ATM-GRADE NETWORK BY DESIGN OR BY REMEDY

Should air navigation service providers accept risks of compromises associated with using off-the-shelf communication equipment for ATM critical applications?

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As air traffic dramatically grows and as digital transformation of air traffic management accelerates, so does critical dependency on the underlying communication network.

There is no room to compromise on safety, security, and reliability when fulfilling air traffic management (ATM) operational efficiency needs and adopting new technologies in communication, navigation, and surveillance (CNS). Meanwhile, world-over, migration from legacy to packet ATM network infrastructure is underway, adding a paradigm shift that affects ATM operation. The stringent ATM network requirements challenge the established assumption of using commercial-off-the-shelf (COTS) equipment as ATM packet backbone, even when aided by an additional remedy layer, promising an "ATM-grade" solution.

As a viable alternative, ABB's proven XMC20 mission critical communication equipment is designed from the ground-up for current and future ATM CNS application needs. The XMC20 networking solution is by design ATM standard compatible and ATM application-aware, addressing ATM requirements in quality-of-service, real-time precision, resiliency, Quantum-Safe security, and inter-working across heterogeneous service provider networks.

Challenges and network needs

ANSP's face a number of daunting challenges that include a sharp increase in air traffic growth, future integration of Unmanned Aerial Systems (UAS), and dynamic security threats. When addressing these challenges, it is paramount that air traffic continues to operate in a safe and reliable manner. Increased traffic volume, linked to aircraft separation minima, cannot come at the cost of safety. More generally, addressing these challenges requires solutions that simultaneously optimise and enhance delivery, without compromise and within reasonable time and cost constraints. Furthermore, future-proof security requirements must be an integral part of, not merely a supplement to any solution. To address these challenges, the aviation industry will rely heavily on innovative technologies and digitalisation.

Many new CNS technologies with packet network dependency have been introduced. Examples include packet-based voice and data ground-air communication, performance-based navigation, and multilateration. As another example, remote virtual towers better serve multiple remote locations with a centralised yet cost-efficient approach. These technologies proliferate requirements on underlying networks. For example, networks must be application-aware, ATM standard compatible, provide service quality guarantees and provide secure real-time guaranteed performance and network-wide high-precision timing. Examples of EUROCAE standards for CNS applications with critical dependency on underlying communication network are ED137 through ED139.

There are often gaps between the performance characteristic of COTS and ATM communication network needs. COTS communication equipment is built to meet fixed-mobile infrastructure and enterprise requirements, serving consumer and common enterprise needs. Enterprise-grade COTS real-time performance varies and typically focuses on statistical performance rather than the worst case under exceptional network conditions. Resulted latency examples are in the order of tens of milliseconds and delay variations are higher than one millisecond. Packet delivery measured examples rates are at 99.9% to 99.99% (examples from Verizion Enterprise online data).

Often used in mobile backhaul applications, COTS equipment life cycle is tied to the cellular generation deployment cycle – around 10 years. In contrast, ABB's XMC20 equipment life cycle exceeds 20 years and is a true hybrid system for smooth migration of legacy to packet. In this process, unlike COTS, ABB XMC20 fulfills ATM network expectation of packet networking with real-time performance and deterministic behavior similar to legacy SDH/SONET. There is nearly a decade of delay in the wide-scale rollout of packet-based voice and other ATM CNS applications due, in part, to suboptimal gaps in quality of service guarantees linked to COTS packet networking equipment.

ABB ATM-Grade Network by Design

ABB XMC20 is by design-ATM grade and simultaneously meets and exceeds all stringent requirements of ATM

communication networks (See table). From real-time performance to high availability to long life cycle, XMC20 delivers an order of magnitude performance advantage over COTS solutions.

ANSP's focusing on ATM challenges that are critically dependent on underlying network real-time performance will be able to safely optimize and leverage new CNS technologies. As an example, ATM EUROCAE standards ED136-139 require delay <50 msec and jitter <15 msec for voice. As shown in the table, XMC20 maximum delay is <10 msec and maximum jitter is <150 µsec, leaving significant room for low-risk future CNS application needs.

The XMC20's encryption solution, SECU1, has been designed from the ground-up to ensure uncompromising real-time performance and Quantum-Safe security. It relies on a physical Quantum Random Number Generator (QRNG) as the source for cryptographic key generation . The secure key generation mechanism and implemented crypto-agility is termed "Quantum-Safe".

Unlike COTS solutions, XMC20's end-to-end integrated data encryption does not compromise critical parameters such as latency, jitter, and asymmetric delay requirements (see table). Applying encryption to system protocols requires careful design to avoid adverse effect on resiliency (OAM protocol) and network timing and synchronization precision (PTP IEEE1588v2 protocol). COTS equipment, lacking such joint optimised design, will result in real-time performance and/ or encryption compromise.

Applying this solution to ABB MPLS-TP based wide area communication networks improves the security of operational networks and removes a major hindering block in transitioning to packet switched network solutions. ❖

CATEGORY	CONDITIONS & CASES	ABB XMC20
SECURE REAL-TIME GUARANTEED PERFORMANCE, INCLUDING ENCRYPTION	Network-wide time/sync precision Acceptable end-to-end latency, jitter, and asymmetry of delay	Order of nsec. time/sync precision <10 msec latency <150 µsec Jitter Maintaining above performance numbers even with encryption
BUILT-IN MULTI-LAYER REDUNDANCY, HIGH AVAILABILITY, AND RESILIENCY	Deterministic behavior, especially under traffic and network load	**99.999%** availability Hitless and sub-50 msec. redundancy
LONG LIFE CYCLE, MEAN TIME BETWEEN FAILURE (MTBF), & RUGGEDNESS	Harsh environment	20+ Years life cycle 50+ years of MTBF -25°C...+60°C operation
SIMULTANIOUS PACKET AND LEGACY	Packet services & QoS guarantees Hybrid legacy transport and interface support	Layer 2 and 3 VPN Legacy examples: Analog, V-Series, TDM E1, and circuit emulation