*International Civil Aviation Organization*

**The First Working Session of System Wide Information Management Implementation Pioneer Ad-Hoc Group (SIPG) – Designing the Asia/Pacific Regional SWIM**
*Bangkok, Thailand, 14 – 17 January 2025*

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**Agenda Item 3:** SWIM Architecture

# ADOPTING MULTIPLE MESSAGE EXCHANGE PATTERNS TO OPTIMIZE SWIM INFORMATION SERVICES

(Presented by China)

**SUMMARY**

This paper proposes the adoption of multiple Message Exchange Patterns (MEP) to optimize SWIM Information Services, designing different MEP application scenarios for both data sharing and system interoperability services, with the aim of reducing the reliance on guaranteed message delivery by EMS in a hierarchical architecture.

## 1. INTRODUCTION

1.1 The relevant trials conducted by SWIM SIPG in 2024 highlighted the importance of guaranteed message delivery for SWIM Information Services. APAC Regional SWIM adopted a hierarchical architecture in the trials, where all stakeholders exchanged messages through the collaboration of EMS nodes, including both GEMS and EEMS. In this process, anomalies on any side, whether it be the service provider, SWIM EMS nodes, or consumers, may lead to consumers not correctly acquiring and utilizing messages.

1.2 Considering that the construction of EMS nodes is a gradual and progressive process, it is recommended that an appropriate set of Message Exchange Patterns (MEP) should be adopted in the implementation of SWIM Information Services to mitigate the issue of message loss and reduce its dependence on guaranteed message delivery capabilities, thereby achieving a balance between complexity and availability.

## 2. DISCUSSION

2.1 Classification and Application of MEP in SWIM Information Services

2.2 The SWIM Information Service can be categorized into two types based on its purpose: Data Sharing or System Interoperability.

- Data Sharing: Data is utilized by consumers who do not directly provide feedback, thus having no impact on the business status of the service provider. Examples include Common Aeronautical Information Services, Common Meteorological Information Services, Common Surveillance Information Services in APAC as well as Data Publication Service in FF-ICE/R1.

- System interoperability: There exists a direct business relationship between service providers and consumers, and the use of data has an impact on both the service provider and the service consumer. For example, in FF-ICE, the Filing Service allows consumers to use it to change the flight status of both eAU and eASP.

2.3 MEP typically encompasses both the publish-subscribe pattern and the request-response pattern. In the publish-subscribe pattern, the service provider controls the timing of information dissemination. In contrast, in the request-response pattern, the consumer initiates a request to the service provider, who then provides a feedback. For data sharing services, the publish-subscribe pattern is often adopted because the publisher, as the data source, accurately knows the status of information updates and can promptly disseminate information. Compared to the request-response pattern, this reduces the delay in updates and resource consumption.

2.4 MEP Scenarios for Data Sharing and System Interoperability

2.5 If information sharing services solely rely on the publish-subscribe pattern, consumers who fail to receive or correctly process a message will have to wait for the next message dispatch to obtain the latest information. To avoid such situations where the latest information may not be obtained, data sharing services can additionally provide a request-response pattern for consumers to invoke.

2.6 Data transmission can be categorized into two scenarios: Scenario 1, where messages are successfully delivered, and Scenario 2, where message loss occurs and requires additional handling. These two scenarios alternate throughout the information exchange process. In Scenario 1, consumers use the publish-subscribe pattern to access data sharing services and the request-response pattern to access system interoperability services. When consumers detect data loss, they need to re-request the data by accessing SWIM Information Services using the request-response pattern in Scenario 2.

| Scenario No. | MEP | |
|---|---|---|
| | Data Sharing | System interoperability |
| 1 | publish-subscribe | request-response |
| 2 | request-response | request-response |

