Roadmap for Aeronautical Meteorological (MET) Information in System-Wide Information Management (SWIM)

April 2021
Version 2.3

International Civil Aviation Organization

RECORD OF REVISIONS

Revisions		
No.	Date	Description
1.0	September 2016	Initial version developed by the ICAO WG-MIE
1.1	April 2018	Updated based on GANP changes and discussions with the Communications and Information Management Panels
1.2	June 2018	Updated based on the outcomes of WG-MIE/4
1.3	October 2018	Updated based on the outcomes of METP/4
1.4	March 2019	Updated based on the outcomes of MIE/MRI Workshop
1.5	September 2019	Updated based on the outcomes of WG-MIE/5
1.6	October 2019	Updated based on the outcomes of WG-MIE/6
1.8	April 2020	Updated in preparation for review by WG-MIE MET-SWIM Work Stream
1.9	May 2020	Updated in preparation for second review by WG-MIE MET-SWIM Work Stream
2.0	June 2020	Updated in preparation for review by WG-MIE
2.1	August 2020	Updated in preparation for review by METP
2.2	October 2020	Updated following review by METP
2.3	April 2021	Updated based on the outcomes of WG-MIE/7

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LIST OF ABBREVIATIONS AND ACRONYMS

AFS	Aeronautical Fixed Service
AFTN	Aeronautical Fixed Telecommunication Network
AIM	Aeronautical Information Management
AIRMET	Airmen's Meteorological Information
AMHS	Aeronautical Message Handling System
AMO	Aerodrome Meteorological Office
AMQP	Advanced Message Queuing Protocol
AMS	Aerodrome Meteorological Station
ASBU	Aviation System Block Upgrade
Doc	Document
FTBP	File Transfer Body Part
GANP	Global Air Navigation Plan (ICAO Doc 9750)
HTTP	Hypertext Transfer Protocol
HWIS	Hazardous Weather Information Service
ICAO	International Civil Aviation Organization
IP	Internet Protocol
IROG	Interregional OPMET Gateway
IT	Information Technology
IWXXM	ICAO Meteorological Information Exchange Model
MET	Aeronautical meteorological
METAR	Routine Aerodrome Meteorological Report
METP	ICAO Meteorology Panel
MET-SWIM	Meteorological Information in SWIM
MET-SWIM Plan	Plan for Aeronautical Meteorological Information in System-Wide Information Management
MET-SWIM Roadmap	Roadmap for Aeronautical Meteorological Information in System-Wide Information Management
MWO	Meteorological Watch Office
NOC	National OPMET Centre
NWP	Numerical weather prediction
OPMET	Operational meteorological
ROC	Regional OPMET Centre
RODB	Regional OPMET Data Bank
RQM	Request/reply Query (for meteorological databank data in TAC format)
SARP	Standard and Recommended Practice
SIGMET	Significant Meteorological Information
SIGWX	Significant Weather
SOA	Service Oriented Architecture
SPECI	Special aerodrome meteorological Report
SWIM	System-Wide Information Management
SWXA	Space Weather Advisory
SWXC	Space Weather Centre
TAC	Traditional Alphanumeric Code
TAF	Aerodrome Forecast
TCA	Tropical Cyclone Advisory
TCAC	Tropical Cyclone Advisory Centre
TREND	Trend Forecast
VAA	Volcanic Ash Advisory
VAAC	Volcanic Ash Advisory Centre
WAFC	World Area Forecast Centre
WAFS	World Area Forecast System
WCS	Web Coverage Service
WFS	Web Feature Service
WG-MIE	ICAO Working Group on Meteorological Information Exchange
WMS	Web Map Service
WMO	World Meteorological Organization

1. INTRODUCTION

1.1 System-Wide Information Management (SWIM) will complement human-to-human communications with machine-to-machine communications and improve data distribution and accessibility. However, the flexibility inherent in human communication is not intrinsically included in Information Technology (IT) systems and must be specified and included in the system design. To enable the desired flexibility, IT systems will increasingly need to "ask for" or "discover" operationally relevant facts, depending on the circumstances, rather than remain "being informed" by pre-agreed messages. Increased machine-to-machine capabilities will enable many new software applications while continuing to support existing human usages.

