



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

TRAJECTORY-BASED OPERATIONS (TBO) DRIVING OPERATIONAL PERFORMANCE

(Presented by Brazil, China, Japan, Singapore, Thailand and the United States)

EXECUTIVE SUMMARY

A41-WP/131 called for ICAO to expand the performance framework to accommodate the trajectory-based operations (TBO) concept in order to assist air navigation services providers (ANSPs) and airspace users (AUs) determine and track benefits of TBO. This is essential to building a business case to prioritize implementation. The Performance Benchmarking Working Group (PBWG) comprising Brazil, China, European Organisation for the Safety of Air Navigation (EUROCONTROL), Japan, Singapore, Thailand and the United States studied the performance objectives achieved by the introduction of TBO and suggested key performance indicators (KPIs) to achieve these performance objectives. It was proposed that the existing ICAO *Global Air Navigation Plan* (GANP, Doc 9750) KPIs be adopted and adapted for the purpose of TBO. These options can be presented as variants in the current performance framework.

Action: The Conference is invited to:

- a) note the contents of the paper;
- b) discuss the performance measures to consider as Member States/Administration and regions take steps towards more seamless air traffic operations, with the aim of achieving TBO;
- c) call on Member States/administration to consider the proposed performance measures within the GANP Performance framework applicable to the TBO concept.

1. INTRODUCTION

1.1 Trajectory-based operations (TBO) is defined by ICAO as an air traffic management (ATM) environment where the flight trajectory of an aircraft is flown as close as possible to the user-preferred route, with as little disruptions as possible through collaborative decision-making mechanism. This includes reducing potential conflicts and resolving demand/capacity imbalances earlier and more efficiently. TBO can therefore bring significant operational and environmental benefits to aviation.

1.2 Some of the operational benefits include: a) improved flight trajectory efficiency, b) improved throughput, c) better predictability and d) more flexibility for stakeholders. It is expected that when TBO is fully implemented, the benefits will extend to other areas including capacity and

environment protection. Given TBO's benefits, and in preparation for future traffic growth, ICAO and the Member States/administration should continue to push for the implementation of TBO globally.

1.3 Expanding the performance framework to accommodate TBO concept is key to helping air navigation services providers (ANSPs) and airspace users (AUs) determine and track the benefits of TBO, and is essential to building a business case to prioritize its implementation. A41-WP/131 proposed that ICAO further develop TBO implementation guidelines to include TBO performance measurement and management.

1.4 The refinements and variants proposed in this paper utilizes existing data and performance framework contained in the current Global Air Navigation Plan (GANP) key performance indicators (KPIs). They are focused on adaptations rather than new metrics. One key item is clear identification with stakeholders on what constitutes a "User Preferred Route".

1.5 The implementation of TBO will require cooperation among neighboring States. To this end, groups cooperating and studying performance metrics, such as the ICAO GANP Performance Expert Group (GANP-PEG) and the Performance Benchmarking Work Group (PBWG) can benefit the aviation community through continued demonstrated use of KPIs applied to TBO. ICAO planning and implementation regional groups (PIRGs), especially those with established data analytics groups should also inform ICAO GANP-PEG and PBWG of its progress and encourage TBO implementation in the regions.

2. DISCUSSION

2.1 ICAO first introduced the performance framework in the fifth edition (2016) of the GANP. To this date, the performance framework in the seventh edition of the GANP covers four key performance areas (KPAs), i.e. capacity, efficiency, predictability and safety, and it aims to eventually cover all 11 key performance areas stated in the ICAO Global Air Traffic Management Operational Concept (GATMOC, Doc 9854). These metrics can be found in the GANP portal <https://www4.icao.int/ganportal/ASBU/KPI>. As the performance framework in the GANP complements the aviation system block upgrade (ASBU) framework, the performance framework takes the perspective of ANSPs. The GANP-PEG was formed in 2019 to study and expand the set of key KPAs and KPIs covered in the GANP.

2.2 The latest GANP review saw changes to the GANP conceptual roadmap which comprises a four evolutionary step process to achieving TBO. In summary, the first step entails operating flight in a digitally rich environment, the second step embraces time-based operations enabled by information revolution, the third step is TBO enabled by full connectivity through the internet of aviation and the final step entails total performance management system focused on business/ mission needs.

2.3 In parallel, the PBWG comprising members from Aeronautical Radio of Thailand Ltd. (AEROTHAI), Brazil's Department of Airspace Control (DECEA), Civil Aviation Administration of China (CAAC), Civil Aviation Authority of Singapore (CAAS), EUROCONTROL, Japan Air Navigation Services (JANS) and the United States Federal Aviation Administration (FAA), commenced performance benchmarking on a number of GANP KPIs. This work group is a collaboration among the seven organizations; it supports the developments of the GANP and is committed to validate and augment the existing GANP performance guidance with respect to indicators. The PBWG members observed an increasing level of TBO technology and real-world application growing in their region with airline stakeholders having increased flexibility in their flight planning and ANSPs having greater ability to control traffic on specific traffic flows using time-based separation. As a practical problem, the PBWG members are investigating the adaptation of the current framework and has the capability to implement trial KPIs for TBO. The PBWG members will also consider the different trajectories exchanged as part of

the flight and flow – information for a collaborative environment (FF-ICE) to support the KPI calculations.

