

**57th CONFERENCE OF
DIRECTORS GENERAL OF CIVIL AVIATION
ASIA AND PACIFIC REGIONS**

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AGENDA ITEM 4: AIR NAVIGATION

**MULTI-REGIONAL TRAJECTORY BASED OPERATIONS LAB
DEMONSTRATION**

Presented by Japan, Singapore, Thailand and the United States

SUMMARY

This paper presents the Multi-Regional Trajectory-Based Operations (MR TBO) Lab Demonstration project, which is a collaborative effort between Japan, Singapore, Thailand, U.S.A., and Canada. The project was developed to better understand the ICAO global TBO concept and its operational values. In order to reap the benefits of TBO as a region, the Conference is encouraged to discuss the harmonised implementation of air traffic management (ATM) capabilities, such as System Wide Information Management (SWIM) and Flight and Flow Information for a Collaborative Environment (FF-ICE), to realise TBO in a progressive manner in Asia Pacific.

MULTI-REGIONAL TRAJECTORY BASED OPERATIONS LAB DEMONSTRATION

1. INTRODUCTION

1.1 The Global Air Traffic Management Operational Concept (GATMOC), ICAO Doc 9854, presents the vision to achieve an interoperable global ATM system that encompasses all users through their different phases of flights, that is economically viable for operations, meets a satisfactory level of safety, is environmentally sustainable and meets national security requirements.

1.2 To achieve this vision, it is essential to have global information utilisation, management, and interchange in a safe, secured and timely manner. This promotes the paradigm shift towards a holistic, cooperative and collaborative decision-making environment, within which the interests and expectations of various ATM stakeholders are considered and balanced. The envisioned ATM system will also have to consider manned and unmanned aircraft and for all phases of flight, including interactions with other trajectories and hazards to achieve the optimum system outcome, with minimal deviation from the user requested flight trajectory, where possible. These provide the basis for TBO.

1.3 The GATMOC describes how ATM services could be delivered through seven key interdependent concept components. TBO synthesizes these concept components and considers the needs and preferences of various actors of the global ATM system with a collaborative approach. For example, airspace users (AU) would prefer that their flights fly a specific trajectory that best meet their business interests. At the same time, ATM service providers (ASP) would want to be able to make good ATM decisions considering the overall air traffic situation, to achieve the best ATM system-wide performance outcomes. Central to the TBO concept is that all actors in the ATM system share, negotiate, and agree to a common trajectory for each flight.

1.4 Flight trajectories are shared among stakeholders so that potential problems can be detected early. This ensures that problem solving and decision-making starts earlier, and follow-on actions such as amendments to flight trajectories be initiated to resolve the problems. With the use of trajectory as the common plan for the flight, traffic flow planning can be refined early by the ASPs managing the trajectories, and the actual flow of traffic can be expected to be executed very close to the AUs' filed plan.

1.5 It is envisaged that TBO can bring about more accurate, timely, consistent and predictable flight trajectories. This will in turn lead to safer and more efficient management of air traffic. The subsequent sections will elaborate on how this may be achieved.

2. DISCUSSION

2.1 TBO Essential Enablers

2.1.1 There are two key essential enablers of TBO, namely System Wide Information Management (SWIM) and Flight and Flow Information for a Collaborative Environment (FF-ICE).

2.1.2 SWIM consists of standards, infrastructure, cyber security and governance which enable the management of ATM-related information and its exchange between qualified parties via interoperable services. FF-ICE services and information exchanges through SWIM will create an information-rich ATM environment, where stakeholders will be able to access and promptly act on the timely, accurate and updated comprehensive flight information, thus enhancing decision making.

2.1.3 FF-ICE will transform the present-day flight plan and flight planning process, by allowing more detailed information exchange, especially the sharing of flight intent and trajectory throughout all phases of flight. This enhanced sharing of updated flight trajectories among the stakeholders facilitates a collaborative decision-making environment where flight trajectories could be optimised, considering not only the AUs' business objectives and preferences but also restrictions and constraints of ASPs. This is the essence of TBO, which is the core principle towards the ICAO global vision for ATM as mentioned in Para

2.2 Operational Values of TBO

2.2.1 TBO will bring about significant enhancements to predictability, flexibility, safety, and efficiency in ATM. Through digitised and automated sharing of flight intent and data related to the ATM operational environment (e.g. constraints) facilitated by a common information exchange platform (SWIM), optimized routing solutions and better traffic management plans can be achieved as coordination and collaborative actions in the form of trajectory negotiations carried out between AUs and ASPs converges to a commonly agreed trajectory. TBO promotes collaborative decision making and at the same time eliminates ambiguity in a flight's trajectory and intent before flight, in flight and in future time.

