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

PROPOSAL TO DEVELOP PROVISIONS FOR LONG-RANGE AIR TRAFFIC FLOW MANAGEMENT (LRATFM) CONCEPT

(Presented by Civil Air Navigation Services Organisation (CANSO) and
International Federation of Air Traffic Controllers' Association (IFATCA))

EXECUTIVE SUMMARY

This paper presents the concept of Long-Range Air Traffic Flow Management (LRATFM) as has been researched by CANSO and discussed in the *Long-Range Air Traffic Flow Management Concept White Paper* published in 2022. Based on a study of existing approaches/trials, a definition of LRATFM has been proposed in the white paper. Using the proposed definition and associated research work as starting points, ICAO should consider developing standard definition and associated provisions to ensure a globally aligned and harmonized implementation of LRATFM, considering its potential benefits and far-reaching trans-regional impact.

1. INTRODUCTION

1.1 Air traffic flow management (ATFM) is a constituent of air traffic management (ATM), having evolved in response to ever-increasing traffic demand and rising airspace complexity. ATFM has been defined as a service to balance the air traffic demand against the capacity of ATM resources (airports, waypoints, or a sector of an airspace)[1], and has been named an important element to be implemented by States/Administrations for "airspace where air traffic demand at times exceeds, or is expected to exceed, the declared capacity of the air traffic control services concerned"[2].

1.2 ATFM has therefore been adopted and implemented globally, at varying complexity levels, by States/Administrations, air navigation services providers (ANSPs), and regional implementation groups. The State-of-the-Art of ATFM implementation thus far focuses primarily on managing local (domestic) or regional/sub-regional air traffic into constrained or congested ATM resource through ATFM solutions, with tools such as ATFM slots (e.g., calculated take-off times (CTOTs)) assigned to a group of flights that can be captured under national or regional/sub-regional agreements.

[1] ICAO *Manual on Collaborative Air Traffic Flow* Management (Doc 9971)
[2] Annex 11 — *Air Traffic Services* to the Convention on International Civil Aviation

1.3 The focus on managing local or regional/sub-regional air traffic with existing ATFM concepts and solutions have meant that long-haul trans-regional air traffic are often "exempted" from participating in the ATFM process and sharing in the absorption of ATFM delays. This has been due to several factors including, inter alia, limited scope of ATFM agreements, lack of procedures to affect ATFM measures trans-regionally, and lack of appropriate automation support. This focus on short and medium-haul traffic while exempting the long-haul flights sometimes results in sub-optimal outcomes of the ATFM process, including, inter alia;

a) ineffective or unfair allocation of delays especially in areas with a large portion of long-haul traffic;

b) reduced predictability for long-haul traffic as they are subjected to last-minute tactical air traffic control instructions; and

c) increased airspace complexity and safety risk as unmanaged long-haul traffic is merged with short and medium-haul traffic.

1.4 It is for these reasons that the concept of Long-Range ATFM, an ATFM concept that can capture long-haul traffic (trans-regional flights) in addition to the current focus on short and medium-haul traffic (domestic and regional/sub-regional flights), has begun to be explored in various places and is viewed by many States/Administrations and regional implementation groups as the necessary evolution of ATFM in the near future, especially as there is an increase in trans-regional flights and the global airspace is becoming increasingly connected.

2. DISCUSSION

Exploring Long-Range ATFM: a White Paper by CANSO

2.1 Long-Range ATFM (LRATFM) has been discussed across the aviation industry for many years. The concept has been developed, and interpreted, differently by different Stakeholders depending on their history, expectations, and perspectives. Several approaches to LRATFM have also been explored by various ANSP groups through early implementations and trials such as the BOBCAT[3] ATFM service, NATS XMAN[4] implementation, LRATFM trial by New Zealand and Singapore, and LRATFM trial by Australia.

2.2 Recognizing the multitude of existing approaches and trials of LRATFM, and that a unified *definition* of the concept remains elusive, CANSO has conducted extensive research and discussed the LRATFM concept and implementation in the recently published *Long-Range Air Traffic Flow Management Concept White Paper (2022)*[5]. In the white paper, CANSO has defined LRATFM as:

> *"The integration of ATFM solutions to deliver a collaboratively balanced flow of long-haul and short-haul aircraft to an ATM resource (airport, waypoint, or a sector of an airspace)."*

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[3] Bay of Bengal Cooperative Air Traffic Flow Management, a cooperative ATFM arrangement managing nighttime traffic over the constrained Afghanistan airspace.

