White paper: Ubiquitous aviation connectivity with LDACS

Enabling CO_2 reductions and cost efficiency

L-band Digital Aeronautical Communications System (LDACS) is a new concept for aeronautical communication that offers benefits to airlines and Air Navigation Service Providers (ANSPs), and provides new opportunities for Communication Service Providers (CSPs) and Data Service Providers (DSPs). This secure broadband terrestrial communications system for aviation addresses the limitations of existing technology, offering an invaluable opportunity for modernisation. Undoubtedly, the future of aviation depends on preserving our climate, and a green recovery requires future-proof aeronautical communication networks that enable efficient air travel. The International Civil Aviation Organization (ICAO) agrees – LDACS is included in its Global Air Navigation Plan (GANP) and it initiated standardisation in 2016. In this paper, we will explore the advantages of LDACS over existing solutions and show how a low-risk deployment is possible. With LDACS, the future of the connected airplane becomes a reality.

Air Traffic Management

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Adapting to a changing world

Change is inevitable and, in many cases, progress is being driven by the development of technologies to make people's lives easier and to increase efficiency. ANSPs are seeking to take advantage of advances in automation to increase availability, streamline processes and reduce the risk of human error. As cyberattacks become more sophisticated, security is a higher priority than ever.

As climate change gathers pace, the aviation industry is under pressure to find ways to make air travel greener. And, of course, greener implies more cost-efficient, which is a perennial industry goal. At the same time, many airlines are aiming to accommodate more flights with the same or declining resources.

These factors are driving the pursuit of more accurate flight paths that save fuel and enable more aircraft to travel in the same airspace safely. To steer aircraft more precisely, teams on the ground and in the air must be able to exchange information at a growing rate and in greater detail. But because any changes to infrastructure must be on a global scale, the sheer size and complexity of the endeavour is holding back advancement.

CSPs are always seeking to future-proof their networks to better serve their client base, which includes both airlines and ANSPs. As part of this effort, they are looking for a competitive alternative for the upgrade of legacy terrestrial air-to-ground data links to complement existing satellite communication systems.

Time for innovation

For a long time, aeronautical communication technology used in-flight has been based on principles first developed in the 1940s. Inevitably, this means that existing solutions have deficiencies that are either challenging or even impossible to resolve.
In the future, aircraft will be able to connect to high-bandwidth communications when at the airport terminal. But once they get into the air, they must continue to rely on narrowband radio channels that are limited to a data throughput capacity measured in the low kilobits per second. For voice communications, both air-to-ground and air-to-air links are via open broadcast channels without any authentication, encryption or other embedded protective measures. Both voice and data communications equipment is either ground-based (using the HF or VHF frequency band) or satellite-based.

Due to the lack of available spectrum, existing HF and VHF data links (VDL Mode 2) are incapable of supporting broadband services now or in the future.

Technology vendors are developing enhanced capabilities for satellite-based communications. However, satellite technologies are not able to cover the high bandwidth demands of heavily congested flight routes and airports. They are also dependent on weather conditions and introduce transmission delays that would prohibit some applications. Therefore, in parallel, technology vendors are also working on ground-based broadband data link technology – LDACS. ICAO and other leading aviation bodies foresee the use of a combination of LDACS and satellite systems to enable future communications infrastructure, as described in the ICAO GANP.

