STREAM

ARRIVAL MANAGEMENT IN MOTION

Delivering cross-border solutions
to optimise air traffic arrival flows

IMPROVING

FLIGHT EFFICIENCY AND ARRIVAL CAPACITY

AT MAJOR EUROPEAN HUB AIRPORTS

DFS, DSNA, NATS, skyguide and their partners led very large-scale demonstrations from Summer 2017 to Summer 2019 to explore further the benefits of Extended AMAN and Target Time of Arrival at Frankfurt, London, Paris and Zurich airports located in the core area. Operational benefits are significant.

These live trials have demonstrated that SESAR solutions are ready for implementation of this new operational concept as required by the Pilot Common Project regulation by 1st January 2024!

SESAR 2020 Project

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement 734139.

Overall Excellence in ATM

ATM Awards 2019

Winner of the **ENVIRONMENT** Category

xStream (Cross-border SESAR Trials for Enhanced Arrival Management) is a project conducted by a consortium of European Air Navigation Service Providers, Airlines and Research Organisations.
Led by DSNA, xStream is one of several large-scale demonstration activities of SESAR 2020, aiming at delivering ready-to-be operational, innovative solutions. The project is co-funded by the SESAR JU within the framework of Horizon 2020 (No 734145).

"The xStream Arrival Planning Improvement procedures were run during an extremely challenging 2019 summer where the European ATM capacity struggled to support record air traffic demand. From the Network Manager Operation Center perspective, the procedures ran very smoothly. The regulations affected very few flights and those flights affected had small ATFM delays."

Richard STEVENS
EUROCONTROL Network Manager

"With the User Driven Prioritisation Process (UDPP), the xStream project provided an excellent and easy solution for Airspace Users (AUs) in order to add our preferences and priorities to the ATM world. This allows AUs to find the best possible and optimised solution in a capacity constraint situation, which is in the interest of the passengers and the Airline Operations."

