

AeroMACS

Data Link Technology for Total Airport services

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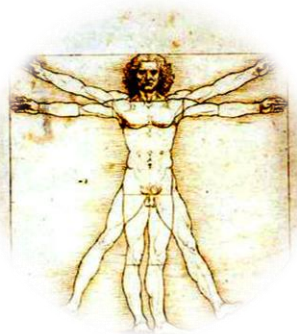
AeroMACS – Finding the roots

Origins and What are the Benefits from AeroMACS?

- AeroMACS is a Broadband wireless communication system that can support the transmission of safety and regularity of flight data for both fixed and mobile applications of the airport surface
- It is based on the mature WIMAX standard IEEE 802.16E and operate in the protected aviation spectrum band from 5091 MHz to 5150 MHz.
- The International Civil Aviation Organisation (ICAO) has approved the AeroMACS standard and recommended practices (SARPS) and Technical Manual , which will help guarantee manufacturer interoperability and Global harmonisation through certified equipment

The AeroMACS general benefits are the following:

- Higher throughput for airport surface communications
- Reduction of congestion of VHF spectrum at airports and delays consequently
- Supporting worldwide interoperability aspects and the integration of critical communications for all the Airport Stakeholders
- Provision of increased security capabilities
- Enhances situational awareness on the airport's surface



Airport Data link Infrastructure Solution

Technological Drivers vs AeroMACS Technical Solution

DRIVERS

- Airport wireless cabling: F.O. rings backup or substitution with a more cost-effective solution
- AOC airport applications are bandwidth-consuming on VHF spectrum (ACARS and VDL2)
- ATC airport applications can be performed on ATN/IPS and ATN/OSI connectivity (worldwide application ATS services)
- Airport needs (e.g. alerts, real time data mngt, etc..) require a common and simultaneously fixed and replaceable sensors



AeroMACS Solution

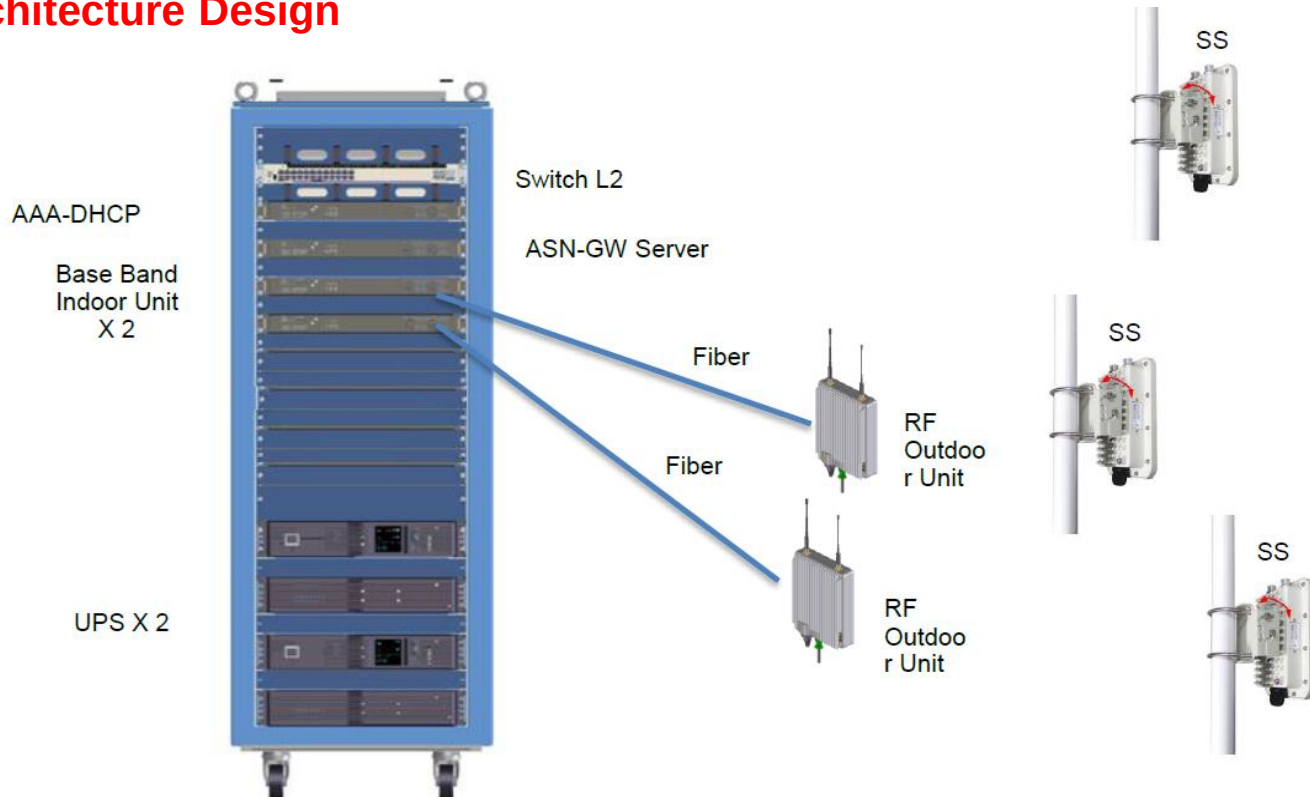
- AeroMACS solution lead to reduce the deployment and maintenance costs by a wireless infrastructure
- AeroMACS solution natively provides support to multiple CSNs (e.g. Airport users, CSPs networks, etc...) and Priority service flows on AeroMACS network
- AeroMACS solution is natively based on IP network. It is able to support both ATN/IPS connectivity and ATN/OSI connectivity via usage of proper convergence function (i.e. SNDCEF) with no further network developments
- AeroMACS solution supports unicast data, broadcast/multicast data traffic.

