International Civil Aviation Organization

Thirty-Second Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/32)

Video Teleconference, 1 – 3 December 2021

Schedule: 10:00 – 13:15 Bangkok Time [UTC+7]

Agenda Item 3: **Performance Framework for Regional Air Navigation Planning and Implementation**

3.2: **ATM**

MULTI-REGIONAL TBO DEMONSTRATION

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

SUMMARY

This paper presents the Multi-Regional Trajectory-Based Operations (MR TBO) Demonstration, a collaborative effort between Japan, Singapore, Thailand, USA, and Canada, to better understand TBO concept as well as its operational values, and to discuss the capabilities required to support TBO.

Strategic Objectives:

B: ***Air Navigation Capacity and Efficiency*** *— Increase the capacity and improve the efficiency of the global aviation system*

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, 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 To enable this vision, it is essential to have global information utilisation, management, and interchange in a safe, secured and timely manner. This supports the evolution towards a holistic, cooperative and collaborative decision making environment, within which the interests and expectations of ATM stakeholders are considered and balanced. The envisioned ATM system will also have to consider and manage the trajectory of manned or unmanned vehicle for all phases of its 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[1]. TBO synthesizes these concept components and considers the needs and preferences of various actors of the global ATM system in a collaborative way. For example, airspace users (AU) would prefer that flights fly a specific trajectory to best meet their business interests. ATM service providers (ASP) would want to be able to make good decisions to achieve best ATM system-wide performance outcomes. Central to the TBO concept is the sharing, negotiating, and agreeing to a common trajectory for each flight, among the actors in an ATM system.

1.4 Trajectories are shared among ATM stakeholders so that potential problems are detected early and ATM decisions that follow can be made to have trajectories adjusted in such a way as to resolve those problems. With the use of trajectory as the common plan for the flight, traffic flow planning can be refined early, and the actual flow of traffic can be expected to be executed very close to ATM plans.

1.5 The accuracy, timeliness, consistency and predictability in trajectory that TBO brings about will lead to safer and more efficient management of air traffic in the future. The subsequent sections will elaborate how this may be achievable.

2. DISCUSSION

TBO Essential Enablers

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

2.2 FF-ICE will transform the present-day flight plan and flight planning process. It allows more information exchange, especially sharing of flight intent and trajectory throughout all phases of flight in greater detail. This enhanced sharing of updated and more accurate flight trajectories among the stakeholders facilitates a collaborative decision-making environment where flight trajectories could be optimised considering not only AUs' business objectives and preferences but also restrictions and constraints of the Air Navigation Service Providers (ANSP) or ASPs. This is the essence of TBO, which is the core principle towards the ICAO global vision for ATM as mentioned in Para 1.1.

2.3 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.

Operational Benefits of TBO

2.4 TBO will bring about significant enhancements to predictability, flexibility, safety, and efficiency in ATM. Through digitized 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), collaborative actions in the form of trajectory negotiations carried out between AUs and ASPs will lead to more optimized routing solutions and better traffic management plans as coordination 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.

[1] Airspace Organisation and Management (AOM), Aerodrome Operations (AO), Demand and Capacity Balancing (DCB), Traffic Synchronisation (TS), Airspace User Operations (AUO), Conflict Management (CM), and ATM Service Delivery Management (SDM)

2.5 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 be thus minimised.

2.6 TBO is a game changer for ATM, and examples in para 2.5 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 capabilities. The global ATM system will evolve as TBO is gradually adopted in ATM.

Multi-Regional Trajectory Based Operations (MR TBO) Demonstration

2.7 To validate the TBO concept and its benefits, several States/ANSPs in the Asia Pacific region (Aeronautical Radio of Thailand, Civil Aviation Authority of Singapore and Japan Civil Aviation Bureau) and NAV CANADA, joined a FAA (Federal Aviation Administration) led Multi-Regional TBO Demonstration. The MR TBO Demonstration seeks to identify, mature, and demonstrate key TBO capabilities. The partners collaborate to design and simulate operational scenarios to better understand the workings of TBO within and across regions.

2.8 The planned capabilities demonstrated in MR TBO 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 enabled at different time frames
- Enhanced demand-capacity balancing
- Enhanced predictability which will increase flight and fuel efficiencies

2.9 A lab demonstration, based on curated operational scenarios between the partners to validate operational values, is scheduled in April/May 2022.

2.10 The CNS Sub-group (CNS SG) of the 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 successfully held in 2019 also helped create better understanding about SWIM, particularly its roles and functions, possible implementation model as well as operational values for Asia Pacific.

2.11 The MR TBO Demonstration aims to bring about better understanding of TBO as well as its operational values, and to provide greater clarity on the role of the enablers in the realization of this new operational concept. The outcomes of the MR TBO Demonstration will be subsequently shared with the related bodies under APANPIRG. APANPIRG may wish to consider further activities to be conducted under its contributory bodies to support the realization of TBO in Asia Pacific, specifically in the areas of SWIM and FF-ICE implementation.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information in this paper;

b) encourage States to share their activities and lessons learnt to support the realization of TBO in Asia Pacific; and

c) discuss any relevant matters as appropriate.

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