3.2: SWIM future developments

Future MET-SWIM Services update

ICAO Meteorology Panel (METP)

Presented by Joonas Eklund, METP WG-MIE Adviser

Outline

- Introduction
- Transition from Products to Information Services
- Requirements for MET-SWIM
  - GANP ASBUs
  - Annex 3 and PANS-MET
- Current and Future MET-SWIM Services
- Stakeholder Impacts
  - Benefits
  - Challenges
- Key Takeaways

Introduction

- SWIM enables interoperability across the entire global air traffic management (ATM) system
- Meteorology in SWIM (MET-SWIM) applies the global SWIM framework to the aeronautical meteorological (MET) domain
- MET-SWIM is intended to replace the Aeronautical Fixed System (AFS), the legacy point-to-point message exchange paradigm

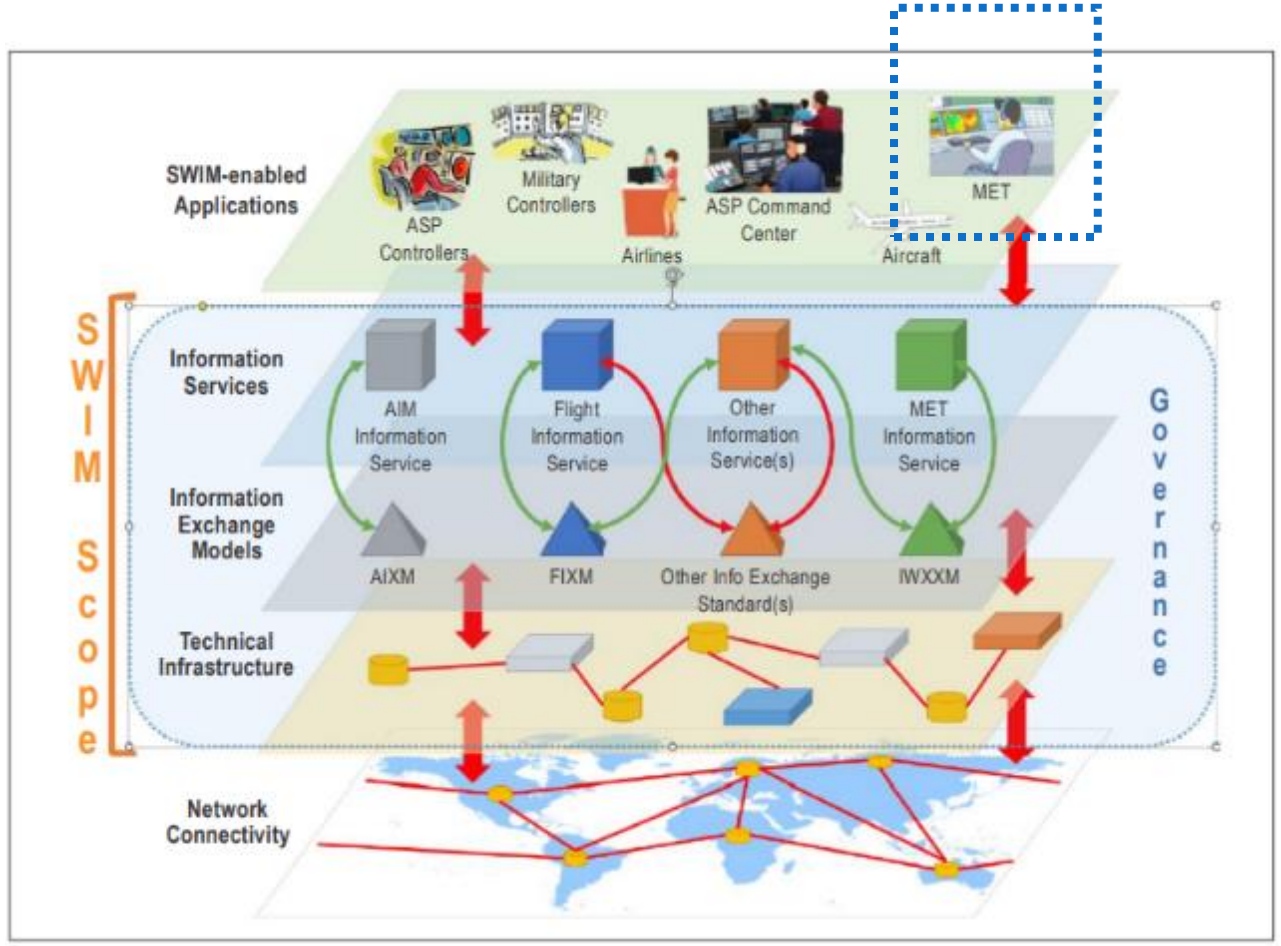


Figure 1-1 from ICAO Doc 10203, *Manual on SWIM Implementation*

Transition from products to information services

- Traditional “text-based” MET products and traditional alphanumeric codes (TAC) no longer suffice for modern international air navigation
- MET information is now required to be provided and exchanged in ICAO Meteorological Information Exchange Model (IWXXM) format (aligned with flight and aeronautical information domains)

Traditional approach	Future approach
Static, text-based products (e.g., METAR and TAF)	Dynamic, machine-readable data (e.g., IWXXM format)
Limited integration with automated systems	Seamless integration with ATM and airline systems, decision-aids

- Information services are automated, tailored to user needs and decision-making timeframes

Requirements for MET-SWIM

- The Global Air Navigation Plan (GANP) Aviation System Block Upgrades (ASBUs) sets the following modules for Meteorology:

AMET	/1	/2	/3	/4
B0	Meteorological observations products	Meteorological forecast and warning products	Climatological and historical meteorological products	Dissemination of meteorological products
B1	Meteorological observations information	Meteorological forecast and warning information	Climatological and historical meteorological information	Dissemination of meteorological information
B2	Meteorological observations information	Meteorological forecast and warning information	Climatological and historical meteorological information	Meteorological information service in SWIM
