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DSNA

The DSNA environmental strategy for a sustainable recovery of air transport

Green Aviation

member of FABEC

MEMBER OF SESAR JOINT UNDERTAKING

The Ecological Transition of Aviation aims to significantly reduce its impact on air quality and noise exposure. Environmental considerations indeed have become a priority, like safety, to recover a sustainable development of air transport following the unprecedented downturn in activity due to the global health crisis. Thanks to innovative technology, each stakeholder is totally involved in this transition.

For the past 20 years, the DSNA, the French Air Navigation Service Provider, has been pushing for greener initiatives to promote an environmental culture. To accelerate this transition, the DSNA has made the reduction of its environmental impact its primary focus, after flight safety by minimising noise pollution for below 2,000 metres (FL 60) around airports and gas emissions above 3,000 metres (FL 100). More than 80% of greenhouse gas emissions are produced above FL 60. Between FL 60 and FL 100, the best trade-off is sought.

This brochure provides a vision of the DSNA's environmental ambitions for 2025. It also provides an opportunity to discover and better understand the various ways in which tangible results will lead to greener skies.

CONTENTS

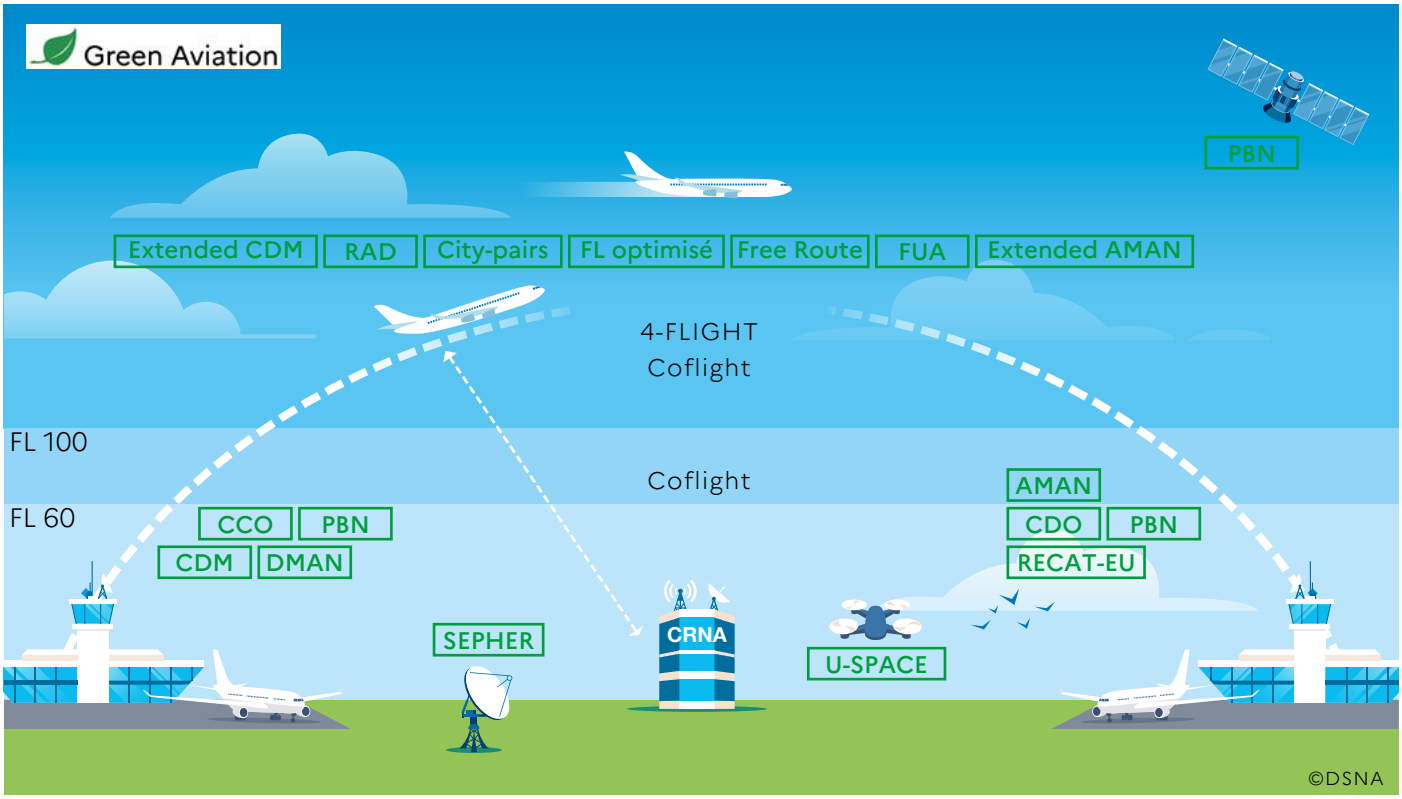
Strategic vision

for more environment-friendly Air Traffic Management within the French airspace by 2025

As per DSNA's strategic plan for 2019 - 2025, the environmental strategy is defined by action plans and collaborative partnerships with stakeholders, both locally and at a European level. This strategy is also consistent with the innovative governance initiated with IATA, the International Air Transport Association, to help better coordinate the implementation of projects.

The DSNA has developped an environmental strategy for the entire flight phases (departure, climb, cruise, descent and arrival). By optimising flight efficiency, the French air navigation services improve their environmental performance and help in developing greener aviation: optimisation of flight profiles, more direct routes (shortening of routes, Advanced-Flexible Use of Airspace), Free Route Airspace above FL 195 in three cells by the end of 2021. This strategy is also based on next-generation tools for measurement and analysis, for fine-tuned management of traffic flow, for ATC with 4-FLIGHT/Coflight, along with consultation and communication processes, Research & Innovation and training.

The DSNA has already implemented specific actions to improve horizontal and vertical flight profiles near major airports, to minimise constraints on route networks and optimise connections for city-pairs.



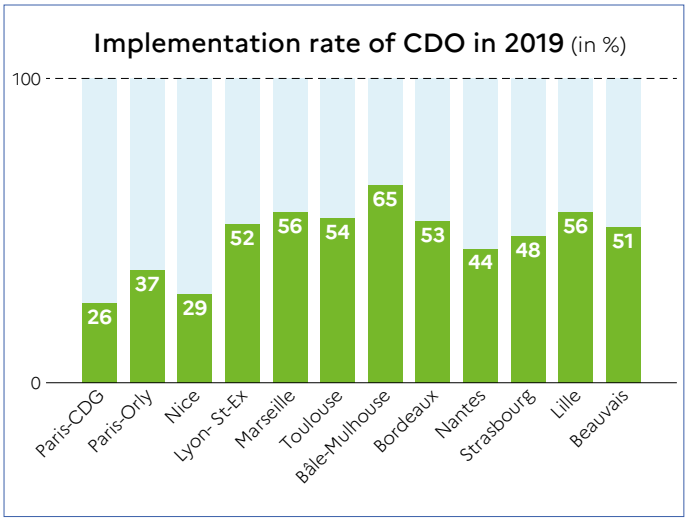
Operational concepts facilitating more environmentally friendly flights

Improving
descent and climb profiles

The DSNA pays particular attention to the climb and descent flight phases to improve the environmental performance of flights. For aircrews, the approach phase is particularly demanding: the pilot has to manage speed, altitude, engine thrust, landing gear, flaps and/or airbrakes as well as to follow ATC instructions.
Thanks to an optimised flight profile and an anticipated flight management, the pilot can fly as silently and economically as possible. Controlling the noise impact is thus a challenge that begins with controlling the flight path. This responsibility lies with both pilot and air traffic controller.

→ CONTINUOUS DESCENT OPERATIONS (CDO)

By minimising levelling-offs from the top of descent to the runway, the continuous descent approach means less engines speed variations, thus reducing noise and fuel consumption in TMA.
DSNA has developed an implementation plan for CDO at all airports where it provides air navigation services. The airport configuration is taken into account and the descent profiles must be integrated with the air traffic constraints in terms of safety (management of flight crossings, ensuring separation standards between aircraft) and capacity.
Therefore, pilots and controllers are encouraged to use optimised descent profiles whenever the operational conditions are met.



PBN to ILS procedures in Paris-CDG: extending CDO all day long

Since 2016, the continuous descent operations from FL 70 (2,150 metres) are carried out for night flights on a single runway pair. The challenge to operate this concept round-the-clock, including at high peak traffic, is tied to the complexity of feeding the airport's two parallel runway pairs. This ambitious project requires major changes to rethink a new air traffic pattern.

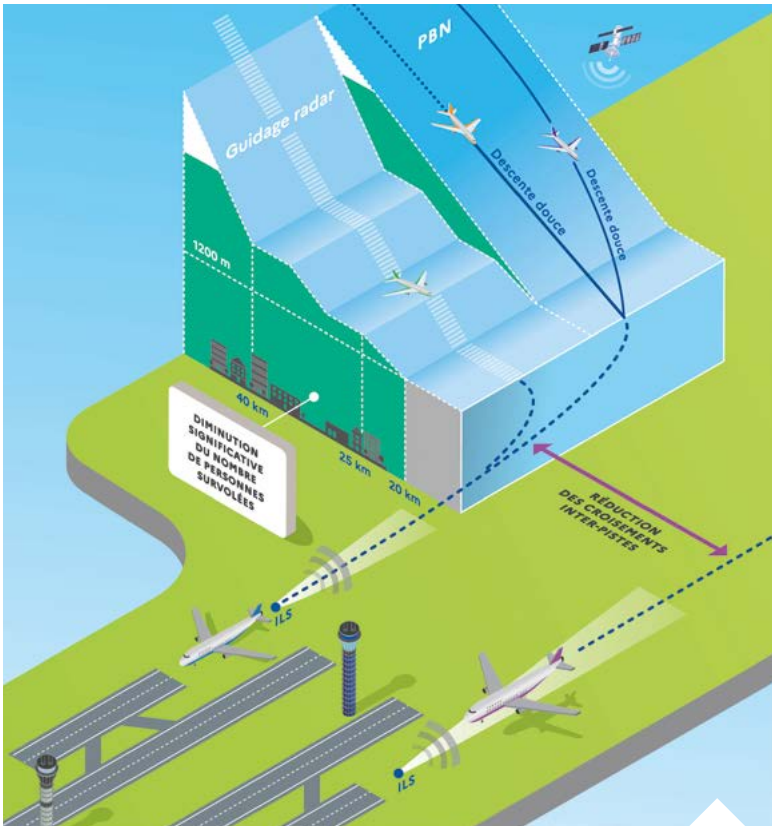
3 phases are planned:

2021: live trials to validate the technical challenges (the objective is to maintain a high level of safety and to evaluate accurate trajectory on tracks in order to reach the ILS axis via the so-called PBN satellite segment). Analyse of safety level and environmental gain obtained. Meetings with local officials, airline companies and local communities.

