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

March 2025
Version 3.0

International Civil Aviation Organization

RECORD OF REVISIONS

No.	Date	Description
1.0	**September 2016**	**Initial version developed by the ICAO WG-MIE**
1.1	April 2018	Minor update based on GANP changes and discussions with the Communications and Information Management Panels
1.2	June 2018	Minor update based on the outcomes of WG-MIE/4
1.3	October 2018	Minor update based on the outcomes of METP/4
1.4	March 2019	Minor update based on the outcomes of MIE/MRI Workshop
1.5	September 2019	Minor update based on the outcomes of WG-MIE/5
1.6	October 2019	Minor update based on the outcomes of WG-MIE/6
1.9	May 2020	Minor update following virtual review of MET-SWIM Work Stream
2.0	**June 2020**	**Full version update following virtual review by WG-MIE**
2.1	August 2020	Minor update in preparation for review by METP
2.2	October 2020	Minor update following review by METP
2.3	April 2021	Updated based on the outcomes of WG-MIE/7
3.0	**March 2025**	**Full version update in preparation for METP/6**

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LIST OF ABBREVIATIONS AND ACRONYMS

AFS	Aeronautical Fixed Service
AFTN	Aeronautical Fixed Telecommunications Network
AIRMET	Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of low-level aircraft operations and which was not already included in the forecast issued for low-level flights in the flight information region concerned or sub-area thereof.
AMHS	Aeronautical Message Handling System
AMQP	Advanced Message Queuing Protocol
ANC	ICAO Air Navigation Commission
API	Application programming interface
ASBU	Aviation System Block Upgrade
EDR	OGC Environmental Data Retrieval
FTBP	File Transfer Body Part. The attachment of an AMHS message that contains the data payload.
GANP	Global Air Navigation Plan (ICAO Doc 9750)
HTTP	Hypertext Transfer Protocol
HWIS	Hazardous Weather Information Service
ICAO	International Civil Aviation Organization
IMP	ICAO Information Management Panel
IP	Internet Protocol
IROG	Interregional OPMET Gateway
IWXXM	ICAO Meteorological Information Exchange Model
MET	Aeronautical meteorological
METAR	Routine aerodrome meteorological report
METP	ICAO Meteorology Panel
NOC	National OPMET Centre
NWP	Numerical weather prediction
OGC	Open Geospatial Consortium
OPMET	Operational meteorological
PANS	Procedures for Air Navigation Services
QVA	Quantitative Volcanic Ash
ROC	Regional OPMET Centre
RODB	Regional OPMET Databank
SIGMET	Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather and other phenomena in the atmosphere that may affect the safety of aircraft operations.
SPECI	Special aerodrome meteorological report
SWIM	System-Wide Information Management
SWXA	Space weather advisory
TAC	Traditional alphanumeric code
TAF	Aerodrome forecast
TCA	Tropical cyclone advisory
TREND	Trend forecast
VAA	Volcanic ash advisory
WAFS	World Area Forecast System
WCS	OGC Web Coverage Service
WFS	OGC Web Feature Service
WMO	World Meteorological Organization
WMS	Web Map Service
XML	Extensible markup language

1. INTRODUCTION

1.1 Background

1.1.1 The International Civil Aviation Organization (ICAO) has published a global System-Wide Information Management (SWIM) concept to enhance global interoperability across information domains. SWIM will complement human-to-human communications with machine-to-machine communications and improve data distribution and accessibility. ICAO Member States are expected to make aviation-related information available as information services across various information domains, including meteorology.

1.1.2 Through a Job Card assigned by the ICAO Air Navigation Commission (ANC), the ICAO Meteorology Panel (METP) is responsible for integrating MET information into the SWIM-enabled environment and further developing the SWIM concept relating to meteorology. As of November 2024, the use of information services to exchange aeronautical meteorological (MET) information is a Recommended Practice in Amendment 81 to ICAO Annex 3[1] – *Meteorological Service for International Air Navigation*.

1.1.3 This document, the *Roadmap for Aeronautical Meteorological (MET) Information in System-Wide Information Management (SWIM)* (MET-SWIM Roadmap), describes the transition plan and associated timelines for implementing MET in SWIM.

