SWIM in ASEAN Demonstration Report

November 2019

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Acronym

A-CDM	Airport-Collaborative Decision Making
ADP	ATFM Daily Plan
AIXM	Aeronautical Information Exchange Model
AMQP	Advance Message Queuing Protocol
AMS	ASEAN Member State
AN-Conf	ICAO Air Navigation Conference
ANSP	Air Navigation Service Provider
AOBT	Actual Off-Block Time
APANPIRG	ICAO Asia/Pacific Air Navigation Planning and Implementation Regional Group
ASBU	Aviation System Block Upgrade
ASEAN	Association of Southeast Asian Nations
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATO	Actual Time Over
ATS	Air Traffic Service
ATTC	ASEAN Air Transport Technical Sub-Working Group
ATWG	ASEAN Air Transport Working Group
CLDT	Calculated Landing Time
CTO	Calculated Time Over
CTOT	Calculated Take-Off Time
ELDT	Estimated Landing Time
EMS	Enterprise Messaging Service
ETO	Estimated Time Over
FAA	Federal Aviation Administration
FF-ICE	Flight and Flow Information for a Collaborative Environment
FIXM	Flight Information Exchange Model
FIXM CCB	FIXM Change Control Board
GANP	Global Air Navigation Plan
GDP	Ground Delay Program
GEMS	Global Enterprise Messaging Services
GEMS WG	GEMS Working Group
GUFI	Globally Unique Flight Identifier
IWXXM	ICAO Meteorological Information Exchange Model
JMS	Java Message Service
PDF	Portable Document Format
SESAR-JU	Single European Sky ATM Research-Joint Undertaking
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SWIM	System-Wide Information Management
SWIM TF	ICAO Asia/Pacific SWIM Task Force
TOBT	Target Off-Block Time
TSAT	Target Start-up Approval Time
TTOT	Target Take-Off Time

1 Introduction

System-Wide Information Management (SWIM) is considered as a key driver for greater Air Traffic Management (ATM) system interoperability, resulting in increased efficiency in air navigation services provision. SWIM is an integral part of ICAO's Global Air Navigation Plan (GANP), particularly the Aviation System Block Upgrades (ASBUs), which was first adopted at the ICAO Twelfth Air Navigation Conference (AN-Conf/12) in 2012. Subsequently, SWIM is highlighted as one of the regional strategic objectives specified in the Asia/Pacific Seamless ATM Plan v2.0 approved by the Twenty-Seventh Meeting of ICAO Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/27) in 2016. Considered as the intranet for aviation, enabling the management of ATM information and its exchange between qualified parties, SWIM is thus an important building block of the Seamless ASEAN Sky and will be one of the major initiatives in the ASEAN ATM Master Plan to be adopted and implemented under ASEAN Transport Strategic Plan 2016-2025.

Under the cooperation framework between ASEAN and USA, USA proposed at the Thirty-Fourth ASEAN Air Transport Working Group Meeting (ATWG/34) in October 2016 to work with ASEAN Member States (AMSs) in SWIM development by providing assistance in conducting a demonstration involving all AMSs. Following this proposal, Singapore and Thailand had been working with USA to develop a SWIM in ASEAN Demonstration (hereafter Demonstration) scope aimed at showcasing the operational benefits enabled by SWIM and presented an overview of this Demonstration at the Fourteenth ASEAN Air Transport Technical Sub-Working Group Meeting (ATTC/14) and the First Meeting of ICAO Asia/Pacific SWIM Task Force (SWIM TF/1) in March 2017 and May 2017, respectively. With the keen interest in participating in this Demonstration, expressed by other Asia/Pacific States outside of ASEAN during SWIM TF/1, and the benefits of inclusion of these States in the Demonstration such as the greater breadth in the types of operational scenarios that can be demonstrated and the consistency with the global and regional concepts, the scope of the Demonstration was extended to include the Asia/Pacific States as well.

1.1 Purpose of the Demonstration

Keeping in mind the ultimate objective to achieve the seamless ATM connectivity for not only ASEAN but also Asia/Pacific region, the SWIM in ASEAN Demonstration was aimed at the following.

- To demonstrate the principles of SWIM, which will in turn lead to a better understanding of SWIM and help accelerate the implementation within the region;
- To show the potential operational benefits of SWIM; and
- To demonstrate a model of SWIM implementation for ASEAN and Asia/Pacific region.

1.2 Goal of the Demonstration

To fulfill the demonstration's purposes previously outlined, the goals of this Demonstration accordingly set were as follows;

- Construct a Global Enterprise Messaging Services (GEMS) network consisting of several interconnected EMSs;
- Achieve broad participation by ASEAN and Asia/Pacific aviation community with all AMSs participating together with several key aviation stakeholders such as airport operators and airlines;

- Demonstrate the operational benefits of SWIM using the Distributed Multi-Nodal Air Traffic Flow Management (ATFM) Network-based scenarios as anchor demonstration scenarios; and
- Generate greater discussions among demonstration participants on SWIM and its implementation in the region.

1.3 Demonstration Participation Level

To ensure that all interested States/Administrations, especially all AMSs, can participate in the SWIM in ASEAN Demonstration, participation based on technological capabilities was divided into 4 levels. Participants, requirements and benefits of each participation level were described in Table 1.

