

*International Civil Aviation Organization*



ICAO

**Twenty Fourth Meeting of the Communications/  
Navigation and Surveillance Sub-group (CNS SG/24) of  
APANPIRG**

Web-conference, 30 November – 4 December 2020

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**Agenda Item 3:** Aeronautical Fixed Service (AFS)

- 3.4 Review outcomes of the Fourth Meeting of System Wide Information Management Task Force (SWIM TF/4);

**OUTCOME OF THE FOURTH MEETING OF  
THE SYSTEM WIDE INFORMATION MANAGEMENT TASK FORCE**

(Presented by the Secretariat)

**SUMMARY**

This paper presents the outcomes of the Fourth Meeting of the SWIM Task Force (SWIM TF/4) for review and appropriate action.

**1. INTRODUCTION**

1.1 The Fourth Meeting of the APAC SWIM Task Force (SWIM TF/4) was held from 3 to 6 November 2020. The Meeting was an on-line meetings using Microsoft Teams.

1.2 The meeting was attended by 135 participants from 17 States/Administrations, 3 International Organizations and 5 Industry partners including Australia, China, Hong Kong-China, Fiji, Indonesia, Japan, Malaysia, Mongolia, New Zealand, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, USA, IATA, IFALPA, IFATCA, Atlas Air, Cirium, Frequentis, PCCW Global and Snowflake.

1.3 13 Working Papers, 9 Information Papers, 7 Presentations were considered by the meeting. The papers and draft report of SWIM TF/4 meeting are available at: <https://www.icao.int/APAC/Meetings/Pages/2020-SWIM-TF4.aspx>

**2. DISCUSSION**

**Election of Co-Chair of the Task Force**

2.1 Ms. Jeri Groce, Chair of the SWIM Task Force briefly recalled the history and efforts of the task force, explained the benefits to enhance the leadership of the task force with regional view to better deal with the challenges and progress the implementation of SWIM, and opened the floor to participants for consideration and nomination. Dr. Amornrat Jirattigalachote, Strategic Planning Manager (Engineering), Policy and Strategy Management Bureau of AEROTHAI, was nominated by USA, seconded by Japan, Singapore, Hong Kong China and China, was elected as co-chair of the APAC SWIM Task Force of APANPIRG.

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**Review SWIM Task Force Programme and outstanding action items**

2.2 The meeting reviewed the development of SWIM TF's work plan and the updating of Action List with highlight on the restructure of the task assignment and numbering. The meeting noted the information, considered the amendment as necessary, and therefore formulated the following decision to adopt the revised task structure.

<b>Decision SWIM TF/4/1 - Revised SWIM TF Task Group</b>	
What: That, the Revised SWIM TF Task Group provided in <b>Appendix A</b> to this Report is adopted.	Expected impact: <input type="checkbox"/> Political / Global <input checked="" type="checkbox"/> Inter-regional <input type="checkbox"/> Economic <input type="checkbox"/> Environmental <input checked="" type="checkbox"/> Ops/Technical
Why: To better align the achievements from various tasks with the global guidance and regional implementation materials and eliminate unnecessary duplication in the original work plan.	Follow-up: <input checked="" type="checkbox"/> Required from States
When: 6-Nov-20	Status: Draft to be adopted by PIRG
Who: <input checked="" type="checkbox"/> Sub groups <input checked="" type="checkbox"/> APAC States <input checked="" type="checkbox"/> ICAO APAC RO <input type="checkbox"/> ICAO HQ <input type="checkbox"/> Other: XXXX	

**SWIM in ASEAN Demonstration Report**

2.3 The SWIM in ASEAN Demonstration was successfully conducted on the 12th and 15th of November 2019, in Bangkok, Thailand and Singapore, respectively. It saw wide participation of aviation stakeholders in ASEAN (Association of Southeast Asian Nations) and Asia/Pacific region, including Civil Aviation Authorities (CAAs), Air Navigation Service Providers (ANSPs), airport operators, airlines, and international organizations such as ICAO Asia/Pacific Regional Office, IATA.

2.4 Singapore and Thailand presented the SWIM in ASEAN Demonstration Report to the meeting, which detailed the demonstration development, including the collection of operational requirements as well as the design, development, and test of SWIM infrastructure and information services. Observations recorded and lessons learnt during the whole course of the Demonstration were also provided.

**An Approach for APAC Regional SWIM Implementation**

2.5 Japan, Task Lead of Task 2 Regional SWIM Infrastructure, presented the research and practical results of previous Task 1.8 and the optional approaches of regional SWIM construction and implementations within transition period. The research work of this Task was carried out in coordination with the tasks of SWIM in ASEAN Demonstration and SWIM Service and Application Validation. To overcome the limitations of CRV and avoid the unsupportable point-to-point connections between all stakeholders, the cooperation between CRV and SWIM service providers is required. As result of discussion, the meeting agreed to adopt an CRV-based interoperable architecture in which the CRV communication and SWIM communication are divided into different layers to assure the performance of CRV for conventional AFTN/AMHS applications and improve the flexibility required for regional SWIM implementation. Common agreements are required to be establish by SWIM service providers

and a collaborative environment is needed to be created at the regional level to ensure information exchange between different systems.

2.6 The meeting further discussed the technical capabilities of SWIM TI required to achieve interoperability during the transition period, such as: 1) The SWIM TI will have two interfaces that enable the exchange of information with both CRV-based legacy systems and SWIM-enabled systems; 2) SWIM-enabled systems need to receive/send different AFTN/AMHS message types (MET, AIS, and ATS) from/to CRV-based legacy systems according to information domain requirements; 3) The SWIM TI is able to decouple CRV-based legacy and SWIM-enabled applications from external systems that implement different communication protocols.

### **SWIM Technical Overview Centered around CRV**

2.7 PCCW Global, the CRV provider selected through ICAO TCB process, presented a system architecture of SWIM service. It is a managed SWIM solution which can be deployed with the preference of each member States and is proposed to run on CRV network as value-added service.

