



**MINISTÈRE  
CHARGÉ  
DES TRANSPORTS**

*Liberté  
Égalité  
Fraternité*



**4-FLIGHT**   
The Innovative ATM Solution

# TECHNICAL MODERNISATION OF THE FRENCH ATM SYSTEM FOR EN-ROUTE CONTROL CENTRES

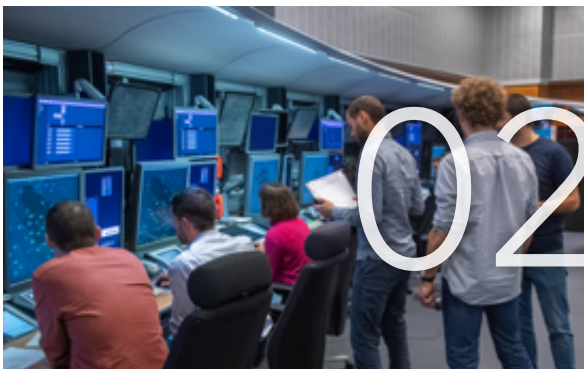
Safe and efficient management for air traffic in the future





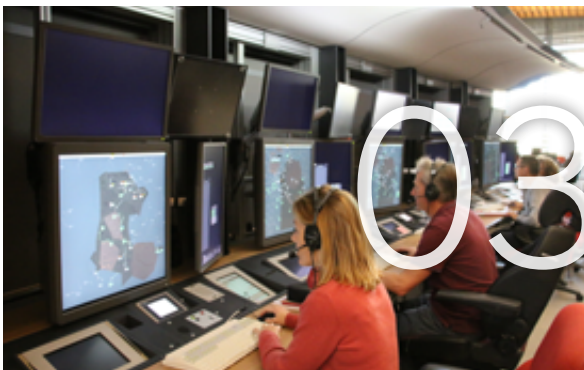
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Paris, June 30<sup>th</sup>, 2022

The implementation of 4-FLIGHT scheduled on June 14<sup>th</sup>, 2022 at the Reims ACC, designated as one of the two pilot-control centres, will represent a major step forward for air navigation in France.

This new-generation system for air traffic en-route control, designed by the DSNA, the French Air Navigation Service Provider, and Thales, a worldwide company, in cooperation with the Defence teams, is part of an ambitious, technological modernisation of our systems, which has become crucial. 4-FLIGHT brings innovative features for more efficient air traffic management.

I would like to highlight the remarkable work of the integrated DSNA/Thales teams, engineers and operational staff (air traffic controllers and maintenance engineers) to develop this complex, new system tirelessly over the past ten years. The intense efforts led since April 5<sup>th</sup>, 2022 to validate the running of the system in a completely safe and efficient way demonstrate the technological leap induced by 4-FLIGHT. This latest operational evaluation phase aims to consolidate the system's acceptance by the operational staff and its robustness in a global operational environment. I know however that at this stage there are still many improvements to be made to the system so that it offers its full potential, and the teams are working on it.

After the Reims ACC, 4-FLIGHT will be deployed in the other French ACCs as soon as possible. Air traffic controllers will thereby be able to handle with a single system throughout the French upper airspace, covering a million km<sup>2</sup>. This unprecedented investment will enable to overhaul our technological architecture and gradually withdraw from certain systems that have been in service for several decades.

The coronavirus pandemic has brought about deep changes. Aviation is becoming more environmentally friendly, driven by the digital transformation of the sector. With 4-FLIGHT, France now has a new-generation technological base that will be equipped to deal with these new air transport challenges.

**Florian GUILLERMET**  
Director of France's DSNA

# 01

## GENERAL OVERVIEW

Thanks to continuous improvement work, the current French ATM system was able to manage more than 3 million flights in 2019. That said, its architecture dates back to the 1970s and it is no longer fitted to handle the latest generation of technological standards and the new, operational concepts involved in the Single European Sky. That is why in 2011, the DSNA and Thales launched 4-FLIGHT, a technical modernisation programme for the French ATM system to cover the five ACCs or en-route control centres.

### 4-FLIGHT, A SYSTEM DESIGNED AROUND DSNA'S VALUES

**4-FLIGHT is in line with DSNA's values:** air navigation safety and public service, human and collective, innovation and the Single European Sky.

The 4-FLIGHT integrated control system is the corner stone of the programme to modernise the French ATM system. 4-FLIGHT is resolutely focused on the human element as a central factor in decision-making and brings a new vision of ATM in France.

Thanks to the major, technological advances of 4-FLIGHT, the DSNA's ambition is to offer innovative tools to operational staff so that they can easily **handle dense, complex traffic in a completely safe and efficient**

**way.** Its ambition is also to provide its customers and airspace users with a very high-quality service. The aim is to be as close as possible to

their operational needs, meeting the environmental requirements that will shape the future development of our business.



#### THE VALUES OF 4-FLIGHT



##### SAFETY AND RELIABILITY

**At the crossroads of design,** flight safety and cybersecurity

A technically robust and resilient system



##### AGILITY AND PERFORMANCE

**Scalable architecture** to meet DSNA's operational needs

Adapting to the new expectations of customers and airspace users, and to new European standards



##### INNOVATION AND THE HUMAN BEING

**Operational and technological excellence**

A tool designed by operational staff for operational staff

## 4-FLIGHT, THE COMBINATION OF TECHNOLOGY, PERFORMANCE AND INNOVATION

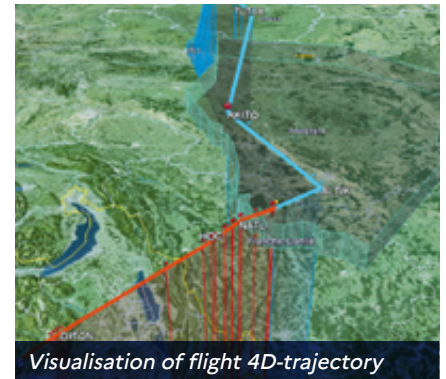
4-FLIGHT is an ambitious, new generation air traffic control system. It delivers high-level operational performance. Thanks to all its assets, it makes seamless air traffic management easier and improves the environmental performance of flights.

### ➔ Coflight, the 4-FLIGHT engine

Developed by the DSNA and its Italian counterpart, ENAV, along with Thales/Leonardo industrial consortium, **Coflight is an enhanced Flight Data Processing System (eFDPS) represents a major operational and technological breakthrough.** At the heart of 4-FLIGHT, Coflight updates the aircraft flight plan trajectory in real time. As a result, the controller has a more accurate forecast of the aircraft's trajectory, reducing flight time and fuel consumption. By integrating a much broader scope of static air traffic data from the EUROCONTROL database than with CAUTRA, the existing FDPS,

Coflight calculates accurate flight profile beyond the French airspace. Dynamic, continuous flight plan processing also feeds the other components of 4-FLIGHT, enabling more efficient functionalities such as conflict detection alerts (Tactical Control Tool) and better communication between sectors and between neighboring centres.

CESNAC teams from the operations directorate (p. 22) are involved in processing flight plan rejections coming from the system (FDO tool) and in providing with national data for systems parameterisation, among other topics.



