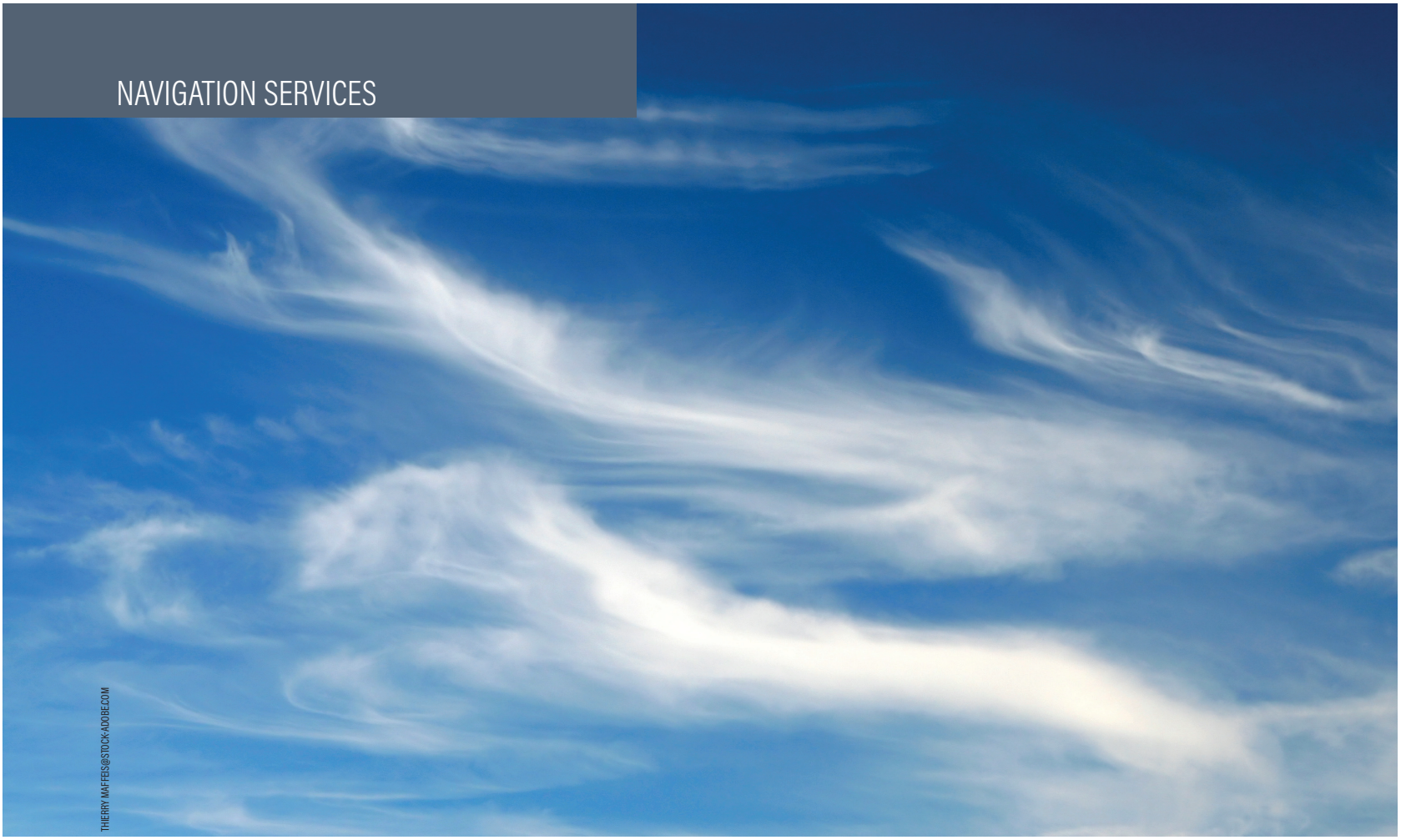


THIERRY MAFFEIS@STOCK-ADOBE.COM

CREATING CLEANER SKIES

Efforts towards cleaning up European skies are moving from reducing fuel burn to research about non-CO_2 sources of climate change such as contrails

Horst Thiel-Ott, DFS Aviation Services / DFS Deutsche Flugsicherung, Ralph Leemüller and Wolfgang Oechler, DFS Deutsche Flugsicherung, Michael Hopp and Frank Lumnitzer, Lufthansa Group

Environmental protection is an issue of increasing concern for the aviation industry. This has led to the development of global solutions for a more sustainable future. DFS, the German air navigation service provider, in collaboration with airlines, among them Lufthansa, has been working on initiatives in this regard for years. DFS is also extending its focus beyond initiatives focusing on fuel consumption to encompass non-CO_2 effects.