1.2 ICAO Doc 10039, *Manual on System-Wide Information Management Concept*, describes general SWIM concepts and characteristics. The *Plan for Aeronautical Meteorological Information in System-Wide Information Management* (MET-SWIM Plan), provides further detail on the role of aeronautical meteorology in SWIM, including the relationship between meteorology and other SWIM domains (such as aeronautical information management (AIM)) in the system, along with design concepts.

1.3 This document, the *Roadmap for Aeronautical Meteorological Information in System-Wide Information Management* (MET-SWIM Roadmap), describes the transition plan and associated timelines for implementing aeronautical meteorological (MET) information in SWIM (MET-SWIM), including the necessary timelines and strategies for implementing necessary non-MET components such as Internet Protocol (IP) networking and Hypertext Transfer Protocol (HTTP) support.

1.4 MET-SWIM implementation and transition will proceed based upon the Aviation System Block Upgrade (ASBU) schedule outlined in ICAO Doc 9750, *Global Air Navigation Plan (GANP[1])*. The current SWIM-related ASBU elements and their respective timelines are shown in Table 1. This timeline does not prevent early adopters implementing MET-SWIM capability prior to 2025.

Table 1. Timeline for ASBU Elements related to MET-SWIM.

ASBU Element	ASBU Element Description	ASBU	Timeline
AMET-B1/4	Dissemination of MET Information	1	2019 – 2024
AMET-B2/4	MET Information Service in SWIM	2	2025 – 2030
AMET-B3/4	MET Information Service in SWIM	3	2031 – 2036
AMET-B4/4	MET Information Service in SWIM	4	2037 – 2042
SWIM-B2/1	Information Service Provision	2	2025 – 2030
SWIM-B2/2	Information Service Consumption	2	2025 – 2030
SWIM-B2/3	SWIM Registry	2	2025 – 2030
SWIM-B2/4	Air/Ground SWIM for Non-Safety Critical Information	2	2025 – 2030
SWIM-B2/5	Global SWIM Processes	2	2025 – 2030
SWIM-B3/1	Air/Ground SWIM for Safety Critical Information	3	2031 – 2036

[1] ICAO GANP Portal found at: https://www4.icao.int/ganpportal/

2. TRANSITION PLAN

2.1 Transition Timeline

2.1.1 Transition to MET in a SWIM environment can be summarized as including the following components:

a) Provision of meteorological information in ICAO Meteorological Information Exchange Model (IWXXM) format;
b) Provision of meteorological information via MET-SWIM information services, including Web Feature Service (WFS), Web Coverage Service (WCS) and Web Map Service (WMS), over HTTP;
c) Additional data types beyond IWXXM, including gridded data and objects; and,
d) Replacement of Aeronautical Fixed Telecommunications Network (AFTN) and Aeronautical Message Handling System (AMHS) "message push" communications with Advanced Message Queuing Protocol (AMQP).

2.1.2 There are several components of the MET-SWIM transition: physical network connectivity, communications protocols, information exchange services and data types exchanged. Table 2 summarizes the MET-SWIM implementation timeline for these components, and is expanded upon in sections below.

Table 2. Components of MET-SWIM Transition.

	Block 0 2013-2018	**Block 1 2019-2024**	**Block 2 2025-2030**	**Block 3 and Beyond >2031**
Communication Protocols	AFTN AMHS Basic	AFTN AMHS Basic AMHS FTBP AMQP/HTTP (optional)	AMHS FTBP AMQP/HTTP	AMQP/HTTP
Information Exchange Services	RODB TAC request/reply RODB IWXXM request/reply	RODB TAC request/reply RODB IWXXM request/reply RODB IWXXM notification (optional) WFS, WCS, WMS (optional)	RODB IWXXM request/reply RODB IWXXM notification (optional) WFS, WCS, WMS	WFS, WCS, WMS Other web services
Data Types	Gridded Objects	Gridded Objects	Gridded Objects	Gridded Objects
Data Addressing	AFS Addressing	AFS Addressing IP (optional) SWIM Registry (optional)	AFS Addressing IP SWIM Registry	IP SWIM Registry

