



PJ14 EECNS COM Open Day

Future Communication Infrastructure

23 October 2019

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Founding Members

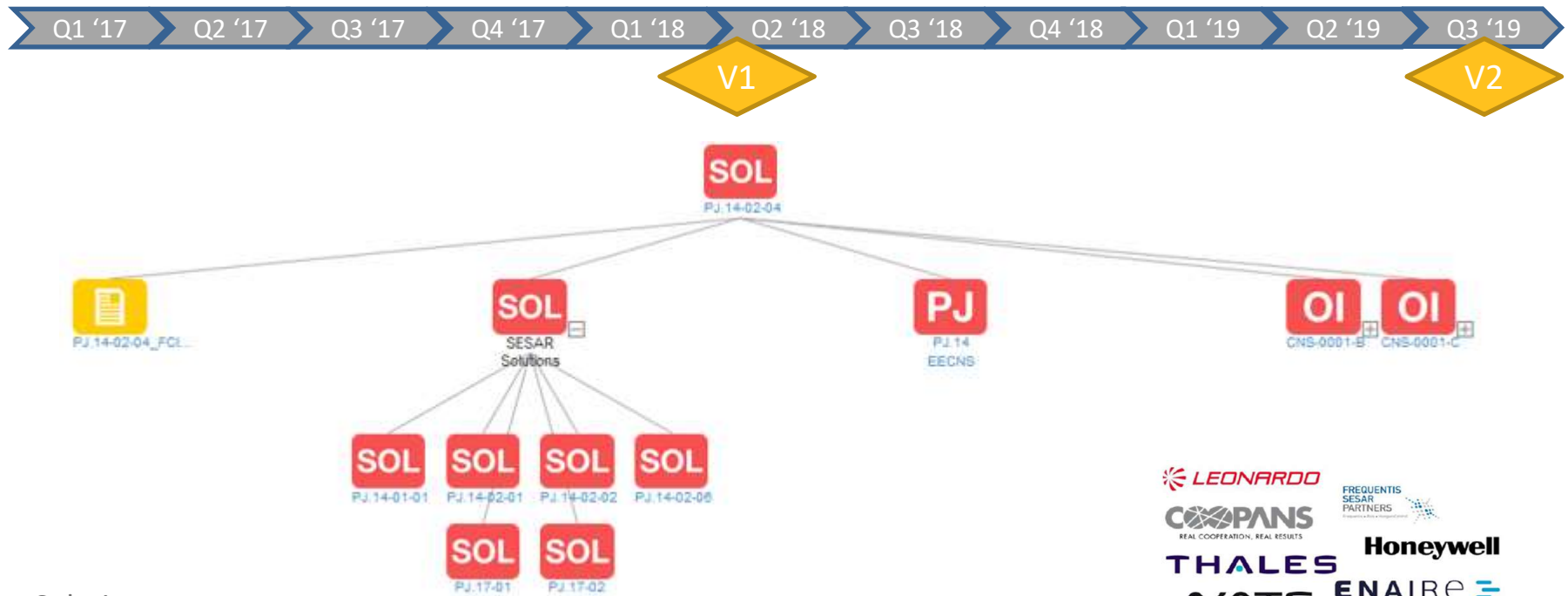


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Introduction and context



Solutions

- PJ.14-01-01: CNS environment evolution
- PJ.14-02-01: FCI Terrestrial Data Link
- PJ.14-02-02: Future Satellite Communications Data link
- PJ.14-02-06: Completion of AeroMACS development
- PJ.17-01: SWIM TI Purple Profile for A/G Advisory Information Sharing
- PJ.17-03: SWIM TI Green Profile for G/G Civil Military

