

**Advanced Data Link Infrastructure Solution
for Next Generation of Air Traffic Management**



Selex ES

A Finmeccanica Company

The Air Navigation Service Providers (ANSPs) are primarily responsible for operational Communication (Data and Voice) ATS services and the associated infrastructure management both in terms of performance and availability.

Consequently, the ANSPs have to directly manage the Communication Network in order to ensure that the infrastructure is able to support them in the ATC operational framework.

The Selex ES Advanced Data Link Solution satisfies these mandatory requirements and the current performance constraints requested by ATM service providers concerning the Data Link Functionality.

It is an integrated system that allows current ATM/ ATC Operational services including Airline Operational Communications (AOC) service sharing the same infrastructure with optimum performance and reduced deployment effort.

The solution satisfies the CIR 29/2009 with the following specific features:

- Priority Assignment to ATC versus AOC messages in order to be compliant to ATC delay time constraints
- Reduced RF conflict and EMC pollution by a unique radio access able to support and manage different ACSPs and ATS End Users
- Ability in Performance Monitoring Figures concerning the ATC and AOC traffic lows
- Dynamic frequency management in operational scenarios depending on phases of light with enlargement of band usage consequently
- Modular and Scalable Architecture able to manage different ATC/AOC operational configuration according to service needs, encompassing ATC and AOC or ATC service only.

In addition, the Selex ES solution ensures the compliance to the operational concepts developed in R&D international programs as SESAR, NEXTGEN and CARATS as well.

THE CONTEXT

The increase of ATM performance requirements, due to the growth of air traffic and its complexity, rises the need to introduce an appropriate Data Link solution in order to support the Air Traffic

Services evolution according to the ICAO Technology Roadmaps and the ATM Key Improvement Areas as defined in ATM Master Plan.

In particular the 4D Trajectory Management Operational Concept needs to be supported by a reliable, scalable, modular and efficient Data Link solution.

This solution has to ensure the interoperability constraints towards the on-board system, as:

- Unique wireless communication platform able to support both ATC and AOC operational services
- Ensure a wireless Data Link connection towards the AOC Communications Service Provider (“ACSP”) network
- Ability to advise the on-board system about the VHF Data Link Mode 2 (VDL2) coverage availability

THE SOLUTION

An effective Air Transport system (ATS) allows people to reach their destination without issue or delay and where the various operators provide services efficiently at a lower cost, respective of the environments.

For these reasons, the increase of air traffic lows foreseen in the next years requires focus in some key areas around the Air-to-Ground Integration of ATS Users. This will necessitate a new communication system.



Leveraging on these topics, the Selex ES Data Link Solution conveys direct benefits in terms of:

- Optimization of Band Allocation, exploiting the outcomes and recommendations coming the Report EASA on CIR 29/2009 – May 2014 edition
- Improvement of Data integrity to guarantee the requested Safety and Security Target Levels according to the international Risk Classification Schemes
- Real Seamless Communication System to support ATC and AOC operational services to manage both En-Route and Terminal air movements



According to previous macro trends, the Key Technical Features of the Selex ES Advanced Data Link Infrastructure Solution are:

- Full compliance to CIR 29/2009 laying down requirements on data link services for the Single European Sky, ensuring the operational availability (Ao >= 99,995%)
- Compliance to Report EASA on CIR 29/2009 about the use of multifrequency, with consequently an optimization of DL infrastructure coverage in order to avoid frequency congestion. This configuration, including the multifrequency functionality, let to enhance the operational service throughput. In addition, the DL Infrastructure Solution is aligned in terms of functionalities and performance figures with the new CIR 716/2014 concerning the establishment of a Pilot Common Project (PCP) supporting the implementation of ATM Master Plan
- Provision of a unique ATC-graded Air-to-Ground infrastructure to Air Navigation Service Providers (ANSPs) which can be managed by the ANSP itself. It satisfies the QoS constraints (e.g. Round-trip (2-way) delay, functional and non functional constraints as Performance, RMA, Safety and Security)
- Full open, scalable and high level of modularity architecture according to the operational needs to support the management of ATS and AOC services in normal operating mode, or ATS services only for non-AOC airlines
- Allowing the deployment of unique Data Link Infrastructure Solution to manage all aircraft in the civil airspace. It makes ANSPs able to agree with the ACSPs for the use of the ANSP network in support of Airline Operation Communication (AOC) traffic services