AeroMACS Logical Architectural Diagram



AeroMACS Ground System Infrastructure Solution - Example

Physical Architecture Design



Note: It can be added up to 8 Base Band in the same rack

Architecture Principles

■ Architecture for Best Airport Deployment

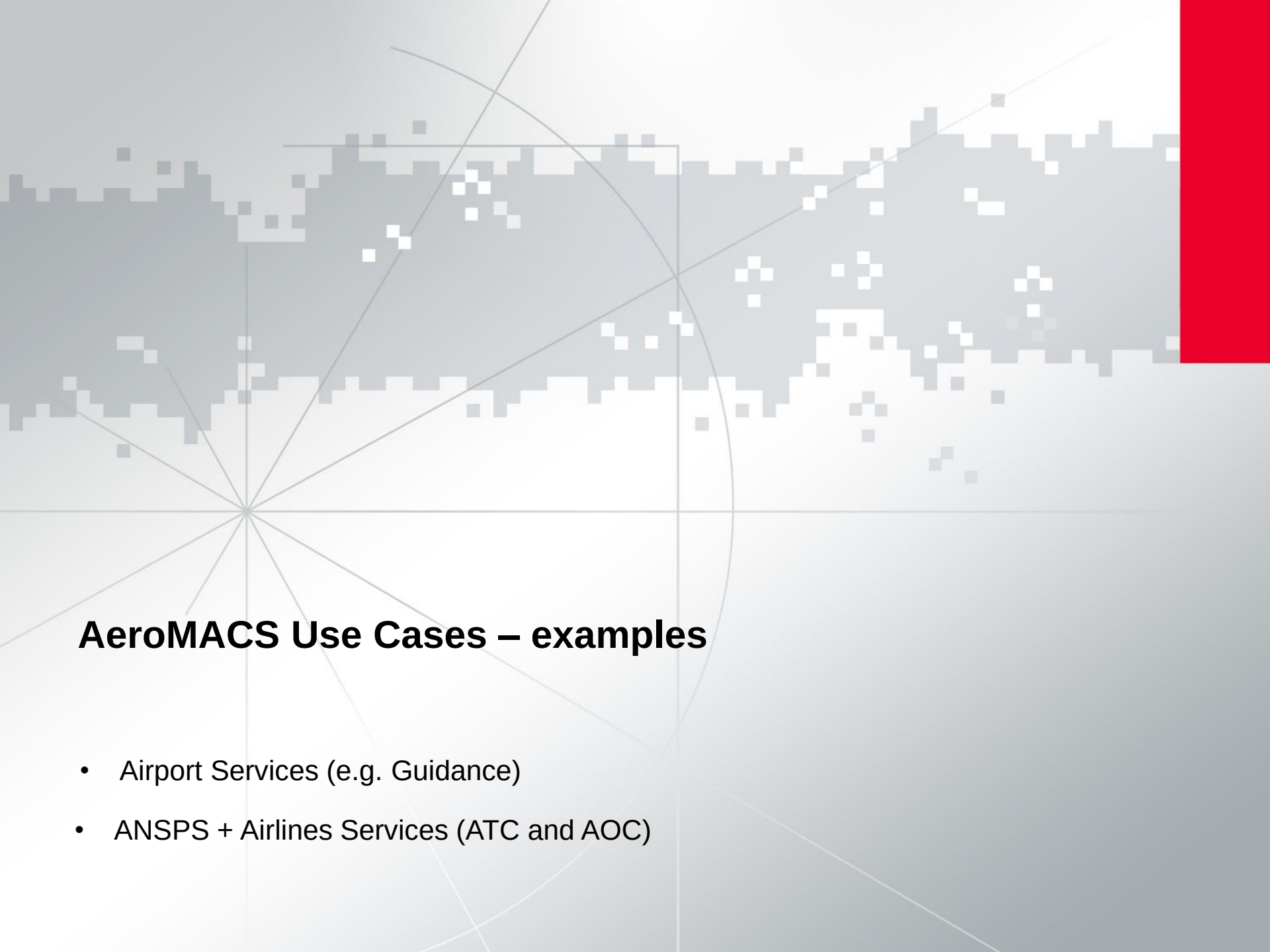
- The Architecture foresees Base Stations split in RF outdoor units and BB indoor unit in order to minimize the RF cabling between RF unit and antenna. Furthermore this architecture allows to centralize the BB indoor units with the ASN-GW in a collocated configuration.
- Rationalisation of the RF Unit Deployment to cover the whole Airport surface without shadow areas

AeroMACS Ground System Infrastructure Solution

System Characteristics

➤ System Characteristics:

- Coverage up to 2500-3000 meters (depending on propagation scenario), fixed and mobile services
- High throughput, low jitter and delay with 1 to up to 4 Service Flows with several modulation downlink and DL/UL Ratio
- Throughput in lines with theoretical expected values
- Quality Of Service: up to 4 different Service Flows with several combinations of protocols (TCP/UDP) and type of flows (BE, nrtPS, rtPS)
- Mobility tested with channel emulator up to 105 km/h
- Network features (dhcp, NTP and AAA).
- Security features.
- Handover and mobility features.
- MIMO 2x1
- Tri-sectoriality



AeroMACS Use Cases – examples

- Airport Services (e.g. Guidance)
- ANSPS + Airlines Services (ATC and AOC)

AeroMACS Guidance Case Study

Test Session Mission

The following section reports the aim, the deployment, setting up, and the outcome of a Test session in terms of D-TAXI field trials, held in Milano Malpensa Airport the 12th of July 2016

■ AIM:

Verification and Technical Validation of the Airport Guidance messages transmission via Airport Data Link Infrastructure (AeroMACS), in order to:

- ✓ Provide guidance instructions to the airport vehicles, included all the information concerning the surrounding traffic displayed on the tablet board to improve the airport awareness
- ✓ Make available a set of Guidance Information in order to allow their actuation through Airport Visual Aids

■ MAIN DIRECT BENEFIT:

Decreasing the taxi time and consequently improving the airport throughput in

- ✓ All weather conditions, especially in case of low visibility conditions
- ✓ Airport with high complexity

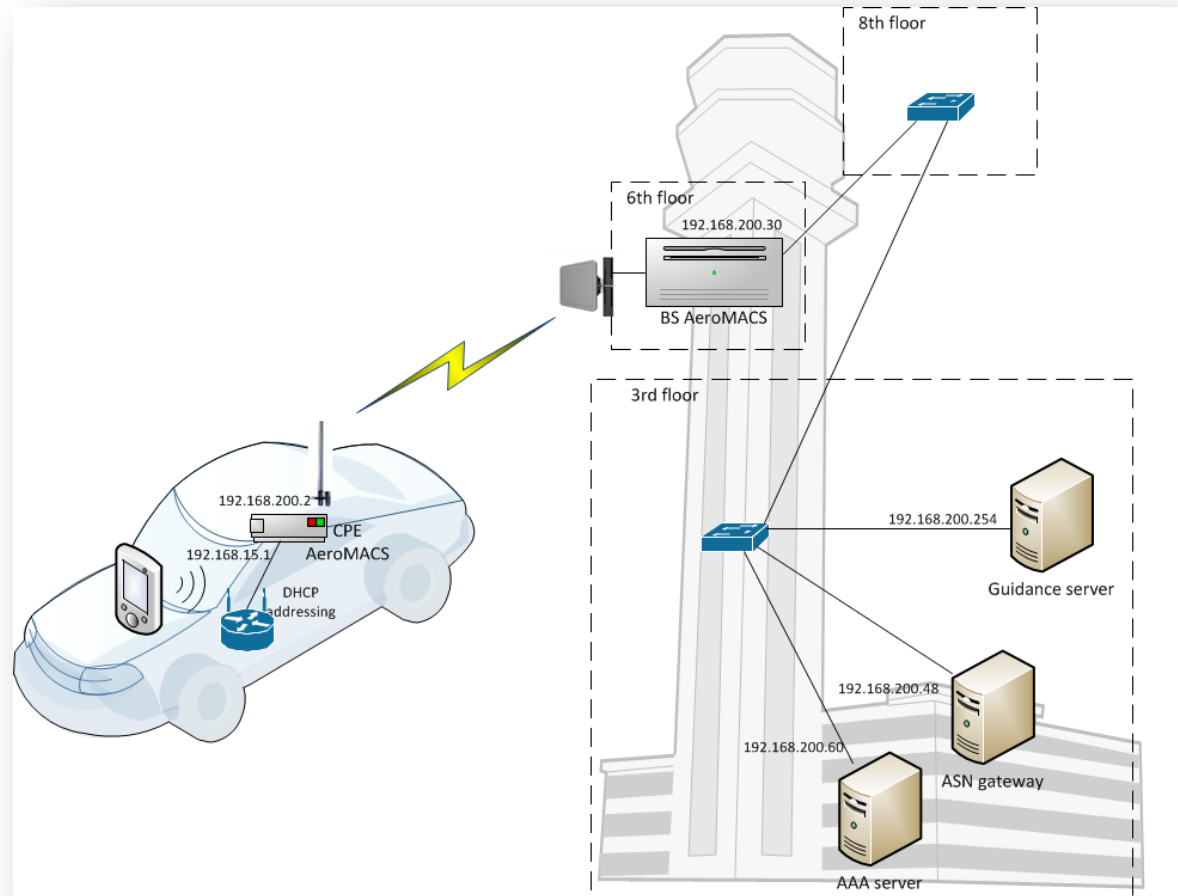
AeroMACS Infrastructure solution for Test Case

