



PJ14 EECNS COM Open Day <WP7 / PJ14-2-6 Completion of AeroMACS Development>

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Founding Members



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Introduction and context



- SESAR1 -> **AeroMACS Solution # 102** ->TRL6 Maturity Level assessed

- P9.16 - New Communication Technology at Airport



- P15.02.07 - Airport Surface Datalink



- SESAR2020-> AeroMACS PJ14-2-6 Solution integrated with ATN, Multilink & VoIP



Aeronautical Mobile Airport Communication System (AeroMACS) in one slide



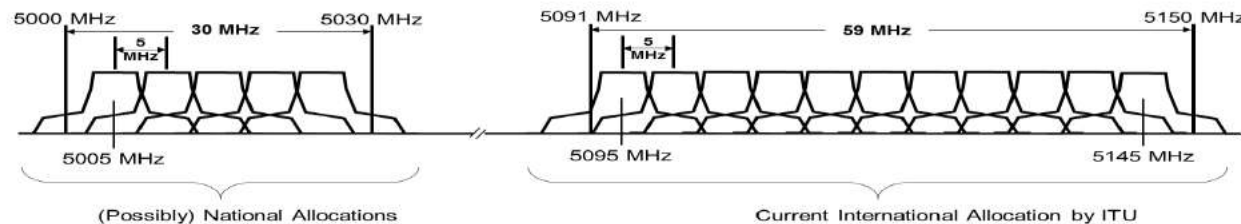
- an **internationally standardised** and **globally harmonised** broadband IP datalink for **safety and regularity of flight** communication exchanges at the **airport surface for Airports, Airlines and ANSPs**
- based on commercial 4G technology (IEEE 802.16-2009 standard)
- a **mature** and **validated solution** to support **mobile & fixed** users
- offering worldwide interoperability and integration of critical communications for ATS, AOC and Airport Authorities communications
- a component of the wider future aviation communication infrastructure (FCI), **supporting the FCI multi-link** concept
- included in the Communication Roadmap of the ICAO Global Air Navigation Plan (**GANP**) and the **European ATM MasterPlan**

AeroMACS Spectrum



AeroMACS SHALL support 5 MHz channels in the 5091 MHz – 5150 MHz band

- 5091 MHz – 5150 MHz: AeroMACS Spectrum has been **Internationally Allocated by ITU at WRC-07** in 2007 (Co-primary AM(R)S allocation)
- 5000 MHz – 5030 MHz: possible national allocations

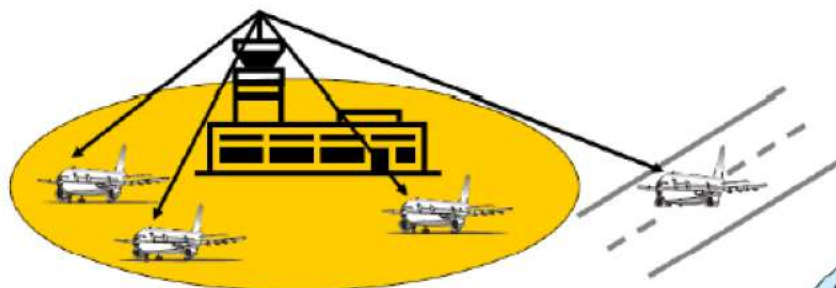


United States - Federal Communications Commission (FCC)

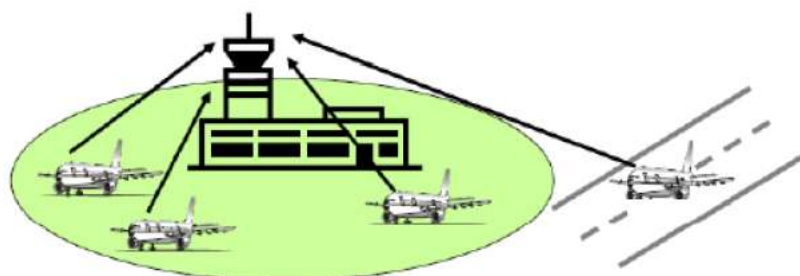
- In **2015**, the FCC starts implementation of the decisions from WRC 07 and WRC 12 with report and order for AeroMACS Spectrum
- In **2017**, the WiMAX Forum submitted a petition for AeroMACS Service Rule to the FCC. The rulemaking will facilitate the wide-spread deployment of fixed and mobile AeroMACS technology at airports within the United States to promote the safety and regularity of flight

AeroMACS Basic Scenarios

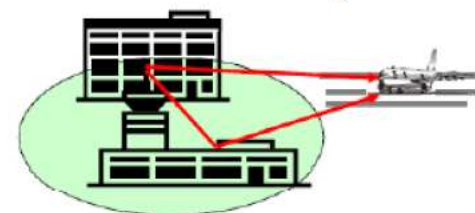
Transmission from control tower to aircrafts



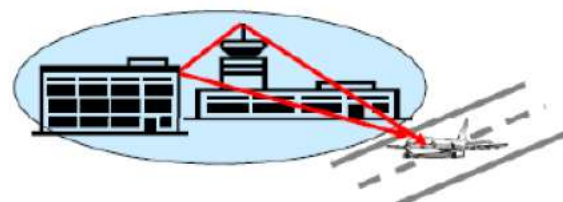
Transmission from aircrafts to control tower