Additionally, the 4-FLIGHT architecture and the dynamic flight-data processing enable the DSNA to study new services such as ATM Data Service Provider (ADSP).

### ➔ Technological Benefits



**Cybersecurity:** compliance with the latest regulatory requirements



**Technical supervision** fitted to the DSNA's needs (parametrisations, tests, commissioning)



**A system designed to be interoperable** with other European air navigation systems



**A modern and scalable system architecture** for flight data processing

### ➔ Operating Benefits: 🛡️ Safety 🌿 Environment 🚀 Capacity 💰 Costs

» **An accurate flight trajectory forecast and tracking close to real-time flight development thanks to Coflight.** They include 4D-trajectory descriptions, a volumetric distribution of information and continuous, real-time, data updates.

» **An ergonomic and streamlined interface (jHMI) in a stripless, electronic environment** provides easy access to comprehensive information.

» **Cooperative and control support tools**, such as the agenda, datablocks and negotiation, to improve safety and efficiency through better information sharing between controllers, as well as between controllers and supervisors. **In terms of technical supervision**, these new tools promote better workload sharing.

» **More graphical, efficient, and high-performance decision support and control tools**, particularly for conflict detections, and when integrating new-generation safety nets.

» **The ability to integrate operational requirements** such as Controller/Pilot Data Link Communications (CPDLC), the full capacity of the Data Link and Free Route environment, the SESAR concept of Trajectory Based Operations (TBO) and advanced civil-military coordination.

» **A high-performance training simulator, as close as possible to the actual operational life**, enabling faster training times for continuous training (the conversion and the refresher trainings) and for student-controllers.

## INVESTMENT CAPABLE OF MEETING THE CHALLENGES

The overall cost of the 4-FLIGHT/ Coflight programmes, designed to last at least 30 years, amounts to just over one billion euros. The 4-FLIGHT project includes:

- the acquisition of the software,
- the purchase and installation of the hardware (racks, furniture and controllers working positions, training simulator),
- the upgrading of the infrastructure (energy, air conditioning, rooms layout),
- the necessary adaptation of the current system (CAUTRA) components to be interfaced with 4-FLIGHT,
- the development of next versions after coming into commission.

**The French Ministry for Armies** has also financed the costs of deploying 4-FLIGHT positions for the military positions (CMCCs) co-located in the

5 ACCs. A new control HMI will be interconnected to its STRIDA control system (p. 17).

What is more, **the European Union**, as part of the Single European Sky technical modernisation programme, has co-financed 10% of the 4-FLIGHT and Coflight programmes. It was recognised that **the operational performance of this new ATM system would be of immediate benefit not only to France but also to the entire European network.** Indeed, 4-FLIGHT is connected to ten Air Navigation Service Providers neighboring to France: ENAIRE (ESP), DGAC Algeria, ENAV (IT), Skyguide (CH), DFS (DE), the Maastricht UAC (EUROCONTROL), Skeyes (BE), ANA (LUX), NATS (UK), IAA (IRL) and the Network Manager (EUROCONTROL). The progress of the 4-FLIGHT pro-

gramme, registered as a SESAR solution, is closely monitored by **the SESAR Deployment Manager** in charge of synchronising and coordinating implementation against the SESAR Deployment Programme, which is seen as a great opportunity and powerful motivation for the DSNA.



Equipped with an intuitive HMI, the latest generation of equipment as well as innovative and sophisticated tools to support flight management and safety, 4-FLIGHT is one of the most advanced stripless air navigation systems in Europe.

Reims ACC : implementation of 4-FLIGHT on June 14<sup>th</sup>, 2022

# 02

## PEOPLE AT THE HEART OF INNOVATION FROM DESIGN TO OPERATIONAL USE

Right from the very start of the programme, all DSNA entities shared with the manufacturer the progress that they were making on this complex project, from system development through to validation, with the manufacturer. Together, they have co-created both the working methods and the training programme for future users.

The Reims and Marseille ACCs were designated pilot-control centres, with the involvement of CESNAC, the central operations centre for air navigation systems. These centres have been a source of cooperation and emulation, which has been beneficial to the running of the programme.

### SAFETY AND CYBERSECURITY CHALLENGES



The Tactical Control Tool (TCT) prevents controllers from potentially serious operational situations. If the controller types in conflictual clearance information, the TCT sends them an alert.



The safety net for en-route (STCA) alerts the controller when aircraft in flight are in hazardous proximity to dangers.

Ensuring flight safety is DSNA's primary mission. Far from being a constraint, safety is a development factor, as it enables controllers and maintenance personnel to have confidence in their working environment. Right from the beginning, the project was designed to be an **innovative, reliable and resilient system that would withstand failures and errors, while being scalable and meeting new ATC requirements**. It was particularly challenging because of the scale of the innovations involved, and their profound impact on existing infrastructures and operational jobs. Responsiveness and adaptability were also essential to meet users' new needs and hazards over the course of the project. These challenges represent a myriad of technical and operational risks to be assessed and removed!

#### 🔄 An innovative approach

In this context, the safety approach was organised around several actions:

- designing of working methods in a collaborative manner for nominal and adverse conditions situations by integrating safety issues.
- taking into consideration critical, operational situations from the design stage.
- creation of a new tool dedicated to safety. The TCT is a real barrier that reinforces the robustness of the system. It has been tested from the pre-operational version.
- creation of an architecture dedicated for the backup system with an enhanced display in case of loss of main control working positions and flight plan.
- implementation of control loops to evaluate the consistency of the system in order to protect against malfunctions of the software and settings.

- compliance of the software coding to the European standard ED-109.
- gradual use of the system on real traffic in order to take ownership of the system (p. 11).

Thanks to a gradual process for validating safety objectives through rigorous evaluations under live conditions, it has been possible to build confidence in the system, a vital approach as well for the operational users as for the National Supervisory Authority responsible for approving the safety case.

#### 🔄 Cybersecurity

The latest requirements in terms of cybersecurity have been taken into consideration to address the most significant threats. 4-FLIGHT is monitored by DSNA's Security Operations Centre (SOC).

## AN INNOVATIVE WAY OF WORKING

Managing a project on the scale of 4-FLIGHT forced the DSNA to adapt its organisation and management methods.

### ➤ One management team entirely dedicated to the programme

The multidisciplinary team created to manage the 4-FLIGHT programme is in charge of leading this modernisation programme both from a technical and an operational point of view. Since 2014, programme management has been based on a modern method called Managing Successful Programmes (MSP), designed for major transformation programmes. The management team has been trained in these practices that ensure a collaborative way of working between all stakeholders, the sharing and dispatching of information and a smooth running of the programme.

### ➤ A partnership based on trust

4-FLIGHT is a new industrial approach for both the DSNA and Thales. It was thus necessary to clearly define the role of each partner. The teams had to learn to work together, across different cultures, all while integrating innovative principles. For example, Thales was accustomed to mastering all the central components of the system, but the DSNA wanted to integrate its own very high value-added components, such as the Coflight eFDPS, the safety net (STCA) and the arrival sequencing tool. In 2014, the Integrated Driving Plan was an important step forward in organising closer cooperation between the customer and the manufacturer with the support of several integrated teams.