B3	Meteorological observations information	Meteorological forecast and warning information	Climatological and historical meteorological information	Meteorological information service in SWIM
B4	Meteorological observations information	Meteorological forecast and warning information	Climatological and historical meteorological information	Meteorological information service in SWIM

Requirements for MET-SWIM

AMET Module – AMET Bx/4 - Dissemination

AMET B0/4: Dissemination of Meteorological Products
Commencement of IWXXM, being the conversion of TAC using an IWXXM schema into XML/GML.

AMET B1/4: Dissemination of Meteorological Information
IWXXM form starts to replace TAC products. Human-readable products start to be derived from the IWXXM information (rather than the other way around). The introduction of web services allows for progressive replacement of fixed line dissemination systems.

AMET B2/4: Dissemination of Information Services in SWIM
Implementation of a data-centric MET information into a SWIM environment. User-defined products derived from meteorological information in IWXXM. Wider use of secure web services and decommissioning of fixed line and satellite dissemination systems. Commencement of the use of business-to-business services, allowing integration of MET information into ATM systems. Increased use of air-to-air datalink for transmission of upper air meteorological observation in near real-time.

AMET B3/4: Dissemination of Information Services in SWIM
Continued implementation of a data-centric meteorological information service into SWIM. Enhancement of IWXXM with further schemas and formats for meteorological information exchange. User-defined products automatically derived from meteorological information IWXXM form. Extensive use of secure web services, in particular business-to-business services that allows full integration of meteorological information.

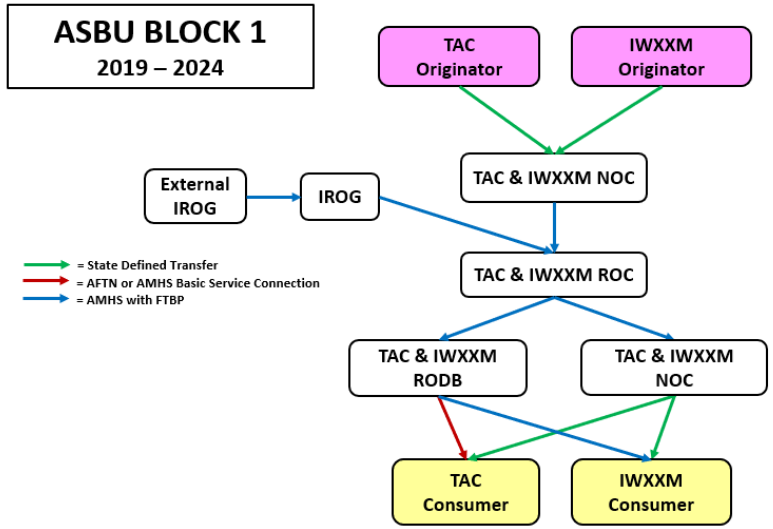
Requirements for MET-SWIM

- Amendment 81 to ICAO Annex 3, *Meteorological Service for International Air Navigation*, included the following provision (ref. para. 2.2.10):