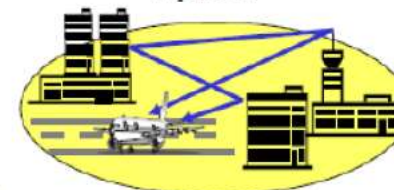
Runway



Taxi



Apron



Parking



PJ14-02-06: Objectives and Exercises



Partners:

Leonardo, Airtel and EUROCONTROL

Tasks:

- T01- International Standardisation and Harmonisation
- T02- Integration of AeroMACS within ATN
 - ATN/OSI
 - ATN/IPS
- T03- Digital Voice Communications over AeroMACS
- T04- Integration of AeroMACS A/G DL within Multilink (ATN/OSI)

Technical Validation Exercises	
EXE01	Verify the integration of AeroMACS and ATN/OSI
EXE02	Verify the integration of AeroMACS and ATN/IPS
EXE03	Verify the integration of AeroMACS and Digital Voice
EXE04	Verify the integration of AeroMACS with Multilink in ATN/OSI environment

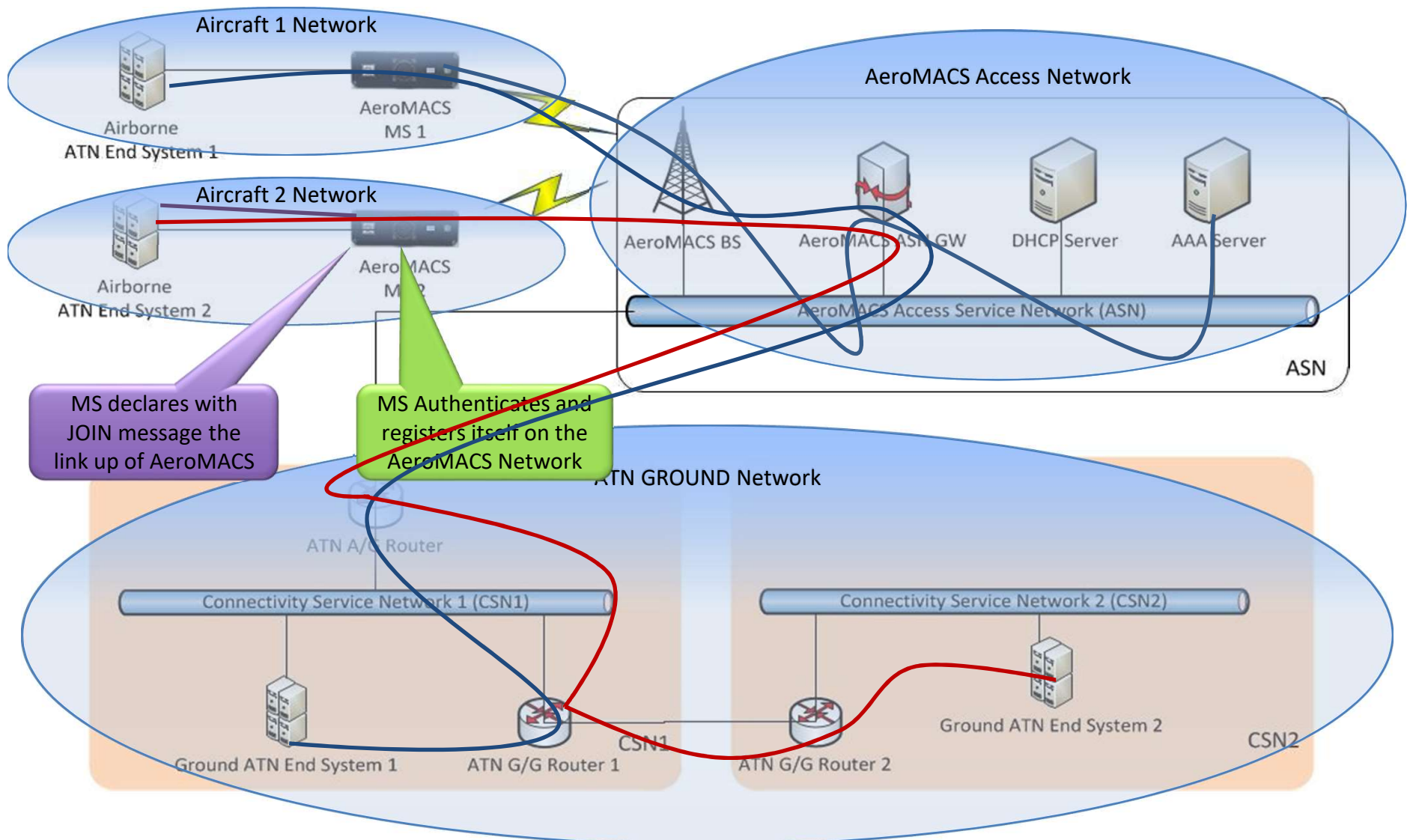
Note: integration of AeroMACS with Multilink in ATN/IPS environment is within the scope of PJ14-2-4

EXE01 - AeroMACS and ATN/OSI (1)