4-FLIGHT at the Marseille ACC: integrated DO, DTI, Thales team

### ➤ Integrated teams

In 2020, more than 1,000 professionals participated in the development of 4-FLIGHT based around a specific way of organising the work between the teams of Thales and the DSNA, bringing together the multitude of skills from each of the partners. These working methods have been essential to better integrating the development processes and strengthening trust between the different players.

### ➤ AGILE methods

This method, which places the end-user at the heart of the project, was incorporated from 2016 onwards and focused on certain components. This approach was made possible thanks to 4-FLIGHT's architecture. The aim was to have rapid turnaround times to encourage the adaptation on components in development, without affecting safety-critical functions. Appropriation of this method is also very useful as the programme gets closer to coming into operations.

### ➤ Implementation of milestones

All successes, however small, and transparency are essential to fostering the development of both skills and confidence. That is why a roadmap has been defined with regular milestones. These steps enable to evaluate achievements and also make it possible to see what remains to be done in a collaborative way. They provide everyone involved with clear and useful visibility on the running of the programme and decisions that have been taken.

### ➤ Involvement of future users

From the beginning of the development process, DSNA and Defence's technical and operational staff were involved. This began in the experimentation and evaluation phases, continuing through to the validation phase. They also intervened on concrete cases, through workshops, to validate certain technical choices. This working method has significantly reduced the risks of the system not being adapted to the needs of future users.

The incremental and iterative approach meant that each release had clearly defined use and evaluation objectives, and to deliver functionalities in a progressive and coordinated way. These releases were used for the validation and parametrisation phases, and to build continuation training programme.

**Progressive appropriation of the system by end-users is essential to limiting the risks associated with the deployment phase.**





➔ **DSNA's Innovative Directorate at the heart of development**

Within the DSNA, the 4-FLIGHT teams of the Directorate of Technology and Innovation (DTI) have:

- **Managed the definition of technical specifications** by organising, when necessary, experiments and workshops involving the future users.
- **Provided DSNA components** such as Coflight or the en-route safety net so that Thales can integrate them into the development of 4-FLIGHT.
- **Received and tested releases of the software**, that have already been evaluated upstream by the manufacturer, during prior validation phases on DTI platforms or on site.
- **Deployed the releases at the pilot-centres** and helped to set up the system correctly.

In 2018, the validation process changed with greater efficiency in mind. Evaluations have been carried out in parallel at the DTI and on site.



The bugs detected are analysed and the necessary corrections made by Thales. Thus, over successive cycles, the system gains in maturity with each new software release delivery. This leads to visible progress that builds confidence! At the same time as developing the software, the DTI contributes to building

the working methods, and the content of the training courses and to producing the safety study. It also participates in tasks required to the 4-FLIGHT deployment in the centres (air conditioning, energy, wirings, furniture...).

**Examples of workshops and experiments with ACCs**



**2012-2013**

Right from the design process of the system, various aspects such as safety and human factors were integrated into the working methods and training.

From June 11 - July 6, 2012, a first experiment took place in the DTI, and then in January 2013 by involving **some twenty controllers-testers from the Reims and Marseille ACCs.**

**2012 - 2013**

Various workshops bringing together teams from Thales and the DSNA were held at the Thales SkyCenter in Rungis to contribute to the design and validation of the new ATC tools and the ergonomics of the new control screen HMI. The teams looked into how to focus on essential tasks, on the definition of the tools of the supervisor...



**October 11 - December 14, 2016**

**About twenty controllers-testers from the Paris ACC** participated in six evaluation sessions of DSNA/Thales platform, over the course of 7 days. The results of these evaluations contributed to later work that helped to define the system, operational procedures and training for the Paris region.

## LESSONS FROM THE PRE-OPERATIONAL VERSION



The pre-operational phase began in 2013. It aimed at giving confidence in the process of the programme by developing an intermediate version called Build Inter, representative of the operational version. This advanced prototype incorporated Coflight, the new HMI with innovative ATC support tools such as the TCT that detects conflicts over a 5-minute horizon and the simulation environment for controllers' continuation training and supervision. An integrated team involving the DTI and the Operations Directorate (DO) staff was formed and contributed to defining the specifications of this platform and its timetable. This approach allowed the creation of a first core of 4-FLIGHT experts.

In 2015, with the delivery of the Build Inter to two pilot-centres, technical and operational evaluations on site took precedence over the experiments. Coflight, the new HMI and the TCT, the key to 4-FLIGHT's safety approach, were the pillars of operational acceptance by controllers. Through their recommendations, the experts have made it possible to advance the maturity of the system and consolidate the elements to enable the change management process (validating working procedures, fine-tuning the training method, building the settings). Since then, the pilot-centres have also become contributors and partners to the programme!

Beyond the technical lessons learnt, the organisational issues of project management were analysed in detail to better prepare the next stage: a sufficiently advanced version that would allow 4-FLIGHT to be employed with more real traffic.

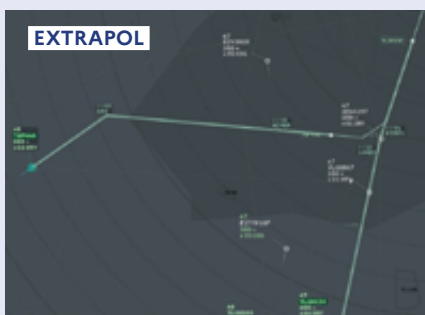
The Build Inter phase was a success. Thanks to this prototype, some operational staff were able to take ownership of the system. It marked a decisive step towards deployment, initiating the broader integration of stakeholders and a promising 'Bottom-Up' approach for greater mastery of the programme objectives.

### A FEW INNOVATIVE ATC SUPPORT TOOLS

With 4-FLIGHT, the air traffic controller can focus on their essential tasks improving flight safety and efficiency.

#### EXTRAPOL

Extrapolation of aircraft trajectories providing an estimate of the future position at any time.



#### FLIGHT LEG

Visualisation of the aircraft trajectory to ensure the consistency of flight data.

#### SEP

Radar separation that allows the calculation of the minimum distance between two flights.

#### WHAT IF

Coordinating flight levels or routes without having to make phone calls with adjacent sectors from the controller's screen display.

#### SEP/TCT



#### TACTICAL CONTROL TOOL (TCT)

More reactive conflict detection between two flights. Forecasts are made up to 5 minutes in advance and integrate clearances given by the controller.

## FIRST OPERATIONAL EVALUATIONS ON LIVE TRAFFIC

Starting in 2017, progress enabled the implementation of 4-FLIGHT's operational trials on real traffic, conducted in safety mode. These exercises are a fundamental step towards the deployment, like flight tests for a new aircraft. For each of them, the DSNA must submit beforehand a safety case to the National Supervisory Authority. These live trials require several months of preparation and constitute a great moment in the life of the project. Their successes testify to the high professionalism of the 4-FLIGHT teams and are a source of motivation.

The first operational trials of 4-FLIGHT took place in a low air traffic context, at night, in stand alone mode. As more robust releases of the system were developed, the duration of these exercises became longer and situations became more complex to reflect the desired final operational situation as closely as possible. The latest evaluations have made it possible to control traffic with 4-FLIGHT for several hours.