AeroMACS Deployment in Milano Malpensa (MXP) Airport

- The AeroMACS solution deployed in Milano Malpensa Airport was composed by:

- The Ground Network installed on MXP Control Tower and connected to Guidance Server

- The Vehicle Network installed on a 'Follow me' car connected via Tablet



AeroMACS Guidance Case Study

Focus on Vehicle System Description

- The AeroMACS Vehicle System was composed by:
 - An AeroMACS CPE and 1 Antenna installed on the 'Follow me' car connected to WI-FI router to ensure the connectivity with the Guidance client Application installed on a Tablet

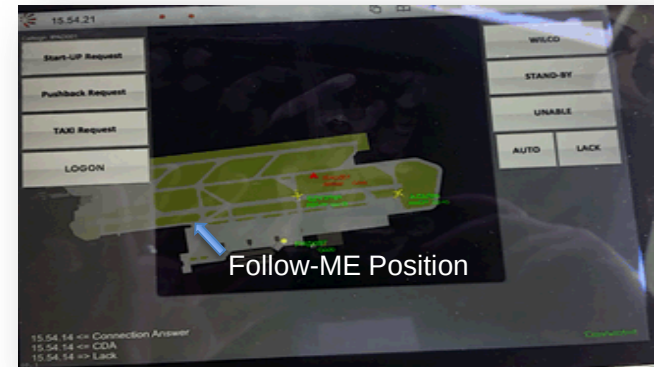


AeroMACS Guidance Case Study

Focus on Guidance Test Description

The current section describes the AeroMACS Guidance Test roll out in three steps

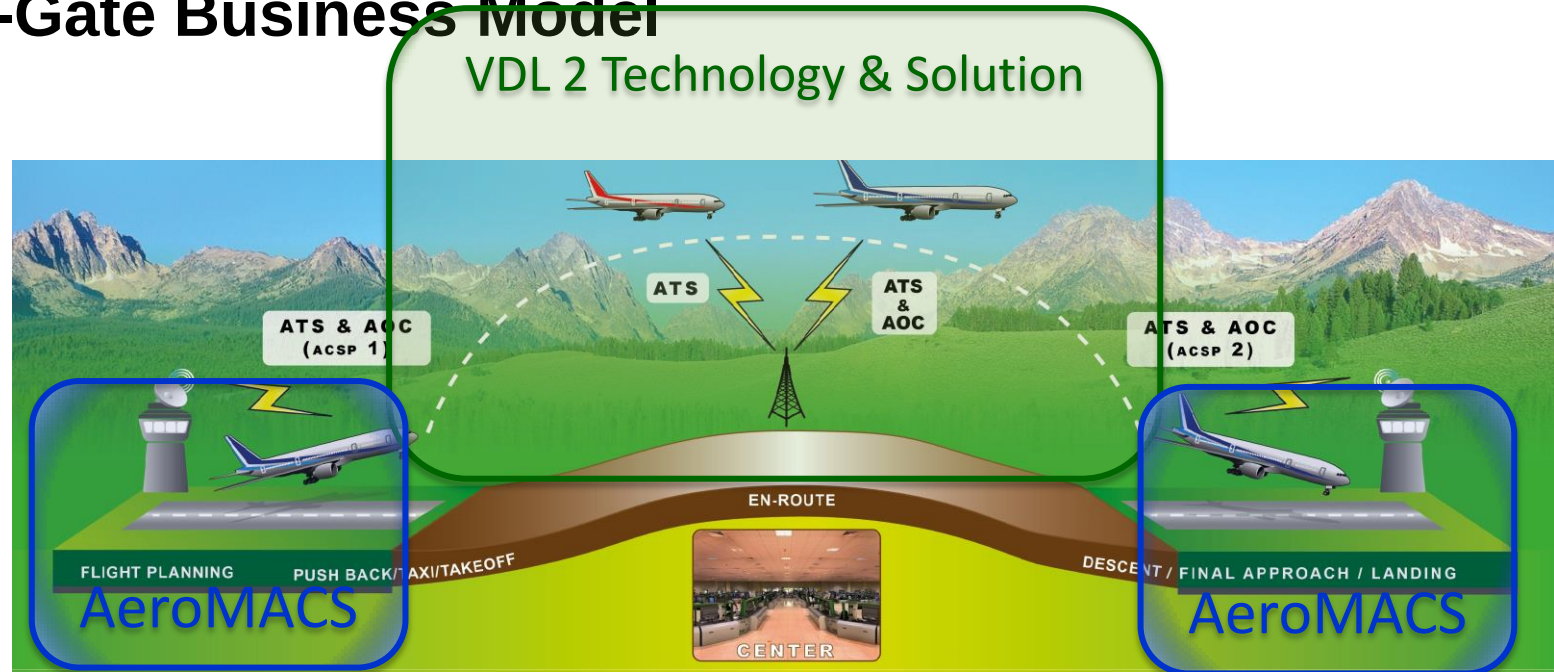
- First Step:
Follow-me vehicle stops on parking area requesting to Logon on the guidance server and after that it receives the position of all vehicles present in airport at the moment at the moment
- Second Step:
Follow-me vehicle requests permission to move to the run-way. It receives the path to be followed
- Third Step:
Follow-me vehicle receives an instruction of change on the path during the movement and an alert concerning the forbidden zone is shown



The background is a light gray gradient. It features several thin white lines: one line descends from the top left towards the center, and two parallel lines ascend from the bottom left towards the top right, meeting the first line in a V-shape.