Eric NANTIER
Swiss International Air Lines / Lufthansa Group

Fuel savings Cost savings Capacity improvements

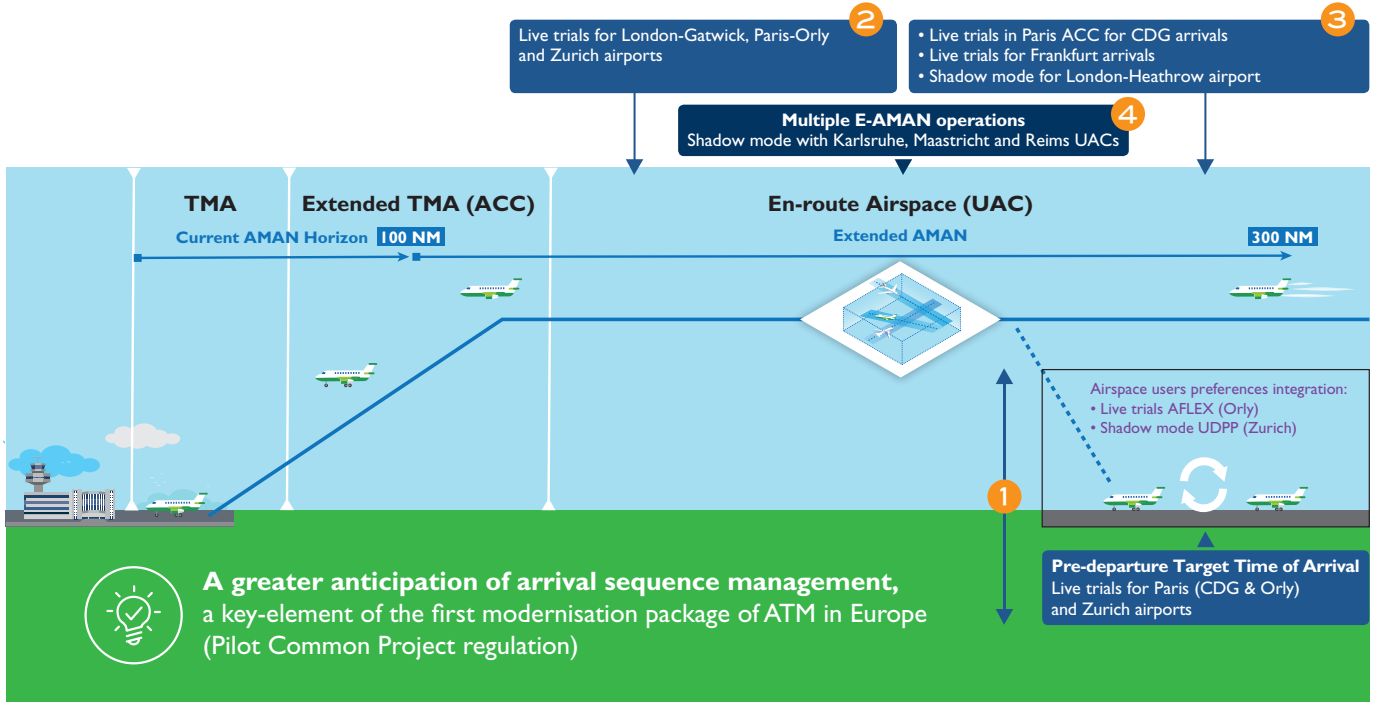
THE OPERATIONAL CONCEPT

Generally, arrival management (AMAN) is only used in a horizon of 100 NM (about 200 km). How to optimise capacity and improve arrival flows to a congested airport using extended arrival management procedures?

With **xStream**, the concept of delay sharing becomes cross-border with the participation of en-route control sectors. This enables flight efficiency improvements by offering capacity gains in the TMA. Combined with Extended AMAN operations, the use of **Target Time of Arrival (TTA)** improves arrival planning management and reduces air traffic flows and capacity management (ATFCM) delays. Moreover, this procedure allows Airspace Users (AUs) to express their business needs and flight priorities at departure (**Arrival Flexibility**), thus reducing the impact and cost of ATFCM constraints.

Furthermore, the use of system wide information management (SWIM) systems facilitates an efficient data exchange between all the stakeholders: the Network Manager (EUROCONTROL), Approach Control and Upper Area Control Centers (UACs/ACCs) and AUs.

Various very large-scale demonstrations (VLDs) were performed from the Summer 2017 to the Summer 2019 at Frankfurt, London, Paris and Zurich airports in order to explore further the benefits of these concepts.



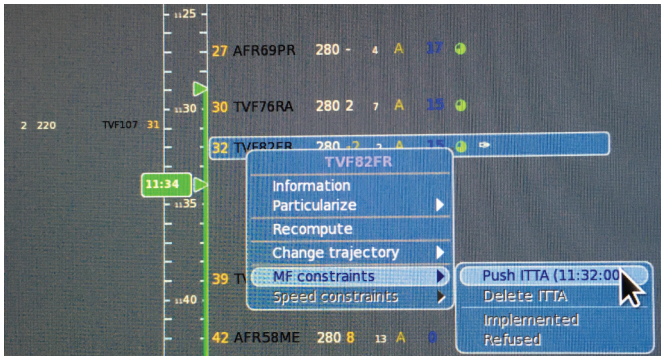
IMPROVING ARRIVAL PLANNING MANAGEMENT USING TARGET TIMES 1

At a horizon of 2 hours and more from the arrival airport, most short and medium-haul flights are at the gate. The first step of arrival planning optimisation is based on the allocation of **Target Times of Arrivals (TTA)** to better match available arrival capacity with traffic demand. This concept shows how a better collaboration between airports, ACCs and the Network Manager can bring benefits to arrival flow management.

ARRIVALS AT PARIS AIRPORTS

From May 2018 to October 2019, trials were carried out in Paris ACC, built on a new web service called API (Arrival Planning Information) developed by the Network Manager. DSNA developed its own experimental arrival management tool to enable Paris Flow Manager (FMP) to optimise ATFCM constraints by electronically sending TTA requests to the Network Manager.

