Demonstration Report

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DSNA; Air France; Regional; Delta Airlines; skyguide; SWISS; DFS; Lufthansa; Airbus Prosky; Boeing; EUROCONTROL.	

Abstract

This document describes the FAIR STREAM project. FAIR STREAM experimented the use of TTA instead of/complementary to CTOT with the purpose to evaluate impacts and benefits. Three exercises (live trials) have been conducted: arrivals in Paris CDG, Munich and Zurich. For each site, some flights per day used a TTA data during two periods of two months in 2013. This report presents the results of the experimentation, as defined by the WP Performance Assessment and the recommendations for further steps in order to develop the concept.

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This deliverable consists of SJU foreground.

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Executive summary

The purpose of FAIR STREAM exercises is to perform flight trials to draw conclusions and to make recommendations for the development and the implementation of the SESAR P7.6.5 concepts, in particular "move CTOT to TTA" which consists for the pre-flight phase to notify the flight crews with a target time over a congested area. Primary objectives of FAIR STREAM exercises were to evaluate:

- the feasibility of the use of a TTA instead of/complementary to a CTOT;
- the predictability of the flights using a TTA instead of/complementary to a CTOT;
- the ATC, flight crew and airline's OCC workload;
- the flight efficiency (time and fuel);
- the possibility to manage TTA within ATC facilities.

Three exercises were conducted: CDG arrivals, Zurich arrivals and Munich arrivals. They took place in May-June and September-October 2013, involving ANSPs, airlines and NMOC. Scenarios could differ from an exercise to another, allowing drawing complementary conclusions.

FAIR STREAM trials demonstrated that TTA could be applicable at the largest scale in today's technical environment.

Below are the key conclusions drawn from FAIR STREAM trials:

- in today's technical environment, the use of TTA is feasible and predictability has been improved;
- variability is sensitive to the 2 following points :
    - take-off : take-off time plays an essential role in the adherence to TTA. It was observed that departure time is subject to many factors that influence its predictability and thus TTA's variability;
    - unplanned Direct routes. It was observed that for operational reasons, unplanned DCTs are necessary and could affect the TTA adherence;
- new questions raised :
    - during LFPG and EDDM trials, few flows used a TTA, it appears necessary to ensure that all flights should use the TTA, how can we deploy it on all flights? How to ensure that all flights will use the TTA? It is feared that if TTAs are defined only as proposed extra constraints, the flights that do not make an effort might gain an unfair advantage, basically overtaking the participating ones;
- it appeared essential to make sure that AMAN operations remain consistent with the TTA ones. It was observed that the freezing of the TTA in the AMAN raised some difficulties in LFPG arrivals mainly because the spirit of the AMAN tool is to deal with the real flow and not to have a specific action on a single flight. It does mean that the optimization under the constraint of one flight frozen in the sequence was less optimal than the global optimization;
- as TTA and approach sequence were not linked in LSZH trial there were no measurable benefit in terms of smoother approach sequence or less holdings during trial: no flight time or fuel burn benefits were experienced for LSZH 2nd trial large scale experiment. Even though more than 80% of all flights inbound LSZH received a TTA.

Other observations are summarized as follows:

- Some pilots could chose a target take-off time, in line with their TTA, by optimising the flight profile to reduce the fuel burn. The use of TTA could offer more flexibility to Airlines. Depending on the situation, pilots can adjust their flight in a way that they met their TTA (for whatever reason they took off earlier, avoiding departure punctuality degradation, and can fly more "fuel efficiently" or later);

- no significant workload increase due to the use of TTA was reported for ATCOs and flight crews. When few flights were using TTA, airline's OCC had no workload increase, however when the number of flights per day was increased for LSZH scenario and given the fact that they had to handle every update of CTOT manually, Swiss dispatch had to develop an internal tool to redistribute automatically the TTA through ACARS.

Based on the conclusions above, the key recommendations are summarised as follows:

- work further on the reduction of take-off time variability: ensure reliable off bloc time and taxi time predictions;
- work further on reliable take-off time and its impact on TTA, and the possibility to update TTA. The usual CTOT window width [-5; +10min] is in itself considered too large for short haul flights to reach a TTA precisely enough;
- further analyse the impact of unplanned short cuts on the use of TTA and work on a possible solution to manage usual tactical direct routes when using TTA. However prohibit tactical direct routes is not an option;
- investigate further the compatibility between TTA and AMAN concepts, and define the operational link in terms of systems, data, and procedures;
- consider any progressive introduction of TTA in real time operations as a new constraint, that should be globally less penalizing than the previous ones, at the same level of enforcement as the current CTOT's, with defined incentives to enforce its application;
- further define expected operational benefits, level of performance required, and evaluate benefits.

1 Introduction

1.1 Purpose of the document

This document provides the Demonstration report for FAIR STREAM, Enhanced ATFCM processes and Traffic synchronization. It describes the results of demonstration exercises defined in FAIR STREAM Demonstration Plan 00.02.00 of 2012 27th. of November and how they have been conducted.

The design of the exercises will be described by the WP1 leader (skyguide). Each exercise is described by the hosting ANSP (DSNA, skyguide and DFS). The results will be presented by the leader of WP3 (DSNA). Airbus Prosky and Boeing will add a generic performance study.

1.2 Intended readership

This document interests SJU, consortium's members, SESAR and FABEC members interested in the development of the concept of the TTA. Especially people working on link with OFAs *05.03.04: Enhanced ATFCM processes* and *04.01: Traffic synchronization* could be interested by this report.

1.3 Structure of the document

This document is organized in 9 parts. After an introduction, it describes the context of the demonstrations, the programme management and the execution of demonstration exercises. Then it presents the exercises results, the demonstration exercises reports, a summary of the communication activities, next steps and references.

1.4 Glossary of terms

NA

1.5 Acronyms and Terminology

Term	Definition
ACARS	Aircraft Communication Adressing and Reporting System
ACC	Area Control Centre
ANSP	Air Navigation Service Provider
AMAN	Arrival MANagement (system)
AO	Airline Operator
AOC	Airline Operational Communication
AOP	Airport Operation Plan
APP	Approach
ASM	AirSpace Management
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
CFMU	Central Flow Management Unit

Term	Definition
CFT	Call For Tenders
CHMI	CFMU Human Machine Interface
CI	Cost Index
CNS	Communication, Navigation and Surveillance
CONOPS	CONcept of OPerationS
CPDLC	Controller Pilot Datalink Communciation
CSP	Communciations Service Provider
CTOT	Calculated Take Off Time
CTA	Controlled Time of Arrival
DCB	Demand and Capacity Balancing
dDCB	Dynamic Demand and Capacity Balancing
DFS	Deutsche Flugsicherung GmbH
DLH	Deutsche Lufthansa AG
DSNA	Direction des Services de la Navigation Aérienne
DMAN	Departure Manager
DOD	Detailed Operational Description
E-ATMS	European Air Traffic Management System
E-OCVM	European Operational Concept Validation Methodology
ETA	Estimated Time of Arrival
FDP	Flight Data Processing
EDDM	ICAO code for Munich Airport
EDDL	ICAO code for Dusseldorf Airport
EDDS	ICAO code for Stuttgart Airport
FABEC	Functional Air Block Europe Central
FAIR STREAM	**F**ABEC ANSPs and **AIR**lines **S**ESAR **Tr**ials for **E**nhanced **A**rrival **M**anagement
FMP	ATC Flow Management Position
FTE	Full Time Equivalent (for workload evaluation)
HF	Human factor
IAF	Initial Approach Fix
i4D	Initial 4D Trajectory
LFBD	ICAO code for Bordeaux Airport
LFBO	ICAO code for Toulouse Airport
LFPG	ICAO code for Paris CDG airport
LSGG	ICAO code for Geneva Airport
LSZH	ICAO code for Zurich airport

Term	Definition
NM	Network Manager
NMC	Network Management Cell
NOP	Network Operations Plan
NSA	National Security Agency
OFA	Operational Focus Area
OSED	Operational Service and Environment Description
RNP	Required Navigation Precision
RTA	Required Time of Arrival
SDP	Surveillance Data Processing
SESAR	Single European Sky ATM Research
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SMAN	Surface Manager
STAM	Short-term ATFM Measures
SVS	Share Virtual Sky
SWISS	Swiss International Air Lines Ltd
TMA	Terminal Area
TOT	Take Off Time
TTA	Target Time of Arrival
TTO	Target Time Over
TWR	Tower
WP	Work Package
XMAN	Cross Center Arrival Manager

2 Context of the Demonstrations

The scope of the FAIR STREAM project is the demonstration of the feasibility of defining a TTA instead of/complementary to a CTOT, transmitting the information, and using it to manage a flight. The project also checks if the predictability of the participating flights is increased.

2.1 Scope of the demonstration and complementarity with the SESAR Programme

In the WP7 roadmap, FAIR STREAM and VP632 were V3 exercises. In release 4, a V2 fast time simulation (VP723) and in release 5 a V3 exercises (VP749) will take place.

The objective of FAIR STREAM exercises is to perform flight trials according to the defined scenarios in order to have the elements to analyze their execution, to draw conclusions and to make recommendations for the development and the implementation of the SESAR P7.6.5 concepts. The objectives of the exercise are to evaluate:

- the feasibility of the use of a TTA instead of/complementary to a CTOT;
- the predictability of the flights using a TTA instead of/complementary to a CTOT;
- the ATC workload;
- the flight crew workload;
- the flight efficiency (time and fuel);
- the possibility to manage TTA and CTA within ATC facilities.

3 exercises have been conducted:

- CDG arrivals;
- Zurich arrivals;
- Munich arrivals.

Several city pairs have been tested:

- Bordeaux – CDG;
- Toulouse – CDG;
- USA – CDG
- Canada – CDG
- CDG – Zurich;
- Düsseldorf – Zurich;
- Geneva – Zurich;
- Stuttgart – Zurich;
- SWISS long haul flights to Zurich;
- CDG – Munich.

A total of 825 flight trials have been conducted and analysed.

Demonstration Exercise ID and Title	**EXE-02.02-D-001 : CDG** **EXE-02.02-D-002 : Zurich** **EXE-02.02-D-003 : Munich**
Leading organization	DSNA Skyguide DFS
Demonstration exercise objectives	The objective is to perform the flight trials according to the defined scenarios in order to have the elements to analyze the execution of the flight trials, to draw conclusions and to make recommendations for the development and the implementation of the SESAR P7.6.5 concepts. The objectives of the exercise are to evaluate: - the feasibility of the use of a TTA instead of/complementary to a CTOT; - the predictability of the flights using a TTA instead of/complementary to a CTOT; - the ATC workload; - the flight crew workload; - the flight efficiency (time and fuel); - the possibility to manage TTA and CTA within ATC facilities.
OFA addressed	05.03.04: Enhanced ATFCM processes 04.01: Traffic synchronization
Applicable Operational Context	The scenarios defined during the design phase have been implemented to a set of flights normally subject to CTOT constraints due to congested entry points of major European hubs. In order to increase the amount of participating flights, non-regulated flights also participated in EXE-02.02-D-001: in that case, ETA was considered as a TTA. The scenarios involved the NMOC, the airlines operation, the crews, the local FMPs and for LFPG scenario, the TWR control of the departure field, ATC sectors of the involved ACC units and the approach control of the destination hub. These flights have been operated by the Airlines members of the consortium.
Demonstration Technique	NA
Number of trials	825 flight trials

Table 1: Exercises overview

Co-operation with SJU WP7 has been established, based on the following principles:

- fulfilment of project specific contractual commitments;
- development and validation/demonstration of a single concept of operations;
- definition of complementary validation/demonstration objectives;
- making the best use of available effort/expertise and common project partners;
- synchronisation of schedules in order to avoid conflicting requests.

FAIR STREAM and WP7 share the following objectives:

- TTA concept for managing arrival congestions (instead of CTOT);
- operational feasibility – how crews, ATCOs, FMPs and NM can handle the procedures? – ;
- technical feasibility with existing ground and on-board systems;
- performance assessment.

The envisaged validation scenarios differ in the fact that FAIR STREAM emphasizes the demonstration objectives to the operational feasibility from an airline and ATC perspective in high density airspace using major airports, whilst WP7 emphasizes the validation objectives to network performance and predictability improvements, using an airport where a few companies constitute a large portion of the operations.

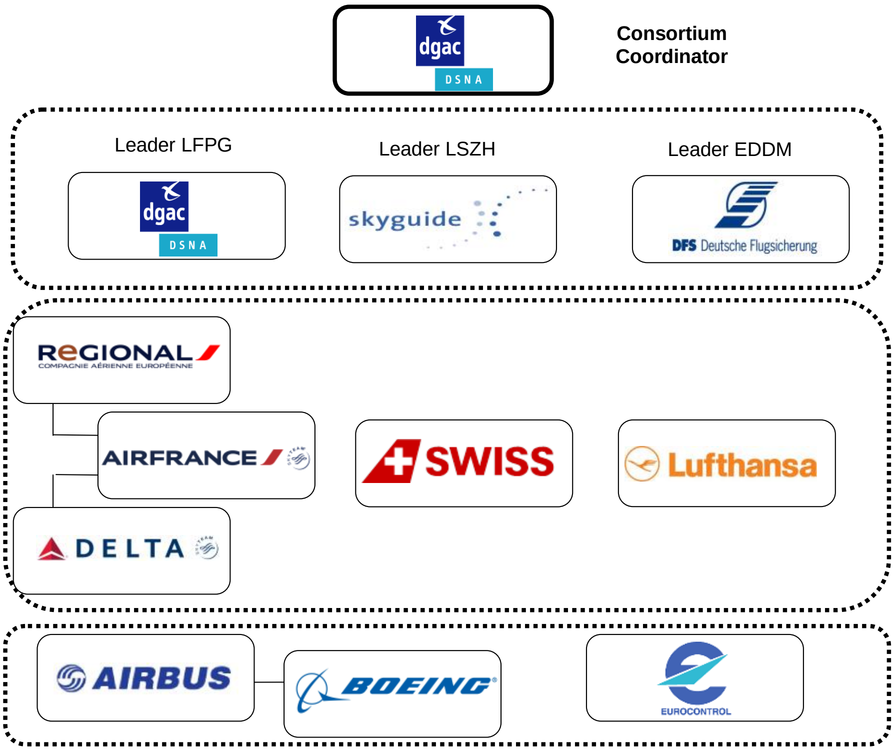
Both validation scenarios are complementary and results and experiences are shared between FAIR STREAM and WP7. WP7 actively collaborates with the FAIR STREAM Work Packages addressing the first period of FAIR STREAM trials. This enables the desired concept alignment between the FAIR STREAM Trials and the WP7 CTOT/TTA Exercise VP632 at Palma. It will also allow WP7 to consider the FAIR STREAM Trial as an initial operational/technical feasibility assessment for Network Performance improvements.

The specifications for the modifications to be made to the NM Technical Systems are derived from the WP7 operational requirements as well as from the WP7 Validation Plan. FAIR STREAM used the same NM systems as developed for the WP7 trials requirements.

FAIR STREAM followed the WP7 Exercise VP632 at Palma as an observer and could use the obtained feed-back as input for the second period of FAIR STREAM trials.

3 Programme management

3.1 Organisation



As coordinator of the FAIR STREAM project, DSNA provides the overall program management activities. The project activities have been organized in Work Packages (WPs). All the WPs have been led by the Project Manager, except for WP1 “Design” led by skyguide and WP3 “Performance Assessment” led by DSNA/DTI.

The FAIR STREAM flight trials activities have been coordinated per site. The ANSP providing the ATC services on each site was responsible for the coordination of the activities related to its involved areas and site.

Each member of the FAIR STREAM consortium designated a point of contact for the management of their activities.

The key roles of the project organization are:

Role in the team	Name/Organization	Involvement
WP management		
Project Manager and WPs Leader except for WP1	[redacted] (DSNA)	20%
Responsible for External interface and communications	[redacted] (DFS)/ [redacted] (DSNA)	10%

Responsible for contract	[redacted] (DSNA)	2%
WP1 leader	[redacted] (skyguide)	15%
WP3 leader	[redacted] (DSNA)	15%
Leader LFPG activities	[redacted] (DSNA)	20%
Leader LSZH activities	[redacted] (skyguide)	20%
Leader EDDM activities	[redacted] (DFS)	20%
Point of contact	[redacted] (Air France)	20%
Point of contact	[redacted] (Regional)	5%
Point of contact	[redacted] (Delta)	5%
Point of contact	[redacted] (SWISS)	20%
Point of contact	[redacted] (Lufthansa)	10%
Point of contact	[redacted] (Airbus ProSky)	20%

The project monitoring and control has been performed according to Project coordinator Quality assurance plan.

The internal project monitoring will include a quarterly progress report that will be submitted to SJU (see §3.2.3 of CFT specifications) and will summarize:

- the key developments;
- the key risks and associated mitigation plan;
- the expected activities, in particular the duration and the number of flight trials.

3.2 Work Breakdown Structure

T0 is considered to be 2012 6th of June.

WP0: Project Management	
Duration:	22 months
Start Event:	T0
End Event:	T0 + 22 months
Objective: The objective of this work package is to conduct the project management aspect of the project in order to ensure that all tasks are completed according to the schedule and that all deliverables are produced with the appropriate quality.	
Method: The coordinator will ensure the objective by ensuring correct application of the methodologies developed in: Task 1: Overall project management: • Management of the project Meeting; • Ensuring that all activities are conducted according to the project schedule;	

<table>
<tr><td colspan="4">

- Managing the timely completion of deliverables;
- Managing coordination with SJU and external stakeholders;
- Managing payment of participant and invoicing etc.

Task 2: Demonstration Plan:

- Development of the demonstration plan. The detailed demonstration plan describes the role and responsibility of all consortium members for the execution of the project.

Task 3: Demonstration Report:

- Development of the demonstration report.

</td></tr>
<tr><td>Inputs</td><td>Outputs</td><td>Nature</td><td>Due</td></tr>
<tr><td>Technical proposal
SJU/LC/70 Specs</td><td>A1

Progress reports

B1</td><td>Demonstration plan

Demonstration Report</td><td>T0+2 months
According to technical proposal and A1
T0 + 22 months</td></tr>
<tr><td colspan="4">Partners involved in the tasks (L=Lead, C=contributor, R=Review)</td></tr>
<tr><td>Task</td><td>Activity</td><td colspan="2">Partners role</td></tr>
<tr><td rowspan="2">T1, T2 and T3</td><td>Coordination and initial drafting</td><td colspan="2">L: DSNA</td></tr>
<tr><td>Contribution and review</td><td colspan="2">C/R: DFS, skyguide, Air France, Regional, Delta, Lufthansa, SWISS, Airbus ProSky, EUROCONTROL</td></tr>
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<tr><td colspan="2">WP1: Flight Trial Design</td></tr>
<tr><td>Duration:</td><td>16 months</td></tr>
<tr><td>Start Event:</td><td>T0 + 1 months</td></tr>
<tr><td>End Event:</td><td>T0 + 17 months</td></tr>
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Objective:

The objective of this work package is to precise all the elements for the flight trials execution and adjacent simulations in order to guarantee a good execution of the demonstrations. This work package will coordinate with P7.6.5 and P7.3.2. This work package covers all the design activities, except those related to the performance assessment that is included in the WP 3.

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Method:

Based on the elements contained in this proposal and the comments made by SJU, the design phase will identify precisely all the elements describing the context and the execution of the flight trials.

Task 1: Scenarios definition:

- The description of the flight trials scenarios will be detailed taking into account the capacity of the legacy systems. It will allow to validate the assumptions that have been used for the proposal or to propose alternate solution.

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</table>

- The scenarios will describe the procedures and the contributions expected from all the partners: AOs, Crews, NMC, Local FMPs and ATCOs.
- The scenarios will cover the following phases:
    - Pre-flight horizon: support to negotiation between NMC and AO;
    - TTA notification to ATC;
    - Flight execution before AMAN horizon: exchange of TTO between Crews and ATC;
    - Adherence, Deviation management from TTA;
    - TTA procedure for AMAN.

Task 2: Traffic selection:

- This task will allow determining the flights that will be selected for the flight trials. Per site proposed by the project, the task will identify an entry point and a time period of approximately two hours per day. At least 30 flights of the consortium members should be affected by a DCB measure per session.

Task 3: flight trials monitoring:

- The project will be conducted in a live context. Although all the measures will have been taken to guarantee a successful execution, some unexpected constraints could prevent the application of the FAIR STREAM scenarios. This task will define the procedures applied by the project to react to any unexpected event during the flight trials;
- In particular, a specific attention will be dedicated to:
    - the number of flights that have correctly performed the trials compared to the plan;
    - the adherence of the staff to the FAIR STREAM scenarios;
    - the quality of the measures for a fruitful post trial analysis;
- This task will make a risk analysis and precise the monitoring of the flight trials.

Task 4: Internal communication plan:

- The flight trials will require an active cooperation from the staff. The success for this project will depend on their capacity to implement the scenarios defined in the project (staff information) and the motivation of all the partners (internal communication);
- This task will develop an internal communication plan, as well as all the communication support material.

Task 5: Design refinement after the FAIR STREAM 1st trials session:

- The project will make a brief analysis of the first session and take any corrective action if necessary. If not done during the previous task, or if new elements are given by SESAR, the FAIR STREAM project will also consider adaptation of the scenarios for the second session.

Inputs	*Outputs*	*Nature*	*Due*
Revised technical proposal A1	Flight trials scenario Flight trials management Internal communication plan Internal communication	1st Report Updated report	T0 + 7 months T0 + 11 months

	material		

Partners involved in the tasks (L=Lead, C=contributor, R=Review)		
Task	*Activity*	*Partners role*
WP 1	Overall coordination	L: skyguide
T1	Coordination Scenarios development	L: skyguide C: DSNA, DFS, skyguide, Air France, Regional, Delta, Lufthansa, SWISS, Airbus ProSky, Boeing, EUROCONTROL
T2	Site LFPG	L: DSNA C: Air France, Regional, Delta, R: Airbus ProSky, Boeing
T2	Site LSZH	L: skyguide C: SWISS R: Airbus ProSky, Boeing
T2	Site EDDM	L: DFS C: Lufthansa, Air France R: Airbus ProSky, Boeing
T3	Flight trials monitoring	L: skyguide C: DSNA, DFS, Air France, Regional, Delta, SWISS, Lufthansa, EUROCONTROL
T4	Design and development of internal communication material	L: skyguide C: DSNA, DFS, Skyguide, Air France, Regional, Delta, SWISS, Lufthansa, Airbus ProSky, Boeing, EUROCONTROL
T5	Scenarios refinement	L: skyguide C: DSNA, DFS, Air France, SWISS, Lufthansa, EUROCONTROL R: Airbus ProSky, Boeing

WP2: Flight Trial Preparation	
Duration:	8 months
Start Event:	T0 + 7 months
End Event:	T0 + 15 months
Objective: The objective of this work package is to put in place all the elements identified during the design phase for the flight trials execution.	

Method:			
Each consortium members will execute the internal communication plan developed in Task 4 of WP1. For the management of the activities, the WP is divided in tasks grouping activities related to each site. • T1 Site LFPG • T2 Site LSZH • T3 Site EDDM			
Inputs	*Outputs*	*Nature*	*Due*
Flight trials scenarios Flight trials management Internal communication Plan Internal communication Material	Informed staff	organizational	T0+15 months

Partners involved in the tasks (L=Lead, C=contributor, R=Review)		
Task	*Activity*	*Partners role*
WP 2	Overall coordination	L: DSNA
T1 Site LFPG	Crews and Airlines operations Internal communication	L: Air France C: Regional, Delta R: Airbus ProSky, Boeing
T1 Site LFPG	Operational staff Internal communication	L: DSNA R: Airbus ProSky, Boeing
T2 Site LSZH	Crews and Airlines Operations Internal communication	L: SWISS R: Airbus ProSky, Boeing
T2 Site LSZH	Operational staff Internal communication	L: Skyguide C: DSNA, DFS R: Airbus ProSky, Boeing
T3 Site EDDM	Crews and Airlines Internal communication	L: Lufthansa R: Airbus ProSky, Boeing
T3 Site EDDM	Operational staff Internal communication	L: DFS C: DSNA R: Airbus ProSky, Boeing

WP3: Performance assessment	
Duration:	15 months
Start Event:	T0 + 5 months
End Event:	T0 + 20 months

Objective:

The objective of this work package is to provide the metrics and the qualitative assessment of the flight trials to support the conclusions and proposals.

Method:

The performance assessment will be based on quantitative (metrics) and qualitative assessment. Outcome of simulations performed adjacent to the flight trials will be taken into account. The quantitative assessment will be based on the comparison of the metrics obtained during the flight trials, and the same metrics applied on the same sample of traffic outside to the flight trials. The qualitative assessment will rely on the feedback of the staff involved in the flight trials. It will be based on questionnaires.

Task 1: Metrics definition:

- This task will consist in defining the metrics and developing the questionnaire that will be used for the evaluation of the trial and more specifically on the KPA listed in chapter 2.1. The following aspects should be evaluated:
    - Flight plan adherence and deviation from TTA, deviation justification;
    - Evaluation of predictability: impact on departure sequencing, impact on arrival sequencing;
    - Impact on ATC staff: En-route ATCOs, approach and ground control;
    - Impact on flight crew workload, impact on airlines operations staff;
    - Impact on flight efficiency: duration of flight and fuel consumption;
    - Impact on NMC;
    - Impact on safety: event analysis.

Task 2: Reference case:

- This task will consist in collecting the metrics on the equivalent traffic flow as for the trials and defining a baseline for the analysis;
- It will use recorded data on regular flights, if available.

Task 3: Data capture during flight trials:

- This task will consist in collecting the metrics during the flight trials;
- It may consist during these flight trials in:
    - Questionnaire collection from staff;
    - Airborne flight data recording, if available;
    - Ground flight data recording.
- In each operational unit a monitoring of the flight trials execution will be performed;
- During flight trials a brief analysis could be made to check the recording process and to validate the quality of the metrics.

Task 4: Recorded Data Analysis:

- This task will consist in analyzing the data collected during the flight trials and to produce the results analysis part of the final report;
- Simulations will support the evaluation of the data retrieved during the trials.

Inputs	*Outputs*	*Nature*	*Due*
Flight trials scenarios Flight trials management Trained staff	Recorded data Filled questionnaire Reports	Data collection Report	T0+20 months

Partners involved in the tasks (L=Lead, C=contributor, R=Review)		
Task	*Activity*	*Partners role*
WP 3	Overall coordination	L: DSNA
T1, T2		L: DSNA C: DFS, skyguide, Air France, Regional, Delta, SWISS, Lufthansa, Airbus ProSky, Boeing, EUROCONTROL
T3	Site LFPG	L: DSNA C: Air France, Regional, Delta
T3	Site LSZH	L: skyguide C: SWISS
T3	Site EDDM	L: DFS C: Lufthansa
T4		L: DSNA C: DFS, skyguide, Air France, SWISS, Lufthansa, EUROCONTROL

WP4: Safety Case	
Duration:	5 months
Start Event:	T0 + 5 months
End Event:	T0 + 10 months

Objective:

The objective of this work package is to develop the necessary safety regulatory environment for the trials execution.

Method:

A safety case will be performed for the flight trials execution. The impact of the flight trials scenarios on safety will be evaluated making use of simulations and mitigation measures. The FABEC ANSPs will use the current FABEC process applied for safety case. It is assumed that there will be no impact on aircrafts.

Task 1: ANSP safety case:

• Development of the FABEC safety case by DSNA, DFS and skyguide (PHA, PSSA, SSA). Task 2: Airline safety case: • Air France Safety Case document conclusion; • SWISS ORE (Operational Risk Evaluation) conclusion; • Check necessity of Lufthansa internal ORE (operational risk evaluation) and if so conclusion; • Regional Safety Case document conclusion; • Delta Safety Case document conclusion.			
Inputs	*Outputs*	*Nature*	*Due*
Flight trials scenarios Flight trials Internal communication Plan Management	Comments on flight trials scenarios and Internal communication plan Safety case(PHA, PSSA, SSA)	Report	T0+10 months

Partners involved in the tasks (L=Lead, C=contributor, R=Review)		
Task	*Activity*	*Partners role*
WP 4	Overall coordination	L: DSNA
T1 ANSP safety case	ANSP Safety case	L: DSNA C: DFS, skyguide
T2 Airline safety case LFPG	Air France, Regional, Delta Safety Case	L: Air France, Regional, Delta
T2 Airline safety case LSZH	SWISS ORE	L: SWISS
T2 Airline safety case EDDM	Lufthansa ORE	L: Lufthansa

WP5: Live trials		
Duration:	4 months	
Start Event:	1st period: T0 + 11 months	2nd period: T0 + 15 months
End Event:	1st period: T0 + 13 months	2nd period: T0 + 17 months
Objective: The objective of this WP is to perform the flight trials according to the defined scenarios in order to have the elements to analyze the execution of the flight trials, to draw conclusions and to make recommendations for the development and the implementation of the SESAR P7.6.5 concepts.		
Method: The scenarios defined during WP 1 will be implemented to a set of flights normally subject to CTOT constraints due to congested entry points of major European hubs. The scenarios will involve the NMC, the TWR control of the departure field, the airlines operation, the crews, the local FMPs and ATC sectors of the involved ACC units and the approach control of the destination hub. The objective is to have		

a relevant amount of flight trials (with a minimum of 30 flight trials) in order to be able to draw conclusions. These flights will be operated by the Airlines members of the consortium. The following units have to be confirmed during the design WP activities.

Task 1: Site LFPG:

- Airlines crews and operation: Air France, Regional, Delta;
- TWR control: LFBO, LFBD;
- ATC units: Paris ACC, Bordeaux ACC, Brest ACC;
- Approach Control: LFPG.

Task 2: Site LSZH:

- Airlines crew and operation: SWISS; TWR control: LSGG;
- TWR control: LFPG, LSGG, EDDS, EDDL;
- ATC units: Paris ACC, Reims ACC, Langen ACC, Geneva ACC, Zurich ACC;
- Approach Control: LSZH.

Task 3: Site EDDM:

- Airlines crew and operation: Lufthansa;
- TWR control: LFPG;
- ATC units: Munich ACC, Karlsruhe UAC, Reims ACC, Paris ACC;
- Approach Control: EDDM.

Inputs	*Outputs*	*Nature*	*Due*
Flight trials scenarios Flight trials management Trained staff	Recorded data Filled questionnaire Reports	Data collection Report	T0+17 months

Partners involved in the tasks (L=Lead, C=contributor, R=Review)		
Task	*Activity*	*Partners role*
WP 5	Overall coordination	L: DSNA
T1 Site LFPG	Site LFPG	L: DSNA C: Air France, Regional, Delta, EUROCONTROL as NM
T2 Site LSZH	Site LSZH	L: skyguide C: SWISS, DSNA, EUROCONTROL as NM
T3 Site EDDM	Site EDDM	L: DFS C: Lufthansa, DSNA, EUROCONTROL as NM

WP6: Final report			
Duration:	7 months		
Start Event:	T0 + 15 months		
End Event:	T0 + 22 months		
Objective: The objective of this WP is to perform the analysis of the flight trials. The conclusions of the flight trials shall contribute the development of SESAR CONOPS and its stepwise implementation. They will be presented in the final report. The content of the final report is given in Annex C.			
Method: Task 1: development of the final draft: • Analysis of the findings of WP performance; • Writing of the final report draft; • Delivery to SJU for comments. Task 2: final report: • Analysis of the SJU comments and writing of the final report; • Delivery to SJU for final validation.			
Inputs	*Outputs*	*Nature*	*Due*
All WP outputs	Draft report Final report	Report	T0+20 months T0+22 months

Partners involved in the tasks (L=Lead, C=contributor, R=Review)		
Task	*Activity*	*Partners role*
WP 6	Overall coordination	L: DSNA
T1		L: DSNA C/R: DFS, skyguide, Air France, Regional, Delta, SWISS, Lufthansa , Airbus ProSky, Boeing, EUROCONTROL
T2		L: DSNA C/R: DFS, skyguide, Air France, Regional, Delta, SWISS, Lufthansa, Airbus ProSky, Boeing, EUROCONTROL

WP7: Communication	
Duration:	19 months
Start Event:	T0+ 3 months
End Event:	T0 + 22 months
Objective: The objective of this WP is to inform internal staff and external stakeholders about the execution of the flight trials and disseminate the conclusions and	

recommendations.			
Method: Task 1: Web sites: • Update consortium members, FABEC and SJU web sites. Task 2: leaflets, newsletters: • Include the FAIR STREAM project in the consortium members newsletters; • Present the FAIR STREAM project in internal technical review. Task 3: FAIR STREAM communication support: • Develop a video (5') and distribute this video on web sites and produce 1000 FAIR STREAM DVDs. Task 4: External events: • Organization of an information day for internal staff; • Presentation at external events; • Participation to SJU information meeting.			
Inputs	*Outputs*	*Nature*	*Due*
All WP outputs	Update websites Newspapers providing information on the FAIR STREAM project Communication material	Information displayed on websites, newspapers Leaflets DVDs	T0+22 months

Partners involved in the tasks (L=Lead, C=contributor, R=Review)		
Task	*Activity*	*Partners role*
WP 7	Overall coordination	L: DFS/DSNA
T1		C/R: DSNA, DFS, skyguide, Air France, Lufthansa, SWISS, Airbus ProSky, Boeing
T2		C/R: DSNA, DFS, skyguide, Air France, Lufthansa, SWISS, Airbus ProSky, Boeing
T3		C/R: DSNA, DFS, skyguide, Air France, Lufthansa, SWISS, Airbus ProSky, Boeing
T4		C/R: DSNA, DFS, skyguide, Air France, Regional, Delta, Lufthansa, SWISS, Airbus ProSky, Boeing

3.3 Deliverables

Deliverable name	Date
Demonstration Plan (A1)	27/11/2012
Demonstration Report (B1)	31/03/2014

3.4 Risk Management

Risk description	Probability assessment (Low/Medium/High/Very high)	Severity assessment (Low/Medium/High/Very high)	Mitigation actions	Owner	Lessons learned
Postponement in evolution of NOP Portal	Medium/Low	Medium	Delay the trials	EUROCONTROL (WP13)	This risk did not occur
Safety case result not permitting flight trials exercises	Low	High	Change the scenario	Project Leader	This risk did not occur
Insufficient samples to draw conclusions	Low	High	Two periods planned Adjust the scenario for the second period of the trials	Project Leader	This risk did not occur
Non availability of reference case	Low	Medium	Use the best available reference case	Project Leader	This risk did not occur
Operational staff	Very Low	High	3 different sites	Project Leader	This risk did not occur
Non acceptance of questionnaires and performance assessment from the staff representation	Medium	Medium	Internal communication	Project Leader	This risk did not occur thanks to the communication on the project
Crews cannot select TTA option	Low	High	Internal communication	Airlines	This risk did not occur thanks to the communication on the project
Impact on ATC workload is considered too high	Low	High	Web conference at the end of the first days of the live trials to exchange about the impact Redesign of	ANSPs	This risk did not occur

			the procedures		
No cooperation from NMC in the trials	Low	High	Involvement of Eurocontrol in the elaboration of the proposal In the project from the beginning	EUROCONTROL	This risk did not occur
Problem with the feedbacks of EXE-0202-003	High	Medium	Contact has been established with Munich and data have been collected	Project Leader	This risk did occur and the issue was solved by exchanging with Munich exercise

4 Execution of Demonstration Exercises

4.1 Exercises Preparation

The preparation of the Exercises was organized around Face-to-Face meetings, WebEx conferences and internal meetings to affine the scenarios. It involved experts from ANSPs, Airlines, Industry (Airbus) and EUROCONTROL (NMOC and SESAR experts).

A common document, "FAIR-STREAM Scenario Description", was elaborated to collect all the information concerning the technical and operational environments and the scenario for each Exercise. This chapter will therefore take most of its content from this Scenarios Description document.

4.1.1 Approach & schedule

The approach followed all along during this preparation phase was to define first the initial concept and goal of FAIR-STREAM, so that each ANSP and airline could develop their scenario taking into account their own systems' and environment's limitations and/or constraints.

For each Exercise, the national ANSP and the airline were involved and EUROCONTROL played a central and essential role to allow the coordination of the new processes.

The interesting part is that each scenario tackled the "Move from CTOT to TTA" Concept by different approaches, because being adapted to the local constraints.

The initial concept implied that only regulated flights could be candidate for the Trials. However, the preparation phase also took into consideration non-regulated flights in order to minimise the risk of having not enough trial flights to meet the Project objectives and to draw reliable analysis and conclusions.

The preparation of the exercises took into consideration two phases:

- Flight Planning phase: 2 hours till 20 min prior to EOBT;
- Flight Execution phase: 20 min prior to EOBT till end of flight.

The definition of the general concept and scenario was the most important phase to permit to all the participants to have the same understanding of the project.

This phase allowed setting the "basis":

- definition of the terms (TTA-fix);
- definition of each actor's role;
- description of the pre-conditions/pre-requisites;
- explanation of the TTA handling by EUROCONTROL, relatively as the current CTOT processing.

The Flight Execution phase anticipated two scenarios:

1. the case where the TTA is reachable;
2. the case where TTA is not; or not any more reachable.

The special handling for the non-regulated flights included the two cases of short-haul non-regulated flights and long-haul flights.

Based on these statements, each ANSP adapted their scenario relatively to their systems' functionalities and existing internal processes, in order to permit Trials execution in a short time-frame, as the Project aimed to (design trials to assess improvements without any change on the current ATC procedures or equipment, neither on the airborne side). No specific training was needed to perform the Trials. However, information and/or briefing were provided to Operations (ANSPs, Airlines).

The next phase of the preparation was the selection of the eligible Trial flights. Depending on the scenario, the selected city-pairs were different.

The WP1 agenda was as follow:

Event	Date & Place	Goal
Face-to-Face meeting #1	14/11/2012 Geneva	First meeting of all the Project's members
WebEx #1	13/09/2012	Work on the scenario description document
WebEx #2	08/01/2013	Work on the scenario description document
WebEx #3	21/02/2013	Work on the scenario description document
Face-to-Face meeting #2	02/04/2013 CDG	Meeting with all partners before the beginning of the live trials
Several internal meetings	04/2013 – 06/2013	Briefings, information
WebEx #4	06/06/2013	Mid-Trials assessments
Face-to-Face meeting #3	11/07/2013 CDG	1st Trials assessments and refinement for the 2nd Trials
Several internal meetings (2nd Trials)	07/2013 – 10/2013	Briefings, information

4.1.2 Targeted scenarios

4.1.2.1 PARIS CDG Airport

TTA FIX	Selected Flights	Use of AMAN	Involvement of ATC	Remarks
SouthWest IAF (BANOX)	Air France Regional and Delta flights on 3 city-pairs and long haul flights: LFBO – LFPG LFBD – LFPG LFBP – LFPG USA – LFPG	Yes (MAESTRO)	Involvement of DEP Involvment of ARR (AMAN)	

The Exercise of Paris makes use of the TTA at the IAF, which is included in the MAESTRO AMAN.

EUROCONTROL provides a TTA being a TTO over last F15 point, but this TTA is translated by CDG ATCO into an IAF TTA that is set in the AMAN.

As soon as the flight is available in AMAN, Paris-ACC (ACC is equipped with CDG-AMAN display) calls CDG (AMAN position) to confirm the last update of TTA (last point of F15 route).

CDG then calculates an IAF-TTA and input it in AMAN. This is done +/-30 to 40min before landing.

The Southwest IAF BANOX is considered for the 1st trials, with the participating flights departing from Toulouse, Bordeaux and Pau.