2.8 PCCW Global has been developing the SWIM service on a private and scalable platform in partnering with one of leading aviation vendors - FREQUENTIS. PCCW Global owned network infrastructure & hosting facilities combining with FREQUENTIS proven knowledge & experience in aviation industry would formulate an alternative solution for ANSPs to facilitate the SWIM initiatives. It provided an alternative approach for States to immediate access to the available SWIM services.

2.9 PCCW SWIM infrastructure could be one of the global/commercial EMS nodes to deliver SWIM services or qualified third party services. The deployment options include on-premise deployment, network based as well as hybrid model. This enables flexibility to meet individual State requirement.

### **Extension Development of FIXM to Support National ATFM Operations and ATFM/A-CDM Integration in China**

2.10 In order to implement data sharing among ATFM stakeholders, and facilitate a seamless and agile exchange of ATFM data, the development of FIXM has been started by ATMB of CAAC in 2019, based on FIXM APAC FLOW Extension version 1.0.

2.11 Additional data attributes required to be exchanged among stakeholders involving in ATFM operations and to support the integration between ATFM and A-CDM were identified in FIXM ATMB ATFM Extension version 0.1.

### **SWIM Discovery Service (SDS): Introduction**

2.12 United States (USA) and Republic of Korea (ROK) introduced the concept of a SWIM Discovery Service (SDS). The ability to search for and locate (discover) services offered by a growing number of independently developed and autonomously managed SWIM domains is highly important and is a precursor for achieving global information exchange. The Federal Aviation Administration (FAA) and Korea Airports Corporation (KAC) are collaborating in an effort to define and test an approach for enabling federated service discovery across geographical and organizational boundaries. In this approach, a “discovery service” is a core SWIM service that allows a user to search for and obtain service metadata from multiple sources in one consolidated result. Discovery services do not need a centralized discovery mechanism since they are self-advertising and also advertise each other. To formalize the approach, the FAA has produced an SDS Implementation Specification v.1.0.0 that establishes guidelines and techniques for developing a discovery service capable of interacting with other SDS-compliant discovery services. The paper described SDS interaction patterns and discussed

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the contents of the Implementation Specification, including SDS behavior model, information model, resource model, interface requirements, and security requirements. The meeting noted that the SDS approach is consistent with the federated registry architecture adopted at SWIM TF/3, and encouraged participants to collaborate on SDS development.

**Security and Trust in the Context of SWIM Service Discovery**

2.13 USA and ROK provided a discussion of Security and Trust in the Context of SWIM Service Discovery. The joint FAA and KAC effort to establish a SWIM Discovery Service (SDS) development and testing environment has identified the need to address issues of security and trust that might occur when multiple independently operated discovery services exchange information. The paper illustrated some of these issues using an example scenario (an end user wants to “find all operational flight services”) that requires intercommunication among three different discovery services. It went on to explain that FAA and KAC are investigating using a federated identity management solution approach to secure the communication and showed how this approach could answer questions raised in the scenario. The paper also provided an overview of the latest relevant security technologies, and it discussed the proposed APAC Mutual Trust Infrastructure being developed as part of the Security Management subtask (Task 5) and its relationship to issues of trust between discovery services. The meeting recommended that issues identified in the paper be addressed by the TF Governance task and TF Security Management task, and encouraged participants to collaborate further on this subject.

**SWIM Service Category Taxonomy**

2.14 USA presented a SWIM Service Category Taxonomy designed for the purpose of organizing SWIM services into classes or categories to make the services easier to find or manage. The paper defined taxonomies as hierarchical classification schemes and described this particular scheme as a 3-level hierarchy with a top level “SWIM Service” classified into two categories, “Information Service” (services that provide information products) and “Core Service” (services that provide support capabilities). Each category has subcategories; e.g., “Weather Service” is a subcategory of Information Service, and “Security Service” is a subcategory of Core Service. The virtue of this taxonomy is that it can be extended horizontally by adding more categories to any level of the hierarchy, or vertically by further dividing a particular category into more specialized subcategories; in this way it is able to meet future business needs. Rendering the taxonomy into machine language (see <https://semantics.aero/service-category>) also allows it to support applications for service discovery or governance processing. The paper concluded by suggesting that the taxonomy be adopted as a standard approach for classifying SWIM services.

**Implementation Status of SWIM Discovery Service (SDS)**

2.15 USA and ROK provided information on the Implementation Status of the joint FAA/KAC SWIM Discovery Service (SDS) effort. In October 2019, FAA and KAC began a collaborative effort to establish a virtual environment for conducting transparent and replicable development of discovery services for future deployment by APAC SWIM initiatives. The paper presented a list of FAA/KAC work items together with the current status of each item. Completed items include: a service registry for ROK SWIM, a SWIM Discovery Service (SDS) Specification v.1.0.0 (<https://discovery.swim.aero/sds/1.0.0/>), a Service Description Model for JSON (SDM-J) (<https://discovery.swim.aero/sdm-j/1.0.0/>), and several SDS operations implemented. Remaining items include carrying out bi-directional testing of SDS operations and formally reporting the result of the joint effort to SWIM APAC TF.

### **Collaboration in Sharing of Surveillance Data in SWIM**

2.16 This paper presents the key considerations leading to a proposal of a Commercial-ANSP collaboration scheme in sharing and enriching surveillance coverage for the region to benefit the aviation community and accelerate the implementation of SWIM. With the concern on the sensitivity of surveillance data and the ownership and accountability of surveillance data correctness, contributing ANSPs need to consider what surveillance data to be shared and associated commitment to high availability, system redundancy and coverage of surveillance data to be shared. General availability to all ANSPs, contributing or not, to the shared surveillance data is recommended to realize benefits such as more rapid expansion of CRV community and the launch of SWIM services. Furthermore, the need for a Surveillance Central Data Processor (SCDP), being a critical infrastructure required for the sharing of surveillance data in SWIM is also explored and discussed in this paper.

