International Civil Aviation Organization

**WORKING PAPER**

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# ASSEMBLY — 42ND SESSION

## TECHNICAL COMMISSION

**Agenda Item 23: Global Aviation Safety and Air Navigation Plans**

# THE COMPLETE AIR TRAFFIC SYSTEM (CATS) CONOPS FOR FUTURE SKIES: A STRATEGIC INDUSTRY PLAN FOR GLOBAL ATM TRANSFORMATION

(Presented by the Civil Air Navigation Services Organisation)

**EXECUTIVE SUMMARY**

This information paper presents an overview of the complete air traffic system (CATS) concept of operations (CONOPS), developed by the CATS Global Council. It expands on concepts put forth in A42-WP/341 submitted to the 42nd Session of the ICAO Assembly. While the working paper outlines specific proposals for ICAO and its Member States, this paper provides an overview of the core vision, structure, and strategic components of the CATS CONOPS.

The CATS CONOPS outlines a transformative pathway to future skies and the global air traffic management (ATM) capabilities needed to accommodate future growth, diversity of airspace users, digitalisation, and sustainability needs. It reflects a consensus developed by over 80 organizations from across the aviation industry, including air navigation services providers (ANSPs), regulators, manufacturers, researchers, and new entrants. The CONOPS outlines three progressive implementation phases.

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| *Strategic Goals:* | This working paper relates to *Every Flight is Safe and Secure, Aviation is environmentally sustainable, Aviation Delivers Seamless, Accessible, and Reliable Mobility For All* and *No Country is Left Behind.* |
| *Financial implications:* | To be determined. |
| *References:* | Doc 9854, *Global Air Traffic Management Operational Concept*<br>Doc 9750, *Global Air Navigation Plan (GANP)*<br>A42-WP/341, *Air traffic management: a global strategic imperative for future aviation*<br>https://www.futureskyvision.com/cats-conops<br>https://www.icao.int/about-icao/Council/Pages/strategic-plan-2026-2050.aspx |

## 1. INTRODUCTION

1.1 The aviation system is undergoing rapid transformation. By 2045, air traffic is projected to more than double. At the same time, emerging types of operations—including drones, eVTOLs, high-altitude platforms, and space launch and recovery missions—will place unprecedented pressure on legacy ATM systems.

1.2 To address this challenge, the complete air traffic system (CATS) Global Council, a broad industry coalition, has developed a comprehensive, forward-looking concept of operations (CONOPS) for future skies. This document aims to support ICAO, States, and industry stakeholders in developing coordinated pathways toward an inclusive, scalable, and resilient global air traffic management (ATM) system.

1.3 The CATS CONOPS is aligned with the ICAO Strategic Plan (2026–2050) and directly supports ICAO priorities related to innovation, interoperability, climate action, and global harmonisation.

## 2. THE CATS TRANSFORMATION FRAMEWORK

2.1 A central feature of the CATS CONOPS is the definition of 16 major transformations—eight foundational transformations (such as digitisation, virtualisation, and service-oriented architecture) and eight operational transformations (such as in time performance management, scalable separation, and higher levels of automation) – See the Attachment. These transformations describe the shift in how airspace will be designed, services delivered, operations conducted, and roles defined.

2.2 A significant effort was invested by the CATS Global Council to reach a shared understanding of the nature and scope of these transformations, including their potential benefits and implementation challenges. Each transformation is supported by a clear rationale as to how it contributes to building a more inclusive, automated, and resilient global ATM system.

2.3 Together, these transformations provide a common language and vision that can help States, regions, and industry actors coordinate their roadmaps, align their investments, and pursue harmonised outcomes.

## 3. A PHASED APPROACH

3.1 The CONOPS outlines three evolutionary phases, each designed to deliver what our future skies require at different points in time and representing collectively a transformation in ATM design, governance, and operational logic:

### 3.2 Phase 1: Digital information sharing and infrastructure transformation

3.2.1 Lays the foundation for future skies through digitisation and virtualisation of infrastructure. Emphasis is placed on interoperable data sharing, modular system architecture, secure networks, and early deployment of trajectory-based operations (TBO). It represents a move from fragmented to connected systems.

### 3.3 Phase 2: Advanced automation and performance management

3.3.1 Focuses on integrating automation in core functions, including separation management and flow optimisation. Human roles shift toward strategic airspace managers supported by intelligent systems. Airspace is managed based on performance, and dynamic service models begin to emerge. This phase marks the transition from human-centric to hybrid operations.

