Trust, from space to cockpit,
for one clever sky.

Future ATS Communications

Looking forward the modernization of aviation segment in Europe

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INTRODUCTION

At this point in time, with a pandemic situation hitting all around the world, air transport current scene is very foggy. It is the perfect moment to pause a little bit, take a breath and analyse how the aviation sector has evolved within the last decades to the present. Being a key instrument of mobility, aviation allows a continuous and accessible global movement and development, connecting parallel business and tourism accessible to almost everyone.

In the 90s, with a great similarity to the Industrial Revolution, the Air Traffic Management (ATM) sector experienced a huge change of thought. At that time, with the aviation growing at a fast pace, unidentified issues and capacity constraints started to become a global concern needing a change from voice to datalink as an enormous modernisation step. Even in more recent years, it was necessary to define future ATS communications that should cope with new necessities, giving raise to the introduction of new Air/Ground technologies complementing the current VDLm2 infrastructure and the introduction of the Unmanned Operations for changing the current ATM model to a more scalable one.

Given the importance of Europe in the global aviation market, the establishment of the SES framework in the early 2000s was pivotal, setting the fundamental keystones for the future growth of aviation and paving the way to European R&D (through the SESAR Joint Undertaking - SJU) with coordinated deployment activities (through the SESAR Deployment Manager – SDM). This framework was complemented with a strong committed regulation along the way. A major modernization process in ATM for civil aviation is currently taking place under this framework in Europe. ATM modernization is required to meet the needs for a sustainable air traffic growth not only in Europe but also at worldwide level, and therefore a key first aspect for this process is the identification and introduction of future communications technologies in order to meet performance, safety and regulatory communications requirements (i.e. those supporting ATS communications).

Credits: European Commission

In this context, long before the COVID-19 pandemic and way after the recovery is achieved, new air-ground technologies will play a key role supporting ATS communications and helping to handle the dramatic growth of the air traffic levels. Since around the world aircraft are being guided around the skies by Air Traffic Controllers keeping aircraft safe, unmanned aircraft will have a direct impact in ATS management.

The VDLm2 network will rapidly reach its limit in the European airspace core area owing on one hand to the limited capacity, technical characteristics and performance of the VDLm2 technology; and on the other hand, the renewal of the fleet with new models of aircraft, which will consume more data for AOC and ATC communications. On the other hand, the expected growth of unmanned and self-piloted operations will also increase the current air traffic load by several orders of magnitude. The digital age of aviation will revolutionize flights, and having in mind that our skies are already busier than ever, the airspace may collapse in coming years, with around 25,000 manned flights in the air complemented by a new type of aviation, the so-called Unmanned Autonomous Aircraft (UAAs).

TWO KEY CONSIDERATIONS FOR FUTURE ATS COMMUNICATIONS

In aviation, as stated in ICAO Annex 11, the goals of Air Traffic Service (ATS) communications aim at regulating and assisting aircraft in real time to ensure safe operations that are translated in a variety of benefits such as preventing collisions between different aircrafts, conducting and maintaining an orderly flow of air traffic, notifying appropriate organizations regarding aircraft in need of search and rescue aid, providing assistance to such organizations as required, and many other activities. In other words, ATS is used for flight information service, alerting service, air traffic advisory service and air traffic control service.

ATS communications are safety and time critical, taking into account that reliable QoS is mandatory and shall support ATC aircraft separation and ATM applications. Next figure shows some specific examples of current ATS communications:

- Aircraft Separation (ADS-C)
- CPDLC Clearances
- Frequency Changes
- Flight Information Services (D-ATIS)
- Exchanges of Trajectory Data

These communications are provided by Air Traffic Service Units (ATSUs), which may offer more than one type of service, mainly depending on the factors listed in the table below:

Taking into account the listed factors, the following key considerations shall be considered as basic characteristics of future ATS communications in terms of capacity, performance and greener aviation:

- **Capable to support ATC and AOC**
- **High BW and throughputs**
- **Global standardisation**
- **Efficient and robust spectrum**
- **Cost-Effective**
- **Seamless transition from current capabilities, avionics and infrastructure**
- **Synchronized deployment among all the stakeholders**
- **Scalable, supporting multiple CNS functions**

Figure 2. Key considerations for future ATS communications

Factor	Description
Traffic Type	Commercial air transport, general aviation
Traffic Density	Load of the airspace
Available Equipment	Facilities available for CNS communications
Meteorological Conditions	Hazardous phenomena typical for a specific area
Geography Considerations	Geography aspects such as mountains, desserts, open waters