This new process, experimented on both conventional and network cherry-picking regulations for flights departing from European airports, led to **a reduction of ATFCM delays** in Paris by at least 5% without impacting safety or controller's workload.



In this arrival sequence, Paris FMP assigns a new TTA to the flight TVF82FR at 11:32, which reduces its ATFM delay by 5 minutes.

ARRIVALS AT ZURICH AIRPORT

From August to September 2018, live trials were led also with the B2B service API. TTA requests could be automatically coordinated both for long and short hauls based on the predicted sequence. The process was combined with Network Cherry Picking regulations which permitted **to enhance the short hauls adherence and the reliability of the targeted landing sequence**.

ARRIVALS AT FRANKFURT AIRPORT

In September 2019, the objective of the trial was to achieve a uniform and continuous arrival flow into the TMA in the first hour after the night curfew ended (from 05:00 local time).

The focus was on long-haul flights which have been steered inflight based on time information provided by the flight crew. This process led **to improve predictability of the arriving traffic and slight reduction of track miles and flying time in the TMA**.

PROVIDE FLEXIBILITY TO AIRSPACE USERS IN PLANNING PHASE 1

Reduced track miles in TMA

Reduction of ATFCM delay and its impact

Better use of capacity

For Airspace Users (AUs), a few minutes gained on a flight can be sufficient to ensure connection for dozens of passengers, or avoid diversion because of a curfew at the destination airport. **Integrating AUs priorities into the planning of the arrival sequence is of great interest to reduce the impact of ATFCM delays for airlines.**

ARRIVALS AT ZURICH AIRPORT

Simulations in July 2018 and shadow-mode trials in September 2019 were performed using the new **User Driven Prioritisation Process (UDPP)** collaborative prototype in order to integrate AUs Preferences during arrival capacity constrained situations. The exercises showed the potential for optimising AUs operations without impacting the network ATFCM situation.

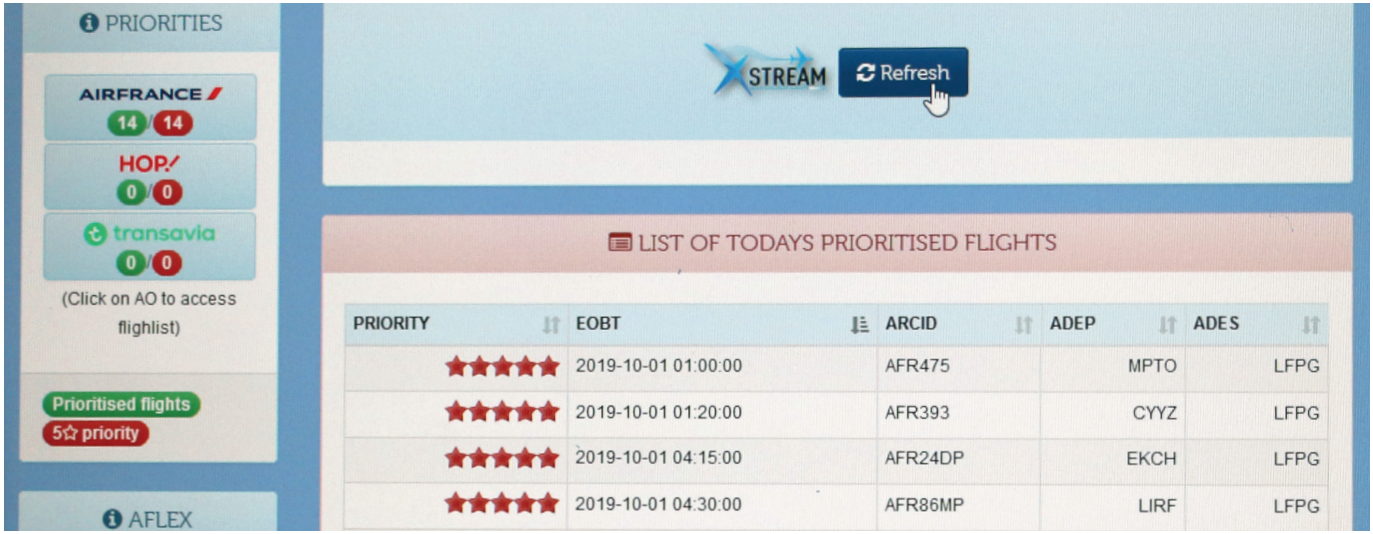
ALL FLIGHTS HAVE NOT THE SAME VALUE IN TERMS OF MONEY