Enter LDACS

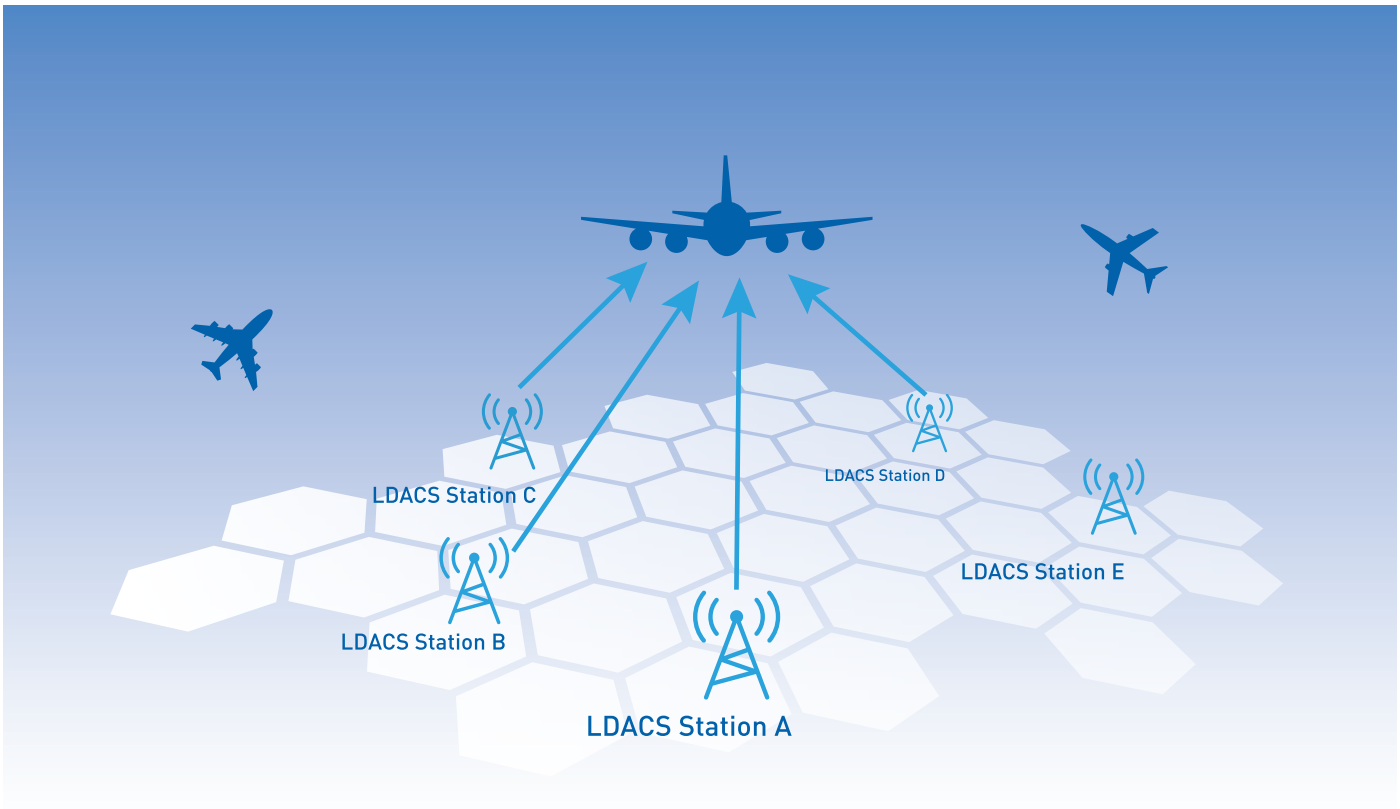
LDACS is a terrestrial aeronautical A/G radio system that enables IP-based data communication between

the cockpit and the ground. The IP-based (IPv6) data communication is standardised by ICAO, EUROCAE and AEEC, with plans for it to be the basis for future air-to-ground data communication. It will provide efficient, secure and high-bandwidth communication capability (voice and data) with embedded navigation capability standardised by ICAO. LDACS will be deployed in the aeronautical L-band (960 to 1164 MHz), sharing the spectrum with the legacy navigation and surveillance systems operating in this band. LDACS is highly spectrum efficient, designed to be placed within those parts of the L-Band where no other service could be allocated. To support future services, LDACS can provide data throughput from 550 kbps up to 2.6 Mbps depending on the adaptive coding and modulation scheme that is selected. This is 50 to 200 times higher than the throughput of the VDL Mode 2 system currently in operation.

LDACS is a cellular communications system that uses a coordinated multiple-access scheme, ensuring collision-free channel access with guaranteed low latency. Compared to LTE, LDACS is designed to meet the requirements of air traffic control to ensure that safety-critical data between aircraft and ground systems can be transmitted efficiently throughout controlled airspace. LDACS cell coverage in regular range mode is up to 200 NM. Since this is comparable with today's Air Traffic Control (ATC) VHF voice and data radio ranges, it enables ANSPs to reuse VDL Mode 2 radio sites and infrastructure.