[4] Extended Arrival Management, implemented by NATS in the United Kingdom to extend the sequencing horizon of the conventional AMAN to help distribute delays into a more fuel-efficient phase of flight.

[5] The White Paper is accessible here: https://canso.org/publication/long-range-air-traffic-flow-management-concept/

2.3 A well-implemented LRATFM based on this definition can provide added benefits to ATM operations and the environment including;

a) improved data sharing among stakeholders, bringing better predictability to the operations;

b) equitable distribution of delays among all airspace users rather than penalizing short- and medium-haul operators;

c) better planning for both airspace users and air traffic service (ATS) providers;

d) more efficient use of the ATM resource capacity through more effective use of aircraft trajectory information; and

e) enhanced opportunities to manage air traffic controller (ATCO) workload arising from increased predictability and better planning, managed delay distribution across multiple air traffic control (ATC) area, approach and aerodrome positions.

2.4 The white paper covers in detail the existing LRATFM approaches and trials and provides a model operational scenario for its implementation. It also discusses potential benefits as well as conceptual and operational considerations when LRATFM is to be implemented. Key excerpts and summary from the white paper are included in the Appendix to this paper.

The Need for LRATFM Provisions

2.5 ATFM is inherently a collaborative process, requiring ANSPs and airspace users to work together to achieve the optimized outcome. This is especially true for LRATFM as its impact can be far-reaching, and its scope will be much broader than "conventional" ATFM horizon. LRATFM will require multi-stakeholder collaboration beyond the national and regional boundaries; it will require aligned understanding, harmonized practices, and common standards trans-regionally or even globally.

2.6 The CANSO white paper provides a starting point for that aligned understanding and harmonized practices which can be used by ANSPs and regional/cross-regional groups to begin their implementation efforts.

2.7 Standards and Recommended Practices (SARPs) will need to be developed for adoption by States/Administrations to ensure globally harmonized and integrated implementation leading to a more effective ATFM process and equitable and efficient use of ATM resources. These SARPS could include:

a) a standard definition of LRATFM;

b) standard terms and definitions applicable to the procedure;

c) applicability of the procedure;

d) an overview and general requirements for the application of the procedure;

e) data, information and analysis requirements for the implementation of the procedure;and

f) performance monitoring requirements for the procedure

3. CONCLUSION

3.1 Considering the growing interest in LRATFM and the potential benefits it can bring, as has been explored in the CANSO white paper, the Conference is invited to note the information presented in this paper.

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APPENDIX

Key Excerpts and Summary from the *Long-Range ATFM Concept White Paper*

Long-Range ATFM (LRATFM) Objectives

The initial LRATFM concepts explored by ANSPs were developed to solve specific problems within their ATFM systems. It is for this reason that LRATFM is often interpreted differently by different stakeholders. The understanding of what is meant by LRATFM depends on the history, expectations, and perspectives of stakeholders. Some of the most common definitions of LRATFM are:

- The application of ground holding to manage demand at a constrained en-route waypoint or airspace sector.

- The integration of ground and airborne delays to manage arrival demand at a constrained airport. In this context, LRATFM focuses on the interplay between Calculated Take-Off Time (CTOT) and CTOT-exempt flights.

- The application of dynamic routing to manage demand at a constrained en-route waypoint or sector of airspace in adverse conditions.

There have been several existing approaches and trial implementations of LRATFM with different objectives, namely:

- In the Bay of Bengal, BOBCAT was introduced to manage air traffic flow more effectively through airspace with severe capacity restrictions.

- In the United Kingdom, NATS XMAN was developed to assist with the distribution of delays into a more fuel-efficient phase of flight and effectively sequence aircraft into congested airspace around high-demand aerodromes.

- In Asia-Pacific, Airways (New Zealand) and CAAS (Singapore) initiated trials to determine if there was a concept that would enable increased predictability of long-haul arrival estimates and integrate them into current ATFM measures.

- In Australia, Airservices Australia has determined that LRATFM will be implemented as an enhancement to their domestic ATFM applications, by extending demand and capacity management to international flights. Their LRATFM concept involves extending the point of intervention for in-bound long-haul flights out to approximately 4 hours through the assignment of Calculated Time Over (CTO) at arrival waypoints.

