LTAG Assessment from a Operations Perspective

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Introduction

This article highlights the results from the LTAG-TG Operations sub group, which was tasked to identify and evaluate existing, foreseen, and innovative in-sector measures in the area of operations that could potentially contribute to reducing CO_2 emissions from international civil aviation, and to develop and analyse in-sector scenarios of operations that represent a range of readiness and attainability.

LTAG-TG OPS SG Methodology

The methodology established an overall approach based on three phases: data collection, data analysis, and outputs to be delivered subsequently to feed the scenarios development. In addition to these three phases, the sub-group undertook additional work to develop its input to the Sample Problem. This took place after completing the data collection phase and before embarking on the data analysis.

Phase 1 – Data collection: A literature review of the information and data sources on current, foreseen and innovative measures to reduce aviation in-sector CO_2 emissions. Data sources reviewed included both internal ICAO documentation and external ICAO documentation (i.e., ICAO/ENV stocktaking questionnaires, library of documents, videos prepared by the Secretariat, additional information provided to the sub-groups by its Members). Gaps were identified and the required information was found to fill them. All measures identified during the literature review were listed in a master excel spreadsheet, and were then subject to a thorough review to ensure that measures were categorized correctly and that no measures were duplicated.

Many of the measures identified during the data collection phase had been captured in the work undertaken in the CAEP/11 WG2 environmental assessment of the Global Air Navigation Plan – Aviation System Block Upgrades (GANP-ASBU), which had assessed ASBU blocks 0 and 1 in 2019. This data had included operational improvements (OI) for the years 2028, 2038 and 2050 for Horizontal Flight Efficiency (HFE), and CAEP was also considering Vertical Flight Efficiency during the time that feasibility report was being prepared. This previous analysis, which served as the baseline, had created 53 rule of thumb fuel saving benefits to be expected from the generic implementations of 31 operational measures and estimated the expected fuel and CO_2 savings based on the planned implementation plans of ICAO States between 2015 and 2025. Table 1 below lists the 31 operational measures already assessed by CAEP.

✓ Remote Tower	✓ Short-Term ATFCM Measures
✓ Enhanced MET information	✓ Advanced FUA (ATFM / Airspace Management)
✓ Flexible use of airspace	✓ RNP-AR approaches
✓ Flex routes	✓ Airport – Collaborative Decision Making
✓ Free Route Airspace	✓ Wake Vortex Re-categorization
✓ User Preferred Routings	✓ Time-Based Separation
✓ Space-based ADS-B surveillance	✓ Arrival Manager
✓ Datalink En-route	✓ Extended Arrival Manager
✓ Datalink Departure Clearance	✓ Terminal Flight Data Manager
✓ FF-ICE Planning Service	✓ Advanced – Surface Movement Guidance and Control System
✓ Continuous Descent Operations	✓ PBN approaches (Radius to Fix)
✓ Continuous Climb Operations	✓ PBN to xLS approaches
✓ PBN STARs	✓ GBAS CAT I/II/III
✓ PBN SIDs	✓ Multi-segment approaches / glideslopes
✓ Flight-based Interval management	
✓ Ground-based Interval Management	
✓ ATFM	

TABLE 1: List of Operational Measures assessed by CAEP

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As a result of its data collection exercise, the OPS sub-group identified a number of operational measures additional to those assessed by CAEP. These additional measures are listed in the Table 2 below.

✓ Dynamic Sectorization ✓ Reduced Extra Fuel On-board ✓ Best Practices in Operations Minimizing Weight ✓ In-Trail Procedure (ITP) ✓ Airline Fuel Management System ✓ Optimized Runway Delivery Support tool and Reduced Pair-Wise Weather Dependent Separation between Arrivals ✓ Electrical Tug Detachable Aircraft Towing Equipment	✓ Support for Optimized Separation Delivery and Reduced Pair-Wise Weather Dependent Separation between Departures ✓ Formation Flight ✓ Geometric Altimetry and RVSM Phase 2 ✓ Global Air Traffic Flow Management ✓ Satellite Based VHF for oceanic/remote areas ✓ APU Shut Down ✓ MAINTENANCE - difference between maintenance and modification to aircraft, technology related

TABLE 2: List of Operational Measures considered by CAEP

Phase 2 – Data Analysis: For the data analysis, the same methodology as that was used previously by ICAO CAEP in its assessments of individual operational measures was utilized. This involved the development of so-called "Rules of Thumb" for each individual operational measure not already included in the CAEP Global Air Navigation Plan – Aviation System Block Upgrades (GANP-ASBU) assessment and conduct a detailed analysis of each of these measures. The objective of the "Rule of Thumb" for each measure was to identify its potential contribution to CO_2 emissions reductions.

In addition to determining the potential contributions to CO_2 emissions reductions, the sub group also made estimates of the likely costs associated with implementation of these measures. The summary information is included in the Attachment A of the ICAO LTAG Report Appendix M4[2].