Airlines operators know the impact of operational constraints on their own flights such as aircraft type, crew rotation, connecting passengers, passengers' status, aircraft rotation, maintenance…

ARRIVALS AT PARIS AIRPORT

In September 2019, during runway works in Paris-Orly airport, the Arrival Flexibility (AFLEX) concept was successfully experimented to reduce the impact and cost of ATFCM regulation.

Through the use of **CDM@DSNA collaborative portal**, participating AUs can express their daily priorities. Paris FMP analyses the situation to integrate them within its arrival planning strategy, for example by swapping two arrival slots of the same airline.



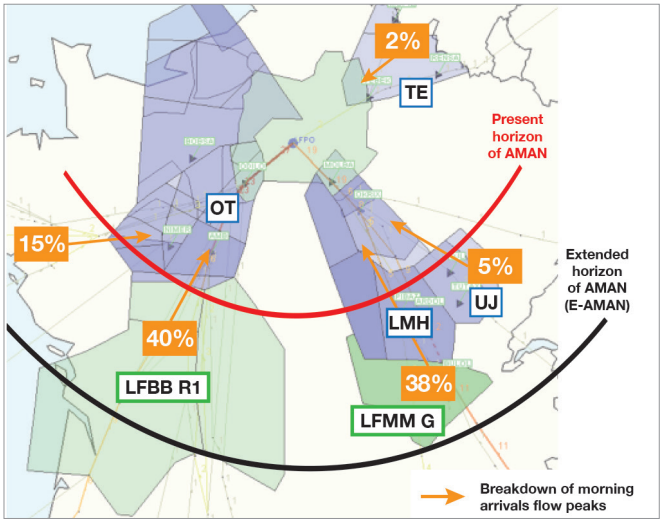
CROSS-BORDER MANAGEMENT WITH EXTENDED AMAN 2
INCREASING EXTENDED-AMAN HORIZON 3

AMAN extended to 200 NM is one of the key functionalities identified in the Pilot Common Project regulation for an implementation by 2024. **Extended-AMAN enables delay absorption earlier in the flight and at higher altitude**, making it more fuel-efficient. To ensure the feasibility of a wide implementation, the concept was further explored in xStream.

EXTENDED- AMAN TO 220 NM AT PARIS-ORLY

From July to August 2017, Paris FMP used a prototype allowing the anticipation of the arrival sequence and to start AMAN delay absorption during the en-route phase in Bordeaux and Paris ACCs. Nearly 200 arriving commercial flights saw their speed reduced at high altitude (approximatively 50 minutes before the estimated landing time). This new procedure enabled the reduction of workload and pressure in Orly TMA thanks to a better sharing of the arrival delay with the en-route sectors. During these operational evaluations, this process enabled **gains in flight time of 90 seconds and a saving of fuel consumption of 30 kg for each arrival**.

This successful trial led to implement this new procedure in 2020 with an automatic coordination between Paris FMP and Bordeaux ACC sectors.



Management of arriving flights at 220 NM from Orly airport.

EXTENDED-AMAN TO 200 NM AT ZURICH

In September 2019, live trials were successfully completed by transmitting Zurich TTAs in Reims UAC. Thanks to the Orthogon Extended-AMAN, the sequence was computed with a 200 NM horizon based on Network Manager data and TTAs were converted into speed advisories for controllers.

Trials demonstrated the ability **to share the arrival delay to the en-route phase** without any impact on safety.