2.17 Through the discussion of key consideration factors, this paper intends to elicit Members' views and thoughts on the Commercial-ANSP collaboration scheme proposed in this paper and the various consideration factors leading to the proposal. Also mentioned in this paper is the data sharing model at EUROCONTROL Network Manager, which could serve as a reference to move the potential scheme of surveillance data sharing in APAC. It is suggested that a study group led by Surveillance Implementation Coordination Group (SURICG) supported by experts in SWIM and CRV, etc. and under the guidance of ICAO APAC to be set up to advise CNS Sub-Group on the best approach for regional surveillance data sharing.

2.18 The meeting agreed to nominate Task Leads or members from Task 2, Task 5 and Task 6 to join the study group proposed by SURICG to further explore the initiative.

### **FF-ICE/R1 Service Validation and Implementation**

2.19 This WP was presented via a joint demonstration led by Japan, China and ROK. To implement FF-ICE/R1 operation, not only SWIM Technical Infrastructure for sharing information between different systems but also information services for supporting operation between different ATM applications are required. The FF-ICE services are expected to be highly automated and are expected to be performed through computer-to-computer links within a SWIM environment. This demonstration validated the implementation of FF-ICE services and the process of related messages for FF-ICE/R1 operation through two scenarios conducted by the FF-ICE/R1 capable ATM Service Providers (ASPs) and AUs (eASP and eAU). The demonstration shows that the SWIM-based FF-ICE operation is capable to provide related information in greater detail and allow the eAU and the eASP to share their expectations in an unambiguous manner via the exchange of trajectory information. Moreover, according to the scenario discussion and the test system development, some technical observations and recommendations was presented for improving regional SWIM and FF-ICE/R1 implementation.

### **SWIM in APAC Region: Where are we now and where are we going?**

2.20 Japan, Task Lead of Task 9 Monitoring of Panels' Work, recalled the main regional activities since the establishment of SWIM Task Force in 2017. Considering the important role and function of SWIM in the Global Air Navigation Plan (Doc 9750) and the Global ATM Operation Concept (GATMOC), as well as the significant impact of COVID-19 on the aviation industry, it is essential to highlight more efficiency and a strengthened and shared strategy for implementing SWIM in the region with stakeholders.

2.21 The meeting agreed to develop an action item for next Task Leads meeting to revise the TOR and further consolidate the list of action items, with consideration on the impact of COVID-19,

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new provisions from GANP edition 6, APAC Seamless ANS Plan, and enhancement of the interaction with various contributory bodies under APANPIRG. The meeting also proposed to consider to prepare another SWIM workshop for this region during the next Task Leads meeting.

**Regional Coordination**

2.22 Task Lead from IATA presented to the meeting about the SWIM related activities (and their interdependencies) in planning or development within other Working Groups (WGs) and Task Forces (TFs) at regional level since SWIM TF/3, for a broader coordination of SWIM activities in APAC (not solely MET) and improved awareness of the work of the SWIM Task Force.

2.23 The access to ICAO APAC SWIM reference and education material resided in ICAO Secure Portal, SWIM briefing videos and IATA SWIM training classroom course were also introduced:

- i. SWIM awareness / educational videos are available from both ICAO at <https://youtu.be/wXI9ep98Z8E> and IATA at <https://youtu.be/QplD6sP--gg>
- ii. two-day IATA SWIM Training classroom course and two-hour online SWIM introductory course, both of which participants can register for at <https://www.iata.org/en/training/>.

**Breakout Session Summaries**

2.24 During the planning period of SWIM TF/4, the chair, Task Leads and secretariat team conducted a number of online discussions, therefore agreed to set up a breakout session for SWIM TF/4 to facilitate the Task Leads and contributors to meet and update their assignment, respectively, with efficiency and effectiveness. Three online breakout meeting rooms were provided to accommodate tasks' discussion. The outcome of breakout session was reported by to the plenary by various Task Leads.

**Room 1: Implementation Planning, SWIM Infrastructure****Task 1: Regional Implementation Philosophy & Roadmap**

*Task Leads: Mr. David Leow & Dr. Amornrat Jirattigalachote*

2.25 Task leads presented a revised Statement Of Work (SOW) document to the breakout room 1 session attendees for comments and discussion.

2.26 The section on “Objectives and scope of the project” was expanded to provide more clarity as to the exact nature of work expected from this task group. Comments were received from the floor regarding the scope and were incorporated into the final draft to be sent to the secretariat.

2.27 Deliverables for this task group were presented to the session with no significant comments recorded. Related to the deliverables, milestones and timelines were also set for each deliverable. It was noted by the session that the 1st draft of the Asia/Pacific SWIM Implementation Roadmap is targeted to be presented at SWIM TF/6 meeting. Members of the session commented that this is too late to meet the ASBU Block 2 timeframe of 2025. To mitigate this, a new milestone for SWIM TF/5 was proposed and adopted into the draft of the SOW.

2.28 Due to the nature of this task, it has many dependencies on other contributory bodies under APANPIRG and the SWIM TF itself. In particular, this task is dependent upon all other task groups in

the SWIM task force. Therefore, there will be a need for more coordination between the task leaders of task 1 and the task leaders of all the other tasks.

Task 2: SWIM Infrastructure

*Task Leads: Mr. Yukinobu Ryu, Dr. Xiaodong Lu & Mr. Henry Chan*

2.29 Task lead, Dr. Xiaodong Lu presented the revised Statement Of Work (SOW) of Task 2 and discussed the related issues with the breakout room 1 session attendees.

2.30 The main objective and scope of this task that is to define the architecture, requirements and implementation policies to ensure technical interoperability in the region were presented and agreed by attendees.

2.31 The deliverables of this task include two parts. One focuses on the Regional SWIM Architecture requirements and policies by considering the interoperability and connectivity of CRV. Another focuses on the requirements of Regional SWIM Infrastructure itself. Members of the session commented that, according to the new version of SWIM Manual, the definitions and requirements of Infrastructure Services (Core Services) and SWIM Information Services should be clarified. This issue will be updated after confirming the new SWIM Manual released by IMP. Moreover, according to the discussion, the more flexible SWIM Infrastructure to adapt new requirements of SWIM information services should be considered.

2.32 For the milestones of this task, how to construct a security framework for SWIM was discussed. The cooperation with Task 3 Security Services is expected.