**Live trials in 2020:** in the conditions mentioned above, controllers in the Reims ACC handled 641 flights over three days with 4-FLIGHT and tested changeovers and backturns, sectors

collapse and de-collapse, controller shifts, and technical supervision. The controllers in the Marseille ACC handled 409 flights with 4-FLIGHT and tested connections between adjacent control centres in France (the Bordeaux and Paris ACCs) and abroad (the Geneva, Barcelona/Palma, Milan and Rome ACCs) as well as data link clearances. Additionally, CESNAC was able to correct some incorrect flight plans in the FDO tool (p. 22).

Live trials continued in 2021. The Marseille ACC has planned four UOPs in 2022 until November before the commissioning scheduled for 6 December 2022.

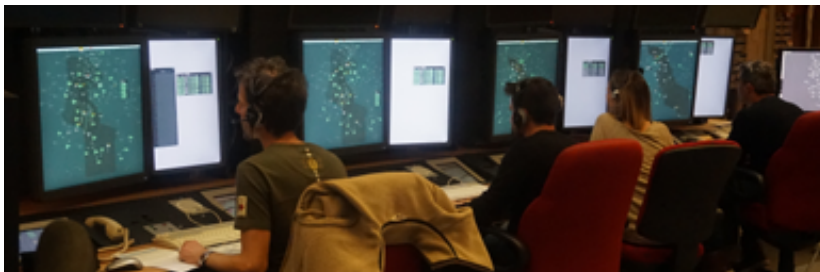
**January 25<sup>th</sup>, 2017 – 00:05 am**

*"Reims Hello! Martinair 7121, direct from Papa Oscar November". First radio contact from a Reims ACC controller with a flight controlled using 4-FLIGHT!*



**December 18<sup>th</sup>, 2019 – from 10:00 pm to midnight**

*Around sixty flights, that were being controlled by Reims ACC with 4-FLIGHT, connected for the first time to the adjacent centres of Brest and Geneva.*



**March 15<sup>th</sup>, 2017 – 11:02 pm** *"Marseille Hello! SpeedBird 352, Flight Level 340, on course to XIRBI". First radio contact from a Marseille ACC controller with a flight controlled using 4-FLIGHT! This trial also involved technical supervisors (on the right) in charge of monitoring the proper functioning of operational systems.*

**August 4<sup>th</sup>, 2020 – 5:45 pm** *Operations room at the Reims ACC: evaluation of sectors de-collapse and controller shifts on 4-FLIGHT control positions.*



**September 1<sup>st</sup>, 2020 – 8:14 pm** *First clearance given via data link by a Marseille ACC controller using 4-FLIGHT! Ground and onboard data exchanges are at the heart of future operational concepts.*

# 03

## THE DEPLOYMENT PHASE

A COLLECTIVE COMMITMENT, AN UNPRECEDENTED ORGANISATION

Modernising 5 ACCs, each one with specific operational contexts in a dense and complex traffic environment, is a major challenge. Achieving operational implementation of 4-FLIGHT, ACC after ACC, is part of DSNA's safety culture, which is based on robust, accurate and efficient work in close collaboration with the National Supervisory Authority.

Following the two pilot-sites, Paris will be the next ACC to accommodate 4-FLIGHT. Paris ACC has also actively contributed to the production phase of the system. Then, in 2025, the Brest and Bordeaux ACCs already equipped with ERATO electronic environment, will switch to 4-FLIGHT.

4-FLIGHT integrates an enhanced Flight Data Processing System (eFDPS) and a new ATC environment: this represents a change of nearly 80% for the French ATM system. This shows the scale of this operation, especially considering that change is usually organised one component after another.

To ensure that the deployment phase is a success, activities of parametrisations, validation and training for operational staff have to be anticipated and coordinated. Additionally, prior to any actual implementation, work to adapt flows will be carried out in collaboration with the airlines and the Network Manager (EUROCONTROL).

Deployment of 4-FLIGHT is also an industrial challenge. The success of this ambitious and vital project

both for France and the European air routes network requires a collective commitment of all stakeholders.

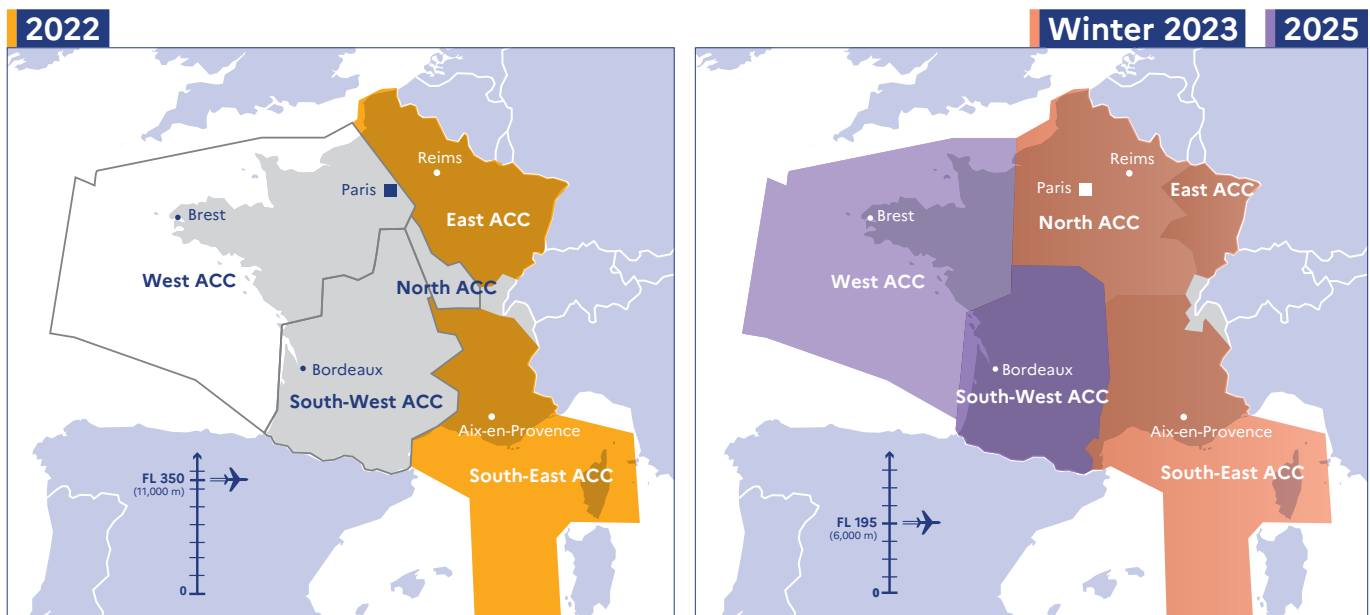
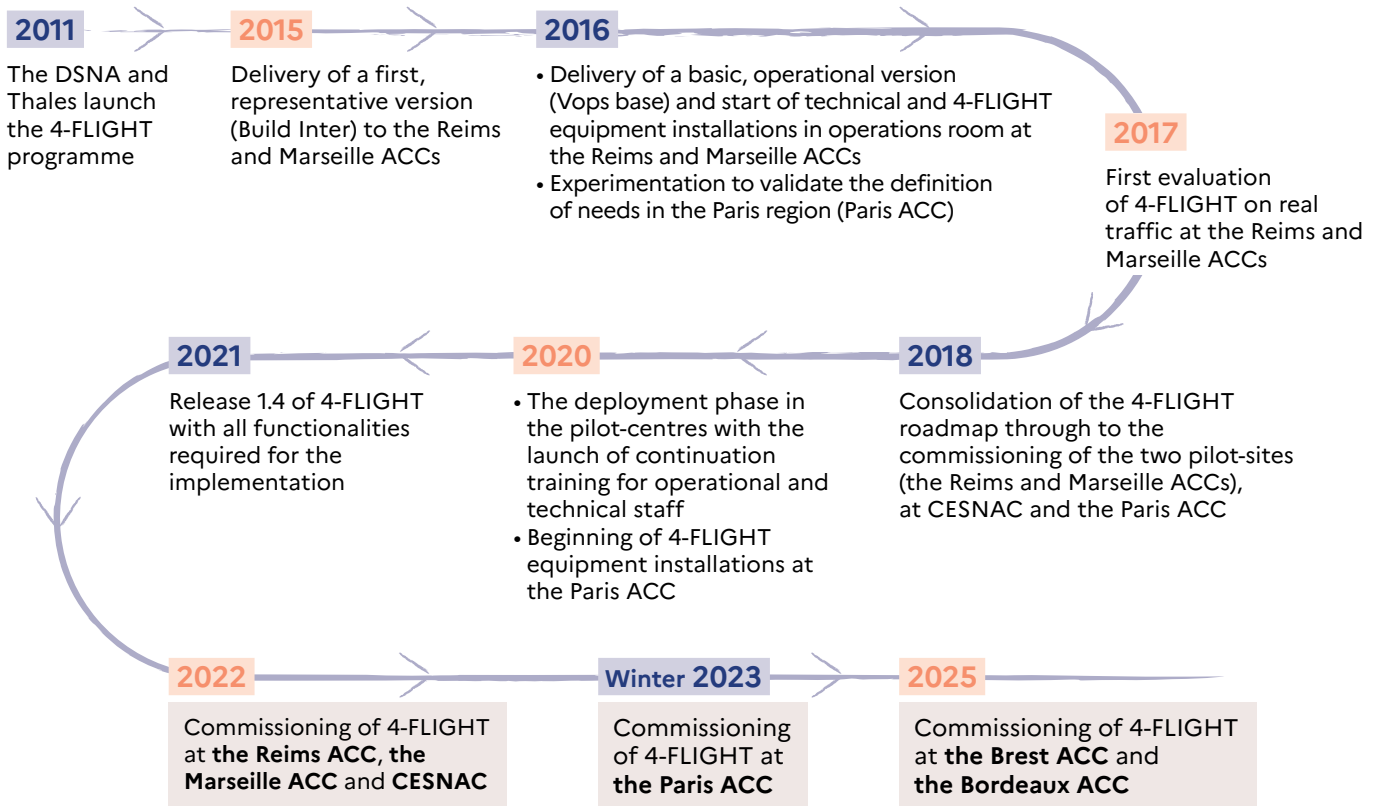
*“The strategy for modernising our ATM systems aims to harmonise and streamline the technical solutions used.”*