2.1.3 Communications protocols include AFTN, AMHS Basic, AMHS File Transfer Body Part (FTBP), AMQP and HTTP in various ASBU Blocks. As indicated in Table 2, AFTN is only applicable to traditional alphanumeric code (TAC), and AMHS is applicable to the exchange of MET information in TAC format where "Basic" is noted. For the exchange of MET information in IWXXM format in Block 1 and beyond, AMHS FTBP and AMQP/HTTP are applicable. AMQP/HTTP is denoted as "optional" in Block 1 as the early adoption of SWIM communications prior to Block 2 is encouraged.

Note 1: — AMHS with FTBP capability shall be implemented by Block 1 to enable the exchange of messages in IWXXM and should fully replace AFTN by Block 2. Therefore, when AMHS is available, it is not advised to continue usage of AFTN. It is understandable that there will be cases in which AFTN must continue to be used leading up to Block 2.

Note 2: — For this document, the terms TAC and TAC format refer to those products in ICAO Annex 3, Meteorological Service for International Air Navigation, that are issued in accordance with code forms prescribed by the World

Meteorological Organization (WMO), such as routine aerodrome meteorological report (METAR) special aerodrome meteorological report (SPECI), trend forecast (TREND) and aerodrome forecast (TAF), as well as those products in Annex 3 that are disseminated in abbreviated plain language, such as SIGMET, AIRMET, volcanic ash advisory (VAA), tropical cyclone advisory (TCA) and space weather advisory (SWXA).

2.1.4 Information exchange services include Regional Operational Meteorological (OPMET) Databanks (RODB) TAC request/reply, RODB IWXXM request/reply, WFS, WCS, WMS and other web services in various ASBU blocks. Much like for communication protocols, RODB TAC request/reply is applicable only for the exchange of MET information in TAC format. For the exchange of MET information in IWXXM format, RODB IWXXM request/reply, RODB IWXXM notification, WFS, WCS and WMS are applicable. RODB IWXXM notification is denoted as optional for Blocks 1 and 2, as it may be utilized but is not required. WFS, WCS and WMS are denoted as "optional" in Block 1 as the early adoption of SWIM communications prior to Block 2 is encouraged. RODB IWXXM request/reply is not included in Block 3 and beyond as the MET SWIM architecture evolves to transition away from National OPMET Centers (NOCs), Regional OPMET Centers (ROCs) and RODBs into an architecture centralized around SWIM services. Other web services may be introduced in Block 3 and beyond.

Note 3: — For more information on RODB IWXXM publish/subscribe and notification, refer to Section 2.6 of the MET-SWIM Plan.

2.1.5 Data types include:

a) Gridded, such as satellite data, radar data and output from numerical weather prediction (NWP) models
b) Objects, such as non-gridded information in IWXXM format

2.1.6 Data addressing methods include Aeronautical Fixed Service (AFS) Addressing, IP and the SWIM Registry in various ASBU blocks. AFS Addressing includes established communications between NOCs, ROCs, RODBs and Interregional OPMET Gateways (IROGs). IP and SWIM Registry are denoted as "optional" in Block 1 as the early adoption of SWIM communications prior to Block 2 is encouraged.

2.1.7 A transition to MET-SWIM will also result in modifications to the organizational roles involved in MET information exchanges (refer to Table 3). The most significant changes are:

a) IP communications and the SWIM Registry will greatly reduce the need for data aggregation;
b) More organizations (especially States) will offer web services and data directly to data consumers.

Table 3. MET-SWIM Roles.

Function/Role	Block 0 2013-2018	Block 1 2019-2024	Block 2 2025-2030	Block 3 and Beyond >2031
Data Provider	MWO, AMO, AMS, VAAC, TCAC, WAFC	MWO, AMO, AMS, VAAC, TCAC, WAFC, SWXC	MWO, AMO, AMS, VAAC, TCAC, WAFC, SWXC, HWIS	Accredited MET Information Service Provider
Data Aggregator and Validator	NOC, ROC, RODB, IROG	NOC, ROC, RODB, IROG	NOC, ROC, RODB, IROG SWIM Broker	SWIM Broker
Data Repository	WAFC, RODB, State/NOC	WAFC, RODB, State/NOC	WAFC, RODB, State/NOC Accredited MET Information Service Provider	Accredited MET Information Service Provider

2.2 Transition from TAC to IWXXM

2.2.1 The ICAO Meteorology Panel (METP) has recommended the eventual removal of TAC from ICAO Annex 3 to ensure that IWXXM will serve as the primary format for the exchange of MET information.