1.2 Relationship to Other Documents

1.2.1 SWIM is conceptually managed by the ICAO Information Management Panel (IMP). The IMP publishes the following documents related to SWIM:

- ICAO Annex 15 – *Aeronautical Information Services*
- ICAO Doc 10199 – *Procedures for Air Navigation Services – Information Management* (PANS-IM)
- ICAO Doc 10039 – *Manual on System-Wide Information Management (SWIM) Concept*
- ICAO Doc 10203 – *Manual on System-Wide Information Management (SWIM) Implementation*

1.2.2 In order to make the broader SWIM concept applicable to MET, the METP publishes the following documents related to MET-SWIM:

- ICAO Annex 3
- ICAO Doc 10157 – *Procedures for Air Navigation Services – Meteorology* (PANS-MET)
- ICAO Doc 10003 – *Manual on the ICAO Meteorological Information Exchange Model (IWXXM)*
- *Guidelines for the Implementation of OPMET Data Exchange using IWXXM*
- *Guidelines for MET-SWIM Implementation*[2]

1.2.3 ICAO Doc 9750 – *Global Air Navigation Plan* (GANP) includes SWIM as an integral target. The Aviation System Block Upgrade (ASBU) schedule[3] presented in the GANP will serve as the basis for the implementation and transition of MET-SWIM. 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.

[1] More information on this Recommended Practice can be found in §2.2.10 of Amendment 81 to ICAO Annex 3.

[2] The *Guidelines for MET-SWIM Implementation* is a draft document and the first edition has not yet been published. It will contain material from the deprecated *Plan for Meteorology in System-Wide Information Management* (MET-SWIM Plan).

[3] More information on the ICAO GANP, including the ASBU Portal, can be found at https://www4.icao.int/ganpportal/.

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		3	2031 – 2036
AMET-B4/4		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

2. TRANSITION PLAN

2.1 Components

2.1.1 The following components are described in the transition from the existing environment into MET-SWIM:

- Communication protocols
- Information exchange services
- Data addressing
- Information exchange flow
- Data aggregator

2.1.2 Communication protocols for the exchange of MET information include the Aeronautical Message Handling System (AMHS) with File Transfer Body Part (FTBP), which is used in the existing environment, and the Advanced Message Queuing Protocol (AMQP) over Hyper Text Transfer Protocol (HTTP), intended for the future SWIM environment. Currently, AMHS FTBP, referred to as a "message push" mechanism, is used to exchange MET information in IWXXM format. However, in a full SWIM environment, States are expected to implement AMQP over HTTP to exchange MET information through information services. Where mutually agreed, States may bypass the implementation of AMHS and instead implement AMQP over HTTP for SWIM-enabled exchange.

2.1.3 Information exchange services for MET information include request/reply services by Regional OPMET Databank (RODBs) for information in traditional alphanumeric code (TAC)[4] and IWXXM, and Open Geospatial Consortium (OGC) Environmental Data Retrieval (EDR) Standardized Services for information services. In the existing environment, RODBs use request/reply services for exchanging both TAC and IWXXM information. MET-SWIM services will utilize OGC services like the OGC EDR Application Programming Interface (API), OGC API – Features, OGC API – Coverages, and OGC API – Maps[5].

2.1.4 The mechanisms for data addressing include Aeronautical Fixed Service (AFS) addressing, Internet Protocol (IP), and SWIM registries. AFS addressing is utilized in the current environment, but MET-SWIM services are expected to utilize IP and SWIM registries for addressing data through information services.

2.1.2 The information exchange flow for MET information in the current environment is fixed, where information flows from National OPMET Centres (NOCs), Regional OPMET Centres (ROCs), RODBs, and Inter-Regional OPMET Gateways (IROGs). In the future SWIM environment, however, the information exchange flow can be dynamic.

2.1.5 Data aggregation functions are currently carried out by NOCs, ROCs, RODBs, and IROGs. MET-SWIM services will also require an aggregator, but details related to the entity responsible for aggregation have yet to be determined. For this purpose, the term "SWIM Aggregator" is used.

