International Civil Aviation Organization
South American Regional Office
Thirty-Fourth Workshop/Meeting of the SAM Implementation Group (SAM/IG/34) - Regional Project RLA/06/901
(Lima, Peru, August 24-28, 2026)

SAM/IG/34-WP/6.4
14/08/2026

Agenda item 6: Other business

SAFE AND HARMONIZED INTEGRATION OF ARTIFICIAL INTELLIGENCE IN AIR TRAFFIC SERVICES (ATS)

(Submitted by Colombia)

ABSTRACT

This paper discusses the opportunities and challenges associated with the incorporation of Artificial Intelligence (AI) in Air Traffic Services (ATS), especially in forecasting, decision support, capacity and demand management, conflict detection, safety analysis and digital surveillance. A harmonized approach based on safety, effective human oversight, human factors, traceability, data governance, cybersecurity, interoperability and lifecycle validation is proposed. It is also proposed to initiate coordinated work to identify use cases, classify risks and develop common criteria that can serve as input to the competent ICAO technical bodies.

References:	Chicago Convention; Annexes 11 and 19; Doc 4444 (PANS-ATM); Doc 9750 (GANP); Doc 9854; Doc 9859; A42-WP/234; A42-WP/489.

1. INTRODUCTION

1.1 The digital transformation of aviation is expanding the use of advanced data analytics, machine learning and Artificial Intelligence in processes related to air traffic management. Among the applications of greatest interest to air navigation service providers (ANSPs) are demand forecasting, capacity management, optimisation of arrival and departure sequences, early detection of conflicts, analysis of safety events and decision support tools.

1.2 Initiatives on the responsible and strategic integration of AI in international civil aviation, including the need for cooperation, harmonization, use case analysis and progressive development of guidance, were presented during the 42nd ICAO Assembly. These initiatives constitute relevant antecedents, and the presentation of a paper should not be interpreted, in itself, as a normative decision adopted by the Assembly.

1.3 The international and interoperable nature of the ATM system makes it desirable to avoid fragmented approaches. The incorporation of AI in safety-related functions requires common criteria to determine its purpose, level of autonomy, data used, expected performance, human-system interaction, contingency mechanisms, and conditions for its validation and monitoring.

1.4 The purpose of this paper is to analyse the opportunities, risks and harmonisation needs associated with the use of AI in ATS and to propose coordinated work to move towards technical and regulatory criteria compatible with the ICAO framework, maintaining an approach focused on operational safety and effective human supervision of critical functions.

2. ANALYSIS

2.1 Scope and use cases

2.1.1 AI can be used in different horizons of ATM management. At the strategic and pre-tactical level, it can support demand forecasting, capacity assessment, and sector configuration; At the tactical level, it can contribute to sequencing, pattern detection, conflict prediction, anomaly identification, and recommendations to operational personnel. These applications should initially be considered as supporting tools, with clearly defined roles, boundaries and responsibilities.

2.1.2 In the aerodrome environment, electro-optical, infrared or thermal cameras, tracking systems, digital or remote towers and other observation technologies constitute surveillance or visual support infrastructure; they are not, in and of themselves, AI systems. AI appears when analytical functions such as automatic object classification, incursion detection, pattern recognition, wildlife alerts or automated generation of supporting information are incorporated. This distinction is necessary to prevent AI requirements from being applied indiscriminately to all digital technology.

2.2 Principles for Secure Integration

2.2.1 The analysis identifies six principles that should guide any future implementation of AI in ATS:

a) operational safety as a primary requirement, demonstrating that the AI-supported function does not introduce an unacceptable risk and that its performance is compatible with operational criticality;
b) effective human oversight and unambiguous assignment of authority and responsibility, particularly when the exit from the system may influence separation, authorizations, emergency management, or other critical decisions;
c) transparency, traceability and data governance, including quality, representativeness, version control, recording of inputs and outputs and ability to reconstruct the behavior of the system;
d) cybersecurity and resilience, considering protection against data manipulation, unauthorized access, degradation of service and attacks that may affect the integrity or availability of the function;
e) interoperability, through architectures, interfaces, information and performance criteria that do not generate barriers between States, ANSPs or ATM systems; y
f) validation and monitoring throughout the lifecycle, especially for models whose performance may vary due to changes in data, operational environment or software updates.