OPERATIONAL CAPABILITIES

The Advanced Data Link Infrastructure Solution supports the Operational Concepts for ATM as defined in R&D international programmes as SESAR for EU, NEXTGEN for US and CARATS for Japan.

The following ATN B1 CPDLC services are currently supported according to the 29/2009 mandate:

- Clearance Request & Delivery
- Information Exchange & Reporting
- ATC Communication Management
- ATC Microphone Check

In digital mode in order to avoid misunderstandings to improve the safety target levels (STL) in normal daily operations.

The multifrequency functionality embedded in datalink solution its low latency figure, its high operational availability leads to a smooth , transition to safety-critical and high performance capabilities as requested in ATN B2 Baseline (Full CPDLC including ADS-C functionalities).

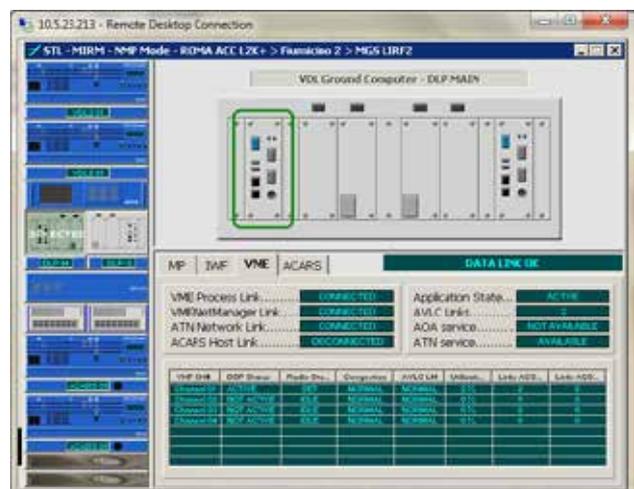
The following topics represents the context to be met by the ATN B2 implementation:

- 4D Trajectory Negotiation & Synchronization
- Operational Terminal Information
- Runway Visual Range
- Hazardous Weather Reporting
- Taxi Clearance
- Flightdeck based Interval Management

The Advanced Data Link Infrastructure Solution is also able to support de-facto standards like FANS 1/A baseline, if any.

The following topics are supported by FANS 1/A:

- Departure Clearance (Revisable)
- Position Reporting (ADS-C)



NON-FUNCTIONAL CAPABILITIES

Selex ES Advanced Data Link Infrastructure Solution is able to guarantee to the end-users (e.g. ANSPs) the satisfaction of the following non-functional capabilities, as requested and recommended by international directives, regulations and guidelines, before to be put into operations.

Performance monitoring and control

Each stakeholder, according its specific operational need, could require both performance monitoring and auditing features to check the overall infrastructure behaviour with respect to the

performance target constraints asserted by each different operational service. This argument could entails that every ANSPs will have to directly monitor and control the infrastructure behaviour, in addition to provide offline consultancy services by means of traffic low scenarios analyses and related metrics evaluation, if any.

The Selex ES Data Link Infrastructure Solution is actually able to support the ANSPs in these operational needs and it contributes to Eurocontrol Central Reporting Office statistics and global European network performance evaluation, as well.

Safety resilience

In general, data link infrastructure is very complex in terms of functional and architectural aspects, including the huge and heterogeneous number of involved stakeholders. This implies that also if it is designed in order not to have a single point of failure, it can suffer of many domino effects.