Below the detailed information flow:

1. NMOC distributes provisional CTOT via the CHMI as soon as the regulation is entered in the ETFMS
2. NMOC distributes CTOT via AFTN/CHMI/NOP & TTA information on NOP 2 hours before EOBT
3. FMPs & OCC receive CTOT via AFTN/CHMI/NOP & TTA information via NOP
4. OCC transmits information to Flight Crew (ACARS INIT Message for CTOT & new ACARS message for TTA)
5. Pilot enters TTA in FMS and calculates TTOT
6. Flight Crew indicates to OCC via ACARS message if they will try to comply to TTA
7. Pilot informs DEP TWR via VHF of TTOT and QFU/SID used for calculation
    1. DEP TWR informs Pilot via VHF about the actual QFU/SID and expected taxi time
    2. If QFU or SID are different from pilot's assumption, then pilot recalculates TTOT and informs DEP TWR of new TTOT.
8. Pilot sends TOBT to OCC via ACARS and informs OCC if speed used to comply to TTA is different from speed in FPL
9. OCC sends a new FPL to NMOC if necessary
10. Flight crew complies with ATC instructions and manage within their range of responsibility to adhere to the TTA constraint
11. NMOC monitors the flight's progress
12. At 1st contact with new ACC, pilot announces to ACC ATCO aircraft speed and TTA (LFFF ACC)
13. ACC ATCO transmits the TTA information to the sequencer ATCO
14. Sequencer ATCO makes the input of TTA over the IAF (BANOX) in the AMAN when given this information by the upstream ACC controller
15. The arrival sequence will be managed to allow the flight to meet its TTA. However, there is no special priority given for these flights

FAIR-STREAM Information Flow - LFPG Arrivals						
Step	**Time**	**From**	**To**	**Via**	**Content**	**Remark**
1	As soon as the regulation is entered in the ETFMS	NMOC	OCC DEP TWR ACCs FMP Arr APP	CHMI	Provisional CTOT	CHMI not available at LFBP
2	2h before EOBT	NMOC	OCC DEP TWR ACCs FMP Arr APP	CHMI NOP	CTOT	
				NOP	TTA	
3	40 minutes before EOBT	OCC	Flight Crew	ACARS Init Message	CTOT	
				ACARS Message	TTA	
4	30 minutes before EOBT	Flight Crew	OCC	ACARS	Indication of compliance to TTA	
5	20 minutes before EOBT	Flight Crew	DEP TWR	VHF	TTOT QFU/SID	
6	20 minutes before EOBT	DEP TWR	Flight Crew	VHF	QFU/SID Taxi Time	
6.1	*15 minutes before EOBT*	*Flight Crew*	*DEP TWR*	*VHF*	*TTOT*	*If previous QFU/SID was different than used for calculation*
7	*15 minutes before EOBT*	*Flight Crew*	*OCC*	*ACARS*	*TOBT* *Speed*	*If speed to reach TTA is different than FPL*
7.1	*15 minutes before EOBT*	*OCC*	*NMOC*	*AFTN*	*New FPL*	
8	*During Flight*	*Flight Crew*				*Flight crew complies with ATC instructions and manage within their range of responsibility to adhere to the TTA constraint*
9	At 1st contact with ACC	Flight Crew	ACC ATCO	VHF	speed	
10	At 1st contact with Paris ACC	Flight Crew	ACC ATCO	VHF	speed TTA	
11	At 1st contact with Paris ACC	ACC ATCO	Sequencer ATCO	Phone	TTA	
12	On phone call	Sequencer ATCO	AMAN	Manual Input	TTA	

Figure 1: LFPG Exercise Flow

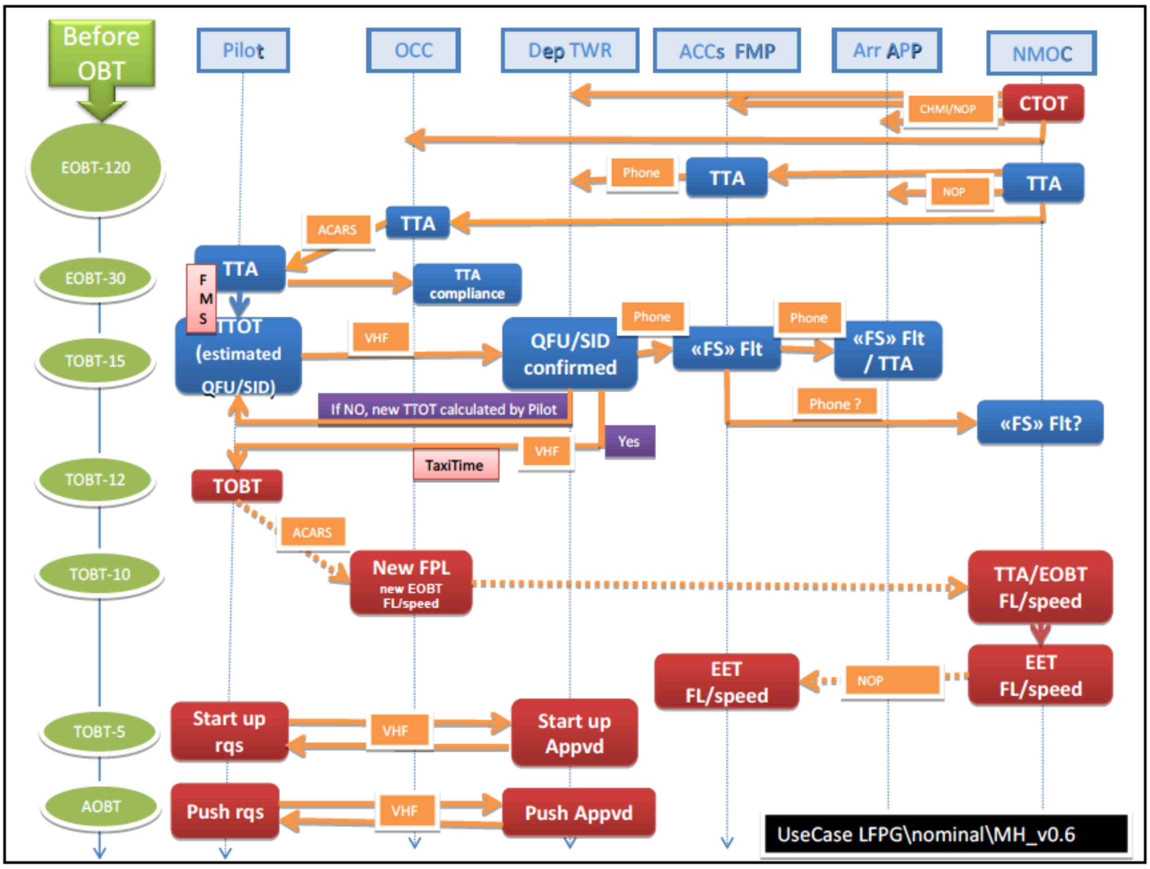


Figure 2: LFPG Use Case Short-Haul – Before OBT

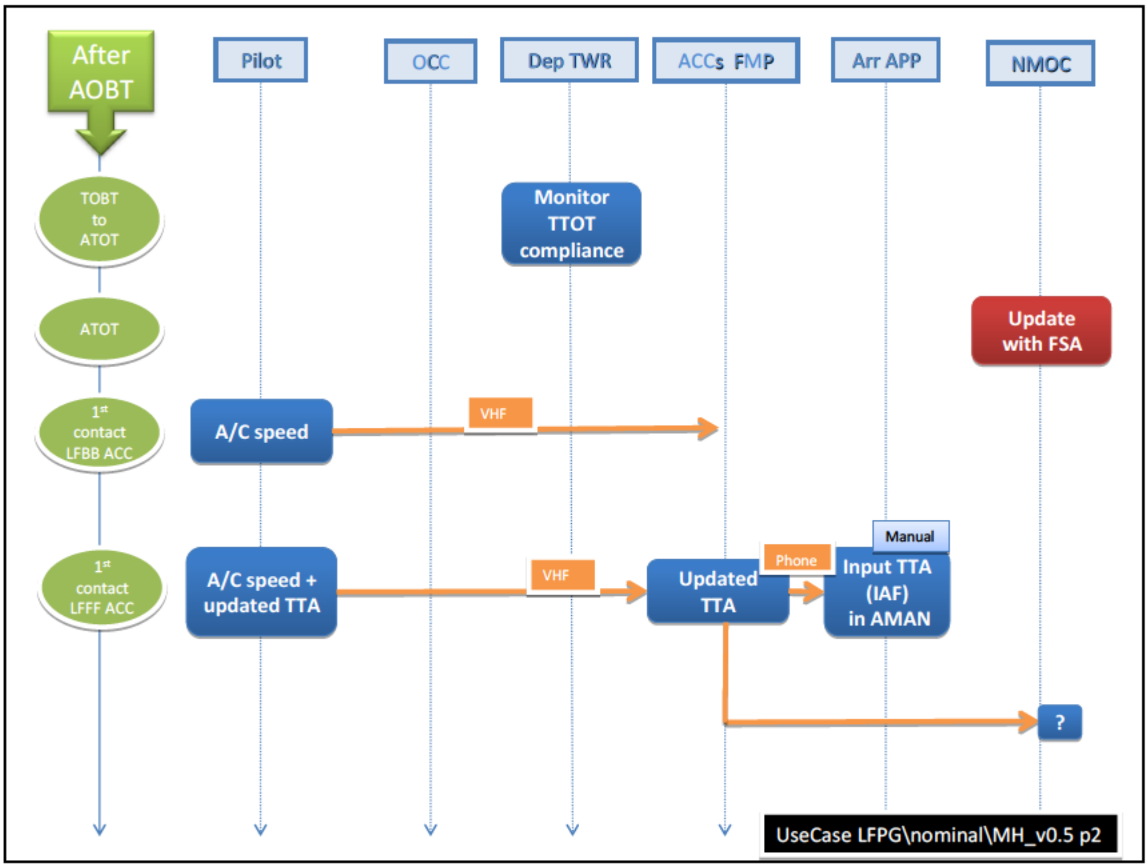


Figure 3: LFPG Use Case Short-Haul – After OBT

Adaptation for 2nd Trials

The Northwest IAF was to be considered for the 2nd trials, and long-haul flights were included.

It was decided to re-conduct short-haul flights live trials, as there was a need for more flights to get significant statistics. Same scenario was applied, all eligible flights were proposed a TTA by the AO dispatch, whether regulated or not. The information (TTA or ETA) is based on the information from the NOP Portal.

- Eligible European flights arriving during the morning peak hour at CDG, 7 days a week;
- LFBO and LFBD flights remain eligible, LFBP flight also if HOP! Internal issues are solved;

possibly 1 or 2 medium-haul flights from UK added to the list (contact made with NATS. Unfortunately, it was impossible to match an AFR flight with an available UK's station therefore no medium haul flight coming from UK participated).

- Proposal of adapted Short-Haul scenario :
  - as decided during the 1st trial, TTA at IAF proposed by CCO (ACARS) to all eligible flights :
    - if regulated, TTA at IAF is based on TTO last field 15 Fix;
    - if non-regulated, TTA is ETO at IAF;
  - at 1st contact with TWR, crew confirms participation to live trial;
  - at 1st contact with each ACC, speed is announced by crew;
  - TTA coordinated: TWR to LFBB / EGTT FMP to LFFF FMP to CDG to CDG sequencer;

- TTA entered in AMAN by sequencer.

- Proposal of Long-Haul scenario:
  - to select a TTA +/- 5 hours before ETA. This TTA could be based on NMOC ETA or adapted from the FMS ETA, modified according to the AO's needs;
  - when entering Shanwick area (030° W), TTA transmitted (by CPDLC) to Shanwick OAC:
    - TTA coordinated by Shanwick to Brest or London FMP ACC, depending on the track;
    - TTA coordinated by Brest or London FMP to Paris ACC FMP;
    - TTA coordinated by Paris to CDG;
    - TTA coordinated to CDG Sequencer and entered in the AMAN.
- Proposed eligible flights : minimum 2 / day
  - AFR039 KIAD –CDG;
  - AFR017 KJFK – LFPG;
  - DAL flights to LFPG.

The main objectives are:

- Check the ability of Long-Haul flights to reach a TTA fixed 5 hours in advance (so to gain or lose 2 or 3 minutes) with "cooperative" because informed ACCs and with an acceptable workload on ATC sectors.
- Check the accuracy of NMOC TTA estimates 5 hours in advance compared to FMS estimates in order to determine if new updates are necessary or not before asking NMOC in the future to issue achievable TTAs.

The participation of NATS was to be confirmed, but contact had been established and NATS declined, because already working on the same topic for Heathrow arrivals.

4.1.2.2 ZURICH Airport

TTA FIX	Selected Flights	Use of AMAN	Involvement of ATC	Remarks
Last Point of the Route (End point of FPL Field 15)	1st Trials: SWISS flights on four city-pairs: LSGG – LSZH EDDS – LSZH EDDL – LSZH LFPG – LSZH 2nd Trials: all SWISS inbound flights in two selected peak periods (including long haul flights)	No	No, information only	

For the first Trials, short haul flights are considered on four city pairs and flights are selected according to their potential impact on operations. The selected flights are among the ones statistically most affected by Arrival regulations in Zurich airport.

Please note that the Zurich Exercise does not aim to involve departure airports. As it is expected to have a CTOT and TTA that are perfectly compatible (TTOT = CTOT and the speed of the operational

FPL taken into account in the CTOT/TTA calculation), no action or specific request is required on the departure side.

Three scenarios were elaborated for the Trials (two for the 1st Trials and one supplementary for the 2nd Trials).

The scenarios are based on the FAIR STREAM concept, and the TTA fix chosen is the Last Point of the FPL Field 15.

- **Scenario 1:**

The scenario concerns trial flights that have an allocated CTOT. The TTA is subsequently allocated to the trial flight and the crew indicates if they participate and try to comply to the TTA constraint. In this case, the crew makes sure to cope with the constraint by managing, where possible, its TOT within their TTOT (= CTOT) and by managing the flight in order to reach the TTA over the TTA fix.

Depending on the actual take off time , the TTA may no longer be achievable. In this case, the flight crew determines their ETO at the TTA fix and communicates this to their OCC. The flight remains within the trial, but its discrepancy from the TTA is measured, and the reason for not adhering is recorded and used in the output of the trials.

This scenario can be run with the different types of Swiss fleet aircraft.

- **Scenario 2:**

This scenario only concentrates on the management of a TTA.

A TTA is allocated to the trial flight and the crew makes sure to cope with the constraint.

This scenario can be run with the different types of Swiss fleet aircraft.

It was afterwards decided that this scenario will not be applied for the Trials in order to concentrate on the previous scenario, which tackles the heart of the "Move from CTOT to TTA" concept.

- **Scenario 3 (long-hauls):**

Three hours before the Estimated Time of Arrival (ETA), the crew communicates their ETA to the AOC, which communicates it to NMOC. NMOC then distributes the TTA over the TTA fix to the airline, which redirects it to the flight crew. The flight crew finally tries to adapt their speed in order to reach the TTA.

The scenario for long-haul flights needed to be confirmed, as well as the TTA fix (ETO at the STAR entry fix). It was discussed again after the 1st Trials in May/June 2013.

The aircraft capabilities in regards to the scenarios are as follows:

	FMS able to manage TTA	FMS not able to manage TTA
Scenario 1: CTOT-TTA (1st trial)	X	X
Scenario 2: TTA only (2nd trial)	X	X
Scenario 3: ETA/TTA Long Haul	X	

Scenario 1

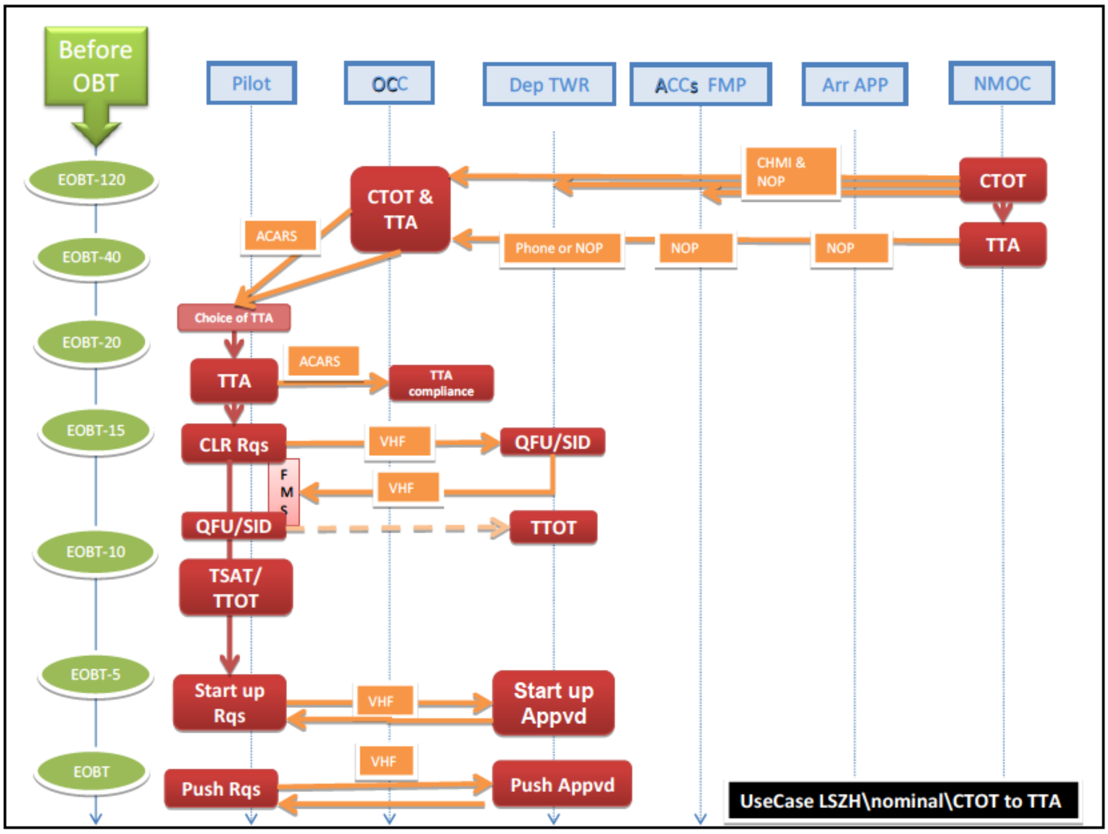


Figure 4: LSZH Use Case Short-Haul – Before OBT

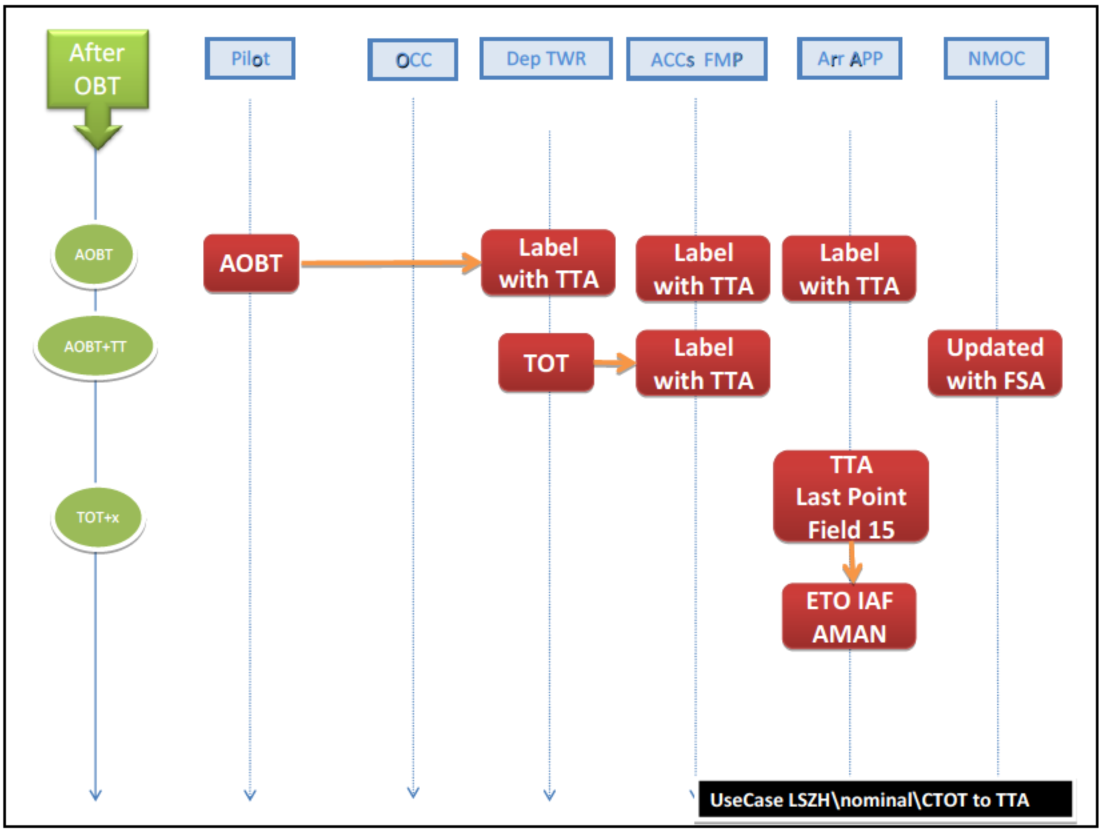


Figure 5: LSZH Use Case Short-Haul - After OBT

1. NMOC distributes provisional CTOT before SIT via the CHMI as soon as the regulation is entered in the ETFMS
2. NMOC distributes CTOT via AFTN/CHMI/NOP & TTA information on NOP 2 hours before EOBT
   2.1. FMPs & OCCs receive CTOT via AFTN/CHMI/NOP & TTA information on NOP
3. OCC transmits information to Flight Crew: CTOT via ACARS INIT Message and TTA via a new ACARS message
   3.1. Pilot enters TTA in FMS and calculates TTOT
4. Flight Crew sends back an ACARS message to OCC if they will try to comply to TTA (log file)
5. Flight crew complies with ATC instructions and manages within their range of responsibility to adhere to the TTA constraint
   5.1. NMOC monitors the flight's progress
6. Zurich ACC FMPs enter "TTA" in the Free Text field of the flight to inform ACC & APP ATCOs
7. Flight is inserted as usual in the AMAN
   7.1. APP ATCO tries to limit penalization for this flight (avoid holdings as possible). However, there is no special priority given for these flights

FAIR-STREAM Information Flow - LSZH Arrivals						
Step	**Time**	**From**	**To**	**Via**	**Content**	**Remark**
1	As soon as the regulation is entered in the ETFMS	NMOC	OCC DEP TWR ACCs FMP Arr APP	CHMI	Provisional CTOT	
2	2h before EOBT	NMOC	OCC DEP TWR ACCs FMP Arr APP	CHMI NOP	CTOT	
				NOP	TTA	
3	40 minutes before EOBT	OCC	Flight Crew	ACARS Init Message	CTOT	
				ACARS Message	TTA	
4	30 minutes before EOBT	Flight Crew	OCC	ACARS	Indication of compliance to TTA	
5	*During Flight*	*Flight Crew*				*Flight crew complies with ATC instructions and manage within their range of responsibility to adhere to the TTA constraint*
6	Before entering Zurich ACC	FMP	ACC ATCO	Manual Input	TTA	"TTA" in the label of the flight
7	At 1st contact with APP	Sequencer ATCO	Sequencer ATCO	Manual Input		Flight is inserted as usual in the AMAN

Figure 6: LSZH Exercise Flow

Concerning the departures from CDG which is a CDM airport, the Use Case may take into account the DPI (Departure Planning Information) messages which provides a more accurate CTOT/TTA calculation.

- FMP from Zurich ACC is informed that the flight is FAIR STREAM trial flight.
- The flight is labelled as "TTA" flight to the ACC & APP ATCOs.
- ATCOs work as usual but are aware that the concerned aircrew has an objective to reach its declared TTA and therefore has to optimise the flight as filed in the Flight Plan.

Scenario 2

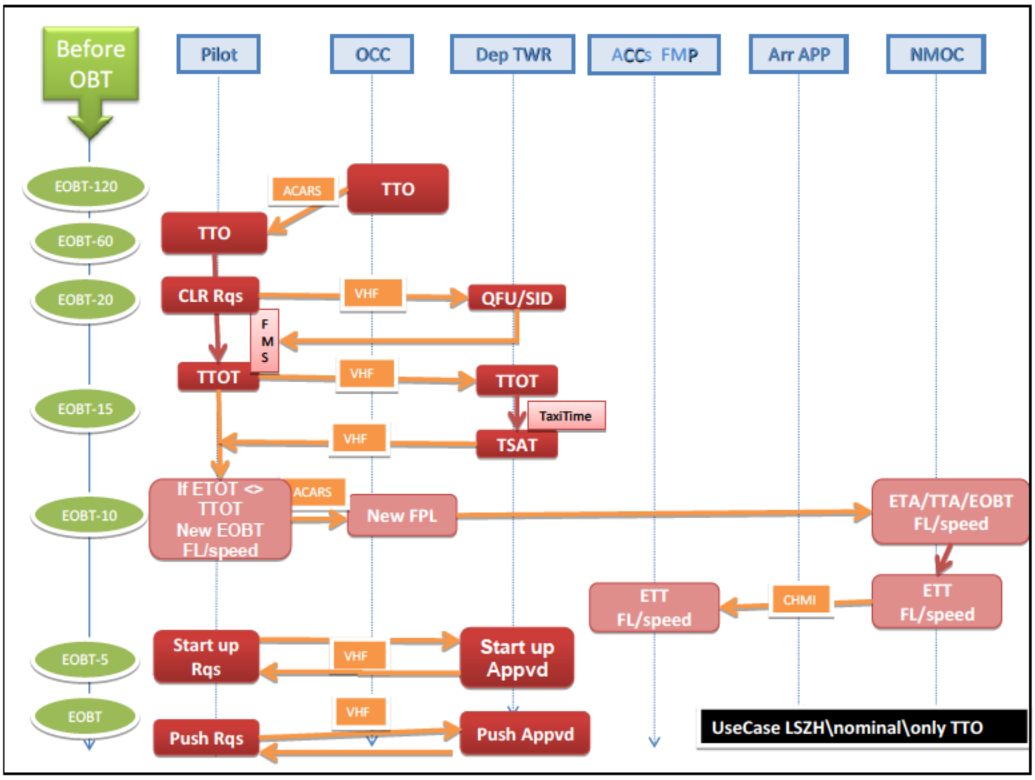


Figure 7: LSZH Use Case Non-Regulated

Scenario 3:

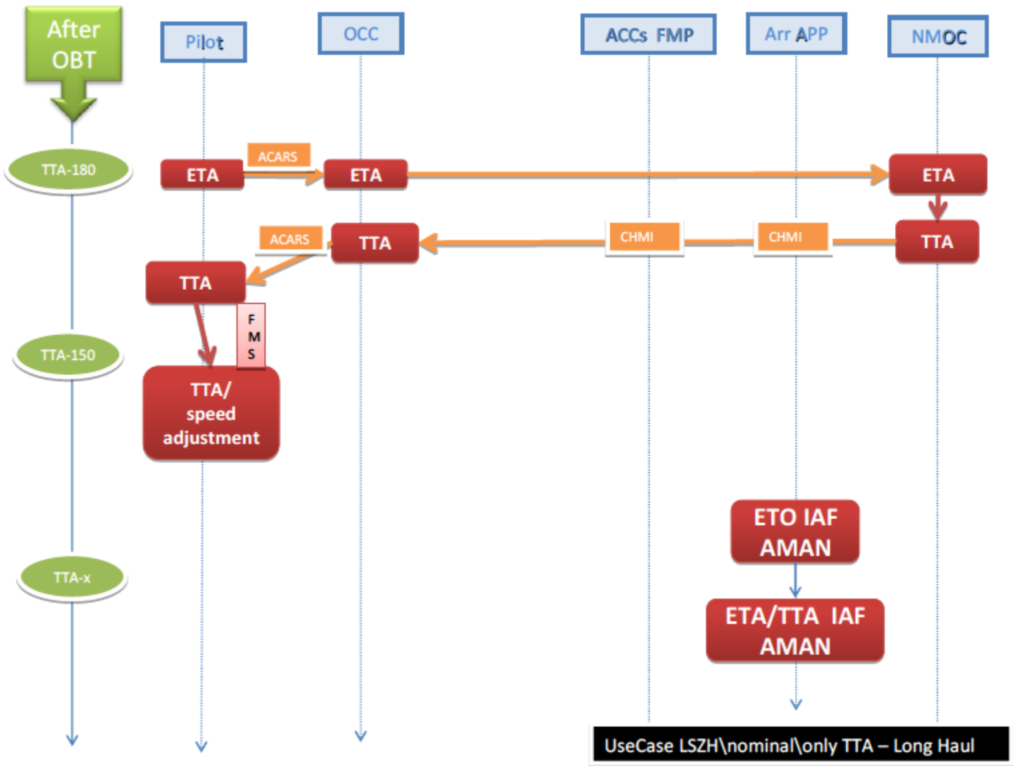


Figure 8: LSZH Use Case Long-Haul

Adaptation for 2nd Trials

The proposed adaptation for the 2nd Trials was to increase the number of trial flights in a pre-defined peak arrival time.

Proposed scenario:

- involve all arrival flights regulated by a LSZH ARR Regulation during a predefined peak period (all airlines);
- each airline's dispatch distribute TTAs to Flight Crews;
- flight crews should participate, if no major operational reasons prevent it;
- flight crews manage their flight in order to reach TTA.

Pre-requisite: dispatch cells (AOC) should use the EET field (EET at TTA-Fix) to fill the FPL to be sent to NMOC, in order to get most accurate CTOT/TTAs.

Environment:

- On-study proposal of reduced arrival rate to 32 (instead of 36 currently)

The scenario for the long-haul flights would be to include the ones arriving in the peak periods selected for the Trials.
The scenario would be the following:

- 3h before ETA, flight crew communicates its ETO (over last fix of field 15) to AOC;
- flight crews should participate, if no major operational reasons prevent it;
- flight crews use their ETO as TTO and try to reach it.

4.1.2.3 MUNICH Airport

TTA FIX	Selected Flights	Use of AMAN	Involvement of ATC	Remarks
Last Point of the Route (End point of FPL Field 15)	Air France and Lufthansa flights on city-pair: LFPG – EDMM	No	No	

The TTA fix chosen for the trials is the last point of the FPL Field 15 (KUNOD, OSDER or ANORA for arrivals from LFPG).

1. NMOC distributes provisional CTOT via the CHMI as soon as the regulation is entered in the ETFMS
2. NMOC distributes CTOT via AFTN/CHMI/NOP & TTA information on NOP 2 hours before EOBT
   2.1. FMPs & OCC receive CTOT via AFTN/CHMI/NOP & TTA information on NOP
3. OCC transmits information to Flight Crew: CTOT via an ACARS INIT Message and TTA via a new ACARS message

3.1. Pilot enters TTA in FMS and calculates TTOT

4. Flight Crew indicates if they will try to comply to TTA
5. Pilot sends back information of TOBT and speed to OCC

   5.1. OCC sends a new FPL to NMOC if necessary

6. Flight crew complies with ATC instructions and manages within their range of responsibility to adhere to the TTA constraint

   6.1. NMOC monitors the flight's progress

7. The arrival sequence will be managed to allow the flight to meet its TTA.

FAIR-STREAM Information Flow - EDDM Arrivals						
Step	**Time**	**From**	**To**	**Via**	**Content**	**Remark**
1	As soon as the regulation is entered in the ETFMS	NMOC	OCC DEP TWR ACCs FMP Arr APP	CHMI	Provisional CTOT	
2	2h before EOBT	NMOC	OCC DEP TWR ACCs FMP Arr APP	CHMI NOP	CTOT	
				NOP	TTA	
3	40 minutes before EOBT	OCC	Flight Crew	ACARS Init Message	CTOT	
				ACARS Message	TTA	
4	30 minutes before EOBT	Flight Crew	OCC	ACARS	Indication of compliance to TTA	
5	30 minutes before EOBT	Flight Crew	OCC	ACARS	TOBT and speed	
5.1	*25 minutes before EOBT*	*OCC*	*NMOC*	*AFTN*	*New FPL*	*If speed to reach TTA is different than FPL*
6	During Flight	Flight Crew				*Flight crew complies with ATC instructions and manage within their range of responsibility to adhere to the TTA constraint*
7	Entering APP	Sequencer ATCO	AMAN	Manual Input	TTA	

Figure 9: EDDM Exercise Flow

Adaption for the 2nd Trials

The consideration of non-regulated flights in order to have more trial flights was proposed.

4.1.3 NMOC new processes

EUROCONTROL played an essential role in preparation and during the trials. The objective has been to implement the TTA process specifically to the FAIR-STREAM Participants.

EUROCONTROL allowed us to query flight lists and data for our analysis.

4.1.3.1 TTA computation

On March 2013, EUROCONTROL put into operations a new version of IFPS (v17). This new version took into consideration the EET fields.

4.1.3.2 TTA distribution

- **New interfaces**

NMOC proposed new graphical displays to the NOP Portal to permit access to the TTA information.

Once the TTAs computed, the information was displayed on two new columns on the NOP Portal:

The snapshot below shows the two new "TTA columns" of the Flight Lists:

- TTO fix;
- ATT.

The TTO (Target Time Over) fix column contains three sub fields: FIX, TIME and LEVEL.

The ATT (Actual Time at Target) column indicates the progress of the flight and provides an ATO time at the fix and conformance indicator.

The whole field will be blank until the flight is reported airborne or if the flight diverts or it is clear that its profile will not achieve the fix.

The conformance subfield will be blank if the flight is within its 3 minutes tolerance, otherwise the flight is indicated as early (/) or late (\).

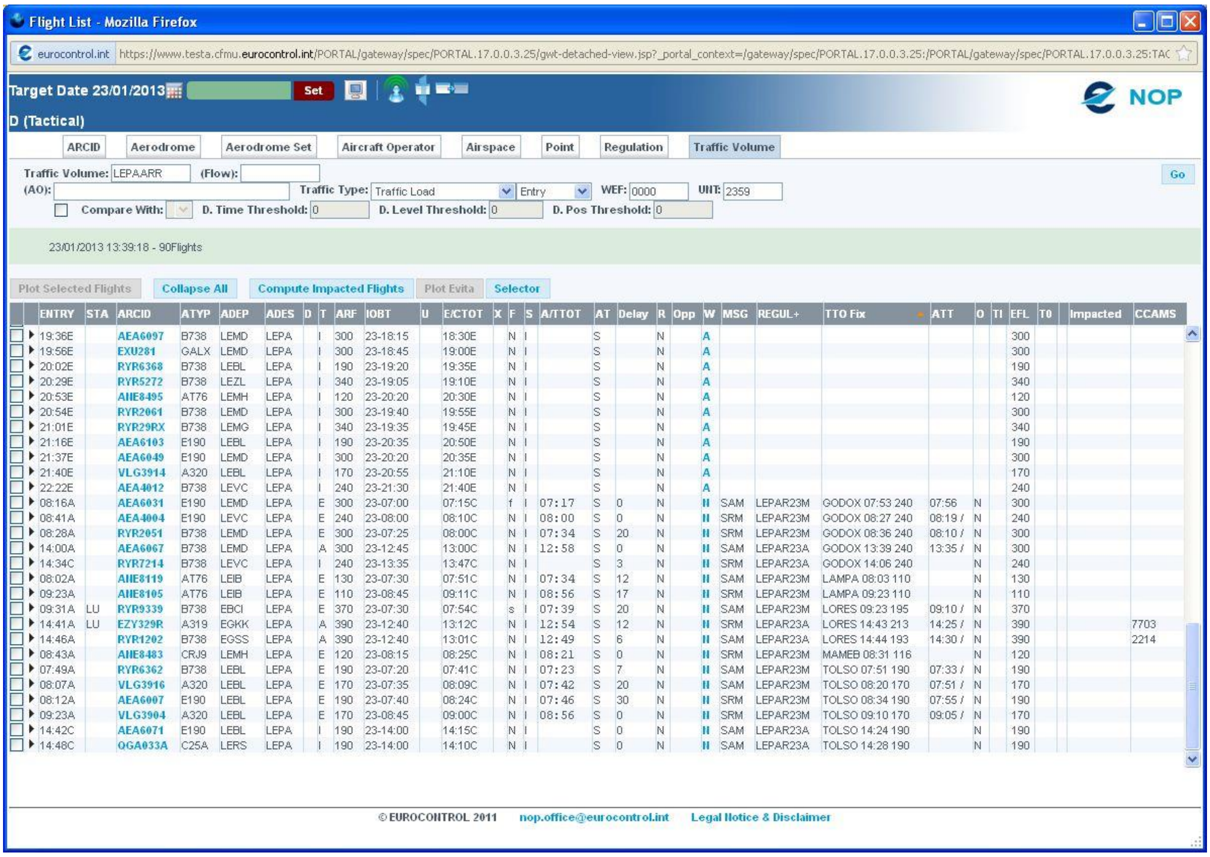


Figure 10: TTA display in NOP Portal

- **New tokens**

EUROCONTROL authorised access to these enhanced NOP portal through allowing special access to the participants' tokens.

During the trial period the users got an additional prompt at log in to select the trial configuration (with TTA and ATT columns).

- **Other concerns**

During the preparation, NMOC was asked about the possibility to assign a "TTA" value to non-regulated flights (e.g. long-hauls or short and medium haul flights without CTOT). However, the process of the TTA is strictly linked to the CTOT and regulation affectation, so without changing concept to be demonstrated, it is not possible to assign a TTA value to non-regulated flights (neither assigning a status "exempted" to these flights). That's why the concept was not changed but ETA was considered as TTA for non-regulated flights.

Another concern was about the attribution of CTOT/TTAs taking into account Wake Turbulence Categories. However, here again this process was not possible without considerable change to the concept to be demonstrated. Since the concept was not changed, Wake Turbulence Categories were not taken into account for the CTOT/TTAs attribution.

4.1.3.3 Enhancements for the 2nd Trials

Due to the requirements for the LSZH 2nd Trials, SWISS submitted the wish to receive TTA e-mails, as for the PALMA Trials. NMOC succeeded to implement the automatic distribution of TTA information through XML formatted e-mail directly to SWISS AOC.

SWISS afterwards developed an internal software to re-distribute the TTA information through ACARS message to concerned Flight Crews.

This mechanism was essential for the 2nd Trials in LSZH to take place by reducing considerably the AOC workload.

4.2 Exercises Execution

Exercise ID	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date	Actual Exercise start analysis date	Actual Exercise end analysis date
02.02.001	PARIS CDG AIRPORT 1st trial	13/05/2013	12/07/2013	13/05/2013	12/07/2013
	PARIS CDG AIRPORT 2nd trial	18/09/2013	13/11/2013	18/09/2013	13/11/2013
02.02.002	ZURICH AIRPORT 1st trial	01/05/2013	30/06/2013	01/05/2013	30/06/2013
	ZURICH AIRPORT 2nd trial	03/10/2013	25/10/2013	03/10/2013	25/10/2013
02.02.003	MUNICH AIRPORT 1st trial	19/05/2013	30/06/2013	19/05/2013	30/06/2013
	MUNICH AIRPORT 2nd trial	07/10/2013	25/10/2013	07/10/2013	25/10/2013

Table 2: Exercises execution/analysis dates

In the following chapters, the actual execution of the scenario will be described and the next chapter "Deviations" will highlight the differences relatively to the initial scenario planned.

4.2.1 PARIS CDG AIRPORT Exercise

For this exercise, TTA fix was the IAF. Non-regulated flights have been included in order to increase the amount of participating flights (FAIR STREAM Procedure for non-regulated flights is available here). For those flights, ETA was fixed as a TTA.

4.2.1.1 1st Trials

- **Timeframe:** 13/05/2013 – 12/07/2013, every day
- **Number of eligible flights:** 90
- **Number of participating flights:** 50

The Trials were performed every day from 13th of May till 12th of July.

1. NMOC distributes provisional CTOT via the CHMI as soon as the regulation is entered in the ETFMS
2. NMOC distributes CTOT via AFTN/CHMI/NOP & TTA (which is the estimated time if no regulation) information on NOP 2 hours before EOBT

3. FMPs & OCC receive CTOT via AFTN/CHMI/NOP & TTA information via NOP
4. OCC transmits information to Flight Crew (ACARS INIT Message for CTOT & new ACARS message for TTA)
5. Pilot enters TTA in FMS and calculates TTOT
6. Flight Crew may indicate to OCC via ACARS message if they will try to comply to TTA
7. Pilot may inform DEP TWR via VHF of TTOT and QFU/SID used for calculation
    1. DEP TWR informs Pilot via VHF about the actual QFU/SID and expected taxi time
    2. If QFU or SID are different from pilot's assumption, then pilot recalculates TTOT and informs DEP TWR of new TTOT
8. Pilot may send TOBT to OCC via ACARS and may inform OCC if speed used to comply to TTA is different from speed in FPL
9. OCC sends a new FPL to NMOC if necessary
10. Flight crew complies with ATC instructions and manage within their range of responsibility to adhere to the TTA constraint
11. NMOC monitors the flight's progress
12. At 1st contact with new ACC, pilot has to announce to ACC ATCO aircraft speed and could announced TTA (LFFF ACC)
13. ACC ATCO transmits the TTA information to the sequencer ATCO
14. Sequencer ATCO makes the input of TTA over the IAF (BANOX) in the AMAN when given this information by the upstream ACC controller if no disturbance of the sequence
15. The arrival sequence will be managed to allow the flight to meet its TTA. However, there is no special priority given for these flights

Only AF-JZ (**AF793JZ**, LFBO - LFPG) and AF-GY (**AF621GY,** LFBD - LFPG) were assigned TTAs.

4.2.1.2 2nd Trials

- **Timeframe:** 18/09/2013 – 13/11/2013, every day
- **Number of eligible flights:** around 400 flights
- **Number of participating flights:** 299

For the second trials, AF-JZ (**AF793JZ**, LFBO - LFPG) and AF-GY (**AF621GY,** LFBD - LFPG) were assigned TTAs again and long haul flights were added.

Since EUROCONTROL can't give a TTA to a long haul flight, the "TTA" was replaced by the estimation from the pilot, 2 to 3 hours before landing. The pilot tried to respect this ETA, however, direct courses were accepted when given by ATC.

4.2.2 ZURICH AIRPORT Exercise

4.2.2.1 1st Trials

- **Timeframe:** 01/05/2013 – 30/06/2013, every day
- **Number of eligible flights:** 437
- **Number of participating flights:** 213

There were 522 SWISS flights in total on the selected city-pairs during this timeframe.

On those total flights, 437 were regulated by a LSZH Arrival regulation (being their most penalizing regulation).

On those 437 eligible flights, 213 flights effectively participated in the Trials.

The Trials were performed according to the initial defined scenario, every day from 1st of May till end of June.

