International Civil Aviation Organization

THE ELEVENTH MEETING OF SYSTEM WIDE INFORMATION MANAGEMENT TASK FORCE (SWIM TF/11)

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Agenda Item 6: State, regional and global SWIM updates

UPDATE ON MET INFORMATION EXCHANGE VIA AMQP IN EUROPE

(Presented by Australia)

SUMMARY

This paper provides an update on the implementation of AMQP brokers in Europe for meteorological information exchange. It describes the current state of the standardization of AMQP headers and message structure as defined by the European MET3SG and key lessons learnt during implementation. It highlights the need for detailed, globally agreed technical specifications for AMQP message and application properties, and the practical differences encountered between different AMQP implementations. It also highlights an aggregation data being performed across the Northern Europe Aviation Meteorology Consortium (NAMCON) states.

1. INTRODUCTION

1.1 The ICAO Meteorological Panel (METP) Working Group on Meteorological Information Exchange (WG-MIE) is tasked with developing guidance to support the implementation of meteorological aspects of SWIM (MET-SWIM). This includes the use of AMQP. WG-MIE receives updates from various States on their development and learnings.

1.2 Within Europe, a MET SWIM Services Sub-Group (MET3SG) is leading the development and implementation of MET-SWIM.

1.3 Defining standards for the structure of AMQP messages is an important pre-requisite for a regional or global use of AMQP for SWIM information exchange. The MET3SG is leading work to develop these standards through consultation with producers and consumers including experts within the systems manufacturer industry (IBL, NetSys, Vaisala, Campbell Scientific and Thales).

1.4 Most European States have now implemented their own AMQP broker as the primary means to access to their IWXXM METAR/SPECI, TAF and SIGMET data. In addition, these States provide request/reply access via OGC Environmental Data Retrieval (EDR) APIs, and in some cases the older OGC Web Feature Service (WFS).

1.5 This paper provides an update on guidance provided with regard to the implementation of European regulation Common Project One (CP1) European Union regulation (EU 2021/116) compliant MET-SWIM services. The paper also shares the main lessons learnt so far, which may be of value to other regions and to ICAO as globally harmonised AMQP (broker) services are developed.

2. DISCUSSION

2.1 NAMCON is the Northern Europe Aviation Meteorology Consortium, and has for over a decade worked towards harmonised and cost-efficient Aviation Meteorology production across its Nordic and Baltic member States.

2.2 The Finnish Meteorological Institute (FMI) set up and hosts the NAMCOM broker. The broker was deployed operationally in late 2025 and has been progressively connected to participating states.

2.3 At present, 4 of the 8 NAMCON states – Finland, Sweden, Norway and Estonia – are actively providing their IWXXM data to the NAMCOM broker. Two further states are actively working on connecting their systems, and the remaining states are expected to follow. The remaining states are planning to provide their data through the common broker, possibly by the end of 2026.

2.4 Currently the NAMCOM broker is transporting the IWXXM payload as data, but a future capability may provide a link to each state's EDR service alongside or instead of the IWXXM payload.

2.5 A key lesson from the implementation is that technical specifications for AMQP-based services need to be very exact. Where specifications leave room for interpretation, providers will easily do things slightly differently, which breaks interoperability for consumers who must otherwise accommodate multiple variants. The guidance available from the Eurocontrol MET-SWIM AMQP Message Structure wiki (https://swim-eurocontrol.atlassian.net/wiki/spaces/MSS/pages/638156804/AMQP+Message+Structure+in+MET-SWIM) was instrumental, but in practice even more detail was required, especially for the AMQP message properties and application properties. For example, optional properties such as "creation-time", "absolute-expiry-time" and "geometry.coordinates" now still differ across implementations.

2.6 For the implementation of the exchange of aeronautical meteorological information over the publish - subscribe message pattern in Europe, version 1.0 of the AMQP Messaging binding was chosen. This decision was made in accordance with the guidelines of the EUROCONTROL SWIM TI Yellow Profile, providing the common base for interoperability of SWIM implementations in Europe.

2.7 Although AMQP 1.0 is a standardised protocol, different AMQP software implementations behave differently in practice. The NAMCON broker is based on RabbitMQ, while other parts of the MET-SWIM community use e.g. Apache ActiveMQ Artemis. Features such as queues and streams are implemented and exposed slightly differently between the two, which can affect how consumers need to configure their clients and how durability, filtering and subscription semantics behave.

2.8 The objectives of standardization are as follows

- Ensure interoperability between different MET-SWIM implementations
- Standardize AMQP message properties for meteorological data exchange
- Enable efficient filtering of messages
- Enable routing of messages to downstream systems based on typical information like report type or aerodrome/FIR code.
- Provide forward compatibility for future meteorological data types beyond the initial basic CP1 SWIM data exchange

2.9 The AMQP message in the MET-SWIM context consists of the following components:

Message Addressing: Destination address using a hierarchical structure

Message Transport Header: Priority settings, expiration
Message Properties: Standard AMQP properties including subject, content-type, etc.
Application Properties: - Custom properties for meteorological data identification and filtering
Message Payload: - The actual data (IWXXM)

2.10 The current CP1 requirement for most States is the exchange of IWXXM METAR/SPECI, TAF and SIGMET. But there is no strict limitation to these data, and some States are also exchanging volcanic ash, tropic cyclone and space weather advisories.

