



PJ14 EECNS PJ14 COM Open Day WP3 – L-band Digital Aeronautical Communications System

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@EUROCONTROL, Brussels
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Outline



- Introduction and Context
 - SESAR2020 Programme and Solution PJ.14-02-01 "FCI Terrestrial Data Link "
 - LDACS – At a Glance
- Solution Objectives and Scope of LDACS Technical Validations
 - Methodology
 - Handover Tests – Scope & Results
- Standardization Activities
- Conclusions and Outlook



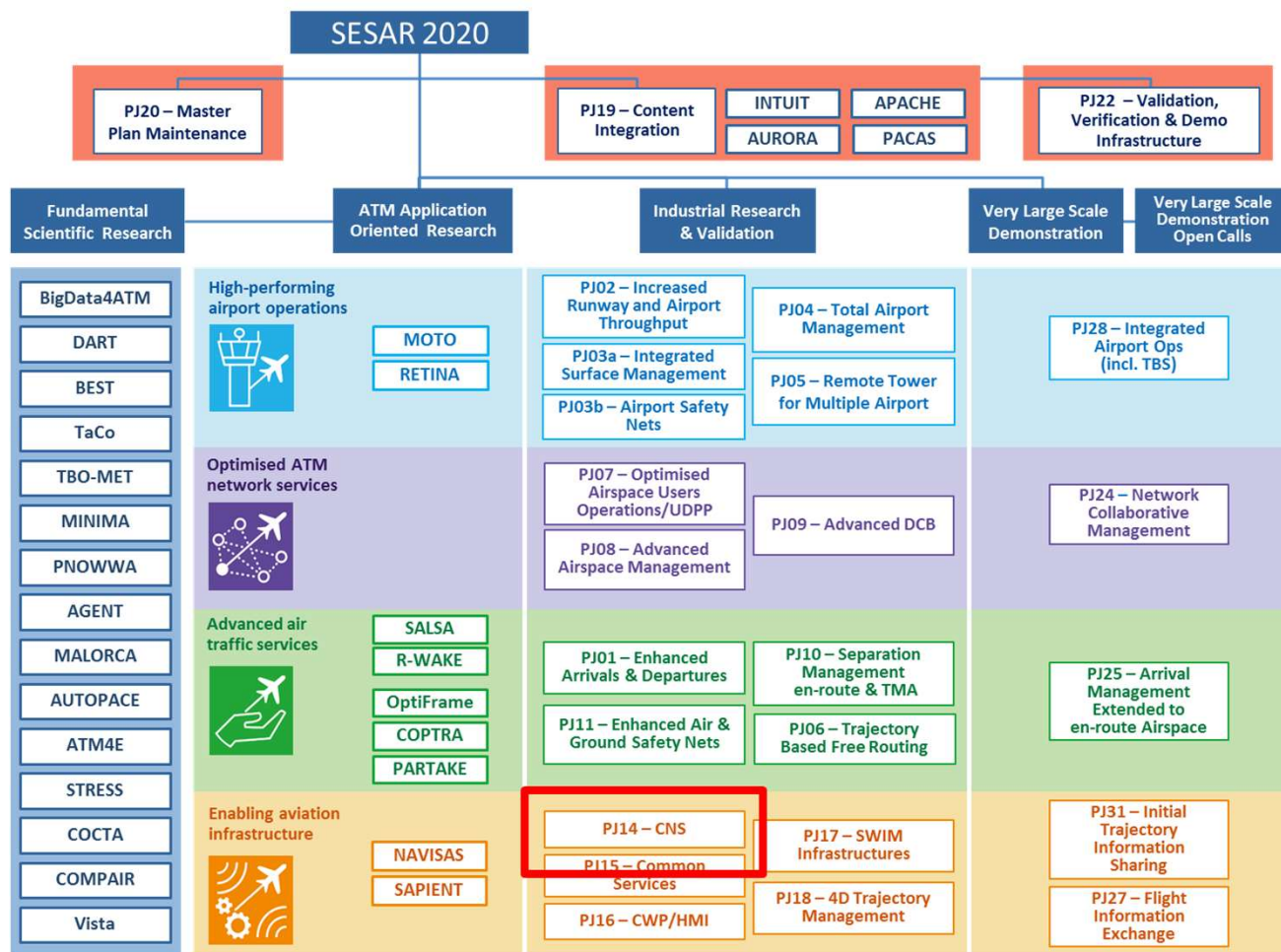
LDACS Solution – SESAR2020 PJ.14-02-01

Introduction and Context



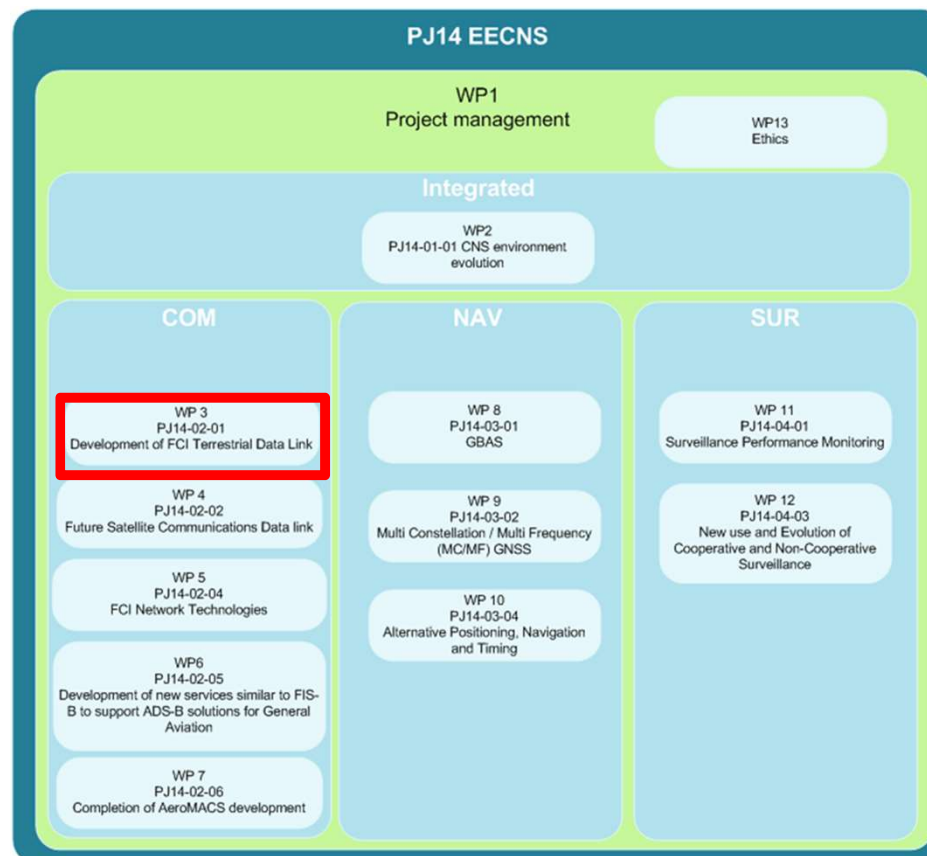
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Introduction: SESAR2020 – Solutions



Introduction: Project (PJ)14 Essential and Efficient CNS

1 Transversal (CNS)
5 COMMUNICATIONS
3 NAVIGATION
2 SURVEILLANCE



SESAR2020 PJ.14-02-01 "FCI Terrestrial Data Link "