2022: a new optimised air traffic pattern project proposed by DSNA with different variants. The decision on final project will be taken in a collaborative way.

2023: start of public enquiry, ATC training and implementation.

Round-the-clock continuous descent for flights facing West at Paris-Orly airport is scheduled for the end of 2023.



In the PBN regulation zone, the exercise will assess the operational and environmental efficiency: navigation accuracy in satellite-guided procedures, interception of the ILS axis, reducing aircraft dispersion (estimated gain on arrival trajectories: - 70% of people overflown below 2,000 metres above sea level).

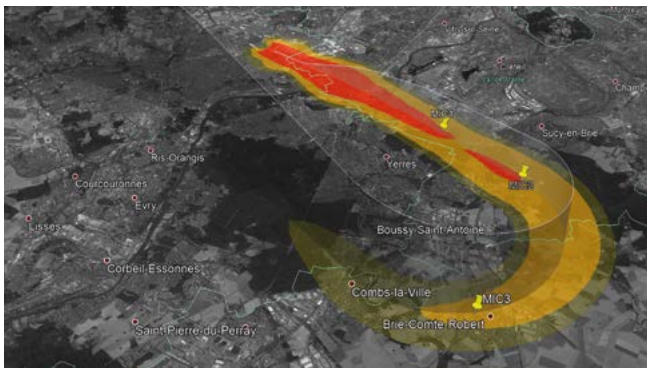
→ COMPLIANCE OF DEPARTURE TRAJECTORIES

Locally, the DSNA operational units analyse the departure trajectories in order to determine, in coordination with the stakeholders, the altitude to reach before leaving the initial trajectory. Continuous climb operations (CCO) at a constant engine thrust prevent traffic dispersion and minimise noise impact. The DSNA recommends, where possible, a climb to FL 100 (3,000 metres) on departure route before reaching the airways in cruising.

ACNUSA, an independent Control Authority on airport noise, closely monitors departure procedures from major airports, as presented to the residents' association representatives in the local Consultative Commission for the Environment. If necessary, financial penalties via evidence of non-compliance provided by the DGAC are imposed.

Studies on flight management in climbing for departure flights from Paris-Orly

A collaborative working group made up of experts in the field of air transport and resident associations explore new aircraft piloting methods in how to reduce the noise impact during the climbing phases. The purpose would be to maintain the aircraft noise reduction procedures up to 3,000 feet (900 metres), followed by a "soft" thrust phase. The group also studies how aircraft software is used to manage the optimisation of climbing profile. Airbus (NavBlue) checks these new ideas to assess their environmental impact.



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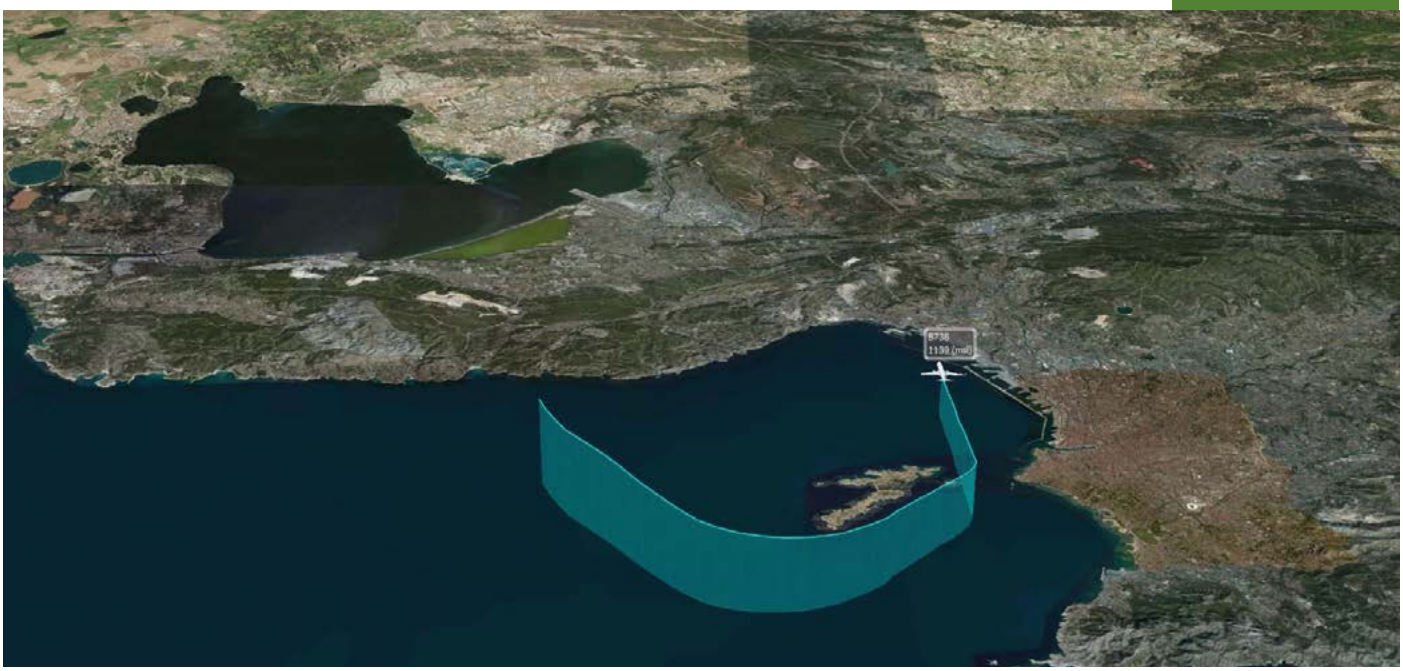


More arrival and departure satellite procedures

The DSNA has strong experience over Performance Based Navigation (PBN). Satellite navigation offers new trajectories for the surrounding areas of an airport, without the need for conventional infrastructure on ground or radar heading given by the controller. Consequently, PBN trajectories enable to avoid overflights of urbanised areas located under the arrival trajectories and to shorten routes.

An air traffic impact study is used to measure and evaluate the environmental impacts which will be caused by the creation or modification of new trajectories. Any modification indeed can call complex balances into question. Designing new arrival and departure PBN trajectories offers aircraft trajectories less spread around urbanised areas. Thus, these studies serve to highlight choices between a nuisance concentration (as for a PBN procedure) or nuisance dispersion.
The DSNA is pioneer in Europe to commission PBN landing procedures with turns. These so-called RNP AR satellite approaches provide optimal and safe accessibility to an airport surrounded by obstacles, by combining a precise series of lateral and vertical guided turns.

Timeline for implementation of PBN procedures in France

92% of runways equipped with PBN procedure **for approaches**
65% of airports equipped with PBN procedures **for arrivals**
56% of runways equipped with PBN procedures **for departures**

2020 — 2021 — 2022 — 2023 — 2024 — 2030

100% of runways equipped with PBN procedure **for approaches**
100% of airports equipped with PBN procedures **for arrivals**
100% of runways equipped with PBN procedures **for departures**

Use of PBN procedures only

CHAMBERY AIRPORT deals with high-density traffic at weekends during the winter period, with a majority of type B737, B757, E190 and A320 aircraft. A reorganisation of arrivals flow from the northeast based on satellite procedures became operational in the winter 2017/2018. This new, planned route (in green) shortened the distance by 8%.

PUBLICATION OF RNP AR PROCEDURES FOR SAINT-DENIS LA REUNION AND AJACCIO. Air Corsica plans to use this new arrival procedure in Ajaccio in the second semester of 2021.

Saint-Denis de La Réunion airport: Air Austral flight in the landing phase using the AR RNP procedure on runway 12.

On this type of complex trajectory, the aircraft benefits from a precise guidance on final approach, even in a constant turn radius, which enables it to automatically align with the final axis.
The DSNA has been working on a transition plan detailing its actions for the 2021, 2024 and 2030 deadlines. This plan explains how conventional ground-based navigation aids (ILS, VOR, NDB) will be gradually rationalised, currently reducing by half (ILS category 1), VOR by 40%, and complete withdrawal of NDB by 2030. As a result, the DSNA reduces its environmental footprint (a drop in energy consumption), and constraints regarding the installation of wind turbines. This equipment rationalisation continues into areas of communication (antennas), and surveillance (radar).

and developing a balanced approach to keep a sustainable sky

The DSNA and its partners are committed to building U-space, together with best class solutions for U-space services through a collaborative approach.

The DSNA promotes a customer-centric approach focused on reliable, safe and efficient drone operations. Particularly, the DSNA supports drone initiatives that contribute to public interest missions: emergency services such as firefighters, maritime and railway surveillance and to aerial work. Drones require little infrastructure and consume little fuel. The DSNA is specifically vigilant concerning drone impact on the Environment and aims at sustainable balance in terms of social acceptance of drone applications.

Drone landing at Toulouse airport.

