International Civil Aviation Organization

Sixth Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (APAC ATMAS TF/6)

Bangkok, Thailand 2-4 June 2025

AGENDA Item 5: ATM Automation System Implementation Experience by States

ANS ARCHITECTURE DESIGN – KEY TO FLEXIBILITY AND INTEROPERABILITY

Presented by Civil Aviation Authority of Singapore

1. INTRODUCTION

1.1 This paper presents architecture design principles to ease the integration of system upgrades and ensure interoperability across various systems. The aviation industry is experiencing rapid transformation, driven by increasing air traffic, technological advancements, and evolving operational requirements. However, Air Navigation Services (ANS) system architecture is traditionally based on closed system architecture which constraints system upgrade options and adoption of new technologies to address new operational requirements as well as interoperability with other systems. As Air Navigation Service Providers (ANSPs) plan for the next generation of ANS systems, they are urged to adopt architecture design principles in developing ANS systems that would be resilient, adaptable and future-ready.

2. DISCUSSION

Key Challenges

2.1 ANSPs face several challenges in planning and implementing next-generation ANS systems:Growth in Air Traffic Volume - The International Civil Aviation Organization (ICAO) projects that air traffic will double by year 2050. This significant growth necessitates the development of systems capable of handling increased traffic efficiently and safely.

2.2 New Operational Requirements - The advent of new concepts of operations (ConOps) and the need for system interoperability, such as Flight and Flow Information for a Collaborative Environment (FF-ICE) and Digital NOTAM, require ANS systems to be adaptable and capable of integrating diverse technologies.

2.3 Airspace Complexity - The proliferation of electric vertical takeoff and landing (eVTOL) aircraft, remote-piloted aerial vehicles, and high-altitude vehicles adds complexity to airspace management. ANS systems must be designed to accommodate these new types of aircraft and their unique operational requirements.

2.4 Climate Change - Climate change is expected to increase the frequency and severity of disruptions in air traffic. ANS systems must be resilient and capable of adapting to these changes to ensure continuous and safe operations.

2.5 Technological Advancements - Rapid advancements in information technology, including big data, artificial intelligence, and cloud technology, lead to fast obsolescence of existing systems. ANS systems must leverage these technologies to remain relevant and effective.

2.6 Cybersecurity Threats - Enhanced connectivity and integration of systems increase the risk of cybersecurity threats. ANS systems must be designed with robust security measures to protect against these threats.

Lessons from Monolithic / Closed System Architecture

2.7 Systems with monolithic and closed system architectures have proven to be costly and lengthy to upgrade and integrate. Future ANS systems need to be flexible, interoperable, and amenable to continual improvements to tackle obsolescence and evolving cyber threats in a cost-effective way.

Architecture Design Principles

2.8 This paper outlines four key architecture design principles recommended for future ANS systems.

2.8.1 Modularity- Allows for the incorporation of new technologies and capabilities independently, enabling updates or fixes without affecting other systems. This principle increases system safety and ease of upgrades by distinguishing between safety-critical and non-safety-critical components.

2.8.2 Open Interfaces & Common Data Exchange Standards - Using proven solutions and mechanisms for information exchanges reduces integration effort through standardization. Common data exchange standards and protocols, such as Aeronautical Information Exchange Model (AIXM), Flight Information Exchange Model (FIXM), and Weather Information Exchange Model (iWXXM), enable the integration of diverse technologies.

2.8.3 Security-by-Design - Ensuring consistent policies and procedures throughout the system's lifecycle establishes a robust network security perimeter and reduces the risk of attack propagation via data exchanges. This principle prepares ANS systems for the evolving landscape of cybersecurity threats and increased connectivity.

2.8.4 Continuous Innovation - A sand-boxed environment that closely mirrors the production configuration allows for experimentation without impacting live operation. This principle allows realistic validation and verification of systems, including integration testing, and drive the development of new ConOps through a data-driven approach.

Singapore's Next Generation ANS Systems

2.9 Singapore's next-generation ANS system architecture emphasizes modularity, interoperability, and cybersecurity. The high-level architecture translates to design includes modular components, common data exchange standards, and robust cybersecurity measures. This approach facilitates system integration from different vendors, minimizes vendor lock-in, supports new ConOps, increases cybersecurity posture, and offers long-term cost savings.

Conclusion

2.10 Digital transformation is happening in the aviation industry, and ANSPs must consider adopting architecture design principles to develop future-ready ANS systems. These principles provide a robust foundation for flexible, interoperable, and resilient systems that can tackle obsolescence, support innovation, and ensure long-term cost savings. ANSPs and the industry are encouraged to share thoughts and plans for digital transformation to enhance interoperability and resiliency of ANS systems.

3 ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matter as appropriate

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