PJ.14 - EECNS



SESAR
JOINT UNDERTAKING

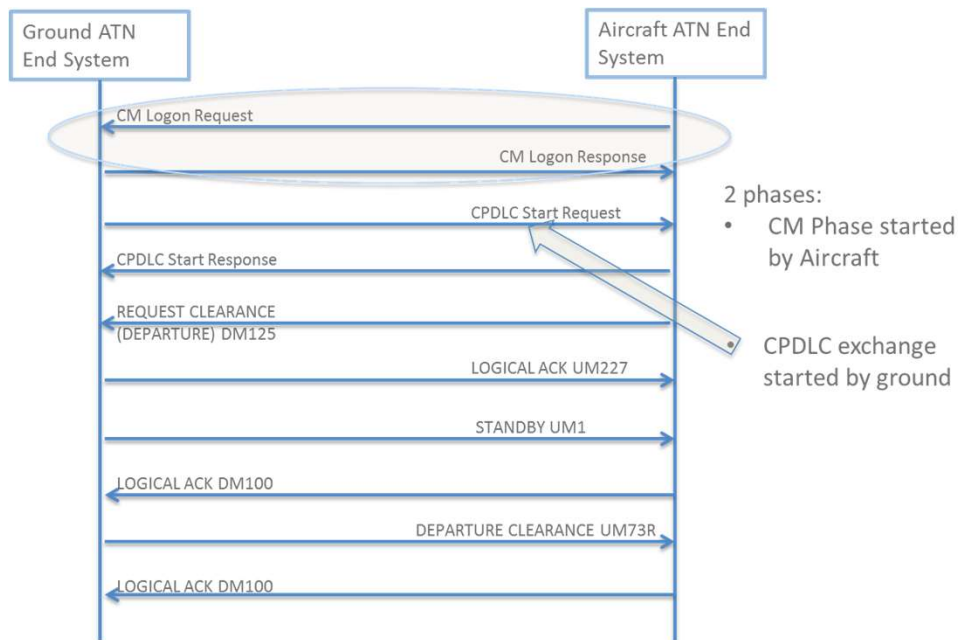


EXE01 - AeroMACS and ATN/OSI (2)

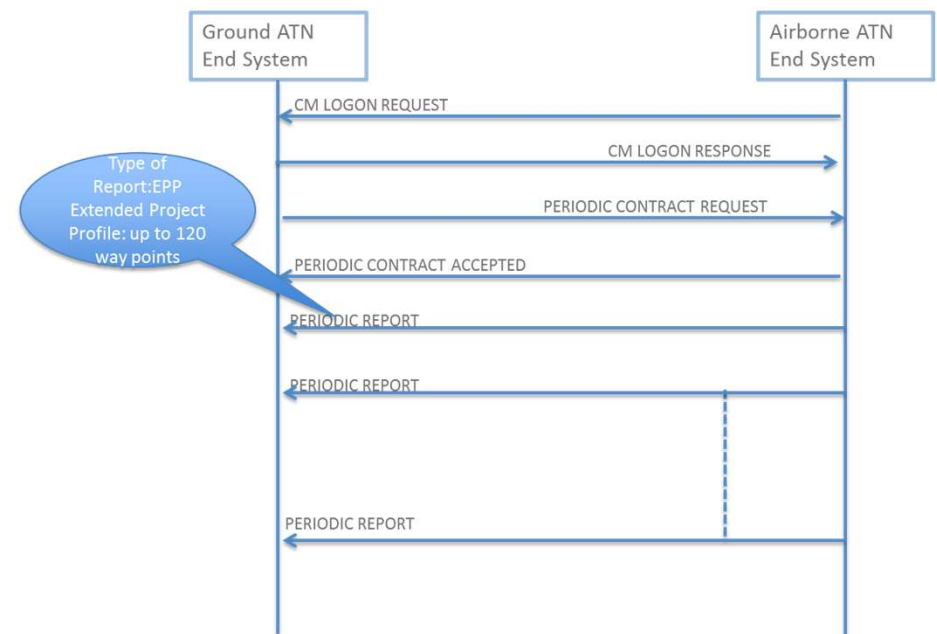
Technical Validation Methodology

- Verify end-to-end exchange of CM/CPDLC and ADS-C messages over AeroMACS in an ATN/OSI environment
- Verify B2 Transaction Times compliance (ED-228A)