For the operational measures already assessed by CAEP, the LTAG-TG OPS sub-group updated the baseline to take into account the following sources of inefficiency, and operational measures to address these sources of inefficiency, the final three of which were new and additional to previous work performed:

- **Horizontal flight inefficiency** - the comparison between the length of a trajectory and the shortest distance between its endpoints;
- **Vertical flight inefficiency** - the flight can't reach its optimum cruising level during the flight nor the flight is kept at a suboptimal flight level during the climb or descent phase;
- **Ground operations inefficiency** - typically infrastructure-related measures that can reduce emissions at taxiway or the gate, i.e. such as semi-autonomous tow-truck (taxibot);
- **Innovative flight inefficiency** - achieved through implementation of new operational measures in the medium term, i.e. notionally from 2038, such as formation flying;
- **Advanced flight inefficiency** - results from the introduction of advanced concept aircraft into the fleet, such as blended wing body (BWB) aircraft. It is possible that these aircraft will have different performance characteristics from conventional aircraft, e.g. in terms of speed, altitude etc.

Phase 3 – Outputs for the LTAG-TG Scenario Development sub-group (SDSG): After development of "Rules of Thumb" for each individual additional operational measure and update of the baseline which was previously established in CAEP, a high-level description of the operations scenarios was prepared. Based on the scenarios fuel savings, readiness level and associated cost related to each individual operational measure were estimated. These outputs were feed into the integrated scenarios developed by the Scenarios Development sub-group (SDSG).

2 https://www.icao.int/environmental-protection/LTAG/Documents/ICAO_LTAG_Report_AppendixM4.pdf

LTAG Operations Scenario Descriptions

The LTAG-TG OPS sub-group then prepared a high-level description of the operations scenarios to feed into the integrated scenarios developed by the SDSG. Three scenarios were proposed — conservative, medium, and aggressive. These scenarios were constructed according to different rates at which the five above categories of measures were assumed to be implemented. The three scenarios are summarised here and in Figure 1 below:

Operations Scenario 1 (O1)

O1 represents the low or conservative end of the range of potential CO_2 emissions reductions from operations. In this scenario, there is a low rate of ASBU element deployment to optimise Horizontal Flight Efficiency (HFE), Vertical Flight Efficiency (VFE) and Ground Flight Efficiency (GFE).

Operations Scenario 2 (O2)

O2 represents the middle of the range of potential CO_2 emissions reductions from operations. In this scenario, there is a medium rate of ASBU element deployment to optimise HFE, VFE and GFE, and low rate of operational measure deployment to optimise IFE and AFE.

Operations Scenario 3 (O3)

O3 represents the high or aggressive end of the range of potential CO_2 emissions reductions from operations. In this scenario, there is a high rate of ASBU element deployment to optimise HFE, VFE and GFE, and medium rate of operational measure deployment to optimise IFE and AFE.

Results and Key Findings

Based on the assumptions on rate and extent of implementation of operational measures for O1, O2 and O3 scenarios fuel efficiency improvements from operational measures were estimated. Figure 2 below shows the average fuel efficiency improvements from operational measures across 2035, 2050 and 2070.

	Operations Scenario 1 (O1)	Operations Scenario 2 (O2)	Operations Scenario 3 (O3)
2035	3%	4.5%	7%
2050	5%	8%	13%
2070	6%	11%	16%

FIGURE 2: Average Fuel efficiency improvements from operational measures across LTAG-TG integrated scenarios

Analysis conducted by LTAG OPS sub group showed that there would be regional variances in implementation of operational measures however; there are opportunities for operations to reduce CO_2 emissions through improvements in the performance of flights across all phases, including unconventional measures such as formation flying.

	LTAG-TG Scenarios		
Baseline	O1 Scenario Low CO_2 reduction from Operations	O2 Scenario Mid CO_2 reduction from Operations	O3 Scenario High CO_2 reduction from Operations
No emissions reductions from operations after 2025 (implementation of ASBU blocks 0 and 1)	Conservative assumptions about rate and extent of implementation of operational measures, based on reduced/slower investment in ground and airborne systems and technologies. Low rate of ASBU element deployment to optimize HFE, VFE and GFE.	Emissions reductions and operational efficiencies in line with existing "Rules of Thumb" developed by WG2 and new "Rules of Thumb" developed by LTAG OPS for new measures. Medium rate of ASBU element deployment to optimize HFE, VFE and GFE. Low rate of operational measure deployment to optimize IFE and AFE.	Aggressive assumptions about rate and extent of implementation of operational measures, based on higher/accelerated investment in ground and airborne systems and technologies. High rate of ASBU element deployment to optimize HFE, VFE and GFE. Medium rate of operational measure deployment to optimize IFE and AFE.

FIGURE 1: Summary of LTAG-TG operations scenarios