The Satcom Datalink Solution for a Greener Aviation

1. References

[1] Iris, The Satellite Communications System for Safe and Secure Air Traffic Management Data Links and Voice
https://artes.esa.int/satellite-communication-air-traffic-management-iris-overview

[2] IRIS Capacity Assessment Report;
https://artes.esa.int/iris-capacity-assessment

[3] https://www.atmmasterplan.eu/

[4] https://ec.europa.eu/transport/sites/default/files/swd20210009.pdf

[5] EURCONTROL Challenges of growth 2018 report

[6] EUROCONTROL 2021-2024 forecast update

[7] Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe.
https://ec.europa.eu/info/sites/default/files/research_and_innovation/knowledge_publications_tools_and_data/documents/ec_rtd_ia-ip-integrated-atm.pdf

[8] ED-120 Safety and Performance Requirements Standard for Air Traffic Data Link Services in Continental Airspace, April 2004

[9] ED-228A Safety and Performance Standard for Baseline 2 ATS Data Communications, March 2016

[10] https://ec.europa.eu/clima/eu-action/european-green-deal_en

[11] https://www.eurocontrol.int/sites/default/files/2020-03/eurocontrol-skyway-magazine-issue72.pdf

[12] https://ec.europa.eu/clima/policies/transport/aviation_en

[13] https://www.atag.org/facts-figures.html

[14] https://theicct.org/sites/default/files/publications/CO2-commercial-aviation-oct2020.pdf ICCT CO2 emissions from commercial aviation report

[15] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:JOL_2014_190_R_0005&from=ET

[16] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0116&rid=1

[17] Updated analysis of the non-CO2 climate impacts of aviation and potential policy measures pursuant to EU Emissions Trading System Directive Article 30(4)

[18] https://www.atag.org/facts-figures.html

[19] https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

[20] SkyHigh Economics Chapter Two: Evaluating the Economic Benefits of Connected Airline Operations

[21] European Environmental Agency Aviation Green house Gases Emissions based on Projections WEM – change in emissions levels from 1990

[22] https://ec.europa.eu/clima/policies/transport/aviation_en

[23] https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases-7/assessment

[24] EUROCONTROL Standard Inputs for Economic Analyses report December 2020

2. Executive Summary

Digitalisation and decarbonisation of air transport are among the key objectives of the European Commission (EC) Aviation Strategy, as highlighted in the Single European Sky ATM Research (SESAR) "ATM Master Plan".

Europe has one of the world's most congested airspace and the currently existing terrestrial infrastructure of VDL-m2 will face a capacity shortage no later than the 2024 - 2027 timeframe. This will cause a decrease in performance from an air/ground communications point of view, with a resulting reduction of the airports' capacity and a gap in the number of served flights. In this context, significant delays and non-efficient flight routes are also expected.

Despite the COVID 19 crisis, the European Union's (EU) air traffic is already back above 70% of the 2019 levels and is expected to be back at 2019 levels by end of 2023.

EUROCONTROL estimates that **by 2040 European air traffic will grow from 10.6 Million flights, in 2017, to 15.6 Million flights (+53%)** and that by then there will be a capacity gap of 1.5 M flights, corresponding to 8% of the total demand.

These 8% of flights would not be served, while the rest of the air traffic would be flying with reduced performance if new solutions will not be put in place.
At the same time, in the framework of the Green Deal, the EU is working on policies, technologies and infrastructure innovations to achieve the target of climate neutrality by 2050, with an intermediate target of at least 55% net reduction in greenhouse gases by 2030.
All sectors, including transportation and therefore aviation, shall contribute to reach this target.