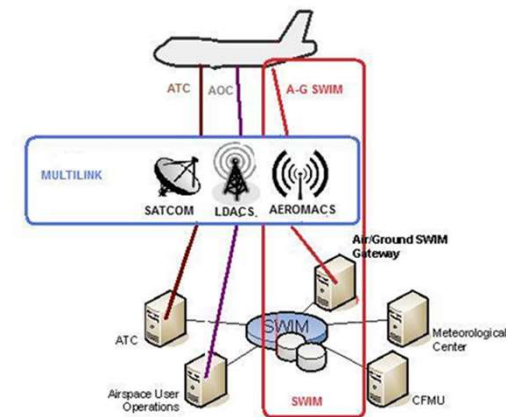


Objectives



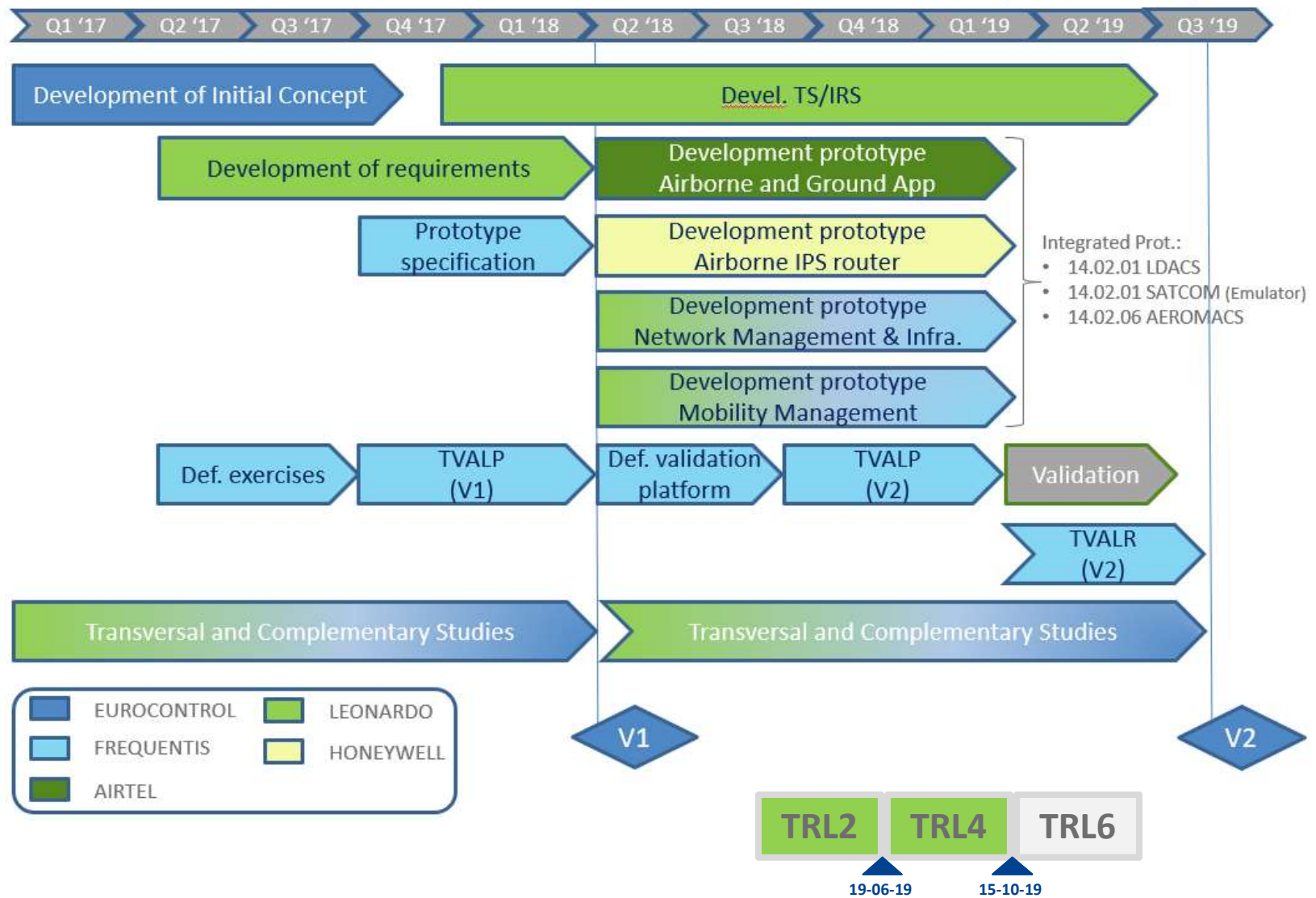
- Evolution of the SESAR1 concept of operations to support **future service concepts** such as **multilink**, **ATN/IPS**, **mobility** and trajectory-based operations with sector-less voice communications,
- Create **technical architecture**, **FCI requirements**, and data link gateway interface documents,
- Development and verification of **prototypes**,
- Address **transversal topics** including **security**, **safety**, and civil-military interoperability
- Support to **standardisation** activities

Solution End Maturity: TRL4 by end of wave 1 (2019)