Based on releated concepts to LTE/4G mobile radio, LDACS is proven, future-proof technology. It enables high-throughput, low-latency data link communications well beyond the scope of current and proposed VHF communications. Covering ATN/B1 and ATS/B2 (these terms describe a basis for a bundle of ATC services with common safety and performance requirements), LDACS is also expected to accommodate ATS/B3 as well as additional future services, including full 4D trajectory-based operations (TBO) and flight-centric air traffic management (ATM).

Figure 1: LDACS cellular concept



Finding a low-risk entry point

Frequentis is working with leading aviation bodies to identify and mitigate risks, enabling a smooth transition to LDACS for airlines, ANSPs and CSPs. Specifically, ICAO is developing LDACS standards to pave the way for a successful roll-out in the near future, and Frequentis is supporting this effort.

Frequentis anticipates gradual deployment, starting in areas where there is the greatest need for high-throughput data communications to supplement VHF data links with the same communications range. Airlines and airplanes either should or will get fewer airspace slots if they use old data link technology, as defined by the SESAR Joint Undertaking, since they will use airspace less efficiently.

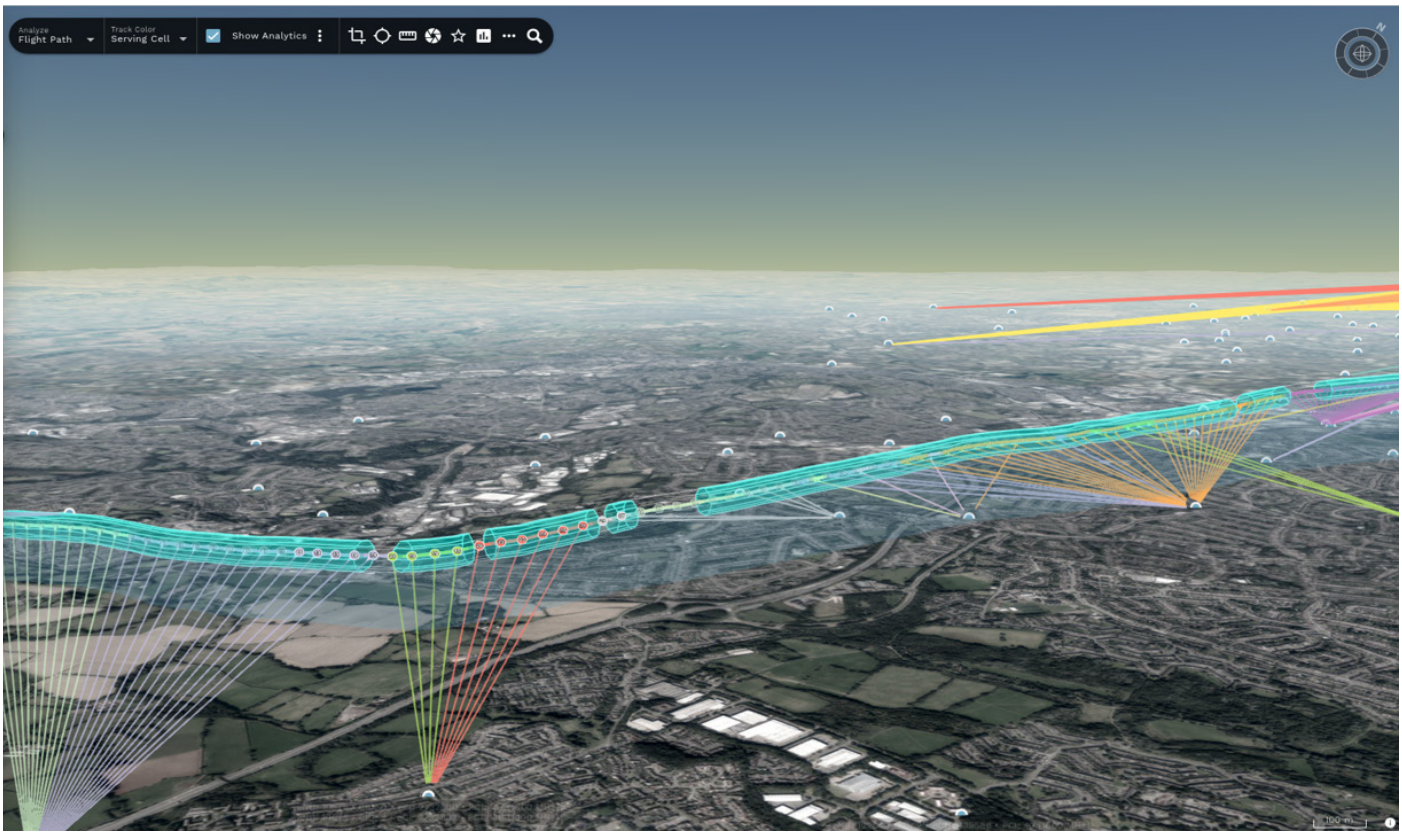
To reduce costs, the goal should be to reuse existing infrastructure onboard the aircraft and on the ground as far as possible. Frequentis therefore proposes a combined multi-mode LDACS/VDL radio, which will allow LDACS to be introduced to aircraft without additional antennas or avionics boxes. The standard IPv6 interface will simplify integration into existing communications infrastructure. By taking this approach, stakeholders can carry out a near one-to-one exchange of VDL with combined LDACS/VDL devices.