Selex ES Solution, however, has been developed according to the recommendations arisen by a dedicated Safety Risk Assessment coming from a Safety Management System (SMS) process. Starting from a Functional Hazard Analysis and the ANSP Safety Objective to be met, a list of Safety Requirements have been developed in terms of functional and architectural constraints.

This process ensures the compliance to the following regulations and standards:

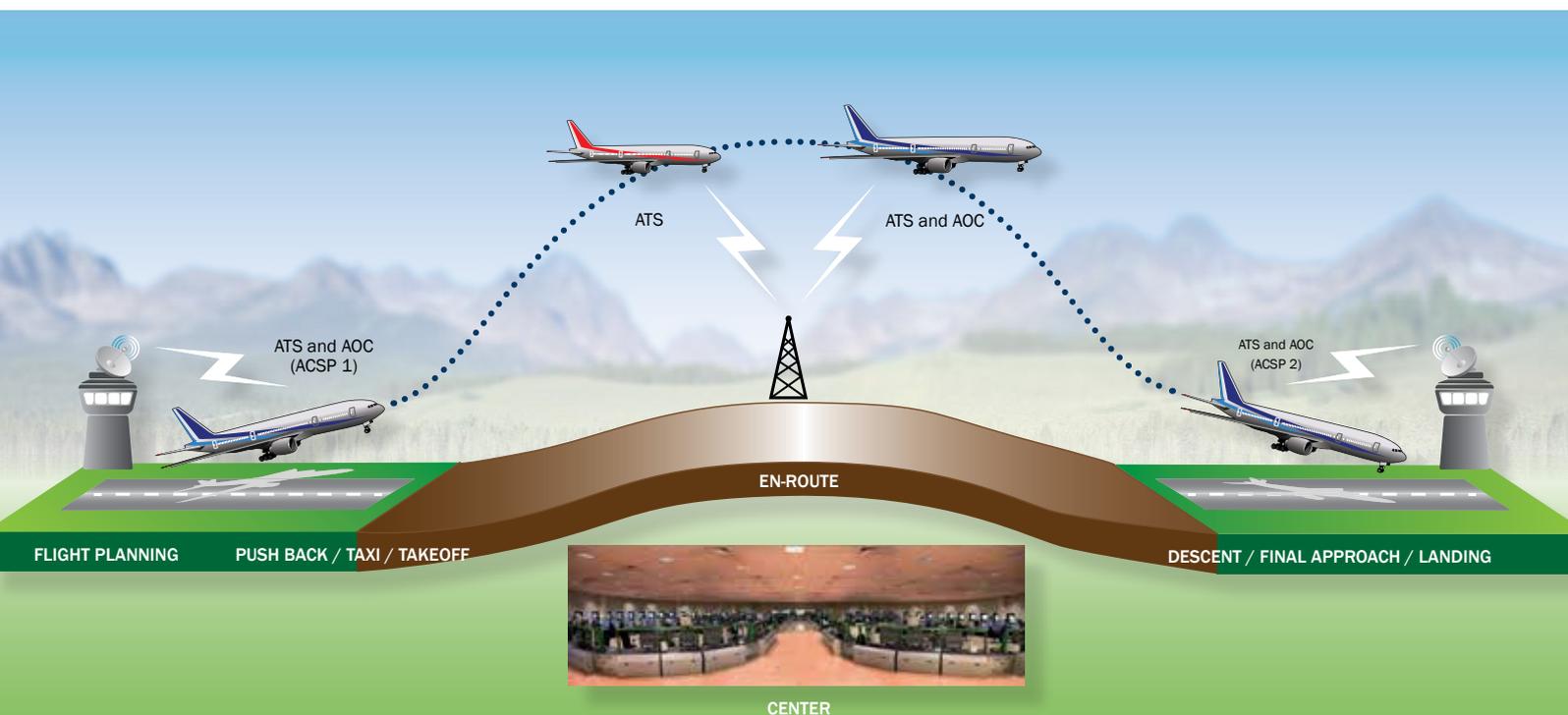
- (EU) No. 552/2004 concerning the Interoperability of the European Air Traffic Management Network satisfying the appropriate Essential Requirements (ERs)
- (EU) No. 482/2008 about the SW Safety Assurance in ATM
- (EU) No.1035/2011 laying down common requirements for the provision of air navigation services and amending Regulations (EC) No. 482/2008 and (EU) No. 691/2010
- EUROCAE ED-153 as acceptable means of compliance for the (EC) No. 482/2008 and (EU) No. 552/2004.