The concept of urban-air mobility has greatly evolved. Innovative aircraft based on VTOL (vertical take-off and landing) capacities will operate on electricity to minimise noise. Live trials with passengers on board are planned prior to the Paris Olympic Games in the Summer 2024. Through regulation, the DGAC is committed to ensuring a sustainable growth of these latest operational stakeholders. As part of a European initiative, six countries, including France, will lead demonstrations on how to integrate drones safely with other users of airspace into urban, ports, waterways and airports environments in the framework of the SESAR project entitled 'CORUS XUAM'. The DSNA's role, in collaboration with the Group Aéroports de Paris, is to study operational procedures to put in place to manage how to integrate drones from different Parisian airports and vertiports (VTOL platforms).

Measurement and visualisation tools
for environmental performance

Developing analysis tools and measuring of the environmental performance as close as possible to the actual flight path are increasingly available. Data obtained from noise measuring stations on ground to tools using algorithms based on artificial intelligence methods contribute to facilitate exchanges between aviation industry professionals, local elected people and national representatives of residents' associations on aviation-related environmental issues.

Noise measurement campaigns *in situ*

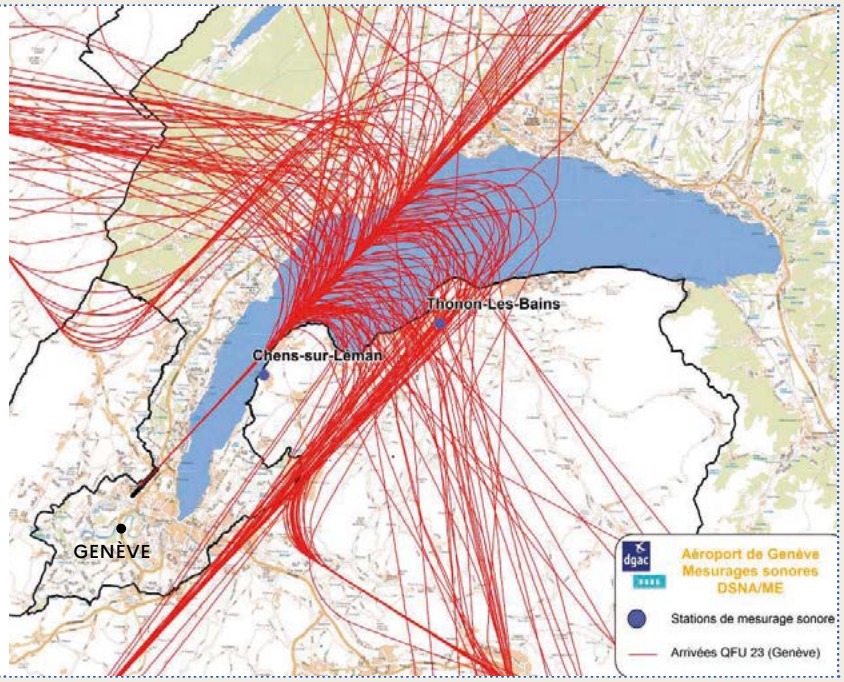
The DSNA can organise campaigns to measure noise exposure by installing mobile stations in appropriate places to assess the environmental impact of an existing procedure or trajectory modifications.

Mobile noise measuring station.

PBN to ILS at Paris-CDG (p. 5): in situ measurements have been carried out during live trials to assess the noise impacts.

Reducing the noise of incoming aircraft at Geneva Airport

To analyse the improvement of overflight conditions on the French side of Lake Leman by aircraft approaching the airport of Geneva, after the repositioning of the interception of the ILS axis, the DSNA, in cooperation with Skyguide, its Swiss counterpart, has carried out campaigns of noise measurements across two sites of Haute-Savoie, Chens-sur-Léman and Thonon-les-Bains. The local authorities acknowledged the benefits brought about this modification enabling reducing the noise for approximately 10 flights per day, and issued a positive opinion on this revised approach procedure.

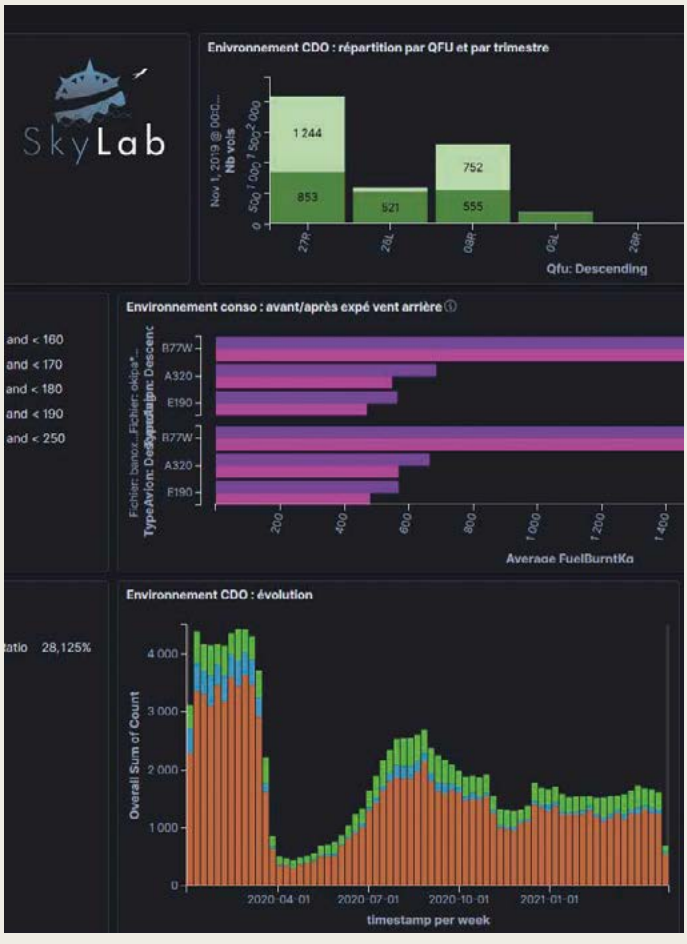


A measurement campaign led in 2019 by the DSNA to evaluate overflight noise reduction over the French territory.

SkyLab,
an innovative tool to drive operational performance

This tool developed by the DSNA registers many key data linked to provided air navigation services in an automated way. Commissioned at the Paris-CDG unit in November 2020, it supplies a series of performance indicators regarding safety, environment, capacity and weather conditions at D + 1. This information provides a better understanding of situational awareness, decisions taken by the controllers, and enabling studies to be conducted as close as possible to operational needs.

Environmental performance is analysed through the rate of executed continuous climbs and descents operations (CCO/CDO), aircraft delivery altitudes by the approach controller in the Paris-CDG TMA, the rate of executed night approaches, respect of procedures, fuel consumption and CO_2 emissions reduction outcomes... Skylab is currently deployed in the operational units of Bâle-Mulhouse, Nice and Paris-Orly. At some stage, it will also be deployed at the Area Control Centres (ACCs).



Extract of Skylab dashboard.

Enhancing performance for greener flights thanks to Big Data

The development of mass data processing (Big Data) represents an opportunity for the DSNA to drive its global performance. The project, called FEAT (Flight Efficiency Analysis Tool), aims to explore Big Data technologies using the flight data and their contexts, and to develop new applications to improve flights' environmental performance.

As part of this project, **SURVOLS** is an application that enables to visualize online the aircraft flight paths handled by the DSNA. It also enables to monitor indicators for aircraft overflying more or less urbanised areas, updated daily.

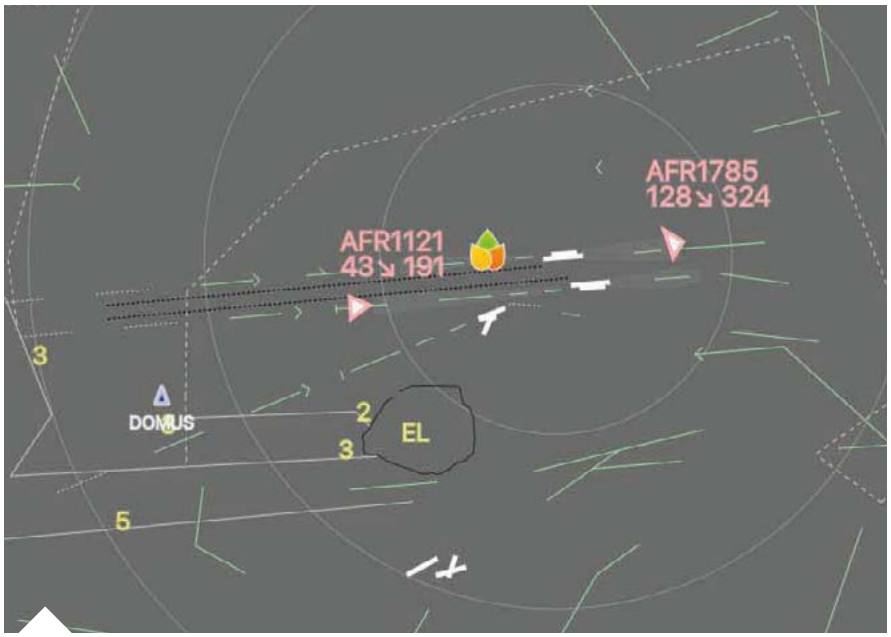
More advanced services are already available for specific studies carried out by the DSNA. A version in compliance with data protection policy will be available to the general audience in 2021.

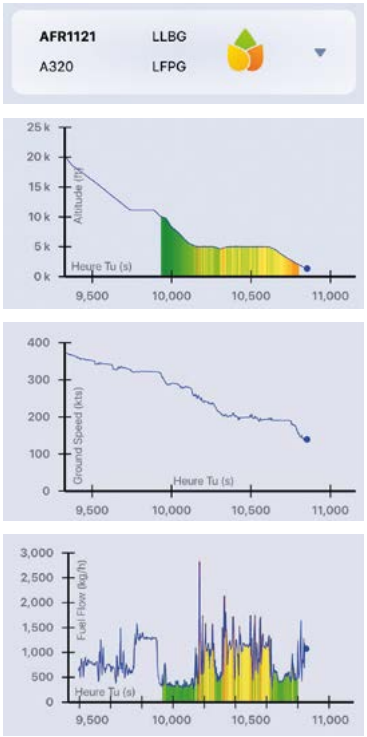
View on the Internet of departures facing West from Orly over the local communities.