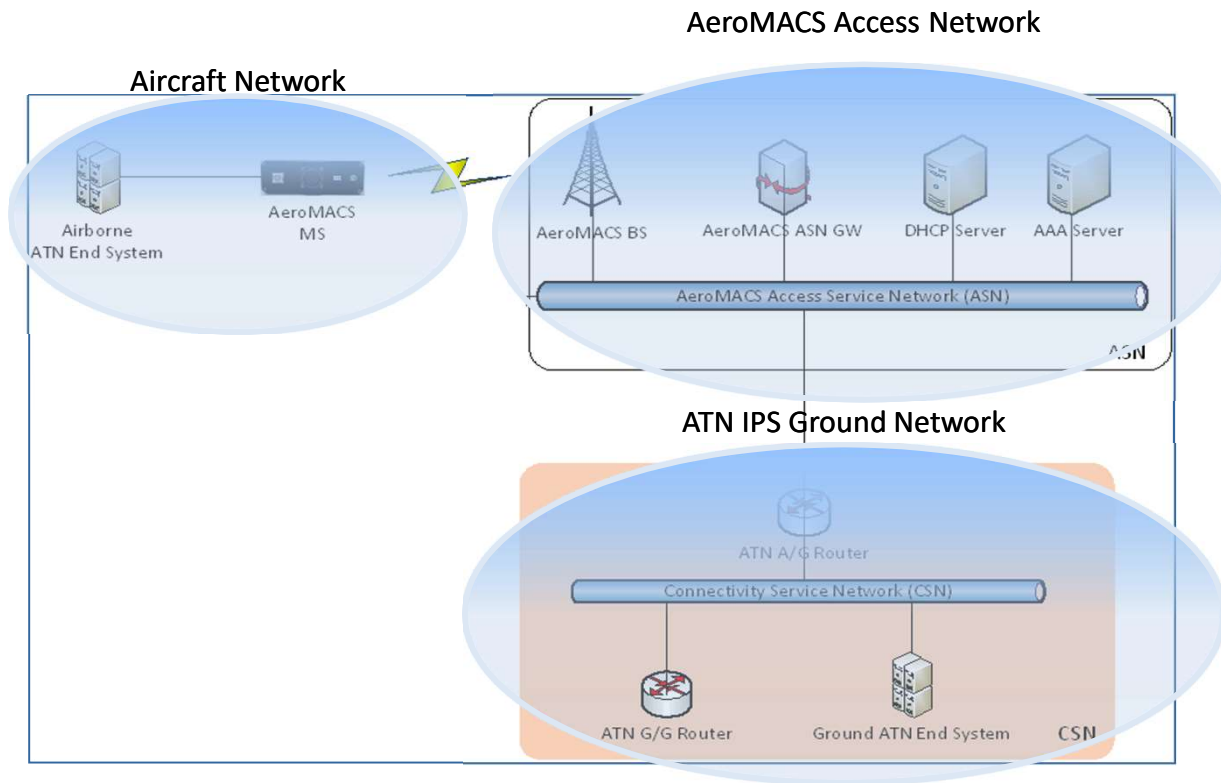
CM/CPDLC End-To-End Traffic



ADS-C End-To-End Traffic



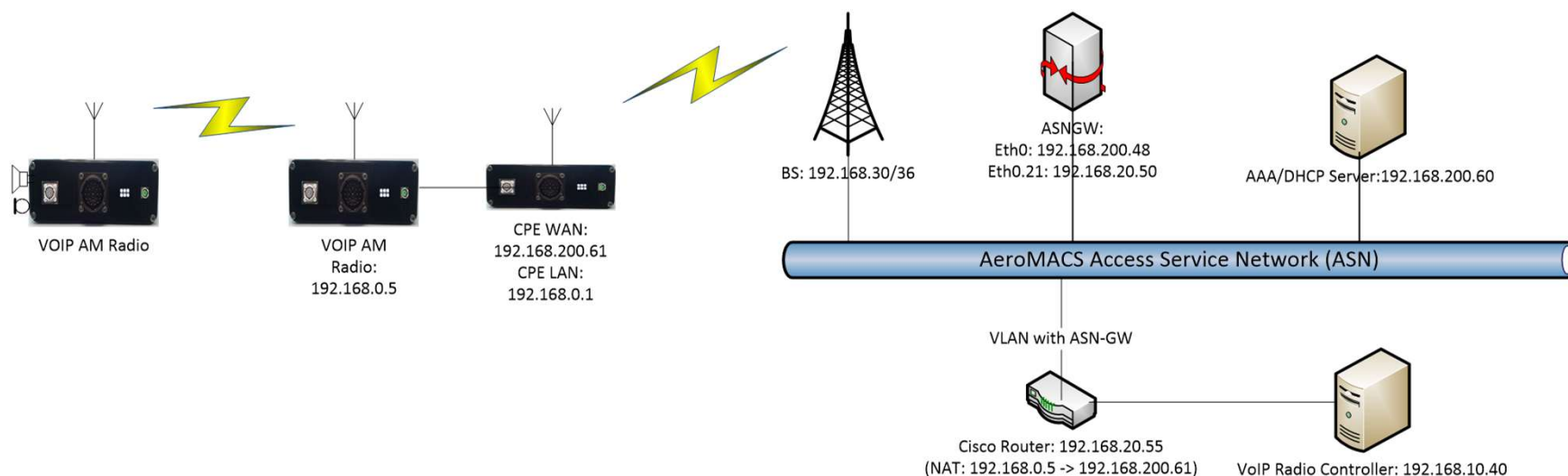
EXE02 - AeroMACS and ATN/IPS



Technical Validation Methodology

- Verify end-to-end exchange of CM/CPDLC messages over AeroMACS in an ATN/IPS environment
- Verify B2 Transaction Times compliance (ED-228A)

EXE03 - AeroMACS and Digital Voice Networks



Technical Validation Methodology

- Establish a SIP session between the VoIP Radio Controller and the remote VoIP AM Radio over the AeroMACS Link
- From the VRC, send speech and/or audio tones via PTT
- At the VoIP AM Radio, measure SIP/RTP Packet Loss and jitter