2.1.6 **Table *2*** below describes the default mechanisms expected over each ASBU as the exchange of MET information is modernized. Capabilities deemed as "optional" indicate that the early adoption of SWIM is encouraged by States that are able to do so. It is expected that the MET domain will achieve a full SWIM environment in Block 4 (2037+).

[4] 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).

[5] OGC has deemed Web Feature Service (WFS), Web Coverage Service (WCS), and Web Map Service (WMS) (referred to as the "W*" services) as legacy, and equivalent counterparts have been developed: OGC API – Features will replace WFS; OGC API – Coverages will replace WCS, and OGC API – Maps will replace WMS.

Table 2. Roadmap for Modernization of MET Information Exchange

	Capabilities Expected During Block 1 (2019-2024)	Capabilities Expected During Block 2 (2025-2030)	Capabilities Expected During Block 3 (2031-2036)	Capabilities Expected During Block 4 (2037+)
Communication Protocols	AMHS FTBP	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 OGC Standardized Services (optional)	RODB IWXXM request/reply OGC Standardized Services	OGC Standardized Services
Data Addressing	AFS Addressing	AFS Addressing IP (optional) SWIM Registry (optional)	AFS Addressing IP SWIM Registry	IP SWIM Registry
Information Exchange Flow	NOC, ROC, RODB, IROG	NOC, ROC, RODB, IROG Dynamic (optional)	NOC, ROC, RODB, IROG Dynamic	Dynamic
Data Aggregator	NOC, ROC, RODB, IROG	NOC, ROC, RODB, IROG SWIM Aggregator (optional)	NOC, ROC, RODB, IROG SWIM Aggregator	SWIM Aggregator

2.1.7 It is important to note that data types, including gridded data (e.g., satellite data, radar data, output from numerical weather prediction (NWP) models) and objects (e.g., non-gridded information in IWXXM format), shall be consistently exchanged throughout this transition, as both types will continue to be supported in a full SWIM environment.

2.1.8 While every State will produce MET information in a SWIM environment, not every State is expected to be an information service provider. It is possible that States may, through bi-lateral agreements or other means, rely on other States for the international provision of MET information.

2.2 Transition from TAC to IWXXM

2.2.1 In the current environment, MET information is exchanged internationally in both TAC and IWXXM formats.

2.2.2 IWXXM became a Standard format for the international exchange of MET information in November 2020 with Amendment 79 to Annex 3[6]. IWXXM uses extensible markup language (XML) and is intended for machine-to-machine

[6] Amendment 79 to ICAO Annex 3 required IWXXM format for specific products (see Footnote 4). Subsequent amendments to Annex 3 made IWXXM a Standard format for all MET information exchanged internationally.

information exchange, making information digital to support the modernization of MET information. IWXXM is less restrictive than TAC, allows for innovation and creativity, and enables commonality across other information domains.

2.2.3 Providing MET information in both formats levies a heavy burden (ex: financial, technical, workload, etc.) on States. Additionally, TAC information will not be exchanged via information services.

2.2.4 To ensure that IWXXM is the sole primary format going forward, the ICAO METP intends to remove TAC as a Standard format from ICAO Annex 3. The METP plans to introduce the change in Amendment 83 to ICAO Annex 3, which has expected applicability in November 2027, noting an embedded date of November 2030 for the removal of TAC as a Standard. This provides States and other aviation stakeholders a formal three-year lead-time to prepare for this upcoming change.

2.2.5 To date, progress toward global availability of IWXXM and associated interregional exchange has been slow. The early notification of the impending removal of TAC as a Standard in Annex 3 is one mechanism that will help enable global availability of IWXMX information.

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 for information in TAC format, they do result in delays to information exchange and are not well suited to large or dynamic datasets (like IWXXM).

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 for the exchange of IWXXM information will help alleviate these issues, and ROCs can provide guidance for issuing individual reports.

2.3.3 While exchange over the AFS (e.g., via the Aeronautical Fixed Telecommunications Network (AFTN) and AMHS) requires bulletins[7], SWIM offers a range of alternate innovative approaches for exchanging meteorological information. Rather than limit implementations by requiring the use of bulletins, individual reports can be made available as part of the base meteorological service, and additional SWIM services can then be built upon this base service. Where necessary, an information service provider could collate these individual reports into bulletins.