In order to have a better understanding of environmental impact of operations, the DSNA is working on **an Artificial Intelligence (AI) tool called ACROPOLE**. This tool combines flight radar data (position, FL, speed) with estimated data of aircraft (aerodynamic configuration, fuel consumption…) using algorithms from Machine Learning.

This technological challenge will add strong value to the DSNA's radar data. Detailed studies on the environmental efficiency of trajectories will be shared with the other stakeholders.

In the term, it would be possible to use ACROPOLE in tactical mode, due to the controller made aware in real time of the environmental efficiency of aircraft trajectories on approach or take-off.





By clicking on the 'flower' of the flight label AFR1121 on arrival at Paris-CDG, the approach controller knows the environmental state of the flight (graphics on the right: noise, aerodynamic configuration and fuel consumption calculated from AI models).

Optimising the network **of routes to improve flight efficiency**

→ IN THE HORIZONTAL PLANE: REDUCE FLOWN DISTANCES

In close coordination with the Network Manager (EUROCONTROL), work on the reorganisation of European airspace aims to reduce its complexity to provide more efficient air traffic management. However, some scenarios require to find complex balances, the development of which only highly advanced simulations can resolve. After months of analysis, the validated scenario may lead to a reconfiguration of the control sectors and to new training for controllers.

The drastic drop in air traffic due to the coronavirus pandemic was an opportunity to rethink and adapt the air route networks to a European scale. Under the aegis of EUROCONTROL, the restrictions on routes (RAD) were eased, allowing connection of major airports served by large traffic flows with permanent direct routes. As a result, airlines can plan shorter routes and reduce significantly fuel loads.
A more efficient route network also means less waiting and taxiing times on apron.

City-pair Lisbon- London: more direct route thanks to new leg LOTEE – LUGIS commissioned by the Brest ACC in 2021. Estimated annual gains by this new 20 NM shorter route: 470 tonnes of fuel savings, 1,500 tonnes of CO_2 emission reductions.

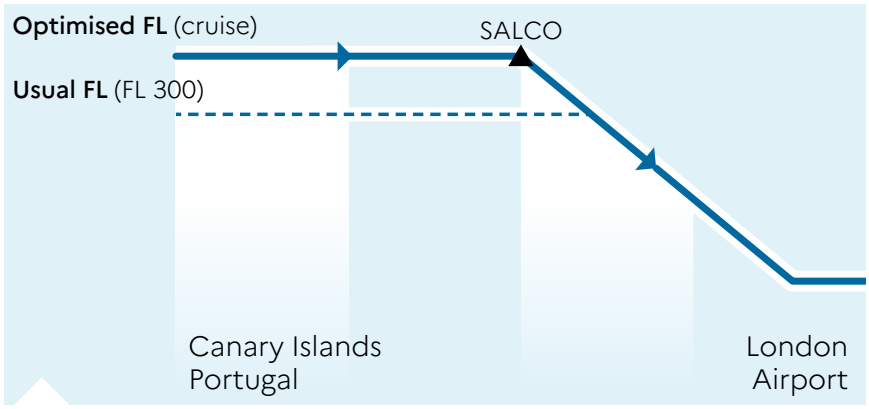
Promoting environmental culture among controllers

To increase awareness for controllers about environmental issues, the Bordeaux ACC presented studies that illustrate potential environmental gains. Example with a direct route (in green) to Nantes (gain of 20 NM) and some orders of magnitude: a medium-haul route shortened by 10 NM saves about 30 kg of fuel per flight (for a planned or direct route given in tactical): a delay of more than 5 minutes at departure of a 2-hour leg can penalise connecting flights ; to start a descent between NASEP and MANAK instead of maintaining the flight in cruise would cost 2 minutes of flight time ($110).

→ IN THE VERTICAL PLANE: OPTIMISE SMOOTH DESCENTS

The Brest ACC and neighbouring centres

To meet the needs of airlines, the Brest ACC has defined optimised delivery flight levels for the hand over to neighbouring ACCs. This coordination allows pilots to configure their aircraft to make an optimised continuous descent from the Top of Descent in a safely manner. The letters of agreement with adjacent control centres of the Brest ACC will gradually be updated as these new measures are put into operation.



Summer 2021: new coordination between the Brest ACC and the London ACC on SALCO exit point for flights to London-Heathrow.

The Paris ACC and Continuous Descents Operations (CDO) to Paris-CDG and Paris-Orly

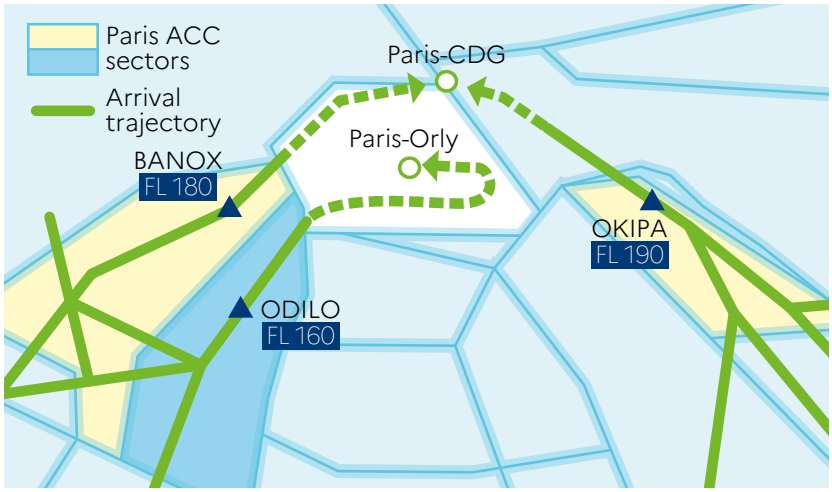
CDO live trials have been conducted on flights to Paris-CDG since the last quarter of 2020 and to Paris-Orly since the first quarter of 2021. These procedures aim to keep the aircraft at a high flight level (FL) for as long as possible by the Paris ACC controller, and to avoid a levelling off during the transfer of flight to the approaches. These evaluations continue for as long as the traffic density permits it.

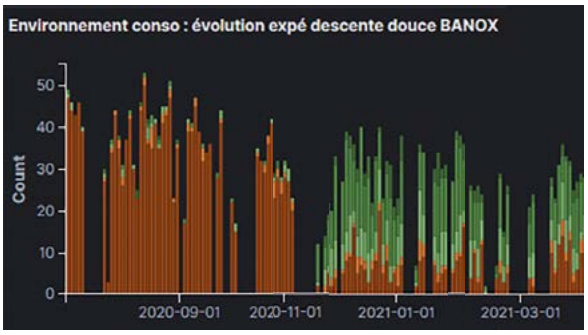
• Paris-CDG

Aircraft fly through BANOX waypoint at FL 180 (5,500 metres), instead of the usual FL 150 (4,500 metres) in a configuration facing West, and through the OKIPA waypoint at FL 190 (5,800 metres), instead of the usual FL 150 in a configuration facing East. The reduction in fuel burn for the A320s was estimated by ACROPOLE at 2% and 7% respectively.

• Paris-Orly

The aircraft fly through ODILO waypoint at FL160 (4,900 metres), instead of the usual FL 110 (3,400 metres) in a configuration facing West. The reduction in fuel burn is estimated between 7% and 9% depending on the aircraft type.

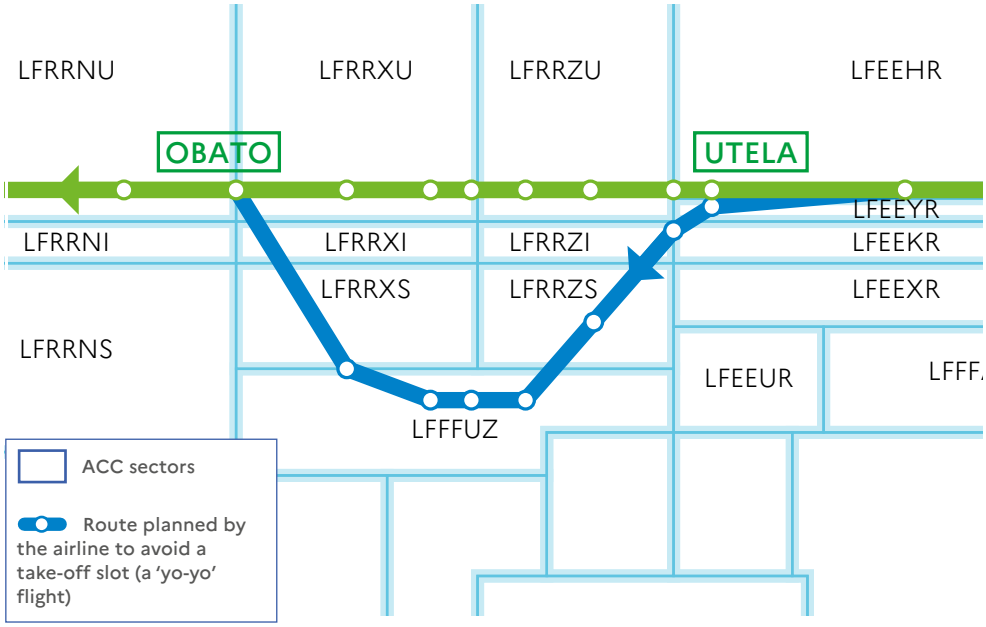




Follow-up of the experimentation at Paris-CDG on the SkyLab tool.