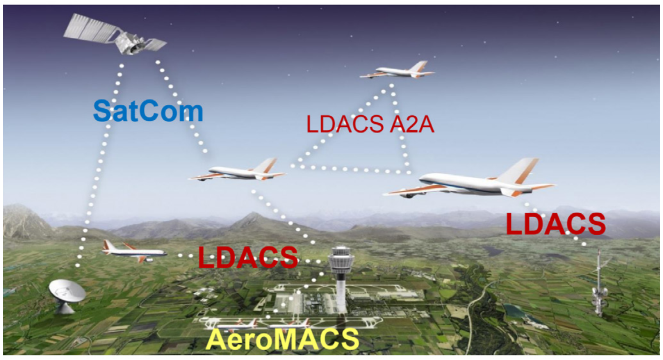
Table 1. Factors affecting the type of service

NEW A/G TECHNOLOGIES

For some decades now, the space-based systems have been enhancing ATM services. The current and expected integration of these technologies has delivered clear and measurable benefits to all stakeholders, now expected also to bring special improvement in the continental areas. For these type of communications, the European Commission (EC) and SESAR are analysing other A/G complementary technologies to VDLm2 (e.g. SATCOM, LDACS, AeroMACS) that can improve communications between pilots and air traffic controllers, decongesting the air traffic load and used as an alternative datalink communication, since VDLm2 has shown difficulties in achieving the target DLS performances, limiting the operational use and adoption of the datalink service.

Thus, it is indispensable that the current congested spectrum does not become the limiting factor for the necessary increase in aviation capacity, moreso being Europe already one of the world's most overcrowded airspaces and recent studies showing a capacity crunch expected in 2028-2030 (as envisaged in the Capacity Assessment Study performed by the University of Salzburg[1]).

The former PCP (IR (EU) Nº 716/2014), now being translated into Common Project 1 (CP1) (IR (EU) 2021/116), set the implementation of ATM Functionality 6 (AF6), introducing



M. Schnell, "Update on LDACS - The FCI Terrestrial Data Link," in 19th Integrated Communications, Navigation and Surveillance Conference (ICNS). New York, NY, USA: IEEE, April 2019, pp. 1–10

the concept of Initial Trajectory Information Sharing (i4D). The implementation of the Extended Projected Profile (EPP) is needed in order to support this future functionality. EPP group parameters and its use are defined in the ATS-B2 standard (ED-228), and provide valuable data to the controllers about the aircraft's intent. That is why a more robust, resilient and larger communications are needed in support of the current infrastructure deployed in Europe.

In this context, ESA, in close coordination with SESAR and in partnership with Inmarsat, launched in 2008 the Iris Programme, with the intention to develop a full ATS satellite

Credits: ESA - P.Carril

[1]CAS-VDL Mode 2 Capacity and Performance Analysis in 2019 within IP1 Project framework (CEF Transport Call 2017)

datalink service in order to support the SES objectives, taking advantage of Inmarsat's SwiftBroadband–Safety (SB-S) technology. With the SB-S, already acknowledged by ICAO for ATS oceanic use, Iris will be extended for use in continental airspace for the provision of datalink ATS services (referred to as ATN-B1 and ATS-B2). Iris is the most mature A/G complementary technology being ready for its entry into service by 2023 with the last phase of deployment starting in June 2022, the so-called Iris Satellite Global Solution, where the ESSP has been appointed to lead the final steps towards the service declaration and the achievement of the Pan-European certification process for the Iris Service Provider (ISP) granted by EASA.

With its ATN/OSI infrastructure compatibility, the system also includes a specific Gateway with cybersecurity mechanisms, protecting accordingly the exchanges between the aircraft and the ground from cyber threats. Hence, as a whole, Iris is providing a new digital communication means to the users (both airlines and Air Navigation Service Providers) for AOC and advanced ATS services whilst also being a secure and scalable system to future needs.