Methodology – Major Tasks

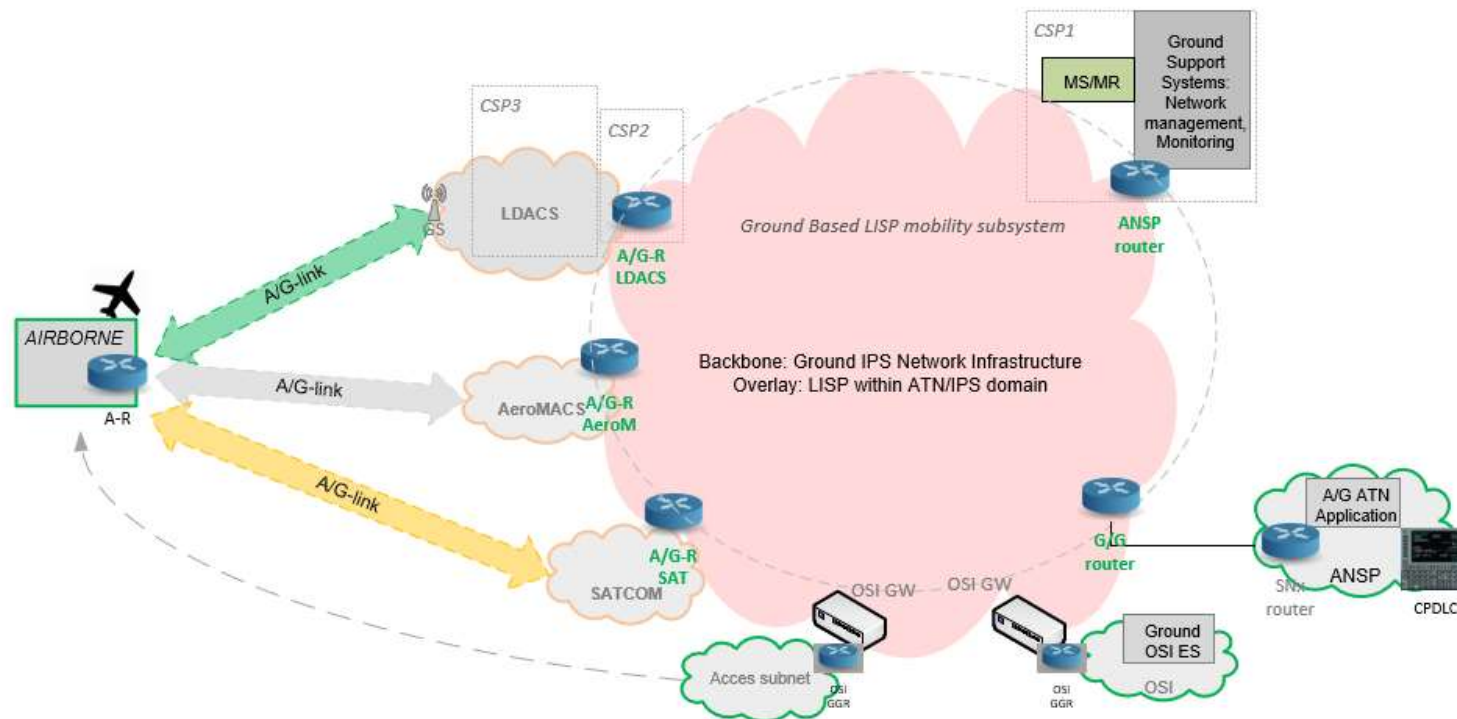
PJ.14 - EECNS



Methodology – Use Case

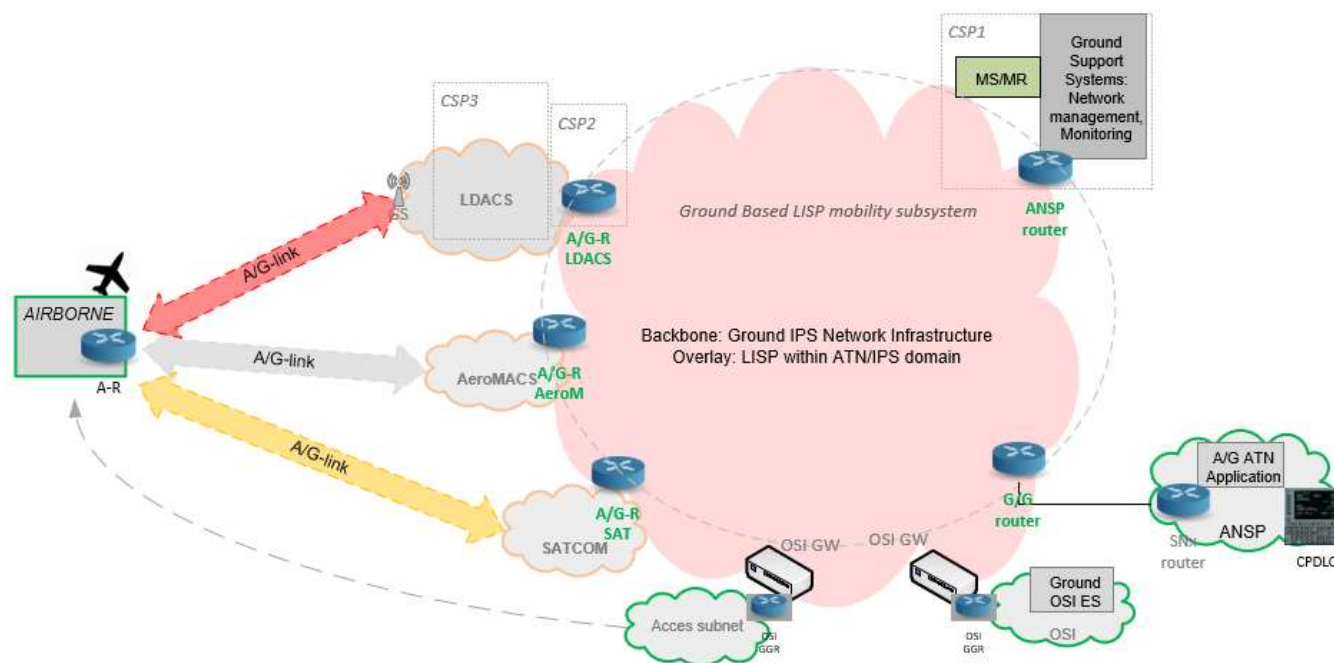
Airplane is connected to SATCOM and LDACS. Airborne router is configured so that **LDACS is primary link** and **SATCOM backup**.

CPDLC is logged on ATC center and EFB is logged in a SWIM service. Messages being exchanged for both services through LDACS.



Methodology – Use Case

A **break** occurs in the LDACS (primary) link.

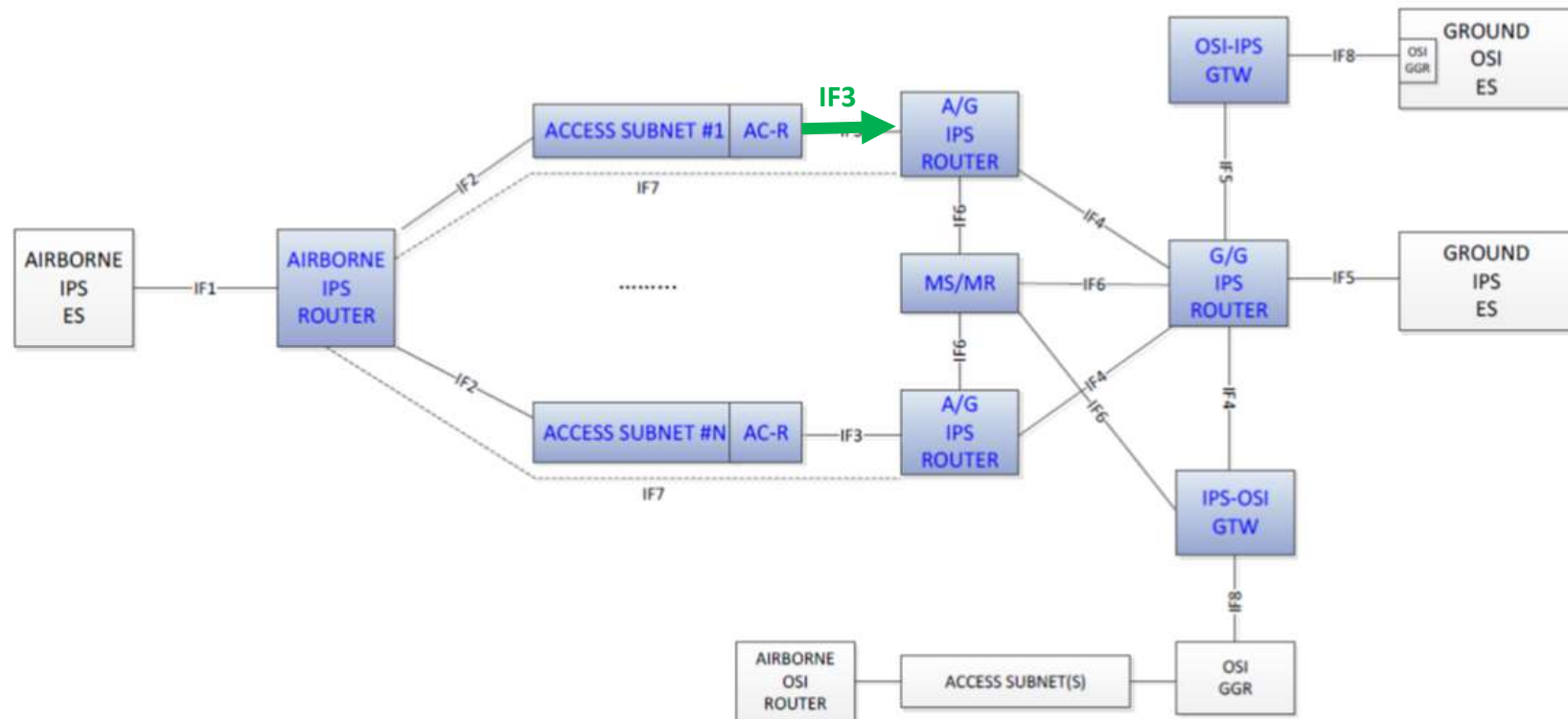


The diagram illustrates a network architecture for connecting Airborne and Ground networks. Key components and connections include:

- Airborne IPS ES** connects to the **AIRBORNE IPS ROUTER** via interface **IF1**.
- The **AIRBORNE IPS ROUTER** connects to multiple **ACCESS SUBNET #1** and **ACCESS SUBNET #N** via interface **IF2**.
- Each **ACCESS SUBNET** contains an **AC-R** (Access Router) and connects to an **A/G IPS ROUTER** via interface **IF3**.
- The **A/G IPS ROUTER** connects to the **G/G IPS ROUTER** via interface **IF4**.
- The **G/G IPS ROUTER** connects to **GROUND IPS ES** via interface **IF5**.
- The **G/G IPS ROUTER** connects to **GROUND OSI ES** via interface **IF8**.
- The **G/G IPS ROUTER** connects to an **IPS-OSI GTW** (Gateway) via interface **IF4**.
- The **IPS-OSI GTW** connects to an **OSI GGR** (Gateway) via interface **IF11**.
- The **OSI GGR** connects to an **ACCESS SUBNET(S)**.
- The **ACCESS SUBNET(S)** connects to an **AIRBORNE OSI ROUTER**.
- A green arrow labeled **IF2** points to the **AIRBORNE IPS ROUTER**.

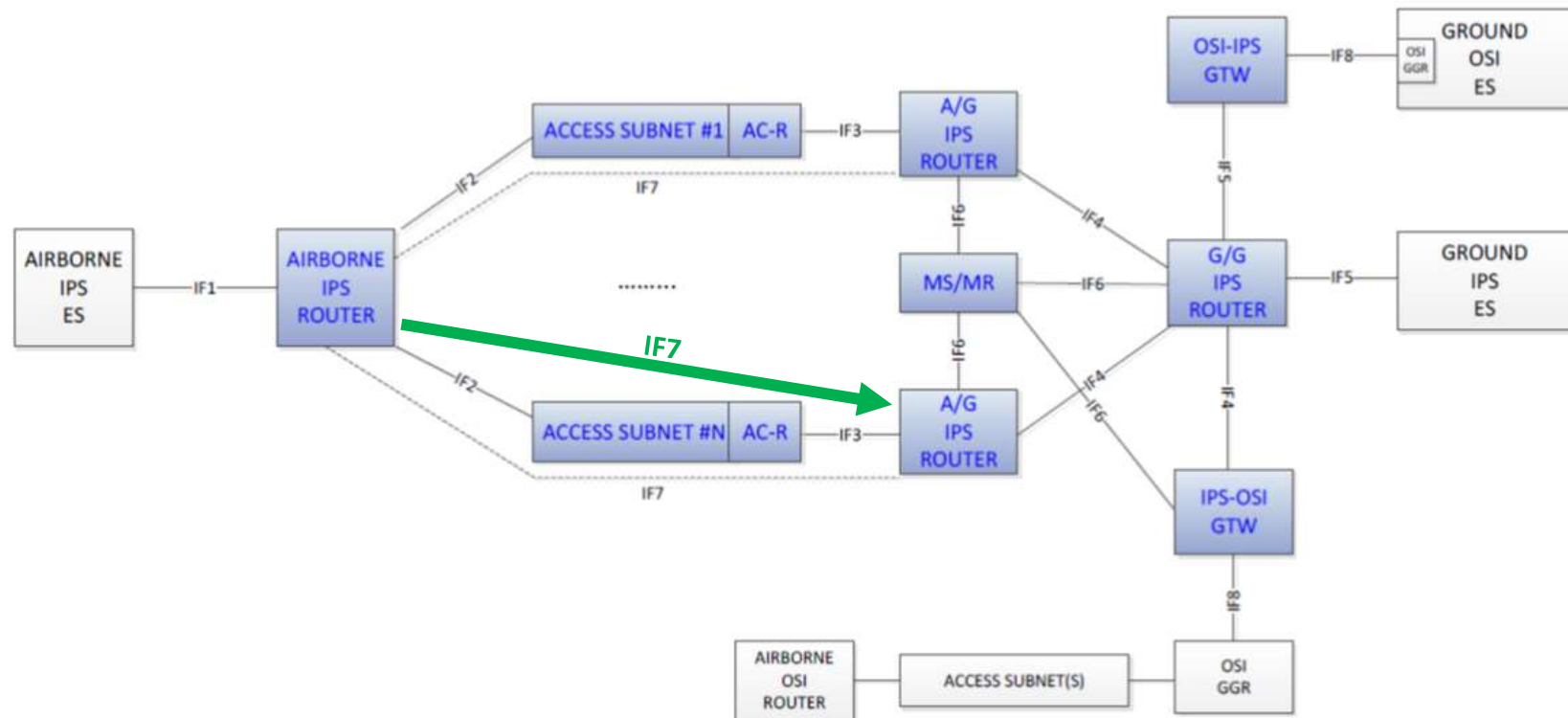
Methodology – Use Case

IF3 message informing the A/G router about the problem with the radio link.