1. NMOC distributes provisional CTOT before SIT via the CHMI as soon as the regulation is entered in the ETFMS
2. NMOC distributes CTOT via AFTN/CHMI/NOP & TTA information on NOP 2 hours before EOBT
    2.1. FMPs & OCCs receive CTOT via AFTN/CHMI/NOP & TTA information on NOP
3. OCC transmits information to Flight Crew: CTOT via ACARS INIT Message and TTA manually, via a new ACARS message
    3.1. Pilot enters TTA in FMS and calculates TTOT
4. Flight Crew sends back an ACARS message to OCC if they will try to comply to TTA (log file)
5. Flight crew complies with ATC instructions and manages their flight within their range of responsibility to adhere to the TTA constraint
    5.1. NMOC monitors the flight's progress
6. Zurich ACC FMPs enter "TTA" in the Free Text field of the flight to inform ACC & APP ATCOs
7. Flight is inserted as usual in the AMAN
    7.1. APP ATCO tries to limit penalization for this flight (avoid holdings as possible). However, there is no special priority given for these flights

4.2.2.2 2nd Trials

- **Timeframe:** 03/10/2013 – 25/10/2013, every Thursday and Friday
- **Number of eligible flights:** 256
- **Number of participating flights:** 256

The 2nd Trials were performed on Thursdays and Fridays of October 2013, during the two biggest arrival peak periods (Waves 3 and 4 at LSZH):

- 10:50 – 12:15 LT
- 15:20 – 16:45 LT

These two arrival peak periods were chosen because they contain the highest ratio of SWISS flights.

1. **03/10/2013 – 04/10/2013**

As NMOC had no ability to assign CTOT/TTAs by grouping aircraft by wake turbulence categories, it was proposed to test a special procedure on the first two days of the Trials (Thursday 3rd and Friday 4th of October), aiming at exchanging the slots of SWISS regulated flights, in order to group the same categories as far as possible (and therefore reduce the mix of aircraft types and smooth the arrival sequence).

The procedure was the following:

1. NMOC (through CHMI) provides the whole list of ARR flights at LSZH during the 2 peak periods (LSZH ARR regulation applied pre-tactically).
2. skyguide APP ATCO prepares an optimized Arrival sequence
3. skyguide FMP exchanges the slots adequately in order to be as close as possible to the optimized sequence (Slot Swap procedure)
4. skyguide FMP tcoordinates with NMOC for the slots swaps.

It was initially proposed to prepare the optimized sequence on D-1, but due to the very high uncertainty of the D-1 slot list compared to the tactical slot list, it was finally decided to perform the procedure 2 hours before off-block time on the day of operations.

2. **10/10/2013 – 25/10/2013**

During this timeframe, at the 2 peak periods per day, all regulated SWISS arrival flights at LSZH were assigned a TTA.

The long-haul participated also by transmitting their estimated time over the TTA-fix 3 hours before ETA, and managing their flight to reach it.

4.2.3 MUNICH AIRPORT Exercise

4.2.3.1 1st Trials

- **Timeframe:** 19/05/2013 – 30/06/2013
- **Number of eligible flights:** 3
- **Number of participating flights:** 3

In May/June only few arrival regulations (e.g. due to WX) have been issued for EDDM. 3 Lufthansa flights (CDG-MUC) were subject to these arrival restrictions.

4.2.3.2 2nd Trials

- **Timeframe:** 07/10/2013 – 31/10/2013
- **Number of eligible flights:** 8
- **Number of participating flights:** 4

4 flights from Lufthansa accomplishing the city pair LFPG – EDDM in the morning timeframe were eligible for FAIR STREAM as they were regulated due to arrival constraints at EDDM and were thus issued a CTOT and a TTA.

4 flights from Air France were also eligible to FAIR STREAM (subject to arrival constraints with CTOT/TTA). However, these flights did not participate in FAIR STREAM because the actual pilots were not trained for this project. Only few pilots from A320 Division were informed/trained for Munich's trial and did not have the opportunity to participate to this part of trial.

4.3 Deviations from the planned activities

The objective as stated in the initial demonstration plan approved by SESAR SJU was to evaluate "the use of TTA instead of CTOT". However, in FAIR STREAM exercises, TTA flights are among "CTOT only flights" and, for flights to Zurich and Munich, the CTOT is still enforced. FAIR STREAM exercises will not enable to draw a conclusion on the substitution of CTOT by TTA; however they will bring elements supporting a judgment on the use of TTA.

In order to be consistent with the aim of FAIR STREAM exercises, some initial demonstration objectives and associated success criterion have been adapted (cf. performance assessment plan):

- **OBJ-0202-003 evaluate the ATC workload**
  ATC procedures did not change thus ATC workload was not expected to change. Expert judgment expressed that comparing workload with historical data was not relevant. The objective is to check for any reported difficulty that would compromise this assumption.
- **OBJ-0202-004 Evaluate the flight efficiency (time and fuel)**
  Expert judgment on aircraft efficiency expressed that the on board recordings would not allow to identify the fuel gain or loss due to the use of TTA because many other factors would have stronger influence. Instead, feedback from pilots gave information on the use of CI or speed to optimise the flight.
  Moreover, in order to assess the impact of the use of TTA on flight efficiency, a generic performance study was carried out conjointly with Airbus and Boeing. The results are presented in **Error! Reference source not found.**.
- **OBJ-0202-005 Evaluate the flight crew and OCC workload**
  The success criterion was a feedback from 80% of participating flight crews and a comparison with historical data on same revenue flights. However, a comparison with historical data on same revenue flight is not needed since the workload due to TTA procedures can be assessed objectively. The objective is more to assess if the increase of workload remains at an acceptable level or not.
- **OBJ-0202-006 - Evaluate the possibility to manage TTA and CTA within ATC facilities**
  This objective has been deleted.
  Indeed, when TTA fix corresponds to the IAF, taking TTA into account in the AMAN system would mean replacing the estimated time over the IAF by the TTA, which was not possible in FAIR STREAM exercises. Moreover, ATC was not expected during FAIR STREAM trials to manage TTA or CTA and to intervene in the management of the TTA flights. Thus it was agreed to drop it.
  Note. For LFPG arrivals, some TTAs have been fixed in the AMAN and a feedback has been done on this experience, see paragraph 6.1.3.1.1.6.

4.3.1 PARIS CDG AIRPORT Exercise Deviations

Regional was not able to participate in the live trials due to the fusion into Hop!.

The expected TTA-fix was the IAF. However, the Network Manager was only able to give a TTA at the last Enroute point. Since it was very important to have the TTA-fix at the IAF, especially in order to have the point in the AMAN horizon, Eurocontrol calculated the flight time between the last Enroute point and the IAF (11 min), and the considered TTA was the NM's one increased by 11 min at the IAF.

Non-regulated flights were included in order to increase the amount of eligible flights. In this case TTA was the time over IAF in the Point Profile Flying Time of the NOP.

TTA flights were not always fixed in the AMAN, since it created disruption in the building of the sequence (see paragraph 6.1.3.1.1.6).

Pilots did not always report their speed to the ATCOs. However no safety event has been reported.

The TTOTs were not always reported to the departure tower.

As it was not possible for NMOC to provide TTAs for long-haul flights during the 2nd trials, a specific procedure was designed to assess the quality of time estimates. This was in order to give an insight on the feasibility of applying the TTA procedure for such flights in the future.

4.3.2 ZURICH AIRPORT Exercise Deviations

Only the scenario for the 2nd Trial has been adapted from the initial description.

Following the experience gained during the first run of trials, it has been decided to modify the sample of traffic. During the first trial, only four city-pairs were involved which induced a "mix" of traffic at the arrival (traffic with TTA constraints, traffic without), which were anyway handled without distinction from other traffic (first come, first served). Thus, even if TTA was reached, it did not impact the arrival sequence (due to limitation of AMAN equipment in operation). Therefore, it has been assessed in cooperation with SWISS to take the highest possible number of flights in a predefined time frame into account for the 2nd Trials.

It has been decided to perform the trials during the two biggest peak arrival periods at LSZH with all SWISS flights (including long-haul), limited to two days per week: Thursdays and Fridays of October 2013, instead of every day from September 1st – October 31st.

With this new 2nd trial set-up enough flights were eligible to reach the project target (at least 70 flights) within only one month instead of two.

During the first two days (3 and 4th of October) of the 2nd Trials, no TTA was distributed to flight crews, due to a technical issue. The TTA-forwarding system developed internally by SWISS was not ready yet to operationally distribute the TTA information.

However, the special “Slot Swap” procedure was tested during these two days.

4.3.3 MUNICH AIRPORT Exercise Deviations

Due to the prevailing clear weather conditions during the trial periods, only few arrival regulations were issued for flights inbound Munich Airport, which reduced significantly the amount of eligible flights.

5 Exercises Results

This chapter provides the summary of the results of the three FAIR STREAM exercises.

5.1 Summary of Exercises Results

The results of the Demonstration Exercises are summarized in the following tables. Each result is compared to the concerned success criteria, identified within the Demonstration Plan per Demonstration Objective. The results are assessed according to the following criteria:

- OK: the concerned result achieved the expectations (expressed by means of the success criteria associated to the Validation Objective);
- NOK: the success criteria associated to the Validation Objective should be further investigated, in the sense that the concerned results do not achieve the expectations or no clear results are obtained.

Exercise ID	Demonstration Objective Title	Demonstration Objective ID	Success Criterion	Exercise Results	Demonstration Objective Status
EXE-0202-001	Evaluate the feasibility of the use of TTA instead of/complementary to CTOT	OBJ-0202-001	Succeed in collecting relevant data to evaluate the feasibility	Data collected	OK
EXE-0202-001	Evaluate the predictability of the flights using a TTA instead of/complementary to a CTOT	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	Calculation of the mean of the absolutes values of deviation at TTA. % of flights having reached TTA at +/-3min +Graphs showing the distribution of deviations through histograms	OK
EXE-0202-001	Evaluate the ATC workload	OBJ-0202-003	Succeed in reporting and analysing of any difficulty due to the TTA use.	Assessment of workload completed.	OK
EXE-0202-001	Evaluate the flight efficiency (time and fuel)	OBJ-0202-004	Succeed in collecting data to evaluate the flight efficiency (time and fuel)	Expert judgments only from the pilots feedback on the use of CI or speed to optimise the flight	NOK (for fuel data only)
EXE-0202-001	Evaluate the flight crew workload	OBJ-0202-005	Succeed in reporting and analysing of any difficulty due to the TTA use.	Assessment of workload completed.	OK
EXE-0202-002	Evaluate the feasibility of the use of TTA instead of/complementary to CTOT	OBJ-0202-001	Succeed in collecting relevant data to evaluate the feasibility	Data collected	OK
EXE-0202-002	Evaluate the predictability of the flights using a TTA instead of/complementary to a CTOT	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	Calculation of the mean of the error between TTA and actual time over. +Graphs showing the distribution of deviations through histograms	OK

Exercise ID	Demonstration Objective Title	Demonstration Objective ID	Success Criterion	Exercise Results	Demonstration Objective Status
EXE-0202-002	Evaluate the ATC workload	OBJ-0202-003	Succeed in reporting and analysing of any difficulty due to the TTA use.	Assessment of workload completed.	OK
EXE-0202-002	Evaluate the flight efficiency (time and fuel)	OBJ-0202-004	Succeed in collecting data to evaluate the flight efficiency (time and fuel)	Data collected	OK
EXE-0202-002	Evaluate the flight crew workload	OBJ-0202-005	Succeed in reporting and analysing of any difficulty due to the TTA use.	Assessment of workload completed.	OK
EXE-0202-003	Evaluate the feasibility of the use of TTA	OBJ-0202-001	Succeed in collecting relevant data to evaluate the feasibility	Data collected	OK
EXE-0202-003	Evaluate the predictability of the flights using a TTA	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	Calculation of the mean of the error between TTA and actual time over.	OK
EXE-0202-003	Evaluate the predictability of the flights using a TTA	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	Difference between EET and actual flight duration	OK
EXE-0202-003	Evaluate the flight efficiency (time and fuel)	OBJ-0202-004	Succeed in collecting data to evaluate the flight efficiency (time and fuel)	Expert judgments only from the pilots feedback on the use of CI or speed to optimise the flight	NOK (for fuel data only)
EXE-0202-003	Evaluate the flight crew and OCC personnel workload	OBJ-0202-005	Succeed in reporting and analysing of any difficulty due to the TTA use.	Assessment of workload completed.	OK
Supplement (Study in Annex B)	Evaluate the flight efficiency (time and fuel)	OBJ-0202-004	Succeed in collecting data to evaluate the flight efficiency (time and fuel)	performance case established for all common flight configuration	OK

Table 3: Summary of Demonstration Exercises Results

5.2 Choice of metrics and indicators

In accordance with the performance assessment plan, the indicators are split into two different types:

- the quantitative metrics, based on a set of measures mainly from radar and flight plan data;
- the experts judgements, based on filled questionnaires.

5.2.1 Quantitative metrics

Those demonstration objectives have been assessed with metrics based on a set of measures mainly from radar, flight plans and on-board recordings data.

Demonstration objectives		KPA	Metrics	Type of recorded data
OBJ-0202-001	Evaluate the feasibility of the use of TTA	N/A	* % of candidate flights having tried the use of TTA * % having completed the exercise until the TTA fix	Number of flights that participated. Number of flights that used TTA until the TTA fix

Demonstration objectives		KPA	Metrics	Type of recorded data
OBJ-0202-002	Evaluate the predictability of the flights using a TTA	Predictability	Respect of the TTA: *comparison of the mean of the absolute values of deviations *% of flights within time window [-3;+3min]	Times over TTA fix: * initial, regulated from FPL data *Actual from radar data and on-board recordings *TTA from NM data and pilot's questionnaires
OBJ-0202-002	Evaluate the predictability of the flights using a TTA	Predictability	* Distribution of flights at off-bloc, take-off and over the TTA fix * Analysis of the impact of take-off time deviations on the use of TTA	Times at off-bloc, take-off and over TTA fix * initial, regulated from FPL data *Actual from radar data and on-board recordings *TTA from NM data and pilot's questionnaires
OBJ-0202-002	Evaluate the predictability of the flights using a TTA	Predictability	Difference between given EET and actual flight duration.	Comparing (TTA – CTOT) vs. (Actual time over TTA fix – ATOT)

Table 4: Quantitative metrics

5.2.2 Expert judgments

Those objectives have been evaluated through expert judgments based on filled questionnaires.

Demonstration objectives		KPA	Metrics	Type of recorded data
OBJ-0202-003	Evaluate the ATC workload	Safety	Record and analysis of difficulties that may be encountered during the trials	Debriefings & Questionnaires
OBJ-0202-004	Evaluate the flight efficiency (time and fuel)	Efficiency	Possibility of flying at optimum and intended speed	Questionnaires
OBJ-0202-005	Evaluate the flight crew and OCC workload	Safety	Workload felt by pilots and OCC	Questionnaires

Table 5: Expert judgments

5.3 Summary of Assumptions

The assumptions as defined in the Demonstration Plan are recalled below. No issue was reported.

Identifier	Title	Description	Flight Phase	KPA Impacted	Owner	Impact on Assessment
001	More predictability implies more capacity	When the traffic predictability is improved, the margins taken by ATC services to control the sectors workload will be reduced, and the real ATC sectors capacity increased	Arrival	Capacity	ANSPs	Impact on OBJ-0202-002

002	No technical evolution	The FAIR STREAM scenarios could be designed and implemented with the existing technical systems capabilities existing at the time the trials will be conducted	All	NA	All	Impact on OBJ-0202-001
003	Availability of NMC support tools to communicate TTA information	This development will be implemented for the SESAR P7.6.5 RELEASE 3 exercises	Departure	NA	ECTL	Impact on OBJ-0202-001
004	No specific procedures for ATC	For TWR and ATC En-route units, the flight trials will not require specific procedures application	All	NA	ANSPs	Impact on OBJ-0202-001 and Impact on OBJ-0202-003
005	No change in standard operating procedures for flight crews	No revision of operating manuals (like OM-A and –B) is necessary. Special crew task will be briefed separately. No release of NSA necessary.	All	NA	Airlines	Impact on OBJ-0202-001 and Impact on OBJ-0202-005

Table 6: Summary of Demonstration Exercise Assumptions

5.3.1 Results per KPA

Safety: to ensure at least the same level of safety

Exercise	Object Identifier	Success Criterion	Result of the demonstration
EXE-0202-001	OBJ-0202-003	Succeed in reporting and analysing of any difficulty due to the TTA use.	No safety event. No controller or pilot report of feeling reduced safety.
EXE-0202-001	OBJ-0202-005	Succeed in reporting and analysing of any difficulty due to the TTA use.	No significant increase of workload for crews. No significant increase of workload for OCC (only two flights a day and no update of CTOT).
EXE-0202-002	OBJ-0202-003	Succeed in reporting and analysing of any difficulty due to the TTA use.	No safety event. No controller or pilot report of feeling reduced safety. Only 1 controller reported an unusual behaviour for an aircraft (very low speed), but it did not lead to a safety event, neither a significant increase of workload and the risk had been identified during the safety case.
EXE-0202-002	OBJ-0202-005	Succeed in reporting and analysing of any difficulty due to the TTA use.	No significant increase of workload for crews. But significant increase of workload for OCC (manual update of CTOT for 1st Trials). Resolved for the 2nd Trials.

EXE-0202-003	OBJ-0202-003	Succeed in reporting and analysing of any difficulty due to the TTA use.	No safety event. No controller or pilot report of feeling reduced safety.
EXE-0202-003	OBJ-0202-005	Succeed in reporting and analysing of any difficulty due to the TTA use.	No significant increase of workload for aircrews. No significant increase of workload for OCC.

Environmental sustainability: to reduce fuel consumption, to reduce gas emissions

Exercise	Object Identifier	Success Criterion	Result of the demonstration
EXE-0202-002	OBJ-0202-004	Succeed in collecting aircraft fuel and time data	Aircraft flying time and fuel consumption data showed no significant benefit during the trials
Supplement (Study in Annex B)	OBJ-0202-004	Succeed in collecting data to evaluate the flight efficiency (time and fuel)	Identification of consumption trends : *Reduced through planning at more efficient speed *Possibly reduced by flying at reduced speed *Possibly increased by adjusting speed to match TTA Identification of the need to balance possible increase with expected operational improvements.

Flight efficiency: to increase flight efficiency (time and fuel)

Exercise	Object Identifier	Success Criterion	Result of the demonstration
EXE-0202-001	OBJ-0202-004	Succeed in collecting data to evaluate the flight efficiency (time and fuel)	Pilots' feedback demonstrated the crew ability to * choose a CI and TTOT to optimize flight * to adjust speed to reach a TTA.
EXE-0202-002	OBJ-0202-004	Succeed in collecting aircraft fuel and time data	Aircraft flying time and fuel consumption data showed no significant benefit during the trials
EXE-0202-003	OBJ-0202-004	Succeed in collecting data to evaluate the flight efficiency (time and fuel)	Pilots' feedback demonstrated the crew ability to adjust speed to reach a TTA.

Airspace Capacity: to better use the existing capacity

NA

Flexibility: to increase flexibility (management of the planning constraints)

Exercise	Object Identifier	Success Criterion	Result of the demonstration
EXE-0202-001			Possibility for the airline to optimize the leaving at the gate and so reduce departure delays.

Predictability: to improve ATC and airline predictability

Exercise	Object Identifier	Success Criterion	Result of the demonstration
EXE-0202-001	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	51% of participating flights within time window [-3;+3min] against 26% of baseline flights. Identification of the reason of failure done.
EXE-0202-002	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	1st Trials: 57% of participating flights within time window [-3;+3min] against 45% of baseline flights.
			2nd Trials: 50% of participating flights within time window [-3;+3min] against 36% of baseline flights.
EXE-0202-003	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	1 flight out of 7 participating flights within time window [-3;+3min].
	OBJ-0202-002	Succeed in collecting and analysing data to evaluate the predictability of flights	Issued EETs were in most cases equal or only slightly longer (+ 2') than the actual flying times.

Table 7: Results per KPA

Cost effectiveness: no major changes expected

Participation: to increase participation

5.3.2 Impact on Safety, Capacity and Human Factors

A FABEC safety case was conducted and concluded to the low impact of the project on safety. The safety case identified 2 hazards: the misunderstanding between the actors concerning the status of a flight (experimentation in progress or not) and the use of an unusual speed of an aircraft due to its participation to the experimentation.

Concerning the first hazard, an appropriate phraseology shared by pilots and ATCOs to stop the experimentation was defined.

Concerning the second one, the ATCOs were aware of the FAIR STREAM flights and pilots reported their speed.

Airlines also conducted an ORE.

During the live trials, no safety event occurred.

5.3.3 Description of assessment methodology

Exercise ID	Indicator (/KPI)	Tools	Method	Measure Value
EXE-0202-001 FAIR STREAM LFPG arrivals	% of flights participating	ACARS messages ATCOs from departure towers feedback	Identify flights that tried TTA and those that could use TTA until the IAF	Number of flights having tried the use of TTA

<table>
<tr><th>Exercise ID</th><th>Indicator (/KPI)</th><th>Tools</th><th>Method</th><th>Measure Value</th></tr>
<tr><td>EXE-0202-001
FAIR STREAM LFPG arrivals</td><td>Flights arriving on time (as planned)</td><td>NMOC FPL data
RDPS data</td><td>Capture the actual time over IAF and compare it with TTA</td><td>Mean of the absolutes values of deviation at TTA
% of flights having reached TTA at +/-3min</td></tr>
<tr><td rowspan="2">EXE-0202-001
FAIR STREAM LFPG arrivals</td><td rowspan="2">Flights departing and arriving on time (as planned)</td><td>NMOC FPL data
RDPS data
Airline systems for OBT</td><td rowspan="2">Capture the initial, regulated and actual OBT, TOT and TO IAF, and compare them</td><td>Distribution of flights at off-bloc, take-off and over the TTA fix</td></tr>
<tr><td>NMOC FPL data
RDPS data
Airline systems for OBT</td><td>Analysis of the impact of take-off time deviations on the use of TTA</td></tr>
<tr><td>EXE-0202-001
FAIR STREAM LFPG arrivals</td><td>ATC workload</td><td>Filled questionnaires from ATCOs and FMPs form:
Departure towers, en route centres and arrival tower.</td><td>Analyse any reported difficulty</td><td>Identification of issues</td></tr>
<tr><td>EXE-0202-001
FAIR STREAM LFPG arrivals</td><td>Flight efficiency</td><td>Pilots questionnaires</td><td>Feedback from pilots on the use of CI and TTOT</td><td>Feedback from pilots on the use of CI and TTOT</td></tr>
</table>

Exercise ID	Indicator (/KPI)	Tools	Method	Measure Value
EXE-0202-001 FAIR STREAM LFPG arrivals	Crew and airline's OCC workload	Filled questionnaires	Check that workload remains at acceptable level	
EXE-0202-002 FAIR STREAM LSZH arrivals	% of flights participating	ACARS messages Pilots feedback	Identify flights that tried TTA until the TTA-Fix	Number of flights having tried the use of TTA
EXE-0202-002 FAIR STREAM LSZH arrivals	Flights arriving on time (as planned)	NMOC FPL data Aircraft data	Capture the actual time over TTA-Fix and compare it with TTA	Mean of the absolutes values of deviation at TTA % of flights having reached TTA at +/-3min
EXE-0202-002 FAIR STREAM LSZH arrivals	Flights departing and arriving on time (as planned)	NMOC FPL data Aircraft data	Capture the initial, regulated and actual TOT and TO TTA-Fix, and compare them	Distribution of flights at take-off and over the TTA fix Analysis of the impact of take-off time deviations on the use of TTA
EXE-0202-002 FAIR STREAM LSZH arrivals	ATC workload	Debriefing from APP ATCOs and FMPs.	Analyse any reported difficulty	Identification of issues
EXE-0202-002 FAIR STREAM LSZH arrivals	Flight efficiency	Aircraft data Pilots questionnaires	Retrieval of flight data (flying time and fuel consumption) Feedback from pilots on the use of CI	Measures of flying time and fuel consumption Feedback from pilots on the use of CI
EXE-0202-002 FAIR STREAM LSZH arrivals	Crew and airline's OCC workload	Pilots questionnaires and debriefing	Check that workload remains at acceptable level	Identification of issues
EXE-0202-003 FAIR STREAM EDDM arrivals	Respect of the TTA (as function of CTOT adherence for EDMM arrivals).	NMOC FPL data RDPS data	Capture the actual time over IAF and compare it with TTA	Mean of the absolutes values of deviation at TTA No. of flights having reached TTA at +/-3min
EXE-0202-003 FAIR STREAM EDDM arrivals	Evaluate the flight crew and OCC workload	Queries at OCC and flight crews	Feedback from OOC personnel and pilots	Feedback from OOC personnel and pilots

Exercise ID	Indicator (/KPI)	Tools	Method	Measure Value
EXE-0202-003 FAIR STREAM EDDM arrivals	Predictability	NMOC FPL data RDPS data	Capture the actual times and compare it with planned times.	TTAs, CTOTs, Actual time over TTA fix, ATOTs
Supplement (Study in Annex B)	Flight efficiency	Airbus/Boeing performance tools and BADA4	Generic performance study Simulation of identified representative flights	Assessment of the impact of the use of TTA on speed and fuel burn.

Table 8: Description of assessment methodology

5.3.4 Results impacting regulation and standardisation initiatives

As mentioned in §5.5.3, it is recommended that any progressive introduction of TTA in real time operations should be accompanied with incentives to enforce its application.

5.4 Analysis of Exercises Results

Exercise ID	Objective ID	Scenario ID	Scenario Title	KPI ID	Measure Value
EXE-0202-001	OBJ-0202-001 Evaluate the feasibility of the use of TTA	001	CDG arrivals	001	63% of eligible flights participated and 54% of participating flights tried to meet the TTA until the TTA fix. Identification of the reason of failure done.
EXE-0202-001	OBJ-0202-002 Evaluate the predictability of the flights using a TTA	001	CDG arrivals	002	51% of participating flights in the time window [-3;+3min], against 26% of baseline flights.
EXE-0202-001	OBJ-0202-003 Evaluate the ATC workload	001	CDG arrivals	N/A	No increase of controllers' workload (departure, en-route, arrival).
EXE-0202-001	OBJ-0202-004 Evaluate the flight efficiency (time and fuel)	001	CDG arrivals	N/A	Pilots' feedback demonstrated the crew ability to optimize TTOT and adjust speed to reach a TTA.
EXE-0202-001	OBJ-0202-005 Evaluate the flight crew and OCC workload	001	CDG arrivals	N/A	No significant increase of workload for flight crews. If TTAs are handled manually and CTOT/TTAs are updated, there could be an increase of the workload for Airline OPS.
EXE-0202-002	OBJ-0202-001 Evaluate the feasibility of the use of TTA	002	Zurich arrivals	001	1st Trials: 49% of eligible flights participated 2nd Trials: 100% of eligible flights participated
EXE-0202-002	OBJ-0202-002 Evaluate the predictability of the flights using a TTA	002	Zurich arrivals	002	1st Trials: 57% of participating flights in the time window [-3;+3min], against 45% of baseline flights 2nd Trials: 50% of participating flights in the time window [-3;+3min], against 36% of baseline flights.

Exercise ID	Objective ID	Scenario ID	Scenario Title	KPI ID	Measure Value
EXE-0202-002 1st and 2nd Trials	OBJ-0202-003 Evaluate the ATC workload	002	Zurich arrivals	N/A	No increase of controllers' workload (departure, en-route, arrival).
EXE-0202-002 1st and 2nd Trials	OBJ-0202-004 Evaluate the flight efficiency (time and fuel)	002	Zurich arrivals	N/A	No improvement of flight efficiency at the approach (flying time and fuel burn).
EXE-0202-002 1st and 2nd Trials	OBJ-0202-005 Evaluate the flight crew and OCC workload	002	Zurich arrivals	N/A	No significant increase of workload for flight crews, neither for OCC thanks to an automatic process specifically developed for the 2nd Trials
EXE-0202-003	OBJ-0202-002 Evaluate the predictability of the flights using a TTA	003	Munich arrivals	002	1 flight out of 7 participating flights within time window [-3;+3min]
EXE-0202-003	OBJ-0202-002 Evaluate the predictability of the flights using a TTA	003	Munich arrivals	N/A	Issued EETs were in most cases equal or only slightly longer (+ 2') than the actual flying times.
EXE-0202-003	OBJ-0202-005 Evaluate the flight crew and OCC workload	003	Munich arrivals	N/A	No significant increase of workload for flight crews and OCC personnel

Table 9: Performance Indicators

5.4.1 Unexpected Behaviours/Results

NA

5.5 Confidence in Results of Demonstration Exercises

5.5.1 Quality of Demonstration Exercises Results

Pilots made particular effort as being part of experiment to reach a TTA. Nonetheless, out of the context of the experimentation the motivation to reach a TTA may not be as strong as during FAIR STREAM trials, thus FAIR STREAM results may not necessarily reflect expected behavior in future operations. See proposed recommendation in paragraph **Error! Reference source not found.** on enforcement / incentive for pilots to reach a TTA.

5.5.2 Significance of Demonstration Exercises Results

The results are significant from a statistical point of view considering the large number of flights of the studied sample: 825 FAIR STREAM flights all exercises included.

For LFPG and LSZH Scenario, the results are also significant from an operational point of view given the fact that the trials took place in normal operations and that no specific procedures for ATC and no change in standard operating procedures for flight crews were necessary.

For the EDDM scenario, the recorded results can only be considered as trend indications due to the very limited number of eligible and participating flights.

5.5.3 Conclusions and recommendations

No issue concerning procedures for TTA distribution and application was raised during the exercises. TTAs were sent to all pilots and a large number of them, 825 flights, participated in the trial and could use TTA until the TTA fix.

<u>This leads to the conclusion that TTA could be applicable at the largest scale in today's technical environment.</u>

A good improvement of the adherence to TTA was observed for the most part of participating flights: all scenarios together, 36% of baseline flights meet the estimated time over the TTA-Fix at plus or minus 3 minutes, whereas it increases to 54% for flights with a TTA. Less variability is also observed.

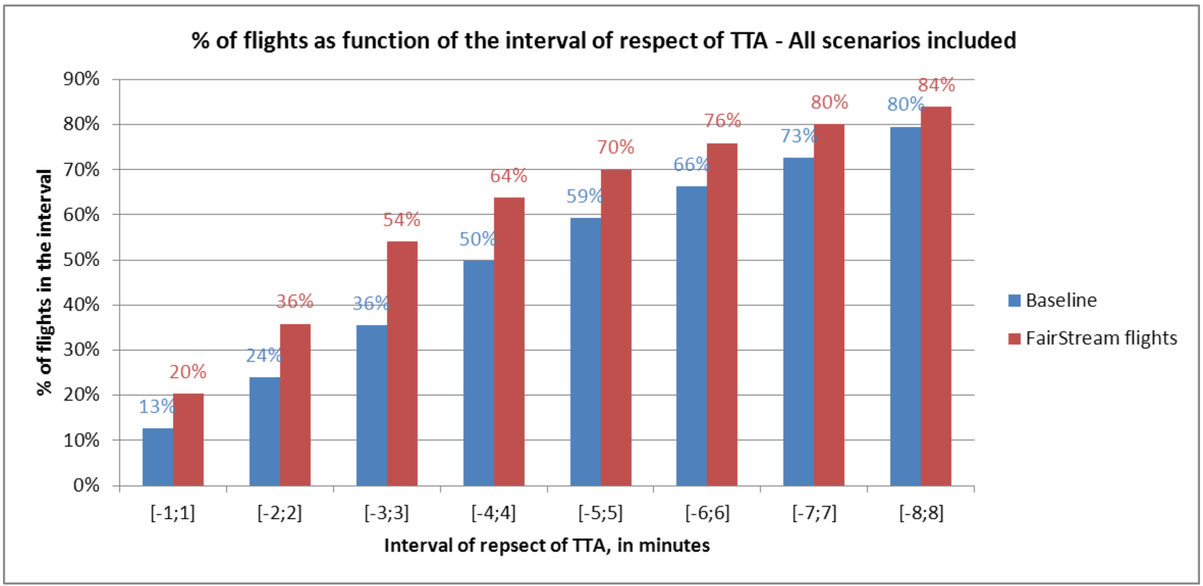


Figure 11: All scenarios - percentage of flights in each interval of adherence to TTA for baseline and FAIR STREAM

The analysis of the impact of take-off time deviation on the adherence to TTA showed that making the effort to comply with a TTA is easier for flights that have a tendency to take-off early than for flights that have a tendency to be late, in the current definition of TTA. Indeed, flights having a tendency to take-off early can manage to take-off closer to CTOT or TTOT to respect their assigned TTA, whereas flights having a tendency to be late can catch up with the delay only to a certain extent. **There is a strong correlation between Take-Off Time and Time-Over the TTA-fix**. It was observed that the usual CTOT window width [-5;+10min] is considered in itself too large for short haul flights to reach a TTA precisely enough.

<u>Thus, a recommendation is to work further on the reduction of take off time variability : reliable off bloc time and taxi time.</u>

Moreover, in LFPG exercises, the pilot could choose a Target Take-Off Time optimizing the flight profile reducing the fuel burn and the departure delay. **Getting the ideal Take-Off Time seems to be the most efficient and cheapest way to comply with TTA**.

The use of TTA could offer more flexibility to Airlines. Depending on the situation, aircrew can adjust their flight in a way that they met their TTA (for whatever reason they took off earlier, avoiding departure punctuality degradation, and can fly more "fuel efficiently" or later).

Updating the Estimated Elapsed Times in the ETFMS (V.17) before Take-off improved the accuracy of CTOT and TTAs.

The analysis of the impact on flight durations of a short cut followed by 90% of flights in LFPG exercise showed that unplanned **direct routes could affect TTA adherence**. On the other hand, this could not be a reason to stop providing shortcuts. Moreover, as these shortcuts are almost systematic, there might be ways to manage that at strategic or planning stages.

It is recommended to further analyze the impact of short cuts on the use of TTA and work on a possible solution to manage usual tactical direct routes when using TTA (however, prohibit tactical direct routes is not an option neither)

The fixing of the TTA in the AMAN in LFPG exercise was not adequate in the current working context because today the two tools rest upon two different logics. Nonetheless it appears important to **make sure that AMAN operations will remain consistent with the TTA ones.** Flights slowing down to match a TTA should not be sped up afterwards, and vice-versa. Flights arriving on target should not be penalized because of those missing their targets.

In the meantime, it appears obvious that the more flights will comply with their TTAs, the more these times will become relevant for AMAN planning and operations. Furthermore, as future AMAN concept tends to increase its time horizon, up to 1 hour before arrival, the borderline between Flow Management and Arrival Management will quickly narrow, and eventually overlap.

Therefore, it is recommended to investigate further the compatibility between TTA and AMAN concepts, and define the operational link in terms of systems, data, and procedures.

No significant workload increase due to the use of TTA was reported for ATCOs and flight crews. When few flights were using TTA, airline's OCC had no workload increase, however when the number of flights per day was increased for LSZH 2nd Trials and given the fact that they had to handle every update of CTOT manually, Swiss dispatch had to develop an internal tool to redistribute the TTA information automatically through ACARS.

Besides, it is feared that if TTAs are defined only as proposed extra constraints, the flights that do not make an effort might gain an unfair advantage, basically overtaking the participating ones.

In order to guarantee the smoothing of traffic expected by all stakeholders, it is necessary to ensure that all flights keep trying to comply with TTA. The experience gained through FAIR STREAM exercise suggests that **significant amount of flights that would disregard TTAs could jeopardize the expected benefits of the concept**. Flights arriving earlier than planned might overtake the compliant flights in the arrival sequence and consequently both gain an unfair advantage and cause unnecessary arrival delay. Flights failing to report an excessive delay might disrupt the overall planning, and in a worst-case scenario spoil airport arrival capacity.

New constraints should be globally less penalizing than the previous ones. It is recommended that any progressive introduction of TTA in real time operations should be accompanied with incentives to enforce its application.

As no benefits were experienced for Zurich 2nd large scale experiment, it is also recommended to further define expected operational benefits, level of performance required, evaluate benefits.

6 Demonstration Exercises reports

6.1 Demonstration EXE-0202-001 Report

6.1.1 Exercise Scope

This session provides the detailed outcomes of the FAIR STREAM exercise EXE-0202-001 concerning Paris-LFPG arrivals.

The Demonstration Plan can be found on the extranet SESAR at the following link.

6.1.2 Conduct of Demonstration Exercise EXE-0202-001

6.1.2.1 Exercise Preparation

The usual configuration was used for this exercise.

See section 4.1 and following.

6.1.2.2 Exercise execution

See section 4.1 and following.

6.1.2.3 Deviation from the planned activities

See section 4.1 and following.

6.1.3 Exercise Results

6.1.3.1 Summary of Exercise Results for Short Haul trials

See Table 3: Summary of Demonstration Exercises Results

6.1.3.1.1 Results per KPA

See section **Error! Reference source not found.**.

6.1.3.1.1.1 Performance indicators

Performance indicators collected during the LFPG arrivals trials to assess the use of TTA are reported in the table below.

Exercise ID	Demonstration Objective ID and title	Performance Indicators (KPI)	Method	Measure Value
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-001 Evaluate the feasibility of the use of TTA instead of CTOT	N/A	Identify flights that tried TTA and those that could use TTA until the IAF	Number of flights having tried the use of TTA Number of flights that could use TTA until IAF
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-001 Evaluate the predictability of the use of TTA instead of CTOT	Flights arriving on time (as planned)	Capture the actual time over IAF and compare it with TTA	Mean of the absolutes values of deviation at TTA % of flights within the time window [-3;+3min]

Exercise ID	Demonstration Objective ID and title	Performance Indicators (KPI)	Method	Measure Value
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-002 Evaluate the predictability of the flights using a TTA instead of a CTOT	Flights departing and arriving on time (as planned)	Capture the initial, regulated and actual OBT, TOT and TO IAF, and compare them	Distribution of flights at off-bloc, take-off and over the TTA fix
				Analysis of the impact of take-off time deviations on the use of TTA
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-003 Evaluate the ATC workload	N/A	Analyse any reported difficulty	Identification of issues
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-004 Evaluate the flight efficiency (time and fuel)	N/A	Analyse feedbacks from pilots	Feedback from pilots on the use of CI,TTOT and speed
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-005 Evaluate the flight crew workload	N/A	Check that workload remains at acceptable level through questionnaires	Identification of issues.

Table 10: Short Haul LFPG scenario - Performance indicators

6.1.3.1.1.2 Number of flights having tried the use of TTA

This chapter aims at highlighting the feasibility of the use of TTA by providing the number and percentage of flights that tried the use of TTA during the trials periods.

For the LFPG Short Haul trials, flights have been divided into the following groups:

- **Baseline flights***:* all the AF621GY (Bordeaux-LFPG) and AF793JZ (Toulouse-LFPG) during these periods:
  - 18th of February 2013 - 13th of May 2013 (before the first set of trial)
  - And 14th of July - 17th of September 2013 (between the two sets of trials).
- **Eligible flights** are:
  - **for the first trials,** all the AF621GY and AF793JZ that were selected by AF OCC for a potential participation,
  - **for the second trials,** all the AF621GY and AF793JZ except during strikes.
- **Flights having tried the exercise:** all eligible AF621GY and AF793JZ that tried the exercise, including flights that had delays at off-bloc or take-off

	Bordeaux-LFPG: AF621GY			Toulouse-LFPG: AF793JZ		
Number of Flights	ALL	Regulated	Having a slot >10' (*)	ALL	Regulated	Having a slot >10' (*)
Baseline	149	53	6	149	52	13
Eligible	101	25	9	101	26	5

Tried the exercise	66	15	5	62	14	1

Table 11: Short Haul LFPG scenario - Number of flights having tried FAIR STREAM exercise per city-pairs

In conclusion, 63% of eligible flights, i.e. 128 flights, participated in FAIR STREAM LFPG arrivals trials.

(*) This column is added to have an idea of the number of flights having substantial ATFM delays.

6.1.3.1.1.3 Adherence to TTA results

This section is intended to highlight the feasibility of the use of TTA by providing results on the adherence to TTA for Short Haul flights.

6.1.3.1.1.3.1 Main results

For each flight has been calculated the absolute value of the difference between the TTA and the actual time over the TTA fix, i.e. the IAF. In order to assess the adherence to TTA, the mean of those absolute values has been calculated for each group of flights.

Note1. For baseline flights, which had not a TTA, the TTA is replaced by the NMOC estimated time over the IAF which is:

- *the initial estimated time if the flight is not regulated or*
- *the regulated time if the flight is regulated.*

Note2. For a better understanding of the trials, Bordeaux-LFPG and Toulouse-LFPG flights need to be analysed independently, in particular because what goes on at departure is different for both airports.

The results are showed in the following table and graphs.

Mean of the error in minutes for:	Bordeaux-LFPG	Toulouse-LFPG
Baseline	5,9	6,5
Eligible	7,8	4,5
Did not participate in FAIR STREAM	7,2	6,2
Tried FAIR STREAM	8,1	3,3

Table 12: Short Haul LFPG scenario - Mean of the error at TTA for each group of flights

The figure below gives the percentage of flights in each interval of adherence to TTA for baseline and flights that tried TTA.