Task 3: Security Services

*Task Leads: Ms. Hannah (Han Hong)*

Task 11: SWIM Implementation Education and Promotion

*Task Lead: Ms. Hannah (Han Hong)*

2.33 Ms. Han Hong (Hannah) from China, who had served at ICAO APAC Office as seconded CNS officer and assisted the secretary of SWIM TF/2 and SWIM TF/3, was proposed as the Task Lead for Task 3 and Task 11, informed the meeting that there were no updates from her since the establishment of these two Tasks, and she would not be able to support these two Tasks in future due to her role and function change within CAAC ATMB, and she returned the Task 3 and Task 11 to the Task Force. The Task 3 and Task 11 in the Revised SWIM TF Task Group provided in Appendix A to this Report was updated to TBD accordingly. The follow up of Task 3 and Task 11 will be discussed in the next Task Leads meeting.

**Room 2: Governance & Information Services**

Task 4: Development and Maintenance of Regional Information Exchange Models

*Task Leads: Mr. Wen Zhu & Dr. Amornrat Jirattigalachote*

2.34 Task leads, presented a revised Statement Of Work (SOW) document to the breakout room 2 session attendees for comments and discussion.

2.35 *Objectives and scope of the project* section was revised to better reflect the expected scope of work to be carried out by this task group, particularly the scope of information exchange models to be examined. Question regarding the inclusion of ASTERIX for the exchange of surveillance data as part of this task's scope was raised. It was discussed that, as ASTERIX is not included in the current

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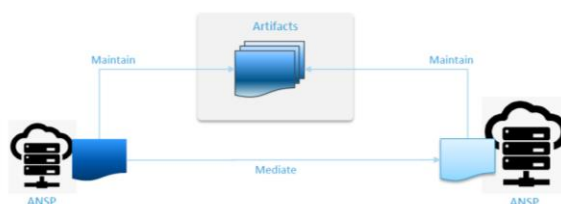
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draft of ICAO Doc 10039 Manual on SWIM, Volume II SWIM Implementation Guidelines, the careful consideration on the inclusion of ASTERIX in this task's scope is required first.

2.36 It was highlighted that, considering the long-term SWIM operation, Deliverables of this task group was expanded to also include the following:

- Strategy to maintain the artifacts required to support the regional development and maintenance of information exchange model(s) and the extensions; and
- Approaches for information exchange model interoperability within the region and with other aviation partners.

- Strategy for development and maintenance of regional extensions
  - Maintain relevant artifacts
  - Establish regional technical body
- Approach for exchange model interoperability
  - Consider scope and strategy for mediation services



2.37 Regarding Strategy for Development and Maintenance of Regional Extensions, the establishment of regional technical body to be responsible for development and maintenance of regional extensions after the dissolution of SWIM TF was articulated and was accepted by the session attendees. It was also discussed that such technical regional body should have close coordination with and report back to the parental information exchange model bodies, e.g. FIXM Change Control Board, on regional extensions.

2.38 On Approach for Exchange Model Interoperability, it was discussed that semantic can play a role in mediation of exchange model extensions in the future. In view of governance, it was echoed that semantics technologies can be used for mediation. Additionally, it was voiced that one version of regional extension at any given time is a preferred option. The role of AIRM in regard to interoperability was also discussed and it was noted that AIRM does not have extensions.

Task 5: Governance (Policies and Procedures)

*Task Leads: Mr. Mark Kaplun & Mr. Jiseok Kang*

2.39 KAC presented the status of the collaborative effort with the USA FAA in developing the SDS operational environment. It was pointed out how much KAC has accomplished by developing the registry and an SDS instance in a very short period (less than a year).

2.40 Australia recognized the SDS value and raised the questions about interactions among registries in APAC region. Australian registry would be using an instance of the EUROCONTROL registry. Australia suggested that all APAC States that consider developing or already have built registries should follow EUROCONTROL's lead in this area. Task Lead explained that the FAA

attempted to convince EUROCONTROL to join the FAA/ROK effort but failed; EUROCONTROL also abandoned other works on interacting among SWIM registries for undisclosed reasons.

2.41 In a response to whether users can obtain ATM-related information from SDS (e.g., MET or flight information), Task Lead explained that the user was getting information about the services from registry or description, only metadata. There is no flight data or weather data, only service description, service capability, interface protocols provided by either a registry or an SDS. However, all registries are different and provide service-metadata differently. SDS uses the standard interface, common format, and shared information model. Regardless of how service meta-data is presented or stored in a specific registry, the SDS responds to requests in a standard, uniform way.

2.42 It was informed that the FAA had developed a standard set of taxonomies to serve as a foundation to ensure that all information service providers use the same vocabulary to describe their information. On answering whether JSON schema for communicating between SDS is published and where it could be found, a link is provided to the schema <https://discovery.swim.aero/sdm-j/1.0.0/>.

2.43 It was asked that "In the future we will be developing weather services there is not a name to break down weather into wind, temperature, etc. Will there be a set vocabulary that will be external to the SWIM infrastructure?" The Task Lead explained that it is not the SDS prerogative to provide or accommodate such vocabulary. It was suggested visiting the FAA registry, which provides some of such features. It was also pointed out that Semantic Technologies may be useful in addressing the issues in question.

2.44 Mr. Mark Kaplun invited the participants to share their vision and expectations of APAC SWIM Governance, i.e., what is the most critical goal for APAC governance? Australia: What are we governing? Is it technical infrastructure, service overviews, policies and procedures? How we exchange data over organizations so there is consistency and reliability and trust in the information? What should be the scope be since there is a broad range of information? USA suggested that APAC needs to establish a trust to create a solid governance framework around interoperability. USA pointed out that there are two essential aspects of APAC governance: a) policies and standards for the region, and b) interoperability between the different governance structures through semantic mediation.

Task 6: Information Service:

*Task Leads: Mr. Marco MH Kok & Mr. John Moore*

2.45 The draft of scope and deliverable of Task 6 were presented to the session. Comments were received regarding the list of information services to be developed, whether it would be a list of specific services to be provided among ANSPs in APAC, or it referred to conceptual requirements of the content of various information services. It was clarified that the scope will focus on the latter one.

