



WORKING PAPER

THIRTEENTH AIR NAVIGATION CONFERENCE

Montréal, Canada, 9 to 19 October 2018

COMMITTEE A

Agenda Item 3: Enhancing the global air navigation system

3.2: Flight and flow information for a collaborative environment (FF-ICE) and trajectory-based operations (TBO)

SUPPORT FOR A GLOBAL TRAJECTORY-BASED OPERATIONS (TBO) FRAMEWORK

(Presented by the United States)

EXECUTIVE SUMMARY

This paper seeks to explain and garner support for a Global Trajectory-based Operations (TBO) Framework and endorsement of key enablers in global air traffic modernization planning, as defined in the Global Air Traffic Management Operational Concept (GATMOC), ICAO Global Air Navigation Plan (GANP) and Aviation System Block Upgrades (ASBUs).

Action: The Conference is invited to:

- a) endorse the Global Trajectory-based Operations (TBO) Concept and the updated module and key enablers such as SWIM and FF-ICE in the revised Global Air Navigation Plan and Aviation System Block Upgrades;
- b) urge States to work with Planning and Implementation Regional Groups (PIRGs) and Regional Aviation Safety Groups (RASGs) to integrate current modernization work with regional transition plans to TBO, SWIM and FF-ICE; and
- c) request ICAO and Member States to work with industry to consider current and future work in TBO, SWIM and FF-ICE that utilize performance-based global frameworks in the areas of information management/sharing, strategic planning, tactical separation/situational awareness, and security to ensure complimentary frameworks.

1. INTRODUCTION

1.1 Trajectory based operations (TBO) is defined by ICAO as a concept enabling globally consistent performance-based four-dimensional (4D)-trajectory management by sharing and maintaining trajectory information, which will enhance planning and execution of efficient flights, reducing potential conflicts, improving predictability and resolving network and system demand/capacity imbalances early.

1.2 The Federal Aviation Administration (FAA) is incrementally transitioning the United States (U.S.) domestic national airspace system (NAS) from the legacy of static distance-based separation

to a more strategic time-based management system through TBO. Together, time-based management and performance based navigation (PBN) contribute to a 4D trajectory (i.e. latitude, longitude, altitude, and time) that airspace users negotiate with the air navigation service providers (ANSPs) in identifying a solution that best accommodates both their needs.

1.3 While domestic implementation of TBO is already underway in some States, the full benefits of TBO will not be fully realized unless it is interconnected through a globally harmonized and holistic system. Such a system must: establish the rules for securely sharing information across borders; allow efficient implementation in a mixed use and flexible environment; and, be cost-beneficial.

2. DISCUSSION

2.1 Evolution to TBO

2.1.1 At the Eleventh Air Navigation Conference (ANConf/11, 2003) (Recommendation 1/1 refers), Member States supported the need to achieve an interoperable global air traffic 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. The 35th Session of the ICAO Assembly endorsed this conclusion and in response the *Global Air Traffic Management Operational Concept* (GATMOC, Doc 9854) was published in 2005.

2.1.2 The GATMOC provided the foundation for the Global ATM Operational Concept that presented a vision for an integrated, harmonized and globally interoperable ATM system planned up to 2025 and beyond. While the operational concept was visionary and challenging, many of the practices and processes continue to exist through the planning horizon. In this sense, the operational concept document was evolutionary.

2.1.3 In continual evolution, ICAO published the *Manual on Air Traffic Management System Requirements* (Doc. 9882) along with the *Manual on Global Performance of the Air Navigation System* (Doc 9883) in 2008 and 2009 respectively. These two documents provided a comprehensive understanding of the intent of, and delivery mechanisms for, the ATM system envisioned in Doc 9854.

2.1.4 Through 2009 to 2012, continuous innovation and improvements such as the *Manual on Flight and Flow — Information for a Collaborative Environment (FF-ICE)* (Doc. 9965) and then system wide information management (SWIM) have led to the ability to begin implementation of the future environment outlined in Doc 9854.

2.1.5 At the Twelfth Air Navigation Conference (ANConf/12, 2012), ICAO and Member States endorsed the aviation system block upgrade module relating to trajectory-based operations included in Block 1, recommended that ICAO use it as the basis of its work programme and agreed, in principle, with the aviation system block upgrade module relating to a 4D trajectory-based operations included in Block 3 as the strategic direction. Between ANConf/12 and ANConf/13, work on the global TBO concept and enablers under the direction of the ICAO Global Air Navigation Plan (GANP) and Aviation System Block Upgrades (ASBUs) has continued.

2.2 TBO Defined

2.2.1 TBO is envisioned to be attained through the culmination of multiple modernization efforts outlined in the ASBUs. It consolidates understanding across multiple ATM operational concept components during tactical planning and flight operations by synchronizing a common view of an

optimized trajectory. TBO balances flexibility for optimizing airspace users operations while simultaneously ensuring the predictability needed to optimize the ATM network as a whole; all the while ensuring that flight safety is never compromised.

2.2.2 With TBO will come better predictability of trajectories due to gate-to-gate, airspace-wide trajectory management instead of piecemeal management by each facility. TBO provides separation support, sequencing, merging and spacing of flights based on a combination of their current and future positions. It uses negotiated 4D trajectory to strategically manage and tactically control surface and airborne operations.

2.2.3 Negotiated trajectories include a path between origin and destination with predicted crossing time estimates at key points along the path, which are more accurate than the estimates used today for strategic planning. The time parameter provides a common planning reference across all phases of flight, including pre-departure. The trajectory facilitates integration across air traffic control (ATC) domains, enables the ANSPs to plan accounting for user objectives, and allows for more collaborative and flight specific solutions in response to airspace constraints. This represents a great improvement over today's strategic planning initiatives and tactical flow management techniques and addresses many of today's operational shortfalls.

2.2.4 A key enabler for TBO is the sharing of flight and flow information from pre-departure negotiation to taxi time to arrival gate on a globally supported SWIM system. This information is part of Flight and Flow — Information for a Collaborative Environment (FF-ICE) which delivers flight information sharing for flow management, flight planning and trajectory management associated with ATM operational components. Given multiple States of global SWIM modernization and implementation of FF-ICE, the Conference should endorse a transition plan as part of the GANP.

2.2.5 By utilizing the key enablers, TBO synchronizes the expected remainder of the trajectory and constraints between all involved ATM stakeholders. These stakeholders increase their awareness enabling them to better anticipate the events that may affect them. As continuous synchronisation is impossible due to the limitations of available communication budgets and network bandwidth, the sharing, updating and coordinating of trajectory changes has to be sufficiently frequent to serve the reliability needs of the various ATM components.

2.2.6 Given the varied levels of TBO and enabler implementation as well as increasing air traffic volumes, it is vital that ICAO develop a global concept that establishes rules for information sharing and security, the required performance levels and capabilities and a transition plan utilizing the GANP and ASBU language to ease integration into State and regional planning.

2.2.7 As part of this, States will need to work closely with their Planning and Implementation Regional Groups (PIRGs) and Regional Aviation Safety Groups (RASGs) to integrate current modernization work with regional transition plans to TBO, SWIM and FF-ICE. The global concept must be holistically strategic to integrate multiple regional systems into a harmonized global framework for seamless operations across all borders.

2.2.8 As much of TBO will rely on continuous innovation, automation and human interaction, it is imperative that ICAO and States work with industry to consider current and future work that utilize performance-based global frameworks in the areas of information management/sharing, strategic planning, tactical separation/situational awareness and security to ensure complementary frameworks.

3. **CONCLUSION**

3.1 The Conference is invited to agree and endorse the actions listed in the executive summary box.

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