int/index.php?lvl=notice_display&id=19508)
  - No.386 (https://library.wmo.int/index.php?lvl=notice_display&id=10728)
  - Schema repository (https://schemas.wmo.int/) and WMO Codes Registry (https://codes.wmo.int)
  - Q&A for implementors of IWXXM: https://groups.google.com/a/wmo.int/forum/#!forum/cbs-tt-avxml
  - GitHub repositories (for development only)
    - IWXXM - https://github.com/wmo-im/iwxxm
    - IWXXM UML Model - https://github.com/wmo-im/iwxxm-modelling
    - TAC-to-IWXXM translation examples - https://github.com/wmo-im/iwxxm-translation
- ICAO
  - Doc No.10003 (https://store.icao.int/en/manual-on-the-icao-meteorological-information-exchange-model-doc-10003)

Hidden Secrets in the Version Number

MAJOR.MINOR.PATCH (X.Y.Z): E.g. IWXXM version 3.0.0

- **A MAJOR (X.y.z) version** introduces major conceptual changes. Forward data mapping is not guaranteed
- **A MINOR (x.Y.x) version** introduces new model elements and capabilities. Forward data mapping is guaranteed
- **A PATCH (x.y.Z) version** is limited to bug fixing. Forward and backward data mapping is guaranteed

* See https://github.com/wmo-im/iwxxm/wiki/Common-approaches-accross-exchange-models for details

Can we prepare reports compliant to latest ICAO Annex 3 in previous IWXXM version(s)?

- In a minor or patch, not all of the report types will be updated. Therefore except the IWXXM version number, the schemas before and after the change, and hence the associated instances, are exactly the same. As both of the schemas are compliant to the latest ICAO Annex 3, it is acceptable to use either version to prepare instances.
- It should be noted that IWXXM 3.0.0 is a major change. All reports in it have been changed and one cannot use a previous IWXXM version to prepare instances.

From IWXXM 2.1.1 to 3.0.0

- Introduced Space Weather Advisory and other Amendment 78 to ICAO Annex 3 changes
- Mandated the use of 2.5D for geospatial representation
- Simplified representation with the removal of OGC Observation and Measurement
- Enhanced schematron rules to include more checks to strengthen the validation process
- Conducted numerous bug fixes and representation / code / documentation enhancements

Compatibility Table (Sample)

ICAO Annex 3	METAR/ SPECI	TAF	AIRMET	SIGMET	TC Advisory	VA Advisory	SWX Advisory	WAFC SIGWX Forecast
Amendment 77	2.1	2.1	2.1	2.1	2.1	2.1	N/A	N/A
Amendment 78	3.0	3.0	3.0	3.0	3.0	3.0	3.0	N/A
Amendment 79 (before Nov 2021)	3.1	3.1	3.1	3.1	3.1	3.1	3.0/3.1	N/A
Amendment 79 (After Nov 2021)	3.1/3.2	3.1/3.2	3.1/3.2	3.1/3.2	3.1/3.2	3.1/3.2	3.0/3.1/ 3.2	3.2

Planned versions

Validation

- Validation is the process of checking a document written in XML to confirm that it is both well-formed and also valid in that it follows a defined structure.
- ICAO considered it important and has asked producers to validate the IWXXM reports prepared before dissemination.
- Validation comes in two parts:
  - Validation against a schema, like taf.xsd
  - Validation against the schematron rules, iwxxm.sch

Schema Vs Schematron

Check against document blueprint (schema)

Check with a script (schematron)


metar-A3-1.xml [C:\Users\blchoy\Downloads\metar-A3-1.xml] - <oXygen/> XML Developer
File Edit Find Project Options Tools Document Window Help
XPath 2.0
Execute XPath on 'Current File'
Project
sample.xpr
css
debugger
epub
fo
import
json
jsp
nvdl
relaxng
schematron
svg
The Master Files support is disabled
Enable
Read more
Outline
Element name filter
iwxxm:METAR "uuid.510df5de-fe
the same as observationTime
iwxxm:issueTime
The aerodrome at which this
iwxxm:aerodrome
time at which the METAR ph
iwxxm:observationTime
iwxxm:observation
metar-A3-1.xml
#comment
<?xml version="1.0" encoding="UTF-8"?>
<!--
An example of a METAR. Original METAR from ICAO Annex 3 Example A3-1:
METAR YUDO 221630Z 24004MPS 0600 R12/1000U DZ FG SCT010 OVC020 17/16 Q10
BECMG TL1700 0800 FG BECMG AT1800 9999 NSW
-->
<iwxxm:METAR xmlns:iwxxm="http://icao.int/iwxxm/3.0" xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml/3.2"
<!-- the same as observationTime except for corrections -->
<iwxxm:issueTime>
<gml:TimeInstant gml:id="uuid.e5460ae4-98a4-48fa-bbfc-21799896f1f2">
<gml:timePosition>2012-08-22T16:30:00Z</gml:timePosition>
</gml:TimeInstant>
</iwxxm:issueTime>
<!-- The aerodrome at which this observation took place -->
<iwxxm:aerodrome>
<aixm:AirportHeliport gml:id="uuid.143d63d9-15f5-442e-9bdc-1f3db93fb6
<aixm:timeSlice>
<aixm:AirportHeliportTimeSlice gml:id="uuid.75c3340c-3679
<gml:validTime/>
<aixm:interpretation>SNAPSHOT</aixm:inte
<aixm:designator>YUDO</aixm:designator>
<aixm:name>DONLON/INTERNATIONAL</aixm:name>
<aixm:locationIndicatorICAO>YUDO</aixm:locationIndicatorICAO>
Text Grid
Attributes
Attribute Value
Attributes Model
Transformation ...
Type filter text
Associ... Scenario
Tr.. Enti.. E..
C:\Users\blchoy\Downloads\metar-A3-1.xml
Validation successful
U+003C
2 : 1
26 new mes...