The Integrated VDL2 / AeroMACS Solution

A Data Link Communication Platform Solutions vs Gate-to-Gate Business Model

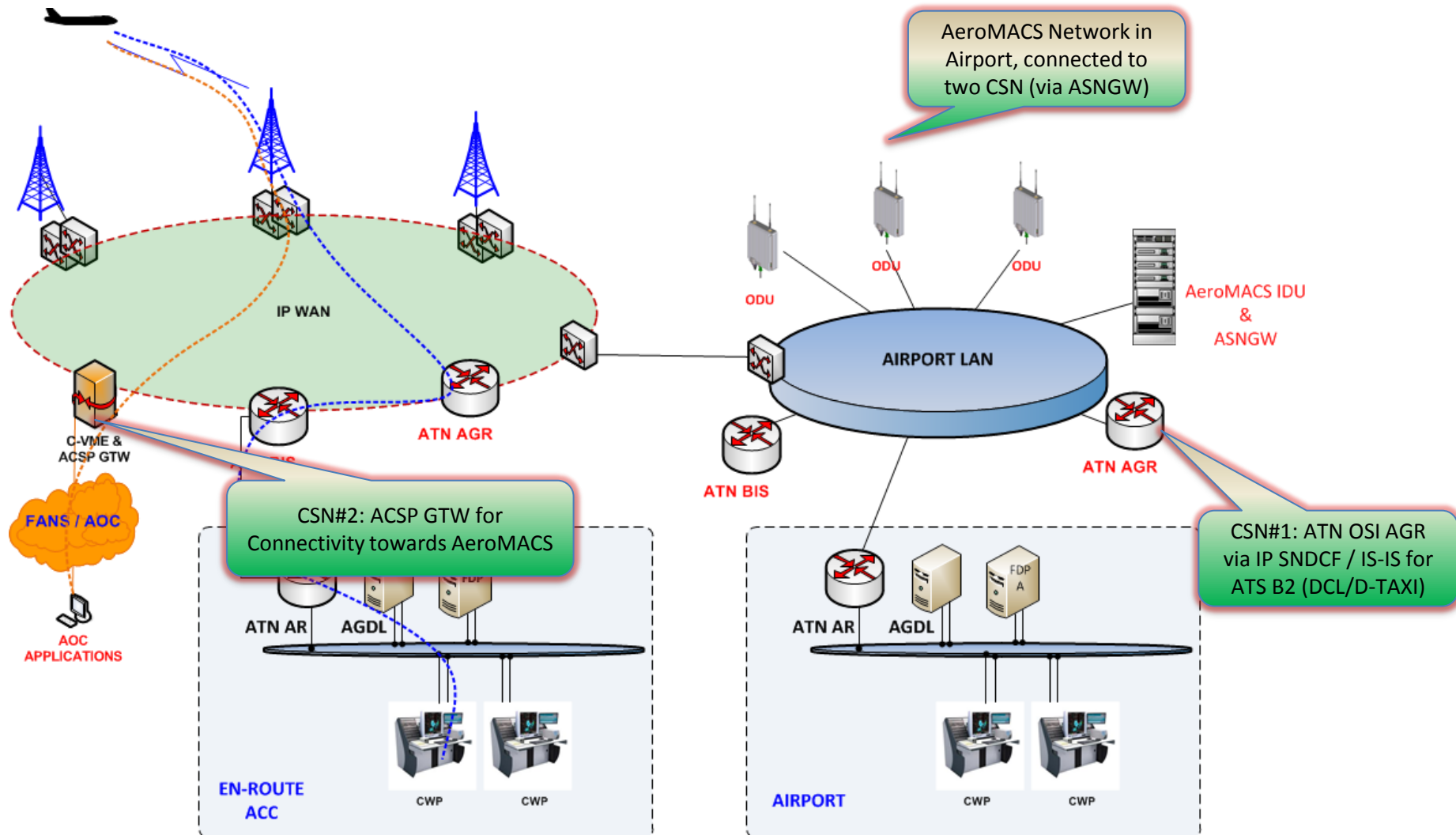


The diagram summarises all the different application areas which are affected by a global SoS approach (Gate-to-Gate approach) and the Leonardo Data Link Communication Platform which provides direct benefits to the ATS

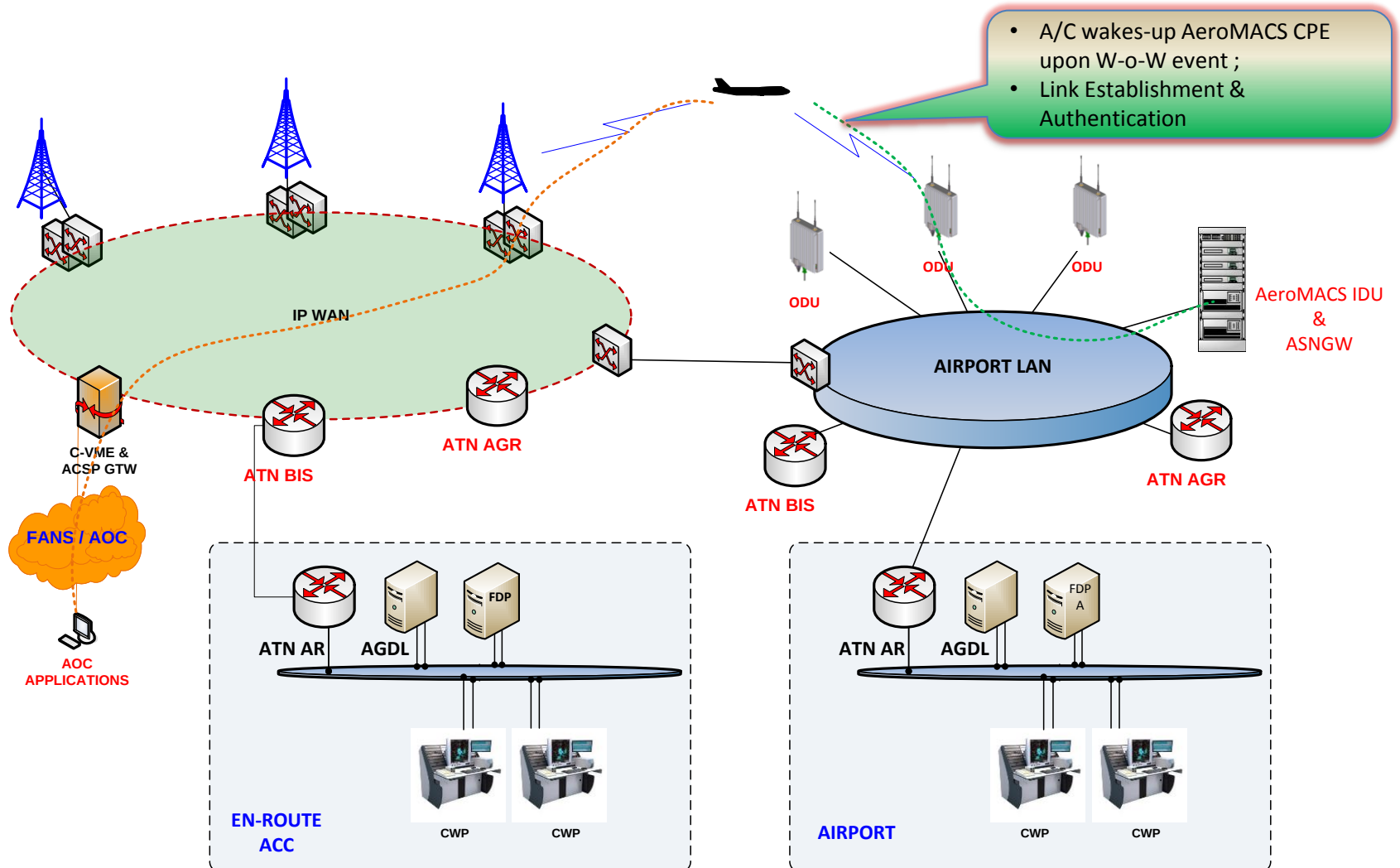
Leonardo Data Link Communication Platform, which is able to manage and support all macro-segments, demonstrates how it is looking at a real «Air Traffic System (ATS)» which engage all the operational needs concerning