The development activities concerning the satisfaction of the above regulations and standards convey an accurate study for the optimum deployment of the Data Link Infrastructure Solution in terms of

functional and architectural aspects (e.g. coverage configuration and redundancy topics for both SW and HW items).

Security resilience

The Selex ES Advanced Data Link Infrastructure Solution includes the security and cyber-security countermeasures in order to protect the ground infrastructure perimeter, in terms of Confidentiality, Integrity, Denial of service and Trustworthiness.



ADVANCED DATA LINK INFRASTRUCTURE SOLUTION KEY POINTS

A long-standing experience in ATC Communication, the active participation in international R&D programmes as SESAR, and the valuable participation in standardization Working Group as CNS driven by Eurocontrol, the wide product and solution portfolio, the integration capability towards a seamless solution for ATM represent the foundation of the Data Link Infrastructure Solution.

The following topics recap the strengths of Selex ES Infrastructure Solution about the Data Link capability:

- Unique Ground Infrastructure Solution which supports all ATS Datalink and AOC services
- Open, Modular and Flexible Infrastructure Solution able to support the specific operational needs of different stakeholders. It follows any local procedures and site-specific requirements according to ATM complexity ;
- Efficient and effective Infrastructure Solution driven by Safety activities in terms of architectural design
- FAB Solution Optimization in terms of centralized management for the performance infrastructure parameters and monitoring, in addition to the inter-FABs interoperability interfaces capability
- EASA Report on CIR 29/2009 Fully Compliant.
- ATS functionalities embedded in an "ATC-graded" infrastructure solution in terms of functional and non functional capabilities (e.g. Performances parameters, Operational Availability; RAMS, etc..)
- Service Level Agreement (SLA) monitoring integrated with auditing functions to support all Stakeholders' needs

- Provision of maintenance activities (preventive and corrective) in order to guarantee an optimum infrastructure operational life cycle
- Future-proof Infrastructure Solution ready to support ATN B2 operational ATS Services