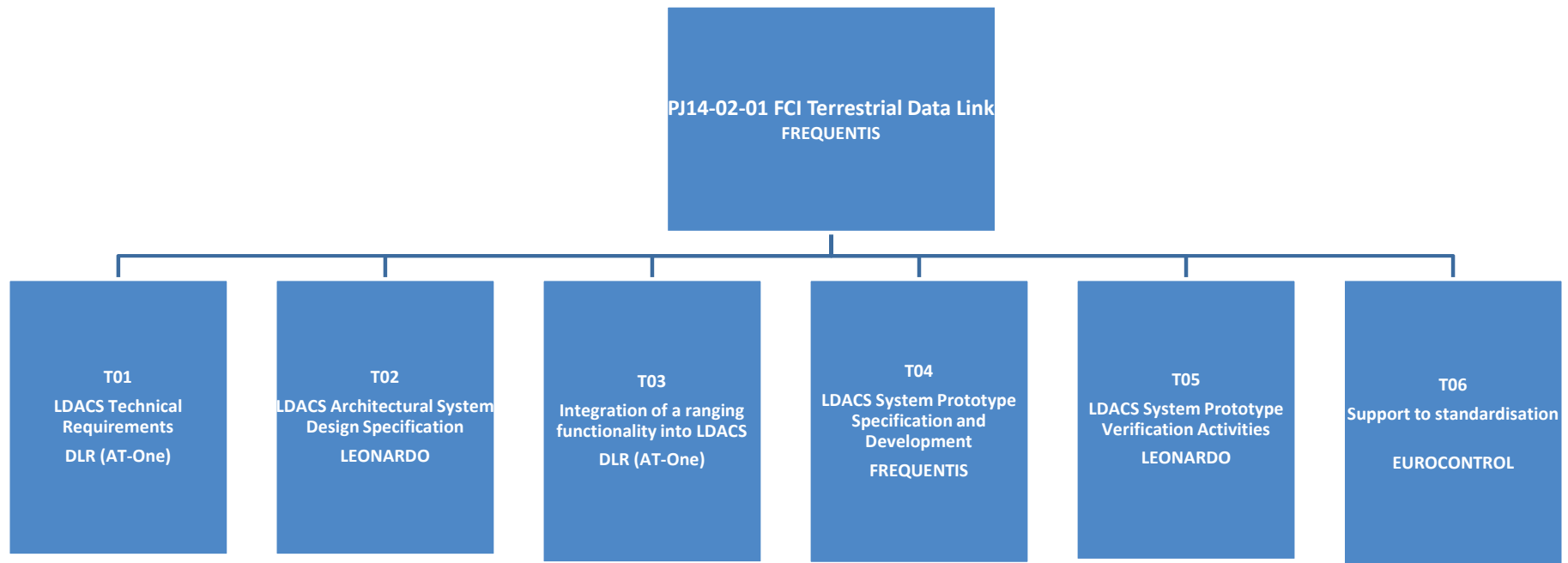
– Project Partners



1	Frequentis (FSP) – Solution Lead	
2	Leonardo	
3	Airbus	
4	DLR (AT-One)	
5	EUROCONTROL	
6	Airtel (NATMIG)	
7	NATS	
8	SITA (as subcontract to THALES AIRSYS)	

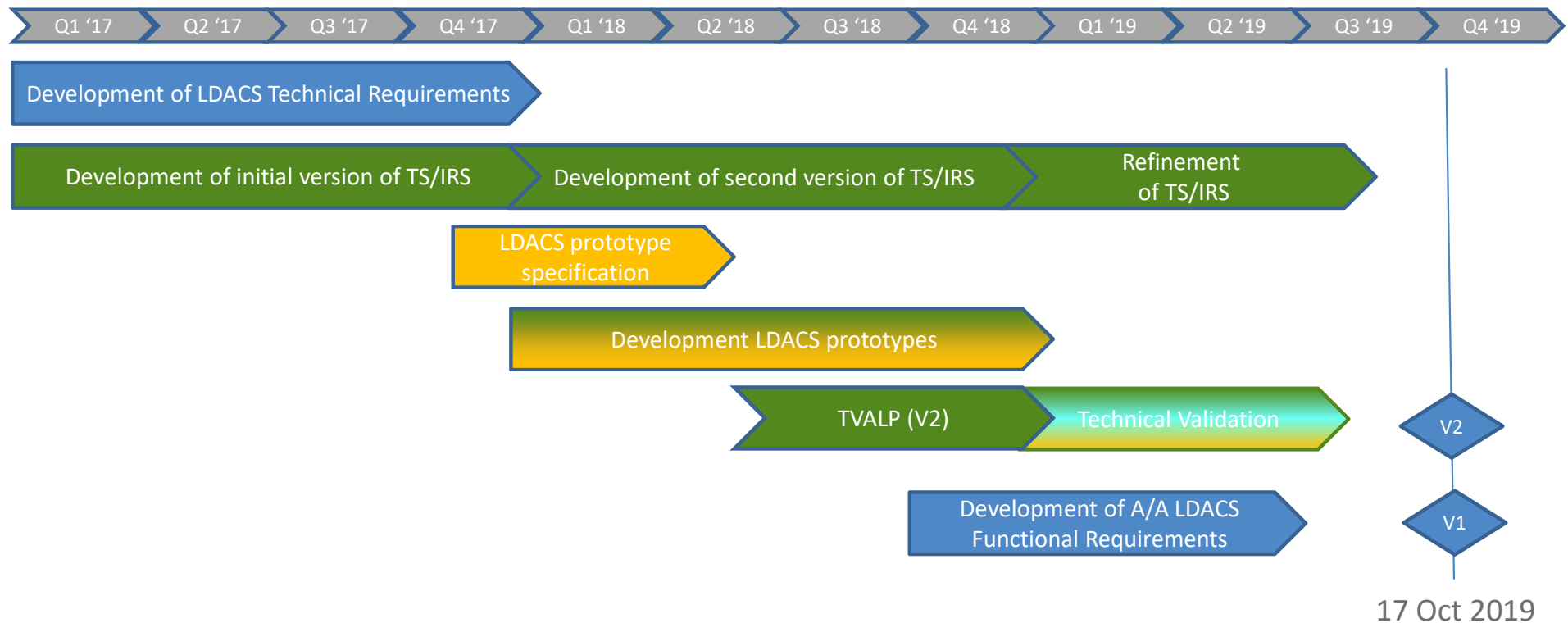
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– Project structure