Table 1 MEP Scenarios for SWIM Information Services

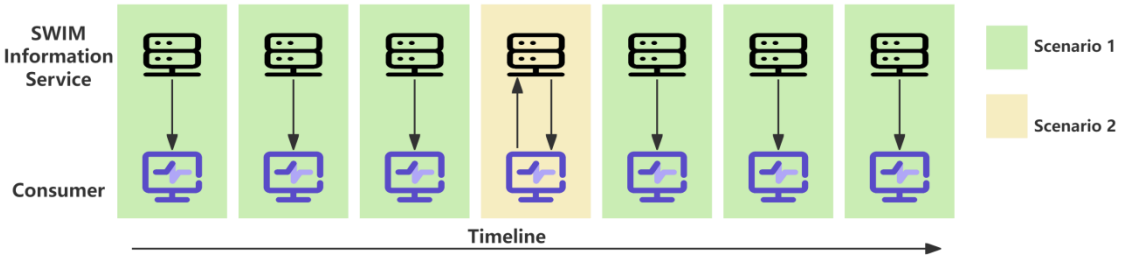


Figure 1 Two scenarios alternate throughout the information exchange process

2.7 Request-response pattern can also be implemented using the SWIM hierarchical architecture and AMQP protocol. Although AMQP itself does not directly support the request-response pattern, it is possible for the requester to include a unique ID in the request

message. Upon processing the request, the service provider can use the same ID to send the response back to a queue that the requester is listening to. The requester then matches and processes the response based on the request ID. This method is known as the asynchronous request-response pattern.

2.8 Consumers need to determine which scenario they are currently in. For Data Sharing services, service providers must incorporate details such as data update frequency or protocols for self-incrementing message sequence numbers within the service description, enabling consumers to ascertain whether a transition from scenario 1 to scenario 2 is necessary. In the case of System Interoperability services, consumers can evaluate based on the response time specified in the service description, and in instances where the response time is surpassed, they have the option to re-execute the operation.

2.9 Illustrative Examples and Practical Implementation

2.10 Considering the Traffic Flow Status Service as an illustrative example, this service provides users with notifications regarding any traffic flow management measures that are currently in effect and how these measures may impact their aircraft. The exchanged information includes Demand and constraints, Miles-in-Trail (MIT), Minutes-in-Trail (MINIT), ATFM daily plan, and Ground Delay Program (GDP). This service is delivered by the service provider to stakeholders with updates, and it has no impact on the service provider itself. Therefore, this service is categorized as a Data Sharing service, which can be provided using both publish-subscribe pattern and request-response pattern.

2.11 In Scenario 1, consumers typically receive updates for Traffic Flow Status data via the publish-subscribe pattern. This means that the service provider sends updates to stakeholders as they occur, and consumers receive these updates without needing to initiate a request. This scenario is efficient for keeping consumers informed of real-time changes.

2.12 However, if consumers determine, based on the service description, that the data has not been updated promptly or if they suspect that they have missed an update, they will transition to Scenario 2. In this scenario, consumers actively request data through the request-response pattern to ensure they obtain the latest information. This can happen if, for example, the service provider indicates in the service description a certain data update frequency, and consumers notice that this frequency has not been met.

2.13 By switching to the request-response pattern, consumers can invoke the service to request the latest data, and the service provider will respond with the most recent information. Once the data updates resume and consumers are receiving timely updates via the publish-subscribe pattern again, they will switch back to Scenario 1.

2.14 In this way, the Traffic Flow Status Service dynamically adapts to the needs of consumers, ensuring they always have access to the most accurate and up-to-date information.

2.15 The FF-ICE Filing Service belongs to the category of system interoperability services. This service provides a means to submit, update, or cancel flight plans through a SWIM-based interface using FIXM, specifically for the registration, update, or cancellation of flight plans. When consumers invoke the FF-ICE Filing Service to send eFPL, they receive

feedback in the form of Submission Response Messages and Filing Status Messages. If no feedback is received, consumers can switch to Scenario 2 and invoke the service again. Alternatively, they can call the Flight Data Request Service, which is also a request-response service, to obtain the latest flight plan information.