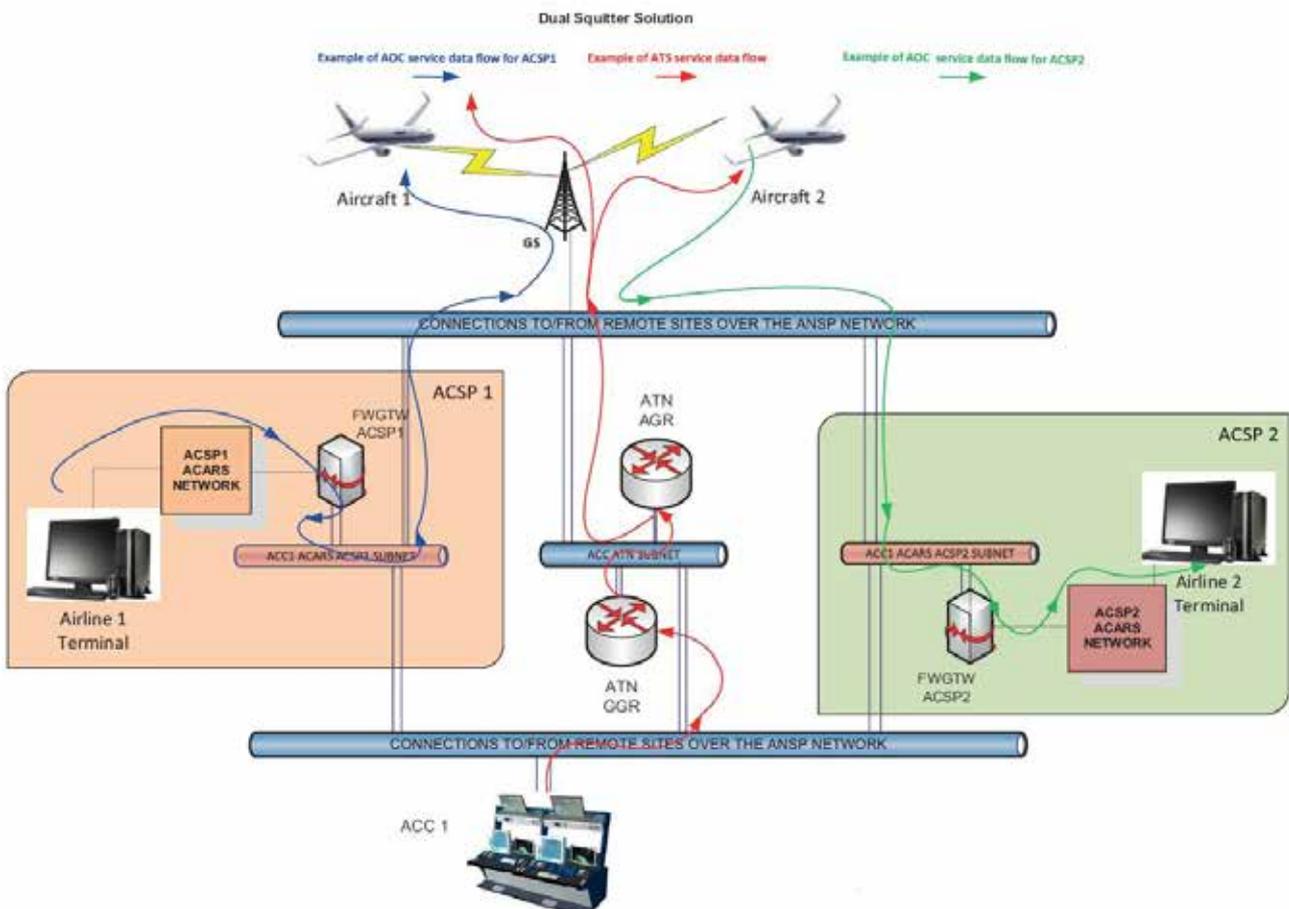
The Selex ES Data Link Infrastructure solution is already ready to support and manage the requested Civil-Military Interoperability as foreseen in the ATM Master Plan Roadmap.