Table 1
Demonstration Participation Level

Participation Level	Requirements	Benefits
Level 1: Observer only Participant: • Myanmar • The Philippines	• Participate in demonstration planning, system interfacing, and system test • Provide lessons learnt from the demonstration • Active participation throughout the project	• Awareness of their own SWIM readiness • Knowledge to identify the feasible implementation approach for ASBU modules • Knowledge on possible support tool to assist decision making regarding fleet and flight management • Understanding on loose system coupling, separation of data production and consumption, open standards, and interoperable services • First level of understanding on global interoperability
Level 2: Legacy-format data producer and consumer Participant: • Cambodia • Indonesia • Lao PDR • Vietnam	• Participate in demonstration planning, system interfacing, and system test • Provide lessons learnt from the demonstration • Active participation throughout the project • Produce legacy-format data* and provide it in native-SWIM format using the data conversion service provided • Able to consume native-SWIM-format data** using the viewer provided	• Knowledge and understanding on the implementation approach of ASBU modules • Knowledge on possible support tool to assist decision making regarding fleet and flight management • Working knowledge of loose system coupling, separation of data production and consumption, open standards, and interoperable services • First level of understanding on global interoperability • Knowledge and understanding on data mediation for backward compatibility in SWIM implementation

Participation Level	Requirements	Benefits
Level 3: Native-SWIM-format data producer and consumer Participant: • Australia	• Participate in demonstration planning, system interfacing, and system test • Provide lessons learnt from the demonstration • Active participation throughout the project • Produce and provide native-SWIM-format data using own system • Able to ingest native-SWIM-format data into own system	• Knowledge and understanding on the implementation approach of ASBU modules • Knowledge and understanding to implement support tools to assist decision making regarding fleet and flight management • Working knowledge and opportunity to take the advantage of loose system coupling, separation of data production and consumption, open standards, and interoperable services • First level of understanding on global interoperability • Knowledge and first-hand experience on Service-Oriented Architecture (SOA) • Access to complete SWIIM dataset • Better information sharing for gate-to-gate operation, airport management, and increased safety
Level 4: Customized EMS Developer and native-SWIM-format data producer and consumer Participant: • Thailand • Singapore • USA • Malaysia • Hong Kong China • Japan	• Early commitment to the project • Participate in all GEMS discussions and system test • Provide services using own system • Participate in demonstration planning, system interfacing, and system test • Provide lessons learnt from the demonstration • Active participation throughout the project • Produce and provide native-SWIM-format data using own system • Able to ingest native-SWIM-format data into own system	• Knowledge and understanding on the implementation approach of ASBU modules • Knowledge and understanding to implement support tools to assist decision making regarding fleet and flight management • Working knowledge and opportunity to take the advantage of loose system coupling, separation of data production and consumption, open standards, and interoperable services • First level of understanding on global interoperability • Knowledge and firsthand experience on SOA • Access to complete SWIIM dataset • Better information sharing for gate-to-gate operation, airport management, and increased safety • Working EMS prototype

Participation Level	Requirements	Benefits
		• Leader in SWIM development and implementation in Asia/Pacific Region

Remarks

*Legacy-format data: Data in ATS-message format, including FPL2012

**Native-SWIM-format data: Data in Aeronautical Information Exchange Model version 5.1 (AIXM v5.1), Flight Information Exchange Model version 4.1 (FIXM v4.1) with Asia/Pacific Extension, and ICAO Meteorological Information Exchange Model version 2.0 (IWXXM v2.0)

The rest of this report is organized as follows. Section 2 gives an overview on how to collect the operational requirements for SWIM implementation and highlights the importance of business rules in designing and developing of SWIM components. Section 3 presents the SWIM infrastructure, including architecture, message protocol, and message routing. In Section 4, service development as well as SWIM infrastructure and service test processes are explained and, finally, Section 5 provides the observations and lessons learnt from the SWIM in ASEAN Demonstration.

2 Operational Scenario Development

2.1 Operation Identification

As SWIM is not developed and implemented for its own sake, i.e. benefits of SWIM lie in improved performance of flight and ATM operations requiring timely and quality information conveyed using SWIM, the first milestone of the SWIM in ASEAN Demonstration was thus to identify the operations that can be better supported by SWIM. Specifically, the operational scenarios based on the current and the foreseeable future operational concepts, which were of particular interest to Asia/Pacific region, were crafted with the detailed interaction among related stakeholders to gather the operational requirements for information exchanged through SWIM. **Annex A** presents the template used for collecting the operational requirements aforementioned.

Aiming at being able to create a better understanding of SWIM and its benefits, which in turn will help accelerate the implementation within Asia/Pacific region, it was agreed to center the Demonstration on cross-border ATM operations with a focus on cross-border ATFM and the integration between ATFM and A-CDM (Airport-Collaborative Decision Making). Moreover, to provide the future view in ATM operations; several trajectory sharing, innovative meteorological information exchange, and FF-ICE (Flight and Flow Information for a Collaborative Environment) based operations enabled by SWIM were also presented. The operational scenarios conducted during the Demonstration were categorized as follows;

- Trajectory sharing for situational awareness;
- Aircraft turnaround process with A-CDM;
- ATFM – Ground Delay Program;
- Long-range ATFM – Airborne ATFM measure;
- Pre-tactical rerouting;
- Tactical rerouting; and
- FF-ICE Release 1 (FF-ICE/R1) pre-departure trajectory negotiation.