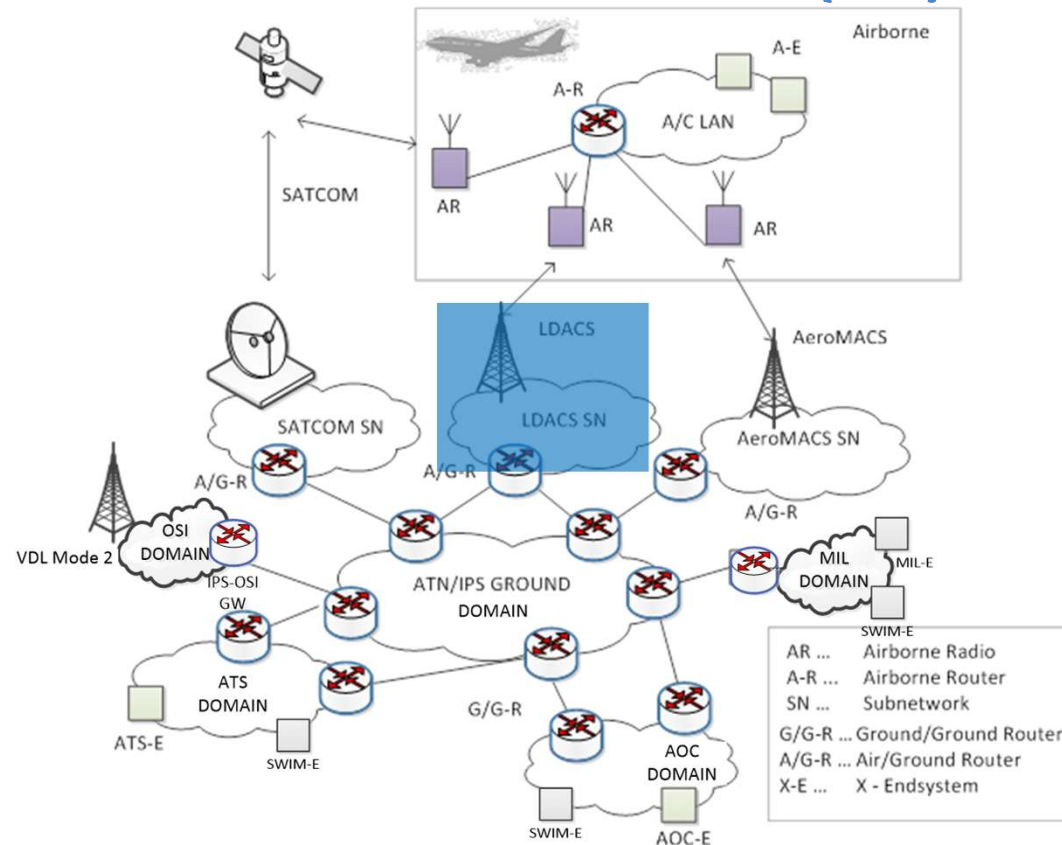


SESAR2020 PJ.14-02-01 "FCI Terrestrial Data Link "

– GANTT (major tasks)



SESAR2020 PJ.14-02-01 "FCI Terrestrial Data Link " & Future Communications Infrastructure (FCI)



Terrestrial A/G Datalink

Why LDACS ?



Reliable (terrestrial) datalink is an essential building block of the European vision for the future communication infrastructure (FCI).

Establishing secure communication between the ground and the air is vital to support the growth in traffic volume and complexity.

The operational concept of trajectory management in 4D needs to be supported by a reliable, scalable, modular and efficient datalink technology.