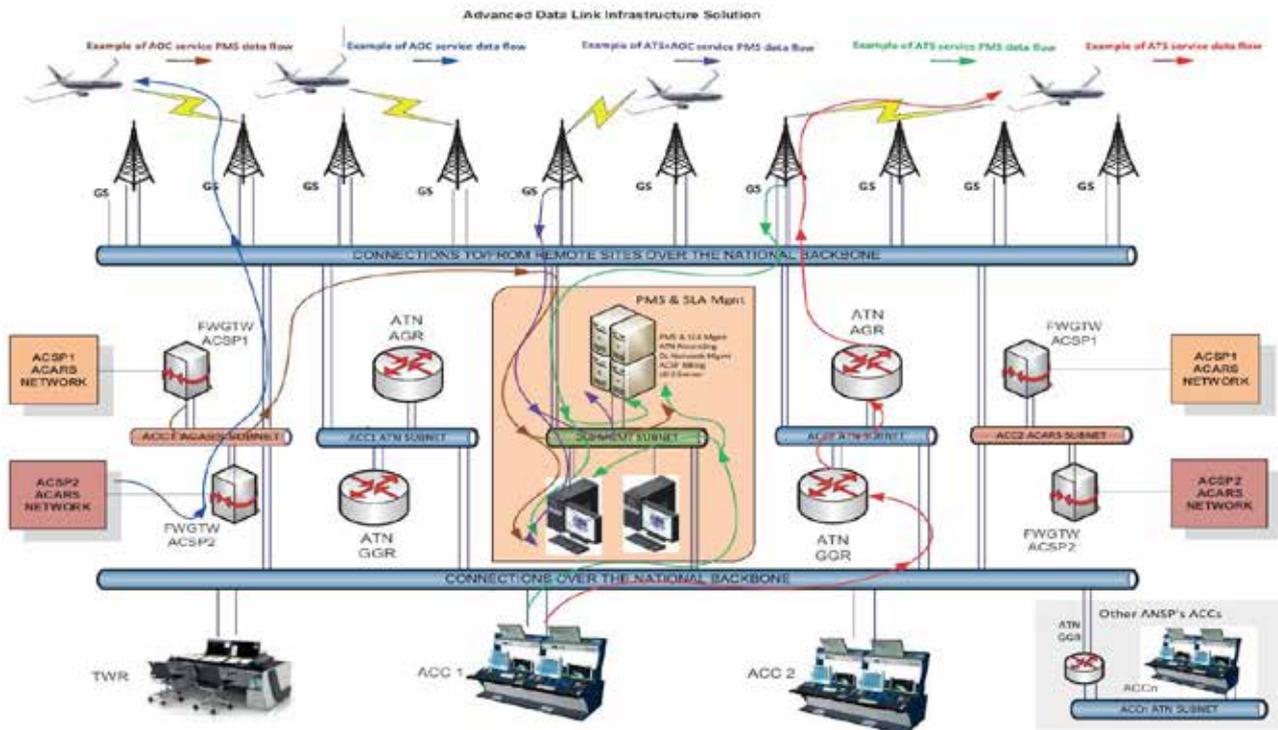
FOCUS ON "DUAL SQUITTER" FUNCTIONALITY

The "Dual Squitter" mode of operation (Selex ES patent pending). allows to a network of Virtual Ground Station (Single physical Ground Station) to full active support le following connectivity features:

- Establishing and/or maintaining the on-board system connectivity with the associated Airline for AOC services. This capability is achieved by a single Virtual Data Link Ground Station (MGS100) which is able to manage wireless separated links towards different aircraft having different ACSPs
- Establishing and /or maintaining ATN connectivity during the transfer of control among different Area Control Centres (ACC) / Airports, managed by different ANSPs

Therefore, the resulting system is based on a common wireless platform which can be integrated with different ground infrastructure typologies (ATS+AOC or ATS operation Only)





SYSTEM ARCHITECTURE

This section depicts the Selex ES Data Link Infrastructure Solution in terms of main elements.

It is a multi-protocol network composed by the following segments:

- A wireless segment (Access Network), managed by the MGS100 (Multi-mode Ground Station) component, implementing all required interfaces to support ATS and AOC services; namely:
 - VHF Data Link Mode 2, supporting ATN, AOC ACSP1 and AOC ACSP2 traffic flows according to Dual Squitter functionality
 - VHF ACARS
- A “Central Function” that helps MGS100 in implementing the mobility management policies in the multi-frequency environment, in order to optimize the aircraft tuning operations
- A “Ground” segment that marks the interconnection boundaries with the ACSPs network infrastructures, in order to exchange ACARS messages between the MGS100, the ACSPs networks and the airports, for both AOC services and ATS services relying on ACARS (e.g. current DCL)
- A Network Management System, composed by:
 - A Fault and Configuration Management System for every Network Element (EMS: Element Management System)
 - Performance Monitoring System (PMS) and Recording for legal purposes
- A “Ground” segment implementing the ATN protocol through the proper Network elements (Air Ground Router and Dual Air Ground Router) to support CPDLC and ADS-C functionalities among aircraft and ACCs or Airports in all phases of flight

Geographical connections between Network Elements are IP-based.