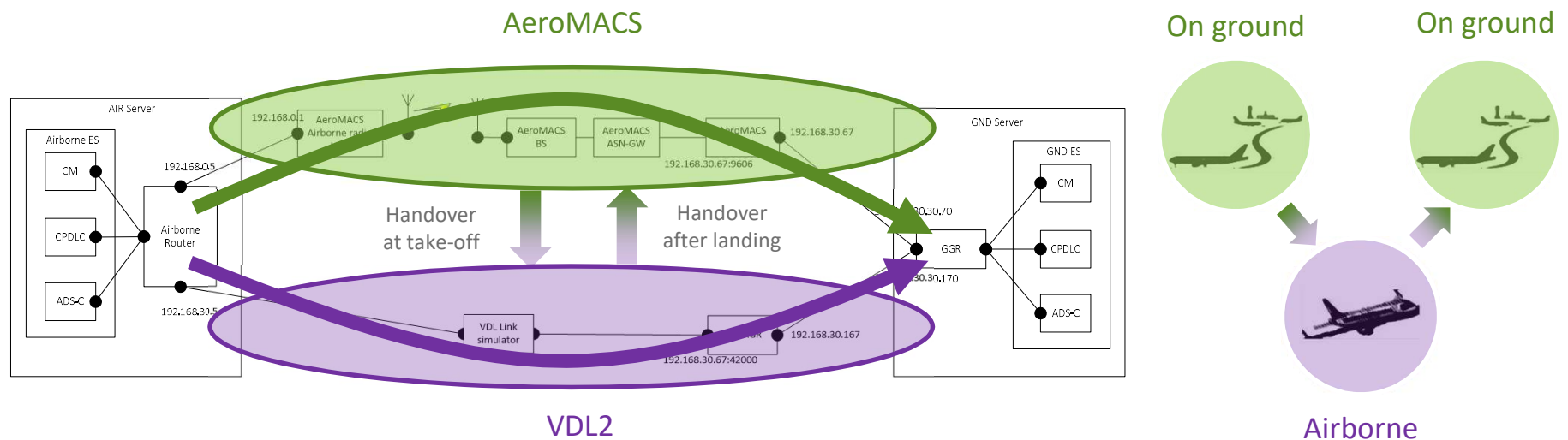
EXE04 - Integration of AeroMACS with Multilink in ATN/OSI environment



Demonstrated in Florence and Madrid at World ATM Congress

ATN B2 messages exchange along the various phases of flight

- Performing seamless “Vertical Handover” between AeroMACS and VDL2 by means of Link preference management at the Airborne Router



Technical Validation Methodology

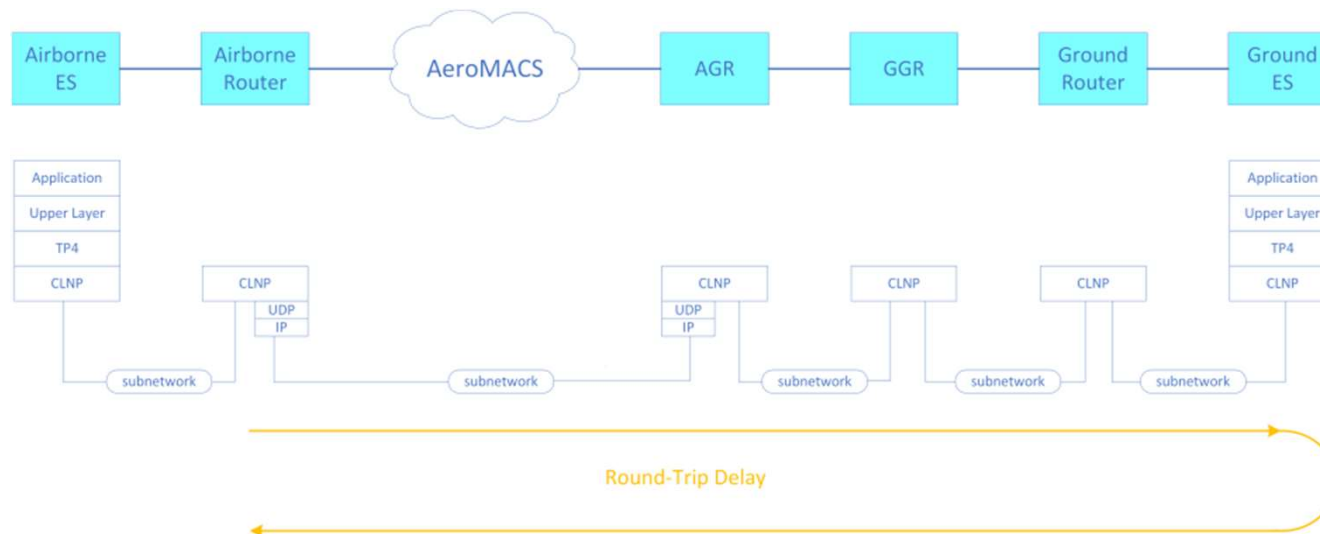
- Perform Technology Handover between AeroMACS and VDL2
- Verify end-to-end exchange of CM/CPDLC and ADS-C messages with no loss of data during Technology Handovers

Performances (1)



The following Performances were measured during the Technical Validations:

- EXE01 (ATN/OSI over AeroMACS): Transaction Time (Round Trip Delay)
- EXE02 (ATN/IPS over AeroMACS): Transaction Time (Round Trip Delay)
- EXE03 (VoIP over AeroMACS): SIP/RTP Packet Loss and jitter