Collectives and aggregation

- An IWXXM report is required to be put into a collective before disseminating via AMHS.
- Some IWXXM report types (METAR and TAF) may require aggregation, in the same way as their TAC counterparts, before being put into a collective
- We listened to the Thai experts and had improved our schematron rules and now it can validate a collective with multiple versions of IWXXM reports (to be published in IWXXM 3.1)

Extension

- To facilitate consistency in how additional content appears in the IWXXM XML documents, the IWXXM schemas have elements named "extension" in many complex type definitions.
- States can define their own XML types that support their additions to the Annex 3 products' technical specifications. Their unique types can then appear within the extension element(s) of the corresponding IWXXM XML documents.
- Because the <any> type has the attribute "processContents" set to "strict", this requires that a schema file (XSD) must exist and be found by the XML processor. The processor then uses this schema file to validate the content inside the <extension> element.

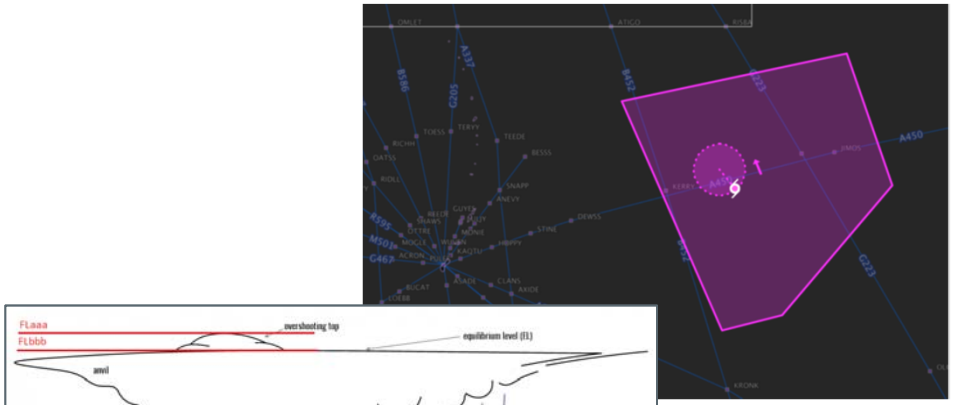
Example: METAR COLOUR STATE INFORMATION

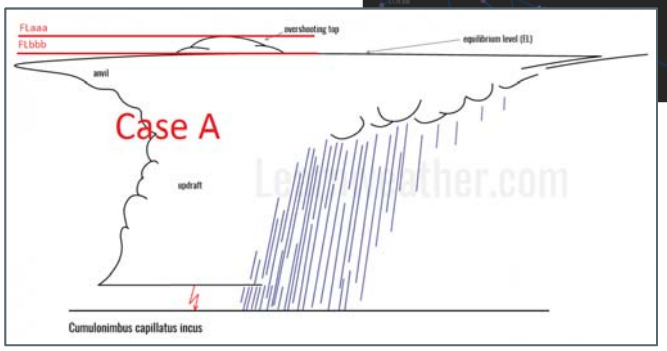
METAR EGUB 120850Z 18024G36KT 9999 BKN017 OVC045 16/13 Q1008 WHT TEMPO 6000 -RA SCT012 GRN=

```
<iwxxm:observation>
  ...
  <iwxxm:extension>
    <ukmoav:UKAerodromeColourState>
      <ukmoav:UKColourState xlink:href="http://reference.metoffice.gov.uk/aviation/UKAerodromeColourStates/WHT"/>
    </ukmoav:UKAerodromeColourState>
  </iwxxm:extension>
  …
</iwxxm:observation>
…
<iwxxm:trendForecast>
  …
  <iwxxm:extension>
    <ukmoav:UKAerodromeColourStateTrend>
      <ukmoav:UKColourState xlink:href="http://reference.metoffice.gov.uk/aviation/UKAerodromeColourStates/GRN"/>
    </unmoav:UKAerodromeColourStateTrend>
  </iwxxm:extension>
  …
</iwxxm:trendForecast>
```