➔ **LDACS** (L-Band Digital Aeronautical Communication System)

LDACS – Design Challenges



Choice of Frequency Band (L-Band)

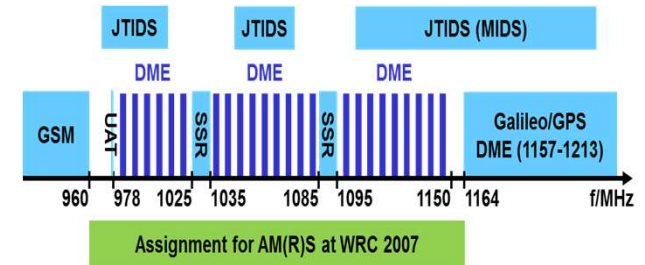
Aviation band with AM(R)S allocation

Drawback: strongly used by aeronautical navigation systems, esp. DME (Distance Measuring Equipment

COTS communications systems not applicable
→ special design required

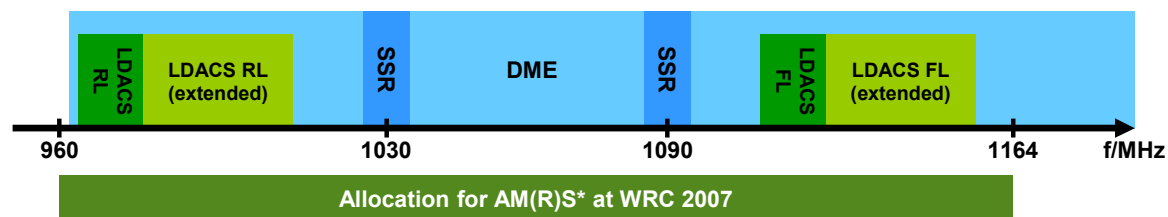
Deployment Approach:

- Ensuring L-band compatibility:
 - Suppression of out-of-band radiation
 - Mitigation of interference impact of legacy L-band systems on LDACS



LDACS – Frequency Bands

LDACS FL (Forward Link) and RL (Reverse Link) Frequency Bands



**AM(R)S - Aeronautical Mobile (Route) Service*

LDACS FL: 1110 – 1156 MHz (initial deployment: 1110 – 1125 MHz)

LDACS RL: 964 – 1010 MHz (initial deployment: 964 – 979 MHz)

LDACS – Design and System Characteristics

Basic Design Considerations

Apply modern state-of-the-art technology like current/future mobile radio standards (LTE/4G)

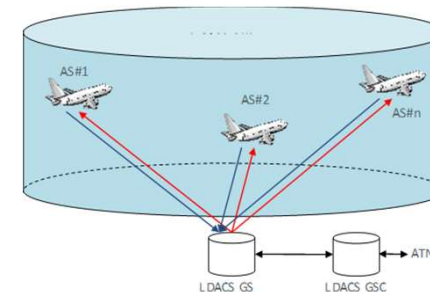
- Orthogonal Frequency-Division Multiplexing (OFDM), highly flexible and scalable
- Strong coding and adaptive coding/modulation

Apply frequency-division duplex (FDD) due to limited bandwidth available with inlay approach

Apply interference mitigation due to inlay approach

System Characteristics

- Cellular communications concept
- Support of „seamless handover“
- Support of data and voice
- Support of Quality-of-Service
- Support of ranging functionality (APNT*)
- Support of A/A communications



*Alternative Positioning Navigation and Timing



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Objectives and Scope of LDACS Technical Validations



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– General scientific & technical objectives



Develop and standardize LDACS, the candidate future terrestrial data link system (that can cope with the increased capacity).

Develop and verify LDACS prototypes and integrate them into an FCI validation platform (Solution PJ.14-02-04).

Address transversal topics and concepts, including seamless transition from existing data link technologies to LDACS and the inclusion of a ranging functionality.

Target Solution Maturity: TRL4 (A/G) and TRL2 (A/A) by end of 2019 (wave 1)
LDACS to be continued in Solution #60 during wave 2

**TRL – Technology Readiness Level*



SESAR2020 PJ.14-02-01 "FCI Terrestrial Data Link “: Objectives and Scope of LDACS Technical Validation