> 2.2.10 **Recommendation.**— *Contracting States should ensure that the meteorological information supplied to the users listed in 2.1.2 is provided through information services.*
>
> *Note 1.— In the context of system-wide information management (SWIM), the notion of information service addresses machine-to-machine interaction in a service-oriented architecture.*
>
> *Note 2.— Procedures on information services are contained in the* Procedures for Air Navigation Services – Information Management *(PANS-IM, Doc 10199).*
>
> *Note 3.— Guidance material on information services can be found in the* Manual on System-wide Information Management Implementation *(Doc 10203).*

- As a result, the ICAO METP is developing subsequent Standards and Recommended Practices (SARPs) to enable information services for the provision of MET information

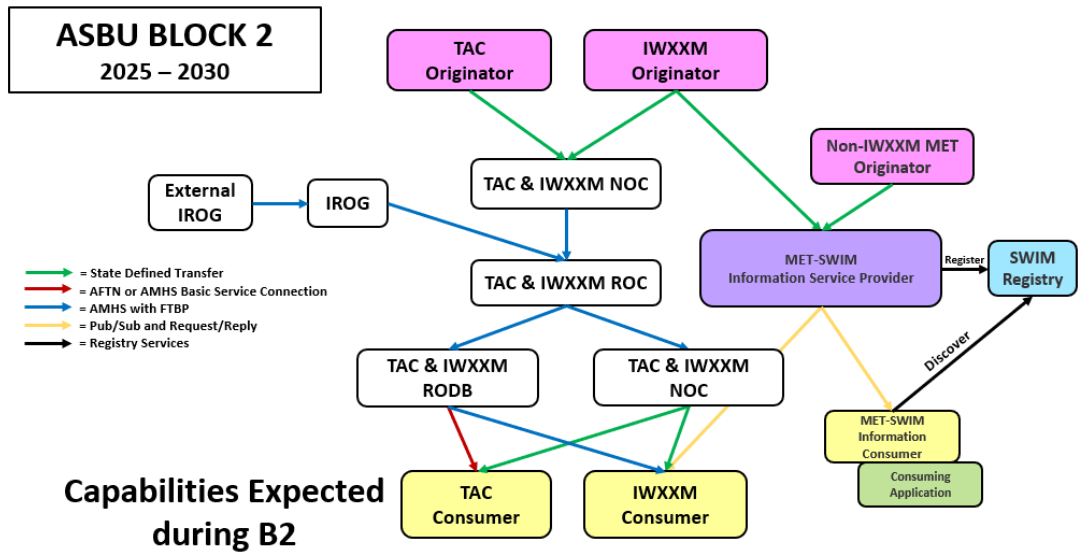
Current and future MET-SWIM services



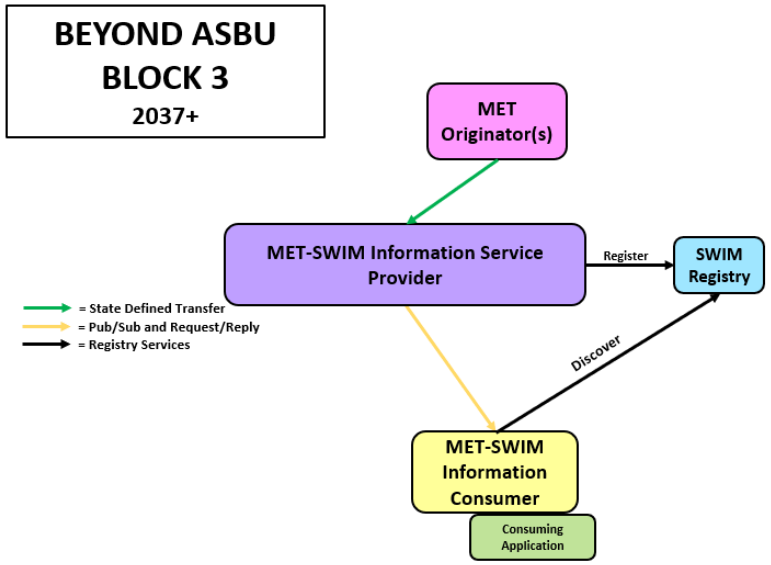
The Past

The provision of aeronautical meteorological information via SWIM-enabled information services will be one of the most significant developments in aviation in the last 30 years