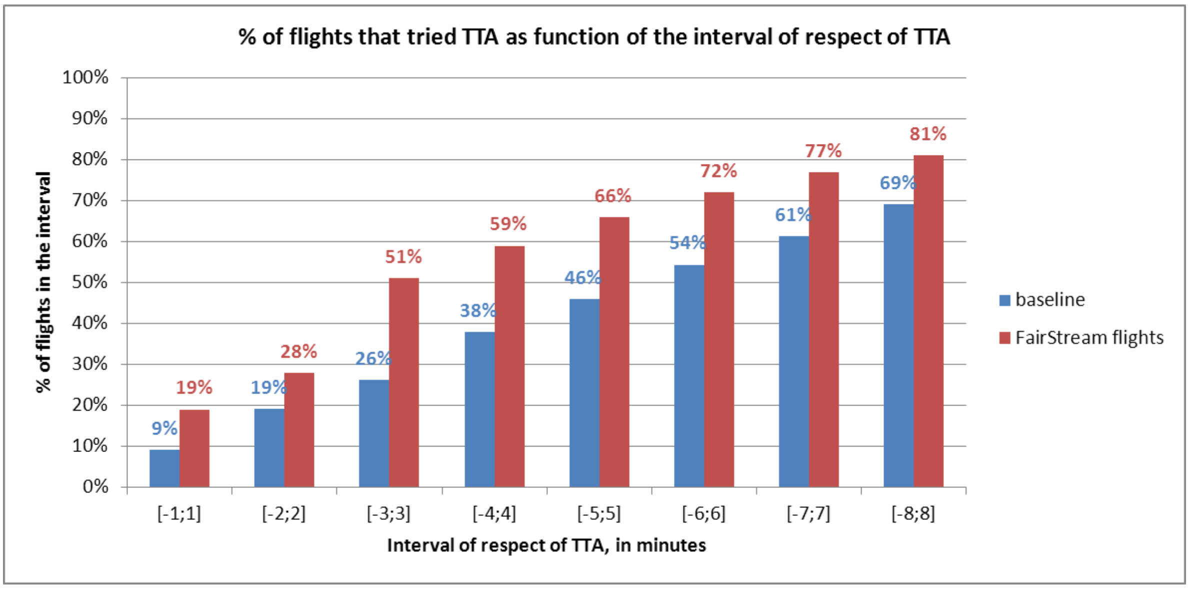


Figure 12: Short Haul LFPG scenario - percentage flights in each interval of adherence to TTA for baseline and flights that tried TTA

<u>It shows that 51% of flights that tried FAIR STREAM reached the TTA at plus or minus 3 minutes, compared to 26% in the baseline.</u>

Same figures have been drawn for Bordeaux and Toulouse:

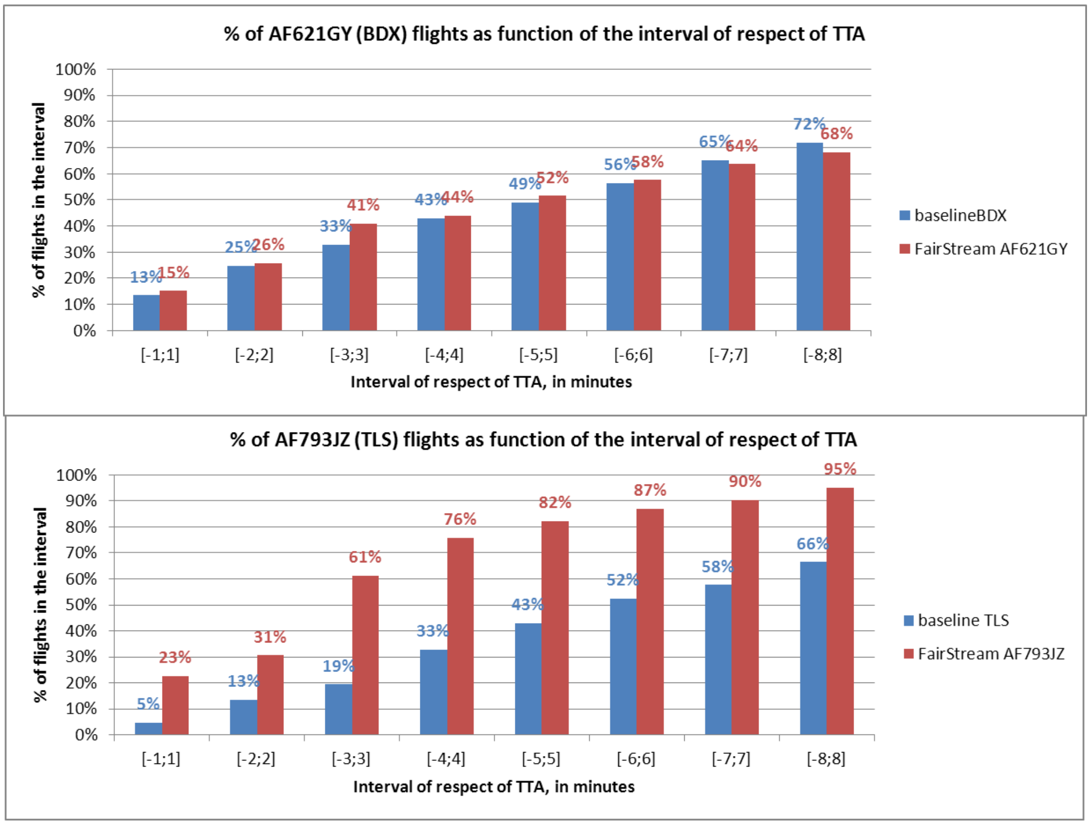


Figure 13: Short Haul LFPG scenario - percentage of AF621GY (BDX) and AF793JZ (TLS) that tried TTA in each interval of respect of TTA

Table 12 and Figure 13 show that Bordeaux and Toulouse flights behaved differently. For Bordeaux the improvement is not as good as for Toulouse: it was observed that Bordeaux flights tend to have significant delays at off-bloc. This bias is further analysed in the following chapter.

6.1.3.1.1.3.2 Results getting rid of the issue of flights with significant ground delays

As shown in Table 12 and Figure 13, there is not a clear improvement of the adherence to TTA for Bordeaux flights.

Actually, 27% of Bordeaux flights had delays at off-bloc and/or take-off (mean of 15 min delays). These flights could not anymore use the TTA initially proposed by the OCC.

Besides, 90% of these flights had no ATFM delays, so are not representative of the expected TTA users. It could be supposed that their ground delay would be superseded by their ATFM delay and their TTA compliance results much better.

Analysing the results without these flights is interesting in order to see how flights can comply with a TTA if they manage to take-off close enough to the target take-off time.

For this purpose, the following analysis does not take into account flights having too much delay at off-bloc and take-off: a 7 minutes delay criteria at take-off has been judged relevant.

The following table show the results for the remaining flights, i.e. the flights that could "reasonably" use the OCC's TTA until the IAF.

Flight that could use TTA until the IAF:	Bordeaux-LFPG	Toulouse-LFPG
Number of flights:		
All	37	57
Regulated	10	14
Regulated with a slot of at least 10min	3	1
Mean of the error in minutes :		
All	2,9	2,6
Regulated	2,1	2,0
Regulated with a slot of at least 10min	2,3	6,3

Table 13: Short Haul LFPG scenario – Number of flights that could use the OCC's TTA until the IAF and mean of their error

The following figure compares results for all groups of flights.

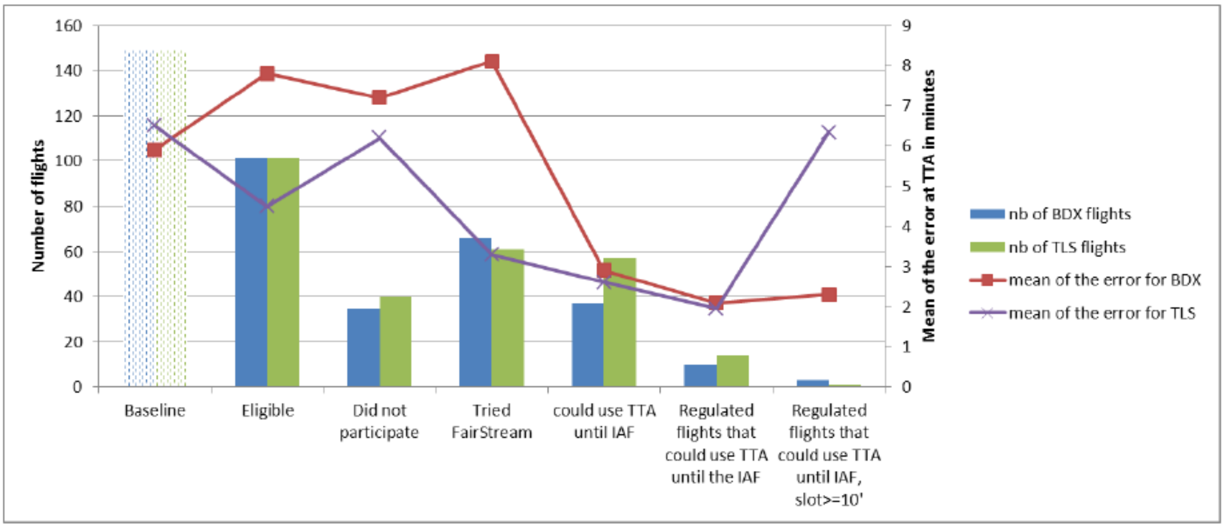


Figure 14: Short Haul LFPG scenario - number of flights and mean of the error for each group of flights

It can be noted that the 27% delayed Bordeaux flights have a strong influence on the results: by removing them, the mean of the error decreases from 8,1 min to 2,9 min.

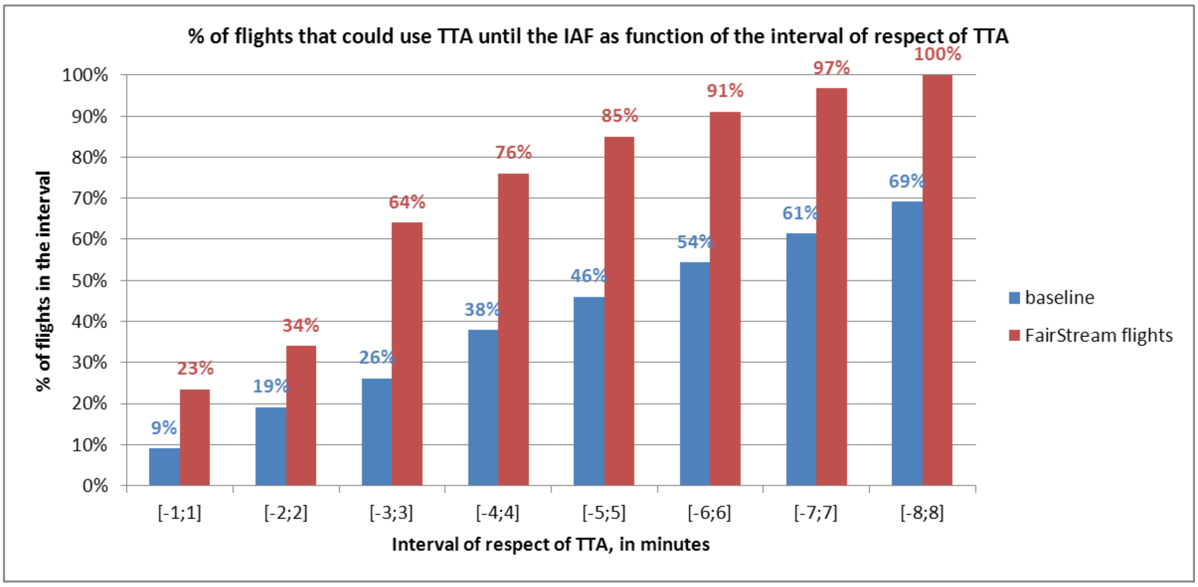


Figure 15: Short Haul LFPG scenario percentage of flights in each interval of adherence to TTA for baseline and FAIR STREAM flights that could use TTA until IAF

Figure 15 shows that 64% of flights that could use the NMOC TTA after take-off could comply with the TTA at plus or minus 3 minutes, instead of 51% in Figure 12. This result is probably optimistic, but it indicates what could happen if flights could take-off close enough to their target take-off time or if delay of delayed flights would be taken into account in a new TTA.

6.1.3.1.1.4 Analysis of the different phases of flight

6.1.3.1.1.4.1 Analysis of the impact of off-bloc and take-off delay on the adherence to TTA

The purpose of this section is to analyse conjointly the adherence to off-bloc time, take-off time and TTA in order to identify what happened in each phase of flight. The independent analysis of Bordeaux and Toulouse is necessary because what happened is different for each city-pair.

For each baseline flight and flight that participated in FAIR STREAM have been calculated:

- the difference between estimated off-bloc time – or calculated off-block time where applicable – and the actual one
- the difference between the estimated take-off time – or calculated take-off time where applicable – and the actual one, and
- the difference between TTA and the actual time over the IAF.

The results of this analysis are presented under the form of histograms below, showing the distribution of flights according to their adherence to TTA.

Note: in order to better catch the influence of TTA on the behaviour of flights, flights with significant take-off delays were not taken into account in this analysis.

<u>Bordeaux-LFPG flights</u>

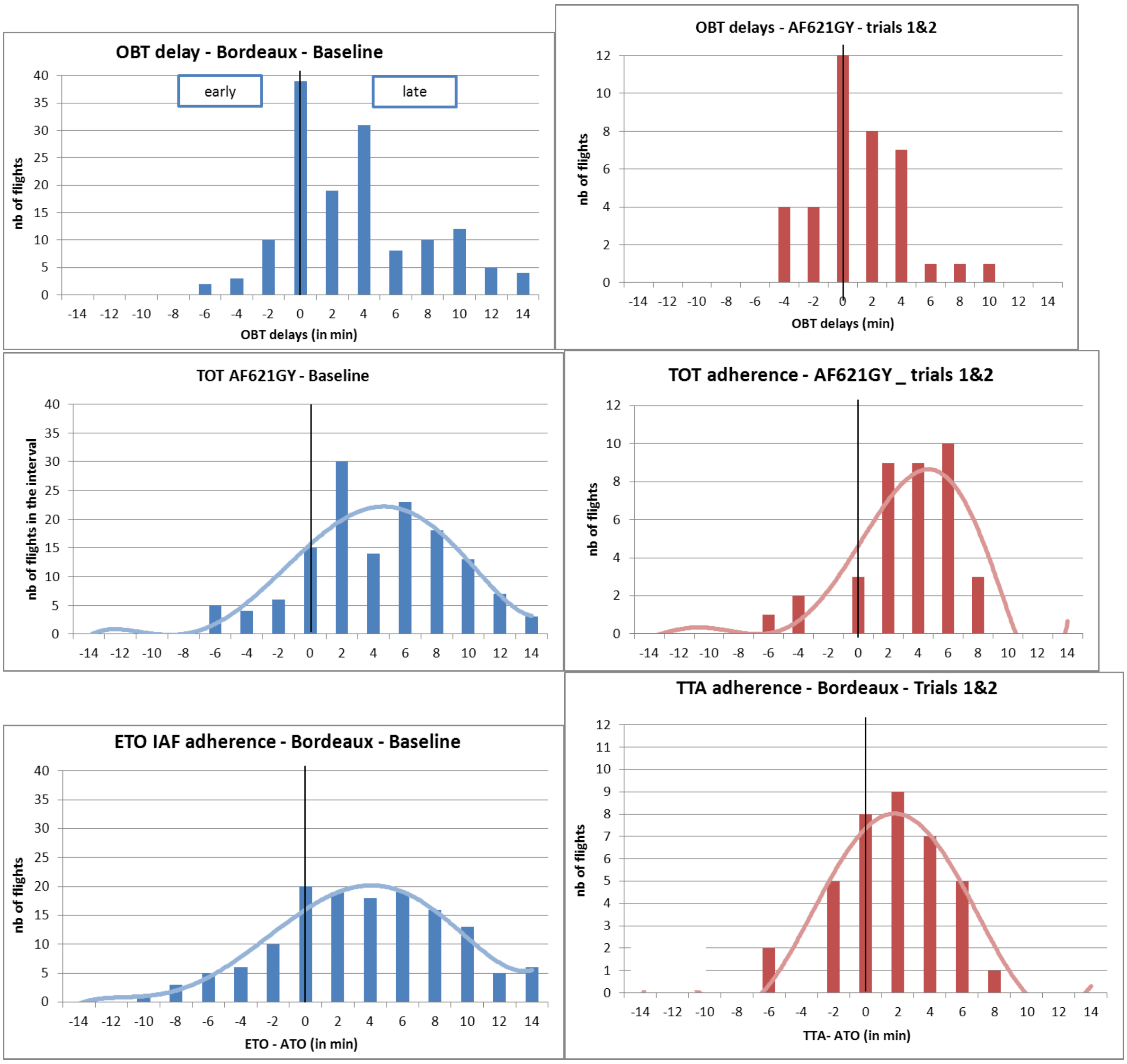


Figure 16: Short Haul LFPG scenario - Distribution of Bordeaux-LFPG flights at off-bloc, take-off and over the TTA fix

Bordeaux-LFPG flights tend to have landside delays at off-bloc causing delays at take-off. Flights do not seem able to catch up with delays greater than 5 minutes, causing delays at the IAF both during the baseline and the trials.

Yet we can note that for flights not having too big delays at off-bloc, the adherence to TTA was better during the trial than for the baseline: the peak is thinner, so less dispersion/variability of operation and closer to TTA during the trials.

<u>Toulouse-LFPG flights</u>

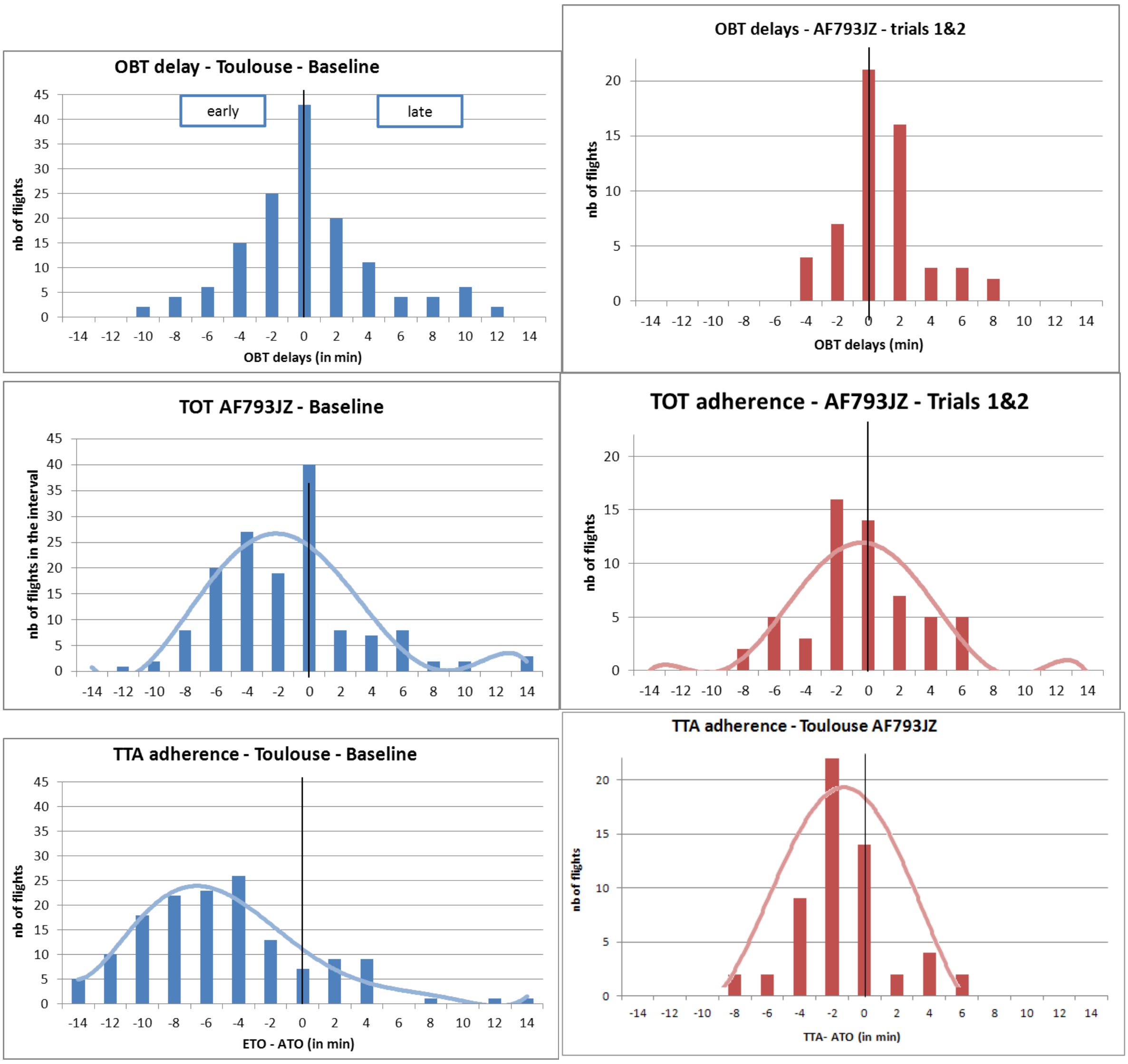


Figure 17: Short Haul LFPG scenario - Distribution of Toulouse-LFPG flights at off-bloc, take-off and over the TTA fix

During the baseline Toulouse flights tend to take-off earlier, which is no more the case for flights that participated in FAIR STREAM.

Moreover, the adherence to TTA is clearly better during the trials.

<u>As a conclusion, being able to take-off at the correct time has a strong positive influence on TTA compliance. Moreover, this confirms that the actual CTOT is a good take-off target.</u>

6.1.3.1.1.4.2 Analysis of the impact of take-off time deviations on the use of TTA

This analysis aims at highlighting the impact of take-off time deviations, early or late, on the use of TTA, through the comparison of the baseline and the flights that could participate in FAIR STREAM until the IAF.

The two graphs below gives the adherence to TTA as function of the deviation at take-off, both for baseline (in blue) and for FAIR STREAM flights that could use TTA until the IAF (in red) for each city-pair. Linear regressions for baseline and for trials have been drawn and their equations added to the graph.

Bordeaux-LFPG

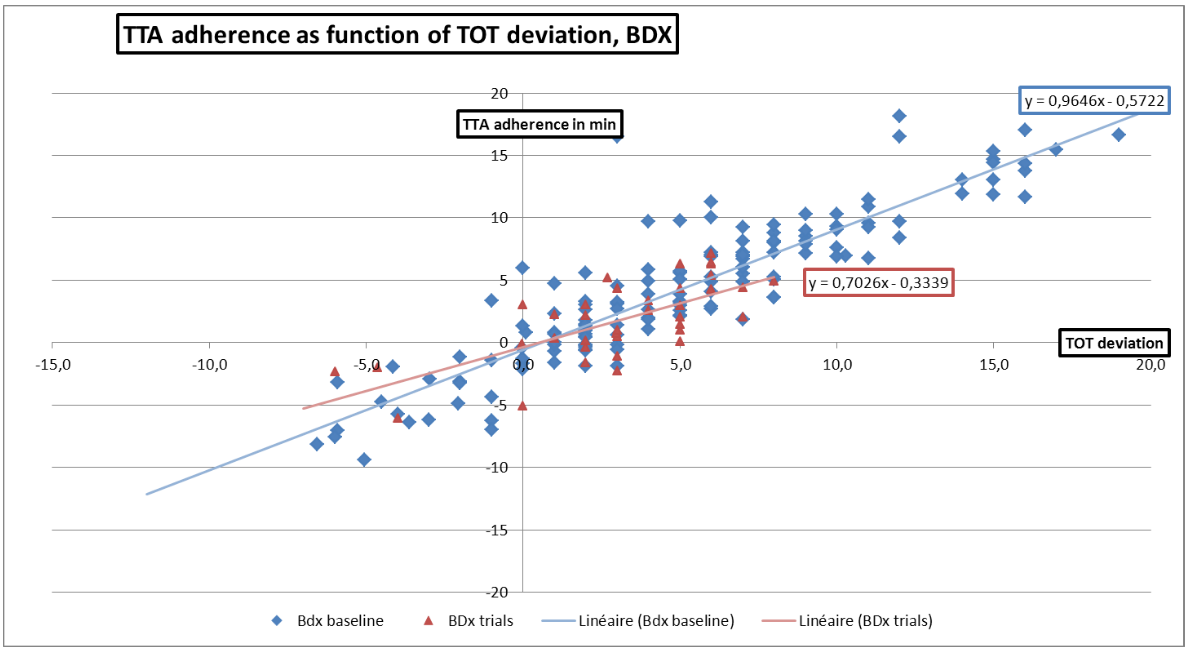


Figure 18: Short Haul LFPG scenario - TTA adherence as function of take-off time deviations for Bordeaux-LFPG flights

Note: the number of flights on the right side of the graphs confirms that Bordeaux-LFPG flights tend to be late at take-off.

Toulouse-LFPG

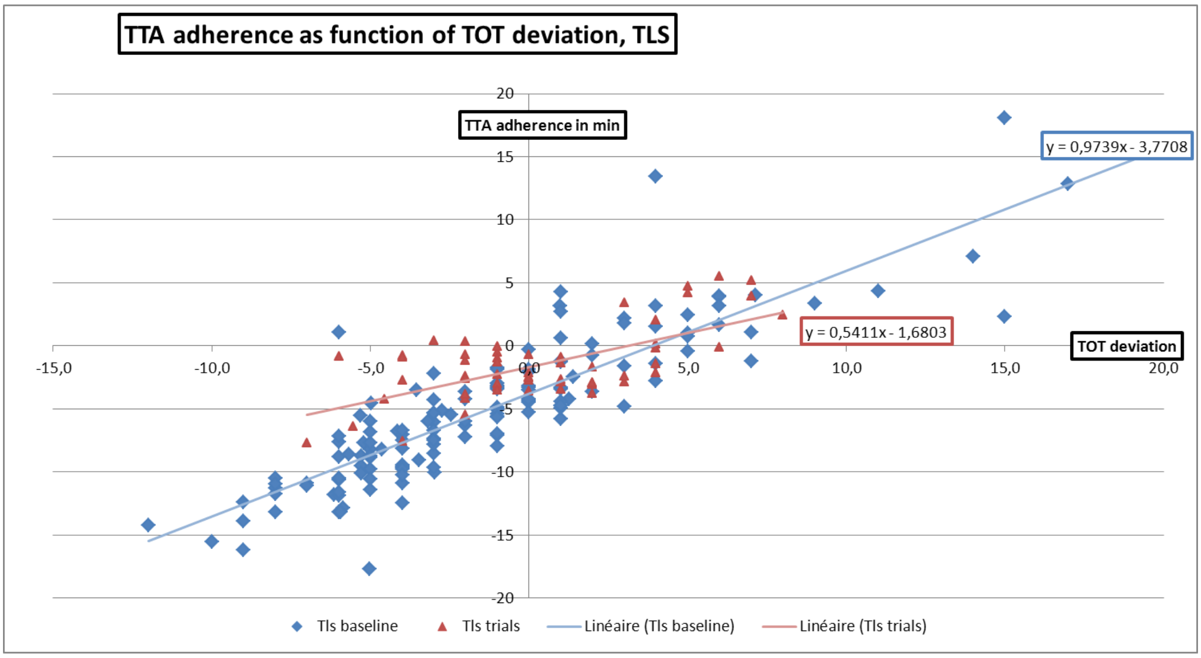


Figure 19: Short Haul LFPG scenario - TTA adherence as function of take-off time deviations for Toulouse-LFPG flights

Note: the number of flights on the left side of the graph confirms that Toulouse-LFPG flights tend to be early at take-off.

The equations are under the form of $y = ax + b$. The value "a", i.e. the slope of the line, provides information on the behaviour of flights that took-off earlier or later. The value "b" provides information on the flights that took-off on time.

- Interpreting the slope ("a" value)

For both city-pairs, the slope of the baseline line is almost 1.0, which means that the deviation over the IAF will be the same as the deviation at take-off.

The slope of the trials line is reduced to 0,5 for Bordeaux and 0,7 for Toulouse, which means that **flights early at take-off tried to slow down to reach their TTA**, and **late flights tried to catch up with the delay.**

Nonetheless, the slope is not zero, meaning that these flights cannot recover the whole take-off deviation.

The values of slopes are summarized in the following table.

Value of slopes for:	Bordeaux-LFPG	Toulouse-LFPG
Baseline's line	1,0	1,0
Trials' line	0,7	0,5

Table 14: Short Haul LFPG scenario - Value of slopes of the lines giving the adherence to TTA as function of TOT deviation

- Interpreting the y-intercept ("b" value)

The b value represents the average difference between estimated flight duration (EET) and actual flight duration. In the baseline flights tend to go faster than estimated, particularly for Toulouse, whereas during the trials they were closer to planned duration, as they flew slower, both because of lower CI planning and trying to reach TTA during flight. This is shown in the table below:

Mean adherence to TTA when the flight takes-off on time for:	Bordeaux-LFPG	Toulouse-LFPG
Baseline	-0,6 min	-3,8 min
Trials	-0,3 min	-0,5 min

Table 15: Short Haul LFPG scenario - mean adherence to EET

In conclusion, the take-off time deviations could be reduced during the flights that used TTA, but the deviation cannot be entirely caught up with.

6.1.3.1.1.5 Feedback on the dispatch of information from NMOC to the OCC, and between the OCC and the flight crew

Dispatchers of the Airline's OCC used the NOP portal to bring back Target Time over IAF.

For flights with CTOT, dispatchers had to add 11 minutes to the TTA given by Eurocontrol in order to have the useful TTA over the useful point (IAF). Although there were no mistake made by this manual process, dispatchers encourage Eurocontrol to provide the TTA where needed.

For flights without CTOT, dispatchers used Point Profile Flying Time of the considered flight. This additional manual used process should be solved by an automatic process.

Then dispatchers send by ACARS the TTA to the flight crew. A preformatted message was created in order to simplify this task.

All those tasks were done during other operational tasks, and some days, dispatchers forget or send too late the TTA to flight crews.

In the future, an automatic TTA, over the relevant point should be sent to Airlines' OCC and in the cockpit as it is done today for CTOT.

6.1.3.1.1.6 Feedback on the use of TTA conjointly with the use of an AMAN system

For LFPG arrivals trials, the TTA fix corresponded to the IAF. In order not to penalize FAIR STREAM flights after the IAF, the scenario envisaged to fix the TTA in the AMAN system.

But the trials showed that this procedure was not a good way to use TTA and AMAN tools together in the current working process because it created extra difficulties in the management of the sequence for ATCOs.

In fact, the TTA in its current definition is a network planning tool based on initial estimated times by the NMOC, which can divert from the actual times. TTA tool is used to prevent congestion by allocating a slot to flights before they take-off, slot that can be superior to 20 minutes.

Whereas AMAN is a sequencing tool based on updated estimated time much closer to actual times than the initial ones, and these estimates need to be precise. AMAN is used by ATCOs to smooth the traffic in the arrival sequence.

As a consequence, if the flight cannot comply with the planned TTA, the fixing of the TTA in the AMAN disturbs too much the sequence and many difficulties due to this issue were reported. That is why we envisaged to updated the planned TTA after Take-Off. But it was not assess during this trial.

On the other hand, if a flight is reaching the IAF at its TTA, but is in an arrival flow that needs to be delayed, it is not operationally possible for ATCOs to extract this flight from the flow and give it a priority.

Moreover, in the trials, few flights had a TTA at the same moment; but if in the end all flights get a TTA, then fixing all TTAs in the AMAN would not make sense and would create unacceptable ATCOs workload increase in the current working process.

<u>For future use, it is recommended to study further the possible link between TTA and AMAN both in terms of data flow and procedure. It remains to be determined whether it is operationally feasible to ensure that flights which comply with a TTA are not penalized in the arrival sequence.</u>

6.1.3.1.1.7 Evaluation of the workload

6.1.3.1.1.7.1 ATC

Expert judgment expressed that comparing workload with historical data was not relevant in particular because ATC procedures did not change. Thus, ATC workload was not expected to change. ATC feedback during FAIR STREAM trials was done to check for any reported difficulty that would compromise this assumption.

The controllers' feedback from departure towers, Bordeaux ACC and Paris ACC showed that they had no difficulty with FAIR STREAM flights.

Only one difficulty has been reported by the arrival tower controllers regarding the fixing of the TTA in the AMAN. However this issue is about the use of TTA conjointly with the AMAN and is not directly related to the concept use of TTA, see paragraph 6.1.3.1.1.6 for further analysis.

Moreover, no safety event has been reported, in particular no flight with unusual behaviour (like low speed) has been observed.

The general feeling is that ATC procedures and work manners did not change and there have been no difficulty due to flights using TTA.

6.1.3.1.1.7.2 Crews

No safety issue were reported.25% of the total flights considered provides crews' feedback. General feedbacks are positive.

The workload for the flight crews was generally not significantly increased. Crews mostly indicate "no change" or "few modification in the working process but it is acceptable".

Some Pilots asked how to deal with the TTA provided if flight is delayed due to landside operational process or in case of improvement of the arrival situation (CTOT cancelled).

Some Pilots proposed also to receive, in flight, a new TTA in line with ATC arrival sequence.

6.1.3.1.1.7.3 OCC

General feedbacks are positives. Workload was acceptable because Dispatchers had only 2 FAIR STREAM flights to manage. However, an automatic process would be appreciated to avoid manual work in the field of operations.

6.1.3.1.1.8 Evaluation of the flight efficiency

Influence of TTA on the flight Cost Index

In this exercise, pilots were allowed to choose their TTOT in order to optimize their flight economically.

Indeed, as the time over IAF is fixed, the Cost Index of the flight is reduced to fuel, making it decrease. This translates into the pilot being able, for the same arrival time, to plan a lower Cost Index so an earlier take-off, and consequently reduced fuel-burn and reduction of departure delay if any.

As a consequence, if the pilot manages to take-off at the optimized TTOT, the fuel is expected to decrease by few dozen kilograms, as shown by Airbus/Boeing study.

AFR asked the crews to use the RTA function before departure in order to calculated an TTOT and then, in flight back to airline's fuel policy.

We usually used CI17, Air France suggested using CI08 for TTOT calculation. Then it gives the opportunity, during the flight to adjust the speed between CI0 and CI17, which means +/- 2 min for the flight duration.

Almost half of crews used CI08 for TTOT calculation. One used CI0.

In term of fuel efficiency, a flight using a CI0 use around 50kg less fuel than a flight using CI17. However the best way to use minimum fuel remains Direct Routing.

6.1.3.1.1.9 Other: analysis of a short cut

During the LFPG arrivals trials, 90% of flights have been given a direct route by ATC. The present section further analyses the impact of this direct route on the flight duration and distance.

Almost 90% of the flights coming from Bordeaux and Toulouse get a short cut between PEPAX and BANOX, as shown on the map below, instead of flying through LUMAN as planned.

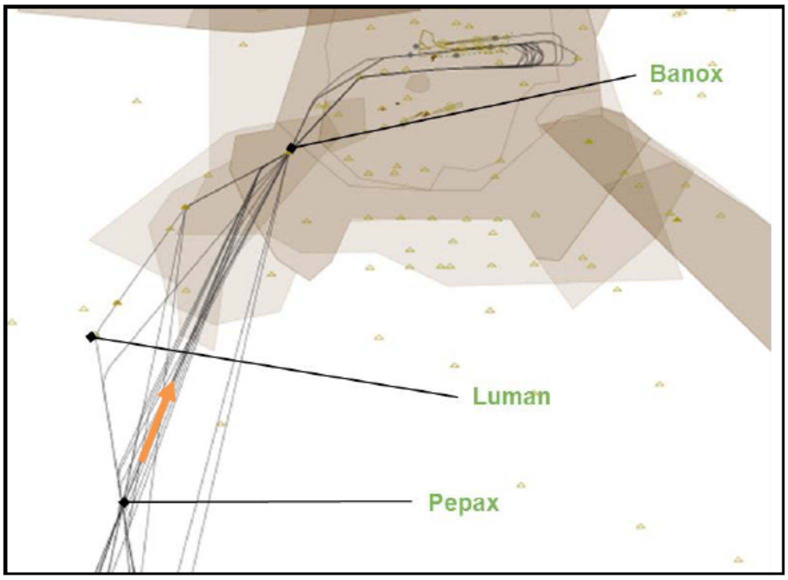


Figure 20: Short Haul LFPG scenario - Example of AF621GY and AF793JZ trajectories between PEPAX and BANOX

The flight plan distance PEPAX – BANOX is 110 NM. The flight duration is around 20 min.

The gained distance through to the short cut is 15 NM. It has been observed that the mean gained time is around 2 minutes.

In order to bring elements to the question of the impact of a direct route on the use of TTA, the results and associated graphs have been recalculated by adding 2 minutes to the flight duration until the IAF, for both baseline and FAIR STREAM flights.

Moreover, in order to get rid of take-off delays, the analysis is done for Toulouse flights only.

The figures and graphs obtained are presented below.

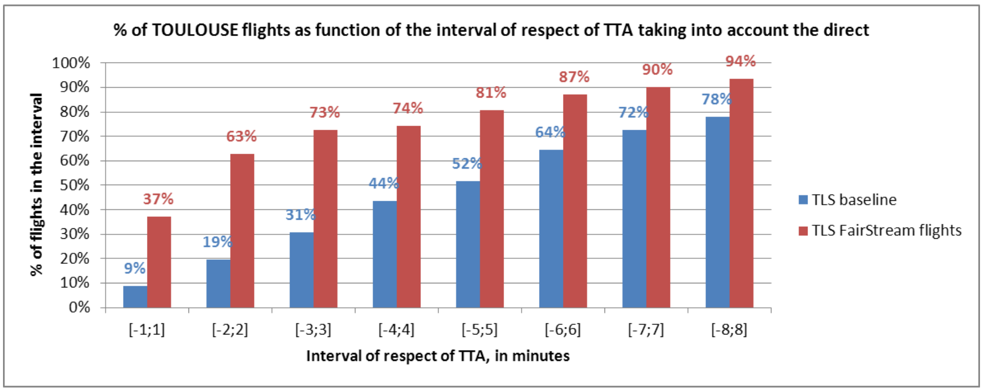


Figure 21: Short Haul LFPG scenario - percentage of AF793JZ (TLS) in each interval of respect of TTA, adding 2 minutes to AF793JZ flight durations

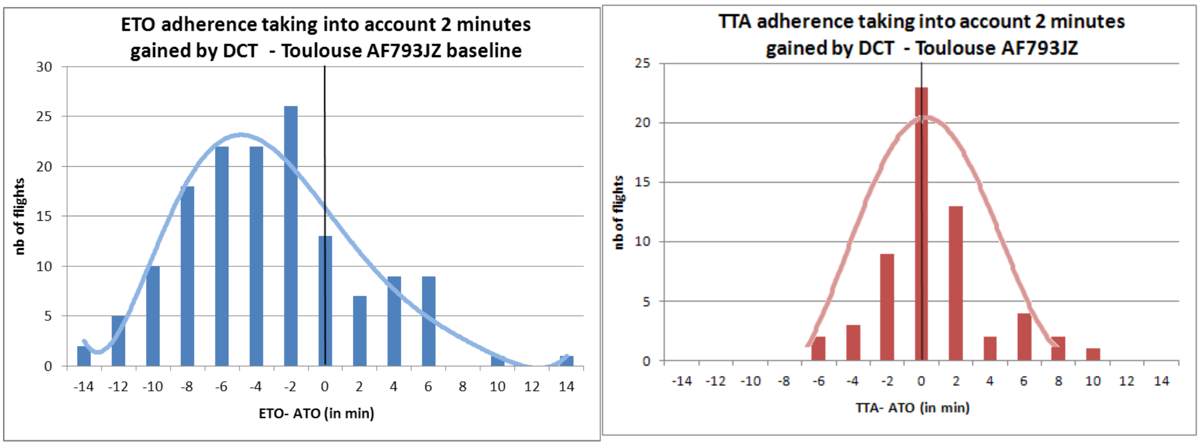


Figure 22: Short Haul LFPG scenario - Adherence to ETO/TTA adding 2 minutes to AF793JZ flight durations for baseline and FAIR STREAM flights

Drawing conclusions from these results needs caution because many other factors may have an impact and the way the pilot planned his flight is not known. Nonetheless, a better adherence to TTA can be observed when removing the effect of a 2 minutes short cut.

Theoretically, a flight right on track at PEPAX which is given the direct, will save 10% of flying duration between PEPAX and BANOX, and will need to slow down by the same ratio in order to still reach BANOX at the TTA. For a flight flying speed 270 kts – a standard value in early arrival – that would mean 235 kts.

According to the pilots' feedback the gained time due to a short cut induce low speed in order to respect the TTA. In some cases, the new speed was not accepted by ATC management, and in some cases it was not flyable according to the pilot.

In the other hand, crews appreciate short cut especially when flight had to avoid CBs and reduce speed due to turbulences, short cut allows to respect TTA.

<u>This unplanned short cut raised sometimes difficulties while trying to comply with the TTA.</u>

6.1.3.1.2 Results impacting regulation and standardisation initiatives

As mentioned in §5.5.3, it is recommended that any progressive introduction of TTA in real time operations should be accompanied with incentives to enforce its application.

6.1.3.1.3 Unexpected Behaviours/Results

NA

6.1.3.1.4 Quality of Demonstration Results

This session provides information on the samples studied so as to assess the quality of the demonstration results of EXE-0202-001.

6.1.3.1.4.1 Analysis of flights that refused to participate in FAIR STREAM trials

During the trial periods, flights could choose to use TTA or not. In order to keep confidence in the results, it is important to show that the studied sample is representative, and in particular to show that when pilots refused, the cause was not the impossibility of the respect of a TTA.

The first element is that 63% of the eligible flights chose to participate in the exercise, which is the biggest part of the eligible flights.