2.3.4 While the global exchange of bulletins will likely continue into Block 3 (2031-2036) as IWXXM information is still exchanged over the AMHS, it is expected that they will cease when a full SWIM environment is achieved in Block 4 (2037+). As such, States who want to create and exchange IWXXM METARs and TAFs as single location messages instead of compiled bulletins are encouraged and supported to transition to this method. Notification of this change to single location messages for METARs and TAFs in IWXXM should be provided to stakeholder NOCs, ROCs, IROGS and RODBs, such as the Meteorological Notice (METNO) service used in the EUR and APAC regions.

2.3.5 To issue single location messages instead of bulletins, the following message header should be implemented:

TTAAii CCCC
TTAA should remain the same (TT = MET type, AA = State)
ii = 20-39 (numbers used for international exchange)
CCCC = registered location indicator name per ICAO Doc 7910

[7] The requirement for bulletins to be exchanged over the AFS is included in §11.2 of Annex 3 and §10.1 of the PANS-MET.

3. ASBU BLOCK 1 (2019-2024)

3.1 **Figure *1*** depicts the current architecture of MET information exchange in Block 1 (2019-2024).

3.2 Data originators disseminate MET information in both TAC and IWXXM formats through State-defined transfers (e.g., domestically) to their respective NOC. Information in both formats then flows from each NOC to ROCs, then to RODBs and back to NOCs over the AMHS (using FTBP for IWXXM information). IROGs (both internal and external) also send information to ROCs.

3.3 Consumers receive MET information in TAC format from RODBs over the AFTN or AMHS Basic service connections), and domestically from NOCs via State-defined transfers.

3.4 Consumers receive MET information in IWXXM format from RODBs via AMHS with FTBP, and domestically from NOCs via State-defined transfers.

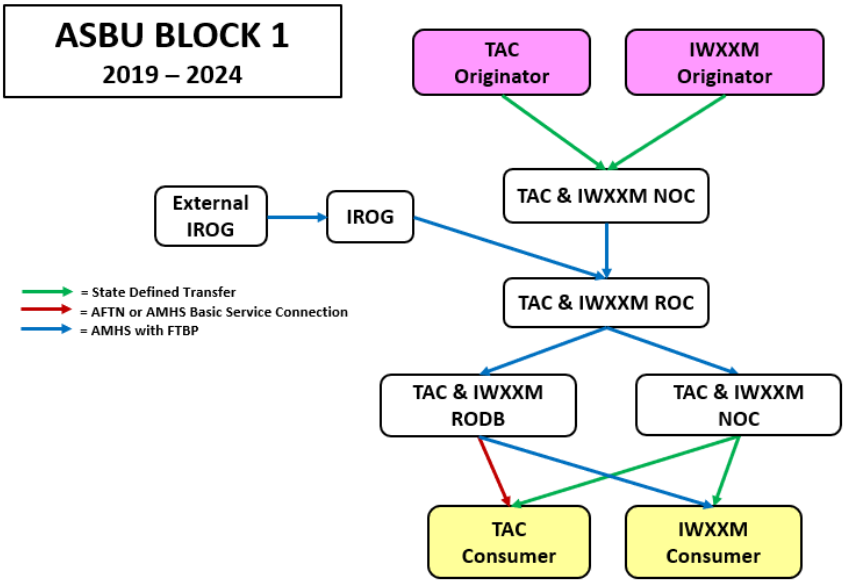

Figure 1. MET-SWIM in Block 1 (2019-2024)

4. ASBU BLOCK 2 (2025-2030)

4.1 **Figure 2** depicts expected capabilities for MET information exchange during Block 2 (2025-2030). While the existing architecture from Block 1 is expected to continue into Block 2 (e.g., TAC and IWXXM exchange via NOCs, ROCs, and RODBs), States should also implement information services to exchange MET information in Block 2 to align with the Recommended Practice to do so in ICAO Annex 3.

4.2 To facilitate the implementation of MET information services, both IWXXM and non-IWXXM MET data originators should disseminate MET information to MET-SWIM information service providers via State-defined transfers (e.g., domestically). MET information service providers are required to advertise their services in a SWIM registry[8].