The Present



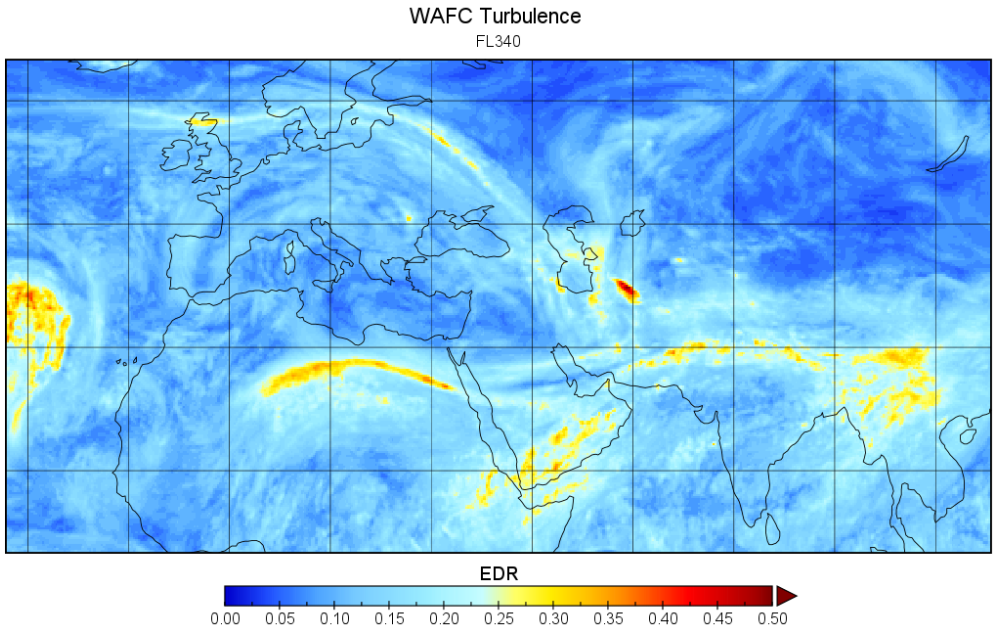
Capabilities Expected during B2

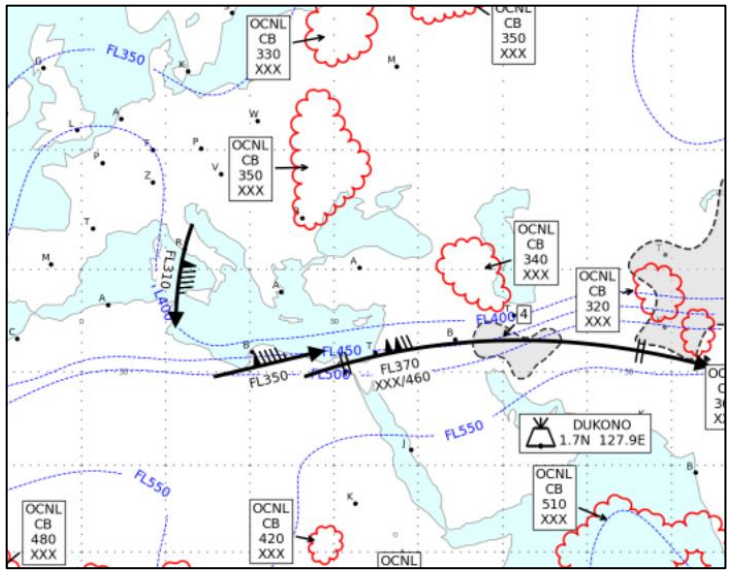


The Future

Current and future MET-SWIM services

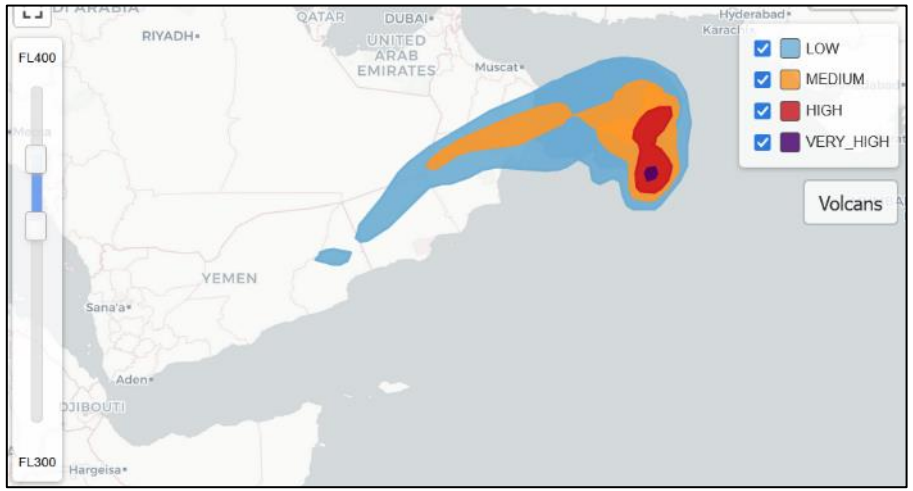
- WAFS
- Secure Aviation Data Information Service (SADIS) and WAFS Internet File Service (WIFS) Application Program Interfaces (APIs)
  - SADIS API, provided by World Area Forecast Centre (WAFC) London, and WIFS API, provided by WAFC Washington, became operational in 2025
  - Both systems are SWIM compliant and based on the Open Geospatial Consortium (OGC) Environmental Data Retrieval (EDR) API framework
  - SADIS API and WIFS API provide access to upgraded WAFS gridded data sets, global METARs, TAFs, SIGMETs and other advisories, and multi-timestep WAFS SIGWX forecasts