Post-operations analysis of planned routes

A route non-compliant with filled flight plan, massive flight plan modifications in response to the implementation of ATFCM regulations and aberrant flight plans impact directly the level of safety and capacity, and ultimately, the environmental performance. Airlines and their computerised flight plan service providers (CFSPs) are increasingly aware of this operational issue.

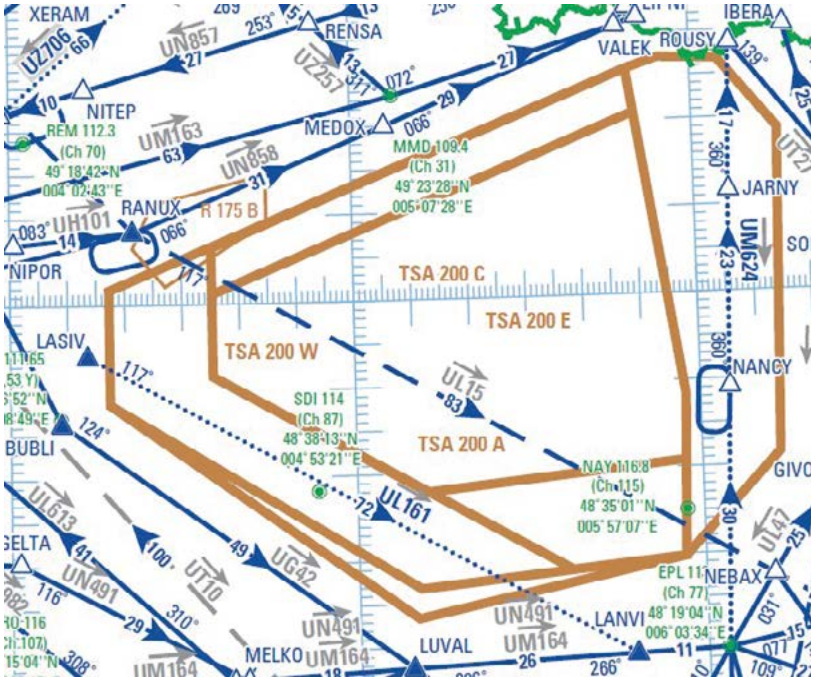


Promoting
a dynamic airspace management

The operational concept: to optimise the use of airspace as much as possible, the concept of the Advanced Flexible Use of Airspace (A-FUA) aims to ensure that airspace, traffic flows and capacity are managed as a whole rather than independently, along with Military Variable Profile Areas (MVPAs), Variable Geometry Areas (VGAs) or with Dynamic Mobile Areas (DMAs).

The French civil-military cooperation doctrine in the field of FUA is very advanced in Europe. This collaboration based on trust minimises the impact of military activity on civilian traffic flows. Dynamic airspace management facilitates more direct flights taking into account flight safety as well as the needs of the airlines, civil airspace users and military operations. Initially aimed at reducing delays, this flexible use of airspace also leads to optimising flight trajectories and a reduction in CO2 emissions.

A means of selection of civil traffic priorities grants civil traffic some priority slots of few hours per day while guaranteeing military activities in the remaining slots. Efforts pursued by civil and military authorities in order to timely use and manage the airspace should be reinforced by airlines operators and their computerised flight plan service providers (CFSPs) using the released airspace and direct routes thereof.



TSA 200 : military VGA in the North-East of France

The deployment of these best practices in Europe contributes to a greener Aviation. They involve all operational stakeholders in the aviation community, because to achieve these ambitious objectives, only a global approach can be adopted.

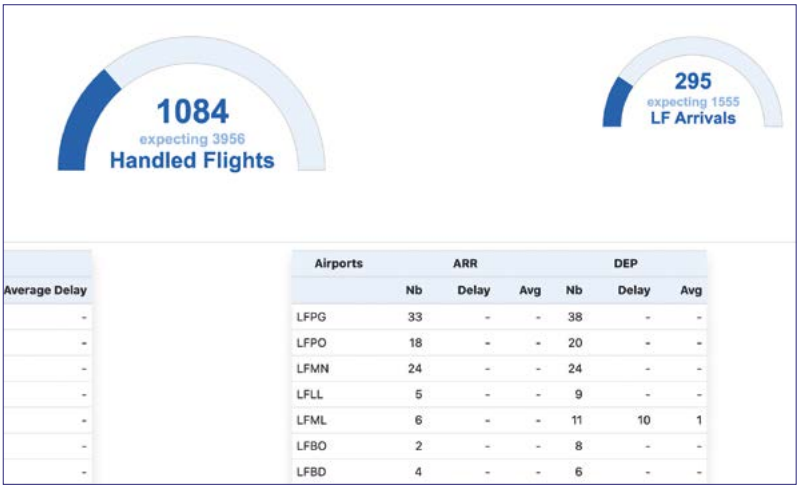
Advanced tools
for fine-tuned management of air traffic flows

The ACCs have modern, high performance tools to analyse the operational situation correctly. These tools are connected to operational data from the collaborative web-service of the Network Manager (EUROCONTROL). They support flight efficiency at the European scale and enable Air Traffic Controllers to maximise the benefits of airspace modernisation.

From D-1 to H

1 Improving flight efficiency thanks to collaborative online services

- Via the **portal CDM@DSNA**, a web-based platform, the DSNA provides its customers and partners with a wealth of operational information, enabling them to share a broader vision of traffic flow management in France and Europe. Exchanges are in either the form of chat or messages. This portal also offers 'what if' functionalities, to analyse the impact of different scenarios and to assist the experts in their decision-making.



Portal CDM@DSNA. The CDM concept is supported by collaborative processes, shared data in real-time and common tools. With CDM, operational actors with different cultures and different needs have a better situational awareness and take coordinated decisions rapidly, equitably and transparently. CDM optimises operations while strengthening safety, and improves traffic predictability for both local operations and the European route network.

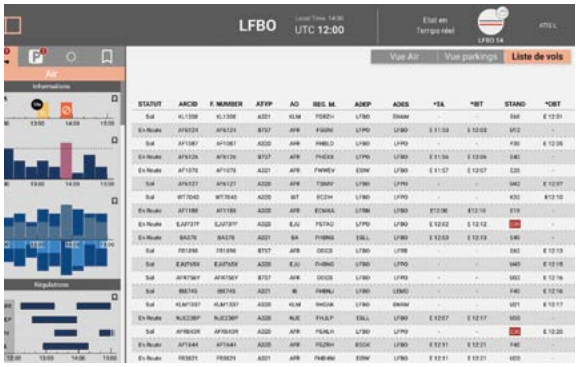
2 Optimising ATFCM and ASM thanks to advanced methods and tools, dispatching this information in real-time with controllers

- The **SALTO** tool provides a modern working environment to anticipate traffic loads in advance and decide on the most appropriate ATFCM measures, supporting working methods of dynamic Demand and Capacity Balancing (dDCB). New functionalities are regularly added. Other decision support tools are currently being developed, integrating a range of meteorological information on a single HMI and visualising the precise impact for the control sectors.

SALTO is used in each ACC, by the room supervisors and the Flight Management Position (FMP) in charge of ATFCM measures in case of hotspots (congested areas).

3 Connecting airports and network operations thanks to CDM

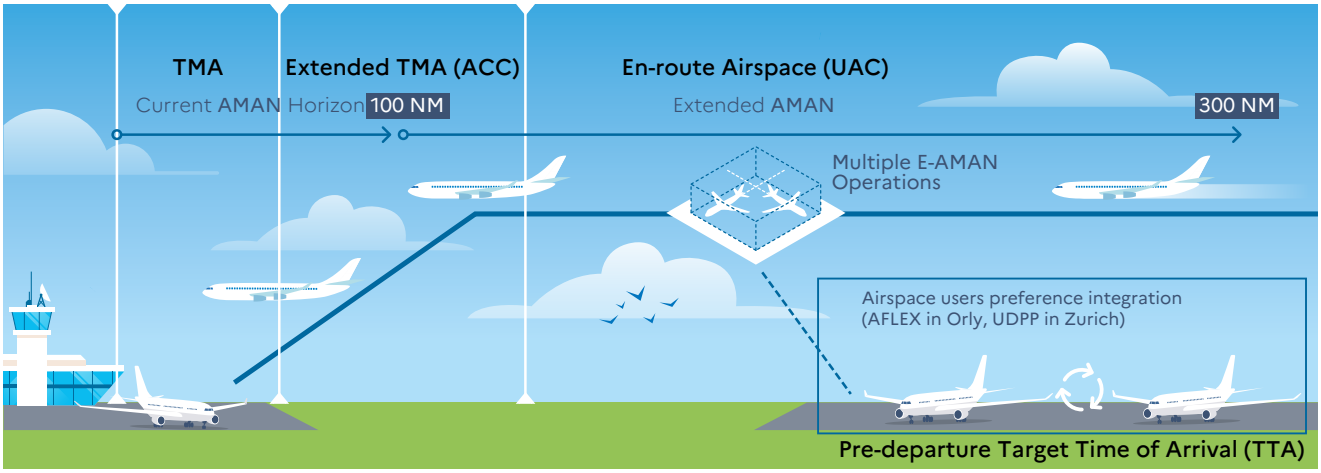
In France, 4 major airports are labellised Airport-CDM: Paris-CDG, Paris-Orly, Lyon-Saint-Exupéry and Nice. They use advanced tool (**DMAN**) to build a pre-departure sequence for taxi clearance and a departure sequence for take-off using collaborative processes. Thus, their operations are integrated with the Network Manager (EUROCONTROL).
The extended participation of other major regional airports is being studied by the DTI (DSNA's technology and innovation directorate) to develop a standard tool for collaboration with airport operator systems. Pilot sites: Bâle-Mulhouse, Bordeaux, Marseille, Nantes and Toulouse.