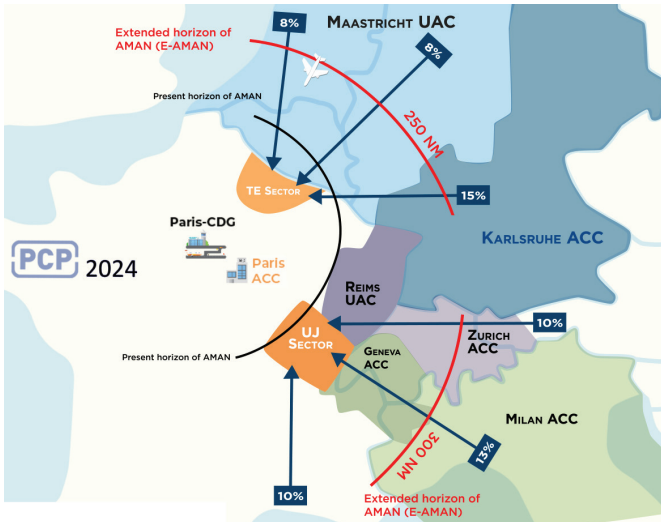
EXTENDED-AMAN TO 350 NM AT GATWICK

Since September 2019, controllers in Maastricht UAC, DSNA, Shannon and Prestwick ACCs have been slowing down Gatwick arrivals passing through their airspace on the 350 NM horizon when a delay is predicted to exceed 7 mins.

NATS controllers additionally instruct a reduced descent speed when a delay is predicted to exceed 5 mins. This transfers the delay out of low level airspace and into the more fuel-efficient en-route airspace, **saving fuel and reducing emissions, noise and congestion in the TMA**.

This is part of broader work that includes sharing arrivals and departure information, published as a SWIM web service, and displayed on a common HMI at Swanwick Terminal Control and Gatwick Airport ATC, to improve predictability of arrival and departure sequencing ahead of deployment of Performance Based Navigation (PBN)-defined airspace. The Gatwick E-AMAN procedure, demonstrated in xStream, has become a permanent operational procedure.

The 200 NM horizon has to be extended further for even more efficiency, and better capacity use. A horizon of 350 NM and more allows greater delay absorption, but with a larger number of in-horizon departures, and less predictability on flight trajectory. It requires a fine tuning of already existing E-AMAN tools.



▶ **The xStream Project: live trials in Paris ACC for CDG arrivals**

EXTENDED-AMAN UP TO 350 NM AT PARIS-CDG

From March 2018 to June 2019, during hub arrival peaks, 100 commercial inbound flights to Paris-CDG airport have successfully tested the xStream arrival management procedure at a horizon up to 350 NM (650 km).

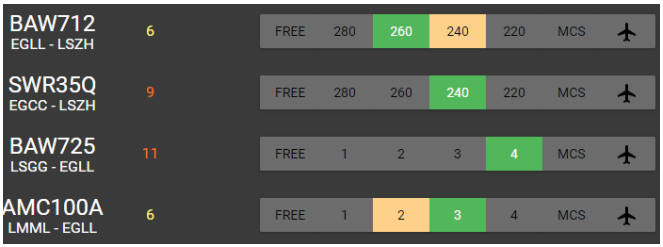
Supported by an extended arrival sequencing tool, a collaborative process was implemented between Paris, Reims, Geneva, Zurich, Milan, Maastricht and Karlsruhe ACCs/UACs to smooth arrival traffic peaks and mitigate the controller's workload in the Extended TMA.

This process enabled delay absorption earlier in the flight, up to two UACs ahead of Paris terminal sectors, at their cruise altitude, **improving the arrivals' flight efficiency in terms of fuel consumption by 30 kg per arrival flight, and enabling an increase of capacity in extended terminal sectors**.

EXTENDED-AMAN TO 500 NM AT LONDON-HEATHROW

NATS and its AMAN supplier (Orthogon) developed a prototype AMAN capable of calculating target times over a boundary coordination point while aircraft crossed a long range extended arrivals management horizon of 500 NM. This was demonstrated as a shadow mode exercise using live Network Manager data during April 2019. The concept is for pilots to manage their own flights to cross a metering point at the target time, thereby 'self-streaming' and reducing aircraft bunching prior to descent.

