



**WORKING PAPER**

**FOURTEENTH AIR NAVIGATION CONFERENCE**

**Montréal, Canada, 26 August to 6 September 2024**

**Agenda Item 4: Hyper-connectivity of air navigation system**

**4.1: Connected aircraft concept and associated challenges**

**HYPERCONNECTED ATM**

(Presented by International Coordinating Council of Aerospace Industries Associations (ICCAIA) and Civil Air Navigation Services Organisation (CANSO))

**EXECUTIVE SUMMARY**

“Hyperconnected ATM” is a new aeronautical communication concept whereby non-safety “off-the-shelf” air-ground links that are available in an aircraft could be used in addition to safety links (e.g., VDL-2) to support safety communications. The solution relies on mechanisms to detect loss or degradation of the connectivity through the commercial non-safety links and to automatically and promptly revert to using the available safety link(s) when needed. This routing concept leverages commercial non-safety communication systems infrastructure where and when possible, as it exists, along an opportunistic approach, and changes back to using the safety infrastructure where and when necessary.

This paper introduces the technical principles of the “Hyperconnected ATM” approach, presents some of the envisioned benefits and brings initial considerations for solving the main challenges.

**Action:** The Conference is invited to agree to the recommendation in paragraph 3.

**1. INTRODUCTION**

1.1 The ongoing modernization of air traffic management requires efficient air-ground datalink with sufficient resources to accommodate the air traffic growth with current and future datalink services exchanges between air and ground ATM components and actors.

1.2 The capacity of current communication links used for safety communications is already reaching its limit and is probably not sufficient to support this transformation in the medium/long term. Although new systems are being standardized by ICAO (such as L-band Digital Aeronautical Communications System (LDACS), Aeronautical Mobile Airport Communications System (AeroMACS)), these may not be deployed globally, or be installed on many aircraft in time to support the transition.

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<sup>1</sup> Arabic, Chinese, English, French, Spanish and Russian versions provided by ICCAIA and CANSO.

1.3 At the same time, aircraft are increasingly equipped with commercial cabin connectivity systems, providing broadband communications access that support both the passenger experience, and aircraft operations. The multiple, emerging, satellite mega constellations, combined with the latest geostationary earth orbit (GEO) very high throughput satellite (VHTS) technologies, and with 4G/5G terrestrial solutions available at airports (International Mobile Telecommunications solutions) and en-route (“air-to-ground” solutions) are bringing massive capacity.

1.4 A new and evolving communication model, called “Hyperconnected ATM”, is being defined, with the objective to allow using this commercial cabin connectivity in addition to safety protected spectrum links. Dedicated mechanisms would allow using such commercial cabin connectivity systems and links, to convey safety communications.

1.5 This paper introduces the technical principles of the “Hyperconnected ATM” approach, presents some of the envisioned benefits and brings initial considerations for the resolution of the main challenges.

## 2. CONCEPT DESCRIPTION

2.1 The “Hyperconnected ATM” solution is a concept, whereby cabin commercial non-safety aircraft connectivity systems (e.g., Ka/Ku broadband Satcom, 4G/5G airport and direct air-to-ground terrestrial systems) are used in addition to the safety links (e.g., very high frequency (VHF) digital link (VDL) Mode 2). The technology relies on three main functional components:

- a) a secure channel (a Virtual Private Network (VPN)) established through the commercial connectivity systems from a trusted domain in the aircraft to a ground trusted organisation involved in aeronautical safety communications (e.g., a Communication Service Provider);
- b) a performance and status monitoring function that continuously monitors the availability and performance of this secure channel and can detect its loss or performance degradation in a timely manner; and
- c) a “switch with reversion” function that takes the decision to use (or not) the commercial connectivity for the transfer of each safety message, and can promptly retransmit over the safety links in case a message attempted to be sent over a commercial connectivity system was not received.

2.2 The “Hyperconnected ATM” concept leverages commercial connectivity systems whatever the technology they are using, with no impact and no new specific requirements on these systems and services.

2.3 With the “Hyperconnected ATM” concept, safety links remain required, with a capacity potentially adapted to take into account the traffic that can be offloaded on different commercial links in nominal conditions, and to manage the risk of having this offload traffic failing to be successfully transmitted.

2.4 It is anticipated that Hyperconnected ATM will bring benefits on the following fronts:

- a) Capacity: the Hyperconnected ATM technology has the potential to provide additional capacity needed for future ATM needs, which remain significantly low compared to

the capacity needs for usual commercial purpose, in complement to the legacy and future safety links.

- b) Timely implementation: the Hyperconnected ATM technology has the potential to be deployed in a timely manner, as aircraft and ground modifications required are assumed to be relatively simple (e.g., possibly software upgrades only), and it relies on existing safety and non-safety physical links.
- c) Fleet penetration: this solution should allow a large and rapid penetration on the aircraft fleet given the increasing adoption rate of broadband connectivity for the cabin domain.
- d) Performance Based Communications and Surveillance (PBCS): Hyperconnected ATM technology aircraft and ground mechanisms will ensure end-to-end integrity and availability, and provide required performance, in accordance with the existing PBCS Framework. No new requirements will be imposed on either safety or commercial communications links.

2.5 The Hyperconnected ATM solution comes with challenging questions notably regarding the mitigation of cyber security risks, the demonstration of compliance to end-to-end safety performance requirements, the use on a complementary basis of “non-protected” spectrum, and the regulatory impacts. First studies of these challenges did not identify any showstoppers, as it is anticipated or considered that:

- a) the cyber security risks can be mitigated with the inclusion of appropriate state-of-art security measures in the solution;
- b) end-to-end safety and performance remain ensured by the timely reversion to the use of safety links and will generally benefit from the increased path diversity and capacity; and
- c) degradations of the commercial links service can be detected and avoided or recovered by switching and retransmitting data over the safety links in a timely manner.

### 3. CONCLUSION

3.1 The Hyperconnected ATM solution brings the capability to leverage state of the art non-safety connectivity infrastructure, including those already deployed and any future innovative commercial technologies (e.g. 5G Non-Terrestrial Network (5G-NTN), 6G, ...), as a complement to safety communication links. It is an opportunity to get additional capabilities for ATM communications, at reasonable costs, which can bring a strong positive case for ANSPs and airspace users, in many geographical areas.

#### **ACTION BY THE MEETING:**

The Conference is invited to agree to the following recommendations:

That States:

- a) consider the massive communication capacity offered by recent and future commercial aircraft cabin connectivity solutions as a new opportunity to support safety communications; and

that ICAO:

- b) evaluate impacts and the need for provisions to leverage non-safety aircraft connectivity links as an additional link to current and future safety communication links, to support ATM safety communications.

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