The second element is the comparison of:

- the mean of the error (i.e. absolute value) between the TTA and the actual time over TTA fix for flights that did not participate in FAIR STREAM;
- and the mean of the error of the baseline flights.

This comparison should tell if the baseline flights and the flights that did not participate in FAIR STREAM are similar.

Mean of the error in minutes for:	Bordeaux-LFPG	Toulouse-LFPG
Baseline	5,9	6,5
Did not participate in FAIR STREAM	7,2	6,2
Tried FAIR STREAM	8,1	3,3

Table 16: Short Haul LFPG scenario - Mean of the absolute values of adherence to TTA for baseline flights, flights that did not choose to participate in FAIR STREAM and flights that participated in FAIR STREAM

- For Bordeaux-LFPG flights, the mean is higher during the trials for both FAIR STREAM flights and flights that did not participate. Besides, the mean for FAIR STREAM flights is higher than the one of flights that refused to use TTA.
- For Toulouse-LFPG flights, the mean is similar for flights that did not participate in FAIR STREAM during the trial periods and baseline flights, meaning that the two samples of flights are similar.

The third element is the time of the choice of the pilot: the ACARS messages giving the choice of the pilot to the airline OCC were sent between 25 and 20 minutes before off-block, time at which the pilot normally does not know yet if it is possible to reach the TTA or not.

These elements lead to believe that participating flights had to face the same conditions as non-participating ones. Refusals were not related to the trial.

6.1.3.1.4.2 23% of FAIR STREAM flights were regulated

In the current concept, TTAs are given to regulated flights only.

But there have been only 105 flights regulated flights – 53 Bordeaux-LFPG and 52 Toulouse-LFPG –, among which only 19 had a delay equal or superior to 10 minutes. The sample is too small to conduct a confident statistical analysis.

As explained in paragraph 4.1.2.1, non-regulated flights were also given a TTA. Nonetheless, this could have induced a bias in the exercise, especially for Bordeaux where they was a lot of delay at departure.

Indeed, some non-regulated flights chose to "update" their TTA, particularly when they were late at departure, but this is not the logic of the use of TTA which is a NMOC constraint. However, if those flights had been allocated a significant ATFM slot, it would probably have covered the ground delay, and they would have had take-off times consistent with their TTAs. Finally, regulated flights with landside delay at departure greater than 15 minutes shall inform NMOC which will update the TTA accordingly.

Thus the analysis of the results above takes this into account, and in particular identifies different groups of flights, including the ones that tried the exercise and the ones that could complete the exercise until the IAF.

6.1.3.1.5 Significance of Demonstration Results

The results are significant from a statistical point of view considering the large number of flights for the studied sample: 128 FAIR STREAM flights and 298 baseline flights.

The results are also significant from an operational point of view given the fact that the trials took place in normal operations, with the existing technical systems capabilities, and that no specific procedures for ATC and no change in standard operating procedures for flight crews were necessary.

6.1.3.2 Summary of Exercise Results for Long Haul Trials

See Table 3: Summary of Demonstration Exercises Results**Error! Reference source not found.**

6.1.3.2.1 Results per KPA

See section 5.3.1

6.1.3.2.1.1 Performance indicators

Performance indicators collected during the LFPG arrivals trials to assess the use of TTA are reported in the table below.

Exercise ID	Demonstration Objective ID and title	Performance Indicators	Method	Measure Value
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-001 Evaluate the feasibility of the use of TTA instead of CTOT	N/A	Identify flights that tried TTA and those that could use TTA until the IAF	Number of flights having tried the use of TTA
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-001 Evaluate the predictability of the use of TTA instead of CTOT	N/A	Capture the actual time over IAF and compare it with TTA	Mean of the error at TTA
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-003 Evaluate the ATC workload	N/A	Analyse any reported difficulty	Identification of issues
EXE-0202-001 FAIR STREAM LFPG arrivals	OBJ-0202-005 Evaluate the flight crew workload	N/A	Check that workload remains at acceptable level through questionnaires	Workload remains at acceptable level

Table 17: Long Haul LFPG scenario - Performance indicators

6.1.3.2.1.2 Number of flights having send an ETO

For the long haul trial, the eligible flights are all AFR351, AFR639, DAL28, DAL184, DAL243, DAL228, DAL270, DAL98 and DAL171, DAL615, DAL631, DAL89 that flew in the Delta trial period, i.e. from September 30th to November 13th.

At least 4 flights a day were expected to send their Estimated Time Over the IAF MOPAR to their operational control centre. During the trial, 221 flights sent a “TTA” to the airline operational control centre.

6.1.3.2.1.3 Adherence to pilot’s ETO (“TTA”)

The adherence to the ETO sent by the pilot for the Long Haul flights is presented in the graph below giving the percentage of flights in each interval of respect of ETO. For instance, 33% of flights had an ETO deviation within the time window [-3;+3min].

Note. The ETO (TTA) was the estimated time over MOPAR in the FMS at the time of the message sent by the pilot. MOPAR is the IAF for flights arriving from North West flow to CDG.

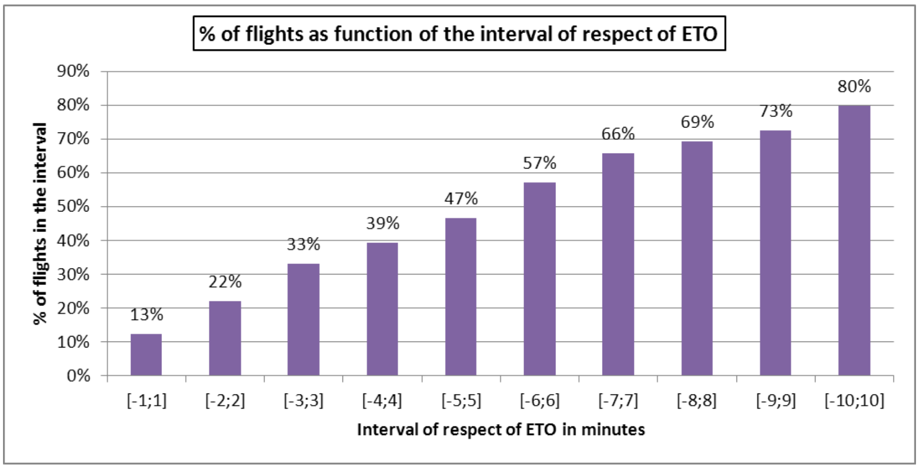


Figure 23: Long Haul LFPG scenario - percentage of flights in each interval of respect of ETO

6.1.3.2.1.4 Feedback on the dispatch of information from flight crew, the OCC, and ACTOs

For Dispatchers from Air France’s OCC, no specific work was required. Indeed, we put in place, with IT, automatic rerouting of the message from cockpit to ATCOs via ACARS.

For dispatchers from Delta’s OCC, they receive the information from cockpit and send a new message to ATCOs.

For both Airlines’ flight crews the message sent via ACARS is an easy way.

In the future, it could be relevant that all ATC facilities be equipped to receive directly ACARS message from cockpit (avoiding automatic rerouting via e-mail box).

6.1.3.2.1.5 Analysis of pilots and NMOC’s estimations

This section analyses the accuracy of the NMOC estimations for the FAIR STREAM Long Haul flights and compares it with the adherence to pilot’s ETO (“TTA”).

The data could not be captured for all FAIR STREAM flights, thus this analysis is based on a set of 82 flights, mainly AFR351, AFR639, DAL28 and DAL98. For them have been captured:

- the estimated time over MOPAR in the initial FPL
- the estimated time over MOPAR updated in the ETFMS after different events:
    - “ACH” event
    - “FSA” event
    - “CPR” event
- The TTA sent by the pilot, i.e. the estimated time over IAF MOPAR in the FMS at the time of the message that the pilot tried to meet.

→ These estimations have been compared to the actual time over IAF MOPAR.

Note. Meaning of ETFMS Flight Data messages:

- *The "ACH" message is output by the IFPS whenever information is received concerning a modification to a flight, so as to update the estimations of the ETFMS. This message is often the last estimation provided before the sending of the pilot's TTA, that's why it will be used to assess the estimation of the pilot.*
- *The "FSA" message supplies the NMOC with estimated times at first co-ordination with new Flight Data Processing Area.*
- *The "CPR" message is sent by ATC to inform the NMOC about the 4D position of the flight and update the ETFMS estimations accordingly.*

The scatter plot below shows the difference between the estimation and the actual time over MOPAR as function of the time of estimation.

Note. The "time of estimation" is the duration between the sending of the message and the actual time over MOPAR.

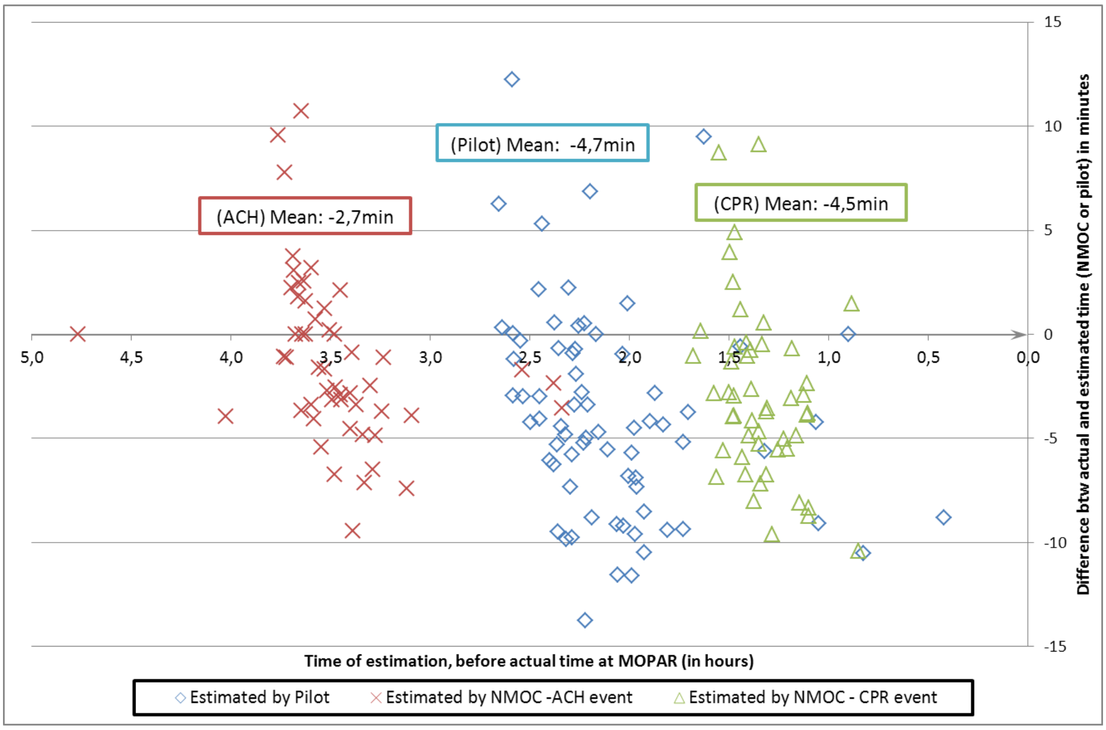


Figure 24 : Long Haul LFPG scenario - Difference between the estimation and the actual time over MOPAR as function of the time of estimation, expressed in time before the actual time at MOPAR

The box plot below compares the difference between pilot's ETO and ATO with the difference between

- the initial estimation and ATO
- the "ACH"' estimation and ATO.

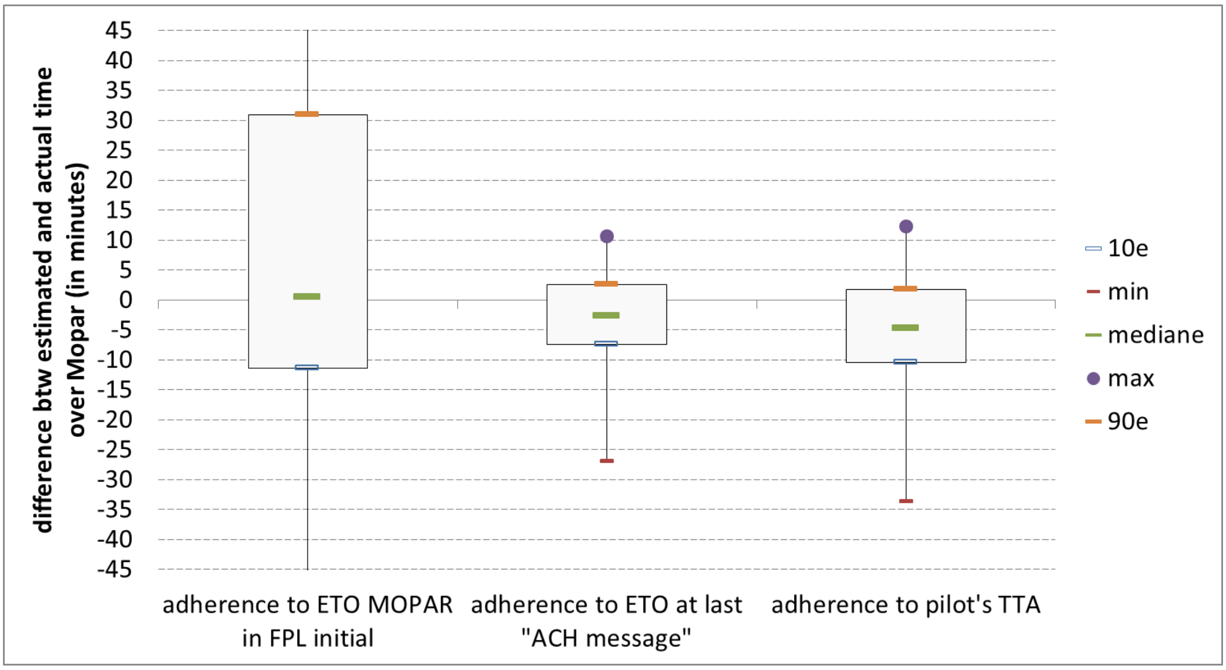


Figure 25: Long Haul LFPG scenario - box plot of the adherence to the estimation depending on the source

As a conclusion, the “ACH message” estimation of the ETFMS seems to be more accurate than the pilot’s ETO at the same moment, with even better anticipation.

6.1.3.2.1.6 Feedback on the use of TTA conjointly with the use of an AMAN system

See paragraph 6.1.3.1.1.6.

6.1.3.2.1.7 Evaluation of the workload

6.1.3.2.1.7.1 ATC

See paragraph 6.1.3.1.1.7.1.

6.1.3.2.1.7.2 Crews

No safety issue raised.

AFR received 45% of Pilots’ feedback. All feedback received indicate “no change”.

80% of crew do not change their aircraft speed. Few of them used a lower speed and only one accelerate his flight. Almost all had DCT in the IFPS zone.

Only one flight indicated a weather reroute caused a greater disparity with its ETA at MOPAR.

Overall there was a positive impression regarding FAIRTREAM.

6.1.3.2.1.7.3 OCC

No specific feedback (see paragraph 6.1.3.2.4) from Air France side.

Few feedback surveys received from Delta’s side but those that did all stated that workload was minimal and manageable.

6.1.3.2.2 Results impacting regulation and standardisation initiatives

As mentioned in §5.5.3, the good results obtained under the experimental status can not be guaranteed in every day's operations, mostly because adjusting flights to match a TTA could be costly for Airspace Users, both in terms of time and fuel if they have to speed up.

These extra costs can only be accepted if the operational benefits obtained are higher. Thus it is feared that if TTAs are defined only as proposed extra constraints, the flights that do not make an effort might gain an unfair advantage, basically overtaking the participating ones.

Nonetheless, in order to guarantee the smoothing of traffic expected by all stakeholders, it is necessary to ensure that all flights keep trying to comply with TTA.

As a consequence, it is recommended that any progressive introduction of TTA in real time operations should be accompanied with incentives to enforce its application.

6.1.3.2.3 Unexpected Behaviours/Results

Information exchanges between the actors have to be improved for long-haul flights eg. by using actual technology ACARS or CPDLC.

6.1.3.2.4 Quality of Demonstration Results

For the Long Haul flights, it was technically impossible for the NMOC to provide a TTA. Thus, the “TTA” was replaced by the estimation of the pilot between 2 and 3 hours before landing. However, the scenario did not mention that pilot had to adjust the flight to meet the TTA. The purpose was instead to provide information to ATCOs in case they had a choice to make.

6.1.3.2.5 Significance of Demonstration Results

The results are significant from a statistical point of view considering the large number of flights for the studied sample: there were 221 FAIR STREAM Long Haul flights and the statistical study has been conducted on a set of 82 flights.

The results are also significant from an operational point of view given the fact that the trials took place in normal operations, with the existing technical systems capabilities, and that no specific procedures for ATC and no change in standard operating procedures for flight crews were necessary.

6.1.4 Conclusions and recommendations (LFPG)

6.1.4.1 Conclusions

The data collected during the LFPG arrivals exercise and their analysis allows drawing the following conclusions.

The **feasibility** of the use of TTA is the main goal of the FAIR STREAM exercise.

EXE-0202-001 trials have been conducted with the existing technical system capabilities in operations: no new technical system has been used during the trials. Moreover, no specific procedures for ATC and no change in standard operating procedures for flight crews were necessary.

A significant number of flights, 128 Short Haul flights and 221 Long Haul flights, participated in the trial and could use TTA until the TTA fix.

A good improvement of the adherence to TTA was observed for the most part of participating flights: 26% of baseline flights meet the estimated time over the IAF at plus or minus 3 minutes, whereas it increases to 51% of flights that used TTA, as shown in the following graph providing the percentage of short haul flights in each interval of respect of TTA less variability is also observed.

In today’s technical environment, the use of TTA is feasible and adherence to TTA Fix is clearly better and there is less variability during FAIRSTREAM trials.

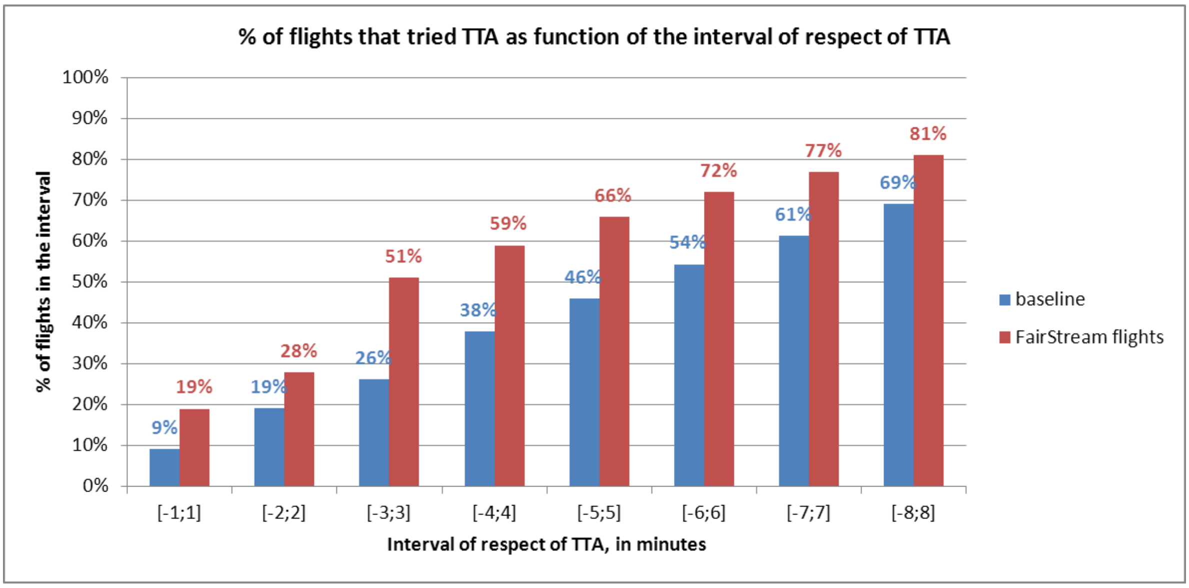


Figure 26: Main LFPG results - percentage of Short Haul flights in each interval of adherence to TTA

The Toulouse-LFPG results highlighted that flights that would be able to take-off before their CTOT or ETOT can reach a TTA by adapting their take-off until an optimal time and then adjusting the speed in flight.

The Bordeaux-LFPG results highlighted that flights that are late on the ground-side can catch up with the delay only up to a certain extent. It is consequently important for NMOC to be informed of these situations as early as possible, in order to manage the necessary rearrangements of the arrival regulations, and possibly update TTAs or to have a tactical TTA updated when flight takes off.

The analysis of the impact on flight durations of the usual unplanned short cut and proposed at the end of the flight showed that tactical direct routes could affect the TTA adherence.

The impact of the use of TTA on **flight efficiency** could not be quantitatively assessed from the trials because the fuel and speed data could not be captured. Nevertheless, most pilots that used the TTA reported that they adapted their CI to gain fuel by lowering the speed and choosing an appropriate Target Take-off Time. The use of TTA could offer more flexibility to Airlines. Depending on the situation, aircrews can leave the gate earlier, avoiding departure punctuality degradation, and can fly more “fuel efficiently”.

No significant **workload** increase due to the use of TTA was reported for ATCOs and flight crews.

The only reported difficulty was about the fixing of TTA in the AMAN system. This was not feasible in the current working context because today the two tools rest upon two different logics.

Safety was not impacted since no safety event has been reported.

6.1.4.2 Recommendations

The aim of this section is to present the technical/operational recommendations and the lessons learnt during the LFPG-arrivals trials.

Although there is less variability during the trials, the adherence of TTA is subject to the 2 main following points:

- **Take-off:** take-off time plays an essential role in the adherence to TTA. It was observed that departure time is subject to many factors that influence its predictability and thus TTA’s variability;

Thus:

- work further on the reduction of take-off time variability: ensure reliable off bloc time and taxi time predictions;
- work further on reliable take-off time and the possibility to update TTA;

  in particular with the idea of sharing a Target Take-Off Time and maybe a Target Off-Block Time, and the objective to manage delays at off-bloc and/or take-off.

  Getting the ideal Take-Off Time seems to be the most efficient and cheapest way to comply with TTA.

  - **Unplanned Direct routes:** the analysis of the impact on flight durations of the direct route followed by 90% of flights shows that tactical directs could affect the TTA adherence. On the other hand, this could not be a reason to stop providing shortcuts. Moreover, as these shortcuts are almost systematic, there might be ways to manage that at strategic or planning stages.

Thus:

- further analyse the impact of unplanned short cuts on the use of TTA and work on a possible solution to manage usual direct routes when using TTA. However prohibit tactical direct routes is not an option.

In order to guarantee the smoothing of traffic expected by all stakeholders, it is necessary to ensure that all flights keep trying to comply with TTA. The experience gained through the exercise suggests that significant amount of flights that would disregard TTAs could jeopardize the expected benefits of the concept. Flights arriving earlier than planned might overtake the compliant flights in the arrival sequence and consequently both gain an unfair advantage and cause unnecessary arrival delay. Flights failing to report an excessive delay might disrupt the overall planning, and in a worst-case scenario spoil airport arrival capacity.

Therefore, a recommendation is to study the incentives that could foster TTA compliance, to prevent negligence.

The freezing of the TTA in the AMAN in LFPG exercise raised some difficulties for the building of the sequence. Nonetheless it appears important that flights slowing down to match a TTA should not be sped up afterwards, and vice-versa. Furthermore, as future AMAN concept tends to increase its time horizon, up to 1 hour before arrival, the borderline between Flow Management and Arrival Management will quickly narrow, and eventually overlap.

It is recommended to investigate further the compatibility between TTA and AMAN concepts, and define the operational link in terms of systems, data, and procedures.

6.2 Demonstration EXE-0202-002 Report

This section provides the detailed outcomes of the FAIR STREAM Exercise EXE-0202-002 concerning LSZH-Zurich Arrivals.

6.2.1 Exercise Scope

The operational concept addressed within the FAIR STREAM Trials and the scope of the Exercises are described at chapter 4.

The Demonstration Plan can be found on the extranet SESAR at the following link.

6.2.2 Conduct of Demonstration Exercise EXE-0202-002

6.2.2.1 Exercise Preparation

The configuration used is described at chapter 4.1.

6.2.2.2 Exercise execution

The approaches followed during execution of the exercise are described at chapter 4.

6.2.2.3 Deviation from the planned activities

The mitigations and deviations that were decided after the 1st trials are explained in chapter 4.3.

6.2.3 Exercise Results

6.2.3.1 Summary of Exercise Results

The LSZH Exercise results are summarized in this part. The 1st and 2nd Trials are analysed separately as they had different configurations.

Please note that the 1st Trials are analysed with NMOC data and that the 2nd Trials are analysed with SWISS aircraft data.

6.2.3.1.1 Results per KPA

Exercise ID	Demonstration Objective ID and title	Performance Indicators (KPI)	Method	Measure Value
EXE-0202-002 FAIR STREAM LSZH arrivals	OBJ-0202-001 Evaluate the feasibility of the use of TTA	N/A	Identify flights that tried TTA and those that could use TTA until the TTA-Fix	Number of flights having tried the use of TTA Number of flights that could use TTA until TTA-Fix
EXE-0202-002 FAIR STREAM LSZH arrivals	OBJ-0202-001 Evaluate the feasibility of the use of TTA	Flights arriving on time (as planned)	Capture the actual time over TTA-Fix and compare it with TTA	Mean of the absolutes values of deviation at TTA % of flights within the time window [-3;+3min]
EXE-0202-002 FAIR STREAM LSZH arrivals	OBJ-0202-002 Evaluate the predictability of the flights using a TTA	Flights departing and arriving on time (as planned)	Capture the initial, regulated and actual TOT and TO TTA-Fix, and compare them	Distribution of flights at take-off and over the TTA fix
EXE-0202-002 FAIR STREAM LSZH arrivals	OBJ-0202-002 Evaluate the predictability of the flights using a TTA	Flights departing and arriving on time (as planned)	Capture the initial, regulated and actual TOT and TO TTA-Fix, and compare them	Analysis of the impact of take-off time deviations on the use of TTA
EXE-0202-002 FAIR STREAM LSZH arrivals	OBJ-0202-003 Evaluate the ATC workload	N/A	Debriefings to analyse any reported difficulty	Identification of issues

Exercise ID	Demonstration Objective ID and title	Performance Indicators (KPI)	Method	Measure Value
EXE-0202-002 FAIR STREAM LSZH arrivals	OBJ-0202-004 Evaluate the flight efficiency (time and fuel)	N/A	Retrieve the flights duration from TTA Fix till Touchdown	Measure time and estimated fuel burn and compare them to baseline + Feedback from pilots on the use of CI
EXE-0202-002 FAIR STREAM LSZH arrivals	OBJ-0202-005 Evaluate the flight crew workload	N/A	Check that workload remains at acceptable level through questionnaires	Identification of issues.

Table 18: LSZH Scenario: Performance indicators

6.2.3.1.1.1 First Trials

6.2.3.1.1.1.1 Eligible flights and Rate of participation

For the first trials, 9 flights per day (only short-haul flights; departures Geneva, Paris CDG, Stuttgart and Dusseldorf) were considered, which led to a total of 522 potential eligible flights.

On those 522 flights, 437 were regulated by a regulation at Zurich Arrival, being their most penalizing regulation. Therefore 437 flights were eligible for the trials.

However, the flight crews were let the choice (mainly for operational reasons) to undergo the trials or not.

By the term "participation", we identify the flights having tried to reach the TTA.

In the first trials, this participation was recorded on the basis of an ACARS message the flight crew had to send back to dispatch, after having received the TTA information.

SWISS recorded the participation of 213 flights.

6.2.3.1.1.1.2 Adherence to TTA

For the analysis, 204 flights were taken into account. On the 213 participating flights, 9 amongst them did not overfly the TTA-Fix.

	Adherence to TTO [-3;+3]	Adherence to TTO [-4;+4]
FAIR-STREAM flights	57%	68%
Baseline flights	45%	61%

Table 19: LSZH 1st Trials - Adherence to TTO

The baseline flights are SWISS flights:

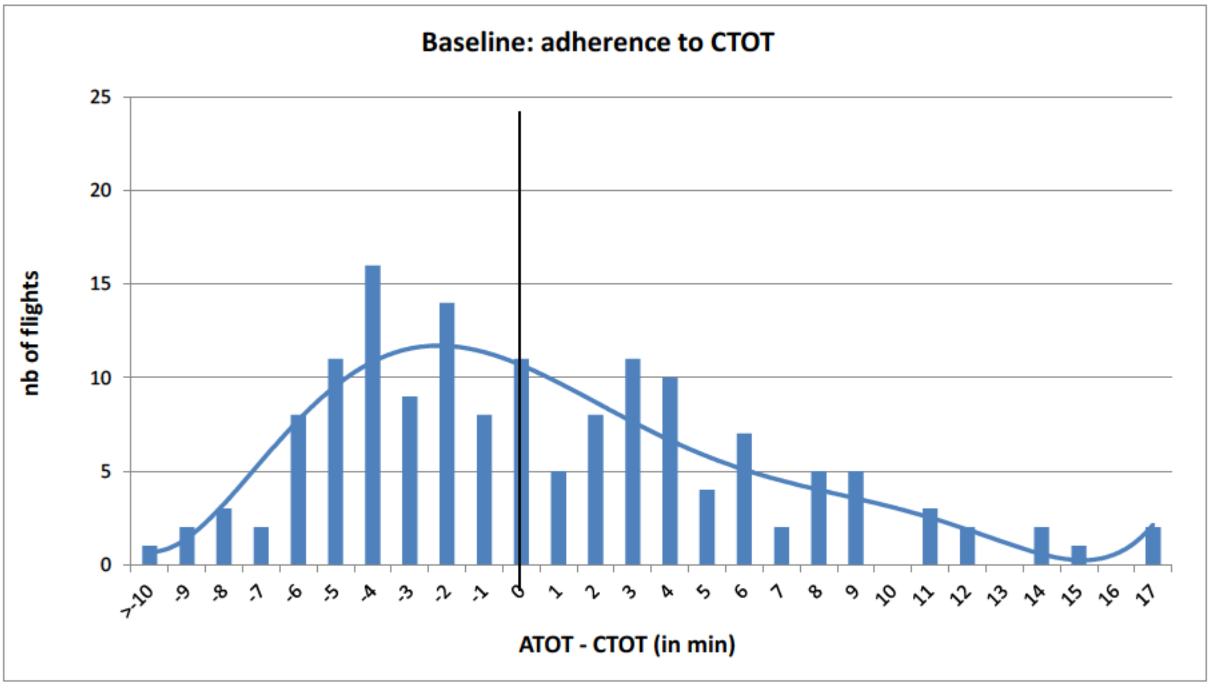
- Within the same period of the trials (Mai/June 2013),
- having the same city-pairs as those selected for the trials (departures LSGG, LFPG , EDDS, and EDDL) and
- being regulated by a Zurich arrival regulation.

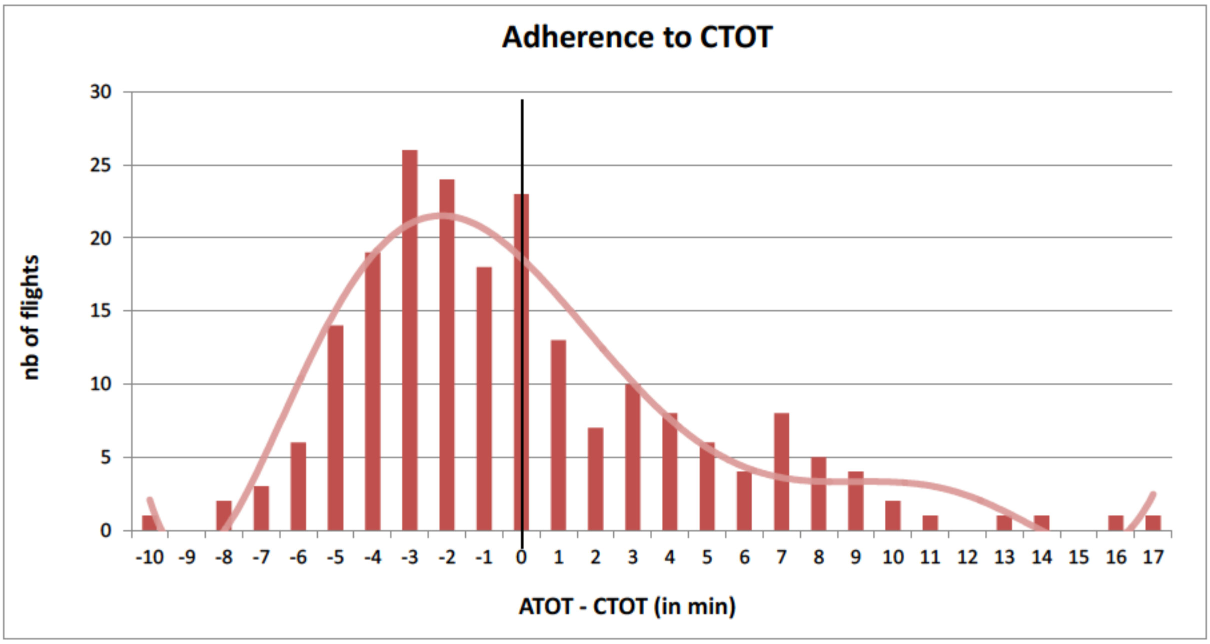
The baseline flights represent a total of 170 flights, on which 152 have ATT available data.

6.2.3.1.1.1.3 Impact of CTOT deviations to TTA adherence

The two following graphs show the distribution of the flights' actual takeoff times compared to their CTOT, and the distribution of the flights' time over the TTA-Fix compared to their TTA.

The take-offs are spread in the window [-5,+10] with a peak on minus 3 minutes, but the distribution window over the TTA is much narrower with a peak on the TTA. This implies that the flight crews are able to manage the flights to reach the TTA, even on a short duration flight.





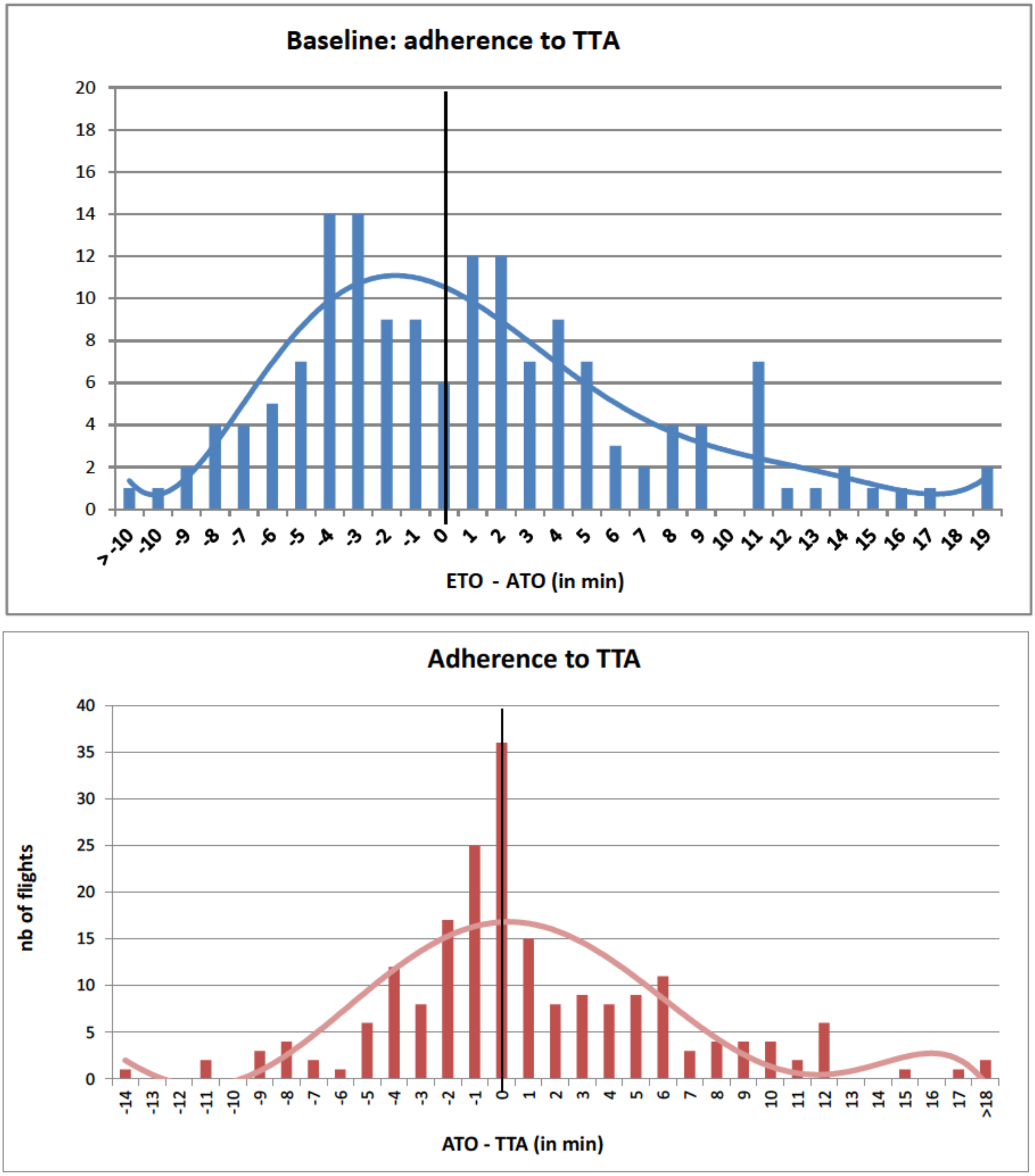


Figure 27: LSZH 1st Trials - Comparison Adherence to CTOT vs. Adherence to TTA

6.2.3.1.1.1.4 Impact of TTA on CTA adherence

The two following graphs compare the distribution of the flights' actual Time Over the TTA-Fix compared to their TTA, and the distribution of their Actual time of Arrival, compared to their Calculated Time of Arrival (CTA).

The adherence to the TTA is well achieved, but the arrivals are largely spread between minus seven minutes and plus seventeen minutes. This implies that even though the flight crews reach the TTA, this does not guarantee a smooth arrival.

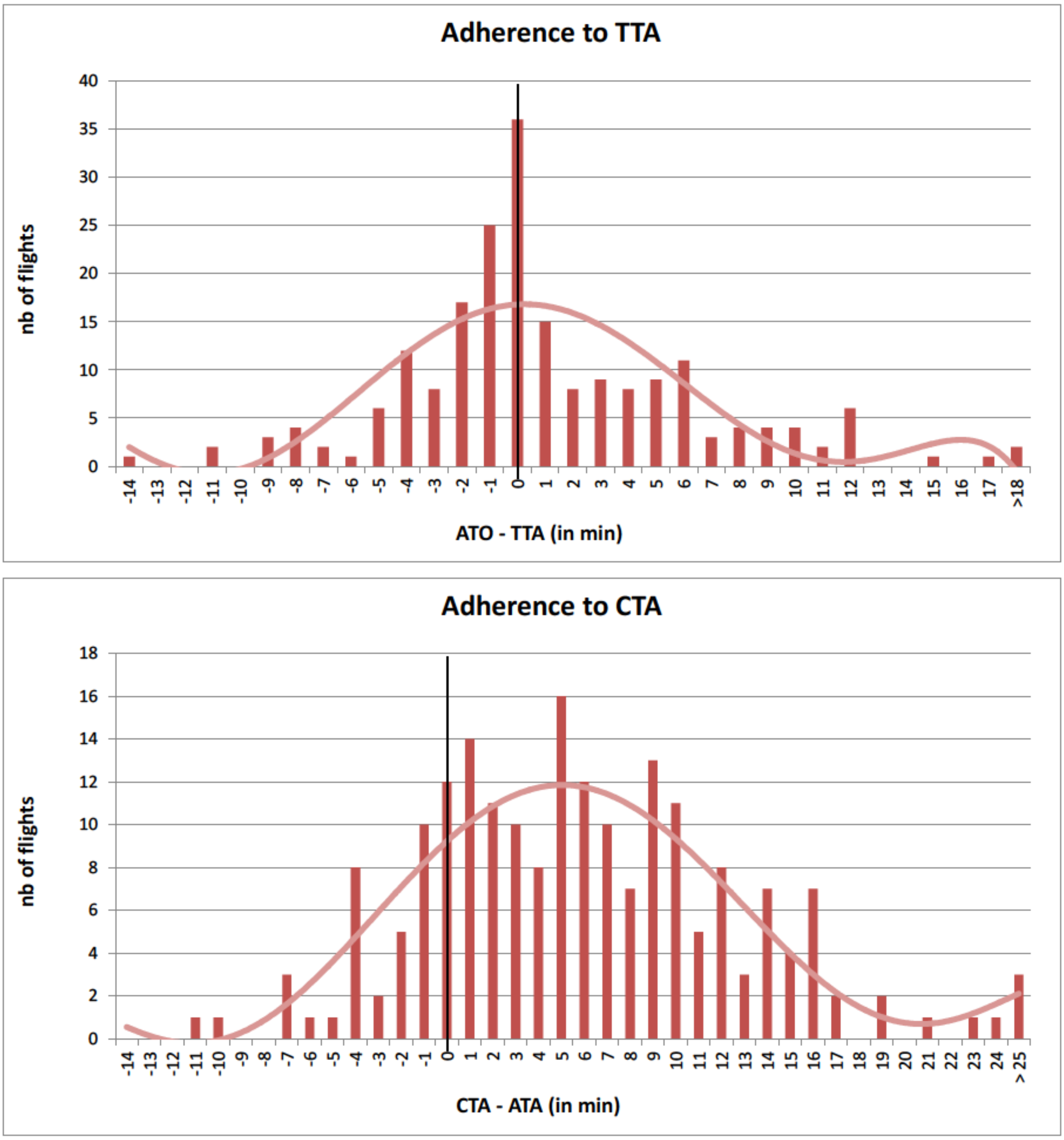


Figure 28: LSZH 1st Trials - Comparison Adherence to TTA vs. Adherence to CTA

6.2.3.1.1.1.5 Accuracy of CTOT

For the Trials flights, the AOC was asked to amend the FPL with the EET for the TTA-Fix in order to be taken into account by the IFPS system for the profiles computation (and mainly the CTOT values). Therefore by comparing the adherence to TTA for the flights with the EET filled and flights without EET filled, the accuracy of the profiles calculation can be revealed.