2.46 The meeting was informed by Mr. Mark Kaplun that the mandatory and optional elements in describing the Information Service Overview has been defined by IMP and were available.

2.47 Regarding suggestion from WP/05 by Japan "FF-ICE is a key enabler to achieve GATMOC and its SARPs and Guidance Material, under developing by ATMRPP, contain several "Information Service" for SWIM", Task 6 will check the information services for FF-ICE with Japan.

2.48 Regarding the naming of the services in the information service, Indonesia commented that it would be better to standardize it, for example meteorological service or weather service, to be in line with the proposed taxonomy presented in WP/10, and it was important to differentiate core infrastructure services from the information services also. Australia suggested Task 6 to look into the alignment with PANS-IM when determining the taxonomy of the information services.

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**Room 3: Validation and Demonstration, Monitoring of Panels Work,  
Regional Coordination and SWIM Related Information**

Task 8: SWIM Services & Application Validation

*Task Leads: Mr. Yukinobu Ryu, Dr. Xiaodong Lu,  
Ms. Honglei Gao & Mr. Jiseok Kang*

2.49 Task Lead presented the revised Statement Of Work (SOW) of Task 8 and discussed the related issues with the breakout room 3 session attendees.

2.50 According to the access limitation of CRV, the main objective and scope of this task is to construct a common platform for SWIM service and application validation and implementation. The attendees of the session commented to consider how to manage and maintain this platform in the future.

2.51 The deliverables of this task include two parts. One is to develop validation requirements for SWIM Infrastructure Services. Another is to define and validate the required SWIM services and applications for supporting different operations. Members of the session commented to consider the SWIM based information sharing for ATFM and A-CDM. This will be discussed and cooperated with Task 6 Information Services.

2.52 For the milestones of this task, the security issues in the FF-ICE/R1 demonstration and how to evaluate security services was discussed. The cooperation with Task 3 Security Services is expected.

Task 9: Monitoring of Panels Work

*Task Leads: Yukinobu Ryu*

2.53 Japan will continue to monitor and collate information and activities related to SWIM from the global ICAO Panels

2.54 Japan is to work with ICAO Secretariat to list the relevant panels that the SWIM TF should establish or retain close communication with. This list will be annotated with those panels that Japan are a member of and can manage the relationship. Other States will be asked to nominate where they can take the lead on any other panels and report information and activities to the Japan member for the purpose of this task.

Task 10: Regional Coordination and SWIM Related Information Sharing

*Task Leads: Mr. John Moore*

2.55 IATA described a proposal for continuing forward with Task 10 - the continued goal is to engage with as many APAC ICAO Working Groups and Task Forces, as well as relevant non-ICAO related meetings in the APAC region

2.56 The messaging would be to summarise the discussions of the most recent SWIM TF meeting and also the known SWIM activities progressing in the region. It would also convey any specific requests from the SWIM TF for input from other groups.

2.57 The task lead would also continue to collate and report back to SWIM TF on the activities of other groups.

2.58 A standard Information Paper needs to be produced summarising the meeting report of the SWIM TF meetings that can then be presented to other relevant group meetings. It will need to be periodically updated as new information becomes available which can be done by a mailout to the SWIM TF members seeking any additional information. It will also need to be tailored for the target audience by the nominated presenter.

2.59 IATA participates in multiple ICAO groups and other non-ICAO meetings. Because of this, IATA can continue to be the primary presenter of the SWIM TF updates however there will be relevant meetings where IATA doesn't attend and so there is a need for members of the SWIM TF to identify where they can provide the relevant presentation. Where a member State cannot be identified, the paper can be delivered by the relevant meeting Secretariat.

2.60 IATA is to work with ICAO Secretariat to list the relevant meetings that would benefit from a SWIM update. This list will be annotated with those meetings that IATA can present at and then SWIM TF States will be asked to nominate where they can take the lead in any meetings, and report information and activities to the IATA member for the purpose of this task.

#### Summary of Task 11 breakout session

2.61 There was no-one presently that leads this task. It was noted in the plenary that the previous lead is no longer with ICAO.

2.62 IATA noted that information on education and promotion can be included in the reports for Task 10 but noted that SWIM TF States and organisations would need to advise what material is available and how to access it.

2.63 Secretariat is requested to seek information from SWIM TF members on what education and promotion material is available and advise where it is located and how it can be accessed. This information can then be passed to the lead for Task 10 for inclusion in regional coordination.

#### Task Participants update

2.64 During the breakout session, it was noted that the list of various task participants contained within the original SOW was out of date, and interested members and parties were invited to join as contributors by emailing contact details to Task Leads to share ideas and experiences for Regional SWIM implementation.

2.65 The meeting was informed that the appropriate process to join the Tasks was to nominate Focal Point of the State/Administration to ICAO secretariat first, and then the list of contributors' contact details would be emailed to secretariat with CC to Task Leads through Focal Point. Individual application would not be accepted.

#### **Update on APAC SWIM Implementation Materials**

2.66 APAC Regional SWIM Implementation Guidance Document was proposed during SWIM TF/3 and the draft Table of Content of APAC SWIM Implementation Materials was adopted as Appendix B to the SWIM TF/3 final report. The Task Leads and the associated contributors were requested to prepare their consolidated input to the APAC SWIM Implementation Materials at SWIM TF/4 meeting based on their presentations and studies, therefore a draft of APAC SWIM Implementation Materials was expected as outcome of SWIM TF/4 meeting.

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2.67 The outbreak of COVID-19 pandemic projected unprecedented impact on aviation industry and also changed the original plan and available resource of this task. Considering the significant change of task force programme after SWIM TF/3, and the progress of Doc 10039 Vol. II, the meeting agreed to suspend ACTION ITEM SWIMTF/3/2 for some time and reactivate it upon further updates during the future Task Leads meetings or SWIM TF/5, and the meeting encouraged the participants and concerned parties to provide and share SWIM-related video, training material and other useful information to SWIM TF and secretariat for future compilation.