Florian GUILLERMET, DSNA



4-FLIGHT: route clearance given via data link by a Marseille ACC controller

## KEY MILESTONES



*The commissioning of 4-FLIGHT will be sequenced, ACC after ACC, to reflect the importance of the change to the new ATM system. When an ACC changes to 4-FLIGHT, all its control sectors will be switched simultaneously to the new system. The migration will be as seamless as possible with adjacent centres not equipped with 4-FLIGHT (other French ACCs and foreign ACCs, military control centres, approach control centres and airport towers).*

## THE PARIS REGION, A SIGNIFICANT CHALLENGE FOR 4-FLIGHT

Serving the busy airports of Paris-CDG, Paris-Orly and Paris-le Bourget in complete safety is a major challenge. The Paris ACC and its approaches use specific, assistance tools in flight sequencing and automated coordination to manage changing flights, while climbing and descending, and high peaks in air traffic.

The Paris ACC, as well as the other ACCs, has been involved right from the development phase of 4-FLIGHT in order to keep a consistency with the product line deployed in the pilot-centres. By its close

interweaving of terminal sectors with Parisian approaches, this centre constitutes a different environment for 4-FLIGHT use. It contributes to a better understanding of Coflight's functionalities and avoiding the risk of a CAUTRA decommissioning.

At the end of 2016, an experiment in the Paris region was undertaken at the DTI (p. 9) to define what a completed release with integrated AMAN functions (sequencing of arrivals) and multiple clearances captures would look like. Since then, as a starting off point, only some of these requirements will be fulfilled

in a software release for the commissioning of 4-FLIGHT in Paris at the end of 2023, after the pilot-sites in Reims and Marseille.

To best prepare for this change, the Paris ACC has begun to install 4-FLIGHT positions powered by the ODS/CAUTRA system. This hybrid, transitional, modular and scalable equipment offer better ergonomics than current control positions and will make it possible to save time during the switch to the 4-FLIGHT system.

### ➔ 4-FLIGHT at the Paris ACC

During the night of 10 to 11 March 2022, in a remodelled work environment, the Paris ACC successfully carried out its first operational evaluation (UOP) of 4-FLIGHT on real traffic in a shadow mode.



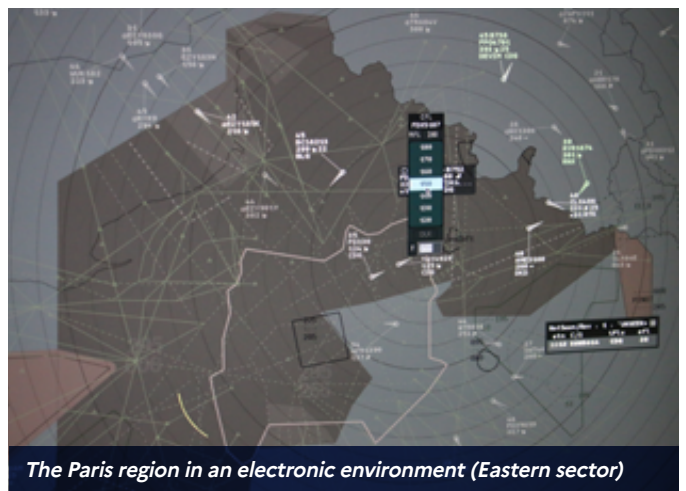
Western sector



Eastern sector



Technical supervisors team



The Paris region in an electronic environment (Eastern sector)

## MODERNISING, EXPANDING, REDEVELOPING AND URBANISING

The arrival of 4-FLIGHT in the centres is a major event and requires a strong bond between the local teams of Technical and Operations departments. On a day-to-day level, preparations require unprecedented

organisation over several years while still maintaining operational activity! It is necessary to:

- **Modernise the equipment:** a new, more powerful Energy & Air Conditioning unit (400,000 W)

to ensure the transition phase when there would be coexistence between both CAUTRA and 4-FLIGHT systems, and a new line of furniture in the operations room. To improve efficiency, other equipment was also renewed.