The following table shows a significant improvement of the adherence to the TTA for the flights having the EET filled, this proves that the new CTOTs stick more accurately to the filled & expected flight profile.

	Adherence to [-3;+3]	Adherence to [-4;+4]
Non-participating With EET filled	57%	68%

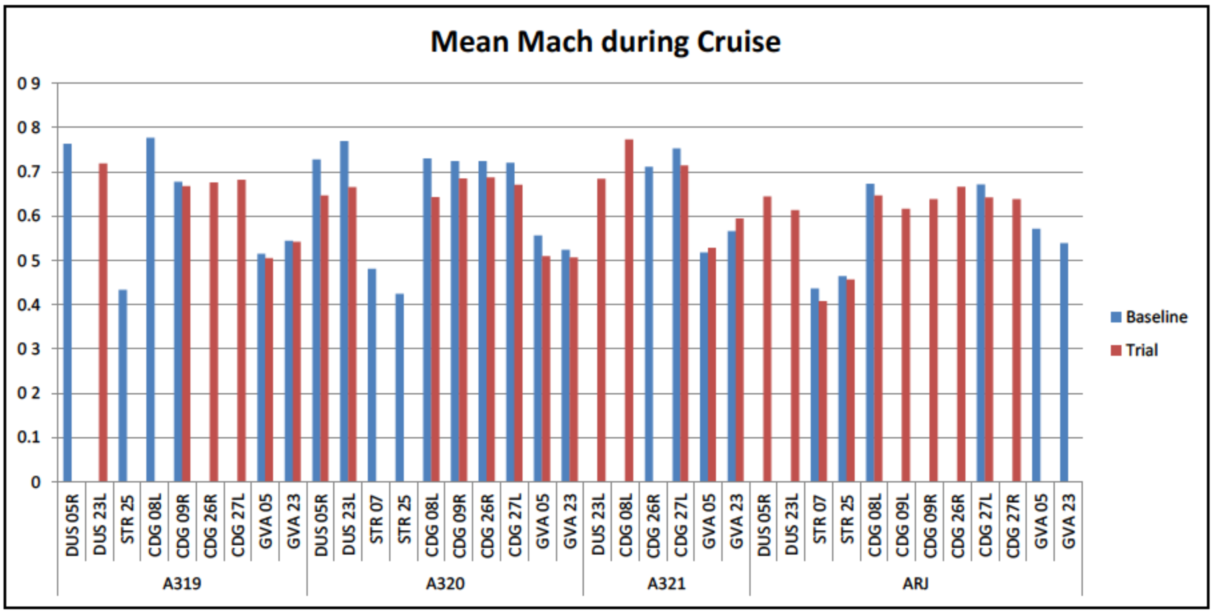
Non-participating No EET filled	42%	54%

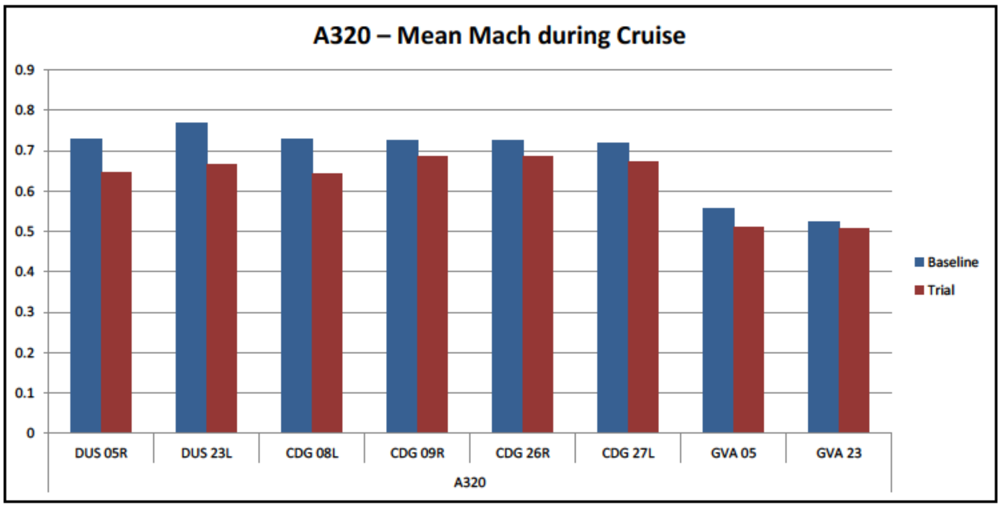
Table 20: LSZH 1st Trials: Adherence to TTO for non-participating flights

6.2.3.1.1.1.6 Impact of TTA on flight efficiency from take-off to TTA-Fix

As the pilots had to adapt the aircraft speed in order to reach their TTA, some impact on fuel consumption was expected.

The following graphs show the mean aircraft Mach number during the cruise phase which starts at the top of climb and ends with the beginning of the descent. Every take-off runway is analysed separately, as the direction and design of each SID has an impact on flight time.





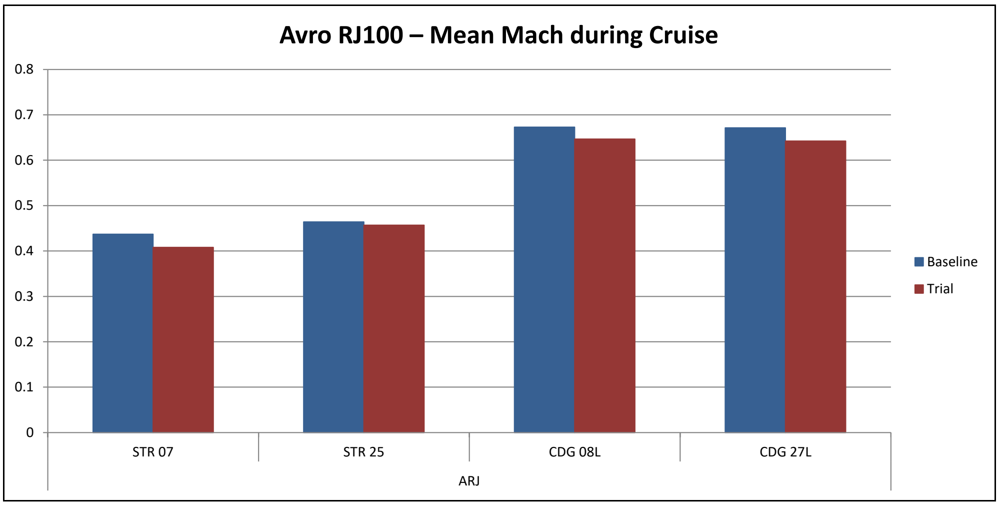


Figure 29: Mean Mach during Cruise

The majority of the trial flights flew with slower speed than the baseline flights, thus eliminating an early arrival at the TTA fix. As the company's speed policy does not allow a speed increase under normal conditions, it can be assumed that not many flights flew faster in order to reach their TTA, which is in accordance with the measured results.

The graphs below show the average amount of fuel which was burned from takeoff to the TTA fix, analysed separately for each take-off runway.

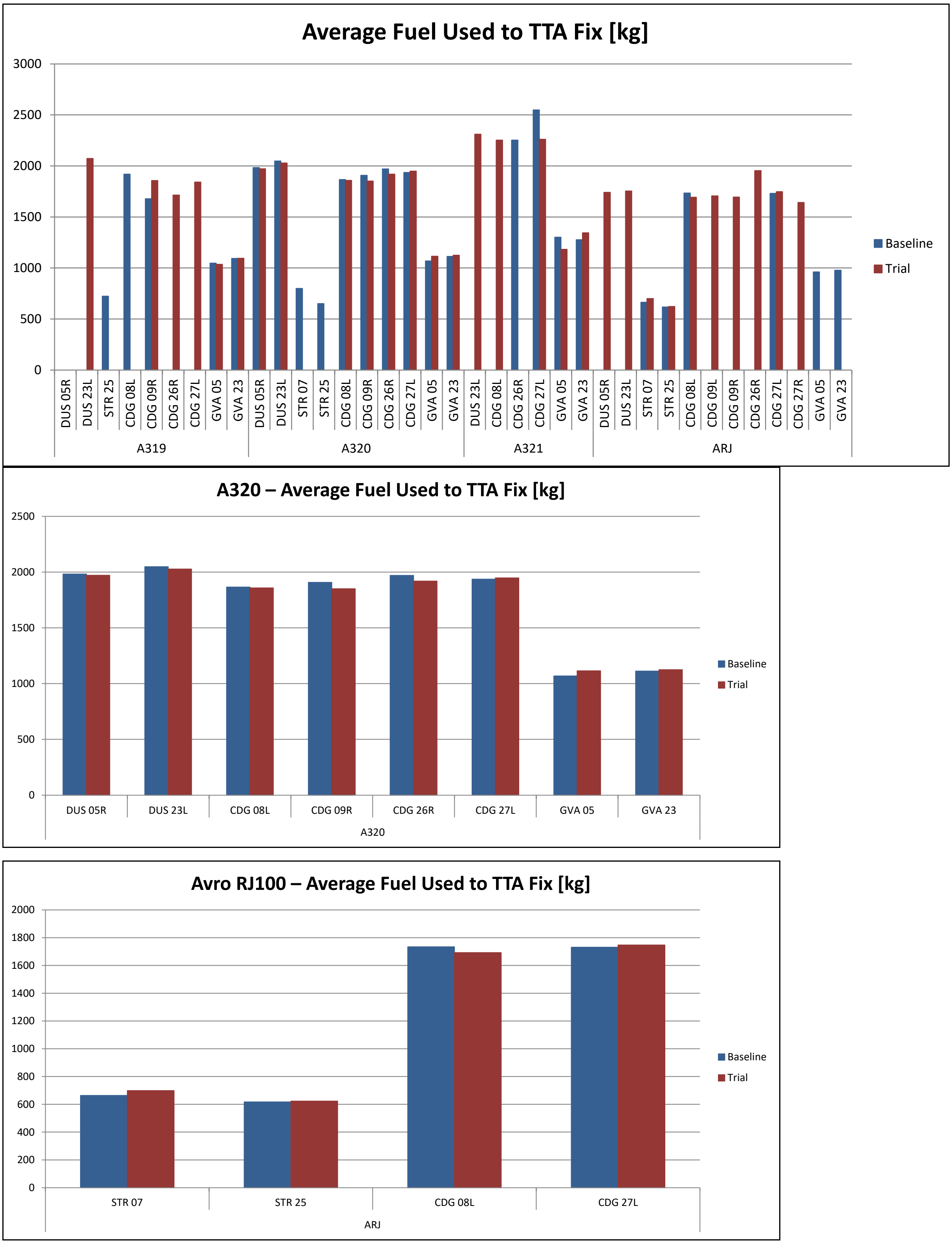


Figure 30: Average Fuel Used to TTA Fix

The speed adaptations executed in order to reach the TTA did not have a major influence on fuel consumption. As the differences are very small, neither a clearly positive nor a clearly negative influence of the TTA concept on fuel consumption can be found. The results mitigate the fear of increased fuel consumption due to the adaptations necessary for the TTA concept.

6.2.3.1.1.2 Second Trials

6.2.3.1.1.2.1 Eligible flights and Rate of participation

For the second trials, all the SWISS flights within the 2 selected time periods were requested to undergo the trials (~40 flights for each period). This led to a total of approximately 480 flights, including short, medium and long-haul flights.

On those 480 flights, 256 were actually regulated by a regulation at Zurich Arrival. Therefore 256 flights participated in the trials (all eligible short and medium-haul flights participated). The results for the long-haul flights, which were not regulated but participated anyway in the trials using Scenario 3, will be described in chapter 1.1.1.1.1.2.6.

Swiss uses a "wave system" for their arrivals and departures in LSZH. This means there are several arrival peaks followed by departure peaks during the day. For the analysis, all arrivals between 10:50 and 12:15 LT (peak of Wave 3) and between 15:20-16:45 LT (peak of Wave 4) were taken into account.

The baseline period covers the SWISS flights for the same weekdays (Thursdays and Fridays) of September 2013.

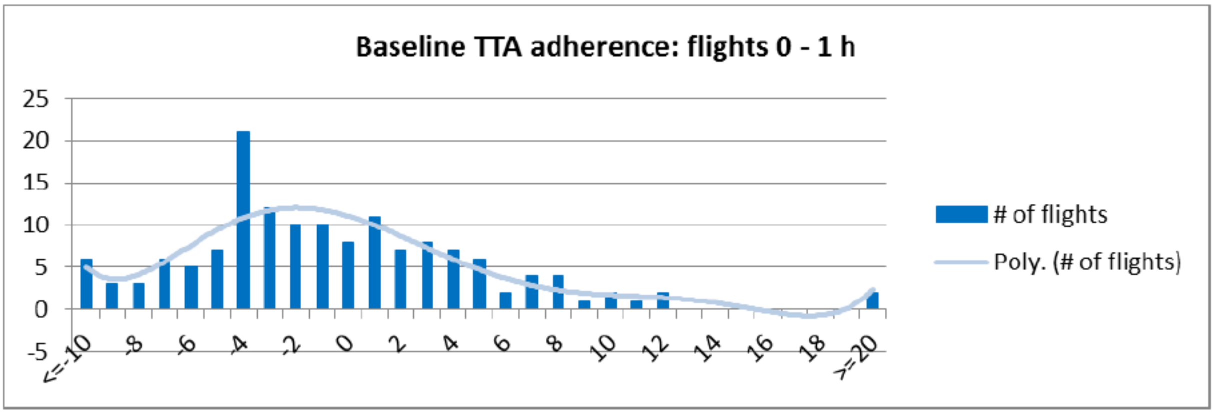
As the procedure for the long haul flights was different, they are analysed separately.

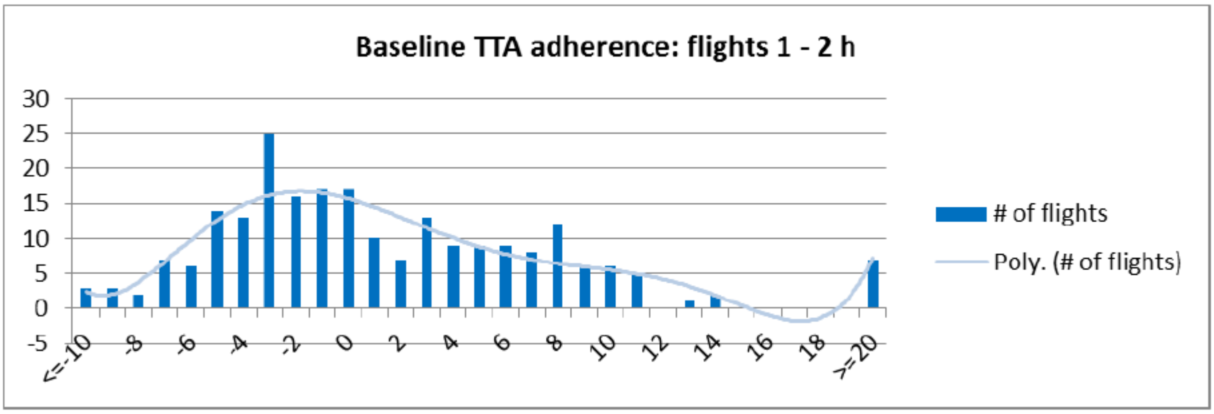
6.2.3.1.1.2.2 Adherence to TTA

	Adherence to TTO [-3;+3]	Adherence to TTO [-4;+4]
FAIR STREAM flights	**50%**	**62%**
Baseline Flights	**39%**	**54%**

Table 21: LSZH 2nd Trials - Adherence to TTA

In order to analyse the impact of flight time on TTA achievement, the following graphs subdivide the flights on the basis of their duration. It is expected that longer flights have better chances to reach a TTA as they have more time to compensate for an unpunctual departure.





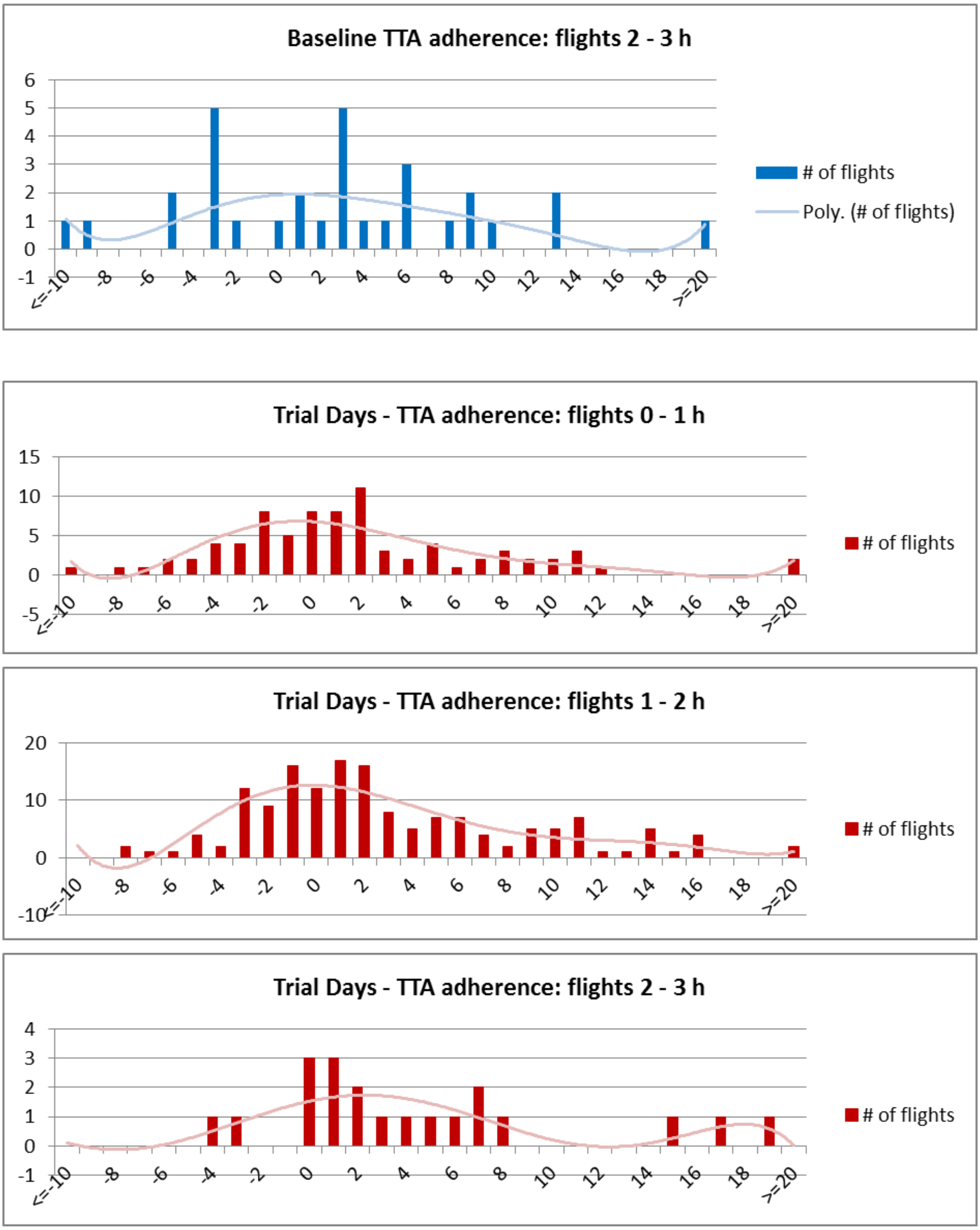
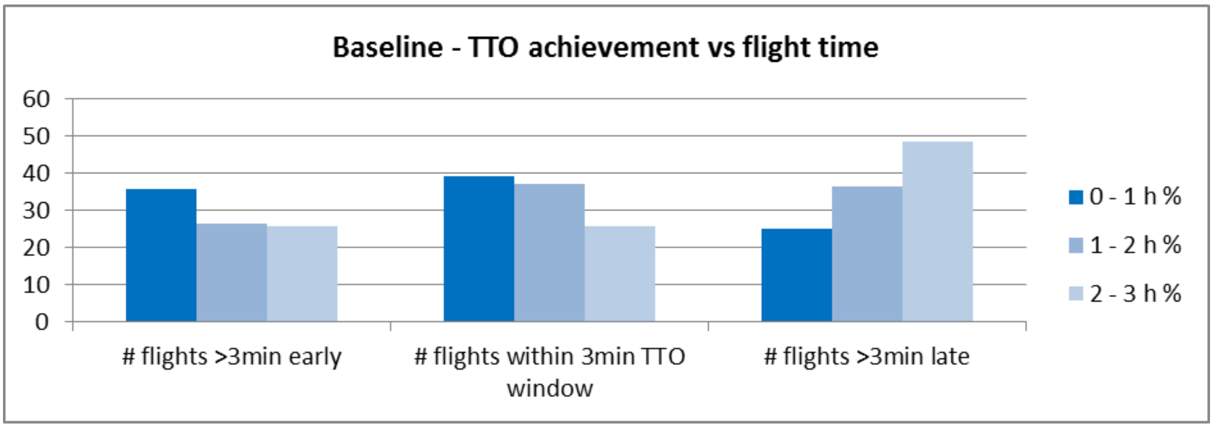


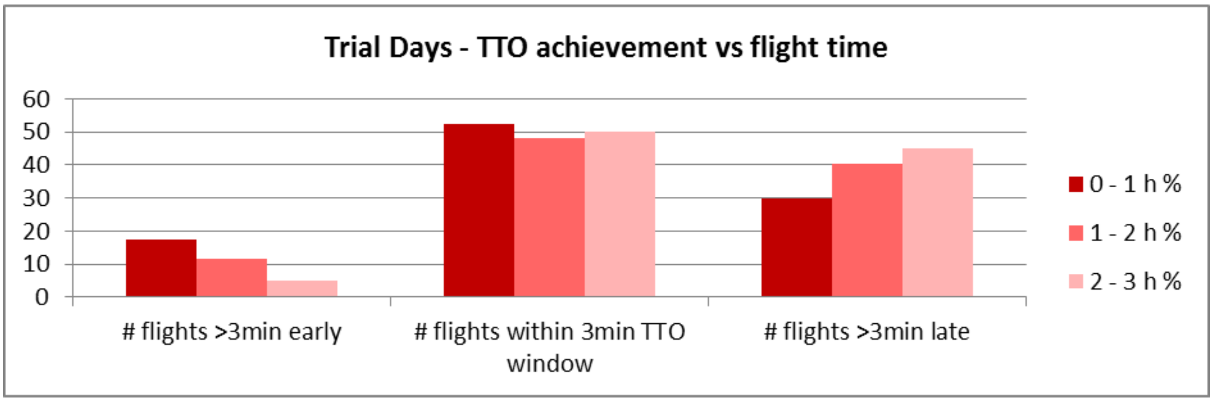
Figure 31: LSZH 2nd Trials - Adherence to TTO according to flight time

The graphs show an improvement of the adherence to TTA during the Trials, and especially a smaller number of flights arriving too early.

For short flights (0-1h), there is a shift of peak from -4 (baseline) to +2 (trial days).
For the 1-2h flights, there is a shift of peak from -3 (baseline) to +1 (trial days).

The baseline graph for long flights (2-3h) shows two peaks at -3 and +3 minutes, whereas for the trial flights the peak has clearly shifted towards the TTA.





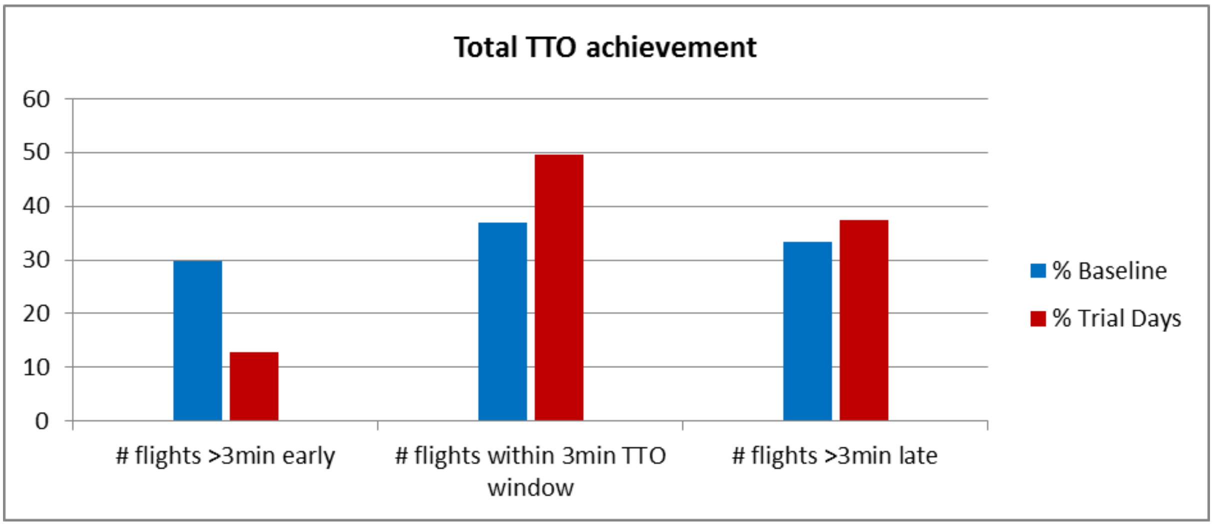


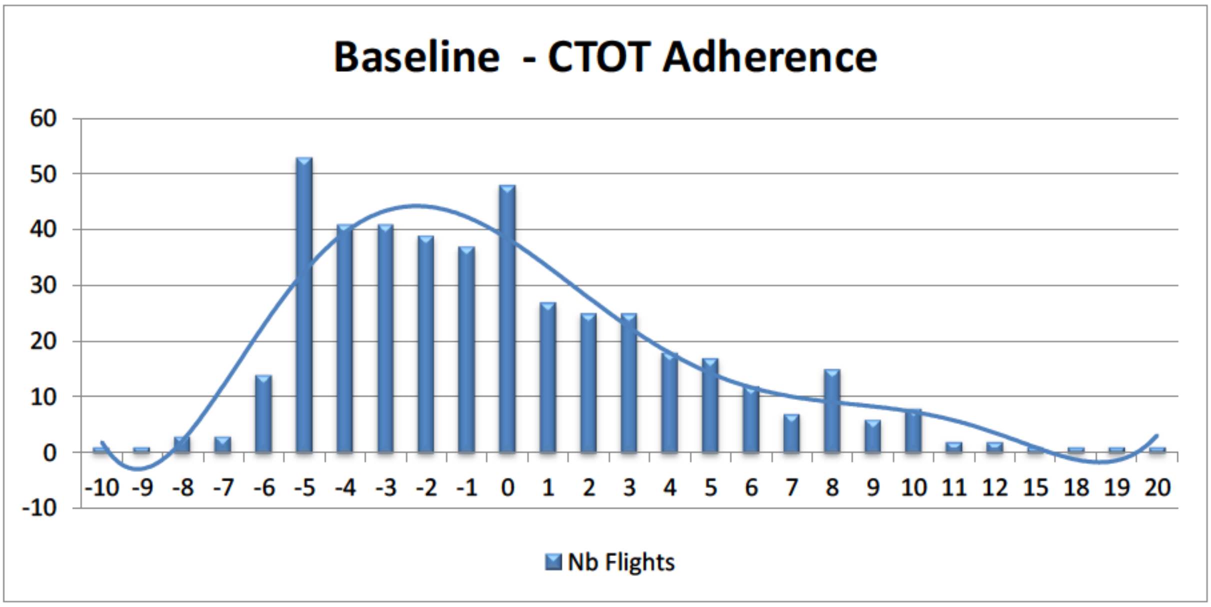
Figure 32: LSZH 2nd Trials - summary of adherence to TTO according to flight time

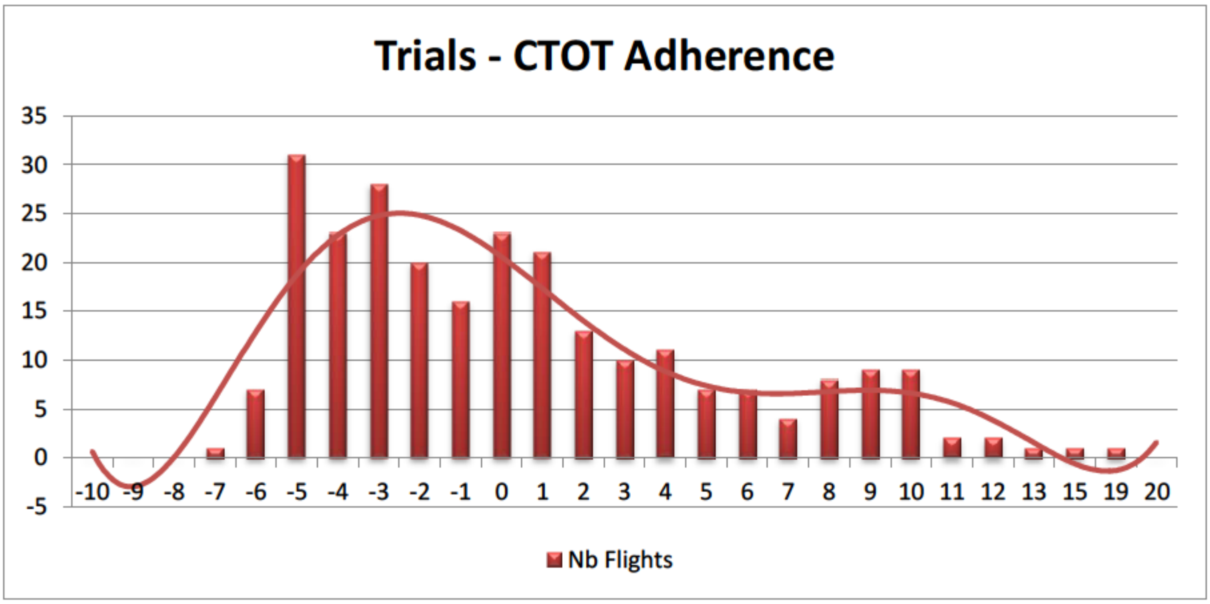
Generally we observe that the longer the flights are, the later are their arrivals compared to their estimated/calculated arrival time.
Long flights (> 1h) with TTA are rarely too early, mostly on time (48%-50%) and between 40% and 45% are late.

Flights with TTA have a significantly better adherence. The targets are achievable even for short-haul flights (as long as the take-off time is close to CTOT).

6.2.3.1.1.2.3 Impact of CTOT deviations to TTA adherence

The following graphs compare the distribution of the flights' actual take-off times as a function of their CTOT, and the distribution of the flights' time over the TTA-Fix as a function of their TTA for both the baseline and the trial flights.





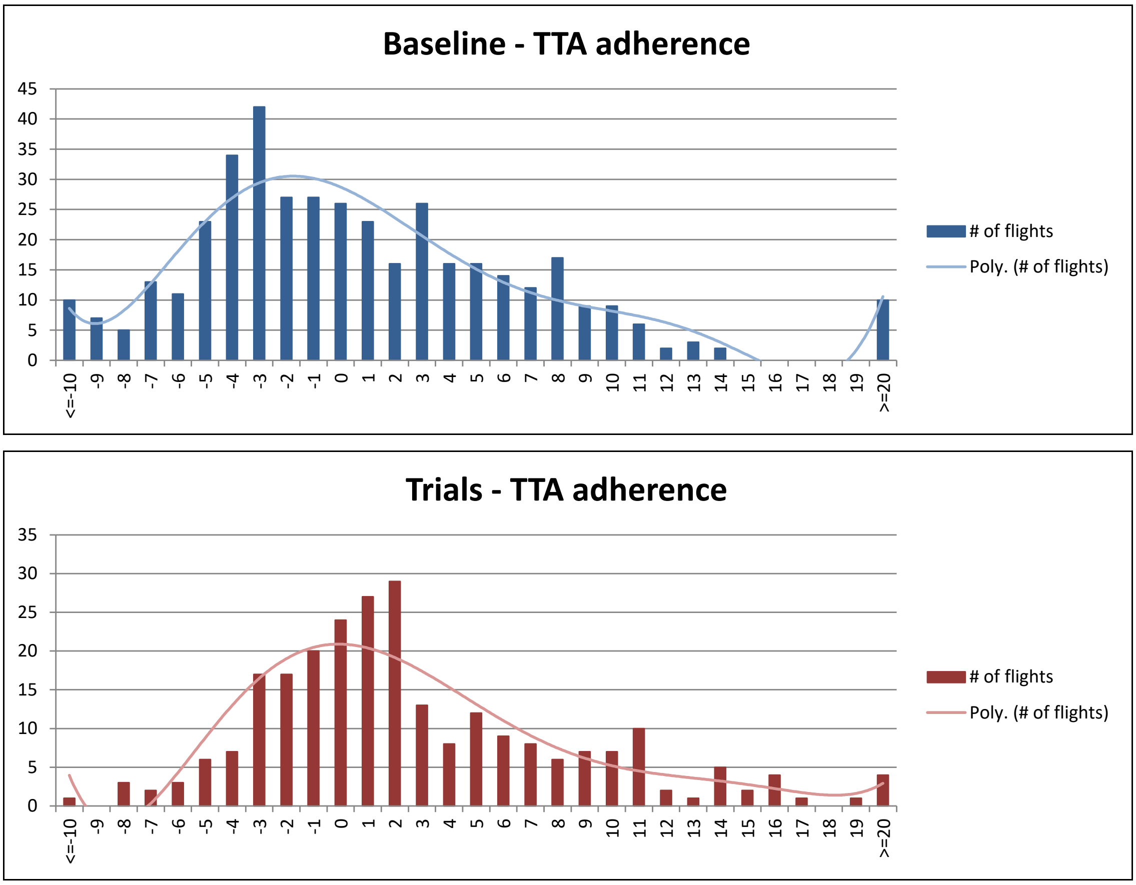


Figure 33: LSZH 2nd Trials - Comparison Adherence to CTOT vs. Adherence to TTO

Whereas the take-off time distribution around CTOT is quite similar for the baseline and the trials, a peak shift for the actual time over the TTA fix can be observed from -3/-2 minutes for the baseline to +1/+2 minutes for the trial days.

The following correlation analysis shows the interdependency of the take-off time and the time over the TTA fix.

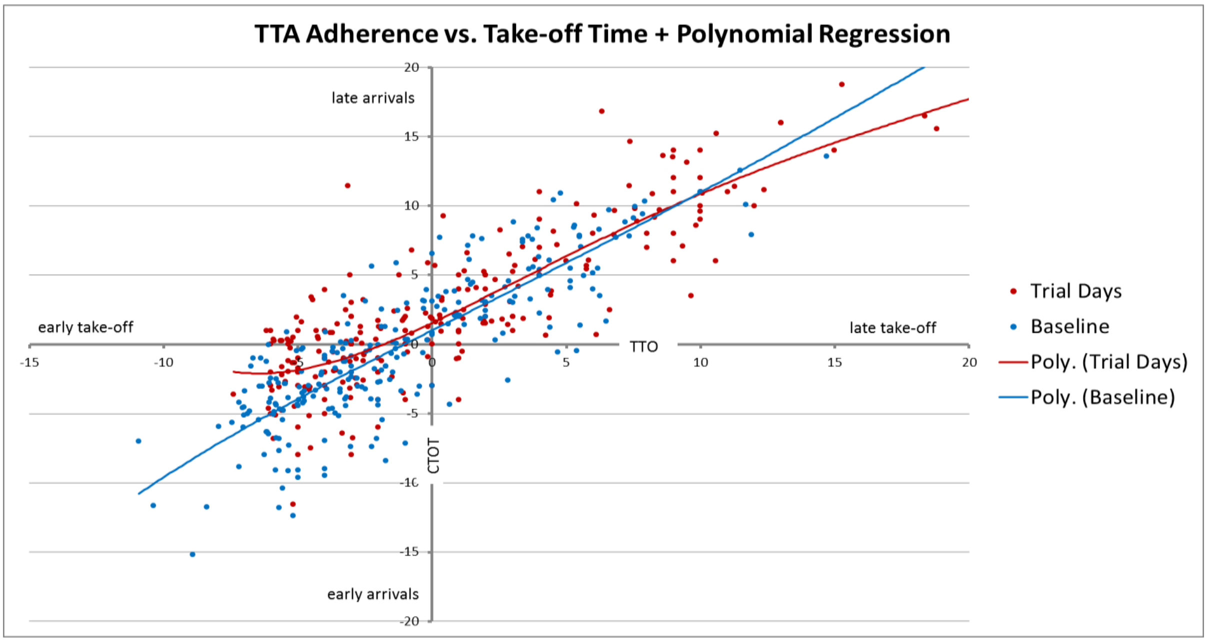


Figure 34: LSZH 2nd Trials - Polynomial regression TTO Adherence vs. Take-Off Time

Generally, flights with TTOs which take-off early tend to fly slower and get closer to their target time than early flights without TTO. A flight with a take-off between CTOT -5 minutes and CTOT +2 minutes has the best chances to reach its TTA time. However, there is a strong correlation between the take-off time and the actual time over the TTA-Fix.

Generally, the actual flight time is somewhat longer than the NMOC flight profile predictions (upward shift of regression line); with an average of +1 minute without TTA and +2 minutes with TTA for a take-off at CTOT.
The general tendency shows longer flight times with early departures (due to CI reduction) and shorter flight times with later T/O.

6.2.3.1.1.2.4 Impact of TTA on CTA adherence

This part aims to analyse the approach efficiency during the trials. For this purpose, the approach duration from reaching the fix until touchdown was measured, which means the values include the time spent in holding patterns as well as extended vectoring.

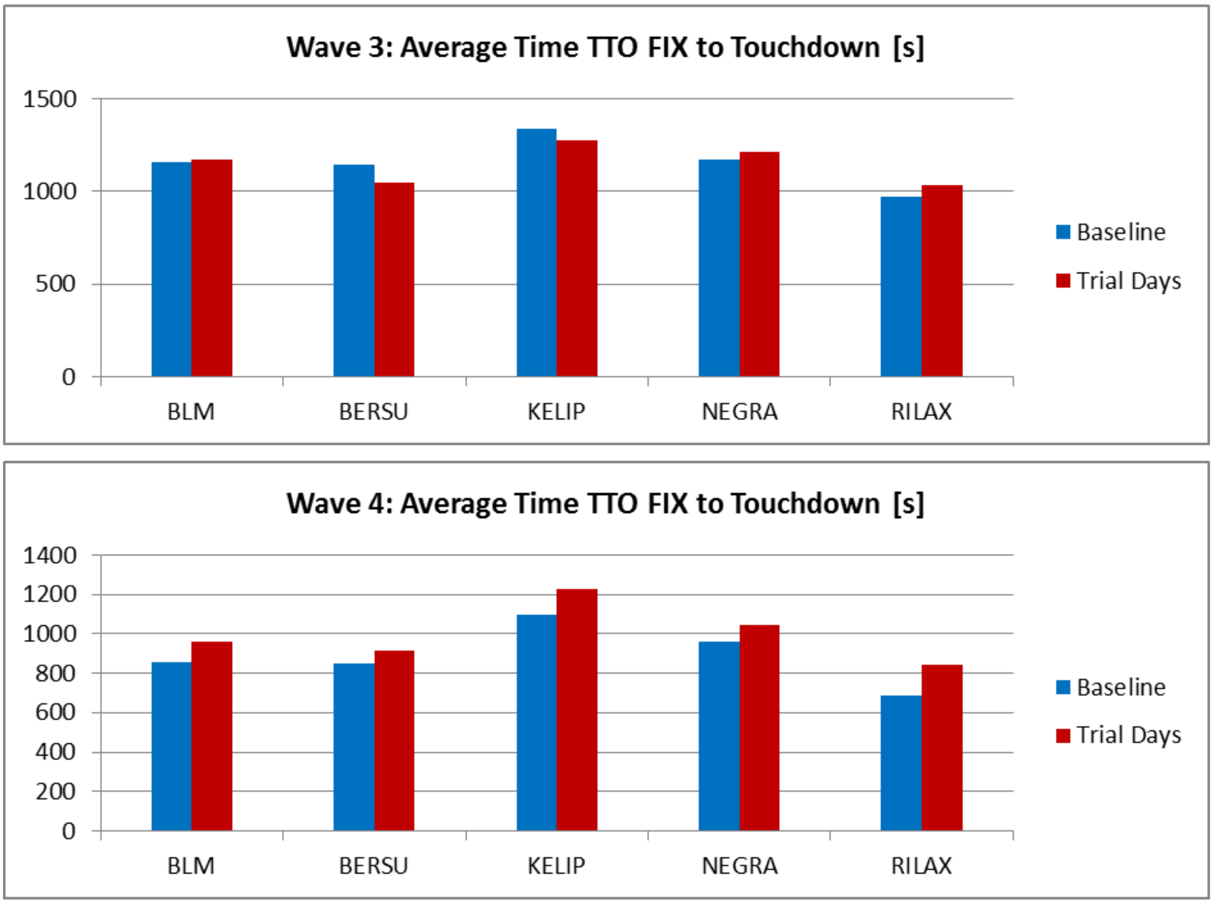


Figure 35: LSZH 2nd Trials - Average time from TTA-Fix till Touchdown

For Wave 3, there is no significant difference in the average approach duration between baseline and trial days.
For Wave 4, the average duration is higher during trials days for all FIXes; however, the reason is not obvious.