2.2 Business Rules Specification

To ensure that the information services able to support the operations as anticipated, the business rules associated with each step of the operational process as per the operational scenarios need to be identified. Specifically, the list of actors and the actions which each actor can perform at each operational step, aka operating procedure, should be provided at the forefront of information service design and development.

One of the very good examples of how crucial the business rules specification is for the development and implementation of information service and SWIM as a whole is the cross-border ATFM currently operated within Asia/Pacific region. Unlike other regions where an ATFM is regionally centralized with an overarching authority responsible for ATFM operation for the entire region, Asia/Pacific has adopted the Distributed Multi-Nodal ATFM Network concept. This concept, as specified in ICAO Asia/Pacific Regional Framework for Collaborative ATFM, is based on a network of Air Navigation Service Providers (ANSPs) leading independent ATFM operation within their area of responsibility and connecting to each other through information sharing framework. In such operational environment, not only systems of related stakeholders should be fully interconnected and interoperable but also the roles and responsibilities of each stakeholder should be clearly defined; so that the information exchange among them can be done automatically using information services and SWIM. **Annex B** shows the example of operational use cases together with defined business rules developed for the Demonstration, while the summary of operational scenarios conducted during the Demonstration can be found in **Annex C**.

With the operations and the corresponding business rules determined, the next milestones of the SWIM in ASEAN Demonstration were to identify and design the SWIM infrastructure and information services accordingly.

3 SWIM Infrastructure

3.1 Architecture – GEMS

To utilize the SWIM in ASEAN Demonstration as a platform to test the suitability and feasibility of the chosen SWIM architecture for implementation in Asia/Pacific region, a couple of architectures were examined. Specifically, at the time of the Demonstration development, there were at least two SWIM implementations in the world, namely the US-FAA SWIM and the SESAR-JU SWIM. Both adopted very different architectures to support their SWIM implementations. However, common in both was the use of the Enterprise Messaging Service (EMS).

In the very early considerations of possible SWIM architectures, it was assumed that EMS would also be the major component of SWIM architecture for the Demonstration. Three possible architectures considered were:

1) Single EMS connecting all participants in the Demonstration;

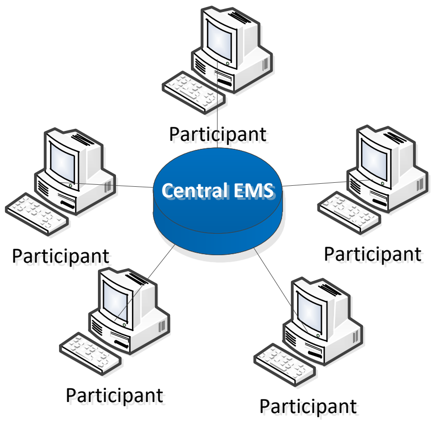

Fig. 1. Single EMS Architecture.

2) Every participant implementing an EMS and all interconnected;

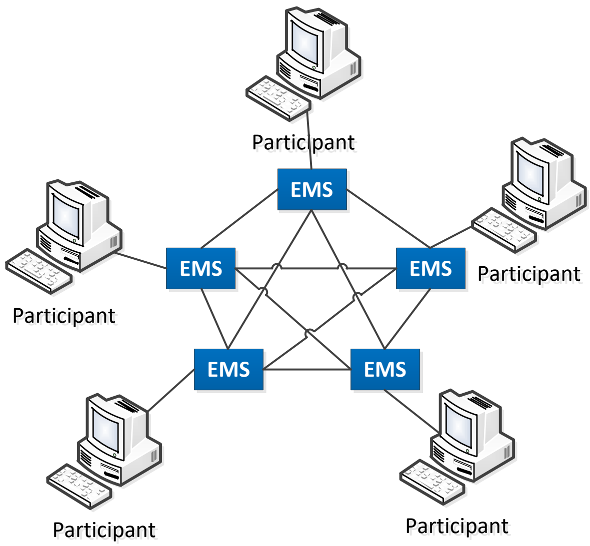

Fig. 2. Every Participant Implementing Interconnected EMS Architecture.

3) Participants, with technical capabilities to do so, implementing an EMS each and private companies providing EMSs to connect the participants without an EMS of their own.

