58th CONFERENCE OF DIRECTORS GENERAL OF CIVIL AVIATION ASIA AND PACIFIC REGIONS

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AGENDA ITEM 4: AIR NAVIGATION

MULTI-REGIONAL TBO DEMONSTRATION

(Presented by Japan, Singapore, Thailand, and USA)

SUMMARY

This paper presents an overview of Multi-Regional TBO Demonstration, a collaborative project undertaken by Japan, Singapore, Thailand, USA, and Canada to validate TBO concept as well as to showcase the TBO operational values and key capabilities, both operational and technical, required to support TBO. Leveraging the experience gained from this Demonstration, the Meeting is encouraged to support the development and establishment of the crucial TBO building blocks to enhance ATM operations and, ultimately, to realize TBO in the Asia/Pacific region.

MULTI-REGIONAL TBO DEMONSTRATION

1. INTRODUCTION

1.1 ICAO Doc 9854 Global Air Traffic Management Operational Concept (GATMOC) presents the vision to achieve an interoperable global ATM system, for all users during all phases of flight, that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable, and meets national security requirements (§ 1.1.1).

1.2 §1.9.2 of ICAO Doc 9854 further describes that the envisioned ATM system considers the trajectory of a manned or unmanned vehicle during all phases of flights and manages the interaction of that trajectory with other trajectories or hazards to achieve the optimum system outcome, with minimal deviation from the user-requested flight trajectory, whenever possible. This premise fundamentally explains Trajectory Based Operation (TBO). To realize TBO, the envisioned ATM system needs to be the one that:

(i) is underpinned by the global information utilization, management, and exchange within the ATM system to support a holistic, cooperative, and collaborative decision making where the diverging expectations and interests of all members of the ATM community are balanced; this global information management and exchange is known as System-Wide Information Management (SWIM); and

(ii) is supported by a collaborative-decision making mechanism that enables dynamic flight trajectory exchange and management among ATM stakeholders to achieve a greater coordination, situational awareness, and ultimately, the optimum ATM system outcome; this flight trajectory exchange and management mechanism is known as Flight and Flow Information for a Collaborative Environment (FF-ICE).

1.3 In other words, TBO will fundamentally bring about a new paradigm of cooperation in ATM, enabled by timely exchange of harmonized operational data not only between ANSPs but also between ANSPs and Airspace Users (AUs). This is different from the current ATM operations in which each ANSP manages flight trajectories within its ATS airspace, without a systemic mechanism to harmonize flight trajectories across ATS airspaces to achieve optimum system outcome.

2. DISCUSSION

2.1 The ICAO global TBO concept and related capabilities are being matured and progressively implemented in some regions of the world. As part of the global effort, Japan (Japan Civil Aviation Bureau (JCAB)), Singapore (Civil Aviation Authority of Singapore (CAAS)), Thailand (Aeronautical Radio of Thailand Ltd. (AEROTHAI)), USA (Federal Aviation Administration (FAA)) and Canada (NAV CANADA) had collaboratively put together the Multi-Regional TBO Demonstration (MR TBO Demo) to validate and demonstrate the TBO concept. The main objectives of this demonstration also included (*i*) to explore the impacts of TBO within the context of modernization initiatives and (*ii*) to support the development of information exchange standards and related ICAO materials.

2.2 MR TBO Demo was divided into two phases:

- Phase 1 (May 2020 – July 2021)
  - Planning and developing activities for TBO demonstrations
  - Establishing (baseline) technical capabilities
  - Establishing industry and international partnership
- Phase 2 (July 2021 – June 2023)
  - Execution of MR TBO Demo
    + Phase 2A (July 2021 – May 2022): Lab Demonstration

+ Phase 2B (June 2022 – June 2023): Live-Flight Demonstration

2.3 The MR TBO Live-Flight Demonstration was conducted on 11-16 June 2023, using the aircraft type B787-10 operating on the following route segments:

- Segment 1: King County International Airport (Seattle) – Tokyo Narita International Airport;
- Segment 2: Tokyo Narita International Airport – overfly Bangkok Flight Information Region – Singapore Changi Airport;
- Segment 3: Singapore Changi Airport – Bangkok Suvarnabhumi International Airport; and
- Segment 4: Bangkok Suvarnabhumi International Airport – Seattle Paine Field International Airport

Throughout the Live-Flight Demonstration week, a series of activities was held across Japan, Singapore, Thailand, and USA, to share knowledge and experience gained from the MR TBO Demo with the goal to foster a better understanding about TBO among both local and international stakeholders. At these events, an opportunity to observe the execution of operational use cases during the live flight was also provided. Furthermore, aircraft visits were organized for high-level policy makers at various airports to exhibit the TBO capabilities using the existing ground and aircraft technologies, in collaboration with Boeing, the airplane technology partner. Importantly, this highlighted the crucial role of policy support in the successful implementation of global TBO.

2.4 Details of the MR TBO Demo were previously presented to APANPIRG and relevant contributory bodies in 2021 and 2023, and the 57th DGCA Conference in 2022. Appendix presents more details of the MR TBO Demo, including:

- Key TBO operational and technical capabilities developed, matured, and demonstrated;
- TBO operational values realized during the Live-Flight Demonstration; and
- Key lessons learned.