BENEFITS OF ADVANCED DATA LINK INFRASTRUCTURE SOLUTION

The international investigation activities driven by the EASA and established in the Report EASA on CIR 29/2009, concerning the actual business model of Data Link Infrastructure solution, to figure out all the key features and to evaluate the pros and cons or the potential issues and benefits at end users level (ANSP), let to highlight some key points of Selex ES Business Model for Data Link Infrastructure with respect to the EASA Topics.



BENEFITS OF ADVANCED DATA LINK INFRASTRUCTURE SOLUTION

ID	Report EASA Issue	Selex ES Solution	Benefits of ANSP Responsibility
1	<p>ATN protocol request high level of performance since it requires feedbacks on the connectivity status even if no operational messages are transmitted.</p> <p>A DL infrastructure based on ACSP network is tailored for AOA service, and not for ATS service which requires an ATN protocol more demanding to manage the Quality of Services (QoS) of ATS exchange messages.</p>	<p>The Selex ES Data Link Infrastructure Solution is an ATC-graded Network, which is designed to satisfy the ATS operational constraints.</p>	<p>High level of Performance to guarantee the requested different operational needs to support all the stakeholders in normal daily operations by an efficient and effective Data Link infrastructure</p>
2	<p>Technical problems related to frequency congestion.</p>	<p>The Selex ES Data Link Infrastructure Solution is able to support more ACSPs in the same time by the delivery of a unique communication platform based on a Virtual Ground Station concept.</p>	<p>The ANSP is able to provide the Data Link Services exploiting an optimum and well deployed communication infrastructure in terms of implementation cost and band frequency usage</p>
3	<p>Need for evidences about the compliance to the Service Level Agreement (SLA) to monitoring the infrastructures performances in charge of the organisation responsible of the data-link services.</p>	<p>The Selex ES Data Link infrastructure is able to provide the SLA figure about the Infrastructure Performances constraints.</p>	<p>The ANSP is able to monitoring and mitigate safety impacts due to SLA figure deviations</p>
4	<p>Potential Provider Aborts due to undetected interferences between AOC and ATS data traffic flow.</p>	<p>The Selex ES Data Link Infrastructure Solution lets to ANSP to directly monitor and control the infrastructure ATS and AOC performances parameters. In addition, it carries out the Data Link service with priority on ATS service.</p>	<p>The ANSP is able to supervise and oversight in terms of organisation responsible of the Data Link services operativity satisfaction</p>
5	<p>Current Data Link Solution is composed by a VHF Ground Station (VGS) unable to distinguish between the CM/CPDLC and AOC data traffic. This behaviour can delay the processing of ATS messages, entailing the round-trip delay.</p>	<p>The Selex ES Data Link Infrastructure Solution lets to ANSP to directly monitor and control the infrastructure performances figures. In addition, it carries out the Data Link service with priority on ATS service.</p>	<p>The ANSP is able to manage and support the increase of traffic lows to an efficient and unambiguous way to exchange information among Pilot and ATCOs in secure mode supported by a performance driven Data Link Infrastructure Solution.</p> <p>In addition the ANSP is able to evaluate the Data traffic flows for each services in order to account the infrastructure usage to Service Providers.</p>
6	<p>Need for evidences of too high level of frequency usage</p>	<p>The Selex ES Data Link Infrastructure Solution is actually able to support the Multifrequency functionality in order to decrease the level of single frequency usage.</p>	<p>The ANSP is able to assign and optimize the frequency usage according to different Air space complexity</p>
7	<p>Need for evidences of interoperability test success among on-board equipment, ATC Ground-based infrastructure and ACSP network</p>	<p>The Selex ES Data Link Infrastructure Solution include an integrated reference system platform to verify and validate different operational scenarios (e.g. handover, etc..) to ensure the respect of interoperability topics.</p>	<p>The ANSP with interoperability sessions can identify the Airborne equipment in order to define a white list in term of interoperability with Ground segments.</p>

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