Even though the whole industry has been confronted with a crisis of unprecedented dimensions caused by the Covid-19 pandemic, DFS saw an opportunity to use the empty skies to elaborate its Environmental and Climate Protection Concept. This concept lays down the strategic direction and the overall procedures in environmental and climate questions for DFS. Without the pressure of fitting an ever-growing number of aircraft into limited airspace, DFS was able to refine the practical implementation in daily operations. Numerous measures have been put in place to reduce emissions.

Sustainability challenge

The challenge is to balance the sustainability component with the other common key performance indicators in European air traffic management, in this case safety, cost-efficiency and as soon as air traffic starts to recover, capacity.

The efforts undertaken during this quiet period will ensure that the recovery can be managed more safely and in a better way for the environment. In addition, the approach is part of a shared vision toward a more automated future for air traffic control.

The focus on the operational level has been on three specific initiatives, which have been transferred into existing operational structures: the Low Demand Concept, Required Navigation Performance (RNP) and High Transition Operations (HTO).

Partnering with airlines

These three concepts have been implemented as part of the collaborative initiative called Optimised Flying, which was established by DFS and major German airlines in 2013, among them Lufthansa and Condor.

One of the main concerns of the working group is to achieve improvements in processes within German airspace by optimizing flight profiles to make flying

Lufthansa is involved in several projects with DFS investigating ways to reduce fuel burn and minimize non-CO_2 emissions such as NO, in contrails

more efficient and improve its environmental impact.

Airlines and ANSPs understand themselves as partners in one system who have to develop a vision and create changes to foster a greener aviation sector. The close and constructive partnership is the essential element in driving change.

Low Demand Concept

The Low Demand Concept used the low traffic volumes to demonstrate potential changes in airspace use and air traffic flow management, which would not have been possible during periods of high demand.

The target of this initiative was to optimize arrivals and departures regarding the fuel consumption and the carbon footprint for traffic at Munich and Frankfurt Airports with a focus on flight planning, laterally as well as vertically.

The low demand provided sufficient airspace to clear arriving aircraft laterally from entry into German airspace towards a defined metering fix at destination. Departing aircraft were cleared at the direct exit point of German airspace as early as possible. The shorter trajectories were analyzed and transformed into conditional direct routes and published arrival distances which can be used for flight planning.

Optimization of the vertical dimension was more complex. The target was to allow a continuous descent from cruising level for all inbounds under low demand conditions. A methodology was developed and communicated to air traffic controllers and pilots on how to communicate the optimum descent. Enabling the optimum profile while crossing over sector boundaries was a challenge but created the largest benefit in CO_2 savings, 72,000kg per day for the Lufthansa Group alone.

Required Navigation Performance at airports

At Frankfurt and Düsseldorf Airport Required Navigation Performance (RNP) has improved approach and departure procedures.

The approach infrastructure of Frankfurt Airport consists of a set of precision and non-precision approaches into the parallel runway system. Ten years ago, DFS and the German airlines developed and implemented a segmented RNP approach into the southern runways as an answer to the request of the local noise abatement commission.

The segmented RNP approach circumnavigates densely populated areas and joins the straight final of the southern runway system at five nautical miles to the runway threshold realizing the shortest arrival distance. The large communities of Mainz, Hanau and Offenbach are located approximately 8 to 15 nautical miles along the runway center lines and get significant relief from aircraft noise emissions.

Before the Covid-19 pandemic, the segmented RNP approach was used during the night only. In the context of the new low demand scenario, DFS and Lufthansa used the time as a chance and developed a new concept to be able to implement segmented RNP approaches during the day.

The additional CO_2 savings for Lufthansa alone are approximately 50,000kg of CO_2 per month. The result is a win-win scenario by achieving considerable fuel savings as well as by reducing noise emissions for a large portion of the population. The challenge is now to transfer this concept into growing traffic numbers.