- **Enlarge the infrastructure, redevelop existing surfaces, and urbanise:** creation of new spaces such as the 4-FLIGHT simulator training rooms, adaptation of surfaces to make the new equipment cohabit with the existing one, whether for the 4-FLIGHT racks in the technical room or for the 4-FLIGHT equipment with their screens in the operations room. At the Marseille and Paris ACCs, the installation of new control positions required a very sophisticated strategy of urbanisation to take into account space constraints.



The 4-FLIGHT racks in the technical room

### 4-FLIGHT PREPARATIONS IN NUMBERS

- > **Enlargement** of the operations room (170 m<sup>2</sup>) and the technical room (150 m<sup>2</sup>) at the Reims ACC
- > **Creation** of a 260 m<sup>2</sup> server room and a 320 m<sup>2</sup> room for parametrisation and evaluations at the Paris ACC
- > **500 km** of new cables at the Marseille ACC

- > **Operations room:**
  - 36 control posts 4-FLIGHT excluding military positions (the Marseille ACC)
  - 29 control posts 4-FLIGHT excluding military positions (the Reims ACC)
  - 22 control posts 4-FLIGHT excluding military positions (the Paris ACC)

- > **Training room on 4-FLIGHT simulator:** 6 to 8 control positions and pseudo-pilot positions
- > **CESNAC:** 3 positions for Flight Data Operations (FDO)



The design of the 4-FLIGHT furniture facilitated the acceptance of the new system



Ultimate backup room (batteries)

## A WIDE RANGE OF TRAINING FOR TECHNICAL AND OPERATIONAL STAFF

Delivering quality training to nearly 350 air traffic controllers per each ACC and about 100 maintenance engineers (ATSEPs), while carrying out day-to-day tasks, is a crucial step in the successful operational commissioning of 4-FLIGHT.

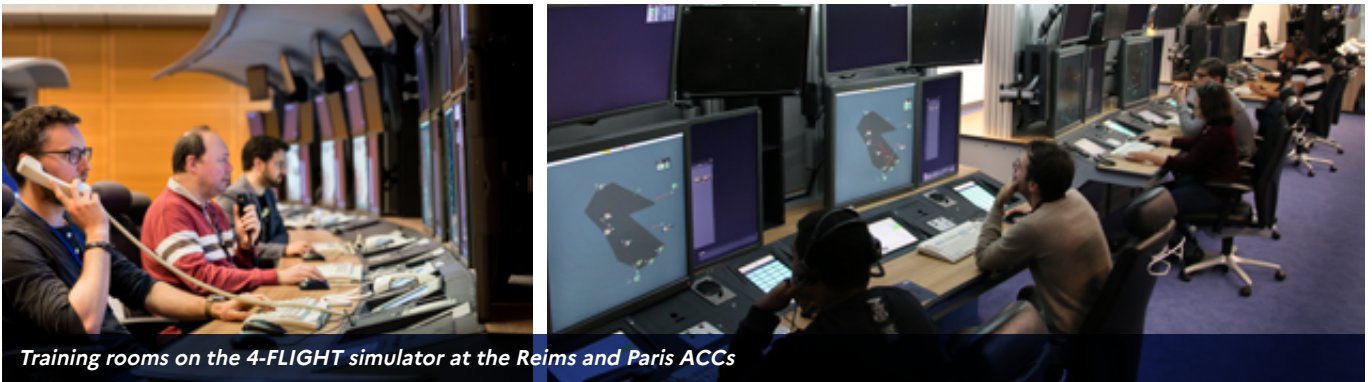
The controllers need to become familiar with the dynamic and volumetric flight profile (Coflight), to master the new tools and alerts, as well as their areas of use, to take ownership of the system with the stripless HMI in all operational situations, including unusual ones.

All the training for the pilot-sites and CESNAC will last for two years. The number of controllers in operations can be reduced up to 25%, except for the busiest periods. **The first training sessions began in 2020.**

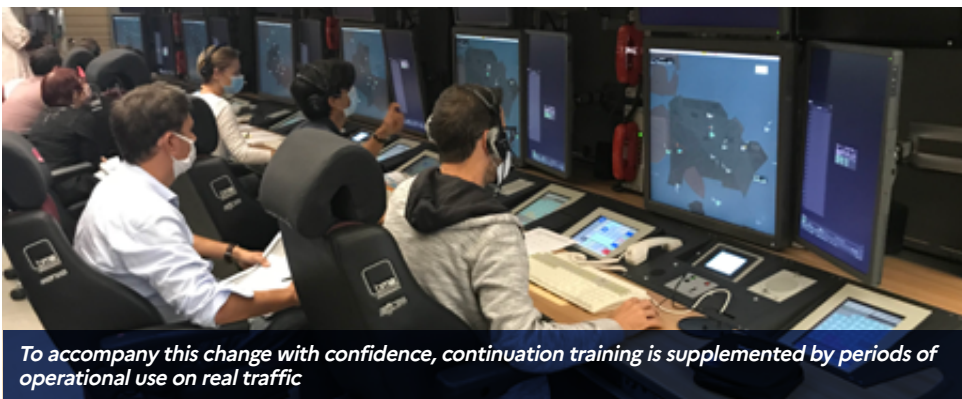
The DSNA shared the strategies to be applied during this period with the Network Manager (EUROCONTROL), the neighbouring control centres and its customers to minimise the impact on traffic flow. On the part of airlines, the prioritisation of some of their flights remains a significant expectation. This Collaborative Decision

Making process will continue until the system is fully implemented.

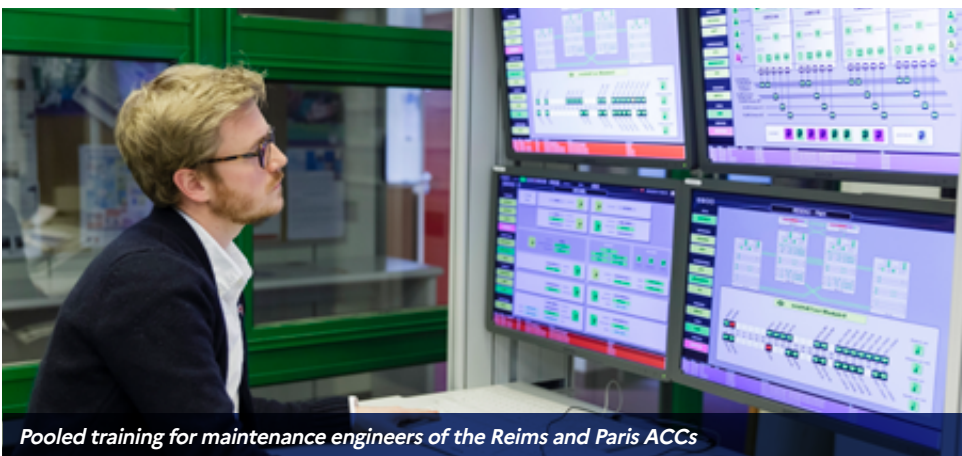
On the military side, DSAE, the French State Aviation Safety Authority of the French Ministry for Armies, uses DSNA's simulators to train its controllers, whether they operate in the CMCC centres co-located in each ACC or in the Flight Test Air Traffic Control Centres (CCER) collocated in the Marseille and Brest ACCs.