### 3.4 Phase 3: Seamless airspace

3.4.1 The final phase—seamless airspace—envisions a fully integrated, unified airspace that accommodates both traditional and emerging users, including uncrewed systems and high-altitude platforms. Building on earlier advancements, this phase introduces key transformations such as adaptive flight rules and flexible airspace structures enabled by real-time digital connectivity; advanced automation in aircraft systems to support autonomous navigation and decision-making; and dynamic, real-time separation protocols powered by advanced "detect and avoid" technologies—ensuring the safe and efficient coexistence of all types of operations.

3.4.2 Each phase builds on the previous one and provides implementation flexibility to accommodate local and regional differences while aligning with a common global vision.

## 4. HIGHER AIRSPACE OPERATIONS (HAO)

4.1 The emergence of novel operations in the upper layers of the atmosphere—such as high-altitude platforms, suborbital vehicles, reusable launch systems, and near-space activities—is increasingly challenging the boundaries of conventional air traffic management. These operations are rapidly expanding in both capability and frequency, often operating above the altitude range served by traditional airspace classifications and ATM service models.

4.2 The CATS CONOPS recognises the growing importance of this operational domain and outlines a forward-looking vision for the safe, coordinated, and sustainable integration of higher airspace operations (HAO) into the future global airspace system.

4.3 CATS proposes a strategic direction for addressing operations above traditional controlled airspace—typically above FL 600—where current regulatory and service frameworks are not fully adequate. It builds on the principle of seamless airspace, encouraging the evolution of performance-based, flexible, and interoperable approaches that enable equitable access and the safe coexistence of diverse airspace users.

4.4 By integrating HAO into the broader CATS vision, the aviation community is encouraged to anticipate and shape the evolution of global airspace, rather than reacting to emerging operations in isolation. The CATS CONOPS reinforces that the upper layers of the atmosphere must be managed as an integral part of a cohesive, performance-driven, and future-ready airspace system.

## 5. SERVICE-ORIENTED ARCHITECTURE (SOA)

5.1 As aviation systems become increasingly digital, distributed, and complex, the ability to deliver air traffic services in a flexible, interoperable, and resilient manner becomes essential. The CATS CONOPS identifies Service-Oriented Architecture (SOA) as a foundational enabler of this transformation.

5.2 SOA refers to the architectural principle of designing services—such as surveillance, navigation, data exchange, separation management, or trajectory negotiation—as discrete, modular components that can be accessed and integrated dynamically through standardised interfaces. This approach departs from traditional, vertically integrated systems and paves the way for more agile, scalable, and globally harmonised service delivery.

5.3 By adopting SOA principles, the future ATM ecosystem can better accommodate a wider range of users, technologies, and operating models—enhancing scalability, efficiency, and innovation without compromising safety or sovereignty. This shift is particularly relevant for global and regional service provision models, including cross-border data services, virtual centres, and federated networks.

5.4 The CATS CONOPS invites ICAO and its Member States to accelerate work on global interoperability frameworks, service interface standards, and performance requirements that enable the implementation of SOA at scale. Doing so will not only modernise existing ATM infrastructure but also unlock the flexibility and modularity required to support tomorrow's aviation ecosystem.

## 6. **STRATEGIC ACTION AREAS**

6.1 The CATS CONOPS identifies six strategic action areas for which focussed collaboration is necessary to guide the transformation of ATM:

a) Securing the economics of change: Exploring sustainable financing and incentive models to enable system upgrades and equitable cost distribution.

b) Transforming regulatory frameworks: Addressing regulatory gaps through adaptive, risk-based frameworks that account for automation, AI, and new operational roles.

c) New airspace service models: Introducing flexible, modular, and virtualised service provision—including cross-border and regional service models.

d) Human performance and trust in automation: redefining human roles, ensuring competence, and strengthening human-machine teaming in increasingly automated systems.

e) Leveraging research, innovation and AI: Establishing pathways to maturity for emerging technologies and strengthening collaboration across R&D ecosystems.

f) Real-time, data-driven performance management: Enabling dynamic system monitoring and adaptation using trusted performance data.

## 7. **CONCLUSION**

7.1 The CATS CONOPS provides a comprehensive roadmap to transform ATM, ensuring a safe, efficient, and sustainable future. By aligning with the strategic goals of ICAO and embracing innovative technologies, stakeholders can collectively achieve a connected and resilient airspace system.