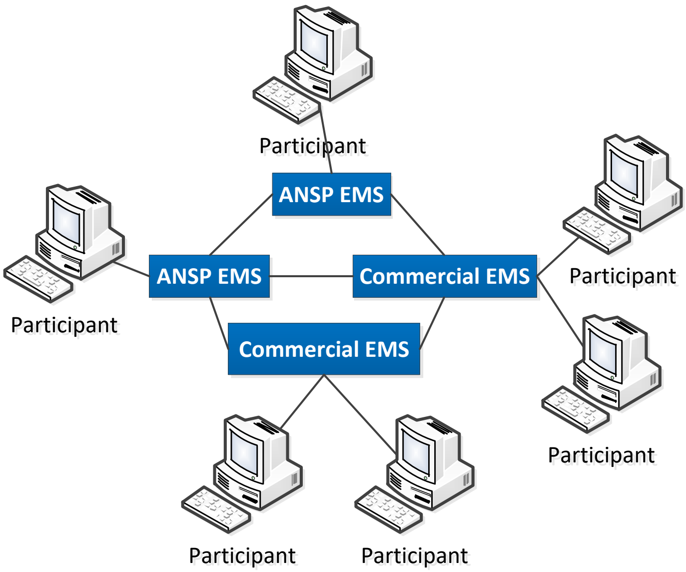

Fig. 3. Combined Public and Private EMS Architecture.

Table 2 lists the pros and cons of each option in the context of the SWIM in ASEAN Demonstration and the needs of the Asia/Pacific region.

Table 2
Pros and Cons of SWIM Architecture Options

Pros	Cons
Option 1 Single EMS Architecture	
• Efficient implementation – Each participant only needs to connect once • Less metadata needed to ensure proper message routing • Faster to integrate	• Hard to get consensus on who to implement the EMS • If EMS is implemented by third party, no participant has control over how messages are routed
Option 2 Every Participant Implementing Interconnected EMS Architecture	
• Every participant is responsible for their own EMS implementation • Each participant has full control over how their EMS routes messages	• Every participant needs to establish EMS-EMS connection to every other participant, leading to point-to-point connection • Message routing is complex and less efficient, compared to Option 1
Option 3 Combined Public and Private EMS Architecture	
• Participants can decide how they wish to connect to regional SWIM, either through their own EMS or through the commercial EMS • The number of EMS being implemented is small	• Although all EMS are required to be interconnected, the complexity is still less than Option 2 • Message routing has to be agreed upon by the group that is implementing the EMSs

After deliberation by the core planning team of the Demonstration, Option 3 was picked as the architecture to support the Demonstration. It was the view of the team that this architecture is the most suitable architecture that makes a compromise between the maximum efficiency and the geopolitical concerns of the participating States/Administrations. The interconnected EMSs in accordance with Option 3 architecture was collectively known as the Global Enterprise Messaging Services (GEMS).

3.2 Messaging Protocol

Once the architecture was decided, the GEMS Working Group (GEMS WG) was formed. This GEMS WG consisted of not only representatives from State participant implementing EMSs but also the commercial vendors supplying commercial EMSs.

The major task of the GEMS WG was to ensure that messages would be routed correctly and in the most efficient manner possible. One of the very first decision made by the GEMS WG was the standard of messaging protocol to be implemented for the Demonstration. It was found that many different messaging protocols fitting with the scope of the Demonstration were available and the three most common protocols considered were:

1) Simple Object Access Protocol (SOAP);
2) Java Message Service (JMS); and
3) Advance Message Queuing Protocol (AMQP).

After through discussion among the GEMS WG, AMQP version 1.0 was chosen to be the standard protocol for this Demonstration. Several reasons aided in the selection of this protocol with the primary reason being that AMQP is an open industry standard that has already been in use commercially by several aviation-related vendors and other industries. Secondly, this standard is one of the standards listed in the Yellow Profile of the SESAR JU SWIM implementation, giving the GEMS WG a template on how to deploy the AMQP on their EMS to support messaging in the SWIM environment. Last but not least, because AMQP is an open standard, there are no licensing fees associated with the use of the protocol, thus reducing the costs of an EMS implementation.

3.3 Metadata

Once the protocol was decided, the GEMS WG consequently decided how messages were to be routed and it was concluded that the most efficient way to route the messages would be to utilize metadata attached to each message. This conclusion was aligned with the property of the AMQP that metadata is allowed to be attached to each message and that the EMS needs to only check metadata for routing information without having to unpack and checking the message body, resulting in quick processing and routing of the messages.

The GEMS WG then made a decision on the fields considered necessary for message routing and the contents which these fields should contain. It is important to note that the field names and field contents must be standardized and each EMS must interpret the data in a standard way so that routing can be consistent. The GEMS WG deliberated on and finalized a metadata document that contains all the fields deemed necessary for routing the messages as well as the allowable contents for each field. This metadata document can be found in **Annex D**.

4 Development Process

4.1 Service Development

Based on the operational requirements for information exchange identified using the approach described in Section 2, the information services together with the service types and the information exchange models were determined. Considering the types of information required to be exchanged among stakeholders as per the operational scenarios developed, it was concluded that the existing standardized information exchange models, namely AIXM (Aeronautical Information Exchange Model), FIXM (Flight Information Exchange Model), and IWXXM (ICAO Meteorological Information Exchange Model) could be utilized for the exchange of aeronautical information, flight information, and weather information, respectively. Furthermore, taking into account the status of these standardized information exchange models at the time of the Demonstration development, the specific version of information exchange models, i.e. AIXM version 5.1, FIXM version 4.1, and IWXXM version 2.0, were selected.