Training rooms on the 4-FLIGHT simulator at the Reims and Paris ACCs



To accompany this change with confidence, continuation training is supplemented by periods of operational use on real traffic



Pooled training for maintenance engineers of the Reims and Paris ACCs



38 trainers, 14 days of training for each of the 350 controllers, 8 weeks of training for each of the 24 maintenance engineers (the Marseille ACC)

16 trainers, 13 days of training for each of the 250 controllers (the Reims ACC), 8 to 10 weeks of training for each of the 54 maintenance engineers (the Reims and Paris ACCs)

2 weeks of training for each of the 27 operators (CESNAC)



## MORE EFFICIENT, REAL-TIME, CIVIL-MILITARY COORDINATION

Interconnection between 4-FLIGHT and the Defence systems requires special attention. In terms of preparations, Defence must make major changes to its air control system, STRIDA, to take into account 4-FLIGHT's interfaces with its entities (Air Force, Flight Tests Centre and Navy) located in the ACCs.

The Defence and DSNA teams are working closely together to ensure that the processing of military operational requirements is fully integrated into the implementation process. In particular, the Military Coordination and Control Centres (CMCC) are fully involved in 4-FLIGHT's local integration teams. They also participated in the workshops organised by the DTI to consider the specificities of military air traffic and to adapt the working methods of military controllers.

With Coflight, a single system manages civil and military flight plans, whereas today, the CAUTRA and STRIDA systems manage flight plans separately. The shared knowledge of flight plans with the presentation of the civil controller's control intentions facilitates direct coordination between controllers. It also makes it possible to optimise trajectories for the operational trai-

ning of military aircraft, while maintaining a high level of safety for civil and military air traffic.

Through its performance, 4-FLIGHT enables the CMCC air traffic controller to carry out their mission of flight surveillance over French airspace more efficiently. Operational evaluations were carried out from 2021.



*We are participating in financing the development of this new generation ATM programme. 4-FLIGHT moves civil-military coordination into a new phase of optimisation through better interoperability of our tools and more efficient direct communication between our controllers to benefit of flight safety.*

Général VIREM, Director of State Aviation Safety Authority



### A MODERN, INTEGRATED SYSTEM

With 4-FLIGHT, civil and military controllers operating in a CMCC in ACC have a shared view of the operational situation and integrated tools for information exchange.



Visualisation of military areas in the Northeast region, alongside civil and military flights

## ON TRACK TOWARDS FOR COMMISSIONING IN ALL 5ACCs!

Over the period 2010-2025, the DSNA has built a technical modernisation programme worth 2 billion euros. The Coflight / 4-FLIGHT programmes represent slightly more than half of this investment. To compensate for the shortfall in revenue in 2020 and 2021 due to the collapse of air traffic, the DGAC took out a state loan which notably secured the deployment phase of these programmes. This shows DSNA's commitment to these major programmes to ensuring the future of air navigation in France and to accompanying a sustainable recovery of air transport.



### ➡ Commissioning at Reims ACC

An operational consolidation phase was required for the Reims ACC and the CESNAC before declaring 4-FLIGHT in operational use. This phase called "a scheduled operational evaluation (EOP)" has been started since April 5<sup>th</sup>, 2022 to ensure a safe transition towards the new system. It aimed to consolidate 4-FLIGHT acceptance by operational staff and its robustness in a global operational environment. It was supported by considerable efforts on the part of the Reims ACC and the CESNAC teams, the 4-FLIGHT programme management, the DO and the DTI, as well as Thales.

Monitoring the traffic load on the control sectors was an essential aspect of this transition phase. Daily close coordination with the EUROCONTROL Network Manager, in the presence of the Reims ACC and DO staff at the Brussels Headquarter, was ensured in liaison with our customers and users. The ACC has initially operated at 70% of its capacity with the activation of diversion scenarios to the Paris, Brest and Bordeaux ACCs and to neighbouring foreign centres, and then gradually adapted its capacity in each sector according to the complexity of the traffic.

**The system was officially declared in operational use at the Reims ACC on June 14<sup>th</sup>, 2022** with continued consolidation of the system.

### ➡ A complex transition phase

**By the time 4-FLIGHT is deployed across the 5 ACCs, ATM in France will be based on two systems:** 4-FLIGHT and the current system, CAUTRA. So that both systems can interact with each other, CAUTRA must be upgraded to harmonise data exchange message formats between control centres. Other technical prerequisites have been identified to switch to the 4-FLIGHT environment, such as the migration of air navigation networks through Internet protocol (IP), the deploy-

ment of new-generation Mode S radars, and the feeding of approach control centres and military control centres.

During this period of coexistence, the CAUTRA system will have to be maintained in operational conditions. However, managing and supervising two systems at the same time will generate a significant workload for the technical services at ACCs and CESNAC. This is why the objective is to reduce the length of this transition period as much as possible.



*Thales is very pleased to have cooperated in partnership with DSNA and its teams on the 4-FLIGHT programme. We have, together, showed our abilities to develop our working methods to carry out this ambitious project with trust. Our teams had to learn to work together, making the most of different cultures, integrating innovative principles for capturing needs, structuring the setting up of prototyping workshops and finally deploying an Agile development method to adapt the HMI for controllers. Our objective was to deliver to DSNA operational staff a reliable and efficient industrial product that meets the requirements of the Single European Sky. Thales welcomes the commissioning of 4-FLIGHT in 2022!*

**Christian RIVIERRE, Vice-President Airspace Mobility Solutions**

Thales is the world leader in air traffic management tools: 40% of airspace in the world is handled by Thales systems.



IMPLEMENTED



The Reims ACC, at the crossroads of main European traffic flows and feeding the busiest airports in the core area

This en-route control centre located in Reims manages overflights in one of the busiest and most complex airspaces in Europe, in which military activity is high. Flight density is linked to the feeding of major international airports (Paris-CDG, London, Amsterdam, Frankfurt, Zurich and Geneva). In 2019, this centre controlled 950,000 IFR flights. Its upper airspace is divided into 20 control sectors. It employs 500 people, 90% of whom are operational staff. The Reims ACC was a pilot-site for the 4-FLIGHT programme.



1 4-FLIGHT control positions 2 Preparation for sector de-collapse 3 4-FLIGHT supervision room 4 Modernisation of the air conditioning unit 5 The Operations room with 4-FLIGHT furniture 6 Controllers in continuation training on the 4-FLIGHT simulator



**The Marseille ACC, strongly marked by seasonal variations in traffic and many changing movements**

This en-route control centre located in Aix-en-Provence (Marseille) manages overflights and flights serving the regional airports of Nice, Lyon, Marseille, Clermont-Ferrand, Montpellier and Corsica in a very busy airspace. Its traffic at the crossroads of the main European traffic flows includes very wide variations (+ 40% of traffic in the summer compared to the winter months) and numerous changes in trajectory. In 2019, this centre controlled 1,150,000 IFR flights. Its airspace is divided into 47 control sectors, further divided into two zones.

It employs 600 people, 90% of whom are operational staff.

The Marseille ACC is a pilot-site for the 4-FLIGHT programme.



