



WORKING PAPER

FOURTEENTH AIR NAVIGATION CONFERENCE

Montréal, Canada, 26 August to 6 September 2024

Agenda Item 3: Air navigation system performance improvement

3.1: Proposals to improve the efficiency of air navigation services contributing to LTAG

ENABLING SUCCESSFUL DEPLOYMENT OF TRAJECTORY-BASED OPERATIONS

(Presented by Hungary on behalf of the European Union¹ and its Member States, the other Member States of the European Civil Aviation Conference², the European Organisation for the Safety of Air Navigation (EUROCONTROL), and Singapore)

EXECUTIVE SUMMARY

The concept of trajectory-based operations (TBO) is about the transformation of air traffic management (ATM) leading to higher levels of safety, efficiency and sustainability. The development and implementation of TBO are in progress in different regions, including Europe, but the full benefits will only be realized through a globally orchestrated approach. Therefore, ICAO need to prepare and maintain a TBO provisions development plan as a common reference. Furthermore, innovative solutions, timely decommissioning of the current flight plan format (FPL 2012) and incentives are needed to enable a scalable evolution of TBO and a transformation of ATM.

Action: The Conference is invited to agree to the recommendation in paragraph 3.

1. INTRODUCTION

1.1 Trajectory-based operations (TBO) is a global strategic operational goal of ICAO, which enables a fully collaborative environment where each flight trajectory is shared, maintained, and used by all the concerned actors, including new entrants, and during all phases of flight, including pre-departure. It will support a better balancing of airspace and aerodrome capacity with user demand that will enable reduced fuel burn and support the achievement of the long-term aspirational goal for international aviation (LTAG) of net zero carbon emissions by 2050. A well prepared and coordinated deployment of TBO will result in immediate and substantial benefits for a safe, efficient, environmentally sustainable and predictable flow of air traffic at global level between ICAO regions as well as within regions.

1.2 TBO is the paradigm change for air traffic management (ATM) and a main focus of European ATM modernization. Global guidance is provided through the *Global Air Traffic Management Operational Concept* (GATMOC, Doc 9854), the TBO concept and the flight and flow – information for a

¹ Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden

² Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Republic of Moldova, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland, Türkiye, Ukraine, and the United Kingdom.

collaborative environment (FF-ICE) concept. The first phase of FF-ICE is the basis for sharing and maintaining flight information during the pre-departure phase between ground actors including the four-dimensional (4D) trajectory. The second phase of FF-ICE supports also the post-departure phase with advanced air-ground data communication capabilities providing the basis for sharing and maintaining flight information between aircraft and ATM ground stakeholders, including the downlink of trajectory data and the uplink of TBO 4D route clearances that are loadable in the flight management system (FMS).

1.3 Implementation of the key TBO enablers extends across the globe, encompassing the European Union as vital participant through its Common Project One (CP1)³ with a deadline of 2027. This includes the implementation of FF-ICE services. Initial air-ground trajectory information sharing is supported by the implementation of part of the ATS B2⁴ standard and is already in operational use in a major European en-route centre. Research and innovation (R&I) are in progress to further develop the TBO flight planning processes as well as the TBO processes involving air traffic control (ATC). The overall objective of R&I and implementation efforts is to realize sustainability benefits and cost savings through higher degrees of flight efficiency by collaboration between all actors for the sharing, revision and update of trajectory data during the pre-departure and the post-departure phases of the flight.

1.4 The development and implementation of TBO is the subject matter of several national and regional R&I programmes. Global harmonization and interoperability are key requirements for ensuring that the Global TBO Concept translates to concrete performance benefits. This is motivated also by the fact that initially, TBO is expected to result in benefits for long haul international flights.

1.5 The 13th Air Navigation Conference (AN-Conf/13) emphasized the need for global guidance on transitioning to a globally interoperable TBO environment in the context of ongoing ATM initiatives, while addressing all domains of ATM and by taking into consideration existing and new types of airspace users. AN-Conf/13 requested ICAO to develop TBO guidance material, which is now part of the work programme of the ATM Requirements and Performance Panel (ATMRPP). To contribute to the timely achievement of the LTAG goals, it is important to ensure that the further development of TBO is proactively and successfully orchestrated at the global level.

2. DISCUSSION

2.1 European Research Projects are developing solutions for a full scope TBO implementation, including continuation of flight planning post departure and development of ATC systems capable of using trajectory information downlinked from the aircraft and provision of TBO clearances via controller pilot data link communications (CPDLC). Implementation of foundational TBO enablers (FF-ICE, (system-wide information management (SWIM) and Extended Projected Profile⁵ (EPP)) is in progress as part of Implementing Regulation 2021/116. The European Network Manager is already using FF-ICE for pre-departure flight planning.

2.2 To achieve the objectives and benefits of TBO, it is necessary to address all ATM processes that use and/or have an impact on the flight trajectory. An important enabler for TBO is increased collaboration between all actors both at network air traffic flow management (ATFM) as well as ATC levels. Military operations may require special considerations. TBO supports and will benefit from the

³ Commission Implementing Regulation (EU) 2021/116 on the establishment of the Common Project One supporting the implementation of the European Air Traffic Management Master Plan provided for in Regulation (EC) No 550/2004, OJ, L36, 2.2.2021.

⁴ ATS Baseline 2 is an air to ground datalink standard which enables TBO and consists of CPDLC v2 and ADS-C (automatic dependent surveillance - contract (ADS-C)).