However, also based on the developed operational scenarios, it was found that the data attributes considered necessary to be exchanged among stakeholders involving in the cross-border ATFM operation, the A-CDM process, and to support the integration between ATFM and A-CDM were not included in the FIXM version 4.1 Core. Considering that these data attributes were flight-specific, FIXM would be the appropriate information exchange model to support the aforementioned operations. Consequently, FIXM version 4.1 Extension was developed to include these data attributes. It was worth noting that this FIXM version 4.1 Extension was adopted by the Thirtieth Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/30) in November 2019 to be the Asia/Pacific FIXM version 4.1 Extension for use by Asia/Pacific States/Administrations to support the cross-border ATFM information exchange. Moreover, the Asia/Pacific FIXM version 4.1 Extension was forwarded to the FIXM Change Control Board (CCB) for review and it was published on the FIXM official website for use by other stakeholders as well. The list of data attributes included in the Asia/Pacific FIXM version 4.1 Extension is shown in **Table 3**.

Table 3
Asia/Pacific FIXM version 4.1 Extension Data Attributes

<table>
<tr><th>Estimated</th><th>Calculated</th><th>Target</th><th>Actual</th></tr>
<tr><td></td><td></td><td>TOBT</td><td>AOBT</td></tr>
<tr><td></td><td></td><td>TSAT</td><td></td></tr>
<tr><td></td><td>CTOT</td><td>TTOT</td><td></td></tr>
<tr><td>ETO</td><td>CTO</td><td></td><td>ATO</td></tr>
<tr><td>ELDT</td><td>CLDT</td><td></td><td></td></tr>
<tr><th colspan="4">Other</th></tr>
<tr><th colspan="2">Trajectory</th><th colspan="2">Aircraft Track</th></tr>
<tr><td colspan="2">• ETO
• CTO
• ATO
• Flight level or Altitude
• Waypoint</td><td colspan="2">• Ground speed
• Bearing
• Flight level or Altitude
• Position (Designator or Latitude/Longitude or Relative Point)
• Time over position</td></tr>
</table>

Additionally, the assessment on the possibility to utilize the existing information exchange models for the exchange of ATFM Daily Play (ADP) being currently distributed among ATFM units and related stakeholders in the Asia/Pacific region was conducted. Nevertheless, it was found that the existing information exchange models would not be the best alternative for the ADP exchange as the information contained in ADP covers more than one information domains. It was thus decided that, under this Demonstration, ADP would be accessible via web services to at least improve its accessibility to be timelier, compared to the current operation where ADP is distributed via e-mail. **Table 4** presents the list of developed information services together with their types and the information exchange models used for this Demonstration.

Table 4
Information Services Developed for the SWIM in ASEAN Demonstration

Information Service	Service Type	Information Exchange Model/Information Format
Aeronautical Information Service	Publish/Subscribe	AIXM v5.1
Flight information Service	Publish/Subscribe	FIXM v4.1 with Asia/Pacific Extension
Weather Information Service	Publish/Subscribe Request/Reply	IWXXM v2.0
ADP Information Service	Publish through web services	PDF

Besides the information services listed above, additional services as shown in **Table 5** were developed and provided to create and test the ATM operation under the partial and full SWIM environment.

Table 5
Additional Services Developed for the SWIM in ASEAN Demonstration

Service	Function
GUFI Service	GUFI (Globally Unique Flight Identifier) provision and validation
Flight Object Management	Flight information management throughout flight's lifecycle
Data Transformation	Conversion of data from legacy format to native-SWIM format

Furthermore, SWIM-enabled applications were developed and provided to facilitate the software development and to test their operational feasibility in SWIM environment. SWIM-enabled applications provided during the Demonstration are as presented in **Table 6**.

Table 6
SWIM-enabled Applications Developed for the SWIM in ASEAN Demonstration

Application	Function
Data Governance Module	Syntactic validation of AIXM, FIXM, and IWXXM messages
Viewer	Geographical and textual data display
ATFM	• Traffic demand prediction and monitoring • ATFM planning and execution, including CTOT/CTO computation
A-CDM	A-CDM milestones coordination
FF-ICE/R1	• Planning service • Trial service • Filing service

4.2 SWIM Infrastructure and Information Service Test

With all required components, including SWIM infrastructure, information services, other additional services, and SWIM-enabled applications developed, the series of different tests were conducted to ensure that these components can appropriately support the operations as anticipated. Towards the live demonstration, the following tests were executed in sequence.

- Connection Test
  - To check the network connectivity among EMS providers.
- Message Test
  - To test the exchange of messages in accordance with the operational steps specified.
  - In order to be certain that (*i*) the messages necessary to be exchanged at each operational step were correctly generated with all required data attributes, (*ii*) the test was conducted in the sequence as reflected in the operating procedure, and (*iii*) the messages were distributed to only concerned parties, the data script and data flow diagram should be prepared to provide the clear instruction for message and test validation. **Annex E** presents the example of data flow diagram developed for the Demonstration.
- Operational Scenario Test
  - At this stage of testing, which was the last stage before the conduct of the Demonstration, all required SWIM components, including SWIM infrastructure, services, and applications were run following the operational steps outlined in the operational scenarios to examine that these SWIM-related elements were able to correctly function and properly support the identified operations.