  - These systems supply data to National Met Services, ANSP's, Flight planning companies, Airlines, and other aviation specific software suppliers across the globe

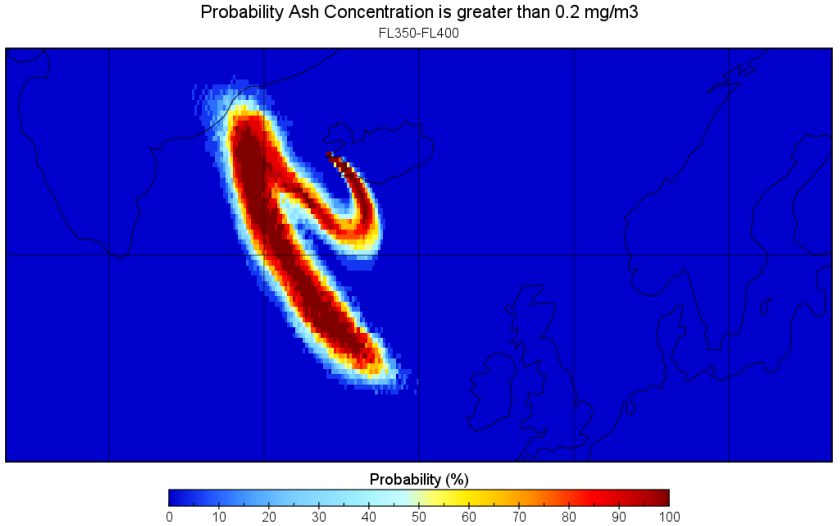


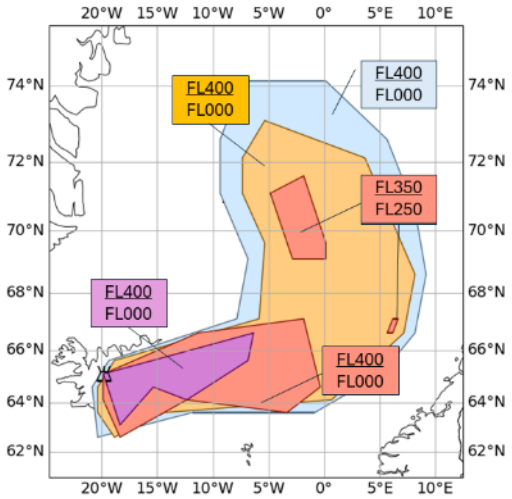


Current and future MET-SWIM services

- Quantitative Volcanic Ash (QVA)
- Introduced to ICAO Annex 3 with Amendment 82
  - VAAC London and VAAC Toulouse QVA API's became operational on 27 November 2025. The other 7 VAACs will follow in late 2026.
  - Provides deterministic and probabilistic gridded ash concentration forecasts as well as QVA ash polygons
  - All VAACs agreed to use the OGC-EDR API framework
  - These systems are starting to supply data to National Met Services, ANSP's, Flight planning companies, Airlines, and other aviation specific software suppliers across the globe