2.3 Human factors and operational responsibility

2.3.1 The introduction of AI changes the distribution of tasks and may lead to new risks related to over- or under-reliance on automation, loss of situational awareness, degradation of skills, increased cognitive complexity or difficulties in understanding the logic of a recommendation. Therefore, the evaluation of human factors must be part of the design, validation, training and commissioning of any AI tool that interacts with ATS personnel.

2.3.2 As an initial principle, this paper proposes that critical ATS functions remain under effective human supervision and that the system enable competent personnel to understand operational status, detect anomalous results, reject or override recommendations where appropriate, and operate under contingency or safe rollback procedures. Any evolution towards higher levels of autonomy should be preceded by a framework of assurance, certification and responsibility expressly defined.

2.4 Digital surveillance and remote towers as an application case

2.4.1 Advanced visual surveillance systems can strengthen the situational awareness of the aerodrome controller through high-definition imaging, night or thermal vision, aircraft and vehicle tracking, and integrated information presentation. When they incorporate AI-based analytics, they can add detection or alert functions, for example in the event of incursions on the runway, the presence of fauna or unforeseen movements.

2.4.2 Its implementation should consider, in addition to the SMS assessment, requirements for performance, latency, integrity and image quality, availability, redundancy, operational continuity, cybersecurity, recording and traceability, contingency procedures, human-machine interface, training and maintenance of competencies. The use of AI in these platforms should be assessed as an additional functional layer and not as an automatic substitute for the requirements applicable to the ATS service or surveillance infrastructure.

2.5 Need for harmonisation and progressive development

2.5.1 The Chicago Convention, Annexes 11 and 19, PANS-ATM and ICAO documents relating to ATM and security management provide a basis for the safe delivery of services and change management. However, the application of AI raises issues that require further technical development, in particular the classification of functions by criticality, model validation, management of training and operation data, explainability proportional to risk, change control, performance monitoring and acceptance criteria for adaptive systems.

2.5.2 It is therefore considered appropriate to move forward gradually, avoiding both a general ban on these technologies and their adoption without common criteria. A risk-based approach would make it possible to differentiate low-criticality administrative or analytical tools from applications that can directly influence ATS operational decisions.

3. COORDINATED WORK PROPOSAL

3.1 It is proposed to develop a roadmap in four stages: i) inventory and classification of use cases implemented, tested or planned by States and ANSPs; (ii) identification of benefits, risks, levels of autonomy and data requirements; (iii) development of common criteria for safety, human factors, validation, cybersecurity, interoperability, training and performance monitoring; and (iv) consolidation of lessons learned and referral of results to the relevant ICAO technical bodies, where appropriate.

3.2 Initial outputs could include a matrix of AI use cases in ATS, a criticality classification scheme, minimum criteria for security and human factors assessment, data governance and cybersecurity recommendations, training guidelines, and a methodology for documenting pilots or operational demonstrations. These products would allow for a common basis to be created before more prescriptive provisions are considered.

3.3 This approach would facilitate the incorporation of innovation in a progressive and verifiable manner, preserving international interoperability and generating operational evidence that can support future standardization work or ICAO guidance material.

4. PROPOSED MEASURES TO THE MEETING

4.1 The Meeting is invited to:

a) take note of the opportunities, risks and implementation principles identified in this paper;

b) recognize the desirability of maintaining a risk-based approach, operational safety, and effective human oversight for the incorporation of AI in ATS;

c) support a coordinated survey of AI use cases in ATS, including applications deployed, in testing or planned by States and ANSPs;

d) promote the development of common criteria on safety, human factors, validation, traceability and data governance, cybersecurity, interoperability, operational continuity, training and performance monitoring;

e) consider developing a roadmap for testing, evaluation, and progressive adoption of AI applied to ATS; y

f) consider, where appropriate, the referral of identified results and gaps to the relevant ICAO technical bodies as a contribution to harmonized internationally oriented development.

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