Methodology – Use Case

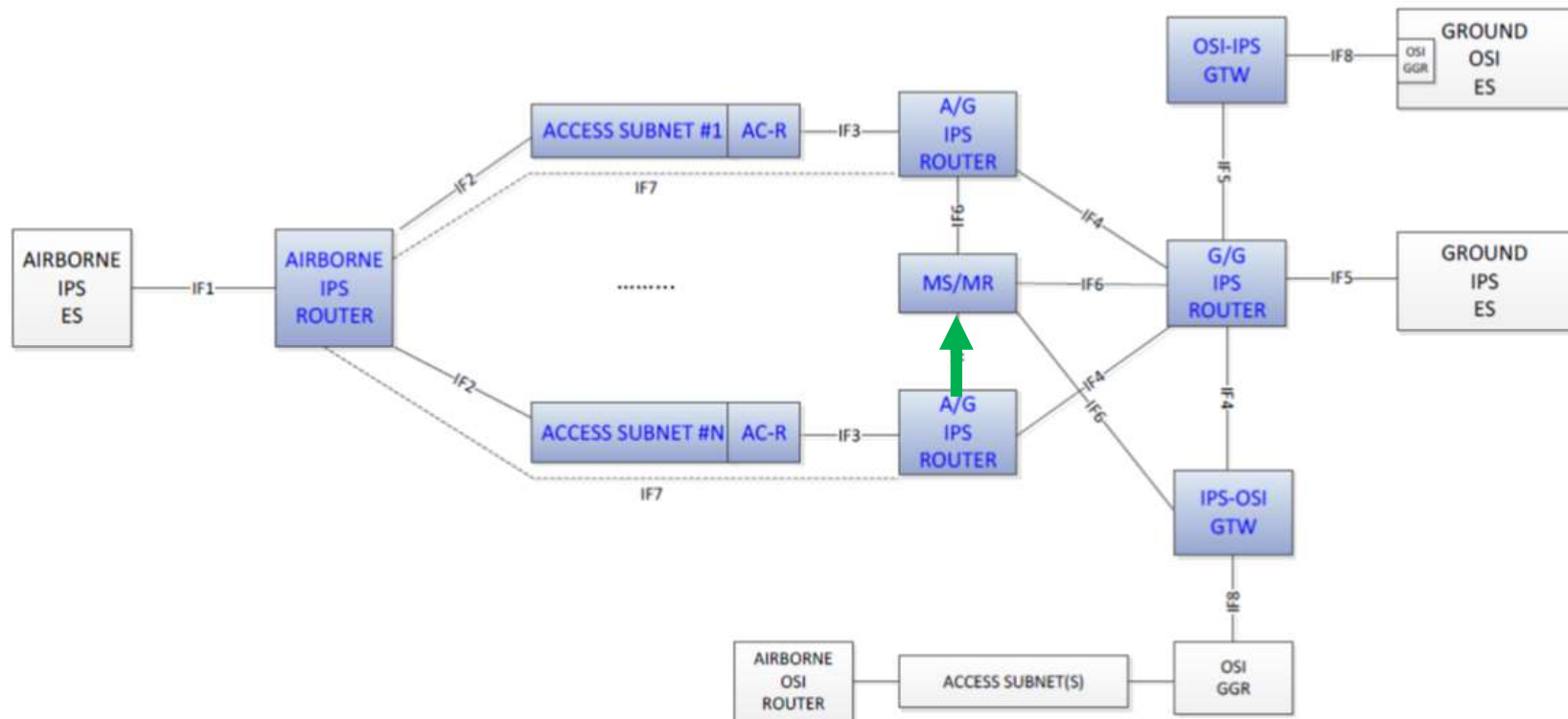
IF7 message sent through SATCOM to inform the SATCOM A/G router of the change



WE WILL RECONNECT WEBEX FROM THE OTHER ROOM . BBACK AT 11:30

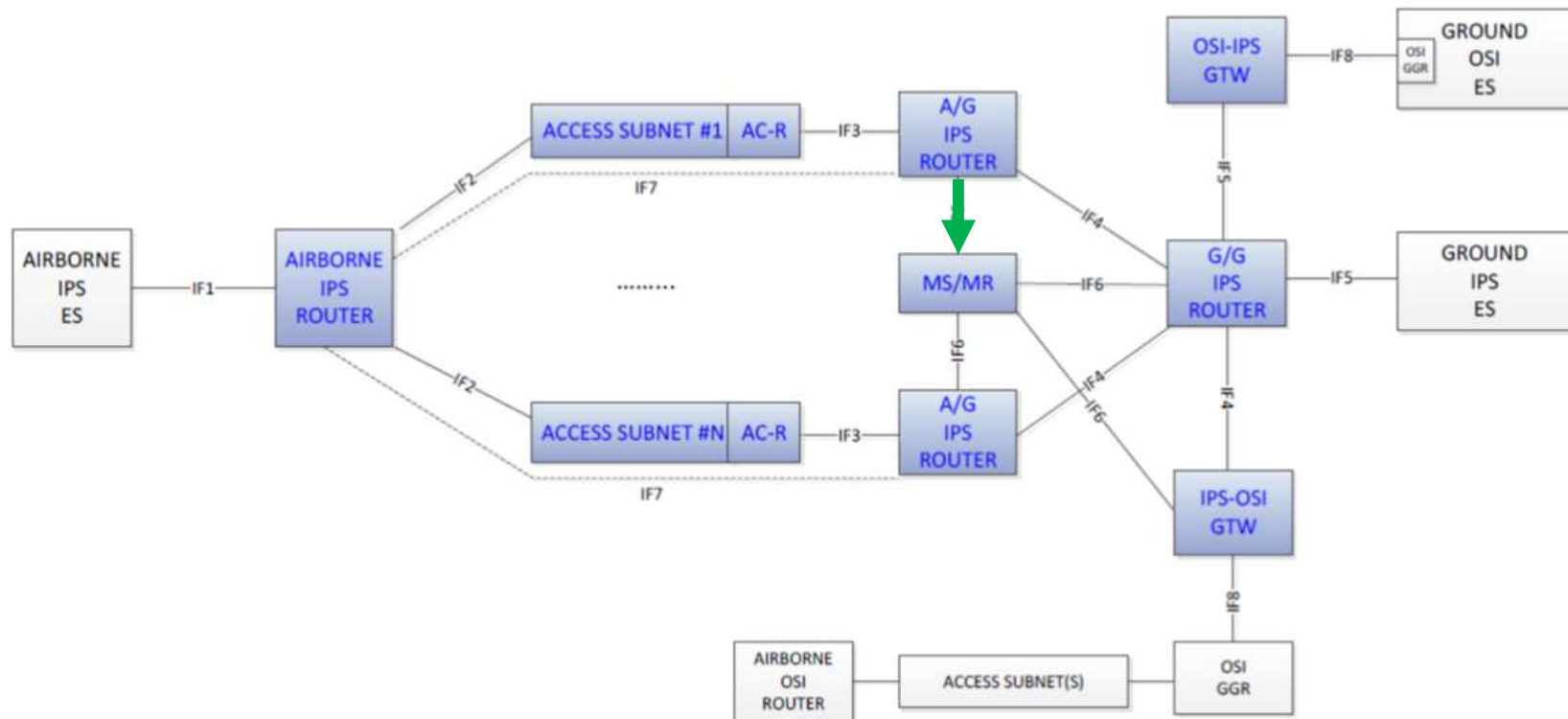
Methodology – Use Case

SATCOM A/G router sends a LISP update message to the MS/MR to register the airborne EIDs with better QoS