**May 5<sup>th</sup>, 2022:** the Marseille ACC conducted a live trial (UOP) in a typical setup of the target architecture linked to adjacent centres and approach control units. For 8 hours, up to 15 control positions were open, including the military positions of the CMCC and the CER. Around 50 controllers and 10 engineers from the technical department were involved. The CESNAC teams were responsible for the initial flight plan processing. Nearly 1,200 flights were safely tested under 4-FLIGHT.

1 The Marseille ACC building 2 Technical supervision during operational evaluation of 4-FLIGHT 3 Route clearance given via CPDLC by the controller for a direct to the MOKIP waypoint 4 4-FLIGHT live trial in shadow mode (UOP) in May 2022



AMB Holding	
210	AFR1031 219 w 20
200	
eat RAM662R 19	190 IBE3400 190 - 19
	180 AFR3507 100 - 10
eat IBE3400 17	170 TVF403E 170 - 17
	160
eat TVF403E 14	150 AF523NW 150 w 15
	140
eat AF523NW 13	130
	120
eat FMI543 12	FMI543 120 w 12

### The Paris ACC, the optimised management for flights at medium altitudes to and from airports in the Paris region

This control centre located in Athis-Mons (near Orly airport) is one of the largest in Europe. It provides medium-altitude air traffic services to airports in the Paris region (Roissy, Orly, Le Bourget) in one of the busiest airspaces in Europe. Its traffic consists of 72% flights departing from or arriving at these airports.

In 2019, this centre controlled 1,270,000 IFR flights. Its airspace is divided into 21 control sectors, further divided into two zones.

It employs 560 people, 90% of whom are operational agents.

The Paris ACC will accommodate 4-FLIGHT after the two pilot-centres.



1 The remodelled operations room 2 STAMAN (Stack Manager), a 4-FLIGHT tool specifically designed to manage arrivals sequencing in the event of traffic peaks or adverse conditions 3 Technical room for parametrisations 4 First live trial in shadow mode (UOP) on the night of 10-11 March 2022 5 Training room on the 4-FLIGHT simulator



### Managing and operating the central systems and air navigation networks

**CESNAC** provides 24/7 coverage for Metropolitan France. This includes:

- availability of a non-stop flight data processing service,
- the management and supervision of technical systems and supervision of national air navigation networks (ATM and AIM).

With its 110 employees, CESNAC is a major player in the continuous upgrading of existing air navigation systems and networks. It is also at the heart of modernisation DSN's air traffic management systems (ATM) such as 4-FLIGHT.



### A new Flight Data Processing tool

CESNAC's multi-system operators are responsible for amending incorrect flight plans, including military ones, when they are rejected by the system. With 4-FLIGHT, these amendments are made using the FDO tool developed by Thales which is connected to the Coflight system in each ACC.

Experts from the Technical and Operational departments have developed and implemented new working methods for 4-FLIGHT. More than sixty CESNAC staff, both supervisors and multi-system controllers, were trained to get the new system up and running.



*CESNAC experts in front of the 4-FLIGHT and STIP (CAUTRA) monitoring displays.*

### CAUTRA to 4-FLIGHT transition

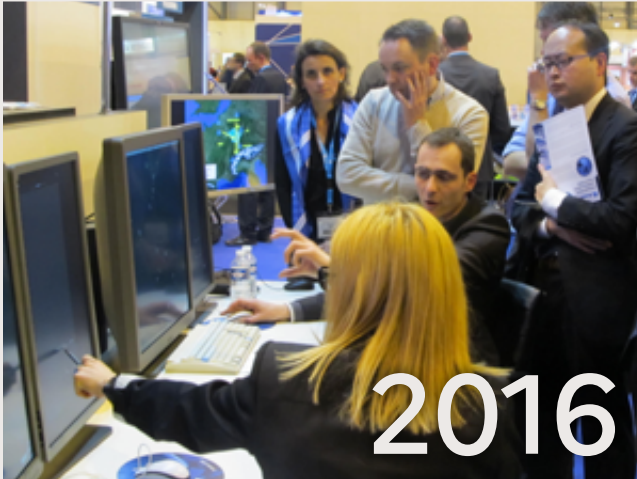
The CESNAC teams have worked hard to adapt CAUTRA and to meet the technical and operational requirements (system installation, network constraints, studies, tests and acceptance) in coordination with the DTI, the pilot-centres and Thales. Moreover, the temporary coexistence of both CAUTRA and 4-FLIGHT systems will lead to an additional workload: the processing of flight plan rejections on the CAUTRA system (STIP) and the 4-FLIGHT "FDO" terminals will have to be managed in parallel, as well as providing AIRAC data monthly in two separate forms.

## 4-FLIGHT at the World ATM Congress (WAC) in Madrid

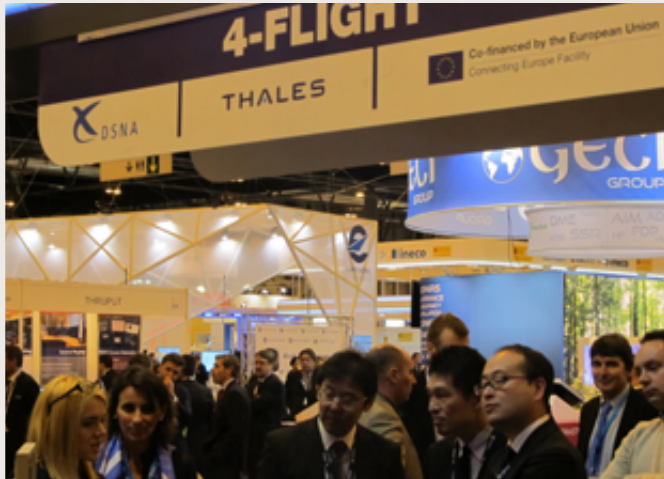
This worldwide event of air navigation professionals took place in Madrid. It brought together huge numbers of visitors, whose interest in DSNA's stand 4-FLIGHT has remained high over the years. Presentations of the tool helped to promote 4-FLIGHT on the international stage and contributed to spreading a positive image of this major ATM programme, which benefits from European co-funding.



2015



2016



2017



2022

ACC	Area Control Center
ATM	Air Traffic Management
ADSP	Air Data Service Provider
CAUTRA	Coordination Automatique du Trafic Aérien
CER	OAT/Flight test air traffic
CESNAC	Centre d'Exploitation des Systèmes de la Navigation Aérienne Centraux
CMCC	Centre Militaire de Coordination et de Contrôle (DSAÉ)
CPDLC	Controller-Pilot Data Link Communications
DO	Direction des Opérations (DSNA)
DSAC	Direction de la Sécurité de l'Aviation Civile
DSAE	Direction de la Sécurité Aéronautique d'État
DSNA	The French Air Navigation Service Provider

DTI	Direction de la Technique et de l'Innovation (DSNA)
FDO	Flight Data Operator
IATA	The International Air Transport Association
INEA	Innovation and Networks Executive Agency
jHMI	java Human Machine Interface
UOP	Utilisation Opérationnelle Programmée
SESAR	Single European Sky ATM Research
SDM	SESAR Deployment Manager
SOC	Security Operations Centre
STCA	Short-Term Conflict Alert
STRIDA	Système de Traitement et de Représentation des Informations de Défense Aérienne
WAC	World ATM Congress

4-FLIGHT: direct route given by a Reims ACC controller