CSPs will be able to reuse current infrastructure, offering a broadband service where available as a complement to the VDL service. Since the coverage of a single LDACS ground station is comparable to VDL coverage, CSPs will be able to reuse ground station installations and network infrastructure. Following this path will enable the seamless introduction of a broadband service to airlines and ANSPs.

Enjoying the benefits

With significantly greater bandwidth and throughput, LDACS will offer much-needed headroom for aeronautical communications, removing barriers to innovation. The technology will also include prioritisation,

Figure 2: Optimal flight path through LDACS



allowing users to reliably transfer large amount of essential operational data (such as engine and maintenance data, graphical weather) without delaying time-sensitive ATC data traffic. The ability to share this operational data during flights will help airlines to support better fleet management and reduce aircraft turnaround times.

LDACS will also introduce unprecedented security to air-to-ground communications, helping stakeholders meet one of their highest priorities at a time when cyberattacks are increasing.

For CSPs, LDACS provides a viable option to ensure their networks are ready for upcoming demands. It meets their need for a competitive alternative to planned satellite systems in Aeronautical Operational Control (AOC) communication, and a necessary addition to ATC communication to meet the required availability for safety-critical communication by using several different links simultaneously. They will also benefit from high-throughput data links, priority management, protected aeronautical spectrum, resilience to cyber-security risks, native IP capability, and conformance with aviation standards.

Partnering with Frequentis

Frequentis will play a key role in flight trials that will be conducted in WAVE 3 of the SESAR Programme. The project will focus on the execution of flight test and validate that the LDACS air-to-ground datalink communication is ready for deployment. Within the project, Frequentis will provide the LDACS equipment in the aircraft and the required LDACS test infrastructure on the ground.

To carry out flight tests, the permission to transmit LDACS signals and the certification that the Frequentis LDACS equipment can be installed in an aircraft is required. The flight tests will be performed in summer 2022 in the Munich area.

In addition, Digital Voice – a concept to complement current analogue VHF voice communication - is part of this project.

The existing LDACS architecture will be enhanced to support digital voice services and the required LDACS prototypes for the digital voice solution will be implemented and used for validating the concept.

As the innovation leader in voice communication, tower automation systems and aviation networks, we have built on our expertise to push the envelope in bringing LDACS to market. Frequentis has fine-tuned a real-world roll-out scenario for LDACS, making us the ideal partner for CSPs and ANSPs taking the first steps into this new era for aeronautical communications.

LDACS is a key part of ICAO's GANP, SESAR's ATM Master Plan and Eurocontrol's future communications infrastructure (FCI). ICAO standardisation was initiated in 2016, with the aim to reach an applicable standard from 2024.

LDACS is coming – putting the future of the connected airplane within reach. Contact Frequentis today to learn more about preparing and getting the best out of this exciting new technology.

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