These approaches and trials of LRATFM are designed to address similar problems and hope to result in similar outcomes. Key recurring problems usually include the equitable distribution of delays throughout the network and increased predictability of arrival aircraft to allow integration into current ATFM systems.

Definition of LRATFM

In the White Paper, LRATFM is defined as a subset of ATFM to meet this requirement:

"The integration of ATFM solutions to deliver a collaboratively balanced flow of long-haul and short-haul aircraft to an ATM resource (airport, waypoint, or a sector of an airspace)."

Collaborative data and/or information exchanges between ANSPs and airspace users are critical in identifying demand through airspace or impacted airports to help identify the need for LRATFM. The establishment of two-way data/information exchanges between ANSPs and/or ANSPs and airspace users increases the situational awareness of all participants in LRATFM and provides for collaborative decision-making with the most accurate information available.

Potential Benefits of LRATFM

Well-implemented LRATFM can provide added benefits to ATM operations and the environment. Below are some potential benefits:

- **Predictability:** Improved data sharing between airspace users and ANSPs, along with integrated decision support tools, can help to manage demand around key constraint points in the affected airspace or airport. The improved data sharing also allows for greater adherence to flight schedules. The well-managed demand and schedule adherence deliver improved predictability of aircraft movement on the day-of-operation.

- **Equity:** Distribute delay among all airspace users rather than forcing only domestic or regional airspace users to absorb most of the required delay. This also allows for the delays to be spread across a larger number of flights, thereby reducing the delay assigned to each flight.

- **Environmental Efficiency:** More efficient end-to-end times will decrease the overall miles flown by reducing vectoring and airborne holding. This will lead to less fuel burn and a smaller carbon footprint for every flight.

- **Reduced Fuel Costs:** More reliable end-to-end aircraft times provide airspace users more opportunities to make better business decisions concerning fleet management and fuel loading.

- **Enhanced Safety:** The ability to plan for demand in a sector of airspace reduces controller workload and enhances safety. Aircraft will arrive at an airspace or airport where demand is exceeding capacity in an efficient and controlled manner, thereby reducing complexity and enhancing safety.

- **Airspace Efficiency:** Increased predictability on the day-of-operations allows flights to absorb delays caused by merging and sequencing in a more fuel-efficient manner. For example, delays that are typically absorbed via holding, low-altitude vectors, excessive speed control, and long down-winds in the current system will be shifted further upstream and absorbed via more efficient means such as speed control, vectors at higher altitudes, or controlled time of departure at the airport of origin.

- **Surface Management Efficiency:** By having a controlled time over (CTO) an en-route waypoint/fix or at an airspace boundary, an associated controlled time of departure can be determined, which will lead to more efficient surface flows and reduced wait times in physical departure queues at departure airports. Gate holds can be used instead of extended taxi times to help manage the departure flow and surface congestion more efficiently.

- **Reduced ATC Workload:** Unplanned or no-notice holding, excessive speed control, and vectoring are workload-intensive and can distract ATCOs from performing other critical tasks. LRATFM is one of many ATFM solutions that can facilitate an orderly flow of traffic that can be managed safely and efficiently.

- **Dynamic Use of Airspace:** Demand and capacity imbalances can be identified and ATFM measures implemented to avoid congested or constrained areas. ATC's vectoring of aircraft off their planned routes can be reduced, and the protection of airspace in case of airborne holding is minimised, allowing for more efficient usage of the airspace. Increased availability of airspace can enhance the opportunities for airspace design that will facilitate continuous descent and continuous climb operations wherever possible.

- **Flight Planning Flexibility:** LRATFM, in conjunction with Airport-Collaborative Decision Making (A-CDM), can enable increased collaboration regarding airspace user trajectory preferences and can help shape customised, business-friendly solutions to airspace and airport constraints. The increased emphasis on strategic planning and the capability for airspace users to submit flight preference information means more flexibility for airspace users in how constraints are managed.