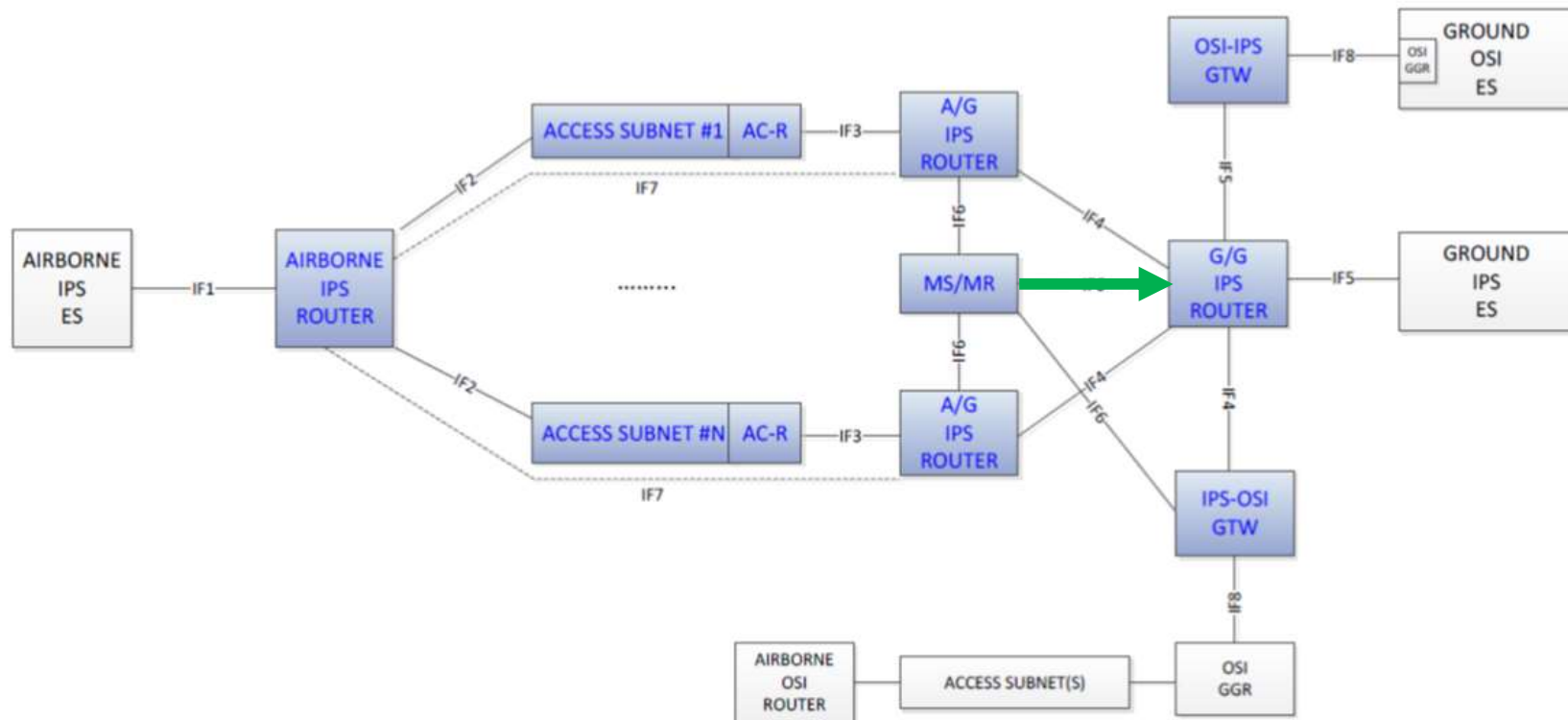
Methodology – Use Case

LDACS A/G router sending a LISP update message to the MS/MR to deregister the airborne EIDs



Methodology – Use Case

MS/MR sending a LISP update message to the G/G router to inform it about the changes

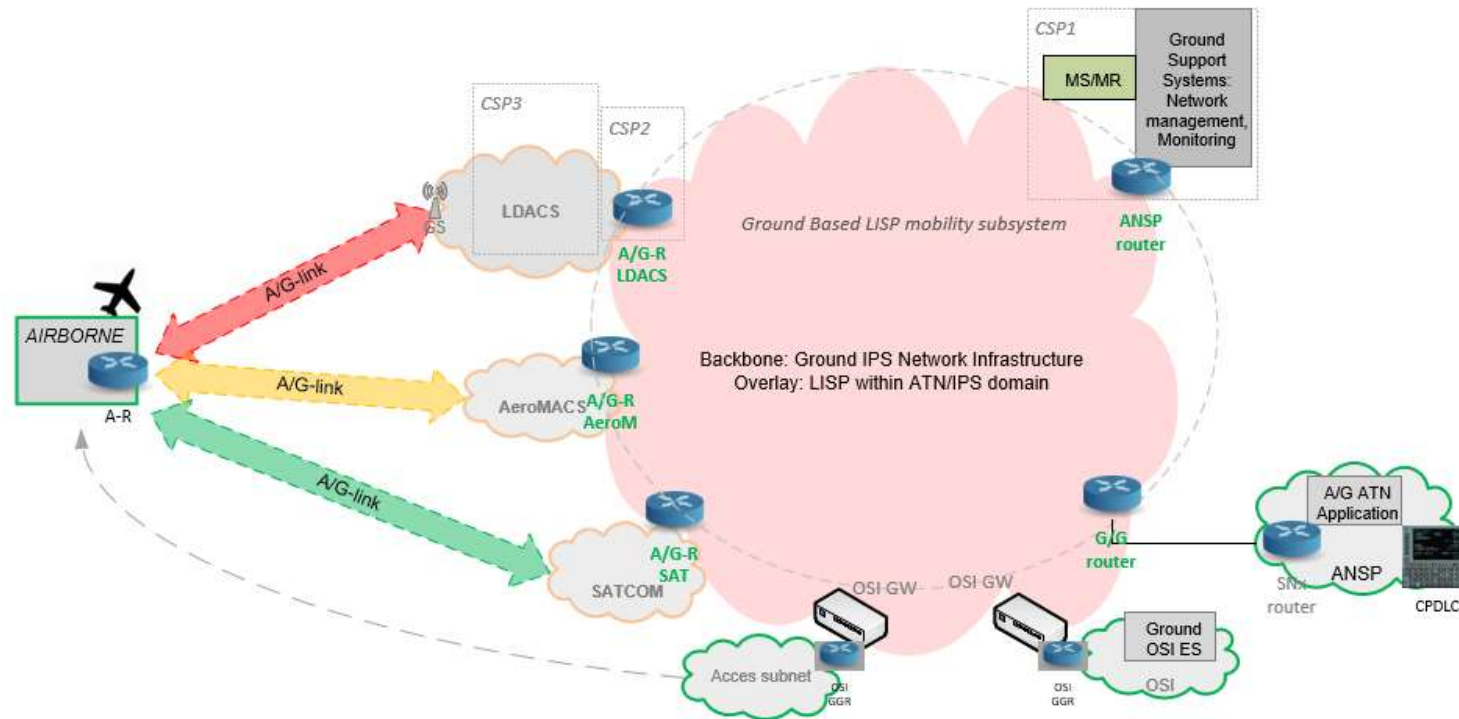


Methodology – Use Case

Airplane is connected to **SATCOM**.