2.2.2 IWXXM format became a Standard for dissemination on 5 November 2020 with the applicability of Amendment 79 to Annex 3 for the following TAC products: SIGMET, AIRMET, METAR, SPECI, TREND, TAF, VAA, TCA and SWXA. Significant weather (SIGWX) forecasts, while not a TAC product, will become a Recommended practice for dissemination in IWXXM as of 4 November 2021.

2.2.3 The METP has noted the benefit in providing multi-year advance notice for TAC to be removed as a standard in Annex 3, thus allowing States and other aviation stakeholders to procure or build alternatives and identify processes to be considered as precursors for the cessation of TAC. The full decommissioning of TAC format and sole requirement for IWXXM format will occur within Block 2 (2025-2030) in accordance with the ICAO GANP, with a specific target date to be determined by the ICAO METP in the future.

2.2.4 IWXXM format will continue as Standard in subsequent Amendments to Annex 3. The removal of TAC format as a Standard and Recommended Practice (SARP) in Annex 3 is planned to coincide with a future Amendment to Annex 3 that is applicable in within Block 2 (2025-2030).

2.3 Transition from Bulletins to Single Messages

2.3.1 Traditionally, TAC reports were collated into bulletins to support the efficient exchange of reports over a network of very low-capacity point-to-point circuits. Whilst bulletins have served a useful purpose, they do result in delays to information exchange and are not well suited to large or dynamic datasets.

2.3.2 With increasing volumes and shorter (more frequent) time steps of data, the advantages of bulletins are considerably less, and bulletins are increasingly difficult to manage from both provider and consumer standpoints. Transitioning to single messages will help alleviate these issues.

2.3.3 It is recognized that the exchange via AFTN and AMHS requires bulletins, however the SWIM architecture offers a range of alternate innovative approaches for exchanging meteorological information. Rather than limit implementations by requiring the exchange of bulletins, it is recommended that individual reports should be made available as part of the base meteorological service. Additional SWIM services can then be built upon this base service. Where necessary, a service provider could collate these individual reports into bulletins.

2.3.4 The requirement for global exchange of bulletins will cease following the formal implementation of SWIM architecture and services in 2025. The use of bulletins may continue on AMHS links carrying IWXXM until 2030. Prior to SWIM implementation, where mutually agreed between States, ROCs and/or IROGs, individual reports may be exchanged. It should however be noted that to support regional and global data exchange, bulletins will need to be generated by either the State, ROC or IROG until at least 2026.

3. ASBU BLOCK 0

3.1 Prior to 2019, a mixed system of AFTN and AMHS communications was utilized for the exchange of MET information in TAC format.

3.2 RODBs utilized the existing request/reply query for meteorological databank information method (RQM) for providing request/reply access to data, and States/RODBs may have also offered information exchange services. States were encouraged to begin exchanging MET information in IWXXM format as early as possible, in addition to TAC format.

3.3 Figure 1 shows the architecture of MET information exchange in Block 0 (2013-2018), where AFTN or AMHS Basic service connections were used for the transfer of information from TAC data producers to NOCs, ROCs, RODBs and TAC data consumers as depicted.