In 2017 direct emissions from aviation accounted for about **3 to 5% of the EU's total greenhouse emissions** and for more than **2% of global emissions.**

An estimate based on data from the European Environmental Agency (EEA) indicates that **in 2019 the domestic and international aviation emissions in EU-27 accounted for at least 146 Million Tonnes of CO2 equivalent gases**, corresponding to 14% of the total EU transport emissions, while in the same year the worldwide global aviation emissions were **920 Million Tonnes of CO2.**

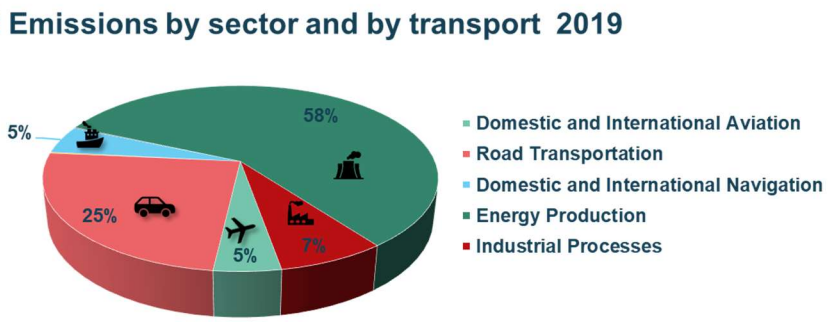

Figure 1. European break down of CO2 equivalent emissions per sector and per transport in 2019

In view of the fact that it will be challenging to compensate for the emissions derived by the air traffic growth forecast, the aviation community has identified several pillars as strategies for significantly reducing aviation related emissions. While technology optimisation of engines and the introduction of sustainable fuel will bring the highest benefits in terms of CO2 emissions reduction (impacting about 80% of the total aviation emissions), Air-Traffic-Management (ATM) modernisation shall also contribute to reduce aviation emissions with a lower but significant share. In particular,

the Single European Sky ATM Research (SESAR) programme has estimated that **ATM modernisation can influence between 5 and 10% of all aviation-derived CO2 emissions in Europe.**

In fact, among other factors, non-optimised flight trajectories and airport congestion imply higher fuel consumption and consequently higher CO2 emissions. Therefore, SESAR has recognised the technological modernisation of the Air-Ground Air Traffic Service (ATS) Data link as a key enabler for aviation decarbonization.
4D Trajectory Based Operations (TBO - or initial 4D) will allow in the short term to reduce separation among flights and optimise flight corridors and routes. The result will be less fuel burn, reduced delays, and lower emissions of carbon dioxide per flight. Furthermore, the capability for airlines to access real time data on the engines status by means of Airline Operational Communications (AOC) will also contribute to monitor and optimize fuel consumption.

In this context, in 2008, the European Space Agency (ESA) kicked off the Iris program as a contribution to the Air-Ground Air Traffic Service (ATS) data link services in line with Single European Sky objectives.
Iris is a satellite based Data Link Service (DLS) funded and promoted by ESA. It is based on Inmarsat Swift Broad Band-Safety (SBB) system, already approved for safety services in oceanic areas, which through the Iris program will be extended for use in continental airspace providing both Data Link ATS services (referred to as ATN B1 and ATS B2) and Airline Operational Communications (AOC). Iris datalink will provide a safe, secure, scalable, and potentially global complementary

component for the European ATM. More information can be found in the Iris White Paper [1].

Further to the ATN-B1 and ATS-B2 applications, Iris supports the ADS-C EPP applications, which are key enablers for TBO or i4D to allow for route optimisation and thus reducing delays, fuel and delivering a better flight efficiency to reduce CO2 emissions per flight. Furthermore, the support of AOC traffic includes both meteorological data and Airline Information Service Domain (AISD) data, functional to optimize not only the aircraft trajectory but also the fuel consumption.

Iris is therefore a ready to use technology that can timely deliver the ATS performance required by ATM modernisation, in a complementary fashion to terrestrial VDL Mode-2, contributing to aviation decarbonisation

To exploit this to the maximum extent, a critical mass of Iris equipped aircraft is needed, which can only be achieved through a suitable deployment plan and a supporting regulatory environment as well as an appropriate funding scheme including ad hoc incentives for airlines and Air Navigation Service Providers (ANSP).

The Iris capacity study [2] has already assessed that the current Iris system can provide enough capacity to cover what would be needed to successfully offload VDL-m2 in the short, medium, and long term (up to 2040), also identifying the number of Iris equipped aircraft that would be required.