Current and future MET-SWIM services

- AMOIS
- AMOIS (Aerodrome Meteorological Observation Information Service) is the future aerodrome observation, which will eventually replace METAR, SPECI and local routine/special report
  - Significantly increased temporal resolution, possibility to provide data on e.g. 1-minute interval
  - Increased optional parameters, multiple sensor data can be included alongside with more traditional aerodrome values
  - Possibility to include both automated and manual observation data
  - New IWXXM schema to be developed
  - Initial base requirements can still be met based on METAR/SPECI.
  - Distribution only via SWIM information services, not planned to distribute via AFS/AMHS

Current and future MET-SWIM services

- AMFIS
- AMFIS (Aerodrome Meteorological Forecast Information Service) is the future aerodrome forecast, which will eventually replace TAF, landing- and take-off forecasts
  - Increased temporal resolution, base forecast time step 1 hour, optionally more (no limit on shortest time limit, for landing and take-off forecast purposes
    - TAF-like change groups are optional and based on State decision to include them in the service
  - Increased optional parameters, e.g. cross-, head/tailwind and wind information aloft
  - Extended use of probabilities for certain parameters and thresholds
  - New IWXXM schema to be developed
  - Initial base requirements can be met based on TAF
  - Distribution only via SWIM information services, not planned to distribute via AFS/AMHS

Current and future MET-SWIM services

- HWIS
- HWIS (Hazardous Weather Information Service) is the future en-route warning information service, which will compliment and eventually replace SIGMETs
  - HWIS parameters to be provided: CB clouds, turbulence and icing
  - Consists of analysis, nowcast and forecast data: T+0 to T+6 hrs
  - Consolidation of state-level hazardous weather information into regional datasets by data aggregators
    - Contributors: in principle, state level data to be provided by local Met Service Providers
    - Missing data supplemented by WAFC data (as a fall-back)
  - Regional HWIS datasets to become initial operational services (trials on-going already)
  - Eventually aggregation of regional datasets into a global operational HWIS service
  - Distribution only via SWIM information services

Current and future MET-SWIM services

- Future MET Information Services expected implementation timelines

- **AMOIS and AMFIS:** initial requirements to be approved by ICAO MET Panel meeting in late 2027
- Expected applicability with Annex 3 AMDT84 (NOV 2030)
  - **Recommendation** at first, METAR and TAF to remain as ICAO standards

- **HWIS:** initial regional implementation expected by 2033 (AMDT85), global implementation in approximately 2036.
  - **Recommendation** at first (regional) introduction
  - SIGMETs to remain the ICAO standard for now

Current and future MET-SWIM services

- Standardisation of MET-SWIM services
  - Information service definitions
  - SWIM Yellow Profile
  - Use of standard interfaces: AMQP and OGC EDR API
  - Technical implementation guidance

Stakeholder impacts

- Benefits of MET-SWIM across the entire aviation system:
  - ATC → Real-time updates and better rerouting
  - Pilots → Real-time hazard awareness in cockpit systems
  - Dispatchers → More accurate flight planning
  - Airlines → Proactive operations management
  - ANSPs → Automated data for ATM systems
  - Aerodrome ops → Better planning for aerodrome conditions

Stakeholder impacts

- Challenges of implementing MET-SWIM services:
  - Much larger data volumes for users to manage
    - Systems must be adapted to handle influx of data
    - Users should only select data they need (ex: not download global data)
  - “No country left behind”
    - Difficult to strike a balance between innovation and realistic expectations for global standardization
    - Not every State has the same capabilities
    - ICAO Regions move at different paces
  - Visualization of MET data
    - As visualization will fall on the users, should visualization of MET data be standardized (or at least guidance provided) in the future, when data is no longer in TAC format?
  - Investment requirements
    - Sustainability of legacy systems (end of lifecycle) and persistent use of legacy products
    - Costs associated with implementing new systems

Key takeaways

- ICAO has endorsed the transition to data-centric MET services
- Transition from legacy METAR, TAF, SIGMETs, etc. to digital, automated information services
- WAFS, QVA, AMOIS, AMFIS, and HWIS define the next generation of aviation weather data
- Final requirements and timelines being actively developed by the ICAO METP
- Stakeholders should:
  - Stay informed of progress on implementation plans
  - Participate in national, regional, and global planning efforts
  - Collaborate with system developers to ensure SWIM and IWXXM readiness
  - Educate and prepare to understand and adopt future MET information services

Thank you!