2.2.2 In addition to the improved demand-capacity balancing (DCB), TBO also enables better traffic synchronization (TS) and conflict management (CM). TS focuses on the adjustment of individual trajectories in the time dimension. Timing constraints can be included in trajectories, allowing flight to be controlled to meet a certain tolerance, for example, within +/- 30 seconds over a merging point. CM augments ATC's ability in separation provision. With updated trajectory prediction, a flight could be assessed ahead of time for any hazards it may encounter within its conflict horizon. If a conflict is detected, a resolution consisting of a manoeuvre and/or constraint can be incorporated into the agreed trajectory to obtain the minimum separation required. Intervention by ATC on a tactical basis can thus be minimised.

2.2.3 TBO will be a game changer for ATM, and examples in para 2.2.2 is the tip of the iceberg. TBO will ultimately lead to increased capacity and efficiency in airspace and airports, better resource utilization, and improved human performance in the ATM system. As technology advances, more and better tools will be built to improve trajectory prediction and execution as well as other associated functions. The global ATM system will evolve as more ATM stakeholders adopt TBO.

2.3 Multi-Regional Trajectory Based Operations (MR TBO) Lab Demonstration

2.3.1 To validate the TBO concept and its values, several ANSPs in the Asia Pacific region (Aeronautical Radio of Thailand Ltd., Civil Aviation Authority of Singapore and Japan Civil Aviation Bureau) and NAV CANADA, joined an FAA (Federal Aviation Administration) led Multi-Regional TBO Lab Demonstration which was conducted in May 2022. The MR TBO Lab Demonstration seeks to identify, mature, and demonstrate key TBO capabilities. The partners collaborated to design and simulate operational scenarios to better understand the workings of TBO within and across regions.

2.3.2 Several curated operational scenarios between the partners were developed to validate operational values. Some of the capabilities demonstrated in MR TBO Lab Demonstration include:

- Pre-departure trajectory negotiation;
- Post-departure trajectory negotiation;
- Collaborative decision-making;
- Efficient exchange of updated trajectory across all stakeholders;
- Mixed-mode operations where ANSPs and AUs will be TBO capable at different time frames;
- Enhanced demand-capacity balancing; and
- Enhanced predictability which will increase flight and fuel efficiencies.

2.3.3 In order to achieve steadfast progress, the partners built from the successes of other ongoing initiatives. The CNS Sub-group (CNS SG) of the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) has been conducting activities to put in place enablers for TBO in the Asia Pacific through the Common Aeronautical Virtual Private Network Operations Group (CRV OG) and SWIM Task Force (SWIM TF). Additionally, the SWIM in ASEAN Demonstration held in 2019, co-led by Singapore and Thailand, had helped create a better understanding of SWIM, particularly its roles and functions, possible implementation model as well as operational values for Asia Pacific.

2.3.4 The MR TBO Lab Demonstration was successful to bring about a better understanding of the global TBO concept as well as its operational values, and to provide greater clarity on the role of the key enablers in the realization of this new operational concept. Some initial lessons learnt include the need

for clear business rules to support the implementation of FF-ICE, and the need for further integration between the strategic and pre-tactical/tactical operation.

2.3.5 States may wish to consider further activities to be conducted under the APANPIRG and its contributory bodies to support the development and realization of the global TBO concept in Asia Pacific, specifically in the areas of SWIM and FF-ICE implementation. To get started on this effort, it is timely for States to discuss and consider having a harmonised implementation roadmap of the essential TBO enablers, such as SWIM and FF-ICE, in order to support the realisation of the global TBO concept.

3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to:

- a) Note the information in this paper;
- b) Encourage States/Administrations to share their activities in support of the development and realisation of the global TBO concept in Asia Pacific and lessons learnt;
- c) Urge States/Administrations to consider working towards a harmonised roadmap in Asia Pacific to implement TBO enablers such as SWIM and FF-ICE; and
- d) Discuss any relevant matters as appropriate.

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