- ✓ People
- ✓ Procedure
- ✓ Equipment

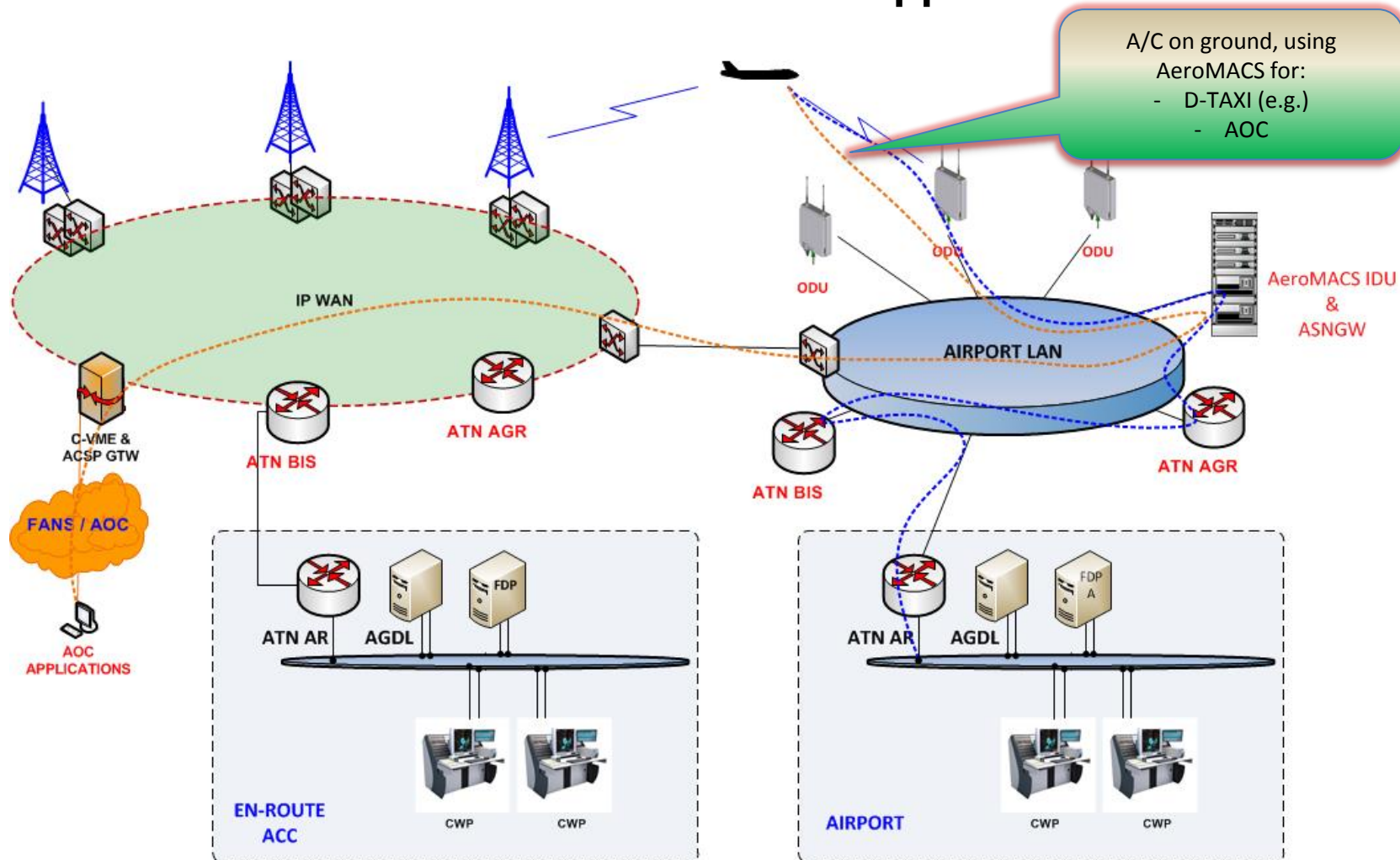
VDL2 / AeroMACS Integrated Solution



After Landing – AeroMACS Connectivity



AeroMACS support to ATN – OSI & AOC



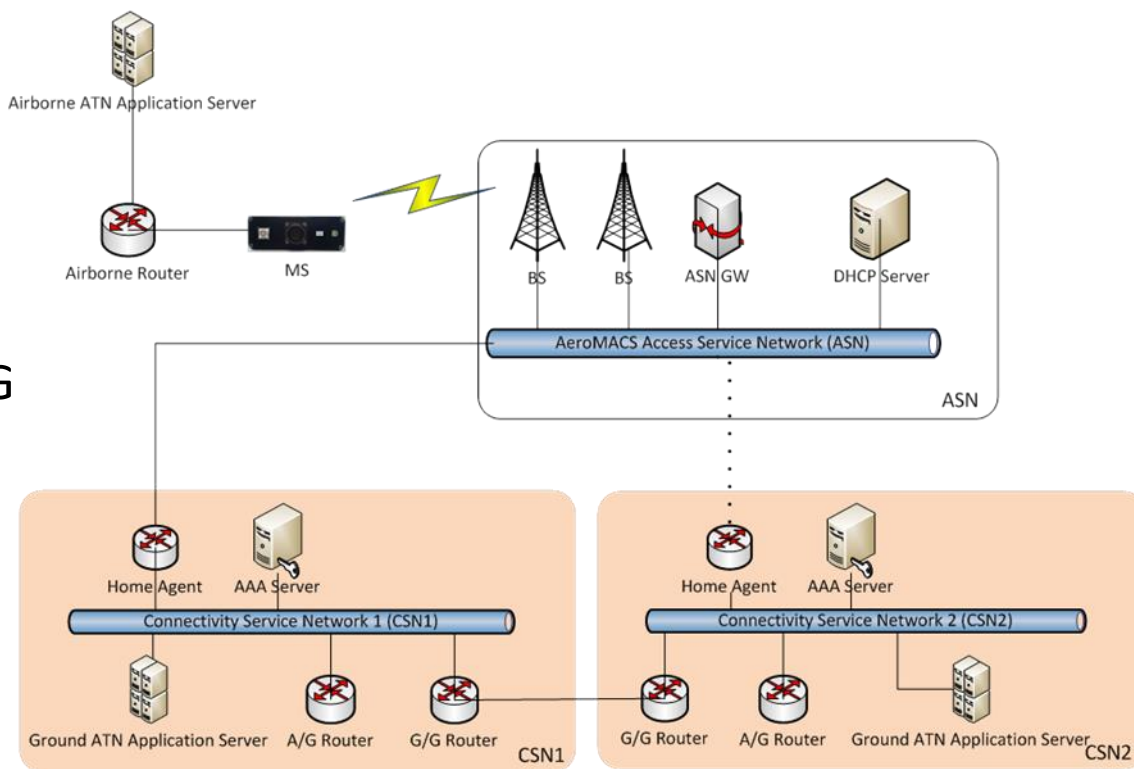
Leonardo participation in SESAR2020 (PJ14-02-06)