The result implies that the use of TTAs was not beneficial in terms of flight time in the arrival phase. The approach sequence is not smoother with TTAs without their integration into the arrival management.

6.2.3.1.1.2.5 Evaluation of the Approach efficiency

- Approach Fuel

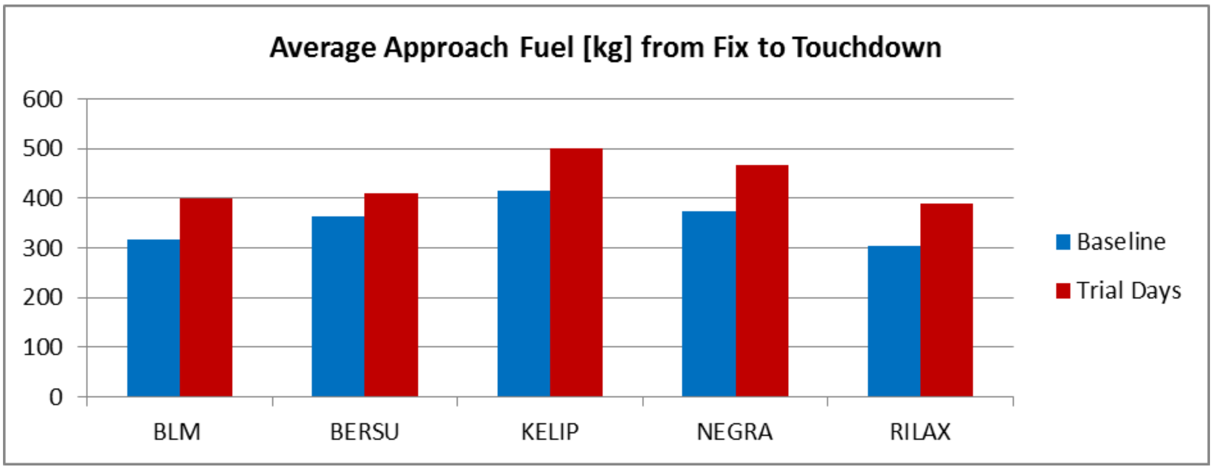
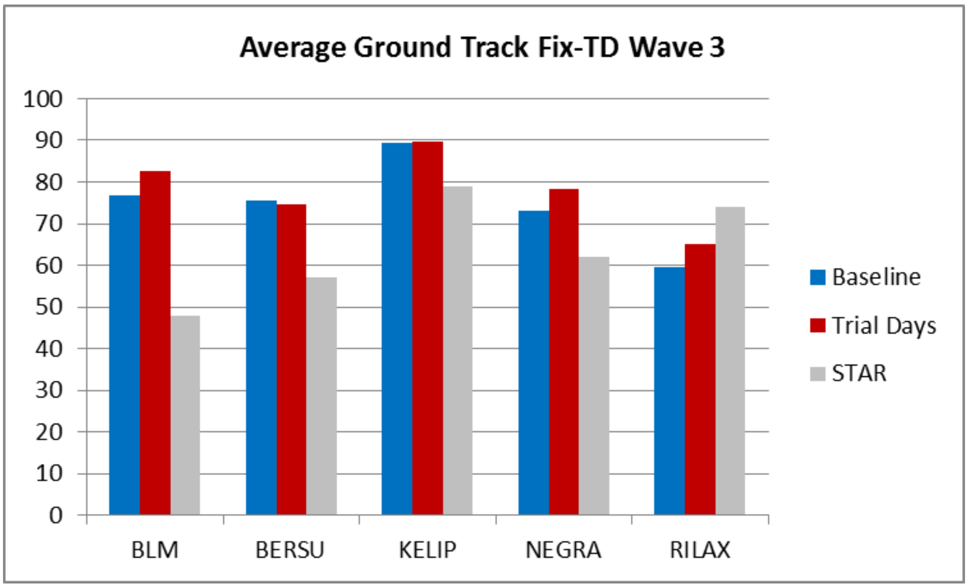


Figure 36: LSZH 2nd Trials - Fuel consumption from TTA-Fix till Touchdown

Fuel consumption is clearly dependent on flight time. However, the fuel consumption increases disproportionately with longer approaches due to level flight and suboptimal descents (speed and rate restrictions by ATC).

- Ground Track distance

The graphs below compare the ground tracks from FIX to touchdown for the baseline versus trials versus STAR flights.



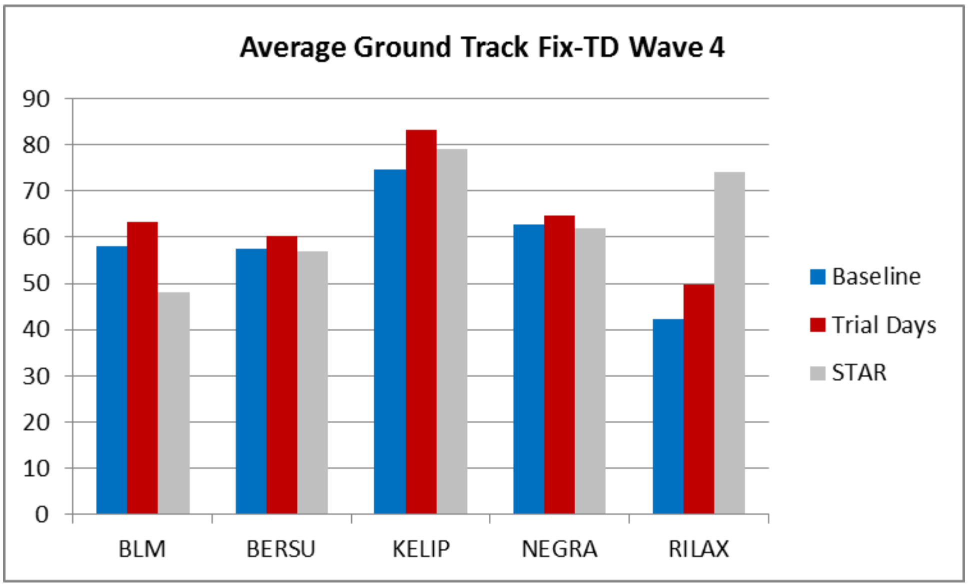


Figure 37: LSZH 2nd Trials - Average ground Tracks from TTA-Fix till Touchdown

The graphs show that distances flown (for the baseline and Trials flights) during peak times are longer than the STARs.

The Rilax1A STAR includes a large buffer which other STARs don't; RILAX1A is rarely used when RWY14 is in use, but a more direct approach via RILAX (see IAC ILS14 ZRH).

6.2.3.1.1.2.6 Results for long haul flights

Out of a total number of 58 eligible long-haul flights, 24 participated in the trials.

Concerning their TTO achievement:

- 6 flights (25%) arrived before TTO – 3 minutes
- 17 flights (71%) arrived within the +/- 3 min window
- 1 flight (4%) arrived after TTO + 3 minutes

The adherence rate for the long-haul flights is good, as 71% of all participating flights reached their TTO within the +/-3 min window. Nevertheless, most flights which did not reach the +/- 3 min window tended to be significantly early (4 flights more than 10 minutes early). The comparison of OFP and actual flight data indicates that only a part of their time deviation from ETO/TTO can be explained by short-cuts or flight level deviations. Other possible reasons could be poor wind data quality or flight management by the crew (speed flown deviating from planned speed). Another possible reason for the early flights could be a wrong ETA transmitted by the crew (using the ETA value in the FMS which represents the estimated time at touchdown instead of checking the ETO value over the TTA fix).

6.2.3.1.1.2.7 Slot Swap Procedure

For the first two days of the 2nd Trials, i.e. Thursday 3rd and Friday 4th of October 2013, the automatic process of TTA for the SWISS dispatch was not ready yet.

In this meantime, another solution aiming to improve arrival sequence was experienced. This experience was derived from the known FMP procedure "Slot Swapping" which is an ETFMS functionality used to swap flights when requested by aircraft operators.

The slot swap requests generally come from an aircraft operator concerning flights for which they are responsible operator (or when there is a formal agreement between both aircraft operators) or from the FMP. The procedure shall happen in Tactical environment (the two concerned flights must be in status slot issued). The two flights shall be subject to the same most penalizing regulation and only one swap per flight shall be accepted.

The aim of this experience was to apply this Slot Swap procedure to the eligible SWISS Arrival aircraft of Wave 3 in order to re-group the aircraft by category (Light/Medium/Heavy), and therefore reduce the mix of traffic, hence the separation minima, hence the arrival delay.

- **Procedure**

The proposed procedure was the following:

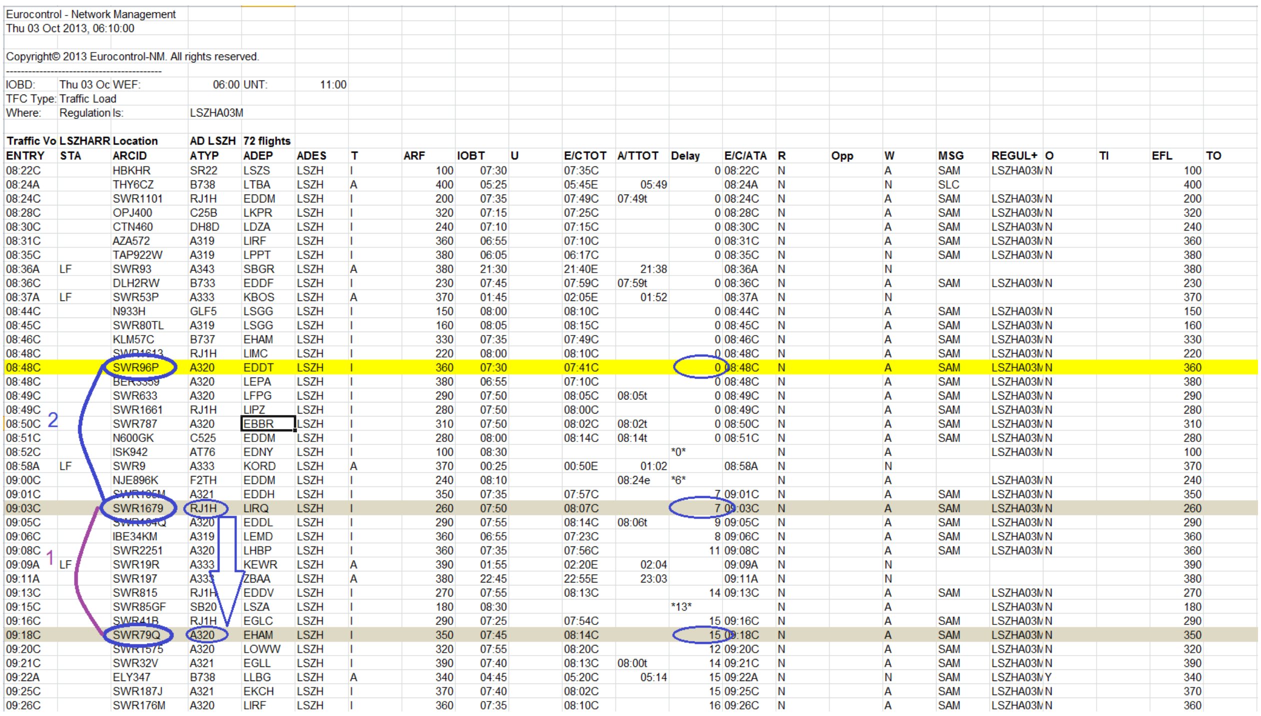
1. D-1: NMOC (through CHMI) to provide whole list of ARR flights at LSZH during the peak period (LSZH ARR regulation applied pre-tactically)
2. D-1: skyguide APP ATCO to prepare an optimized Arrival sequence
3. D: skyguide FMP to exchange adequately the slots in order to be as close as possible to the optimized sequence (Slot Swap procedure)
4. D: skyguide FMP to coordinate with NMOC for the slots swaps.

On D-1, an APP ATCO elaborated an optimized arrival sequence, from the Predict Arrival Flight List.

On the day of operations, once the regulation was applied on the arrivals of LSZH, the goal was to re-arrange the slots in order to come as close as possible to the optimized sequence defined by the APP ATCO.

In a Slot Swap, the NMOC system exchanges the Calculated Time Over the RWY, which means that the FMP has to compare the flights with old and new slot (calculated backwards with new CTO over the RWY).

Below are described two examples of Slot Swaps performed. The figures show the Predict Arrival Flight Lists at LSZH, the first column being the expected time over the RWY.



Eurocontrol - Network Management
Thu 03 Oct 2013, 06:10:00

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IOBD: Thu 03 Oc WEF: 06:00 UNT: 11:00
TFC Type: Traffic Load
Where: Regulation Is: LSZHA03M

Traffic Vo LSZHARR Location AD LSZH 72 flights

ENTRY	STA	ARCID	ATYP	ADEP	ADES	T	ARF	IOBT	U	E/CTOT	A/TTOT	Delay	E/C/ATA	R	Opp	W	MSG	REGUL+	O	TI	EFL	TO
08:22C		HBKHR	SR22	LSZS	LSZH	I	100	07:30		07:35C		0	08:22C	N		A	SAM	LSZHA03M	N		100	
08:24A		THY6CZ	B738	LTBA	LSZH	A	400	05:25		05:45E	05:49		08:24A	N		N	SLC				400	
08:24C		SWR1101	RJ1H	EDDM	LSZH	I	200	07:35		07:49C	07:49t	0	08:24C	N		A	SAM	LSZHA03M	N		200	
08:28C		OPJ400	C25B	LKPR	LSZH	I	320	07:15		07:25C		0	08:28C	N		A	SAM	LSZHA03M	N		320	
08:30C		CTN460	DH8D	LDZA	LSZH	I	240	07:10		07:15C		0	08:30C	N		A	SAM	LSZHA03M	N		240	
08:31C		AZA572	A319	LIRF	LSZH	I	360	06:55		07:10C		0	08:31C	N		A	SAM	LSZHA03M	N		360	
08:35C		TAP922W	A319	LPPT	LSZH	I	380	06:05		06:17C		0	08:35C	N		N	SAM	LSZHA03M	N		380	
08:36A	LF	SWR93	A343	SBGR	LSZH	A	380	21:30		21:40E	21:38		08:36A	N		N					380	
08:36C		DLH2RW	B733	EDDF	LSZH	I	230	07:45		07:59C	07:59t	0	08:36C	N		A	SAM	LSZHA03M	N		230	
08:37A	LF	SWR53P	A333	KBOS	LSZH	A	370	01:45		02:05E	01:52		08:37A	N		N					370	
08:44C		N933H	GLF5	LSGG	LSZH	I	150	08:00		08:10C		0	08:44C	N		A	SAM	LSZHA03M	N		150	
08:45C		SWR80TL	A319	LSGG	LSZH	I	160	08:05		08:15C		0	08:45C	N		A	SAM	LSZHA03M	N		160	
08:46C		KLM57C	B737	EHAM	LSZH	I	330	07:35		07:49C		0	08:46C	N		A	SAM	LSZHA03M	N		330	
08:48C		SWR1613	RJ1H	LIMC	LSZH	I	220	08:00		08:10C		0	08:48C	N		A	SAM	LSZHA03M	N		220	
08:48C		SWR96P	A320	EDDT	LSZH	I	360	07:30		07:41C		0	08:48C	N		A	SAM	LSZHA03M	N		360	
08:48C		BER3359	A320	LEPA	LSZH	I	380	06:55		07:10C		0	08:48C	N		A	SAM	LSZHA03M	N		380	
08:49C		SWR633	A320	LFPG	LSZH	I	290	07:50		08:05C	08:05t	0	08:49C	N		A	SAM	LSZHA03M	N		290	
08:49C		SWR1661	RJ1H	LIPZ	LSZH	I	280	07:50		08:00C		0	08:49C	N		A	SAM	LSZHA03M	N		280	
08:50C 2		SWR787	A320	EBBR	LSZH	I	310	07:50		08:02C	08:02t	0	08:50C	N		A	SAM	LSZHA03M	N		310	
08:51C		N600GK	C525	EDDM	LSZH	I	280	08:00		08:14C	08:14t	0	08:51C	N		A	SAM	LSZHA03M	N		280	
08:52C		ISK942	AT76	EDNY	LSZH	I	100	08:30				*0*		N		A		LSZHA03M	N		100	
08:58A	LF	SWR9	A333	KORD	LSZH	A	370	00:25		00:50E	01:02		08:58A	N		N					370	
09:00C		NJE896K	F2TH	EDDM	LSZH	I	240	08:10			08:24e	*6*		N		A		LSZHA03M	N		240	
09:01C		SWR105M	A321	EDDH	LSZH	I	350	07:35		07:57C		7	09:01C	N		A	SAM	LSZHA03M	N		350	
09:03C		SWR1679	RJ1H	LIRQ	LSZH	I	260	07:50		08:07C		7	09:03C	N		A	SAM	LSZHA03M	N		260	
09:05C		SWR104Q	A320	EDDL	LSZH	I	290	07:55		08:14C	08:06t	9	09:05C	N		A	SAM	LSZHA03M	N		290	
09:06C		IBE34KM	A319	LEMD	LSZH	I	360	06:55		07:23C		8	09:06C	N		A	SAM	LSZHA03M	N		360	
09:08C 1		SWR2251	A320	LHBP	LSZH	I	360	07:35		07:56C		11	09:08C	N		A	SAM	LSZHA03M	N		360	
09:09A	LF	SWR19R	A333	KEWR	LSZH	A	390	01:55		02:20E	02:04		09:09A	N		N					390	
09:11A		SWR197	A333	ZBAA	LSZH	A	380	22:45		22:55E	23:03		09:11A	N		N					380	
09:13C		SWR815	RJ1H	EDDV	LSZH	I	270	07:55		08:13C		14	09:13C	N		A	SAM	LSZHA03M	N		270	
09:15C		SWR85GF	SB20	LSZA	LSZH	I	180	08:30				*13*		N		A		LSZHA03M	N		180	
09:16C		SWR41B	RJ1H	EGLC	LSZH	I	290	07:25		07:54C		15	09:16C	N		A	SAM	LSZHA03M	N		290	
09:18C		SWR79Q	A320	EHAM	LSZH	I	350	07:45		08:14C		15	09:18C	N		A	SAM	LSZHA03M	N		350	
09:20C		SWR1575	A320	LOWW	LSZH	I	320	07:55		08:20C		12	09:20C	N		A	SAM	LSZHA03M	N		320	
09:21C		SWR32V	A321	EGLL	LSZH	I	390	07:40		08:13C	08:00t	14	09:21C	N		A	SAM	LSZHA03M	N		390	
09:22A		ELY347	B738	LLBG	LSZH	A	340	04:45		05:20C	05:14	15	09:22A	N		N	SAM	LSZHA03M	Y		340	
09:25C		SWR187J	A321	EKCH	LSZH	I	370	07:40		08:02C		15	09:25C	N		A	SAM	LSZHA03M	N		370	
09:26C		SWR176M	A320	LIRF	LSZH	I	360	07:35		08:10C		16	09:26C	N		A	SAM	LSZHA03M	N		360	

Figure 38: LSZH 2nd Trials – Slot Swap - Predict LSZH ARR Flight List Wave 3 of 03-10-2013

1. Exchange SWR1679 (aircraft type RJ1H delayed 7 min) with the SWR79Q (A320 delayed 15 min), in order to re-group the “small” aircraft RJ1H together and to avoid having a RJ1H just after the long-haul SWR9.

Consequences of this swap:

→ SWR79Q would have been on time, but SWR1679 would have get more than 20 min delay.

2. Due to the significant increase of the delay, decision to exchange SWR1679 with SWR96P instead (no delay)

2.1 Agreement with Swiss dispatch to confirm the slot swap

2.2 Coordination with NMOC

Result: SWR1679 was on time, but SWR96P got 15 min delay.

Before: SWR1679 had 7 min delay and SWR96P was on time.

On the Second day:

Eurocontrol - Network Management	
Fri 04 Oct 2013, 08:09:42	
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IOBD: ,Fri 04 Oct 2013,WEF: ,08:20,UNT: ,10:20	
TFC Type: ,Traffic Demand	
Where: ,Aerodrome,Is: ,LSZH	
Show Predicted Flights,Category: ,Arrival	
AO(s): ,SWR,46 flights	
TA,STA,ARCID,ATYP,ADEP,ADES,D,T,RFL,IOBT,U,E/CTOT,X,F,S,M,AT,A/TTOT,Delay,E/C/ATA,R,Opp,W,MSG,REGUL+,O,TI,EFL,TO	
08:31E,,SWR1101,RJ1H,EDDM,LSZH,,P,200,07:35,,,,N,I,,C, ,*0*,,N,,N,,LSZHA04,N, ,200,	
08:35E,,SWR1325,A321,UUDD,LSZH,,P,340,05:28,,05:27E,,N,I,,S, ,,08:35E,N,,N,,,, ,340,	
08:35E,,SWR15X,A333,KJFK,LSZH,,P,390,01:23,,01:34E,,N,I,,S, d,,08:35E,N,,N,,,, ,390,	
08:40E,,SWR65,A333,KMIA,LSZH,,P,410,23:58,,23:58E,,N,I,,S, ,,08:40E,N,,N,,,, ,410,	
08:40E,,SWR53P,A343,KBOS,LSZH,,P,390,01:56,,01:58E,,N,I,,S, d,,08:40E,N,,N,,,, ,390,	
08:45E,,SWR9,A333,KORD,LSZH,,P,390,00:36,,00:25E,,N,I,,S, d,,08:45E,N,,N,,,, ,390,	
08:45E,,SWR80TL,A320,LSGG,LSZH,,P,160,08:05,,,,N,I,,S, ,*6*,,N,,N,,LSZHA04,N, ,160,	
08:47E,,SWR1613,RJ1H,LIMC,LSZH,,P,220,08:00,,,,N,I,,S, ,*6*,,N,,N,,LSZHA04,N, ,220,	
08:48E,,SWR96P,A320,EDDT,LSZH,,P,360,07:30,,,,N,I,,S, ,*7*,,N,,N,,LSZHA04,N, ,360,	
08:49E,,SWR105M,A320,EDDH,LSZH,,P,350,07:35,,,,N,I,,S, ,*7*,,N,,N,,LSZHA04,N, ,350,	
08:50E,,SWR93,A343,SBGR,LSZH,,P,380,21:47,,21:38E,,N,I,,S, d,,08:50E,N,,N,,,, ,380,	
08:51E,,SWR787,A320,EBBR,LSZH,,P,310,07:50,,,,N,I,,C, ,*7*,,N,,N,,LSZHA04,N, ,310,	
08:52E,,SWR1661,RJ1H,LIPZ,LSZH,,P,280,07:50,,,,N,I,,S, ,*9*,,N,,N,,LSZHA04,N, ,280,	Blue not possible
08:53E,,SWR633,A320,LFPG,LSZH,,P,290,07:50,,,,N,I,,C, ,*10*,,N,,N,,LSZHA04,N, ,290,	
08:56E,,SWR79Q,A320,EHAM,LSZH,,P,350,07:45,,,,N,I,,S, ,*14*,,N,,N,,LSZHA04,N, ,350,	
08:57E,,SWR41B,RJ1H,EGLC,LSZH,,P,290,07:25,,,,N,I,,S, ,*14*,,N,,N,,LSZHA04,N, ,290,	
08:58E,,SWR104Q,RJ1H,EDDL,LSZH,,P,290,07:55,,,,N,I,,C, ,*15*,,N,,N,,LSZHA04,N, ,290,	
08:58E,,SWR1679,RJ1H,LIRQ,LSZH,,P,260,07:50,,,,N,I,,S, ,*16*,,N,,N,,LSZHA04,N, ,260,	
08:59E,,SWR815,RJ1H,EDDV,LSZH,,P,270,07:55,,,,N,I,,S, ,*18*,,N,,N,,LSZHA04,N, ,270,	
09:01E,,SWR2251,F100,LHBP,LSZH,,P,350,07:35,,,,N,I,,S, ,*46*,,N,,N,,LSZHA04,Y, ,350,	
09:05E,,SWR197,A333,ZBAA,LSZH,,P,380,22:54,,22:53E,,N,I,,S, ,,09:05E,N,,N,,,, ,380,	
09:05E,,SWR32V,A320,EGLL,LSZH,,P,390,07:40,,,,N,I,,C, ,*13*,,N,,N,,LSZHA04,N, ,390,	
09:09E,,SWR187J,A321,EKCH,LSZH,,P,350,07:40,,,,N,I,,S, ,*13*,,N,,N,,LSZHA04,N, ,350,	
09:09E,,SWR1575,A320,LOWW,LSZH,,P,320,07:55,RC,08:08E,,N,I,,S, ,,09:09E,N,,N,,FL2ALP04,Y, ,320,	
09:10E,,SWR85GF,SB20,LSZA,LSZH,,P,180,08:45,,,,N,I,,S, ,*13*,,N,,N,,LSZHA04,N, ,180,	
09:10E,,SWR176M,A320,LIRF,LSZH,,P,340,07:35,,,,N,I,,S, ,*15*,,N,,N,,LSZHA04,N, ,340,	
09:10E,,SWR1189,E190,EDDN,LSZH,,P,220,08:20,,,,N,I,,S, ,*16*,,N,,N,,LSZHA04,N, ,220,	
09:15E,,SWR47Z,F100,EGBB,LSZH,,P,350,07:40,,,,N,I,,S, ,*13*,,N,,N,,LSZHA04,N, ,350,	
09:20E,,SWR140H,A320,LYBE,LSZH,,P,300,07:52,,,,N,I,,S, d,*10*,,N,,N,,LSZHA04,N, ,300,	
09:20E,,SWR19R,A333,KEWR,LSZH,,P,390,02:08,,02:17E,,N,I,,S, d,,09:20E,N,,N,,,, ,390,	
09:21E,,SWR158A,A321,LEBL,LSZH,,P,320,07:45,,,,N,I,,S, ,*12*,,N,,N,,LSZHA04,N, ,320,	
09:23E,,SWR1485,RJ1H,LKPR,LSZH,,P,280,08:10,,,,N,I,,S, ,*12*,,N,,N,,LSZHA04,N, ,280,	
09:25E,,SWR74V,RJ1H,ELLX,LSZH,,P,190,08:49,,,,N,S,,S, ,*12*,,N,,N,,LSZHA04,N, ,190,	
09:25E,,SWR145J,RJ1H,EDDS,LSZH,,P,130,08:50,,,,N,I,,S, ,*12*,,N,,N,,LSZHA04,N, ,130,	
09:27E,,SWR531,F100,LFLL,LSZH,,P,180,08:40,,,,N,I,,S, ,*13*,,N,,N,,LSZHA04,N, ,180,	
09:27E,,SWR35Q,F100,EGCC,LSZH,,P,350,07:40,,,,N,I,,S, ,*14*,,N,,N,,LSZHA04,N, ,350,	
09:29E,,SWR175L,F100,EPWA,LSZH,,P,300,07:30,,,,N,I,,S, ,*14*,,N,,N,,LSZHA04,N, ,300,	
09:34E,,SWR233P,A320,LEMD,LSZH,,P,380,07:35,,,,N,I,,S, ,*16*,,N,,N,,LSZHA04,N, ,380,	Not possible
09:45E,,SWR58M,A320,LFMN,LSZH,,P,260,08:40,,,,N,I,,S, ,*12*,,N,,N,,LSZHA04,N, ,260,	

Figure 39: LSZH 2nd Trials – Slot Swap - Predict LSZH ARR Flight List 04-10-2013

1- (yellow color): SWR1613 <-> SWR633: in order to group RJ1H together and avoid having a Small just after the Heavy one (SWR9).

2- (blue color): SWR1661 <-> SWR79Q:
   i. Not possible because SWR79Q would need to depart earlier than normal ETOT.

Those swaps were selected in order to regroup the categories of aircraft without adding too much delays to the exchanged aircraft.

- **Issues**

Slot Swapping is quite restrictive as it is not possible on flights with 0 minute of delay or with flights having too different delays. In order to arrange one flight, it may penalize another one even more and compromise should be done.

Furthermore, there is no prediction of the slot swap result. The knowledge of SWISS wished arrival order has to be taken into account as their operational needs (connections, PAX, etc…) may differ daily.

This procedure is quite time-demanding for the FMPs to check for eligible candidates and mentally compute the effect in order to not penalize too much the flights. And NMOC does not have a test system or a "tool" to assess the result before actually entering it in the operational system. That's why the FMP was reluctant to perform other slot swaps in order to not add delays to other flights. This procedure should also be conducted in close cooperation with SWISS AOC as their wished arrival sequence is of relevance to perform Slot Swapping.

- **Results**

The examples illustrated above show the complexity of the procedure.

Only 3 Slots Swaps could be realized in final (one on the first day and two on the second). However, no significant benefit in terms of delay reduction resulted from these swaps.

This procedure should be reviewed or adapted to permit an easiest modification of the arrival sequence without endangering the global arrival traffic (by adding delays).

6.2.3.1.1.3 Evaluation of workload

6.2.3.1.1.3.1 ATC

Geneva and Zürich ATCOs were informed of the Trials but were not actors. Only one specific issue raised the attention of an En-Route ATCO (see paragraph 6.2.3.1.3) but globally, for the 2 Trials, the impact was very low on the ATC side.

6.2.3.1.1.3.2 Flight Crews

The workload in the cockpit was generally not significantly increased. A slight increase was reported by a large minority of pilots for the planning phase and before push-back, as well as inflight. Only few pilots felt a slight workload increase during taxi.

The main causes for an increased workload were planning issues and additional communication with dispatch before the flight, as well as the monitoring of the progress towards TTA inflight.

It can be assumed that the workload would be even lower once the procedures are well-known.

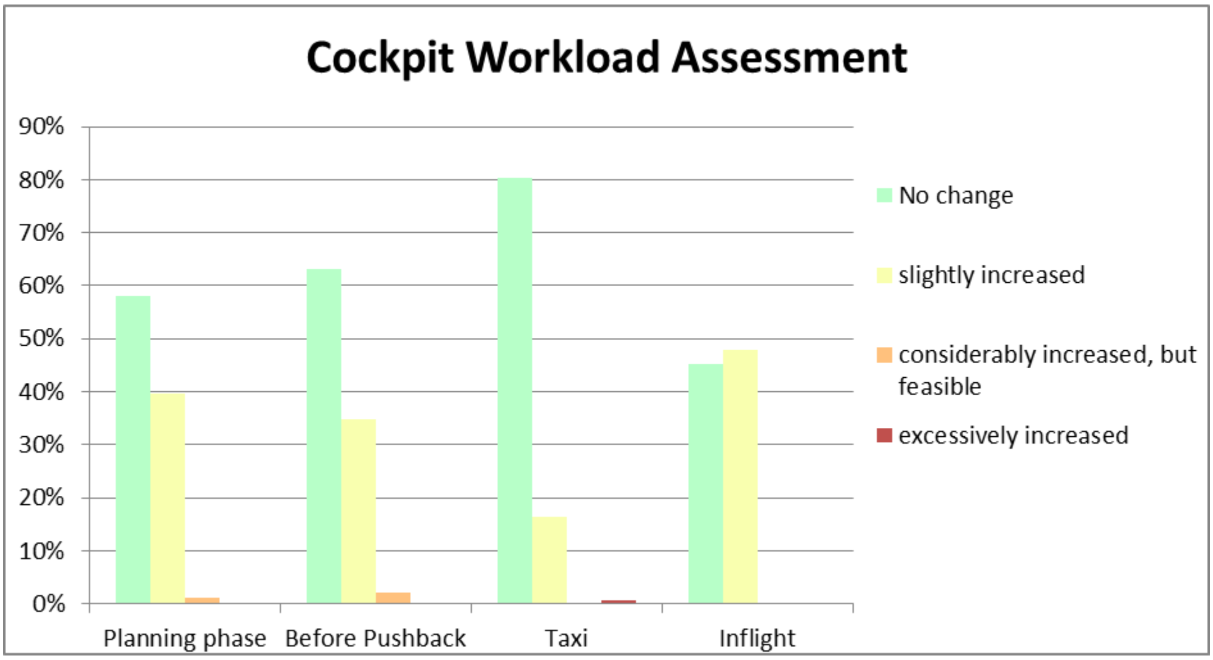


Figure 40: LSZH 2nd Trials - Cockpit Workload Assessment

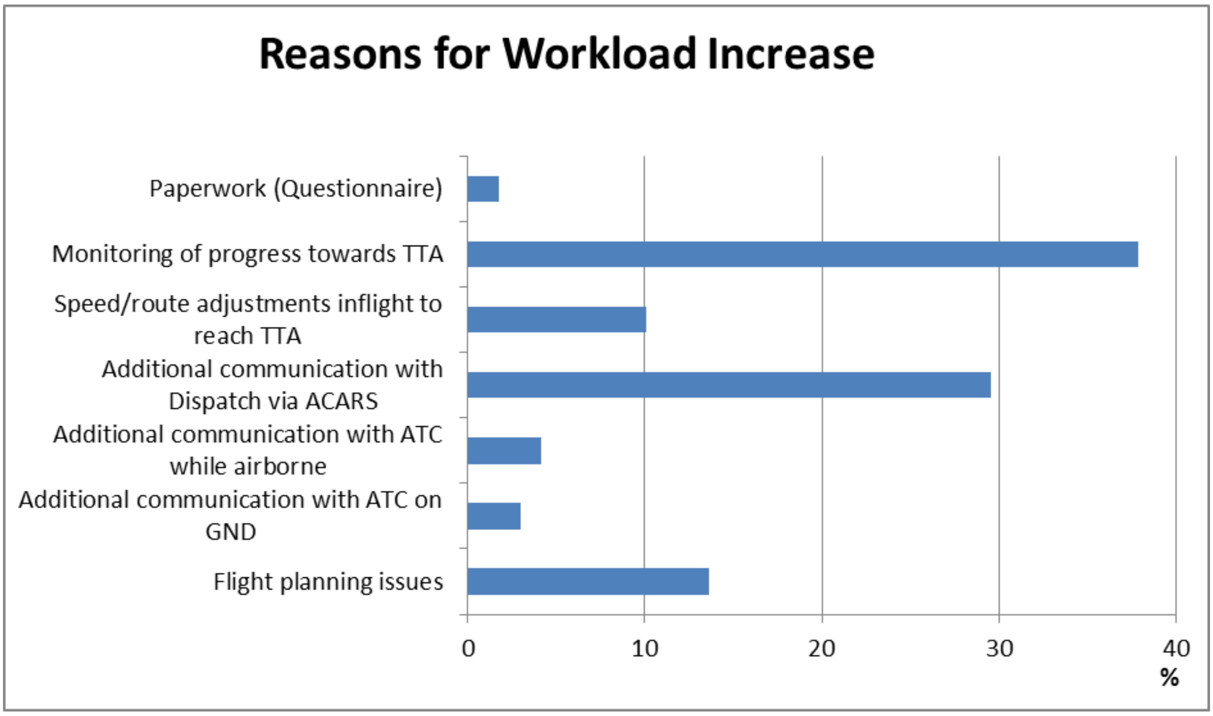


Figure 41: LSZH 2nd Trials - Reasons for Cockpit workload increase

6.2.3.1.1.3.3 AOC

The AOC encountered a significant increase of workload during the 1st Trials due to the manual handling of TTA flights. This issue was resolved for the 2nd Trials with an automatic process of TTA distribution.

6.2.3.1.2 Results impacting regulation and standardisation initiatives

As mentioned in §5.5.3, it is recommended that any progressive introduction of TTA in real time operations should be accompanied with incentives to enforce its application.

6.2.3.1.3 Unexpected Behaviours/Results

During the 1st Trials, no specific restrictions were given to the Flight Crews except the instruction to reach the TTA Target.
Therefore, some Pilots adapted their speed in consequence and it occurred once that a flight Geneva-Zurich was flying at very low speed (180kts) which surprised the En-Route ATCO. This flight was overtaken by 2 other flights arriving at Zurich. However, this case did not raise safety issues; moreover it had been identified as a risk in the safety case.

From SWISS side, no unexpected behaviours or results were reported or detected.

6.2.3.1.4 Quality of Demonstration Results

Concerning the accuracy of the results, it has to be noted that the TTA Times were given in 1 minute resolution for the 1st and 2nd Trials.
For the 1st Trials, the analysis were made on Archive NMOC data.
For the 2nd Trials, the analysis were made with aircraft data, as these figures are 1 seconds resolution.
The comparison of Actual Times-Over the TTA fix between both sources (aircraft and NMOC) for the 2nd Trials showed an average of 1 minute 39 seconds difference. Due to this high difference and in order to have the best accuracy of analysis, it was decided to use aircraft data for the analysis.
However, the Pilots were distributed TTAs with 1 minute resolution.

6.2.3.1.5 Significance of Demonstration Results

The results are relevant from a statistical point of view considering the large number of flights for the Trials and the baseline sample: 493 FAIR STREAM flights and 558 baseline flights.
The results are also relevant from an operational point of view as the trials took place in normal operations, with the existing technical systems capabilities, without any new or added specific procedures for ATC and without any change in standard operating procedures for flight crews.

6.2.4 Conclusions and recommendations (LSZH)

6.2.4.1 Conclusions

This section gives a summary of the conclusions raised by the Demonstration Exercise analysis.

The Trials demonstrated that:

- Flight Crews are able to meet a Target Time over a Point: **the adherence to TTA is significantly better for Trial flights, for short, medium and long (0-3h) flights (as long as the take-off is not too late)**
- There is a strong correlation between the Take-Off Time and the Time-Over the TTA-fix
    - Closest ATOT to CTOT → Closest ATO to TTA
        - Best adherence for flights having taken off between [-4;+1] of their CTOT for the 1st Trials
- Flights with TTA tend to reach TTA-fix later than the baseline flights (less number of flights arriving too early at the TTA fix)
- New ETFMS (V.17) is now able to provide more accurate CTOTs/TTAs thanks to EET information
- Departures from CDM airports show a very good adherence to TTA
    - TTA and CDM are compatible
- The RTA function was barely used during the trial and it led to a flight with a very unusual low speed that could have caused a safety event if it hadn't been immediately taken into account by the ATCO.

The limitations concerning the LSZH Exercise were the following:

- TTA-Fixes
    - → End of En-Route: flights are still in the ACC airspace (5 to 10 minutes of flying time before the entry in the Approach sector)

  - → 3 different geographical points (East, North-East, West)
  - → No possibility to integrate these TTA-fixes in the AMAN
- Inflexible AMAN: no input possible (time, sequence…)
  - → TTA information not taken into account to build approach sequence
  - → Inconsistent sequence with the TTAs
- Dense traffic
  - → In Normal operations, no specific priority was given to the TTA flights, so the current procedure applied, i.e. First one, first served.
- Mix of Light, Medium and Heavy aircraft, as well as slow and faster aircraft in the sequence
  - → Increased separation leading to lower arrival rate
- LSZH configuration (DEP RWY16)
  - → Each departure from RWY16 induces a 10-minutes gap for the Arrivals (enforce holdings) which disturbs the sequence
  - → No grouping neither accurate prediction of these departures
- Optimistic Arrival Rate
  - → An internal study is on-going to determine the possibility to reduce the Arrival Rate of LSZH during the peak periods.

Due to these limitations, even though the flights achieved better adherence to the TTA-fixes, there was a high discrepancy between the Time-Over the TTA-fix and the Arrival Time.

The Trials did not permit to improve the Arrival flow and it is difficult to assess of a better efficiency on the Arrival phase. On ANSP side, there was no improvement of predictability of the traffic concerning the Approach sector, and for the airspace user, there was no improvement of the punctuality.

However the first aim of the Trials was to assess the possibility for the flights to achieve TTA adherence and this goal was very well reached.

The propagation of the TTA adherence into the smoothing of the arrival sequence is part of the concept “Move from CTOT to TTA” future studies.

6.2.4.2 Recommendations

The next step of the concept “Move from CTOT to TTA” to study is to have more synergies between the TTA-fix and the arrival phase and conciliate the TTA coming from the DCB and dDCB measure to a TTA as a sequencing input.

In order for the concept to bring its benefits for the arrival flow, the main recommendation issued from the LSZH trials is to have the possibility to integrate the TTA information into the AMAN, so the AMAN takes into account the TTA times for the approach sequence computation.

For the concept to be effective, it has to include complete flows, so that non-TTA traffic does not disturb the computed sequence. The ETAs of the long-haul flights would have to be integrated into the TTO/CTOT distribution process by NMOC.

The results show that the take-off time is the most relevant factor for TTA achievement. Especially aircraft departing after CTOT often fail to reach their TTA. To avoid these situations, the time window for the take-off slot should be narrowed to ideally no more than 5 to 7 minutes.