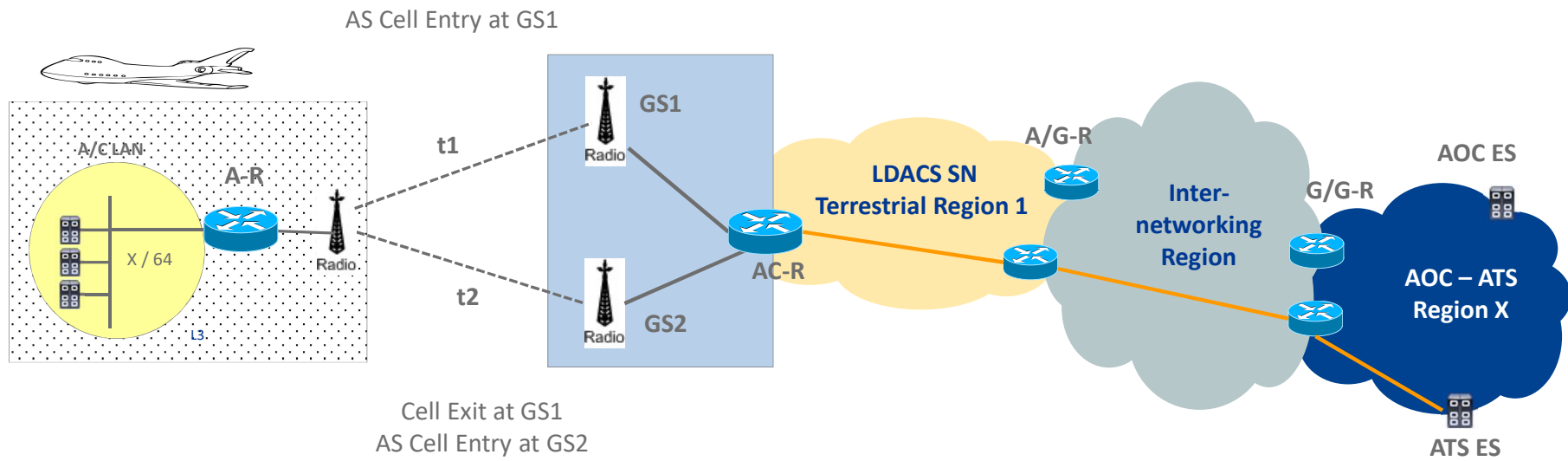
Technical validations LDACS performed in SESAR Solution PJ.14-02-01 aim at demonstrating that LDACS has reached Technology Readiness Level 4 (TRL4)

- TRL 4: "technology validated in lab"

PJ.14-02-01 validation comprised verification of the

1. RF front-end and physical layer with regard to the LDACS A/G specification (transmitter & receiver performance, channel coding, OFDM structure)
2. Interoperability of TX/RX prototypes developed by different vendors
3. Interoperability of LDACS airborne and ground prototypes integrated with the ATN/IPS ground network, including the verification of LDACS mobility support during LDACS AS handover

LDACS Validation Use Case: Handover between two LDCAS cells



Verification Goal:

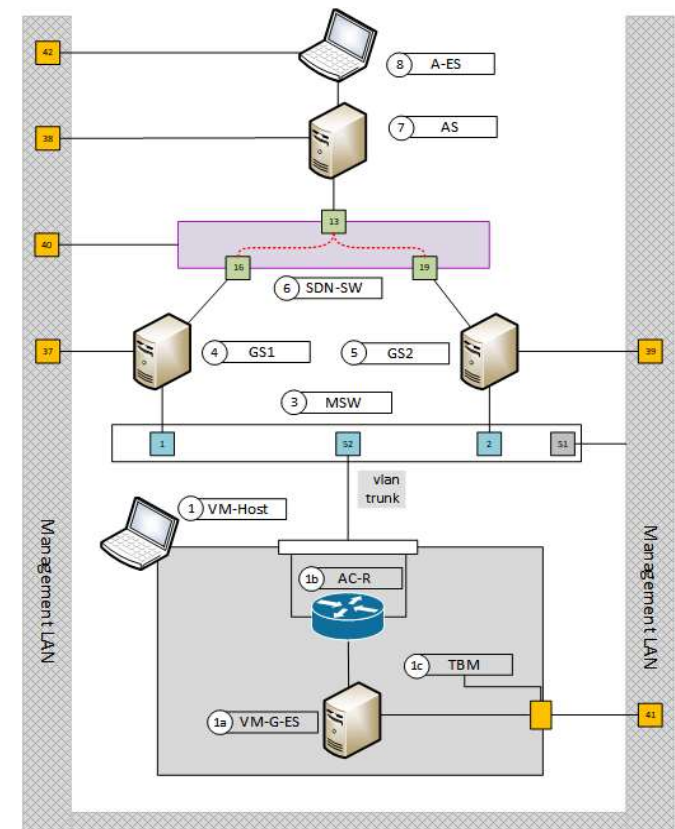
When LDACS AS moves between LDACS GS1/2, the exchange of data between Layer3 entities (hosts, routers), interconnected via LDACS data link, should continue without loss of data