Partners:

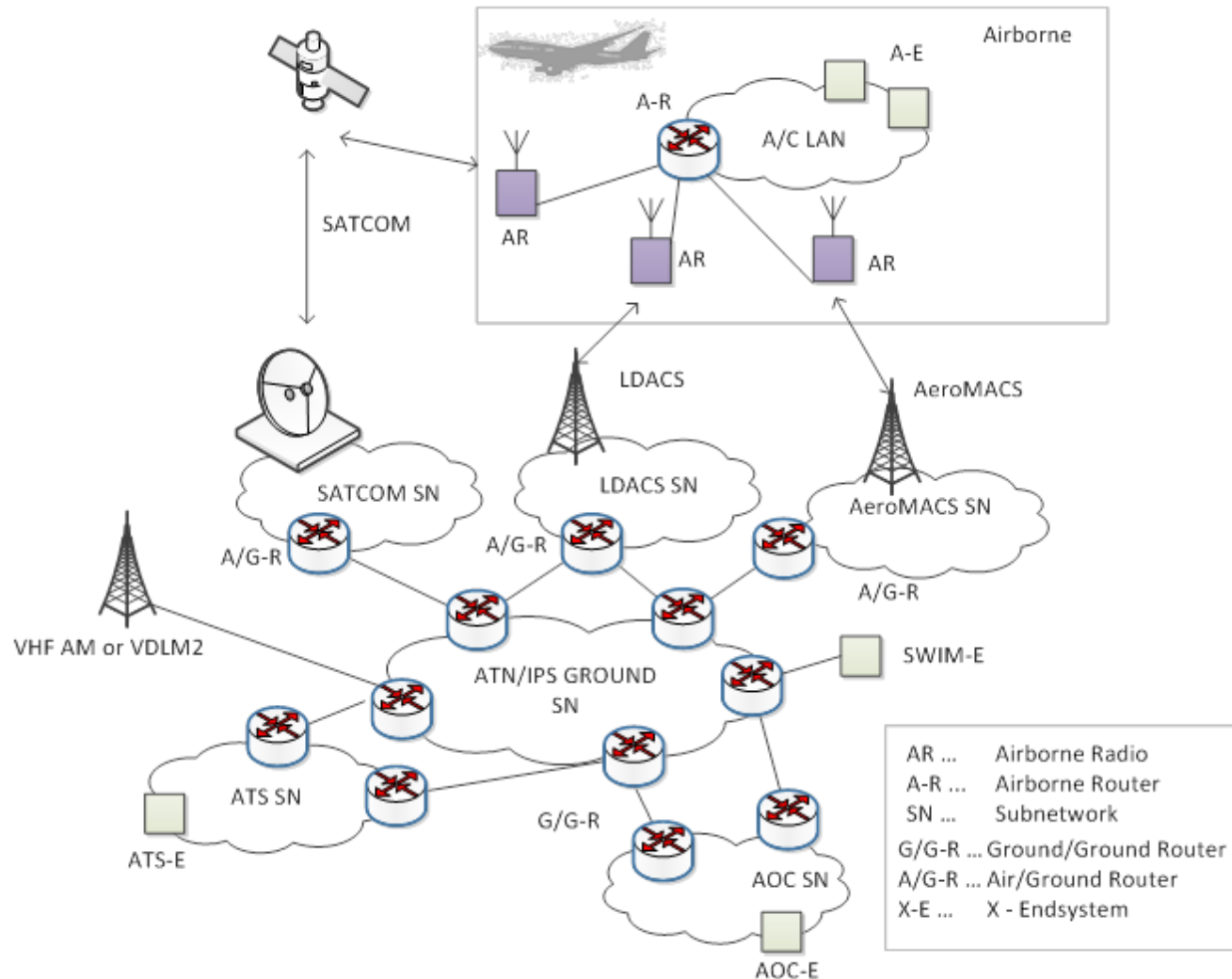
Leonardo, Airtel, EUROCONTROL

Tasks:

- Integration of AeroMACS within ATN (OSI and IPS)
- Digital voice communication solution over AeroMACS
- Integration of AeroMACS A/G DL with Multilink environment
- Support to standardisation and global harmonisation



AeroMACS in the Future Communication Infrastructure (Multi-link -> PJ14.02.04)