This will be needed ahead of planned deployment of PBN-defined Standard Arrival Routes (STARs).

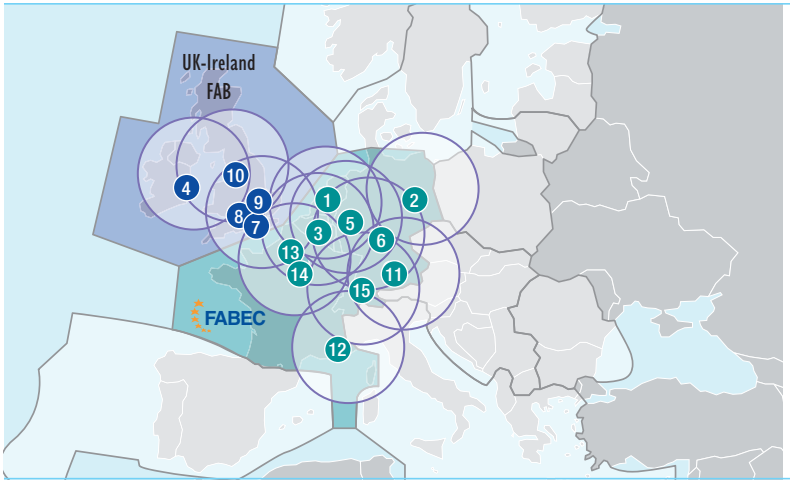


Extended-AMAN to Zurich (LSZH) and to London-Heathrow (EGLL) airports handled by Reims UAC

MULTIPLE EXTENDED-AMAN OPERATIONS AND STRATEGY MANAGEMENT 4

Optimise overlapping procedures

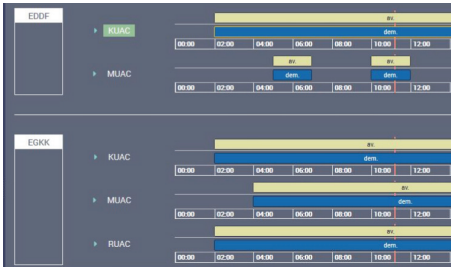
The cumulative effect of the E-AMAN speed reduction requests during the cruise may lead to a significant increase of workload for controllers because of the competition between the flows, and potential conflicts induced between flights at different cruising speed. This is why a Collaborative Decision-Making (CDM) process has to be implemented to better coordinate E-AMAN activities and deliver the E-AMAN services for multiple airports.



Overlapping of E-AMAN horizon for Pilot Common Project (PCP) airports:
en-route sectors in the core area may have to handle more than 10 concurrent arrival flows!
10 airports are located in the FABEC airspace and 5 in the FAB UK/IRL airspace.

1. Amsterdam
2. Berlin
3. Brussels
4. Dublin
5. Düsseldorf
6. Frankfurt
7. London-Gatwick
8. London-Heathrow
9. London-Stansted
10. Manchester
11. Munich
12. Nice Côte-d'Azur
13. Paris-CDG
14. Paris-Orly
15. Zurich

MULTIPLE E-AMAN OPERATIONS IN MULTIPLE UACs/ACCs



In order to set up this CDM process and to execute pre-defined E-AMAN strategies, a so-called "**XMAN Portal**" was developed for this trial performed with Reims, Maastricht, Karlsruhe UACs and the E-AMAN units Paris and Frankfurt in September 2019. All these control centers were connected to the XMAN Portal and could share the operational situation as a collaboration platform.
The shadow mode trial demonstrated the potential of the multiple E-AMAN concept to exploit the available capacity while maintaining E-AMAN operations to the highest degree possible.

*"With xStream, operational benefits have been fine-tuned.
Real benefits for greener flights have been demonstrated!
A SESAR Solution ready for deployment."*

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