5 Observations and Lessons Learnt

The observations and lessons learnt, which had been recorded during the whole course of the SWIM in ASEAN Demonstration project, are as follows.

a) Seamless information exchange among aviation stakeholders is critical in order to be able to not only cope with the tremendous air traffic growth but also the changing landscape of air navigation. With real-time data exchange enabled by SWIM, all stakeholders have access to the most up-to-date and reliable information of the current ATM environment, increasing common situational awareness, predictability as well as augmenting in collaborative decision making process.
b) Increasing need for SWIM is a fact. It was proved during the Demonstration that SWIM not only helps improve the current operations such as ATFM, A-CDM but also enables the advance operations like FF-ICE.
c) More distinct operational benefits can be achieved with increasing SWIM implementation. It was observed that, in the case where some ANSPs were not SWIM-capable, participations of airspace user's flight operations center system via ground/ground SWIM tangibly contributed to improved ATM performance. The more SWIM capable is, the better ATM performance will be.
d) Use of AIXM, FIXM, and IWXXM plays an important role in achieving interoperability. To address the specific needs, e.g. the Asia/Pacific regional ATFM requirements, Extensions to the Core of the existing information exchange models are viable and effective solution.
e) Mediation is a key to bring diverse stakeholders with different technical capabilities on board and to enable the early leveraging of seamless information sharing in the partial SWIM environment where some stakeholders are SWIM capable and some are not.
f) Clearly defined operational use cases and processes are crucial to and prerequisite for SWIM development and implementation. Technical enhancement without operational view is challenging.
g) Interconnected EMSs is a candidate model of SWIM implementation for Asia/Pacific region.
    - Use of open standards and utilization of open-source protocol which is mature and widely used in other industries can make the regional and global adaptation and communication happen at ease.
    - Governance of metadata, i.e. metadata with clearly defined format and possible values, is crucial for ensuring the correct message routing.
    - Relation between fields in metadata, e.g. the relation between header defining message type and other related headers, should be defined to ensure the completeness of the message being exchanged.
    - For each message type, required data attributes containing in the message body should be specified to assist in message validation.

6 Annexes

Annex A	Operational scenario template
Annex B	Operational use case example
Annex C	Summary of operational scenarios conducted at the SWIM in ASEAN Demonstration
Annex D	SWIM in ASEAN Demonstration GEMS Metadata
Annex E	Example of data flow diagram

Annex A Operational Scenario Template

Name
Provide the name which can well represent the action accomplished based on the operational scenario
Brief Description
Describe briefly the objective of the operational scenario
Actors
Specify a list of units involved
Pre-conditions
Specify actions required prior to the execution of the operational scenario
Basic Flow of Events
Specify how the operational scenario is executed step-by-step
Required Data Elements
Data to be Exchanged *Specify data elements involved in the operational scenario and required to be exchanged between related systems*
Locally-Derived Data *Specify data elements involved in the operational scenario but not required to be exchanged between related systems*
Required Information Services
Specify information services required to support the data exchanged between related systems

Annex B Operational Use Case Example

Example 1

Name
Demand-Capacity Monitoring for Airport
Brief Description
This scenario focuses on the determination of traffic demand against arrival airport capacity, to be performed by arrival ATFM unit (ATFMU).
Actors
1. Arrival ATFMU 2. Airspace User (AU) 3. Airport Operator (AO)
Pre-conditions
1. AAR (Airport Acceptance Rate) has already been determined through separate process 2. Standard Taxi-Out Time (STT) from departure airports have been agreed (*or use default*)
Basic Flow of Events
<u>Initial Demand Prediction</u> 1. Arrival ATFMU generates initial (strategic) arrival traffic demand based on flight schedule parameters (SIBT) 2. AU submits FPL as per standard process 3. Arrival ATFMU extracts relevant information from the basic FPL a. Flight ID – ACID, ADEP, ADES b. Timing parameters – EOBT, EET 4. Arrival ATFMU generates relevant timing parameters to estimate arrival demand, and supplements to the strategic demand profile a. ETOT = EOBT + STT b. ELDT = ETOT + EET 5. Arrival ATFMU updates traffic demand profile at arrival airport <u>Updated Demand Prediction: Pre-Departure</u> 6. AU submits CHG / DLA / CNL message as per standard process 7. Arrival ATFMU extracts relevant information from the message a. Flight ID – ACID, ADEP, ADES b. Timing parameters – (new) EOBT, EET 8. Arrival ATFMU generates relevant timing parameters to estimate new arrival demand, and update accordingly <u>Tactical Demand Update</u> 9. Departure ATSU submits DEP message as per standard process 10. Arrival ATFMU extracts relevant information from the message a. Flight ID – ACID, ADEP, ADES b. Timing parameters – ATOT (DEP) 11. Arrival ATFMU generates relevant timing parameters and updates arrival demand accordingly
Required Data Elements
<u>**Data to be Exchanged**</u> 1. Flight ID – ACID, ADEP, ADES 2. EOBT 3. EET 4. ATOT
<u>**Locally-Derived Data**</u> 1. ETOT