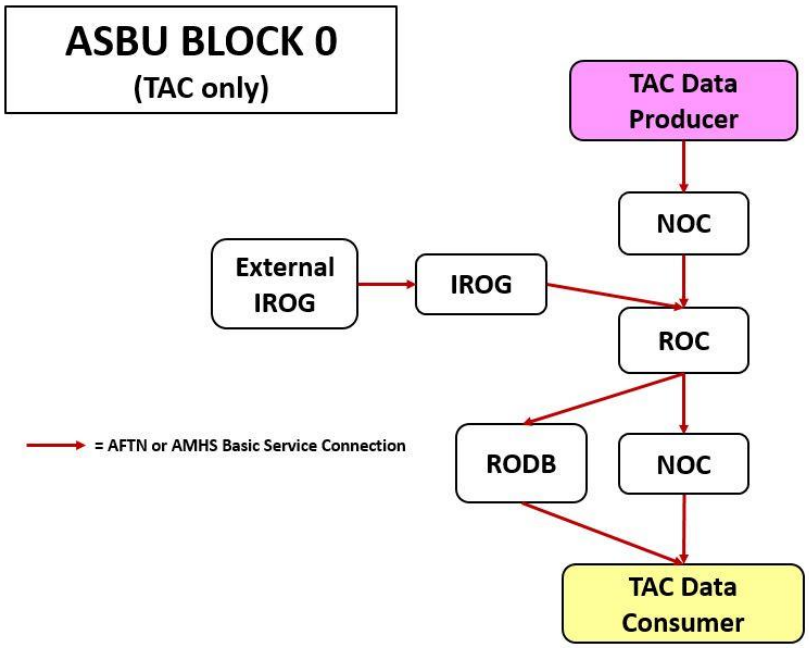

Figure 1. MET Information Exchange in Block 0 (2013-2018).

4. ASBU BLOCK 1: TRANSITION TO IWXXM

4.1 As of 5 November 2020, States were required by ICAO Annex 3 to implement IWXXM format for the international exchange of MET information. However, TAC production will continue throughout Block 1 as well. States, ROCs and RODBs in a position to do so will begin to disseminate gridded and imagery products throughout Block 1.

4.2 States, ROCs, RODBs and IROGs in a position to implement AMQP communications in addition to AMHS FTBP are encouraged to do so for IWXXM dissemination.

4.3 For those RODBs, ROCs and States in a position to do so, AMQP and HTTP (SWIM) communications should be adopted in addition to AMHS-related communications for publish/subscribe messages and request/reply communications in Block 1. Specifically, ROCs and IROGs should prioritize the adoption of AMQP communications to facilitate State SWIM progress, RODBs should utilize WFS for request/reply access as an alternative to the AFTN and AMHS FTBP request response interface, and IWXXM data consumers should use the WFS to consume messages and implement AMQP message consumption.

4.4 Figure 2 shows the architecture for MET-SWIM in Block 1, where both TAC and IWXXM data is provided to NOCs, ROCs and RODBs via AMHS with FTBP or AMQP and HTTP (SWIM). TAC data consumers will continue to obtain TAC information in the same manner as Block 0. IWXXM data consumers will obtain information in IWXXM format from the NOCs and RODBs through state defined transfers.

4.5 The early adoption of SWIM communications is depicted in Figure 2 by the faded architecture on the right-hand side of the diagram, where the IWXXM data producer uses a state defined transfer to share IWXXM data with National / Specialized and Regional / Global MET-SWIM web services, who are also obtaining data from information service providers. This information is then transferred to SWIM consuming applications through publish/subscribe and HTTP request/response connections to SWIM consuming applications, from which information service consumers obtain the information.

4.6 Examples of National / Specialized and Regional / Global MET-SWIM information services can be found in the SWIM Registry.