⁵ The initial trajectory information-sharing solution is based on the aircraft downlinking trajectory information directly from the FMS to the ground systems via an updated standard for the ADS-C.

migration to global collaborative ATFM. Since long-haul flights could have early benefits from TBO implementation, it is important that ICAO provisions for global collaborative ATFM are timely available.

2.3 All ATC separation provision and traffic synchronization processes (whether strategic, tactical and or pre-tactical) will benefit from improved trajectory information through air/ground data sharing and collaboration. TBO includes trajectory management concepts that use predicted trajectory data downlinked from the aircraft, as well as the increased use of CPDLC clearances that are loadable in the FMS and the development of advanced support for ATC-to-ATC coordination concepts. This is not part of the current ICAO work programme on TBO and FF-ICE but should be included.

2.4 For TBO to be a concept for the future, it should be scalable in terms of number of flights and geographical implementation. In this context it is essential to consider the role of the human as well as to explore to the extent possible supportive use of automation. A fundamental principle in ATM is the continuous and maintained assurance of consistency between the flight plans used by the flight crew and by ATC. Changes to the flight plan are subject to rigorous and safety-proven procedures standardized through ICAO. The TBO environment enables trajectory optimisation which can result in frequent trajectory revisions. Because this should not result in an increase in controller workload, it is necessary to find solutions using automation guaranteeing higher or at least the same level of assurance and safety as the current controller-pilot procedures. This is not part of the current ICAO work programme on TBO and FF-ICE but should be included.

2.5 It is recognized that at global level, TBO will be not always implemented in the same way and/or at the same time in terms of, for example, implemented functions or enablers. At the same time, it is of paramount importance that all TBO implementation solutions are harmonized and interoperable and can integrate aircraft operators (ground and air components) with minimal investments. History has shown that this is not achieved through an organic process but requires global orchestration.

2.6 The LTAG requires innovation in ATM and must drive the timing for development and implementation of sustainability improvements such as TBO. AN-Conf/13 acknowledged and invited States along with stakeholders to address proactively multidisciplinary issues in a timely and globally interoperable manner to ensure that TBO delivers anticipated performance benefits. Such multi-disciplinary issues include:

- a) optimum level of automation while keeping the “human in control” for operationally critical decisions and responses;
- b) required competencies and skills of aviation personnel (air traffic controllers, pilots, and flight operations officers, etc.);
- c) mechanisms that balance the efficiency of individual flights with the stability and efficiency of the network as a whole; and
- d) means and criteria for performance management on automation and decision-making processes.

2.7 ICAO provisions have been and are being developed for the sharing and maintenance of flight information, including the aircraft 4D trajectory which will also support operations of new entrants. New entrants may require new information elements and new services to be developed for FF-ICE. Work is progressing through the Advanced Air Mobility Study Group (AAM SG) to identify these needs. This and the issues listed in paragraph 2.6 above or, in general, a full scope TBO approach will generate needs for further ICAO provisions. To properly manage an orchestrated global TBO approach leading to safe and interoperable implementations, a maintained and comprehensive ICAO TBO provisions development plan

is needed covering all ATM domains and issues. Therefore, the ICAO work programme on TBO should be expanded to include the development and maintenance of such a plan which should also be integrated in the *Global Air Navigation Plan* (GANP, Doc 9750) .

2.8 Not only should new enabling technology and functionality be introduced in a timely manner, legacy systems and functionality should also be phased out to minimize any potential negative impacts during the mixed mode operations of current ICAO flight plan processing and FF-ICE. To achieve this objective, AN-Conf/13 invited ICAO to develop a robust transition strategy. FF-ICE enables TBO and mitigates the shortcomings of the current flight plan format (FPL 2012). The presenters of this paper support the ICAO efforts to minimize the period of mixed mode operation and advocate for an ambitious sunset date for FPL 2012. Advancements of other key enablers are equally essential and include the need for a secure, scalable and spectrum efficient air-ground datalink that offers a significant increase in bandwidth.

2.9 TBO will bring many benefits for aircraft operators that are capable, both in the pre-departure phase and during the execution of the flight. In addition, TBO and automation enables further evolution of the airspace and equity considerations outlined in the GATMOC towards a more modern Service Priority Policy. As part of the preparation for global transition to TBO, ways to create incentives should be investigated, for example by applying a most capable best served approach that gives priority to the capable flights without increasing controller workload and thus degrading the overall performance of the ATM system.

3. CONCLUSION

3.1 The ICAO TBO concept is widely supported and serves as the foundation for numerous national and regional R&I and implementation initiatives. While a global concept provides the starting point, it alone does not endure consistent and interoperable implementations. It is therefore necessary that ICAO provides guidance and, where necessary, standardizes the more detailed aspects of TBO across its entire scope, i.e. also addressing the use of enhanced flight information. In doing so it is necessary to ensure a fully scalable design/approach that reduces human workload while maximizing performance benefits. Implementation should be incentivized through application of a most capable best served approach.

3.2 In light of the above, the Conference is invited to agree the following recommendation:

Recommendation 3.1/x – Enabling successful deployment of trajectory-based operations

That the Conference:

- a) note the progress of development and implementation of trajectory-based operations (TBO);
- b) request ICAO to expand its work programme to include the development and maintenance of an ICAO TBO provisions development plan addressing the full scope of TBO as input to the GANP;
- c) request ICAO to prioritize the development of provisions for global collaborative ATFM supporting TBO;
- d) request ICAO to expand its work programme on TBO and FF-ICE to include the development of provisions for automated air/ground trajectory synchronization;

- e) request ICAO to facilitate an ambitious FPL 2012 sunset date; and
- f) request ICAO to investigate the evolution of its Service Priority Policy in the GATMOC in support of TBO implementation.

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