At Düsseldorf Airport, a new departure route was implemented in August 2020, which has been used under regular conditions within the past months.

Departing flights from the west have to reach flight level 210 before entering Belgium airspace so they can overclimb crossing traffic flows directly behind the border. This restriction required that the original departure route made a long and inefficient detour to the north. Nowadays, modern aircraft with better climb performance do not need such a long route. Thus, DFS and Lufthansa implemented a performance based navigation routing, which shortened the departure route by 12 nautical miles. When designing the route, noise emissions for urban communities in the area were taken into consideration. The key to success was the continuous exchange with the local noise abatement commission.

Since the start, more than 1,000 flights have used the new route, achieving 60,000kg of CO_2 savings.

High Transition Operations

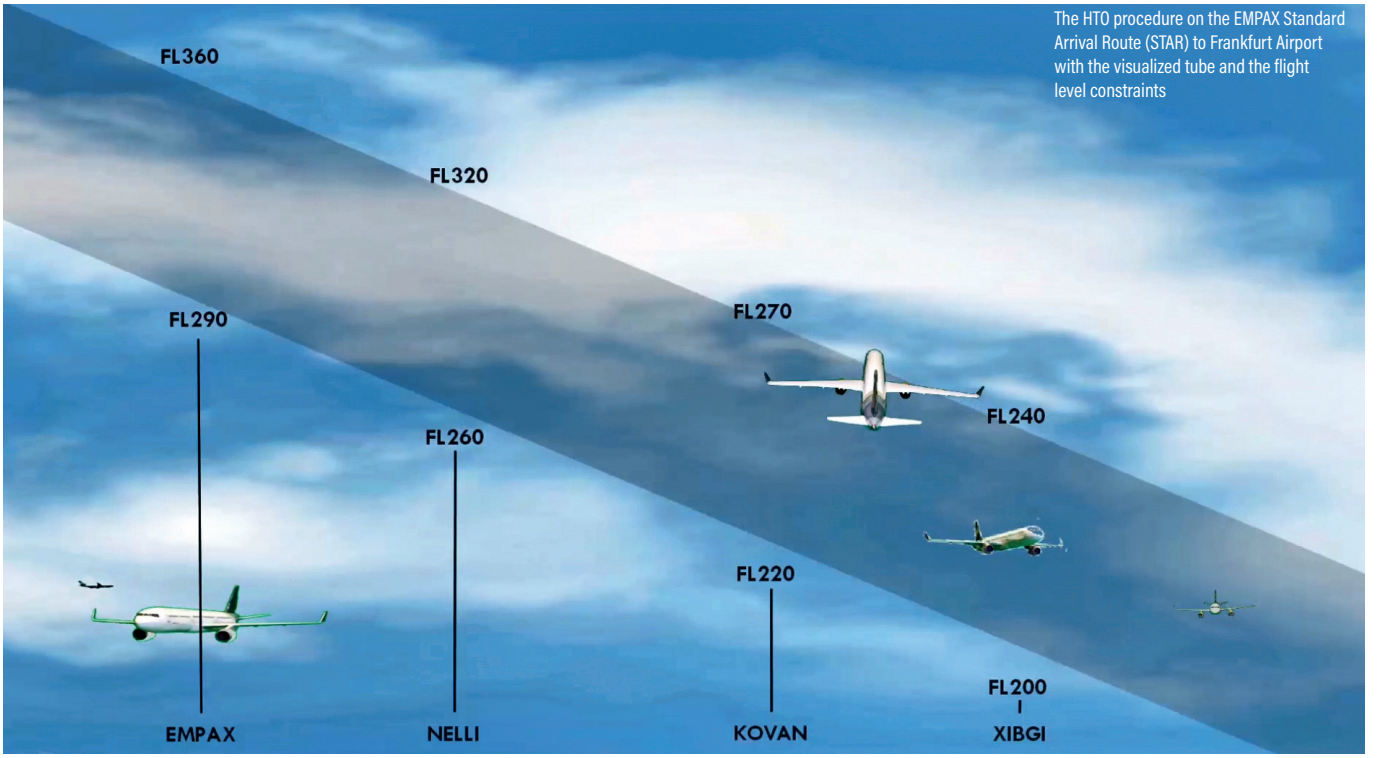
The third concept of High Transition Operations (HTO) was developed for high traffic demand, but it was defined more specifically during the low-demand period in the past months.