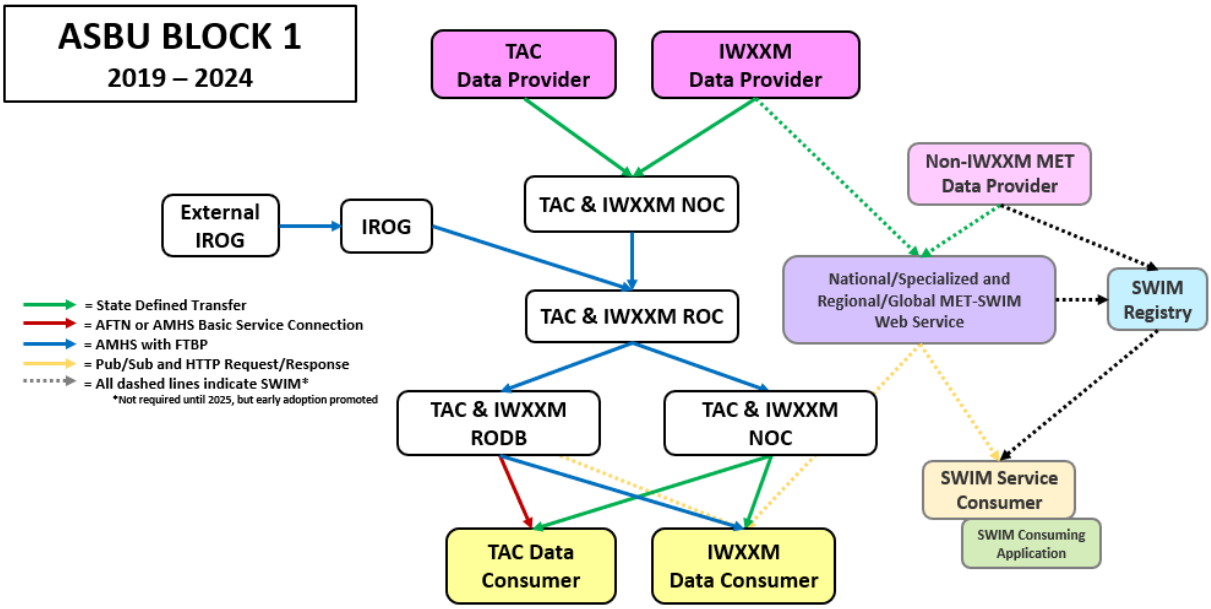

Figure 2. MET-SWIM in Block 1 (2019-2024).

5. ASBU BLOCK 2: SWIM IMPLEMENTATION

5.1 States, ROCs, RODBs and others should commence and complete SWIM technology adoption in Block 2, noting that IWXXM will become the primary format for meteorological information exchange in within Block 2 as TAC format will no longer be a Standard in Annex 3. Thus, meteorological information in IWXXM format will continue to flow from MET data providers to NOCs, ROCs and RODBs over AMHS with FTBP or AMQP and HTTP (SWIM), and IWXXM data consumers will obtain this information from NOCs using publish/subscribe and HTTP request/response transfers.

5.2 Figure 3 shows the architecture for MET SWIM in Block 2, where MET data providers are producing meteorological information in IWXXM format and continuing dissemination through NOCs, ROCs and RODBs as in Block 1. However, MET data providers are also using publish/subscribe connections to exchange MET information with National / Specialized and Regional / Global MET SWIM services. Both the data providers and MET-SWIM services register with the SWIM registry, from which SWIM consuming applications retrieve information for service consumers to use.

5.3 Figure 3 also depicts a transition from separate “TAC / IWXXM Data Provider” and “SWIM Data Provider” in Block 1 to a broader category of “MET Data Providers” in Block 2. Examples of MET Data Providers include (but are not limited to) World Area Forecast System (WAFS) providers, satellite information providers, aerodrome observations and other MET service providers.