Recommendations for ICAO KPI guidance

2.4 The GANP is a strategic document for regional and national planning for air navigation infrastructure and the GANP-PEG is a subgroup under the GANP Study Group to develop, maintain and evolve the performance framework of the GANP. As such, this paper recommends expanding and generalizing GANP guidance to support new concept of operations such as measuring control time adherence and delay metrics using day of operation times from traffic flow automation systems. As automation systems mature or new ones are introduced, the general concepts of calculating control time adherence and delays remain, however, the specifics can differ (i.e., there is a need to use more stringent adherence thresholds for time-based operations due to high precision of the system). Instead of continuing to prescribe the exact way of calculating a metric, it is suggested ICAO give general guidance and allow practitioners freedom in determining how best to apply it in their specific situation.

2.5 For adherence to target-times, there could be general guidance in a KPI overview section. KPI03 can be generalized to address any situation where both actual time, control time and airline ready times are present for a particular event. The size of an adherence window is dependent on what system produces the control times and the tolerance for adhering to those times. General language is preferred indicating that an appropriate window size needs to be determined for assessing adherence and predictability.

2.6 For delay, both KPI07 En-route ATFM delay and KPI12 Airport/Terminal ATFM delay address the same fundamental concept of measuring the difference between airline ready times that might be provided in the flight plan and air traffic controller (ATC) control times for flights affected by a flow restriction. It is recommended that generalized KPI's be introduced that define ATM delay for any event in current or future technology for which a controlled target-time is obtained from an air traffic flow management system.

2.7 Additionally, the importance of causal factors should be stressed. Retaining causal factors for a particular restriction allows for metric disaggregation and more in-depth analysis. Stakeholder buy-in is greatly improved through identification of causal factors as well as the linking of performance outcomes and performance objectives.

2.8 This paper recommends ICAO consider the advantages of generalizing KPI guidance to highlight adaptability over continuing to add KPIs and variants to respond to a dynamic and evolving system. The system will most likely continue to evolve making it difficult for those implementing a performance-based approach to follow the guidance. A prescriptive KPI guidance constrains users from developing metrics that meet the specific-measurable-achievable-relevant-time-bound (SMART) criteria. Lastly there may be cases where specific ICAO GANP KPI and variants, developed over 20 years even become obsolete.

2.9 The existing GANP KPIs relevant to TBO are:

KPI01 Departure punctuality

KPI02 Taxi-out additional time

KPI03 ATFM slot adherence → to be adapted/generalized as a target-time adherence metrics

KPI04 Filed flight plan en-route extension → to be adapted for the different trajectory types proposed under the TBO concept

KPI05 Actual en-route extension → to be adapted for the different trajectory types proposed under the TBO concept

KPI07 En-route ATFM delay → to be generalised as an enroute delay metric

KPI08 Additional time in terminal airspace

KPI10 Airport peak throughput

KPI11 Airport throughput efficiency

KPI12 Airport/Terminal ATFM delay → to be generalised as an enroute delay metric

KPI13 Taxi-in additional time

KPI14 Arrival punctuality

KPI15 Flight time variability

KPI16 Additional fuel burn

KPI17 Level-off during climb

KPI18 Level capping during cruise

KPI19 Level-off during descent

2.10 While some of the above-mentioned KPIs can be directly applied, the others will need to be adapted for the purpose of TBO. It is suggested that the PBWG continue to study and propose additional variants to address new concept developments for consideration by the GANP.

3. CONCLUSION

3.1 Over the years, the GANP has successfully developed, maintained and evolved its performance framework for relevance. Generalizing and adapting the performance framework to accommodate the TBO concept is key to helping ANSPs and AUs determine and track the benefits of TBO. The expanded performance guidance will benefit the PIRGs in facilitating the discussion on performance-based approach for the region and will be the glue for stakeholders to work together to achieve regional excellence. This can be promoted through increased or even formal dialog between GANP-PEG and ICAO regional data analytics groups. The PBWG will also continue work in this regard to advance the GANP performance framework.

3.2 Beyond the development of the performance standards by GANP-PEG, it is crucial that Member States/administration and the regions seek:

- a) strong participation from stakeholders when establishing performance measures;
- b) strong participation from Member States at the regional levels on data exchange necessary to increase predictability and inform stakeholders on effective implementation; and
- c) continued advancement of the GANP KPIs in the regions including ability to assess improvements in predictability.