Looking at the sustainability aspect, with this paper we aim at quantifying the potential benefits directly related to the Iris datalink deployment in Europe in terms of CO2 emissions reduction thanks to the data and applications supported by Iris and associated economic savings.
In this analysis, the data from the European Environmental Agency (EEA) on aviation pollution and the 5-10% estimate for CO2 emissions reduction identified by EUROCONTROL for the whole ATM modernisation have been used together with some assumptions on the Iris equipage rate ramp-up in order to derive an estimate of the Iris green benefits.

First, the overall ATM modernisation share of the CO2 emission reductions has been estimated over the 2024-2040 timespan:

the overall ATM modernisation benefits have been estimated to bring an average CO2 emissions savings per year of up to 16 Million Tonnes and a cumulative saving over 2024-2040 timeframe of 125-250 M Tons CO2 .

Then, it has been considered to have a progressive deployment of technologies and applications to achieve the mandate of TBO operational by end of 2027. Further to this, it has been assumed that SatCom is active during all flight phases except Airport operations (resulting in 85% of the flight) and that SatCom complements for 50% of time current terrestrial technologies.

Finally, to assess a more realistic Iris share of the CO2 emissions reductions and related savings, two Iris equipage rate ramp-up assumptions have been used to scale the benefits accordingly.

The first assumption is based on the Equipage rate considered in the Inmarsat Cost Benefit Analysis Scenario " Enabling ATM Masterplan benefits" which reaches 90% fleet equipage by 2040.
Based on this assumption, the estimate of the Iris benefits over the 2024-2040 timeframe are the following:

- The Iris related average CO2 savings per year in Europe over the 2024-2040 time span is estimated to be around **1.5-3 M Tonnes**
- Cumulative CO2 savings of **27-55 Million of Tonnes CO2** (with the 5% and 10% assumptions, respectively, over the 2024 – 2040 timeframe);
- CO2 emissions saved per year will reach **up to 6.5 M Tonnes in 2040**

From a financial point of view, these CO2 emissions savings are associated to a cumulative fuel savings of up to **18 M Tonnes** over the 2024-2040 timeframe, resulting in up to **3.5-7 B EUR** savings (average **200-400 M Eur /year**) just for lower fuel consumption.

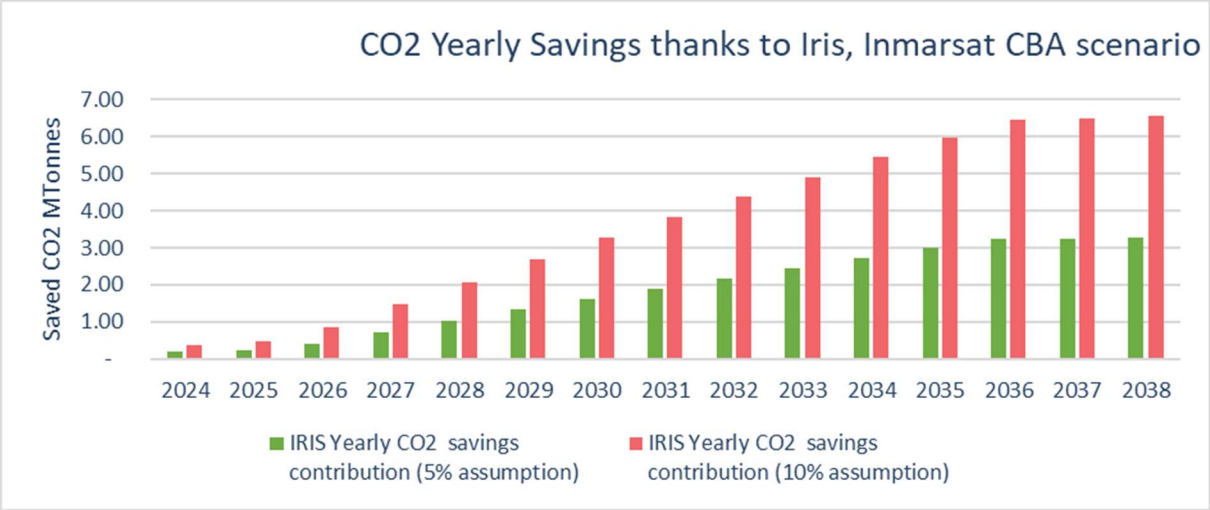

Figure 2. CO2 emissions savings thanks to Iris from 2024 with Inmarsat CBA "Enabling Master Plan benefits" scenario equipage rate

Based on the above figures we can observe that:

- Saving up to 55 Million Tonnes of CO2 thanks to Iris would correspond to the 2019 emissions of a country like Peru and would be higher than the yearly emissions of Sweden or Norway.