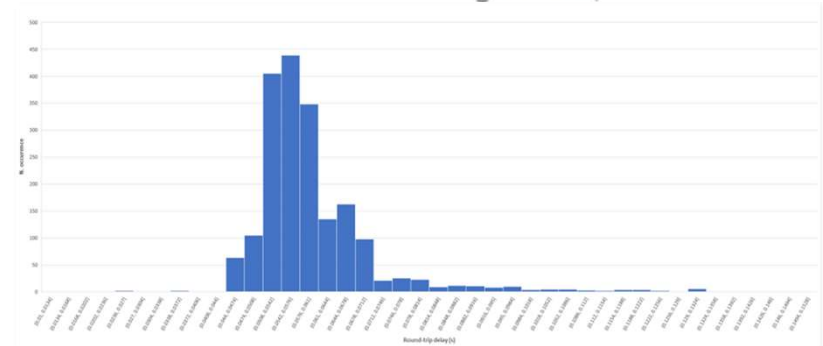


ATN/OSI over AeroMACS: Protocol Stack description

Performances (2)

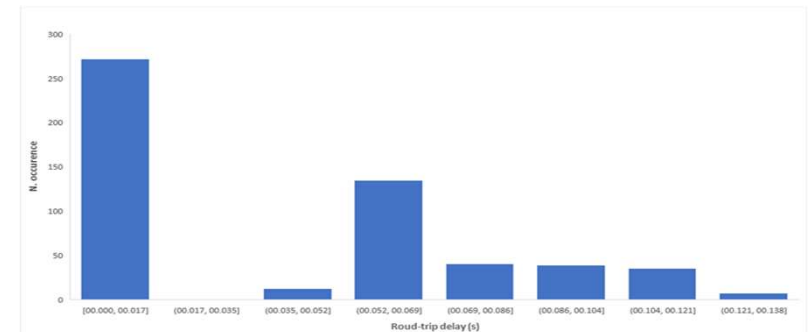


ATN/OSI over AeroMACS – Transaction Time



average TT < 58 ms

ATN/IPS over AeroMACS – Transaction Time



average TT < 46 ms

VoIP over AeroMACS - SIP/RTP Packet Loss & jitter



- Measured SIP/RTP Packet Loss < 0,05%
- Measured jitter < 10 ms

Standardization



ICAO COM Panel

- AeroMACS SARPS
- AeroMACS Technical Manual

EUROCAE / RTCA

- AeroMACS Profile
- AeroMACS MOPS

EUROCAE:

- AeroMACS MASPS

WiMAX Forum

- PICS
- CRSL
- AeroMACS PKI Certificate Policy
- AeroMACS Radio Conformance Test (RCT)
- AeroMACS Protocol Conformance Tests (PCT)

ARINC AEEC

- Form Fit and Function (FFF) avionics AeroMACS standard

ETSI (ongoing)

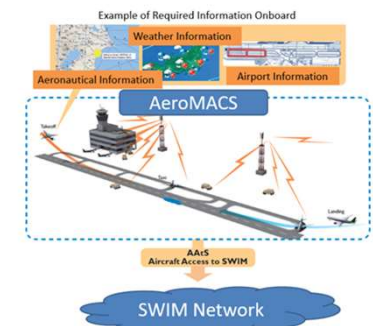
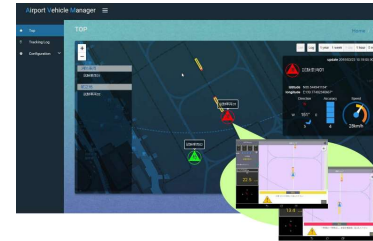
- TG_AERO development of:
 - Harmonized European Norm (EN) covering the essential requirements of article 3.2 of the Radio Equipment Directive (RED) for AeroMACS
 - AeroMACS Community Specification for compliance with the Essential Requirements for ATM/ANS and air traffic controllers, contained in the EASA Basic Regulation (EU) 2018/1139, following EC Mandate M/524

AeroMACS – International Developments (1): Japan and Brazil



Japan:

- Information Paper – ICAO WG-I 26th Meeting
- Deployments in several airports including Sendai and Haneda
- SWIM over AeroMACS Demonstrators
- D-TAXI, A-SMGCS, Geo-Fencing



Brazil:

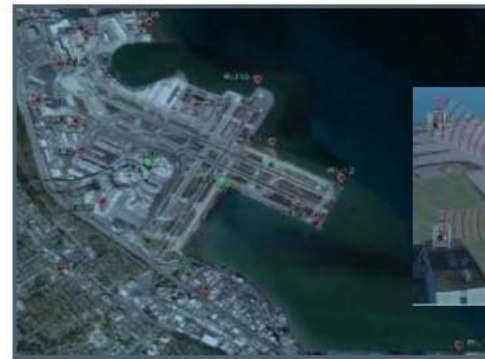
- Galeão International Airport - Rio de Janeiro
- Fixed Service (Multilateration) + Mobile Services (Vehicles)



AeroMACS – International Developments (2) - United States



CLE - Cleveland Airport - NASA



SFO - San Francisco Airport



FAA Airport Surface Surveillance Capability (ASSC)

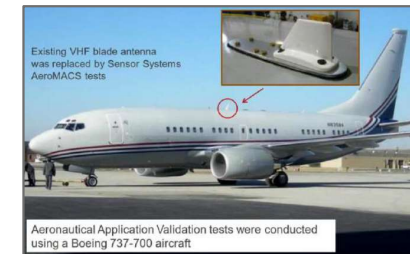
FAA Enterprise Network Services (FENS) Program