2.11 The address structure used for the **Message Addressing** uses a simplified three-level hierarchical structure inspired by the World Meteorological Organisation (WMO) WMO Information System 2.0 (WIS 2) topic hierarchy[1]. For aeronautical meteorological data, level1=`weather` and level2=`aviation` is fixed, with level3 having currently one of the following options "`metar`, `taf` or `sigmet`".

2.12 Wildcards (e.g. * or #) can be used for subscriptions, but different AMQP v. 1.0 brokers implement wildcard support with varying levels of compatibility. In addition, backward compatibility to AMQP v. 0.9.1 cannot be expected.

2.13 The NAMCON broker currently exposes four default streams, aggregating the corresponding product types across all connected provider states:

a) METAR: namcon.weather.aviation.metar
b) TAF: namcon.weather.aviation.taf
c) SIGMET; namcon.weather.aviation.sigmet
d) OPMET: namcon.opmet (a combined stream carrying all of the above)

2.14 The **Message Transport Header** enables setting the message priority and expiration. In general, SPECI should have a higher priority than METAR, TAF AMD a higher priority than a regular TAF, and SIGMET should have the highest priority, although given high capacity of links the difference may be immaterial. Guidance on how to set the priority, similar to traditional message exchange via AFS, should be agreed.

2.15 The AMQP Message Properties defines the AMQP 1.0 message properties used in Europe MET-SWIM implementations. There are mandatory, conditional and optional elements:

- **subject (MANDATORY)** The subject SHALL represent the type of data transmitted, analogously to the WMO WIS 2.0 concept of topics and equal to the source address. This is useful for disambiguating data when using wildcard source address subscriptions. Example: `weather.aviation.metar`

- **content-type (MANDATORY)** Indicates the MIME type of the payload and SHALL be set to `application/xml` for the IWXXM XML data.

- **content-encoding (CONDITIONAL)** By default, payloads are not compressed, and in this case, the content-encoding property can be left out. However, when compression is applied to the payload, the `content-encoding` is mandatory. The MET-SWIM service AMQP implementations and clients SHALL support the following content-encodings:

    - `gzip` - for compressed data. This is the most widely supported compressed `content-encoding` in HTTP.
    - `identity` - for uncompressed data (default if omitted).

[1] See https://wmo-im.github.io/wis2-topic-hierarchy/standard/wis2-topic-hierarchy-STABLE.html

- **absolute-expiry-time (OPTIONAL)** Unix-like UTC timestamp in milliseconds, indicating when the message should expire in the broker and from the durable queues.

- **creation-time (OPTIONAL)** This is the Unix UTC timestamp (in milliseconds since the epoch) indicating when the AMQP message was initially created. It mostly serves an informational purpose in AMQP and is used in the ttl calculation in some brokers.

2.16 The AMQP Application Properties are the most flexible mechanism for identifying the data sent using AMQP and enabling server-side filtering using AMQP Filter Expressions 1.0. The AMQP specification does not regulate AMQP application property names and meanings. They are custom-defined by individual services that use AMQP as their notification layer.

2.17 The following application properties have been defined as mandatory and therefore must be present in all meteorological data messages:

- properties.report_status one of the following values:
  - NORMAL – Regular report
  - AMENDMENT – Amendment of a previous report
  - CORRECTION – Correction of a previous report

  This is directly based on the IWXXM reportStatus attribute

- properties.icao_location_identifier

- properties.icao_location_type (OPTIONAL)
  Can be optionally used for disambiguation when the location referred to by the `properties.icao_location_identifier` is not clear.

2.18 If there is a service definition the data conforms to (e.g. the CP1 compliant SWIM Service Definitions), **properties.conformsTo** SHOULD link to the service definition. The field identifies the specification version and the corresponding SWIM service definition.

2.19 Temporal Properties contain date and time information extracted from the IWXXM data:

- properties.issue_datetime (mandatory)

- properties.datetime (conditional) For METAR/SPECI only, observation time in RFC 3339 format from `iwxxm:observationTime` , eg. `properties.datetime: "2025-03-31T03:00:00Z"`

- properties.start_datetime (conditional) For TAF/SIGMET - start of validity period in RFC 3339 format from `iwxxm:validPeriod`

- properties.end_datetime (conditional) For TAF/SIGMET - end of validity period in RFC 3339 format

2.20 The **Message Payload** SHALL contain the complete IWXXM XML document representing one METAR, SPECI, TAF or SIGMET report. The message property `content-type` must be set to `application/xml`. The payload can be optionally compressed using gzip; in this case, the `content-encoding` message property SHALL be set to `gzip`.

2.21 Further the introduction of additional application properties to further support the operational information exchange over MET SWIM might be considered. Possible examples may

include the geographical reference of a message (e.g. LAT/LON) to enable basic geographic filtering or permissible usage.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) consider adopting the same approach/guidance for (at least the meteorological information exchange aspects) of APAC SWIM;

c) consider if there is a need to align the metadata used across different information domains; and

d) discuss any relevant matter as appropriate.

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