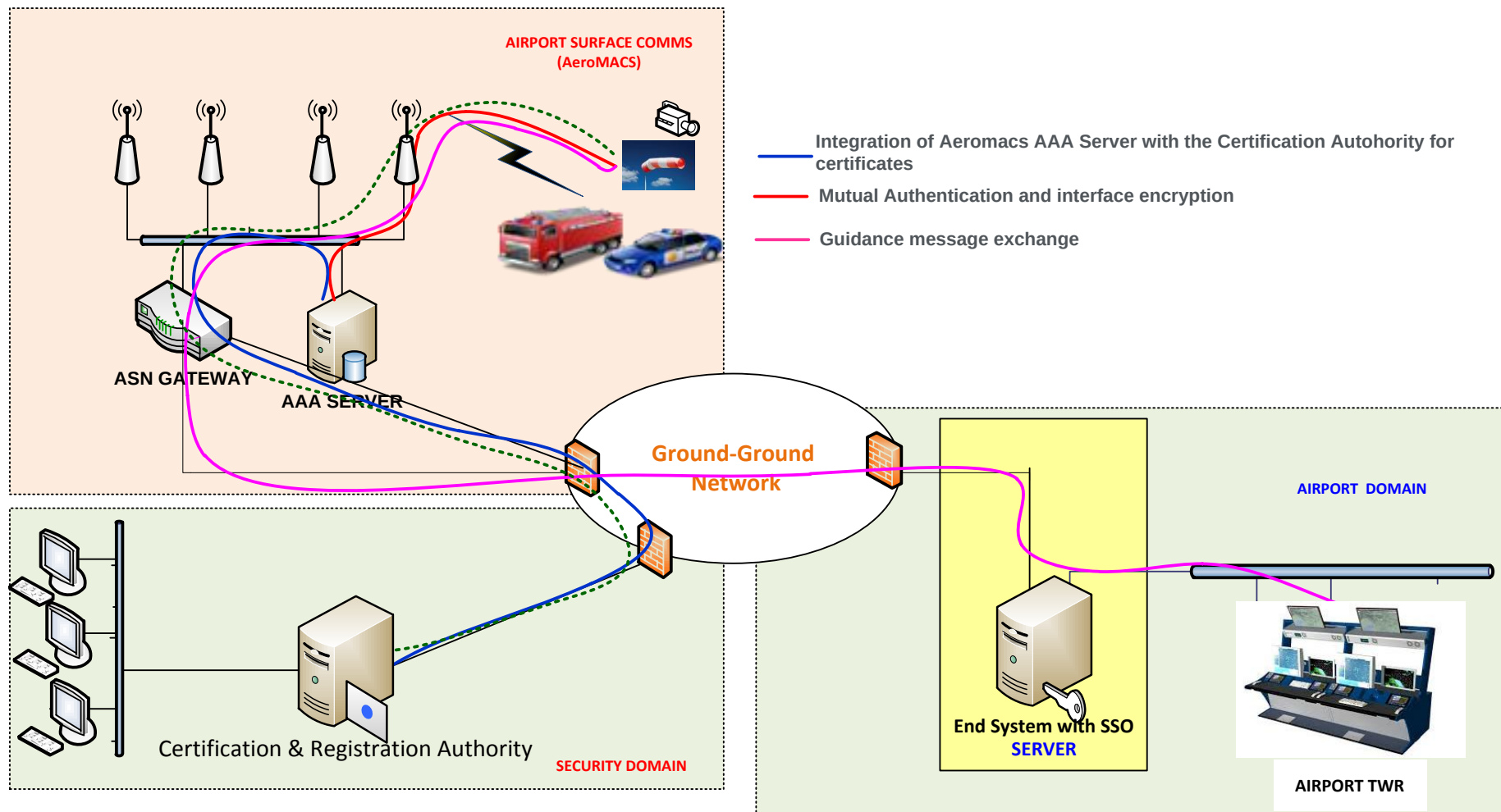


THANK **YOU** FOR YOUR ATTENTION

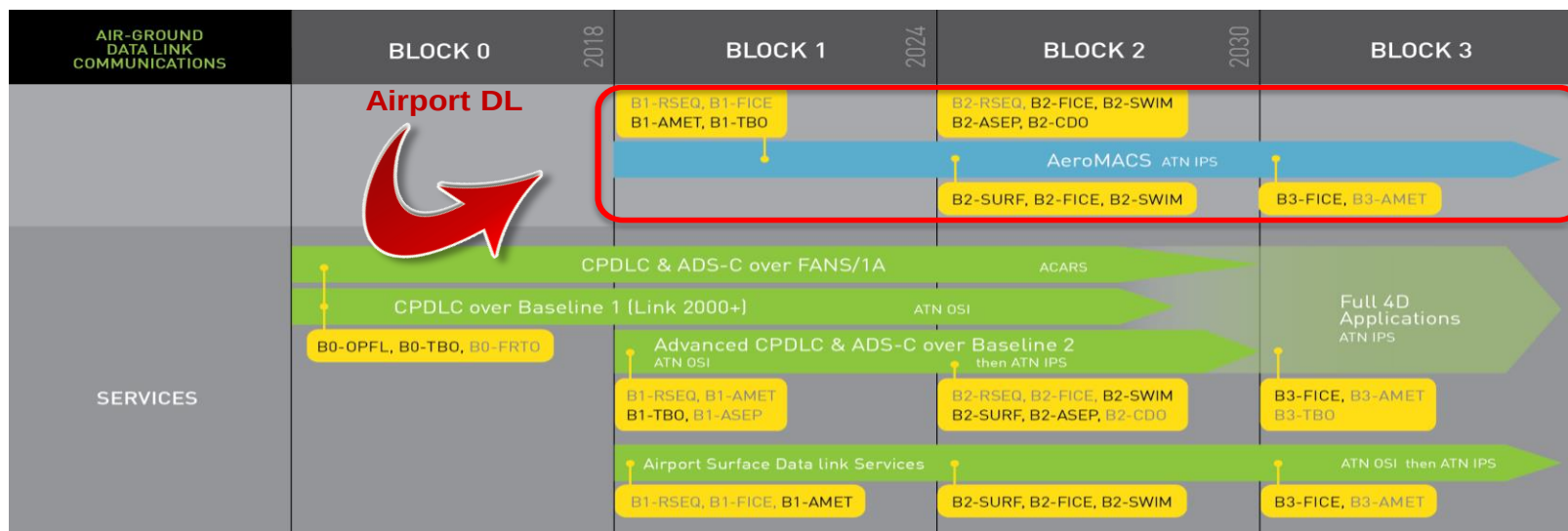


Backup slides

AeroMACS High Level Diagram for Cyber aspects



Drivers by ICAO Global Air Navigation Plan



A path from Data Link Technologies to the End-to-End Operational Needs via ICAO GANP

Airport Data Link Technologies

ICAO Aviation System Block Upgrade (ASBU) –
ref. Block 1 Short-Medium Term

ATM Key Operational
Changes

AeroMACS (for Airport)

B1-TBO – Trajectory
Based Operations

B1-AMET – Advanced
Meteorological
information

Integrated Surface
Management

Integrated Surface
Management DL

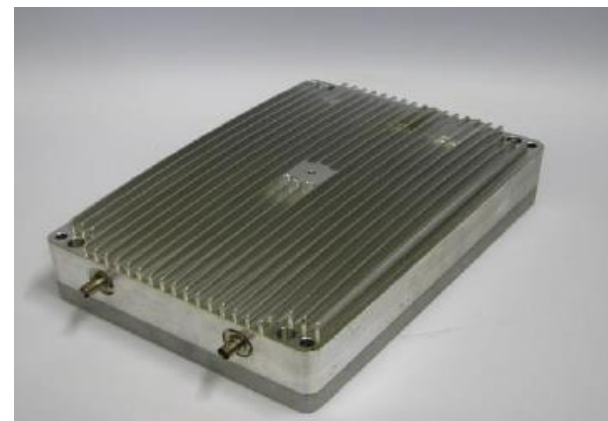
Meteorological Information
Exchange

Are managed by the CPDLC, Airport
MLAT capability. Nav aids and Meteo
Data included