4.3 Consumers of MET information will continue to receive IWXXM information from RODBs over the AFTN (or AMHS Basic service connections) and from NOCs via State-defined transfers.

4.4 In the SWIM environment, consumers can discover available services via a SWIM registry, and then receive the information they desire from the information service provider via publish/subscribe and request/reply services. An information service overview, required for all information services, will indicate which message exchange pattern the service uses. SWIM service consumers will likely rely on consuming applications to obtain and use MET information.

4.5 MET information in TAC format will not be exchanged via information services. Consumers of TAC information will need to transition to utilizing IWXXM information during Block 2 ahead of the removal of TAC as a Standard from Annex 3.

4.6 Initial international MET information services will include an aerodrome observation information service, aerodrome forecast information service, a Quantitative Volcanic Ash (QVA) information service, and information services for World Area Forecast System (WAFS) data (via an OGC EDR API). These services will likely be included as Recommended Practices in Amendment 83 to ICAO Annex 3 (with expected applicability in November 2027).

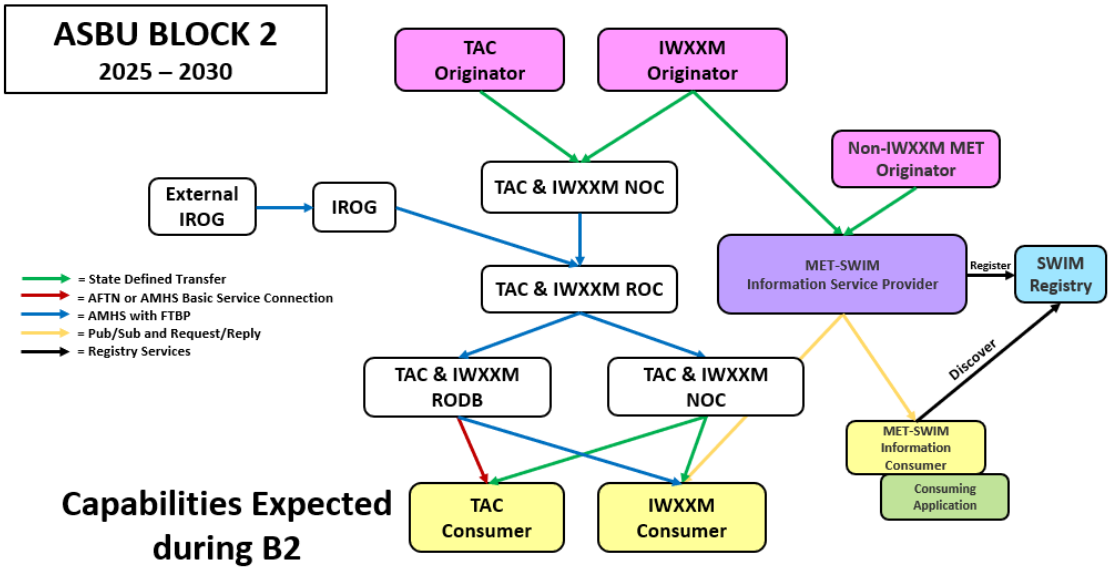

Figure 2. MET-SWIM in Block 2 (2025-2030)

[8] For more information on SWIM registries, refer to §2.3 of the *Guidelines for MET-SWIM Implementation*.

5. ASBU BLOCK 3 (2031-2036)

5.1 **Figure *3*** depicts expected capabilities for MET information exchange in Block 3 (2031-2036).

5.2 As TAC is to be removed as a Standard from ICAO Annex 3 in November 2030, global information exchange in Block 3 will no longer include TAC information over AFTN (or AMHS Basic service connections). Consumers of TAC information will need to have transitioned toward utilizing IWXXM by this time. Existing exchange mechanisms (e.g., AMHS with FTBP through NOCs, ROCs, and RODBs) will continue to provide IWXXM information from MET originators to IWXXM consumers.

5.3 MET information exchange via information services should continue and increase during Block 3 as initial services are continuously improved and consumers continue to transition. As more MET information becomes available via information services, States are encouraged to transition away from AMHS exchange and toward these services.

5.4 Future international MET information services beyond those initially expected include a Hazardous Weather Information Service (HWIS) and others to be determined by the ICAO METP.