**Generation and Life Cycle Management of GUFİ and Related Issues**

2.68 China implemented the wide-area surveillance network function verification system which was fed with various data sources including AFS message system, satellite/ground-based ADS-B system, surveillance radar system, ACARS, etc. The system provides multi-category data services for airlines, airports, ATC units, administration, GADSS-related organizations and other data users. GUFİ (Globally Unique Flight Identifier) is used in flight data management in the system, which is usually generated in the flight planning stage by the simulated ATM role, is used in the subsequent data exchange, and is managed in the entire life cycle of a flight, so as to realize the persistent storage of FIXM format flight data in the system.

2.69 The paper briefed the GUFİ's textual representation, encoding rules, and the accessing of various flight-related data, part of which is generated in real time, while others are generated after the flight. At each flight data access point, a GUFİ management component is set up. Some identified issues to be addressed were also discussed in the paper such as the method to exchange data between systems in different countries/regions, difficulty to uniformly generate GUFİ on a global scale, and GUFİ use to exchange flight data in the transition environment.

**The Status of SWIM R&D in the Republic of Korea**

2.70 ROK has been conducting SWIM R&D following the ICAO Global Air Navigation Plan (GANP) and Korea's National ATM Reformation and Enhancement Plan (NARAE) since 2016. KAC is in charge of SWIM R&D and its purpose is to implement SWIM testbed and lay the foundation for the transition to a SWIM environment.

**Report on SWIM in Australia**

2.71 Australia summarised the activities and plans for the design and implementation of SWIM services in Australia for customers and stakeholders. SWIM architecture and planning activities have been carried out by Airservices Australia (ASA) and the Australian Bureau of the Meteorology (BOM) over the past 18 months. A number of proposals for the APAC SWIM community were proposed.

**New IWXXM design to better support SWIM**

2.72 Hong Kong China, being one of the members of the Task Team on Aviation Data (TT-AvData) of World Meteorological Organization (WMO), presented the latest update on the development of a new IWXXM design being studied by WMO TT-AvData for future versions of IWXXM. The new IWXXM design would introduce "Weather Object" to better facilitate retrieval and consolidation of individual meteorological element through SWIM information services.

**The Status of Shared Information Quality Management in China**

2.73 The paper presented the exploration and practice of Civil Aviation Administration of China (CAAC) for establishing information quality management system based on SWIM concept. As the

number of participants and information shared for operation coordination are increasing rapidly, it is necessary to clarify the accountabilities, standardize the procedures and enhance the platform functions for information quality management.

### **Future Meetings**

2.74 The meeting agreed to tentatively schedule its next meeting, SWIM TF/5, as a face-to-face meeting while plan a virtual version as backup. There was a proposal to conduct the SWIM TF/5 no later than May of 2021, with a target to back to the normal track of APAC meeting plan. However, the meeting noted the progresses that could be made from now to next May might not meet the expectation for such a large group. Finally, the meeting agreed to follow up the exact mode and date for SWIM TF/5 in the next Task Leads meeting, and the States/Administration will be informed via due course by ICAO APAC Regional Office.

### **3. ACTION BY THE MEETING**

3.1 The meeting is invited to:

- a) note the updated Revised Task Group for SWIM TF in Appendix A;
- b) note the SWIM in ASEAN Demonstration Report in Appendix B; and
- c) discuss any relevant matters as appropriate.

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## REVISED TASK GROUP

Groups	Task No.	Subject/Task	Task Leads
Implementation Planning	1	Regional implementation philosophy & roadmap (combined previous Task 1-1 and Task 1-2)	David Leow (Singapore) & Amornrat Jirattigalachote (Thailand)
SWIM infrastructure	2	Regional SWIM infrastructure (previous Task 1-8)	Xiaodong Lu (Japan), Yukinobu Ryu (Japan), Henry Chan (Hong Kong, China)
	3	Security service (New task)	<b>TBD</b> & Joe Jones (USA)
Technical Architecture	4	Development and maintenance of regional information exchange models (previous Task 1-6)	Amornrat Jirattigalachote (Thailand) & Wen Zhu (USA)
Governance	5	Governance (Policies and Procedures) (combined previous Task 1-4, Task 1-5, Task 2-1-2, Task 2-1-4)	Jiseok Kang (ROK), Mark Kaplun (USA), Yukinobu Ryu (Japan), Xiaodong Lu (Japan), Honglei Gao (China)
Information Services	6	Information services (previous Task 1-2)	Joe Jones (USA) & Marco Kok (Hong Kong, China)
Validation & Demonstration	7	SWIM in ASEAN Demonstration (previous Task 2-1-1)	David Leow (Singapore) & Amornrat Jirattigalachote (Thailand)
	8	SWIM services and application validation (previous Task 2-1-3)	Yukinobu Ryu (Japan), Xiaodong Lu (Japan), Honglei Gao (China), Jiseok Kang (ROK)
Coordination and Promotion	9	Monitoring of Panels' work (previous Task 1-7)	Yukinobu Ryu (Japan)
	10	Regional coordination and SWIM-related information sharing (previous Task 1-3)	John Moore (IATA)
	11	SWIM implementation education and promotion (New task)	<b>TBD</b>



# 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
GUFID	Globally Unique Flight Identifier
IWXM	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