2.5 Building on the insights gained from the MR TBO Demo, particularly emphasizing the significance of SWIM and FF-ICE, the partners have been conducting several activities under the APANPIRG contributory bodies, i.e. SWIM Task Force (TF) and FF-ICE Operational Requirements Small Working Group (SWG) of the Air Traffic Management Sub-Group (ATM/SG), to share knowledge with the aim of establishing these two key TBO enablers in the Asia/Pacific region.

2.6 ICAO State Letter dated 29 December 2022 communicated the proposed amendments and consequential amendments to ICAO Standards and Recommended Practices (SARPS) and Procedures for Air Navigation Services (PANS) in a range of Annexes and PANS documents concerning the initial implementation of the FF-ICE services. The amendments are envisaged for applicability on 28 November 2024. Parallelly operating the current flight planning and FF-ICE systems will create not only significant cost implication but also operational complexity for both ATM Service Providers (ASPs) and AUs. Moreover, it will also impact the improved overall ATM network performance achievable by adopting FF-ICE.

2.7 Considering the characteristic of airspaces in the Asia/Pacific region composing relatively small FIRs, in turn corresponding to low flight transit times, a harmonized regional FF-ICE implementation roadmap is required to ensure a seamless and cost-effective transition to FF-ICE for all related stakeholders in the region. Unlike SWIM, the regional target FF-ICE implementation timeframe has not yet been agreed upon in the Asia/Pacific. Additionally, apart from ASPs and AUs, regulators (Civil Aviation Authorities (CAAs) play a pivotal role in the FF-ICE transition as well. With the proposed amendments to the ICAO FF-ICE-related provisions aforementioned, assessment on a need to amend the existing and/or introduce new national regulations to support the mixed-mode[1] and FF-ICE operations is essential.

[1] A mixed-mode operation is an operation with a mix of FF-ICE capable and non-FF-ICE capable ASPs and AUs.

2.8 With (*i*) the adoption of APANPIRG/33 through Conclusion APANPIRG/33/9 on the 2024-2030 Asia/Pacific SWIM implementation timeframe, (*ii*) the ongoing work of FF-ICE Operational Requirements SWG, and (*iii*) the establishment of Workstream 2 – Accelerate the Development and Implementation of Seamless ANS and Collaborate on Green Initiatives to Enhance ANS Sustainability under Asia and Pacific ANSP Committee (ACC), it is timely for Asia/Pacific ATM stakeholders to collaborate on building these two capabilities to enhance ATM operations towards the goal of implementing TBO in Asia/Pacific. SWIM and FF-ICE are key building blocks to the realization of TBO in Asia/Pacific and as such their implementation should be prioritized.

3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to:

a) note the information contained in this paper;

b) collaborate on laying the policy and regulatory foundation required to:

i. support the mixed mode of existing and FF-ICE operations;

ii. support the development and establishment of the key TBO building blocks, i.e. SWIM and FF-ICE, to enhance ATM operations and, ultimately, to realize TBO in the Asia/Pacific region; and

c) discuss any relevant matters as appropriate.

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Appendix – Details of the Multi-Regional TBO Demonstration

I. To design the capabilities required to support the conduct of the operational use cases, draft provisions and guidance materials developed by ICAO Technical Panels such as Information Management Panel (IMP), ATM Requirements and Performance Panel (ATMRPP), and the APANPIRG contributory body – SWIM Task Force (TF), were leveraged. The key TBO operational and technical capabilities developed, matured, and demonstrated, included, such as:

Operational Capabilities	Technical Capabilities
• Pre-departure and post-departure trajectory planning, negotiation, and revision • Seamless exchange of trajectory information update among ATM stakeholders • Enhanced demand and capacity balancing • Improved collaborative decision making	• FF-ICE/R1 services • Initial FF-ICE/R2 services • SWIM technical infrastructure and SWIM information services • Secured information exchange in standardized data formats • TBO clearance delivery

II. Apart from validating the TBO concept, the technical performance requirements to support TBO were recorded during the conduct of operational use cases in each segment of the live flight as well. Moreover, the following TBO operational values were realized during the Live-Flight Demonstration.

- Enhanced predictability – A common plan (strategy) shared among stakeholders enhances predictability and improves operations by mitigating confusion with stakeholders operating of the same trajectory;
- Alignment of strategic plan and tactical actions – Sharing, management, and use of the trajectory as a common framework help create alignment of strategic plan and tactical actions;
- Increased reliable flexibility – Sharing, management, and use of the trajectory as a common framework among stakeholders provide flexibility in accommodating trajectory changes while maintaining business objectives;
- Improved strategic planning – Improved planning (incorporating out-of-zone traffic) helps mitigate deterministic delay factors, improve network performance and more equitably delay distribution; and
- Decrease uncertainty – Improved trajectory accuracy decreases uncertainty in the system.

III. Key lessons learned were, for example:

- TBO is about sharing, maintaining, and using trajectories as common references across stakeholders. However, further development and refinement on several artifacts, e.g., the tactical/strategic integration, processing of agreed trajectory by downstream ASPs, are still needed;
- The globally standardized information exchange models are foundational to the success of TBO;

- The continued evolution of the Connected Aircraft is required to enable the sharing of more information among stakeholders, allowing the active participation of flight crews in the collaborative decision making.

IV. Above all, it was also proved from the execution of MR TBO Demo that SWIM and FF-ICE are the two essential building blocks for TBO.

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