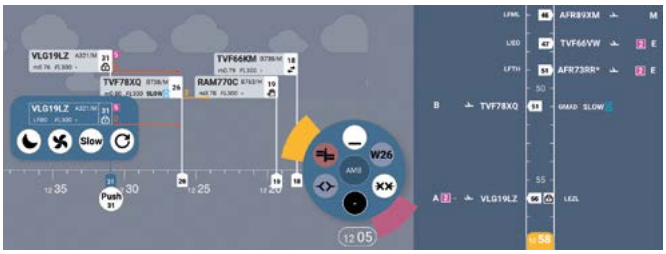
Regional Airport-CDM: prototype developed by the DTI ongoing evaluation in 2021.

4 Supporting extended arrivals operations at major airports thanks to innovative tools

The arrivals sequencing (AMAN) to best integrate traffic flows at peak times is essential at busy airports. With the operational concept **Extended AMAN**, the en-route controller can adapt the speed of the flight in cruise up to 300 NM (550 km) upstream of the destination airport by coordinating in advance with neighbouring ACCs. This absorption of delay in high altitude is highly beneficial to the environmental impact. Another concept (TTA) aims at allocating flight a Target Time of Arrival upon the departure, before take-off, for a smoother flight.



The DSNA has developed an innovative HMI (**IODA**) to improve the management of flights in the extended Paris TMA Paris managed by the Paris ACC. The IODA touch screen HMI provides an intuitive representation of airport-related ATFCM data and arrivals sequences. In particular, this tool is appreciated for monitoring the curfew at Paris-Orly.



5 Post-operations analysis tools

Two indicators monitor the Horizontal Flight Efficiency (HFE) for en-route:
- **KEA** indicates the average deviation between the real trajectory and the direct trajectory
- **KEP** indicates the average deviation between the last flight plan filed trajectory and the direct trajectory

In the FABEC airspace, these indicators have fluctuated between 3% and 4% over the last 5 years, showing environmental performance in the horizontal plane that is already high.

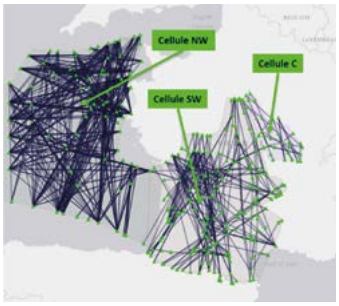
Anticipating the balance between available capacity and traffic demand, including in adverse situations (bad weather conditions, technical failures...), makes it possible to optimise the flight route and ensure air traffic flows as smoothly as possible.

Free Route
A new way to fly in upper airspace

The operational concept: in a Free Route Airspace (FRA), airlines are encouraged to plan their flights on the most direct available routes between defined entry and exit waypoints. With a much better flight adherence to the filed flight plan, traffic organization is more efficient and safer, and facilitates an optimized arrival management during peak hours at busy airports (Extended AMAN).

European regulation provides for a progressive entry into force of Free Route above FL305 from December 2022. The FRA in Europe will become cross-border by the end of 2025. In particular, for busy and complex airspaces such as those within FABEC, this implies a better management of the 4D flight trajectory, closer to the real flight trajectory, information exchange capabilities on these trajectories with other control centres and advanced flexible use of airspace between civilians and the military.

France will offer Free Route from 2 December 2021, above FL 195 (5,950 metres) in three cells managed by the Brest ACC, the Bordeaux ACC and the Paris ACC. This first phase will cover almost 50% of French upper airspace. Civil and military users, as well as our stakeholders, are given a regular progress report. The widespread use of the FRA in France will take place after the commissioning of 4-FLIGHT in the Reims and Marseille ACCs from the end of 2023 until 2025.



Roadmap for Free Route commissioning in European airspace

31 December 2022

Initial Operating Capabilities
with possible changes in time and space

31 December 2025

Full Operating Capabilities at least above FL 305 (9,300 metres)
This phase will ensure connectivity with the approaches and will allow direct cross-border planning.

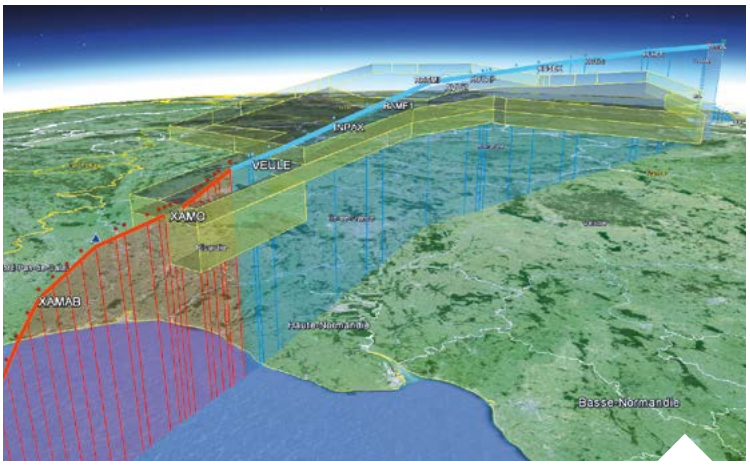
EUROCONTROL considers that when the organisation of upper airspace in Free Route reaches its full potential, air transport will be able to save up to 3,000 tonnes of fuel per day, equivalent to 10,000 tonnes of CO_2 emissions per day.

What are the expected benefits from Free Route?

Airlines: flight efficiency (User Preferred Route), flight plan flexibility, reduction of gas emissions. No need for any additional specific on-board equipment.
Air Traffic Control: increased level of safety due to a best route adherence to flight plan, more environmentally friendly flights. On the strategic front, traffic organization can be more easily adapted to changes in traffic flows.

4-FLIGHT
A new vision of ATM in France

4-FLIGHT, the new integrated Air Traffic Management system in France for area control centres (ACCs), provides sophisticated and high-level performant tools so that air traffic controllers can easily handle dense, complex traffic in a completely safe and efficient way. It is in line with the innovative European concepts such as Free Route and new requirements in terms of environmental efficiency.



4D-trajectory calculated by Coflight.

Visualisation of a direct route on 4-FLIGHT display.

In 2022, the Reims ACC and the Marseille ACC will be the first en-route centres equipped with 4-FLIGHT. This new generation stripless system, among the most advanced in Europe, integrates an innovative flight data processing system (Coflight) that updates flight plan information in real-time by taking into account ATC clearance and optimises the flight path. Moreover, Coflight calculates accurate flight profile, as close as possible the flown trajectory, beyond the French airspace.

Thanks to the technical breakthroughs with 4-FLIGHT, controllers can focus on their essential tasks improving flight safety and efficiency.

Regular training sessions on the 4-FLIGHT simulator and operational evaluations on live traffic to strengthen the robustness of the system address environmental issues. With 4-FLIGHT, customers and airspace users will benefit from a high-quality service, tailored to their operational needs.

4-FLIGHT delivers high-level operational performance. It makes seamless air traffic management easier and improves the environmental performance of flights. In particular with Coflight, the controller has a more accurate forecast of aircraft's trajectory, reducing flight time, fuel consumption and CO_2 emissions.

Research & innovation

→ FRENCH BODIES FOR AERONAUTICAL INNOVATION

The DSNA lends its expertise to industrial R&D studies for innovative solutions.

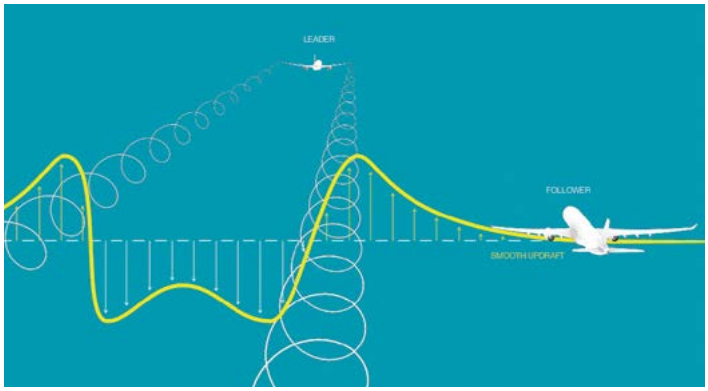
CORAC is a public-private partnership for all professions in the aviation industry. Chaired by the Minister of Transport, CORAC's mission is to drive and financially support French aeronautical research, addressing issues such as the environment, safety and competitiveness. A multi-annual research roadmap is established optimising everyone's efforts.
More specifically, to decarbonise aviation, three priorities have been identified: the electric aircraft, the hydrogen aircraft and the optimisation of flight operations.
Through its knowhow, the DSNA contributes to define new 'Concepts of Operations (CONOPS)' and to elaborate safety studies such as the WER projects (Airbus) on the technical feasibility of flying in formation and the PROVERT project (Thales) on the optimisation of air navigation operations through advanced ground-on board cooperation in pre-tactical.

The WER project: fello'fly, a new way to fly

This project aims to fly in formation long haul civil aircraft with equivalent performance, for greater environmental efficiency, in an airspace where air traffic control does not need to separate traffic for frequent requests for changes in heading or flight levels. The physical principal of formation flying is based on the use of the vertical component of wake vortices to provide additional lift to a follower aircraft.

The optimal position of the follower aircraft is in the horizontal plane at approximately 1.5 NM (3 km) by the leader aircraft, and vertically approximately 50 – 100 ft (30 metres), below the leader aircraft. The aircraft must have exactly the same speed.

The Brest ACC represents the DSNA in this project. It has to deliver the designated pair of aircraft on the same route, at the same speed, but separated vertically by 1,000 ft. This allows for stabilised flight formation. The phase when aircraft join up, is performed automatically by the on-board systems of the two aircraft, which enter into communication. This tricky sequence significantly increases the complexity of air traffic management and has been used in simulations by controllers from the ACC Brest.



The project is led by Airbus in partnership with EUROCONTROL and the French (DSNA), British (NATS), Irish (IAA) and Canadian (NAV CANADA) air navigation service providers, as well as the airlines Frenchbee and SAS.
The first live trials to demonstrate the technical feasibility started with two aircraft flying together, operating in the North transatlantic flows from West to East and East to West. The drop in fuel consumption is in the range of 5 – 10% per trip, i.e. a significant reduction in CO_2 emissions.