2. ELDT
Required Information Services
Flight ID, EOBT, EET, ATOT → Flight information service

Example 2

Name
GDP Activation for Airport
Brief Description
This scenario focuses on the activation of Ground Delay Program (GDP) and distribution of Calculated Take-Off Time (CTOT) to manage the arrival traffic demand at an airport, after an arrival ATFMU has determined that unconstrained demand will exceed the airport capacity (AAR).
Actors
1. Arrival ATFMU 2. Departure ATFMU / ATSU 3. Airspace User (AU) 4. Airport Operator (AO)
Pre-conditions
1. Arrival ATFMU has performed demand prediction and monitoring, and has determined that unconstrained demand will exceed airport capacity (AAR) 2. Arrival ATFMU has sufficient support system to generate, distribute, and manage CTOTs 3. Departure ATFMU / ATSU, AU, AO understand the operating procedure on CTOTs 4. Standard Taxi-Out Time (STT) from departure airports have been agreed (*or use default*)
Basic Flow of Events
<u>ATFM Daily Plan Distribution and CDM Web Conference</u> 1. Arrival ATFMU generates ATFM Daily Plan (ADP) *either auto or manual* 2. Arrival ATFMU distributes* ADP to AU, AO, and Departure ATFMU along with call for CDM web conference **ADP delivery currently relies on e-mail; this can be revised once there is an agreement on how to deliver this under SWIM environment** 3. AU, AO, Departure ATFMU join CDM web conference to discuss the situation <u>GDP Activation and CTOT Distribution</u> 4. AU submits FPL as per standard process 5. Arrival ATFMU extracts relevant information from the basic FPL a. Flight ID – ACID, ADEP, ADES b. Timing parameters – EOBT, EET 6. Arrival ATFMU generates relevant timing parameters to estimate arrival demand and calculate CTOT a. ETOT = EOBT + STT b. ELDT = ETOT + EET c. CLDT = Appropriately sequenced ELDTs d. CTOT = CLDT – EET 7. Arrival ATFMU distributes CTOT to AU, AO, Departure ATFMU *a. CLDT can be distributed along with CTOT for information; compliance is taken at departure against CTOT* <u>Departure Facilitation</u> 8. Departure ATFMU, AU, AO receives CTOT from Arrival ATFMU and prepare for compliant departure a. Departure ATFMU alerts or forward information to relevant ATSU

b. AU: Operations Control Center (OCC) ensures flight crews are briefed or ensures CTOT is communicated to airborne flight *short turnaround case*
c. AO ensures gate planning takes into consideration CTOT

9. Departure ATSU facilitates departure in compliant to CTOT
10. Departure ATSU submits DEP message as per standard process
11. Arrival ATFMU extracts relevant information from the message
    a. Flight ID – ACID, ADEP, ADES
    b. Timing parameters – ATOT (DEP)
12. Arrival ATFMU logs the information for post-ops analysis

Required Data Elements

<u>Data to be Exchanged</u>

1. Flight ID – ACID, ADEP, ADES
2. EOBT
3. EET
4. CTOT, CLDT
5. ATOT

<u>Locally-Derived Data</u>

1. ETOT
2. ELDT
3. ALDT

Required Information Services

Flight ID, EOBT, EET, CTOT, CLDT, ATOT → Flight information service
ADP → ADP service

Annex C Summary of Operational Scenarios Conducted at the SWIM in ASEAN Demonstration

Trajectory Sharing for Situational Awareness

The scenario explored gate-to-gate flight operations with timely and continuous sharing of trajectory updates through area of partial SWIM implementation by some Air Navigation Service Providers (ANSPs) and Airspace Users (AUs). The scenario exhibited an enhancement in ATM system performance when trajectory updates were provided to downstream Area Control Centers (ACCs) and other ATM stakeholders with SWIM capabilities. With the sharing of trajectory updates, advance situational awareness of an incoming flight, which can be used to support common situational awareness across stakeholders, create more accurate demand predictions, and improve operational planning and predictability, can then be achieved.

In the scenario, data exchanges included participation of the airline Flight Operations Center (FOC) via ground-ground (G/G) SWIM across FIR(s) with partial SWIM implementation. It demonstrated the value to the ATM system, including operators, ATM Service Providers (ASPs) and other stakeholders, if an AU with G/G SWIM capability, can share information even though an intermediate ASP/FIR may not be SWIM capable.

Aircraft Turnaround with A-CDM

The scenario explored the process of pre-departure management for a flight from an airport with Airport-Collaborative Decision Making (A-CDM) system and process in place. The scenario showed the benefits of information exchange between all stakeholders, especially with an A-CDM system that can communicate across borders. The scenario also demonstrated the way in which SWIM can enable such sharing of information to happen with ease. Note that this scenario did not follow flight from gate to gate, but rather focused on the turnaround process at the departure end to highlight the A-CDM operations.

ATFM – Ground Delay Program

The scenario demonstrated how a Ground Delay Program (GDP) activated under the Distributed Multi-Nodal ATFM Network environment looked like when operated using SWIM-based technologies. The scenario covered full process from pre-tactical demand monitoring to Calculated Take-Off Time (CTOT) distribution and management. The MET information in native-SWIM format provided directly from MET service provider together with the MET visualization support tool connected through SWIM was also explored in the scenario. For this scenario, the arrival airport capacity was reduced due to inclement weather in the terminal area and a GDP was activated by ATFM Unit to manage the incoming demand. The scenario also explored how A-CDM process was connected to ATFM operations using an example from one of the departure airports in the network. Through the scenario, the distinct benefits one can see from moving the ATFM and A-CDM operations on to SWIM network included not only reduced workload in ATFM information coordination but also more efficient and automated information exchange across different systems.