A-R ... Airborne Router
AC-R ... Access Ground Router
A/G-R ... Air/Ground Router
G/G-R ... Ground/Ground Router

Handover Tests – Set-up

Handover tests were performed using a dedicated testbed

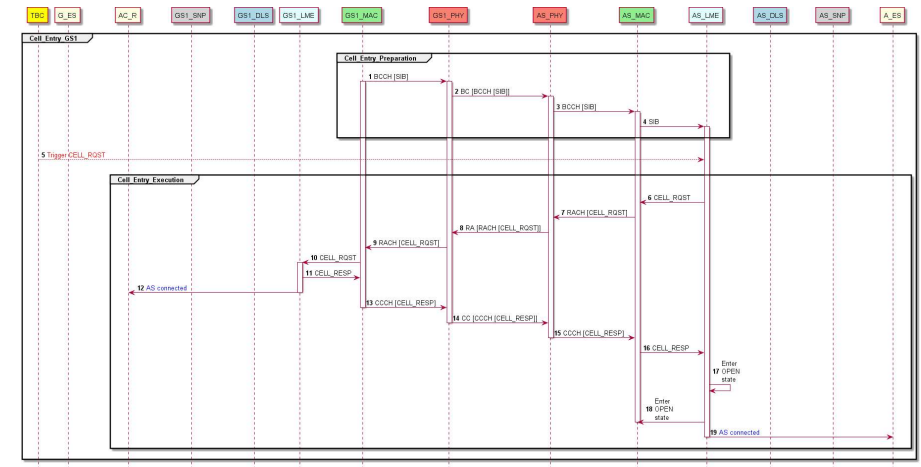
- Airborne end-system (A-ES)
- LDACS AS
- LDACS GS1 and GS2
 - Channel switchover between GS1/GS2 channels emulated by using Software-Defined Network Switch (SDN-SW)
- Physical PC, accommodating
 - Access router (AC-R)
 - Ground end-system (G-ES), as a Virtual Machine (VM)
 - Testbed Manager (TBM), as a VM
- Managed Switch (MSW) for emulating point-to-point connections between AC-R and GS1/GS2, respectively



Handover Test Procedure

Following specific atomic test cases have been investigated during the handover type 1 testing:

- AS Cell Entry at GS1
- RL/FL Resource Allocation at GS1
- AS Preparing HO and Cell Exit at GS1
- AS Cell Entry at GS2
- RL/FL Resource Allocation at GS2

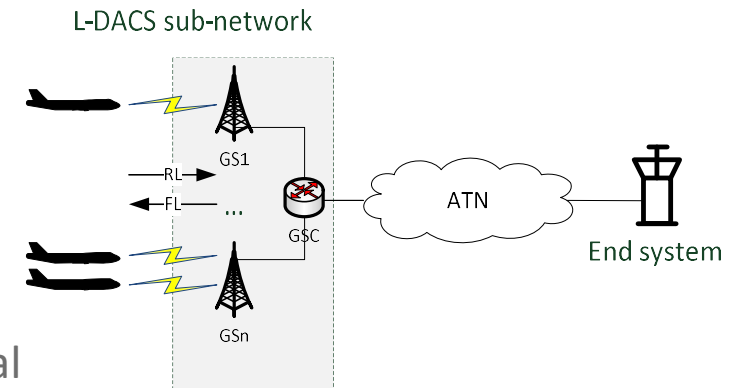


Handover Type 1 Test – Results



It could be successfully demonstrated that

- LDACS layer 2 entities (implemented in AS and GS) exchange control-plane signalling messages over the emulated air interface, as required for the concerned procedures
- L2 procedures related to the AS cell entry at certain GS (initial AS attachment or re-attachment after the HO) are conform with the specified behaviour
- LDACS layer 2 entities correctly execute other procedures (FL/RL resource allocation, HO preparation, cell exit)
- LDACS layer 2 entities involved with handover – SNP, LME, DLS, MAC – operate as specified