The newly created **Transport Innovation Agency** will enable collaboration to be extended to all modes of transport and will support the achievement of projects to invent the transport of tomorrow. Among the projects selected, the DSNA will lead the projects ACROPOLE (p. 11) and SEPHER (p. 23).

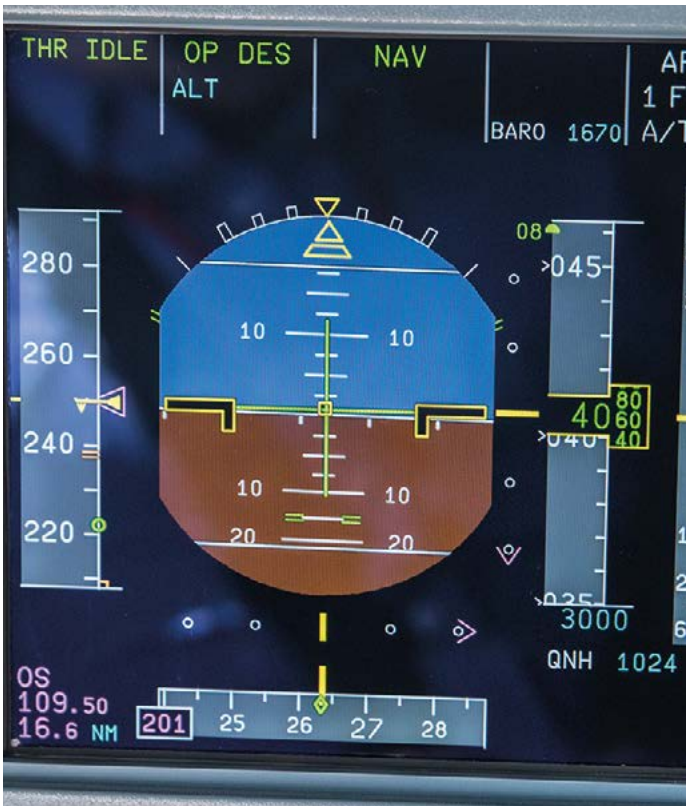
→ THE SESAR PROGRAMME PROJECTS[1]

The SESAR programme, involving all the stakeholders of aviation industry, is preparing the future of air navigation in Europe. The SESAR solutions ready for industrialisation and deployment in the real operational world are integrated into a European regulation led by the SESAR Deployment Manager (SDM). They contribute to the objective of reducing the environmental impact of air navigation by 10%. The DMAN, AMAN /Extended-AMAN, PBN to ILS, RNP-AR and Free Route projects implemented by the DSNA are based on SESAR solutions.

In 2021, the DSNA got involved in two new projects with a beneficial impact on the environment:

ADSCENSIO, *Trajectory Based Operations in 4D*

This project led by the DSNA with Airbus aims to improve the prediction of aircraft trajectory in air traffic management. With the support of the DTI (Technology and Innovation Directorate) of the DSNA, the Paris ACC will demonstrate the environmental benefits when using trajectory profile data to manage arrivals at medium altitude towards Paris airports; the Reims ACC will evaluate tools to verify the consistency between ground trajectories (Coflight) and on-board trajectories (pilots). Moreover, the ESSP (European Satellite Service Provider) company in charge of operation and maintenance of the European navigation satellite system EGNOS, as a partner, will validate a data acquisition and distribution service at a European level. This should limit contact with the aircraft and prevent saturation of the air-ground networks.



A321neo Primary Flight Display.

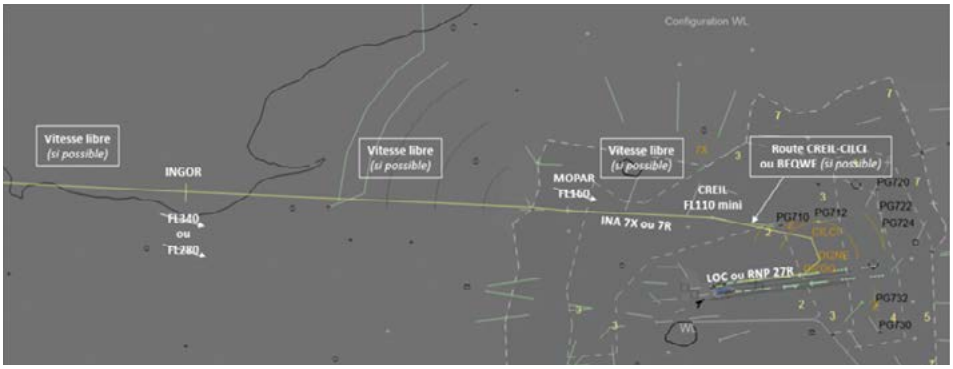
1. The SESAR programme, the technological pillar of the Single European Sky, is led by SESAR JU, a public-private partnership composed of all categories of the aviation community. This ambitious programme aims to modernise Europe's ATM system by developing new operational concepts in a new generation technological environment with harmonised standards.

ALBATROSS, *the most energy efficient flying bird*

This project led by Airbus aims to demonstrate in real conditions the feasibility of implementing a "perfect flight", in other words the most fuel-efficient flight, through a series of live trials in a number of European countries. The live trials will address the flight gate-to-gate and will showcase solutions in the SESAR portfolio that deliver environmental benefits both on the ground and in the air.

Optimisation of descents at 300 NM (500 km) from Paris-CDG

In this project, Air France and the DSNA are evaluating operational conditions to optimise the arrival trajectory of transatlantic flights by A350/B777 (aircraft technically capable of performing such operations) at Paris-CDG.



"I just came back from Boston. The Paris-CDG approach controller gave us a predictive base turn time. We overflew INGOR at well over FL 330, then no restrictions on MOPAR arrival. With radar vectoring, the controller cleared us to smooth out our arrival trajectory.
As a result, fuel consumption was reduced by 200 kg, with 2 minutes less flight time!"
Captain AFR
April 2021

POWERED BY SESAR JOINT UNDERTAKING

Co-funded by the European Union

Other environmental topics are being studied: emissions of particles other than CO_2, condensation trails (impact of meteorology, study of new Air Traffic Management methods to minimise effects)...

→ "DESTINATION 2050": THE ROAD MAP FOR THE AVIATION INDUSTRY

The role of air navigation service providers is essential during this transitional phase until the introduction of enhanced environmental performance aircraft fleets.
In order to meet the EU's goal of net zero CO_2 emissions for European airspace by 2050, four pillars have been identified: designing greener aircraft and engines thanks to new-generation technology, use of Sustainable Aviation Fuels (SAF), smart economic support measures, and improvements in ATM and aircraft operations. This last item would account for 6% of the emissions reduction.

The DSNA's environmental strategy is fully in line with these goals.

Produce
and store green energy

AN INNOVATIVE SOLUTION TO PRODUCE RENEWABLE ENERGY (PHOTOVOLTAIC AND HYDROGEN-BASED) TO SUPPLY DSNA GROUND ATC SYSTEMS FOR ISOLATED SITES

Most communication and surveillance systems for air traffic control (ATC) are installed onto isolated sites. They are equipped with diesel generators to ensure constant availability of electrical energy in case of national electrical network failure. *The DSNA SEPHER project aims to replace those polluting generators with new generation systems using hydrogen, produced from renewable energies. This technology will contribute to reach the objective of zero carbon emission for air navigation activities at all of these sites.*

A first demonstrator project on the radiocommunication antenna of Sarlat (Dordogne) combines photovoltaic and hydrogen technologies: solar panels supply the station directly, the energy excess is used both as short-term energy storage into Li/Ion batteries, and long-term energy storage in the form of hydrogen produced by water electrolysis. Therefore, in case of need, the hydrogen can be used through a fuel cell to produce the electricity necessary for the radio antenna. The whole system is thus designed to operate in autonomy at 75% and to reduce CO_2 emissions by nearly 60%.

This innovative solution has been labeled by the SOLAR IMPULSE foundation created by Bertrand Piccard which rewards 1,000 eco-responsible initiatives around the world.

A second site will be deployed in 2022 onto the La Roche-sur-Yon DSNA radar station (Vendée). Taking advantage of the renovation of the energy distribution of this site, the fuel generator will be replaced by an electro-hydrogen generator. This initiative will provide an opportunity to experiment with the logistics supply of "green hydrogen" while ensuring DSNA's operational requirements in terms of continuity of service.

In the scope of the European project ALBATROSS (SESAR), SEPHER will participate in an exercise to reduce the global carbon footprint of a zero-emission live trial. Numerous partnerships between European air navigation service providers are emerging in the context of EUROCONTROL'S activities on the decarbonization of this type of infrastructure.

Concertation, **consultation and communication**

Concertation, consultation and communication are the pillars of the DSNA's strategy in its relationships with politicians, residents' associations, its customers and partners.

→ FORMAL CONSULTATION BODIES

The DSNA has committed to total transparency regarding its everyday actions towards residents' associations and overflown populations to keep them ever better informed and to find together local solutions fitted to the airport configuration when it comes to limiting noise pollution : trajectory modifications for arrivals and departures, delayed engines start-up, new air traffic pattern, extension of overflight areas to avoid, restrictions on the number of aircraft simultaneously in the traffic circuit…

Any creation or modification of an air traffic pattern in the TMA is presented to the airport's Consultative Commission for the Environment (CCE) and to the ACNUSA, an independent authority, when the airport falls within its remit. Depending on the importance of the change, a public enquiry may be held. These consultation committees serve to strengthen and facilitate dialogue between all those concerned on the environmental impacts prior to any implementation of new departure / arrival trajectories.

Nice-Côte d'Azur, a busy airport with strong geographical constraints.