Long-range ATFM – Airborne ATFM Measure

The scenario explored gate-to-gate flight operations where the flights experience tactical re-routing due to volcanic ash and airborne ATFM measure as a result of heavy fog. With participation of AUs and MET service provider with SWIM capability, the interruptions, trajectory updates, and traffic flow information were seamlessly shared across stakeholders, leading to advance and common situational awareness. The enhanced awareness, in turn, improved operational predictability and planning.

Pre-tactical Rerouting due to Airspace Closure

The scenario dealt with the concept of Flexible Use of Airspace (FUA), a concept designed to enhance airspace management to accommodate the growing traffic demand and all user requirements at the greatest possible extent. In particular, the scenario demonstrated the linkage between civil and military operations through an exploration of conditional route (CDR) underling FUA concept and the pre-departure rerouting that had to occur when said CDR was announced closed. The focus of the scenario was on how SWIM can enable highly-efficient publication and timely distribution of NOTAM containing the availability information of CDR, allowing the AU to adjust their planned operations accordingly.

Tactical Re-routing due to Significant Weather

The scenario explored the rerouting of an airborne flight due to significant weather. The scenario reflected how ATM system performance can be highly enhanced by a full SWIM implementation of all related stakeholders. It demonstrated the distribution of digital MET data and flight information through SWIM, which can then be directly interfaced to ATM ATFM as well as airline's FOC systems. Through SWIM-based efficient distribution of information, the scenario exhibited how the timely assessment of impact on flight trajectory and greater and continuous situational awareness can be achieved by all related stakeholders, leading to higher operational efficiency in both planning and management.

FF-ICE/R1 Pre-departure Trajectory Negotiation

The scenario demonstrated the operation based on Flight and Flow Information for a Collaborative Environment (FF-ICE) concept with a focus on pre-departure flight planning coordination among FF-ICE-enabled AU (eAU) and FF-ICE-enabled ASPs (eASPs). It was assumed that the aircraft used in the previous scenario continued its operation in this scenario. With the arrival delay incurred due to significant weather of the flight in the previous scenario, this scenario explored how the advanced and highly-efficient information sharing among stakeholders brought about by SWIM played a crucial role in improved flight operation planning and, importantly, how SWIM can enable the enhanced and automated collaborative decision making following FF-ICE concept, boosting ATM system performance to the next level.

Annex D SWIM in ASEAN Demonstration GEMS Metadata

Header Name	Values	Descriptions
SOURCE	<Country of origin>_<Organization>_<System>	Country of Origin should take the country codes found in GEMS_DEP_AIRPORT
GEMS_MESSAGE_TYPE	ARRIVAL	Flight Arrival
	BOUNDARY_COORDINATION	Flight Boundary Coordination
	CLEARNACE	Flight Clearance
	DEPARTURE	Flight Departure
	EMERGENCY	Flight Emergency
	ENROUTE	Flight En-Route
	OBJECT	Flight Object
	ROUTE	Flight Route
	STATUS	Flight Status
	TRAJECTORY	Trajectory
	TRACK	Flight Track
	FPL	Flight Plan 2012
	CHG	ATS Change Message (CHG)
	DLA	ATS Delay Message (DLA)
	CNL	ATS Cancellation Message (CNL)
	DEP	ATS Departure Message (DEP)
	ARR	ATS Arrival Message (ARR)
	EST	(Estimate)
	CTOT	Calculated Take Off Time
	NOTAM	Notice to Airmen in AIXM format
	TAF	MET Message Types
	SIGMET	
GEMS_XML_VERSION	FIXM_4_1_APAC	FIXM v4.1 with APAC Extension
	FIXM_4_1	Only FIXM v4.1 Core
	AIXM_5_1	AIXM v5.1
	IWXXM_2_0	IWXXM v2.0
GEMS_ARR_AIRPORT	4-letter ICAO Code	
GEMS_DEP_AIRPORT	4-letter ICAO Code	
GEMS_ACID	Use FIXM Version Regular Expression	Use FIXM Version Regular Expression
GEMS_AIRLINE	Use ICAO Airline	

Header Name	Values	Descriptions
TIMESTAMP	Timestamp (EPOCH TIME) At a minimum this is required: Example: JCAB_IN: 1410889512345, SBH_IN:1410889512356, SBH_OUT:1410889512367, SBM_IN:1410889512389, SBM_OUT:1410889512389	Time of message leaving the EMS
RECIPIENT LIST	YM	Australia
	VD	Cambodia
	VH	Hong Kong
	WI	Indonesia
	RJ	Japan
	VL	Lao PDR
	WM	Malaysia
	MY	Myanmar
	NZ	New Zealand
	RP	Philippines
	WS	Singapore
	VT	Thailand
	VV	Vietnam
	"K" or "P"	United States

Annex E Example of Data Flow Diagram