LDACS Solution – SESAR2020 PJ.14-02-01

Standardization Activities

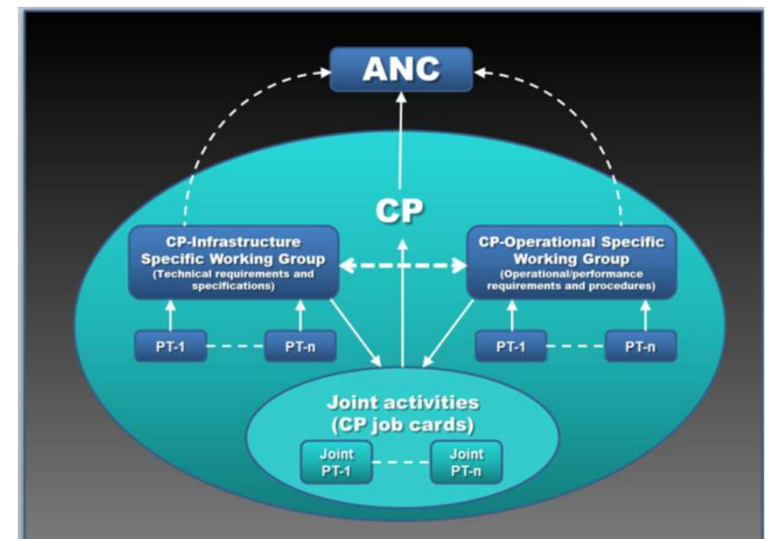
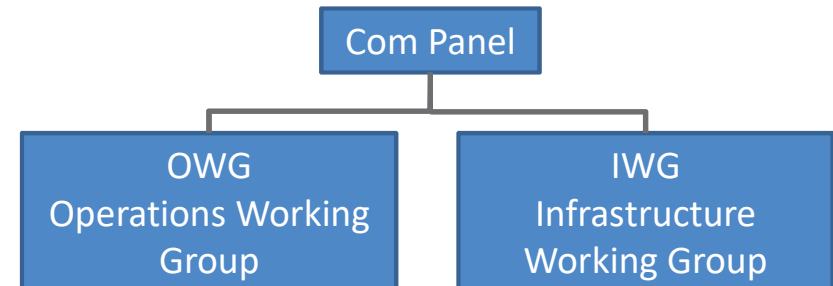
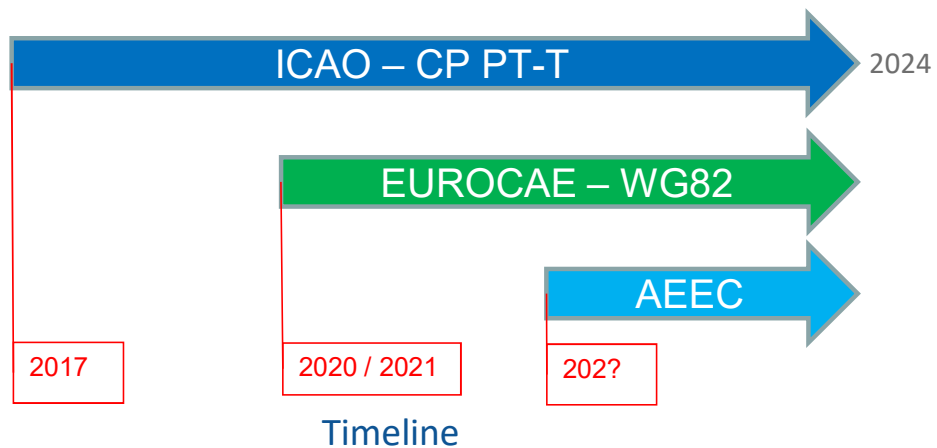


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Standardization Activities

- ICAO in Infrastructure Working Group (IWG)
 - Project Team Terrestrial (PT-T)
- Applicability of SARPs aimed for Q4/2024
 - Initial SARPs* for LDACS: Delivered in Q4/2018 (affected document = ANNEX 10 Vol III)

*Standards and Recommended Practices





LDACS Solution – SESAR2020 PJ.14-02-01

Conclusions and Next Steps



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Conclusions and Next Steps

- LDACS conformance tests have demonstrated that physical layer requirements and radio requirements from the LDACS specification have been properly implemented in prototype LDACS TX and RX equipment
- Handover tests have demonstrated that LDACS Layer2 entities involved with handover procedure – SNP, LME, DLS, MAC – operate as specified with adequate performance
- Some aspects will require further validation
 - HO trials, which were conducted by using an SDN switch for emulating AS frequency switchover between involved GSs, with fully integrated TX/RX prototypes
 - A/A data link & A-PNT (Alternative Positioning Navigation and Timing functionality
 - Digital A/G voice functionality
 - Security aspects
 - Integration with Future Communications Infrastructure (FCI) supporting multilink testing
 - Spectrum Compatibility Tests (in progress)





SESAR2020 Solution PJ.14-02-01 @ PJ.14 COM Open Day

Thank you very much
for your attention!



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