AeroMACS Ground Station

- GS is composed by one or more Indoor Units (Base Bands) and up to three Outdoor Unit connected via fiber per Base Band
- RF Unit has a mean-time-between-failures (MTBF) of 45000 hours
- GS reaches an availability of 99,999 % (redundant architecture)
- Maximum transmit power ($PT_{x,max}$) of GS transmitter for each sector is:
 $27 \text{ dBm} \leq PT_{x,max} \text{ (Power Class 3)} < 30 \text{ dBm}$
- GS use a Global Position System (GPS) signal for system synchronization
- GS provide system status and event using Simple Network Management Protocol (SNMP)

RF Outdoor Unit



Base Band Indoor Unit



AeroMACS Ground System Infrastructure Solution

AeroMACS Ground System: ASNGW

- ASN GW features:
 - compliant with profile C as requested in DO 346 MOPS for AeroMACS
 - support a RADIUS client
 - provide system status and event using Simple Network Management Protocol (SNMP)

AeroMACS Ground System: AAA Server

- AAA Server features:
 - support RADIUS server
 - support EAP TLS for Authentication
 - support encrypted X.509 Version 3 digital certificate for authentication and encryption of data flow



AeroMACS Ground System: DHCP Server and NAT Features

- DHCP server must allocate private address to MS/SS
- Optionally Network Address Translation (NAT) should be installed and configured

AeroMACS Fixed Subscriber Station

■ Fixed SS features:

- Standard Compliance IEEE 802.16-2009
- Antenna port N-type x 2 (or embedded antenna)
- System Configuration TR-069, Web UI
- Encryption CCM mode 128bits AES, CCM mode, AES key wrap with 128-bit
- Authentication PKMv2, EAP-TLS, X.509 digital certificates
- Interface RJ-45 Power-over-Ethernet (proprietary)
- PoE Adapter 110~240VAC, 56V DC,
- Dimensions 247mm x 247mm x 80mm
- Weight 1.5 Kg
- Operating temperature -40° C +55° C
- Outdoor water-proof casing IP67/IP68
- Type Approval EMC & EMI: EN 301 489-1, EN 301 489-4, FCC Part 15
- Safety Compliance: IEC 60950-1, EN 60950-1, UL 60950-1



Fixed SS

Airport Data link Infrastructure Solution

Focus on UL - DL Troughput

DL -UL Ratio	QPSK 1/2		16 QAM 1/2		64 QAM 1/2	
	UL (Uplink)	DL (Downlink)	UL (Uplink)	DL (Downlink)	UL (Uplink)	DL (Downlink)
35:12	580 Kbit	1,8 Mbit	1,1 Mbit	3,6 Mbit	1,7 Mbit	5,4 Mbit
31:16	780 Kbit	1,1 Mbit	1,5 Mbit	3,1 Mbit	2,3 Mbit	4,6 Mbit
26:21	1 Mbit	1,2 Mbit	2 Mbit	2,4 Mbit	3 Mbit	3,6 Mbit

AeroMACS Ground System Infrastructure Solution

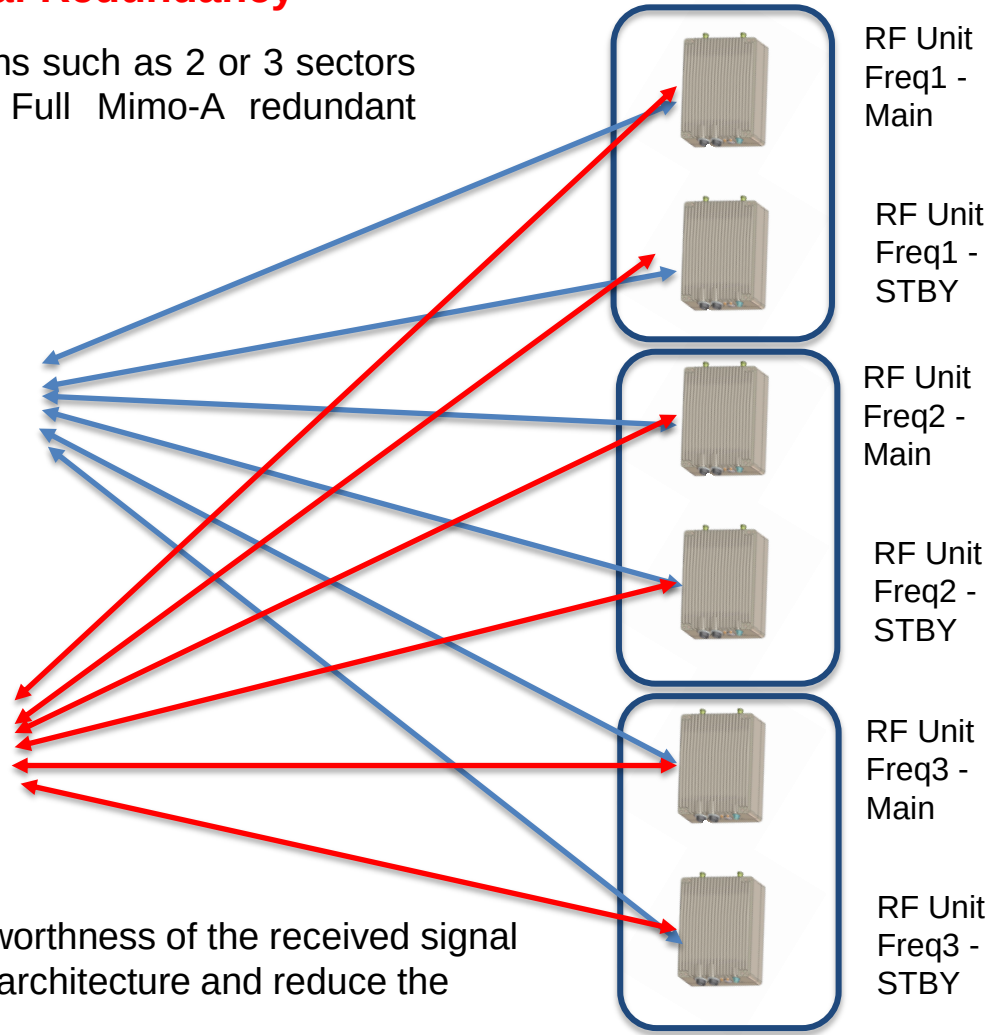
Focus on next evolution on Architectural Redundancy

GS has multiple sector redundant configurations such as 2 or 3 sectors redundant configurations, 2 or 3 sectors - Full MIMO-A redundant configurations

Base Band 1



Base Band 2



Benefit:

- MIMO extends coverage whilst increasing trustworthiness of the received signal
- Three sector base station optimise deployment architecture and reduce the installation equipment cost
- Full redundancy of both base bands equipment and RF units in order to achieve the Ground system resilience to double crossed failures.

AeroMACS Ground System Infrastructure Solution

Focus on next evolution on Architectural Redundancy