Iris is well positioned to work in a multilink configuration together with the current VDLm2 technology as well as other future terrestrial technologies like LDACS, in order to jointly provide a greater datalink capacity, giving also the benefit to air space users to be able to choose the most appropriate link to match their operational objectives. The resulting available bandwidth and throughput enable the growth of ATS data communications and offer a solution to increasingly demanding new AOC services. From the cost/benefit standpoint, it should be underlined that Iris allows per design the sharing of service cost between multiple users across several application fields (i.e. aviation and non-aviation users such as maritime or land mobile). Next figure shows the main benefits derived from Iris adoption in Europe:

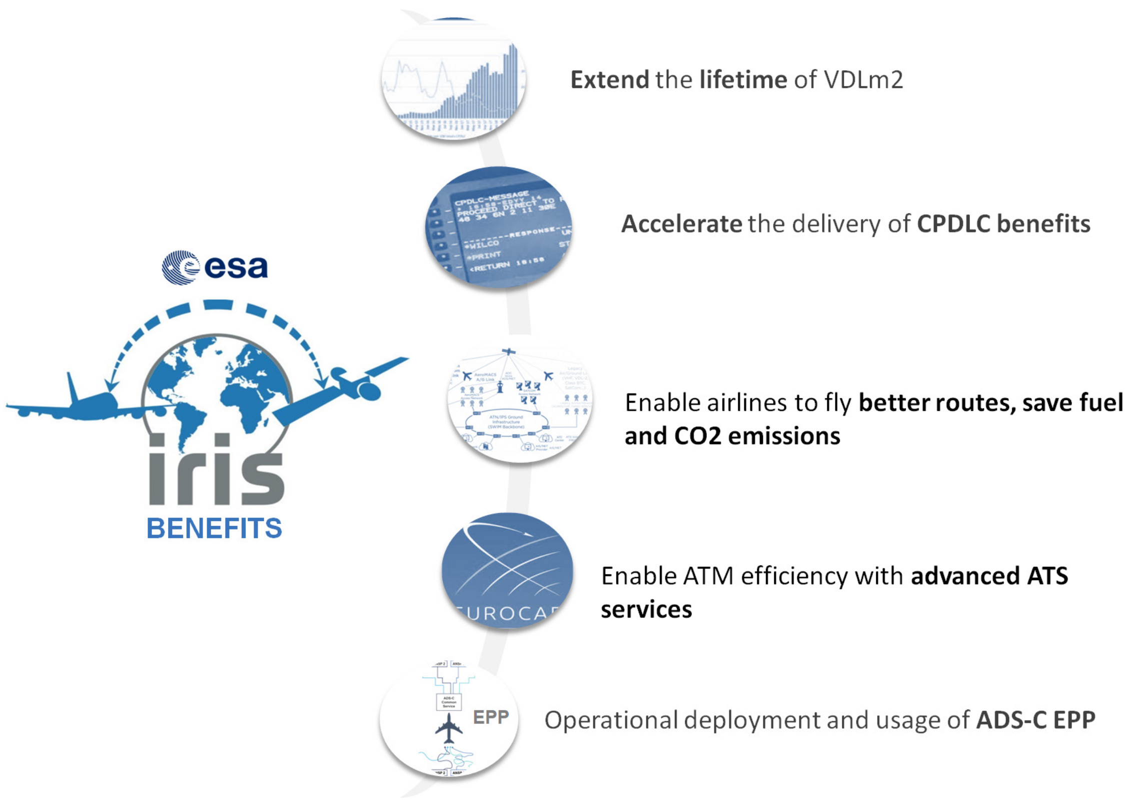
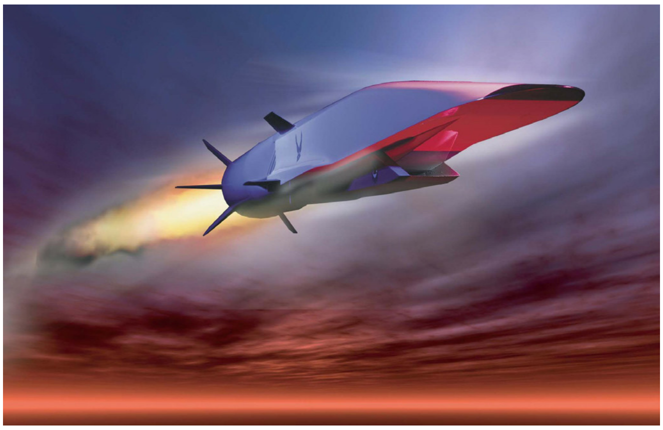


Figure 3. Iris benefits

As mentioned before, a major modernization process in ATM for civil aviation is currently taking place in Europe under the framework of SESAR. This modernization is required in order to meet the future needs of sustainable air traffic growth in Europe. Other A/G technology, apart from SATCOM, is the terrestrial technology LDACS. This technology is not only useful for ATS communications, but also is extended toward navigation and surveillance. With these extensions, LDACS could become another A/G technology for civil aviation in a future together with VDLm2 and SATCOM. LDACS uses a common ground infrastructure; such an integrated approach simplifies deployment and reduces costs for both deployment and maintenance.