CPDLC is logged on ATC center and EFB is logged in a SWIM service.

Messages being exchanged for both services through **SATCOM**.



Methodology – Technical Validation



EXE #01: FCI Multi-Link and IPS Mobility Management

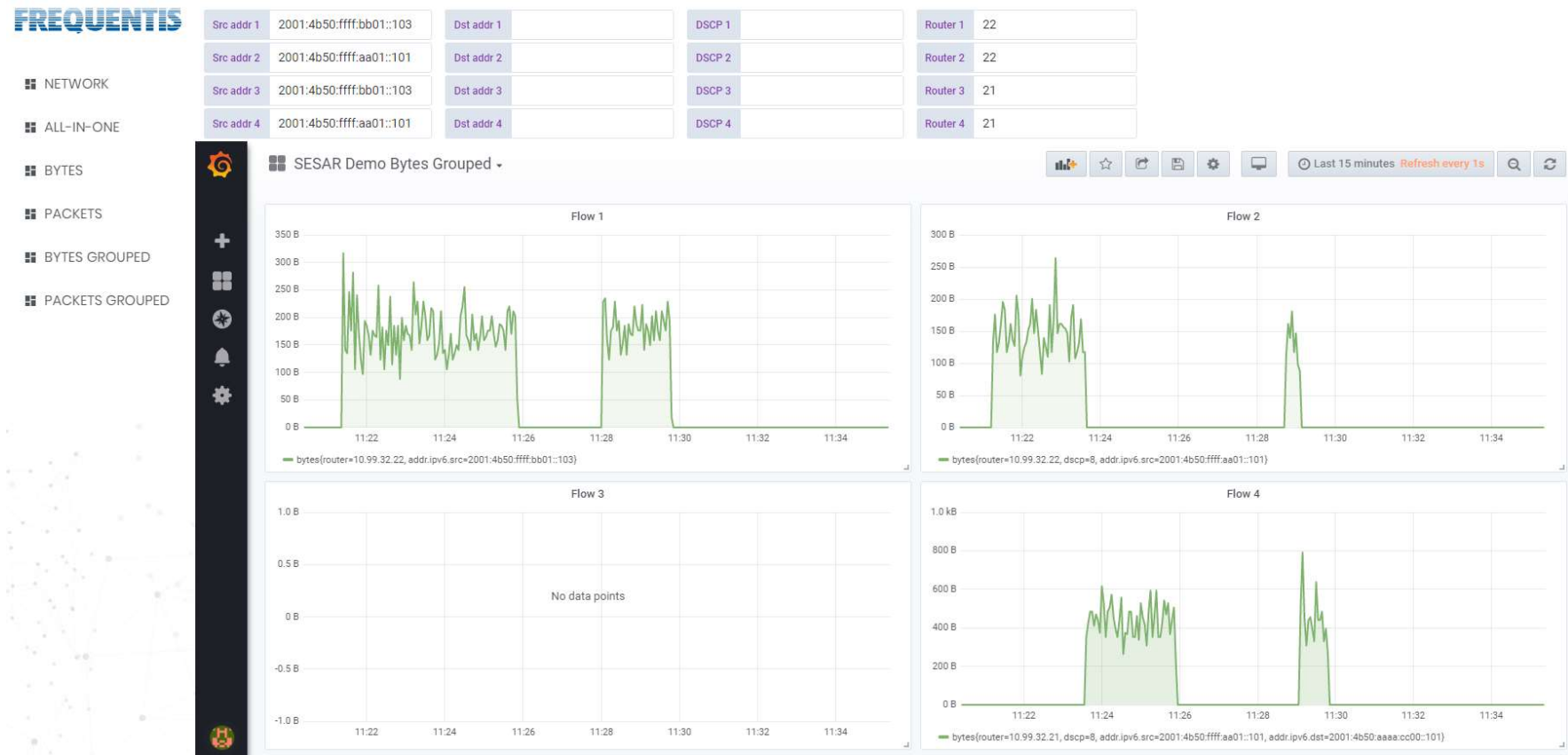
EXE #02: FCI IPS Data Connectivity and QoS Management

EXE #03: Interoperability with OSI Domains

EXE #04: Secure FCI Connectivity



Methodology – Visualization Tool



The figures show traffic from one EID being moved from SATCOM (represented as Flow 2) to LDACS (represented as Flow 4) while traffic from a second EID stays on the SATCOM link (represented as Flow 1).

Results



The system can announce all airborne EIDs over all available radio links according to the policy preference defined in the A-R.

GB-LISP performances were tested in a laboratory environment. The Pub/Sub feature solves the problem of the first packet loss since the G/G gets the information about available EIDs avoiding the need to look for this information when it needs to send traffic.

The system can route traffic to a more preferred route (radio link).

During the switchover between radio links of different type, no traffic was lost provided that the A/G-R is setup to use a static EID aggregate for all airplanes. In this configuration, the A/G-R will immediately route all traffic received from any airborne subnet.

An analysis on the overhead of the mobility solution was performed

On the ground, a very limited number of LISP messages (3) are required to register an airborne subnet and make it available to a system. No relevant information could be gathered on the air to ground interface due to the use of OSPFv3.

Results



The system can perform a mobility handover between Network Regions.

During the mobility handover between radio links of the same type, traffic is dropped. Please note that in this use case and due to the use of OSPFv3, the performance measurements cannot be considered relevant in the scope of the FCI validation. This type of handover is also validated by each sub-system (LDACS, SATCOM, AEROMACS) independently of FCI.

The system can handle the loss of an active radio link.

During a failover caused by the loss of the active radio link, traffic is lost in both directions until the A-R receives the link status and switches to the secondary link (less than 10 packets on approx. 600 sent in both directions).

The system can handle traffic prioritization and avoid degradation of high priority traffic in case of high volume of low priority traffic.