→ HOW TO FACILITATE EXCHANGES IN A COLLABORATIVE WAY

The DSNA organises regular meetings with its stakeholders to collect their needs and determine in a collaborative way how best to implement operational strategies. In addition, environmental challenges are at the heart of join commitment between DSNA and IATA, in defining and implementing French strategy for the modernisation of air traffic management.

The DSNA also organises bi-annual meetings within the framework of **its national platform (Collaborative Environment Management)** to facilitate exchanges between aviation industry and national representatives of local residents' associations on operational air navigation issues, airport and aviation activities and their environmental impacts in France. This collaborative approach allows to better share common issues and the achievements made to respect the environment.

Toussus-le-Noble, an aerodrome in the Paris region with heavy VFR traffic.

Training **of operational staff**

The environment is a constant concern for the operational staff of the DSNA, as shown by the subjects developed in this brochure. As key players, air traffic controllers benefit from environmental training during their ab-initio course at the ENAC, the French Academy for civil aviation, which is reinforced throughout their career depending on the type of control they practice.

→ INITIAL TRAINING AT THE ENAC

The ENAC is working to give a cross disciplinary dimension to the ecological transition in its training courses. In September 2021, the curricula's pedagogical objectives for future professionals in the aeronautical sector will enable all students (engineers, technicians, pilots, controllers...) to acquire a global vision of the climatic and economic challenges of air transport. This will give them the knowledge as well as the technical and methodological skills needed to accompany this ecological transition in their respective jobs.

As for students-air traffic controllers, they will be made more aware of environmentally friendly flight procedures. To further reduce the carbon footprint, their piloting training on progressively electric light aircraft, will emphasise appropriate flight management, even if safety remains the priority. As for the maintenance engineers, they will be made more aware of the energy consumption of the various systems and installations. All new curricula for DSNA operational staff must be approved by the national supervisory authority (DSAC).

→ CONTINUOUS TRAINING

As part of their continuous training, air traffic controllers follow an Environment module and practical exercises on simulator adapted to the specificities of their operational unit. Briefings inform them, as necessary, of the new improvements to the flight paths and routes managed in their control space.

New TWR training simulator at Paris-CDG implemented at the end of 2020: this new-generation equipment enables simulating situations as close as possible operational life.

The Bordeaux ACC : On-The-Job-Training Instruction.

International Awards

CAP (Environment ATC Awards / 2016)

The DSNA has **developed an advanced collaborative ATFCM management to define with the airline operations centres and the Network Manager** (EUROCONTROL) the best route options such as a change of FL avoiding congested en-route control sectors. This enhances flight efficiency by minimising the need to regulate departing flights.

RISE (Environment SES Awards / 2017)

This SESAR project evaluated different types of **PBN approach procedures over eight European airfields with highly constrained local configurations**. The DSNA has conducted live trials of this type of procedure at Nice and Ajaccio, successfully testing the guidance of a constant radius turn on final approach.

RECAT-EU (Environment ATC Awards / 2018)

This project, developed by the DSNA in collaboration with EUROCONTROL, has been commissioned at Paris-CDG and Paris-Le Bourget, a first in Europe. It enables **reducing the separation between aircraft on approach depending on the sequencing of aircraft, facilitating a smoother flow of arrivals**.

XSTREAM (Environment ATC Awards / 2019)

This SESAR project led by the DSNA has demonstrated very encouraging gains in terms of **fuel economy and CO_2 emissions reduction through pre-sequencing of flights at peak times, up to 300 NM upstream of the destination airport** (Extended AMAN). This project was awarded the Overall Excellence in ATM Award.

FABEC (Environment ATM Awards / 2020)

FABEC, of which the DSNA is a member, received an award for its **efforts to improve environmental efficiency of flights in a dense and complex airspace**. In FABEC airspace, the efficiency of flights in the horizontal plane (HFE) is better than that of flight plans.

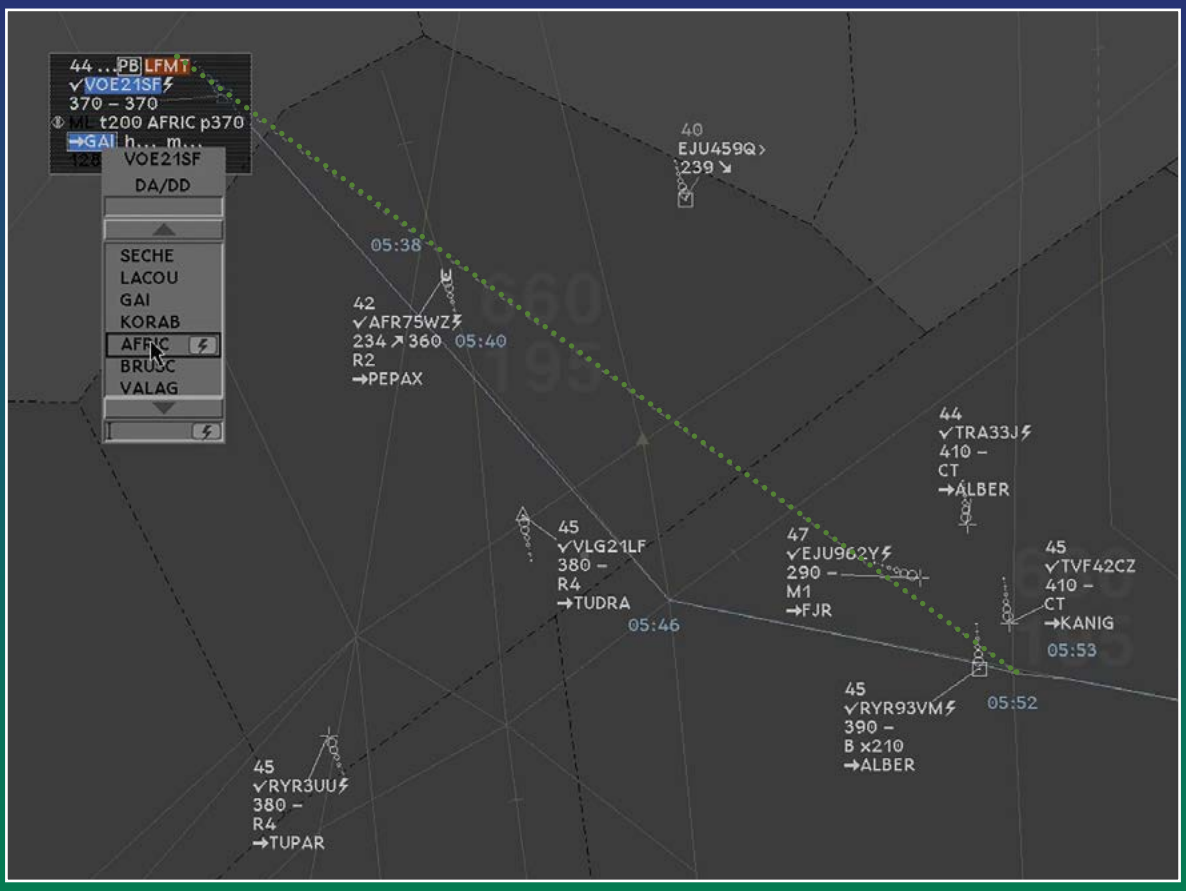
FABEC consists of six states: Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland.

ACC	Area Control Centre
ACNUSA	Autorité de Contrôle des Nuisances Aéroportuaires
ACROPOLE	Aircraft operations noise & fuel efficiency
ADSCENSIO	ADS-C enables and supports improved ATM operations
AMAN	Arrival Management
ASM	Airspace Management
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
BAR	Board of Airlines France
CAP	Collaborative Advanced Planning
CCE	Commission Consultative de l'Environnement
CDM	Collaborative Decision Making
CDO	Continuous Descent Operations
CEM	Collaborative Environmental Management
CFSP	Computer Flight Service Provider
CORAC	Conseil pour la Recherche Aéronautique Civile
ENAC	Ecole Nationale de l'Aviation Civile
FABEC	Functional Airspace Block Europe Central
FEAT	Flight Efficiency Analysis Tool
FL	Flight Level
FMP	Flight Management Position
FMS	Flight Management System
FNAM	Fédération Nationale de l'Aviation Marchande
FRA	Free Route Airspace
FUA	Flexible Use of Airspace
HMI	Human-Machine Interface
IATA	International Air Transport Association
ILS	Instrument Landing System
KEA	Key performance Environment indicator based on Actual trajectory
KEP	Key performance Environment indicator based on last filed flight Plan
NATS	The English air navigation service provider
NDB	Non-Directional Beacon
NM	Nautic Miles
PBN	Performance Based Navigation
RAD	Route Availability Document
RECAT-EU	European wake vortex recategorisation
RISE	RNP Implementation Synchronized in Europe
RNP	Required Navigation Performance
RNAV	Area Navigation
SALTO	Swift ATFCM/ASM Local Tools Organizer
SEPHER	Secours Electrique à base de Pile à Hydrogène et d'Energies Renouvelables
SESAR	Single European Sky ATM Research
TMA	Terminal Manœuvre Area
TOD	Top Of Descent
UFCNA	Union Française Contre les Nuisances des Aéronefs
VFR	Visual Flight Rules
VOR	VHF Omnidirectional Range
VTOL	Vertical Take-Off and Landing
WER	Wake Energy Retrieval
XSTREAM	Cross-border SESAR trials for enhanced arrival management

MINISTÈRE
CHARGÉ
DES TRANSPORTS

Liberté
Égalité
Fraternité

dgac direction générale de l'Aviation civile
DSNA



Direct route given tactically by a ACC Bordeaux air traffic controller to a flight from Nantes to Montpellier at FL 370 (the standard route is planned further west).

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September 2021
www.ecologie.gouv.fr

member of FABEC

MEMBER OF SESAR JOINT UNDERTAKING

Publisher : Florian GUILLERMET • Editor : DSNA Communication (F. Richard- Bôle) • Layout : Citizen Press
Pictures : DSNA – Armée de l'Air/SIRPA – Airbus • Printing : SIA – September 2021.