<b>Participation Level</b>	<b>Requirements</b>	<b>Benefits</b>
Level 1: Observer only	<ul style="list-style-type: none"> <li>• Participate in demonstration planning, system interfacing, and system test</li> <li>• Provide lessons learnt from the demonstration</li> <li>• Active participation throughout the project</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of their own SWIM readiness</li> <li>• Knowledge to identify the feasible implementation approach for ASBU modules</li> <li>• Knowledge on possible support tool to assist decision making regarding fleet and flight management</li> <li>• Understanding on loose system coupling, separation of data production and consumption, open standards, and interoperable services</li> <li>• First level of understanding on global interoperability</li> </ul>
Participant: <ul style="list-style-type: none"> <li>• Myanmar</li> <li>• The Philippines</li> </ul>		
Level 2: Legacy-format data producer and consumer	<ul style="list-style-type: none"> <li>• Participate in demonstration planning, system interfacing, and system test</li> <li>• Provide lessons learnt from the demonstration</li> <li>• Active participation throughout the project</li> <li>• Produce legacy-format data* and provide it in native-SWIM format using the data conversion service provided</li> <li>• Able to consume native-SWIM-format data** using the viewer provided</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge and understanding on the implementation approach of ASBU modules</li> <li>• Knowledge on possible support tool to assist decision making regarding fleet and flight management</li> <li>• Working knowledge of loose system coupling, separation of data production and consumption, open standards, and interoperable services</li> <li>• First level of understanding on global interoperability</li> <li>• Knowledge and understanding on data mediation for backward compatibility in SWIM implementation</li> </ul>
Participant: <ul style="list-style-type: none"> <li>• Cambodia</li> <li>• Indonesia</li> <li>• Lao PDR</li> <li>• Vietnam</li> </ul>		

<b>Participation Level</b>	<b>Requirements</b>	<b>Benefits</b>
<p>Level 3: Native-SWIM-format data producer and consumer</p> <p>Participant: • Australia</p>	<ul style="list-style-type: none"> <li>• Participate in demonstration planning, system interfacing, and system test</li> <li>• Provide lessons learnt from the demonstration</li> <li>• Active participation throughout the project</li> <li>• Produce and provide native-SWIM-format data using own system</li> <li>• Able to ingest native-SWIM-format data into own system</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge and understanding on the implementation approach of ASBU modules</li> <li>• Knowledge and understanding to implement support tools to assist decision making regarding fleet and flight management</li> <li>• Working knowledge and opportunity to take the advantage of loose system coupling, separation of data production and consumption, open standards, and interoperable services</li> <li>• First level of understanding on global interoperability</li> <li>• Knowledge and first-hand experience on Service-Oriented Architecture (SOA)</li> <li>• Access to complete SWIIM dataset</li> <li>• Better information sharing for gate-to-gate operation, airport management, and increased safety</li> </ul>
<p>Level 4: Customized EMS Developer and native-SWIM-format data producer and consumer</p> <p>Participant: • Thailand • Singapore • USA • Malaysia • Hong Kong China • Japan</p>	<ul style="list-style-type: none"> <li>• Early commitment to the project</li> <li>• Participate in all GEMS discussions and system test</li> <li>• Provide services using own system</li> <li>• Participate in demonstration planning, system interfacing, and system test</li> <li>• Provide lessons learnt from the demonstration</li> <li>• Active participation throughout the project</li> <li>• Produce and provide native-SWIM-format data using own system</li> <li>• Able to ingest native-SWIM-format data into own system</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge and understanding on the implementation approach of ASBU modules</li> <li>• Knowledge and understanding to implement support tools to assist decision making regarding fleet and flight management</li> <li>• Working knowledge and opportunity to take the advantage of loose system coupling, separation of data production and consumption, open standards, and interoperable services</li> <li>• First level of understanding on global interoperability</li> <li>• Knowledge and firsthand experience on SOA</li> <li>• Access to complete SWIIM dataset</li> <li>• Better information sharing for gate-to-gate operation, airport management, and increased safety</li> <li>• Working EMS prototype</li> </ul>

Participation Level	Requirements	Benefits
		<ul style="list-style-type: none"> <li>• Leader in SWIM development and implementation in Asia/Pacific Region</li> </ul>

**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.

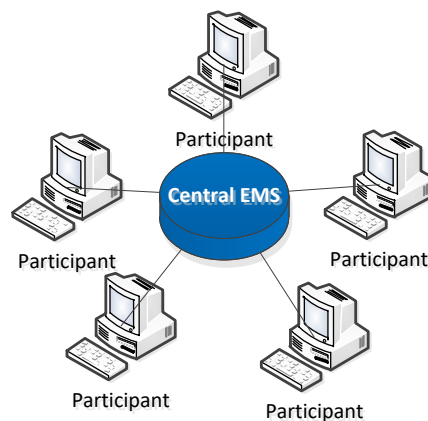
### 3 SWIM Infrastructure

#### 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).

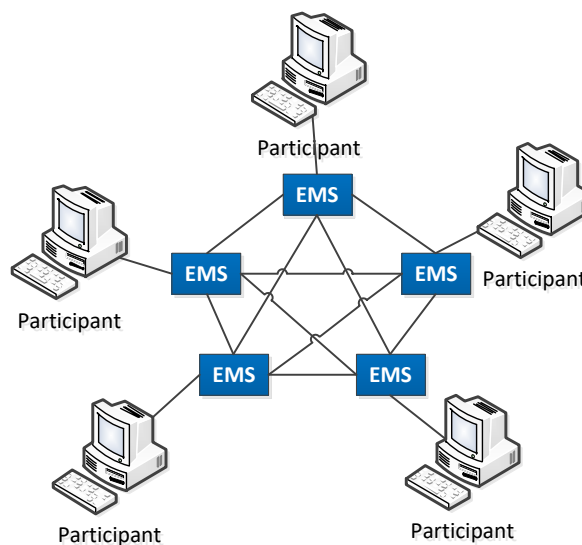
In the very early considerations of possible SWIM architectures, it was assumed that EMS would also be the major component of SWIM architecture for the Demonstration. Three possible architectures considered were:

- 1) Single EMS connecting all participants in the Demonstration;



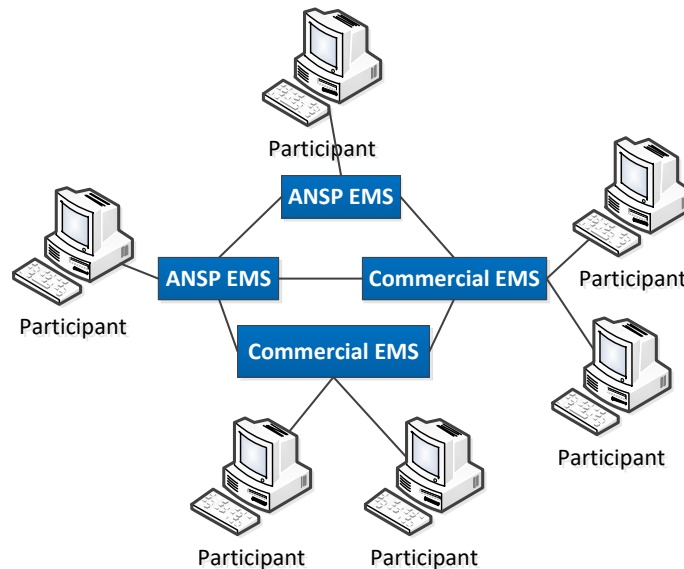
**Fig. 1.** Single EMS Architecture.