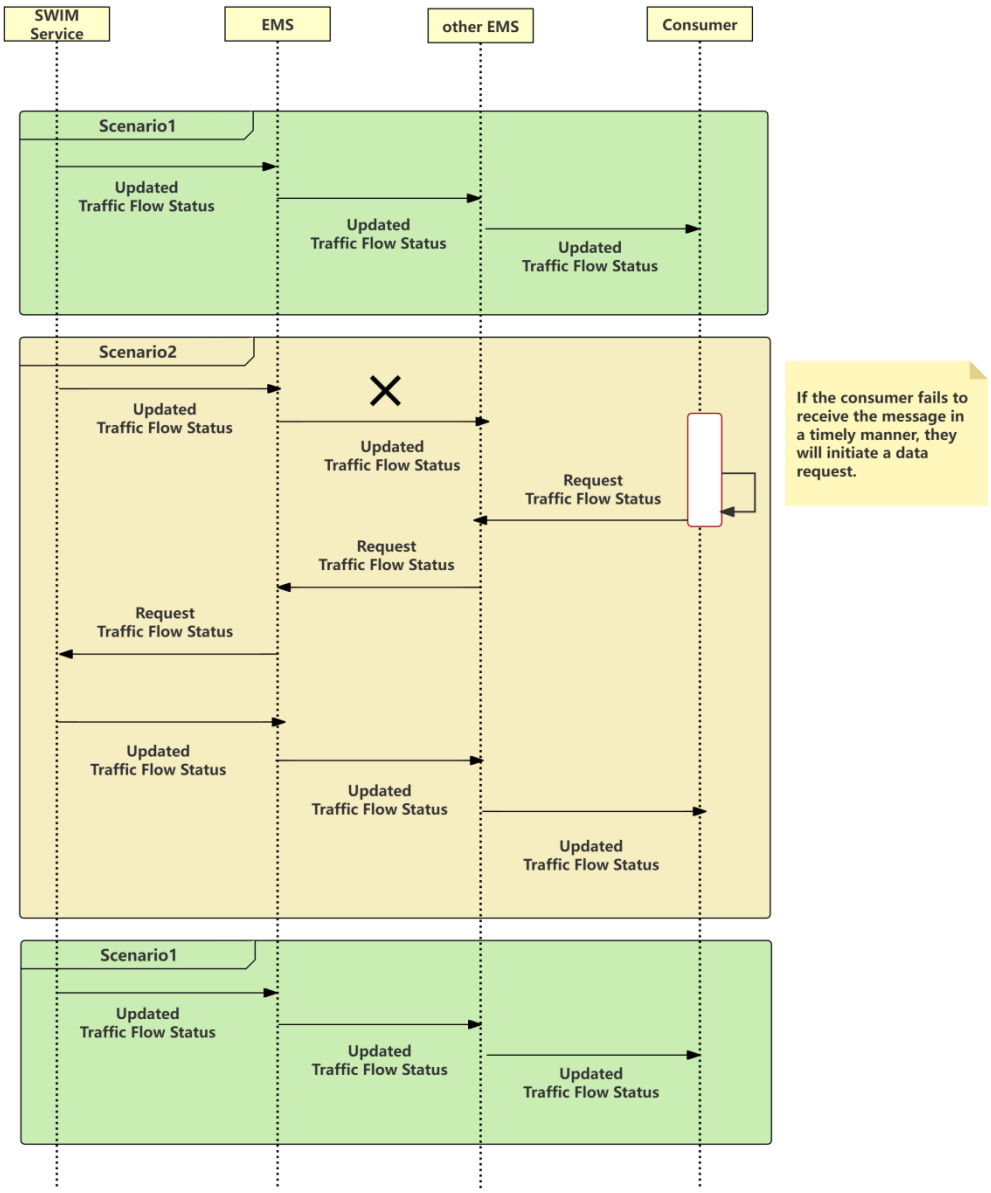


Figure 2 the Traffic Flow Status Service utilizes various MEP to ensure the timeliness of data

## 3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matter as appropriate

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