- Saving up to 6.5 M Tonnes of CO2 in 2040 thanks to Iris is comparable to the whole 2019 yearly emissions of a city like Seville or Florence or a

medium Italian region.

The second assumption considers the EUROCONTROL Future Communications Infrastructure (FCI) Business case SATCOM NG scenario equipage rate, where in 2040 about 60% of the fleet is Iris equipped and the resulting benefits are the following:

- The Iris related average CO2 savings per year in Europe over the 2024-2040 time span is estimated to be around **1-2 M Tonnes**
- Cumulative CO2 savings of **18-36 Million of Tonnes CO2** (with the 5% and 10% assumptions, respectively, over the 2024 – 2040 timeframe);
- CO2 emissions saved per year will reach **up to 4.2 M Tonnes in 2040**

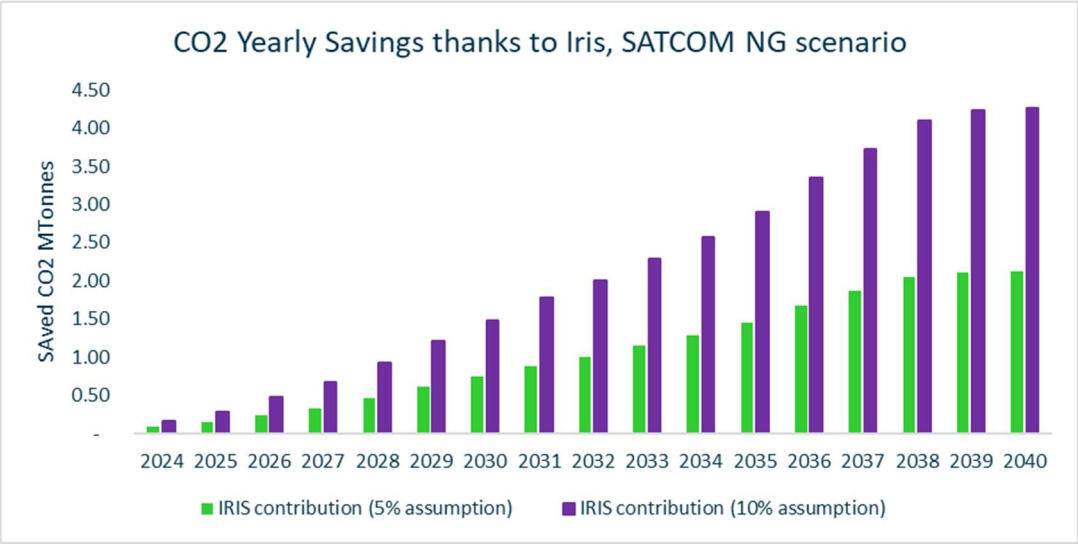

Figure 3. CO2 emissions savings thanks to Iris from 2024 with a EUROCONTROL SATCOM NG scenario equipage rate

The current analysis however, does not include a thorough assessment of the savings that would derive by all benefits directly related to ATM modernisation, (e.g. does not include the benefits of a leaner and therefore greener ATM ground infrastructure).
Other factors to be considered in the future could include for example the direct and indirect benefits (for airlines and/or passengers) of a reduction in delays, less flights cancellations, optimised scheduled maintenance, reduced unplanned maintenance or weather disruptions, optimised on-board inventory and other benefits that would sum up for a better service and reduced costs.

We can therefore conclude that Iris is a key enabler and complementary component for the ATM modernisation that will allow safer and more secure flights, alleviating the congestion of the traffic in the busiest European areas; Iris will also be contributing to the reduction of delays and excess fuel consumption, enhancing flight efficiency, and resulting in lower CO2 emissions, for a more sustainable European and global aviation.
The deployment of Iris as complementary datalink, if appropriately supported by incentives, is a key enabler of a greener European aviation and will bring significant benefits to passengers, airlines, and all the main aviation stakeholders.