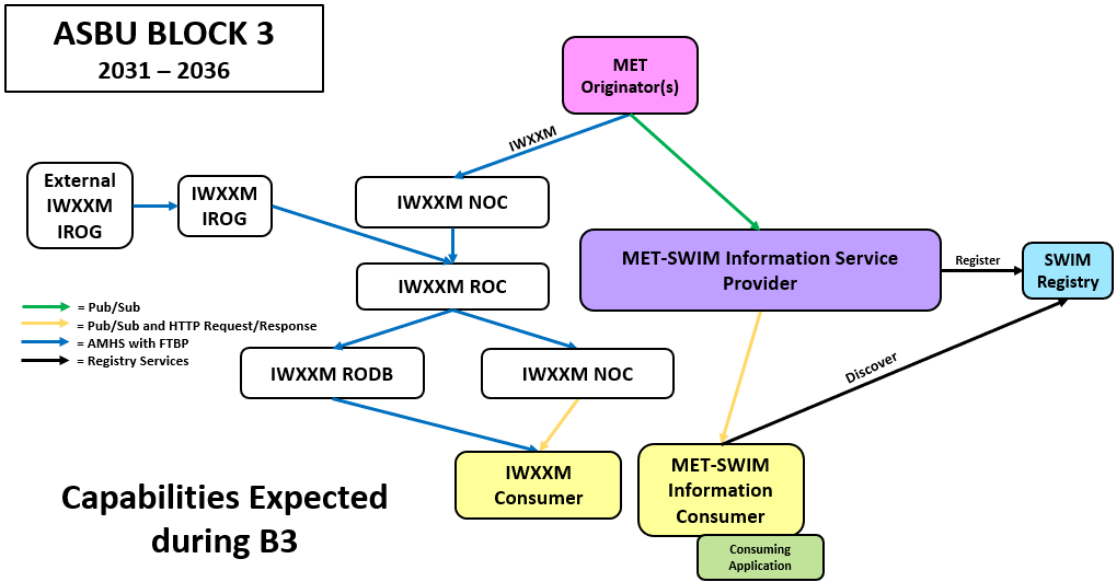

Figure 3. MET-SWIM in Block 3 (2031-2036)

6. BEYOND BLOCK 3 (2037+)

6.1 **Figure *4*** depicts expected capabilities beyond Block 3 (2037+).

6.2 It is expected that after Block 3, the MET domain will have achieved a full SWIM environment, no longer utilizing AMHS for the exchange of MET information and instead relying on information service providers to provide all necessary MET information via information services.

6.3 Greater detail about the capabilities beyond Block 3 will be developed as services are implemented and refined in time.

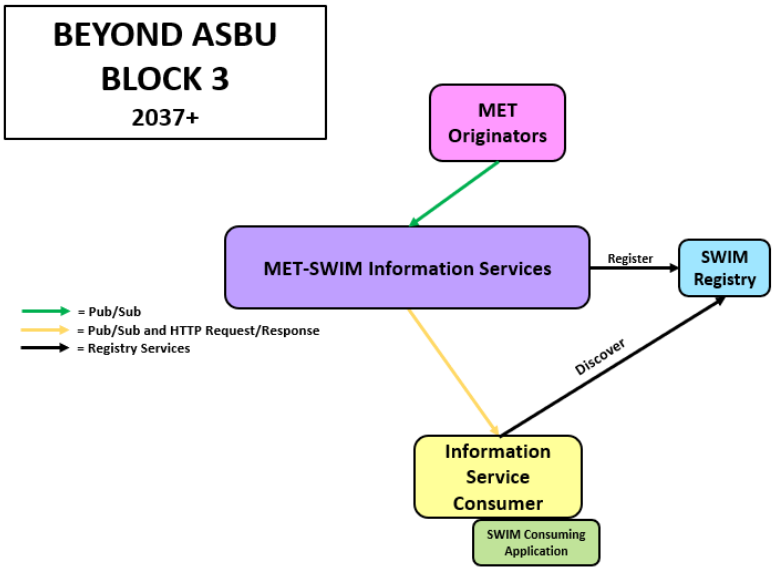

Figure 4. MET-SWIM beyond Block 3 (2037+)

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