- AeroMACS has been deployed at 12 airports in US
- ASSC contract at 9 airports, and 3 support systems
- With options for up to 58 more to leverage airport surface detection equipment

By courtesy of WiMAX Forum

AeroMACS – International Developments (3) - China

- Chinese AeroMACS frequency is centrally controlled and the licenses are released by State Radio Regulatory Commission (SRRC) and CAAC
- ADCC (Aviation Data Communication Corporation) has been formally authorized AeroMACS frequencies in 2017 to setup **110** airports with AeroMACS network and provide services. **21** Airports have already been setup (incl. Beijing International with **14** AeroMACS base stations)
- CAAC and ADCC reported that modified procedures using AeroMACS reduced the clearance delivery time by 20 minutes per flight
- AeroMACS substantially improved operating efficiency of the Tower Control as well as overall integrity of the clearances
- Trials: D-TAXI, SWIM & Surface vehicle surveillance and navigation
- Information Paper - ICAO Air Navigation Conference 13



By courtesy of WiMAX Forum

AeroMACS – International Developments (4) - Europe

- Lisbon Airport: AeroMACS fully operational (February 2019)
- Airport fixed services
- Vehicle applications

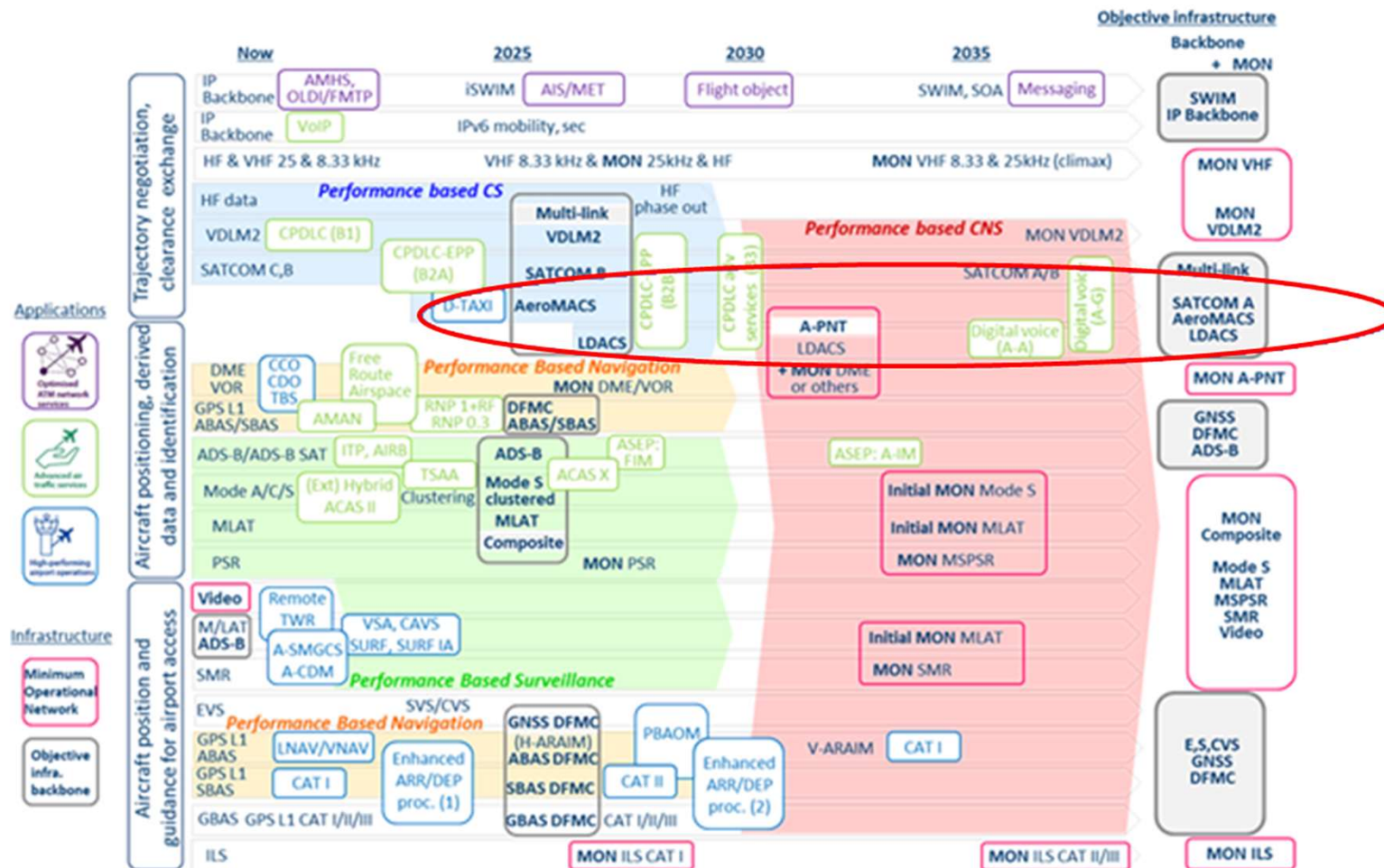


Regulatory - Frequency Allocation

Name	Frequency [MHz]	Site
F1	5100	CAP Central 1
F2	5105	SLCI 2
F3	5110	Porta 141
F4	5115	CAP Sul 1
F5	5120	CAP Central 2
F6	5125	CAP Sul 2
F7	5130	CAP Norte
F8	5135	SLCI 1