- 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
<b>Option 1 Single EMS Architecture</b>	
<ul style="list-style-type: none"> <li>• Efficient implementation – Each participant only needs to connect once</li> <li>• Less metadata needed to ensure proper message routing</li> <li>• Faster to integrate</li> </ul>	<ul style="list-style-type: none"> <li>• Hard to get consensus on who to implement the EMS</li> <li>• If EMS is implemented by third party, no participant has control over how messages are routed</li> </ul>
<b>Option 2 Every Participant Implementing Interconnected EMS Architecture</b>	
<ul style="list-style-type: none"> <li>• Every participant is responsible for their own EMS implementation</li> <li>• Each participant has full control over how their EMS routes messages</li> </ul>	<ul style="list-style-type: none"> <li>• Every participant needs to establish EMS-EMS connection to every other participant, leading to point-to-point connection</li> <li>• Message routing is complex and less efficient, compared to Option 1</li> </ul>
<b>Option 3 Combined Public and Private EMS Architecture</b>	
<ul style="list-style-type: none"> <li>• Participants can decide how they wish to connect to regional SWIM, either through their own EMS or through the commercial EMS</li> <li>• The number of EMS being implemented is small</li> </ul>	<ul style="list-style-type: none"> <li>• Although all EMS are required to be interconnected, the complexity is still less than Option 2</li> <li>• Message routing has to be agreed upon by the group that is implementing the EMSs</li> </ul>

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

Estimated	Calculated	Target	Actual
		TOBT	AOBT
		TSAT	
	CTOT	TTOT	
ETO	CTO		ATO
ELDT	CLDT		
Other			
Trajectory		Aircraft Track	
<ul style="list-style-type: none"> <li>• ETO</li> <li>• CTO</li> <li>• ATO</li> <li>• Flight level or Altitude</li> <li>• Waypoint</li> </ul>		<ul style="list-style-type: none"> <li>• Ground speed</li> <li>• Bearing</li> <li>• Flight level or Altitude</li> <li>• Position (Designator or Latitude/Longitude or Relative Point)</li> <li>• Time over position</li> </ul>	

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
GUFU Service	GUFU (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	<ul style="list-style-type: none"> <li>• Traffic demand prediction and monitoring</li> <li>• ATFM planning and execution, including CTOT/CTO computation</li> </ul>
A-CDM	A-CDM milestones coordination
FF-ICE/R1	<ul style="list-style-type: none"> <li>• Planning service</li> <li>• Trial service</li> <li>• Filing service</li> </ul>

## 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

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

## Annex B Operational Use Case Example

### Example 1

<b>Name</b>
Demand-Capacity Monitoring for Airport
<b>Brief Description</b>
This scenario focuses on the determination of traffic demand against arrival airport capacity, to be performed by arrival ATFM unit (ATFMU).
<b>Actors</b>
1. Arrival ATFMU 2. Airspace User (AU) 3. Airport Operator (AO)
<b>Pre-conditions</b>
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*)
<b>Basic Flow of Events</b>
<p><u>Initial Demand Prediction</u></p> <ol style="list-style-type: none"> <li>1. Arrival ATFMU generates initial (strategic) arrival traffic demand based on flight schedule parameters (SIBT)</li> <li>2. AU submits FPL as per standard process</li> <li>3. Arrival ATFMU extracts relevant information from the basic FPL <ol style="list-style-type: none"> <li>a. Flight ID – ACID, ADEP, ADES</li> <li>b. Timing parameters – EOBT, EET</li> </ol> </li> <li>4. Arrival ATFMU generates relevant timing parameters to estimate arrival demand, and supplements to the strategic demand profile <ol style="list-style-type: none"> <li>a. <math>ETOT = EOBT + STT</math></li> <li>b. <math>ELDT = ETOT + EET</math></li> </ol> </li> <li>5. Arrival ATFMU updates traffic demand profile at arrival airport</li> </ol> <p><u>Updated Demand Prediction: Pre-Departure</u></p> <ol style="list-style-type: none"> <li>6. AU submits CHG / DLA / CNL message as per standard process</li> <li>7. Arrival ATFMU extracts relevant information from the message <ol style="list-style-type: none"> <li>a. Flight ID – ACID, ADEP, ADES</li> <li>b. Timing parameters – (new) EOBT, EET</li> </ol> </li> <li>8. Arrival ATFMU generates relevant timing parameters to estimate new arrival demand, and update accordingly</li> </ol> <p><u>Tactical Demand Update</u></p> <ol style="list-style-type: none"> <li>9. Departure ATSU submits DEP message as per standard process</li> <li>10. Arrival ATFMU extracts relevant information from the message <ol style="list-style-type: none"> <li>a. Flight ID – ACID, ADEP, ADES</li> <li>b. Timing parameters – ATOT (DEP)</li> </ol> </li> <li>11. Arrival ATFMU generates relevant timing parameters and updates arrival demand accordingly</li> </ol>
<b>Required Data Elements</b>
<b>Data to be Exchanged</b>
1. Flight ID – ACID, ADEP, ADES 2. EOBT 3. EET 4. ATOT
<b>Locally-Derived Data</b>
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**

ATFM Daily Plan Distribution and CDM Web Conference

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

GDP Activation and CTOT Distribution

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*

Departure Facilitation

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**

**Data to be Exchanged**

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

**Locally-Derived Data**

- 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
	CLEARANCE	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