HTO is an arrival procedure which allows for an optimized continuous descent operation (CDO) without level-offs from top of descent.

The first operations started on the EMPAX Standard Arrival Route (STAR) to Frankfurt Airport in 2016. Since then, significant modifications were implemented, which led to full regular operations in October 2019.

The STAR is designed like a tube with upper and lower flight level constraints. The constraints separate the crossing traffic. This enables a managed flight (auto pilot) from cruising level (FL 360) down to approach, which ends at the entry of the terminal maneuvering area at flight level 100. Level-offs basically no longer exist, because within this defined tube, the arriving aircraft can fly their own CDO. The extent of this CDO is unique. It was created to be used during all traffic situations, including times of dense traffic.

Overall, there was a significant decrease in fuel consumption and CO_2 and an increase in capacity. About 20,123 flights annually on the EMPAX STAR can lead to 2,600 tonnes of CO_2 savings. In addition, the radiotelephony workload of air traffic



The HTO procedure on the EMPAX Standard Arrival Route (STAR) to Frankfurt Airport with the visualized tube and the flight level constraints

controllers was reduced by about 50%, which can significantly increase sector capacity.

Nevertheless, the introduction of this procedure was and is not completely problem-free. There were numerous challenges with the introduction and common understanding of a new radiotelephony procedure. The ICAO Amendment 7 has unfortunately not been implemented by most States or there are different interpretations of it.

Besides, it became apparent that even though modern flight management systems (FMS) can fly laterally with extreme precision, vertically they still urgently need to be improved. As a result, there were aircraft that were too high or too low at certain constraints. And air traffic control had zero feet tolerance at each constraint for safety and separation reasons.

The team continued the development work towards an innovative vertical separation procedure during 2020 and 2021. In a next service level, vertical aircraft separation should be achieved by adherence to altitude constraints of crossing departure and arrival routes. To implement vertical separation by using level constraints, the team was required to determine a risk level resulting from altitude constraint infringements. A complex monitoring program was established. Systematic faults were identified, for example, in FMS behavior or phraseology. The team arranged a set of combined briefing sessions for pilots and air traffic controllers to improve the understanding for each side. Aircraft, and especially FMS behavior, were determined as a risk factor as performance on HTO profiles was not always satisfactory. Those aspects needed to be addressed with the respective fleets and included into training plans.

The developments will ultimately lead to further reduction in air traffic controller workload and an increase in sector capacity. Now, the procedures have replaced individual altitude clearances issued by the air traffic controller on a STAR by vertical restrictions at defined waypoints due to transfers to downstream sectors and / or crossing traffic.

It is planned to implement the HTO procedure on more RNAV1 Standard Arrival Routes towards Frankfurt Airport.

Contrail induced Cirrus

Apart from these operational initiatives, DFS is working on innovative environmental research. One project focuses on non-CO_2 effects in aviation, representing a different focus than the fuel-burn-reduction initiatives.

Impacts include changes in atmospheric ozone, NOx and methane concentration, as well as the formation of contrail cirrus. The contribution of non-CO_2 impacts to anthropogenic climate change due to aviation makes up two thirds of the overall net radiation force, according to a study published by EASA in 2020. The proposed mitigation of contrail cirrus is of great interest, especially for air traffic control.

DFS has set itself the goal to evaluate the occurrence of contrail-induced cirrus and is participating in the government-funded D-KULT project in cooperation with scientific organizations, weather service providers, airlines and other aviation industries. The aim will be to avoid contrail cirrus whenever possible. Within the project, crucial questions are being addressed, such as how robust are the predictions of weather and climatologic models? How to measure the findings? What would be needed regarding procedures and air traffic controllers?

It is expected that the conclusions drawn will help to demonstrate how to adapt procedures for air traffic control and airlines during the course of the project. A transition to FABEC and other stakeholders is foreseen.

The operational concepts and innovative projects DFS has been and is working on are part of the global drive to manage the ecological footprint of the aviation industry. It will take the efforts of all partners in the aviation system to work towards a green future and clean skies. ❖