Model LRATFM Scenario

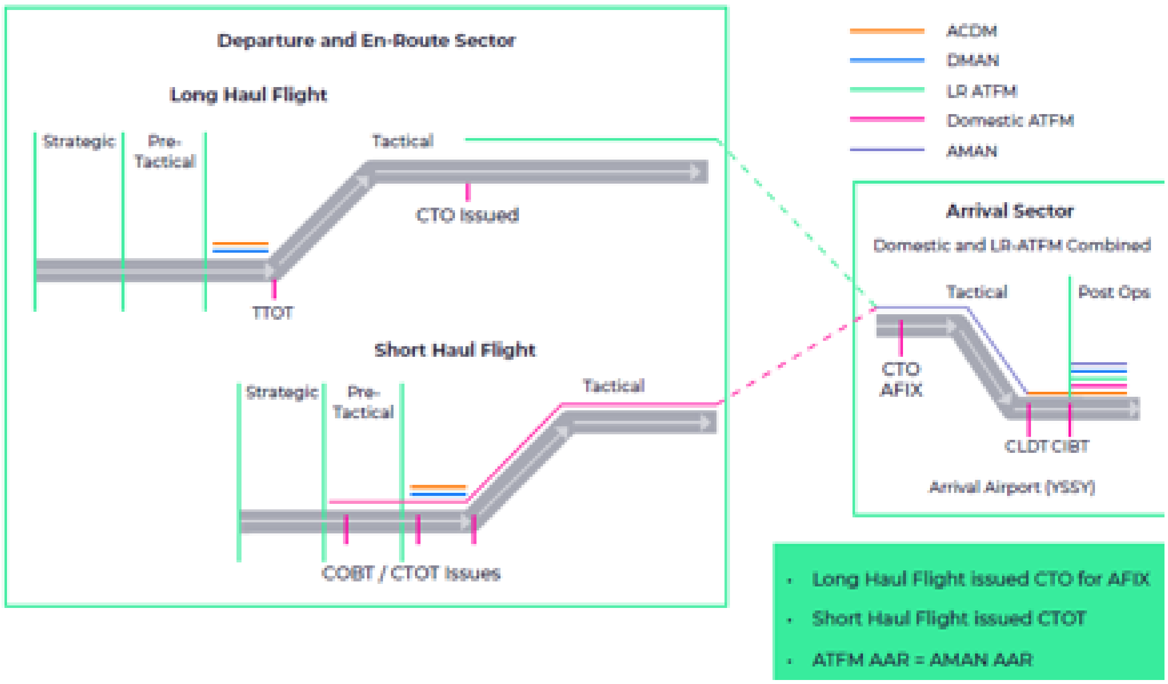
In this model LRATFM scenario, a capacity and demand imbalance has been identified at an aerodrome several hours in advance, requiring ATFM solutions to be implemented.

Not-yet departed inbound aircraft will be subject to a Ground Delay Programme (GDP), and inbound aircraft already airborne will be subject to a LRATFM solution. A combined ATFM programme, generating Calculated Take-off Times (CTOT) and Calculated Times Over (CTO) will be facilitated by a tool to assign required delays to both airborne and on-ground aircraft.

The amount of delay that can be allocated to airborne aircraft through LRATFM is restricted to what can be realistically achieved through speed reduction for the remainder of the flight. For these aircraft, the CTO with which to comply when passing over a downstream waypoint will be sent from the issuing ATFM authority to the ATS units that have jurisdiction of the aircraft, ideally through technological infrastructure based on the System-Wide Information Management (SWIM) concept. The CTO is subsequently passed to the flight crew by ATC using VHF/HF or Controller-Pilot Data Link Communications (CPDLC).

The flight crew will then adjust the cruise strategy to meet the CTO. By applying the LRATFM solution, the flow of long-haul aircraft managed by the CTO is now being pre-conditioned prior to arrival.

In conjunction with the flow of short-haul aircraft managed by the GDP, the combined flow of long haul and short haul aircraft should align with the acceptance rate at the aerodrome. The result of this method of demand and capacity balancing is a decreased need for ATC to assign significant additional airborne delays and for most aircraft to be able to progress along an efficient descent profile to their destination.


Departure and En-Route Sector
Long Haul Flight
Strategic
Pre-Tactical
Tactical
CTO Issued
TTOT
Short Haul Flight
Strategic
Pre-Tactical
Tactical
COBT / CTOT Issues
ACDM
DMAN
LR ATFM
Domestic ATFM
AMAN
Arrival Sector
Domestic and LR-ATFM Combined
Tactical
Post Ops
CTO
AFIX
CLDT CIBT
Arrival Airport (YSSY)
Long Haul Flight issued CTO for AFIX
Short Haul Flight issued CTOT
ATFM AAR = AMAN AAR

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