Therefore, new air-ground technologies will clearly be an important element for ATS communications supporting VDLm2 as the current technology in terms of performance, where the UAAs will coexist in the short-medium term with the controlled aircraft increasing the number of flights in the airspace.

UNMANNED TRAFFIC MANAGEMENT



It is now a reality that the airspace and future flights will be improved by the digital age of aviation. In the short term, a crowded airspace will be shared with a new type of aircraft, the Unmanned Autonomous Aircraft.

A new scalable and digital system is necessary in order to cover all the future air traffic expectations that the current ATM systems are not able to. This new system will monitor and manage this increase in traffic. In this regard, the Unmanned Traffic Management (UTM), built to enable future applications, does not only refer to a single centralized system that mandates a single way of operating; it is a networked collection of services based on common rules. The challenge of the UTM is to design a system that can remain relevant as technology progresses and market necessities mature, without knowing what the future will bring. As an example, we could contemplate an ecosystem where different type of aircraft coexist whilst serving communities through new missions and flight profiles, such as self-piloted media drones, blood delivery, emergency services and passenger delivery.

Nowadays, the aviation community is analysing and considering the requirements needed for operating Unmanned Aerial Systems (UASs) within the current ATM infrastructure. Some studies, considering the implications of operating UASs in non-segregated airspace, are under analysis in several regions of the world (Europe in particular). Due to their immaturity, requirements to support command and control links have not been addressed in the Communications Operating Concepts and Requirements (COCR) document for the future radio system developed by Eurocontrol. Other communications services within UASs are expected to be similar to the current manned aircraft. In the short term, the number of these aircraft will represent a large load of an ATSU's traffic level. When providing ATS to an UAS, this may involve the relay of communication and execution instructions to and from a remote pilot; however, operational performance requirements between an ATSU and an UAS remain the same as those between an ATSU and any manned aircraft.

The underlying principles of and approaches to UTM frameworks in development are very similar around the world. In Europe, the system is provided by U-Space (SESAR); while in the US, NASA is developing a private model known as Unmanned Aircraft Systems Service Suppliers, which will be certified by the Federal Aviation Administration (FAA).

U-space is a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. As such, U-space is an enabling framework designed to facilitate any kind of routine mission, in all classes of airspace and all types of environment while addressing an appropriate interface with manned aviation and air traffic control.

With new companies looking forward to contribute in this scenario, the space-based systems will collaborate in delivering advanced flight tracking and management capability for Unmanned Aerial Vehicles (UAVs). By utilising satcom technology as the sector-leading global network of satellites and leveraging its substantial experience in ATM communications, the UTM needs of emergency services will be addressed and therefore able to remotely manage UAVs, increasing their range of safe operations in mixed airspace of manned and unmanned vehicles.

At the time of writing this paper and after the world crisis produced by the COVID-19, the expected grow in aviation is again gaining momentum. The issues and constraints in the current ATS communications have become a global concern. Thanks to the new Air/Ground technologies, with Iris almost ready, it will be possible to define a future ATS communications that should cope with the necessities of unmanned aircraft based on an a more scalable and efficient UTM model.

ACRONYMS

Acronym	Definition
ADS-C	Automatic Dependent Surveillance-Contract
AF	ATM Functionalities
ANSP	Air Navigation Service Provider
AOC	Airline Operational Communications
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Service
ATSP	Air Traffic Service Provider
ATSU	Air Traffic Service Unit
AU	Airspace User
CPDLC	Controller–Pilot Datalink Communications
CNS	Communication, Navigation and Surveillance
CP1	Common Project 1
DLS	Data Link Service
EC	European Commission

Acronym	Definition
EPP	Extended Projected Profile
ESA	European Space Agency
IR	Implementing Rule
ISP	Iris Service Provider
LDACS	L-band Digital Aeronautical Communications System
PCP	Pilot Common Project
QoS	Quality of Service
SATCOM	Satellite Communications
SB-S	SwiftBroadband–Safety
SDM	SESAR Deployment Manager
SES	Single European Sky
SJU	SESAR Joint Undertaking
UAA	Unmanned Autonomous Aircraft
UTM	Unmanned Traffic Management

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