7.2 The CATS CONOPS is more than a roadmap; it is a collective call to action. It urges States, industry, and partners to accelerate the transformations required to ensure that aviation remains a cornerstone of global mobility, economic growth, and environmental sustainability.

## 8. ATTACHMENT:

8.1 CATS CONOPS For Future Skies full document: https://www.futureskyvision.com/cats-conops.

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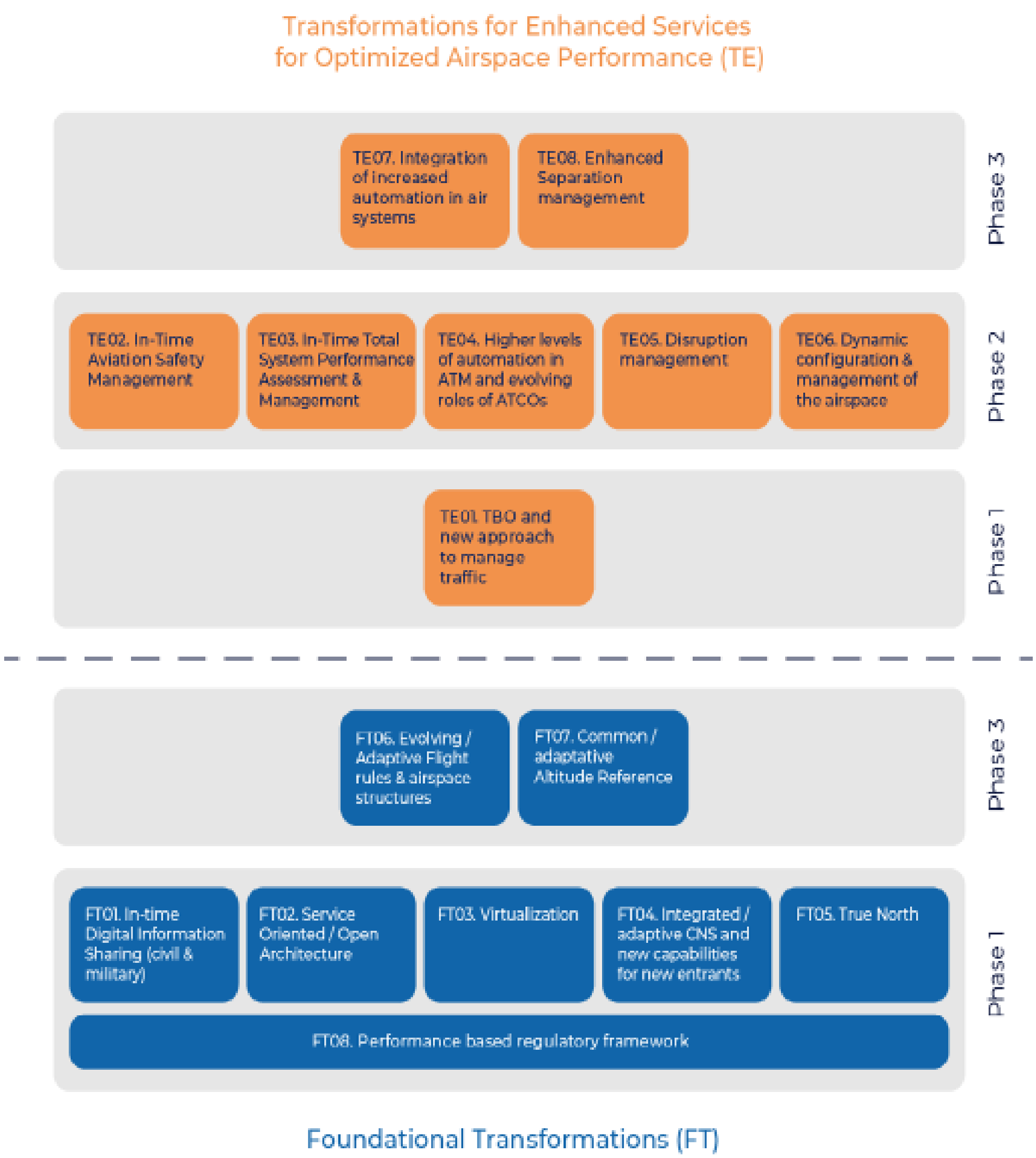
## APPENDIX A

## KEY TRANSFORMATIONS IN ATM

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