The system is capable of transmitting traffic with different DSCP values without altering them and it can also prioritize traffic according to the values. In case of congestion high priority traffic was not affected and lower priority traffic was dropped.

Results



Loss of active mobility devices was tested by bringing down G/G, A/G and MS/MR.

The loss of non-redundant mobility components led to loss of functionality until the components were restored. This behaviour is in line with the outcome of the initial FCI safety analysis which recommends redundant mobility components. Please note that due to the use of one A/G-R per radio link, this recommendation does not apply to this element.

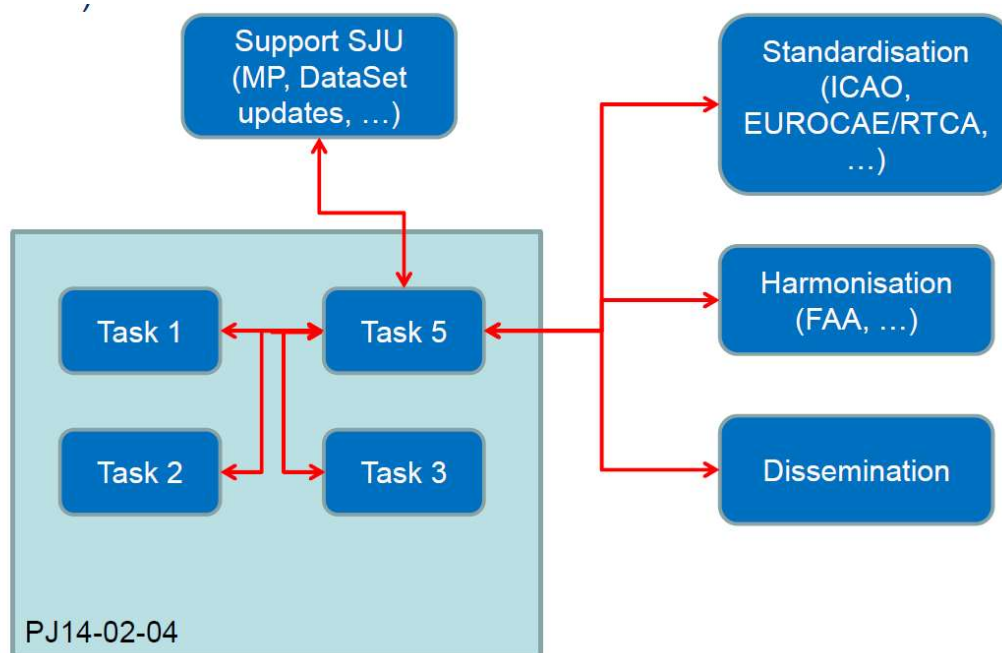
Loss of a redundant G/G router

In the direction from ground to air the traffic was affected in a negligible way when the G/G router failed, and the function was taken over by the redundant G/G router. In the direction from air to ground a significant traffic loss was experienced. This is the result of a non-optimized backbone network and the time can be minimized with further optimizations of the underlying network.

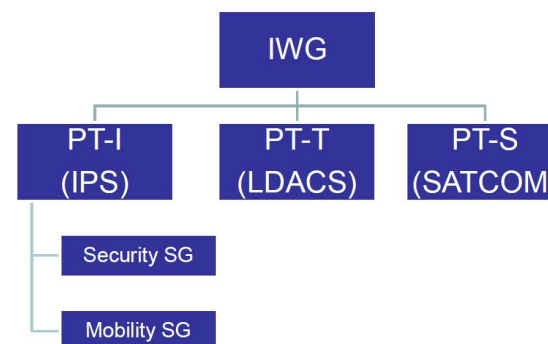
Loss of a redundant MS/MR

The failure of a primary MS/MR did not cause any traffic loss in the validation environment. Redundant MS/MR is recommended for seamless operation.

Standardisation Activities



- ICAO WG-I
- EUROCAE WG-108/RTCA
- AEEC



Next steps – Wave 2



The **objective is to achieve TRL-6** for the FCI elements to support ATN-B1 services, ATN-B2 services, future ATN-B3 services, AOC services and safety SWIM services, as well as interoperability with ATN/OSI systems and infrastructure.

The technical validation consists of **multiple technical validation exercises**:

- FCI Multi-Link and IPS Mobility Management.
- FCI Security Infrastructure.
- FCI scalability and performance.
- FCI digital voice communication.
- Lab tests with ATN/OSI FANS B or C airborne systems: to validate interoperability with ground ATN/IPS system through a ground OSI/IPS Gateway.
- Lab tests with an ATN/IPS Airborne Router prototype integrated with a Satcom (IPS capable) and with VDLm2.

Conclusions



- The solution validation demonstrates that multiple mobile prefixes residing inside an aircraft can be announced over multiple radio paths. Traffic routing is done according to a predefined policy residing inside the airborne router. On the IF2 in the aircraft link status and quality information can be communicated from the radio to the airborne router. This information can be used as a parameter for routing decisions made by the airborne router.
- Multiple aircraft can communicate with multiple sites on the ground by utilizing ATN and IPS traffic.
- Backwards compatibility towards currently deployed airborne and ground OSI end systems has been demonstrated with the OSI-IPS Gateway, that has been successfully integrated within the FCI.
- Roadmap to the next phase TRL6 has been completed.



Presentation name

Presenter's contact data

Thank you very much for your attention!



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Founding Members



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Results



Exercise Number	Exercise Title	Award Criteria
1	FCI Multi-Link and IPS Mobility Management	Resilience Embedded redundancy of the Communication Infrastructure Equipment for ensuring an adequate information sharing
2	FCI IPS Data Connectivity and QoS Management	Capacity - Fully support, via digital technologies to accommodate any levels of traffic flow and improve operational efficiency - Exploiting of all data sources to improve the Decision Support procedures both in daily operations and crisis management Safety - Harmonized and aligned data sharing according to roles and responsibility of all stakeholders
3	Interoperability with OSI Domains	Predictability - Harmonized and coordinated Operational Environment based on a real-time situation awareness - Improvement of reliability against the specific performance target level for the phase of flight under consideration - Full Interoperability for all legacy and future systems to ensure the data exchange timely and according to the role and responsibility of the stakeholders
4	Secure FCI connectivity	Security - Ability to manage Confidential and Safety Critical information in a very complex environment - Ability to share heterogeneous information according to different policies of confidentiality and according to the areas of Responsibility of the End-Users - Possibility to manage different Data Flows in segregated mode