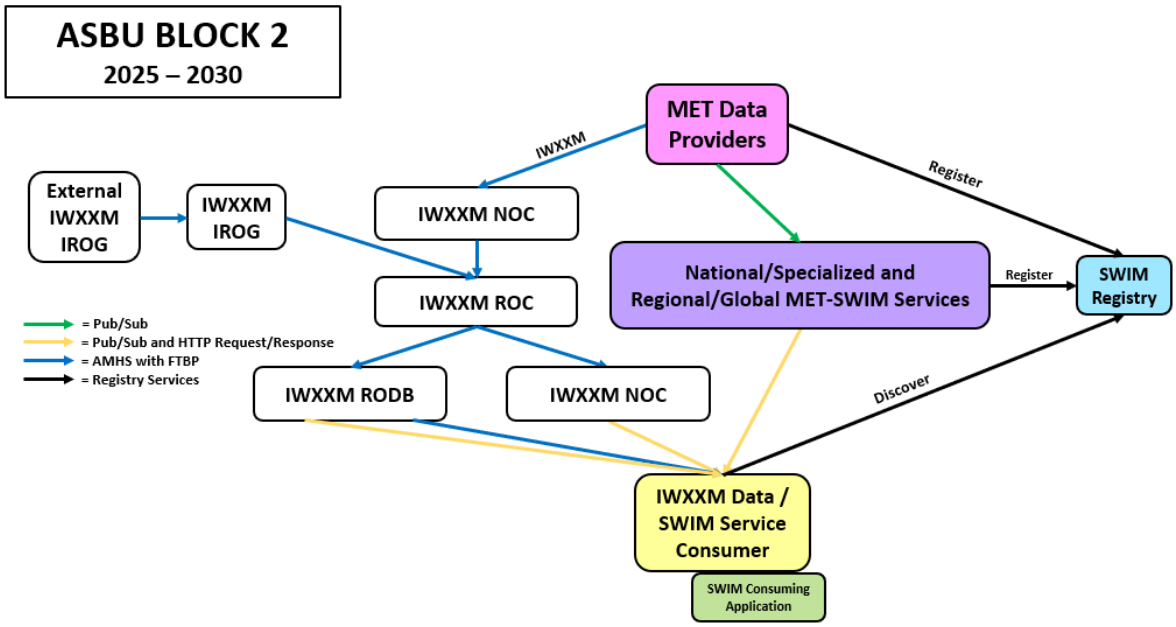

Figure 3. MET-SWIM in Block 2 (2025-2030).

6. ASBU BLOCK 3: FUTURE ENVIRONMENT

6.1 In Block 3, the MET SWIM architecture evolves to transition away from NOCs, ROCs and RODBs into an architecture aligned with SWIM services, or a service-oriented architecture (SOA) with national, specialized and regional/global MET SWIM services.

6.2 Figure 4 shows the architecture for MET SWIM in Block 3, where similar to Block 2, MET data providers use publish/subscribe connections to share meteorological information with National / Specialized and Regional / Global MET-SWIM services. Additionally, MET data providers also register services in the SWIM registry, as do National / Specialized and Regional / Global MET-SWIM services. SWIM consuming applications then obtain meteorological information from the MET-SWIM services via publish/subscribe and HTTP request/response connections, as well as through the SWIM registry. SWIM service consumers rely on SWIM consuming applications to obtain and use the meteorological information.

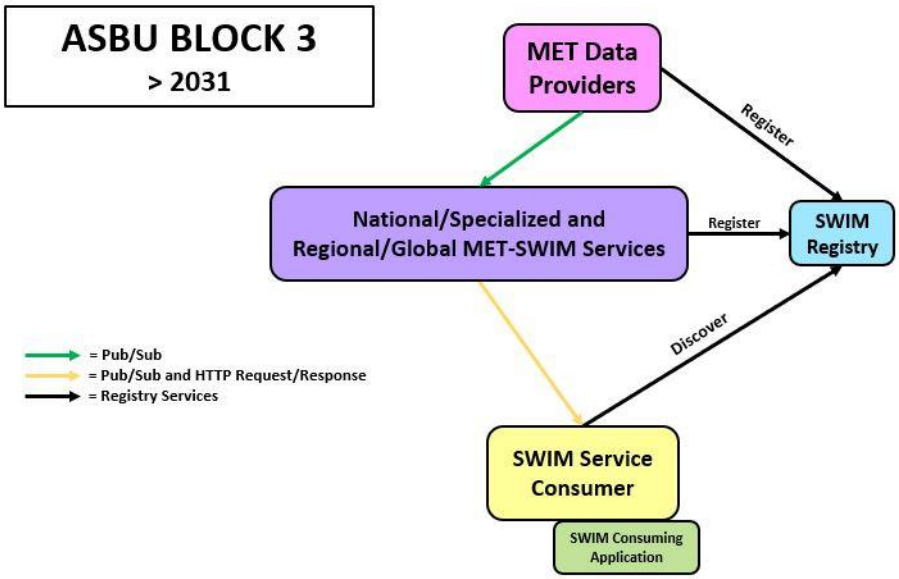

Figure 4. MET-SWIM in Block 3 and beyond (>2031).

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