Links with AIXM

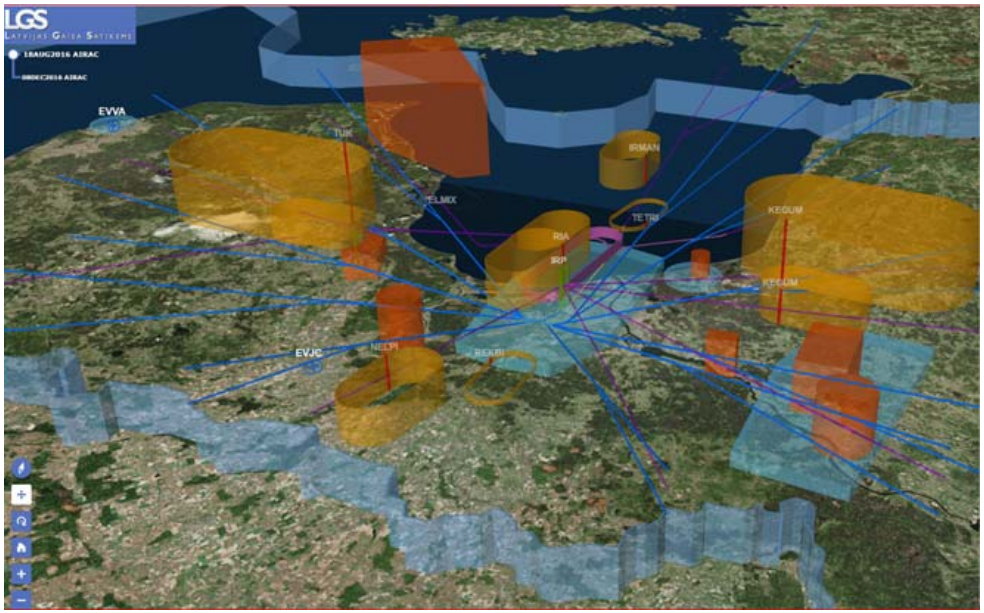
- Aeronautical Information Exchange Model (AIXM) enables the provision of aeronautical information in digital format
- IWXXM imports AIXM for:
  - identifying
    - ATM units
    - FIR/UIR/CTA
    - Aerodromes
    - Runways
  - defining the geospatial coverage of weather features (e.g. a thunderstorm)





Geo-referencing

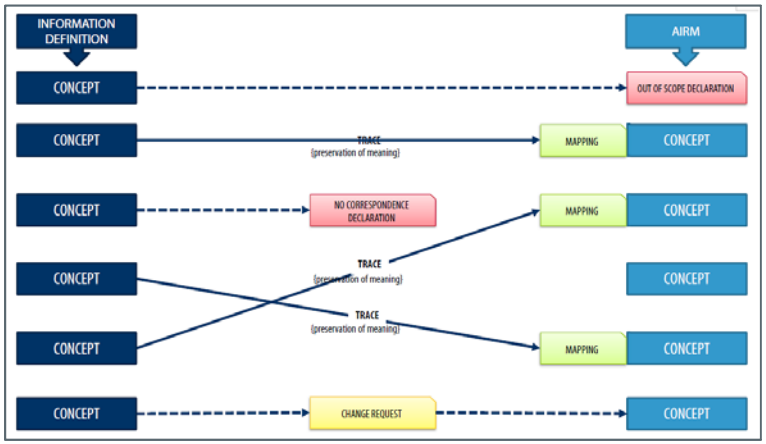
- IWXXM mandates the use of 2.5D (a short form for geospatial references making use of a two dimensional CRS with coordinate tuples and separate definition of elevation) for geospatial representation
- In alignment with AIXM which streamlines computation involving geospatial objects of weather and aeronautical features



Original image from https://ext.eurocontrol.int/aixm_confluence/display/AIX/Latvia

Links with AIRM

- The ATM Information Reference Model (AIRM) is the ATM system-wide reference vocabulary for defining ATM information
- To achieve semantic interoperability, Features in XMs are mapped to concepts in AIRM
- Users should note that the current semantic mappings from IWXXM to AIRM was based on version 1.1 which has been deprecated. Efforts are being made to refresh the mappings to IWXXM 3



Limitations of IWXXM induced by TAC Counterparts

- TAC has a number of constraints which are natural consequence of its compactness. This makes the representation of certain cases difficult, if not impossible.
- Examples include:
  - Maximum and minimum temperature forecasts in TAF
  - Dissipation of tropical cyclone within the forecast period in a Tropical Cyclone Advisory
  - Including of more than 4 RVR reports in METAR
- It was considered a better approach to allow greater range of information to be provided with IWXXM, and relax unnecessary constraints on the number of report to be included for an elements. These suggestions will be brought up for ICAO's consideration

Coming versions of IWXXM will include

- Amendment 79 to ICAO Annex 3 changes (minor)
- New Weather Objects (WxObjects) to support:
  - WAFC SIGWX (high and mid levels) features
  - (Low level) area forecast features
  - Regional Hazardous Warning Advisory features
  - High fidelity MET data
- …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