AeroMACS in CNS Roadmap (14-1-1)

PJ.14 - EECNS



Conclusions



- The Exercises executed within the Solution allowed to technically validate the integration of AeroMACS with any ATN System, including Multilink, and VoIP.
- AeroMACS is mature for supporting any ATM Solution in Airport, allowing the following benefits:
 - Higher throughput for airport surface communications
 - Reduction of congestion of VHF spectrum at airports and delays consequently
 - Supporting integration of critical communications for all the Airport Stakeholders (Airport Authorities, ANSPs, Aus)
 - Provision of increased security capabilities
 - Enhances situational awareness on the airport's surface
 - Potential to reduce overall costs (via synergies of sharing infrastructure)



WP7 – Completion of AeroMACS Development
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Thank you very much
for your attention!



This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No [number]



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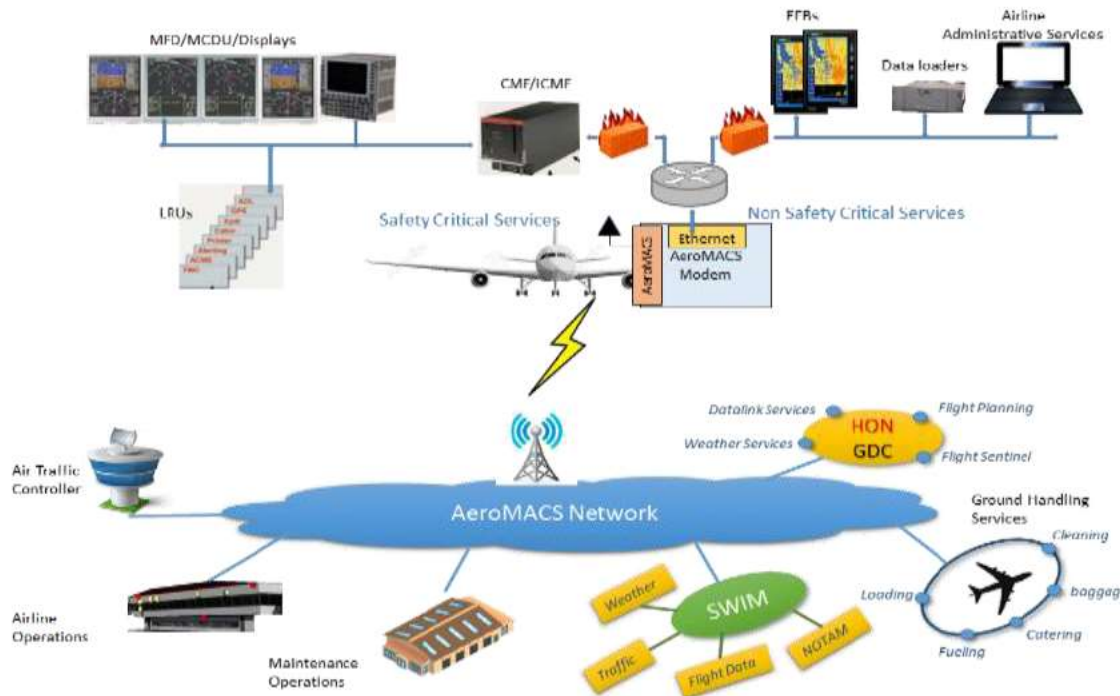
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Backup slides

AeroMACS Security

AeroMACS Public Key Infrastructure (PKI) provides the digital certificates to aircraft, ground device, and servers for strong device to device authentication. This mechanism provides the foundation for application authorization, access control, and data confidentiality



AeroMACS PKI:

- Minimizes cyber threats
- Provides efficient, reliable, and secure broadband connectivity across the entire airport footprint
- Securely collects data from fixed and mobile terminals
- Securely maintains communications with staff and aircraft

AeroMACS Throughput Performance

AeroMACS Throughput:

DL UL Ratio	QPSK 1/2	16 QAM 1/2	64 QAM 1/2	64 QAM 3/4
35:12	UL Throughput = 580 Kbps DL Throughput = 1,8 Mbps	UL Throughput = 1,1 Mbps DL Throughput = 3,6 Mbps	UL Throughput = 1,7 Mbps DL Throughput = 5,4 Mbps	UL Throughput = 2,6 Mbps DL Throughput = 8,1 Mbps
31:16	UL Throughput = 780 Kbps DL Throughput = 1,1 Mbps	UL Throughput = 1,5 Mbps DL Throughput = 3,1 Mbps	UL Throughput = 2,3 Mbps DL Throughput = 4,6 Mbps	UL Throughput = 3,5 Mbps DL Throughput = 7 Mbps
26:21	UL Throughput = 1 Mbps DL Throughput = 1,2 Mbps	UL Throughput = 2,4 Mbps DL Throughput = 2 Mbps	UL Throughput = 3 Mbps DL Throughput = 3,6 Mbps	UL Throughput = 4,6 Mbps DL Throughput = 5,5 Mbps

AeroMACS Applications Growth