6.3 Demonstration EXE-0202-003 Report

6.3.1 Exercise Scope

6.3.1.1 Scope of the exercise and compliance with the SESAR Programme

Demonstration Exercise ID and Title	EXE-0202-D-003: Munich
Leading organization	DFS
Demonstration exercise objectives	The FAIR STREAM project will evaluate through in-flight trials the benefits of "Move CTOT to TTA" concept on the flight efficiency, validate the capability of on-board and ground systems and will evaluate how crews, ATCOs, local FMPs and NMC can handle the procedure and the impact on traffic complexity and staff workload.
High-level description of the Concept of Operations	Use of TTA instead of CTOT as a DCB measure.
Applicable Operational Context	The scenarios defined during the design phase will be implemented to a set of flights normally subject to CTOT constraints due to congested entry points of major European hubs. The scenarios will involve the NMC, the TWR control of the departure field, the airlines operation, the crews, the local FMPs and ATC sectors of the involved ACC units and the approach control of the destination hub. These flights will be operated by the Airlines members of the consortium.
Expected results per KPA	Safety: to ensure at least the same level of safety Environmental sustainability: to reduce fuel consumption, to reduce gas emissions Cost effectiveness: no major changes expected Flight efficiency: to increase flight efficiency (time and fuel) Airspace Capacity: to better use the existing capacity Flexibility: to increase flexibility (management of the planning constraints) Predictability: to improve ATC and airline predictability Participation: to increase participation
Number of flight trials	#1 flight trial in May/June 2013 #2 flight trial in October 2013: A minimum of 10 flights is expected to participate, depending on ATFCM constraints.
Related projects in the SESAR Programme	P7.6.5: Dynamic DCB P7.3.2: Integrated network CDM P5.6.4 Tactical TMA and En-route Queue Management and P5.6.7: Integrated Sequence Building/Optimization of Queues
OFA addressed	05.03.04: Enhanced ATFCM processes 04.01: Traffic synchronization

Table 22: Scope of the EDDM scenario

6.3.1.2 Stakeholder identification, needs and involvement

DFS	DFS will provide the ATC segment for the flight trials executed at Munich airport and the concerned German Airspace. DFS will involve ACC/APP Munich and UAC Karlsruhe and the associated ATS-Systems in the trials. DFS will make use of the following systems/components: • Flight data and surveillance data processing systems, HMI systems, recording systems: • CHMI/NOP Portal interface to receive CTOT/TTA constraints and applying flight trials scenarios.
Deutsche Lufthansa AG	Deutsche Lufthansa is an International Airline with experience in flight trials for EUROCONTROL, SESAR and inside Germany. DLH will participate in the EDDM scenario with its city-pair flights from Paris (CDG) to Munich as already planned in its own actual fleet with current embedded equipment. DLH will make use of existing systems for the trials. These are: • Flight Plan Preparation System and System dealing with ATFCM slot: Flight plan preparation staff uses the system in order to calculate an optimized FPL (Route, Flight Level and Fuel consumption) needed for the Flight Plan Preparation based on the daily conditions for all DLH flights. It will be used to check a priori the feasibility of TTA and/or link between CTOT and TTA and disseminate CTOT/TTA to the crew; • ACARS tool: Aircraft communications and recording system that allows the Dispatcher to exchange information with the cockpit crew via Data Link Communication. • Tool to calculate flight efficiency based on average fuel flows.
Air France	Air France is an International Airline with experience in Flight Trial for EUROCONTROL and SESAR JU. Air France will participate in the EDDM scenario with its city-pair flights from Paris (CDG) to Munich as already planned in its own actual fleet with current embedded equipment: Air France will make use of the existing AOC systems for the trials. These are: • Flight Plan Preparation System and system dealing with ATFCM slots: Flight plan preparation staff uses the system in order to calculate an optimized FPL (Route, Flight Level and Fuel consumption) needed for the Flight Plan Preparation based on the daily conditions for all Air France flights. It will be used to check a priori the feasibility of TTA and/or link between CTOT and TTA and disseminate CTOT/TTA to Crew; • ACARS tool: Aircraft communications and recording system that allows the Dispatcher to exchange information with the cockpit crew via Data Link Communication. • FDM system: Air France Flight Analysis Database: For flight analysis purposes, Air France records parameters

	(such as position, speed, heading, fuel flow) of each flight every second. This information is stored into the Air France Flight Analysis Database and is available after the flight. Once available, it is possible to extract all of the flight information or just part of it; The Database will be used to collect the fuel consumption and any other parameters needed for results analysis, for all of the demonstration flights as well as to define the baseline. Since all the flight parameters are recorded every second, it is possible to focus on any particular phase of the flight.
EUROCONTROL (NMOC)	As Network Manager, EUROCONTROL will support the execution of the proposed live trial exercises in 2013 through its technical facilities (ETFMS, CHMI, NOP portal) available in the Network Manager Operations Centre or locally in the different Air Traffic Control Centers or Airline Operations Centers and the participation of the required NM operational staff (flow managers). EUROCONTROL, as WP7 "Network Operations" and WP13 "Network Information Management Systems" leader, will establish the required cooperation and coordination to ensure the full alignment of the proposed validation activities, with the relevant SJU projects P7.3.2 "Integrated Network CDM", P7.6.5 "Dynamic DCB" and P13.2.3 "Network Operations & Monitoring sub-system definition".

Table 23: EDDM scenario stakeholders

(1) In the EDDM scenario of the FAIR STREAM project generally only city-pair flights from LFPG to EDDM that are subject to an arrival restriction at EDDM (and that have thus been assigned a CTOT for LFPG) will be evaluated.

(2) However, in most cases EDDM arrivals will only be subject to arrival restrictions when the weather at the destination is foreseeable (> 2hrs) deteriorating for a longer time period which is unlikely at least for the first trial period.

6.3.2 Conduct of Demonstration Exercise EXE-0202-003

6.3.2.1 Exercise Preparation

DFS	DFS will use the following systems/components: • ATS Systems at ACC/APP Munich and UAC Karlsruhe; • Flight data and surveillance data processing systems, AMAN system, HMI systems, recording systems. • CHMI/NOP Portal interface. DFS issued a supplementary regulation to the Manual of Operations for ATS in support of FAIR STREAM. The airspace as well as the ATC procedures will be unchanged for the trial. The only relevant time with legal background is the CTOT and all trial flights have to adhere to the CTOT. Therefore, TTA and the CTOT have to be compatible. Official established procedures will not be overruled by the trial concept. Flights on this city pair participating in the FAIR STREAM trial will get no priority handling. ATCOs will be advised to rather avoid any instructions to accelerate or delay FAIR STREAM flights unless for safety reasons.

	The flight itself will be handled by the ATCOs in the same way as every other flight. No special activities by ATCOs will be made to influence "TTA-only-flights".
EUROCONTROL (NMOC)	The Network Manager activates a DCB ATFCM arrival regulation to overcome a predicted airport hotspot. IFPS has been upgraded to take into account the field 18 of FPL: EETPT (Estimated Elapsed Time at a Point), which will enable the NMOC to calculate flight profiles with much better accuracy. The AOs were requested to fill the FPL with the EET over the TTA fix, in order to have the best calculation of the CTOT and TTA, and therefore the best compatibility between these two values.
Air France	Air France participated in the trial with its city-pair flights LFPG to EDDM. Only few pilots of the A320 Division were informed and trained in the FAIRSTREAM trial process. Unfortunately, these dedicated pilots had flights without any CTOT and had therefore no opportunity to participate in the trial. The AOs filled, as requested by NM, the FPL with the EET over the TTA fix, in order to have the best calculation of the CTOT and TTA, and therefore the best compatibility between these two values.
Lufthansa	Deutsche Lufthansa participated in the trial with its city-pair flights LFPG to EDDM. The AOs filled, as requested by NM, the FPL with the EET over the TTA fix, in order to have the best calculation of the CTOT and TTA, and therefore the best compatibility between these two values.

Table 24: Exercise preparation

6.3.2.2 Exercise execution

See section 4.1 and following.

6.3.2.3 Deviation from the planned activities

- In order to generate a sufficient number of participating flights it was proposed to assign a TTA also to unregulated flights identified by the airline operators and to publish this via a flight list in the NOP. However, the process of the TTA is strictly linked to the CTOT and regulation affectation; so, it was not possible in Munich to assign a TTA value to non-regulated flights (neither assigning a status "exempted" to these flights) without changing the concept to be demonstrated. (see chapter 4.1.3.1 NM processes: TTA distribution)
- AMAN system has not been enabled for TTA input, because it calculates its sequence for metering fixes which are closer to EDDM than the TTA fixes, which are located in the EnRoute airspace almost at the edge of the Munich FIR. Without an extended AMAN horizon (as planned in the XMAN project) Munich ATCOs had no opportunity to influence FAIR STREAM flights according to possible AMAN proposals prior reaching the TTA fix.
- The objective as stated in the initial demonstration plan approved by SESAR SJU was to evaluate "the use of TTA *instead of CTOT*". However, in the EDDM FAIR STREAM exercises, the CTOT remains valid and participating flights have to adhere to the issued CTOT. FAIR STREAM Munich exercises will not enable to draw a conclusion on the substitution of CTOT by TTA; but they will provide elements supporting the use of TTA.

- The idea was to compare the relevant values of FAIR STREAM city-pair flights like flight times, distances, etc. with the equivalent average values of Non-FAIR STREAM flights (only arrival regulated, same aircraft type, same routing, etc.) outside the FAIR STREAM timeframe. However, due to the expected very low number of available regulated city pairs (route structure, traffic, weather etc. should be as closed as possible to the conditions during the FAIR STREAM trials) there will be not enough data to construct a reliable reference case for Munich trial. Furthermore, the expected low number of FAIR STREAM flights will not give a sufficient data pool for a thorough analysis. Thus, there will be no reference case available for the EDDM scenario.
- While elaborating the performance assessment plan for the individual FAIR STREAM exercises, it became obvious, that – for the EDDM scenario - the expected very low number of eligible flights (and their rather short flight time) will not allow reliable statements for most of the KPAs listed in Table 1.

  Therefore, the assessment will concentrate on the following aspects

  Feasibility of the TTA concept**:**

  - % of candidate flights completing the exercise
  - Workload felt by pilots and OCC
  - Record and analysis of difficulties that may be encountered during the trials

  Predictability:

  - Difference between ETFMS estimated flight durations and actual duration
  - Respect of the TTA

6.3.3 Exercise Results

6.3.3.1 Summary of Exercise Results

The manner of TTA presentation in the NOP Portal was found to be of limited suitability for the operational personnel (FMP operators).

During the first trial period which took place from May 19th until June 30th only a few arrival regulations (due to WX) have been issued for EDDM. 3 Lufthansa flights (CDG-MUC) were subject to these arrival restrictions.

Date	Callsign	CTOT	ATOT	T/O punctuality	TTA fix	TTA	ATO (over TTA fix)	Delta (TTA-ATT)	Flight time to TTA Fix	EET
22.5	DLH06M (A321)	11:34	11:31	00:03	ANORA	12:25	12:21	00:04	00:50	00:51
31.5	DLH44T (A319)	15:24	15:18	00:06	KUNOD	16:11	16:04	00:07	00:46	00:47
24.6	DLH44T (A320)	15:44	15:40	00:04	ANORA	16:33	16:29	00:04	00:49	00:49

Table 25: EDDM scenario - List of participating flights 1st trial period

During the second trial period, additional to the DLH-flights listed below, 4 flights from Air France were eligible to FAISTREAM (subject to arrival regulation at EDDM). However, the respective pilots have not been trained in FAIRSTREAM processes and did therefore not participate. (3 of these flights met their assigned TTA.

Date	Callsign	CTOT	ATOT	T/O punctuality	TTA fix	TTA	ATO (over TTA fix)	Delta (TTA-ATT)	Flight time to TTA Fix	EET
14.10.	DLH08H (A319)	05:13	05:08	00:05	KUNOD	05:57	05:51	00:06	00:43	00:44
22.10.	DLH08H (A319)	05:09	05:13	00:04	KUNOD	05:52	05:53	00:01	00:40	00:43
25.10.	DLH08H (A319)	05:37	05:34	00:03	KUNOD	06:19	06:12	00:07	00:38	00:42
31.10.	DLH37Y (A319)	06:09	06:04	00:05	KUNOD	06:54	06:47	00:07	00:43	00:45

Table 26: EDDM scenario - List of participating flights 2nd trial period

For the above listed flights the following observations were made:

- 1 flight reportedly received a short direct routing in French airspace (DLH08H on 14/10). An impact on the flight duration compared to other flights was not detectable.
- Only 1 flight met its assigned TTA in the [-3;+3] window (= 14%).
- 4 flights arrived significantly earlier than TTA (6 to 7 min).
- All flights, except DLH44T on 31.05., met their CTOT slot (-5/+10 min):
  - 5 flights took off 3 to 5 min earlier;
  - 1 flight took off 4 min late (this was the only flight that met its TTA).
- Issued EETs were in most cases equal or only slightly longer (+ 2’) than the actual flying times.
- In 1 case EET was undercut by 4’ (almost 10% of the flight time).

6.3.3.1.1 Results per KPA

Feasibility of the TTA concept:

- Number of candidate flights that completed the exercise.
  - DFS: there were no reports received that any airborne TTA-flight cancelled its participation.
  - Lufthansa: 7
  - Air France: 0
- Workload felt by pilots and OCC:
  - DFS: NA
  - Lufthansa: no major increase in workload.
- Record of difficulties that may be encountered during the trials:
  - DFS: None.
  - DSNA: None.
  - Lufthansa: OCC: Additional Access to separate NOP.
  - NMOC: None.

Predictability:

- Difference between CFMU estimated flight durations and actual duration:
  - Issued EETs were always longer (up to 4 min) than the actual flying times.
- Respect of the TTA
  - 6 flights (= 86%) missed their TTA.

- 6 flights took off 3 to 6 min earlier than CTOT. These early take-offs were not compensated Enroute.
- 1 flight compensated a late take-off (+ 4 min) and caught up 3 min Enroute to finally meet its TTA.

Environmental sustainability / Fight efficiency:

- Lufthansa: No statement.

6.3.3.1.2 Results impacting regulation and standardisation initiatives

NA

6.3.3.1.3 Unexpected Behaviours/Results

NA

6.3.3.1.4 Quality of Demonstration Results

Due to the very limited number of eligible flights the recorded results cannot be considered as being more than trend indications.

6.3.3.1.5 Significance of Demonstration Results

For the EDDM scenario the recorded results cannot be considered as being more than trend indications due to the very limited number of eligible and participating flights.

6.3.4 Conclusions and recommendations (EDDM)

6.3.4.1 Conclusions

With respect to the low number of participating flights, the following drawn conclusions can be at most initial indications:

- Aircrews tend to take off at the beginning of their assigned CTOT slot.
- Aircrews tend to rather compensate late take-offs than to lose time Enroute to meet their assigned TTA.

It appears that a TTA can only be met, when the EET is well calculated and the ATOT lies within the same tolerances around the CTOT that are valid for the TTA.

A compensation of multiple minute deviations from the target times seems to be hardly being accomplishable for short-haul flights.

6.3.4.2 Recommendations

Because of the low number of participating flights, it is not possible to draw reliable recommendations out of the limited amount of data.

A way to overcome this lack of data might be to conduct a simulation exercise to validate the TTA concept in terms of its effects on Flow Management.

To validate the practicability of the TTA concept with regard to its procedures and applicability in real operations, it seems recommendable to repeat these flight trials with the following points taken into consideration:

- raising aircrews awareness for TTA compliance;
- involvement of ATC at departure aerodromes (to allow take-offs even closer to CTOT times);
- assignment of same time tolerance for TOT as for TTA;
- further elaboration and application of TTA-procedures for non-regulated flights.

7 Summary of the Communication Activities

7.1.1.1 Common material

The consortium has written a common material to promote the FAIR STREAM concept. This paper describes the project, explains main results and limitations and explores next steps. From this information, a Powerpoint presentation is given. It includes two speeches, one of DSNA ATCO (Paris ACC), another of a SWISS pilot, both being part of FAIR STREAM Project Team. A specific drawing has been made to identify the project.

7.1.1.2 Publications achieved by the consortium between June 2012 and March 2014

FABEC

Press Release "FAIR STREAM: common approach to increase flight efficiency" / December 2012

The FABEC E-newsletter

Leaflet FAIR STREAM / February 2013

CONSORTIUM

A leaflet "Traffic Synchronization" for WAC Madrid / March 2014

DSNA

An article in the leaflet "Dossiers de la DSNA" / April 2013

Annual Report 2012 / June 2013

An article in the newsletter "Lettre InfoDSNA" / August 2013

These documents are available on our website

Skyguide

An article in the internal magazine "Skytalk" / June 2013

DFS

An article on the corporate intranet / December 2012

An information on the corporate intranet / June 2013

Eurocontrol

Air France

Presentation to the Ops Directorate and to operational people concerned by the project

An article in the internal magazine "Pilotes Info" / October 2013 and April 2014

SWISS

Presentation to the Ops Directorate and to operational people concerned by the project

Airbus Prosky

Press Release "ATM teams from Airbus and EADS to participate in 7 SESAR JU Integrated Flight trials" / November 2012

An article on SESAR activities in the external magazine "Up to Planet" and in the Airbus' corporate internal magazine "One" / October 2013

7.1.1.3 External communication

The project leader presented the topic on 5th of March 2014 for the SESAR Workshop "Demonstrating solutions" at the World ATM Congress Madrid.

7.1.1.4 A short educational video

The writing on the story board is on progress. It's validation by all partners is scheduled on the 31st of March 2014. The layout of the video will begin. All partners will be invited to comment the first version no later than the 30th of April. The final version will be sent to the SJU in May.

8 Next Steps

8.1 Conclusions

- **The FAIR STREAM trial shows an increase of the predictability of the flights at the TTA fix**, with all the actors in the loop and current technical on-board equipment.

Although there is less variability during the trials, the adherence of TTA is subject to the 2 main following points:

- **Take Off: there is a strong correlation between Take-Off Time and Time-Over the TTA-fix**. Flights having a tendency to take-off early could choose to take-off closer to CTOT or TTOT in order to respect their assigned TTA, whereas flights that having a tendency to be late could catch up with the delay only to a certain extent. It was observed that the usual CTOT window width [-5;+10min] is considered in itself too large for short haul flights to reach a TTA precisely enough.

  Moreover, in LFPG exercises, the pilot could choose a Target Take-Off Time optimising the flight profile and reducing the fuel burn. The use of TTA could offer more flexibility to Airlines. Depending on the situation, aircrews can leave the gate earlier, avoiding departure punctuality degradation, and can fly more “fuel efficiently”. **Getting the ideal Take-Off Time seems to be the most efficient and cheapest way to comply with TTA.**

- **Unplanned tactical directs: could affect the adherence for TTA compliance**. On the other hand, this could not be a reason to stop providing shortcuts. Moreover, as these shortcuts are almost systematic, there might be ways to manage that at strategic or planning stages. However, prohibit tactical direct routes is not an option neither.

- The experience gained through FAIR STREAM exercise suggests that **significant amount of flights that would disregard TTAs could jeopardize the expected benefits of the concept**. In order to guarantee the smoothing of traffic expected by all stakeholders, it is necessary to ensure that all flights keep trying to comply with TTA.

- Adjusting speed in flight to match a TTA could be costly for Airspace Users, both in terms of time and fuel. **These extra costs can only be accepted if the operational benefits obtained are higher**. In the meantime, as no operational priority could be safely given, participating flights tended to experience at least as much arrival delay as non-participating flights and no benefits were experienced for Zurich large scale experiment.

- It appears important to **make sure that AMAN operations will remain consistent with the TTA ones**. The freezing of the TTA in the AMAN in LFPG exercise raised some difficulties for the building of the sequence. Nonetheless flights slowing down to match a TTA should not be sped up afterwards, and vice-versa. Furthermore, as future AMAN concept tends to increase its time horizon, up to 1 hour before arrival, the borderline between Flow Management and Arrival Management will quickly narrow, and eventually overlap.

- **Updating the Estimated Elapsed Times in the ETFMS (V.17) before Take-off improved the accuracy of CTOT and TTAs.**

- The actors' workload was acceptable during the trial as soon as – for the LSZH scenario – internal software had been developed in order to re-distribute the TTA information through ACARS message to concerned Flight Crews, which enables to reduce AOC workload.
- Flights departing from CDM Airports (e.g. CDG) succeeded in respecting their TTA so we can conclude that **CDM and TTA concepts are compatible**.
- The impact on fuel efficiency of a global use of TTA could not be clearly studied on FAIR STREAM flights. **The network impact on fuel efficiency is then not clear.**

8.2 Recommendations

On 2013 19th of December, VP632 and FAIR STREAM held a joint workshop in order to define the needed further works on the concept. These works are done through brainsessions and fast time simulations in 2014. OSED and DOD will be then updated according to the feedback of the workshop and the results of these further works.

FAIR STREAM is a first step in the TTA concept in order to demonstrate the feasibility. That's why there's a need to further investigate its development.

Some points may be studied (**MP**:Main Programme, **DW**: Demonstration Work):

Concerning the expected benefit:

- **MP -** further define expected operational benefits, level of performance required, and evaluate benefits;
- **DW -** test on complete flows in order to be able to evaluate the impact on capacity and to investigate the predictability after the TTA fix.

Concerning the ATFM part:

- **DW -** test TTO (with an Enroute most penalizing regulation);
- **DW -** find a solution to take long-haul flights better into account;
- **MP -** consider that TTA can be used complementary to CTOT.

Concerning the airside ground phase:

- **MP -** further work on the reduction of take off time variability : reliable off bloc time and Taxi Time;
- **MP -** further work on reliable take off time and the possibility to update TTA.

Concerning the relation with en route and/or approach ATC:

- **MP -** ensure that flights are globally less penalized after TTA-fix;
- **MP -** study how to manage flights which will not comply with their TTA, not voluntary and voluntary;
- **MP -** further analyse a mean to manage tactical direct routes when using TTA;
- **DW -** study the collaboration between TTA and AMAN.

Airbus Prosky recommends investigating in the improvement of adherence to TTA by using the on-board FMS RTA function.

Regarding the need for improvement of TTA adherence, Air France demonstrated through the LFPG trials that a significant increase in TTA has been reached without using the RTA function during the flight. The level reached in terms of TTA adherence (plus or minus 3 minutes) is so far in line with the operational needs and constraints (like potential direct routings …). So trying to improve the adherence to TTA for a single flight is not the right question to address. The right questions to address in the next steps are:

- "could TTA concept be deployed large-scale on a complete flow" as mentioned in the beginning of this section,
- How to reduce the impact of the 2 major factors for TTA non-adherence, which are the Take-off variability and unplanned direct routes?

Regarding the use of RTA, SWISS advised their short haul pilots against using it as the current RTA function allows speed adaptations exceeding the company's speed policy as well as ATC rules (adherence to filed speed schedule).

Skyguide strongly supports this point of view.

This is also supported by Air France whose flight operations share the same observation and it is recommended not to use it.

From a DSNA point of view, the use of the RTA function led to a flight with a very unusual low speed that could have caused a safety event if it hadn't been immediately taken into account by the ACTO.

New constraints should be globally less penalizing than the previous ones. Eventually, an evolution of the regulation might be needed to guarantee the smoothing of traffic expected by all stakeholders. Indeed, it is feared that if TTAs are defined only as proposed extra constraints, the flights that do not make an effort might gain an unfair advantage, basically overtaking the participating ones. As a consequence, it is recommended that any progressive introduction of TTA in real time operations should be accompanied with incentives to enforce its application.

9 References

9.1 Applicable Documents

[1] EUROCONTROL ATM Lexicon
https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR

9.2 Reference Documents

The following documents provide input/guidance/further information/other:

[1] ATM Master Plan
https://www.atmmasterplan.eu

[2] Operational Focus Area, Programme Guidance, Edition 03.00.00, date 4.05.2012

[3] SJU Communication Guidelines

[4] Technical Proposal in response to call ref. SJU/LC/0070-CFP FAIR STREAM

[5] Financial Proposal in response to call ref. SJU/LC/0070-CFP FAIR STREAM

[6] Operational Service and Environment Definition (OSED) P05.06.04

[7] Operational Service and Environment Definition (OSED) P05.06.07

[8] OSED Step1 V3 Initial - 07.06.05 D035 - Edition 00.01.00

[9] SESAR B4.2 CONOPS

[10]07.06.05 Step 1 V3 Validation Plan

[11] 07.03.02 Step 1 V3 Integrated Validation Plan

[12]13.02.03 Technical Specification

[13]"Step 1 Release 3 Network Detailed Operational Description (DOD)" - D27 - Edition 00.02.00

[14]VP632 Exercise Report - Integrated and Pre Operational Validation 00.01.00

[15]FAIR STREAM Demonstration Plan 00.02.00

[16]FAIR STREAM Scenarios Description 00.01.00_Released

[17]FAIR STREAM Procedure for non-regulated flights V1.0

[18]FABEC notification FAIR STREAM V1.0

[19]FAIR STREAM Safety Case – common document V1.0

[20]FAIR STREAM EPIS-CA V1.1

[21]FAIR STREAM Project ISA v1.0

[22]Meeting a Time Constraint through Speed Changes – A generic Efficiency Study by Airbus and Boeing v1.0

Appendix A KPA Results

Safety: to ensure at least the same level of safety

No safety event.

No controller or pilot report of feeling of reduced safety.

No significance increase of workload for crews. Workload for airline's OCC does not increase if few flights per day, When a lot of flights used TTA in the same time, a software has been developed not to increase OCC's workload.

Environmental sustainability: to reduce fuel consumption, to reduce gas emissions

Identification of consumption trends :

*Reduced through planning at more efficient speed

*Possibly reduced by flying at reduced speed

*Possibly increased by adjusting speed to match TTA

Identification of the need to balance possible increase with expected operational improvements.

Flight efficiency: to increase flight efficiency (time and fuel)

Pilots' feedback demonstrated the ability to adjust TTOT and speed to reach a TTA.

Airspace Capacity: to better use the existing capacity

NA

Flexibility: to increase flexibility (management of the planning constraints)

The use of TTA could offer more flexibility to Airlines. Depending on the situation, aircrews can leave the gate earlier and can fly more "fuel efficiently"

Predictability: to improve ATC and airline predictability

36% of baseline flights meet the estimated time over the TTA-Fix at plus or minus 3 minutes, whereas it increases to 54% for flights with a TTA. And less variability is also observed.

Cost effectiveness: no major changes expected

NA

Participation: to increase participation

NA

Appendix B Meeting a Time Constraint through Speed Changes – A generic Efficiency Study by Airbus and Boeing

Note: This is only an extract of the generic efficiency study. The whole document is available on FAIR STREAM extranet. link

Content

Summary

Airbus invited Boeing to participate, under sub-contract, to support the SESAR FAIRSTREAM project—an evaluation of time-based operations. The project mission includes contributions to integrating several SESAR Operational Focus Areas linked to traffic sequencing and initial 4D trajectories for optimized flight profiles and procedures. SESAR's intent is to introduce this new concept in an operational environment by validating procedures and potential technical systems necessary to support implementation of the concept.

Both Airbus and Boeing provided collaborative contributions from a manufacturer's perspective in assessing generic flight efficiencies when using Target Time of Arrival (TTA) instead of calculated take-off time as a demand and capacity-balancing alternative. The Airbus / Boeing collaborative contributions to the final FAIRSTREAM report are primarily in support of Work Package 3 (Performance Assessment) as assigned by DSNA (Direction des Services de la Navigation Aérienne), the leader of this section of the project. The following scenarios outline the Airbus / Boeing studies assuming no wind conditions, a standard atmosphere, and a TTA metering fix or holding at flight level 100 in the approach area of an arrival airport.

Scenario 1, (ab-initio): develops airplane-agnostic trends using manufacturers' tools to show typical but generic fuel burns for a heavy and a light jet as a percentage of trip fuel. Trends are shown graphically as relative fuel burn over time (to lose or to gain).These trends represent the effect of small speed adjustments to maintain a TTA. This scenario includes comparing relative fuel burns if the flight had to lose time through a holding to meet the assigned TTA.

Scenario 2, (en-route): uses BADA 4 simulations and provides similar results as did scenario 1 except that the trends in generic fuel burn are for distances defined as "distances to go to the TTA meter fix" measured from a waypoint while the airplane is in cruise. In this scenario, the fuel burn is in kilograms for a typical heavy and light jet versus distance as speed changes in small increments. These speed increments provide generic trends in fuel burn, about the nominal Mach initially selected for the flight, and are within a plus/minus Mach .04 envelope to reflect realistic operations. Included are

comparisons of fuel burn for flights that maintain their initial (and faster) speed assignment throughout the flight but then have to lose time through a holding pattern in order to maintain a TTA.
Scenario 3, (shortcut) and Scenario 4, (path stretching): use BADA 4 simulations to illustrate how small speed adjustments influence fuel burn trends in kilograms for a typical heavy and light jet compared with their respective nominal Mach initially assigned to the flight. These comparisons illustrate the effect of speed related fuel burn to maintain the assigned TTA when accommodating either a shortcut or path stretching during the flight. The speed changes selected are within a plus/minus Mach .04 envelope that realistically reflects operational situations.

1. Purpose

The objective of this study is to analyze the impact of time-based operations on fuel efficiency of an individual flight. The study considers a single time constraint, Target Time of Arrival or TTA, for each participating flight with an assumed metering fix at Flight Level 100 in the arrival phase. The study does not attempt to analyze demand/capacity balancing or arrival sequencing but the assumption is that it could support such analyses in the future.
The study develops generic performance results and provides trends in delta fuel relative to trip fuel to maintain a TTA for short and long haul airplane weights. These trends include small speed variations about a nominal value initially assigned for the flight and compares holding at this nominal value. The study also compares delta fuel burn for shortcut or path stretching alternatives against the nominal speed to maintain a TTA. The graphically illustrated trends are only indicators of how airplane configurations might influence fuel efficiencies under TTA conditions; they do not reflect a particular airplane performance or capability.
Judgments or interpretations made from remarks or results presented within this study are solely those of the reader and do not reflect the manufacturers position. For specific information pertaining to a particular aircraft type with operational weights tailored to a given city pair, please contact the individual manufacturer.

2. Variables

Both cases for meeting the time constraint are studied:

- speed reduction (Time to Lose – TTL)
- speed increase (Time to Gain – TTG)

The speed variations studied are within a window of about +/-0.04 Mach above or below the nominal speed in order to concentrate on the most relevant operational cases. The efficiency of the speed change depends mainly on the following three parameters, which are variables in the study:

- remaining distance to the metering fix
- time to be lost or gained
- company Cost Index (CI).

3. Scenarios

Four scenarios are considered, for each of which the variation in fuel burn is calculated compared to a reference case:

- <u>Scenario 1, ab-initio</u>: The time constraint is known before take-off and is taken into account in the speed profile for climb, enroute and descent till metering fix. This is compared to flying with nominal speed and to a holding for the time to lose case.

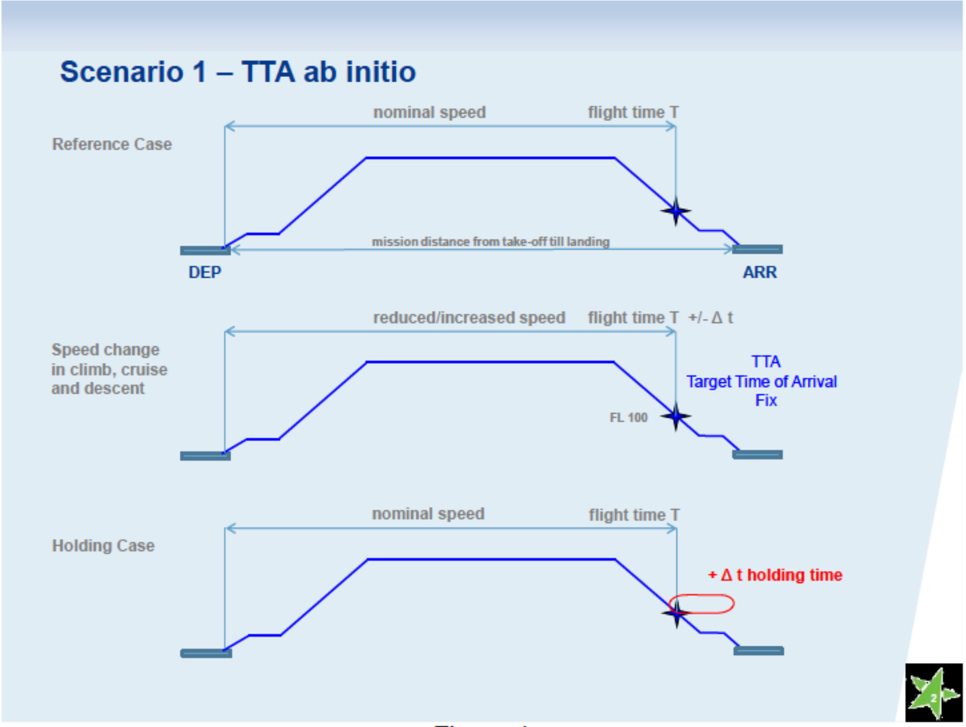


Figure 1

- Scenario 2, en-route: The time constraint is targeted as from an en-route point onwards and speed change is applied in the remaining en-route phase and descent till metering fix. This is compared to flying with nominal speed and to a holding for the time to lose case.

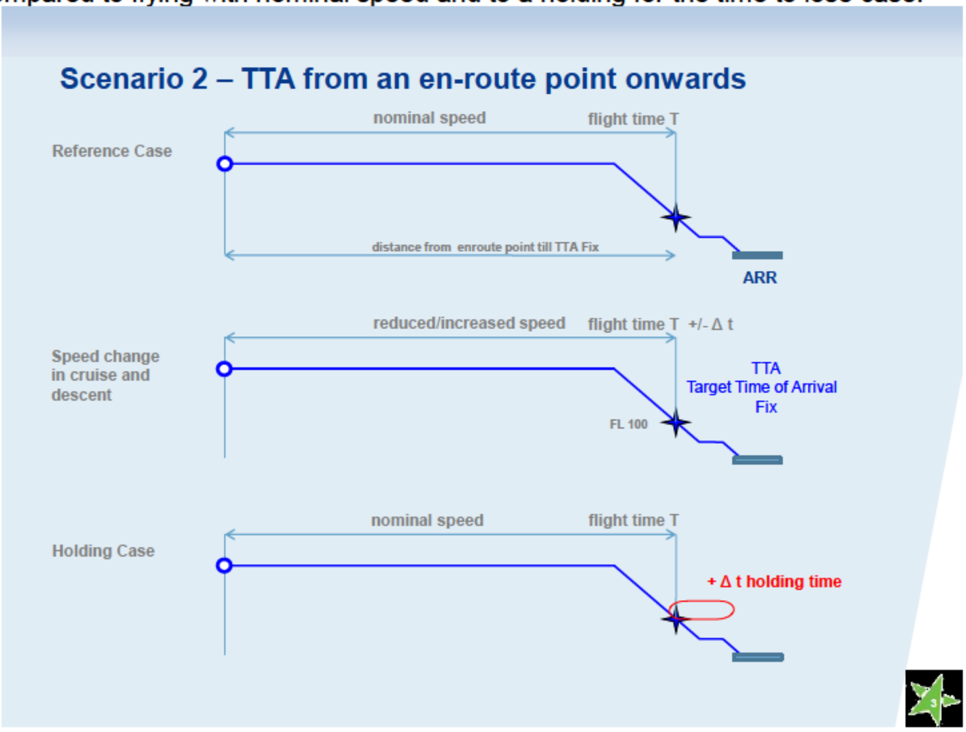


Figure 2

- Scenario 3, shortcut: The time constraint is maintained to be targeted although a shortcut has been accepted; this results in a speed decrease. This is compared to the reference case, where the non-shortened distance is flown with nominal speed.

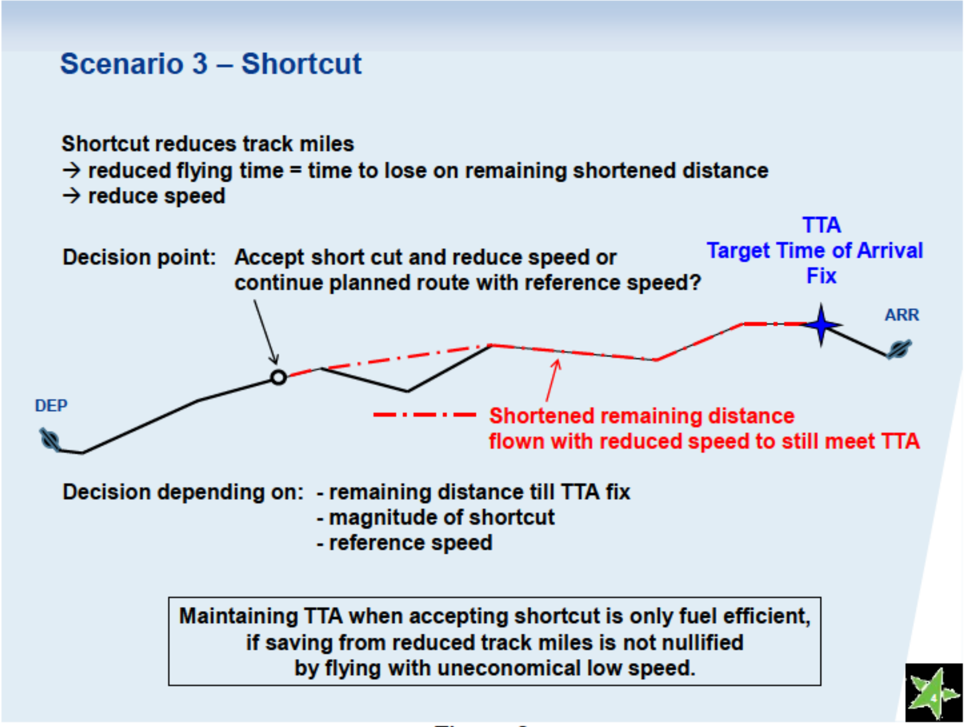


Figure 3

✈ <u>Scenario 4, path stretching</u>: The time constraint is maintained to be targeted in spite of a path-stretching; this results in a speed increase. This is compared to the reference case, where the stretched distance is flown with nominal speed.

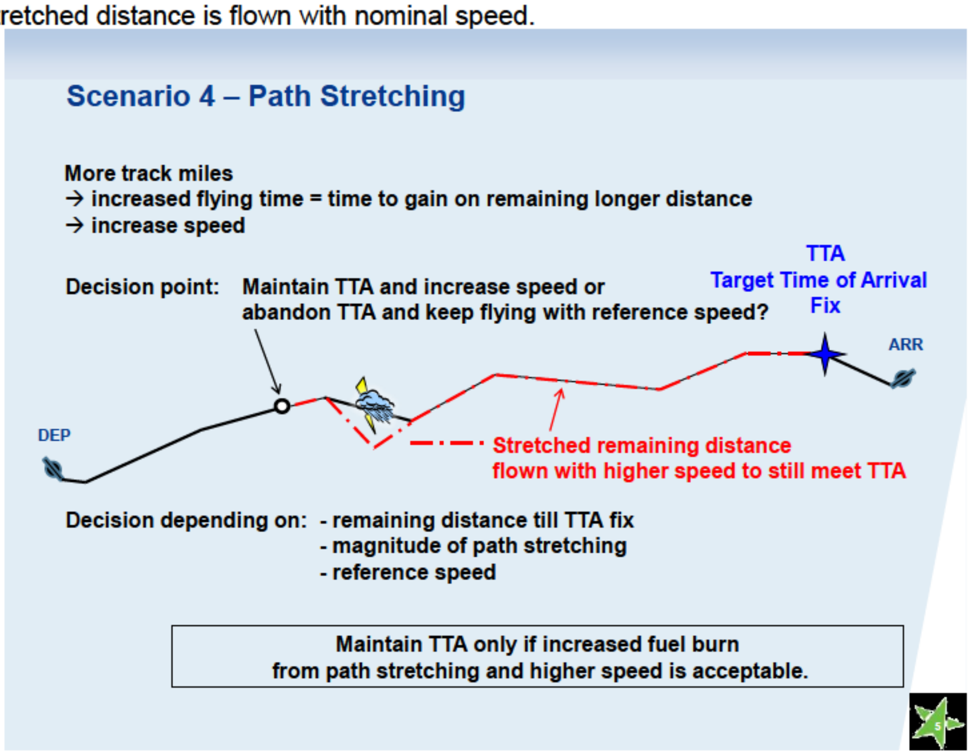


Figure 4

4. Aircraft Categories

Four different aircraft categories were chosen in order to cover a wide range of performance behavior. Three different single aisle aircraft are simulated with different weights and speed behavior and one long range aircraft, referred to as

- continental light jet 1
- continental light jet 2
- continental heavy jet
- long range heavy jet

The exact aircraft types and weights are not disclosed on purpose because the study wants to remain notional showing generic trends. However, the manufacturers can be contacted for further studies, which may be tailored to specific city pairs, aircraft types and weights.

5. Simulation Tools

Two different tools are used:

- Aircraft manufacturers' performance tools
- Eurocontrol BADA tool, latest issue 4 (currently under validation)

5.1 Manufacturers' Tools

The manufacturers' tools allow making sensitivity analysis related to the cost-index. They were used to calculate Scenario 1 for the following cases:

- continental heavy and continental light jet 1
- reference cost index 0, 20 and 40
- holding at FL100
- 300, 700 and 1100 NM (mission distance from take-off till landing) to represent a typical distribution of the mission distances flown in Europe by the A320 family and 737 fleet.

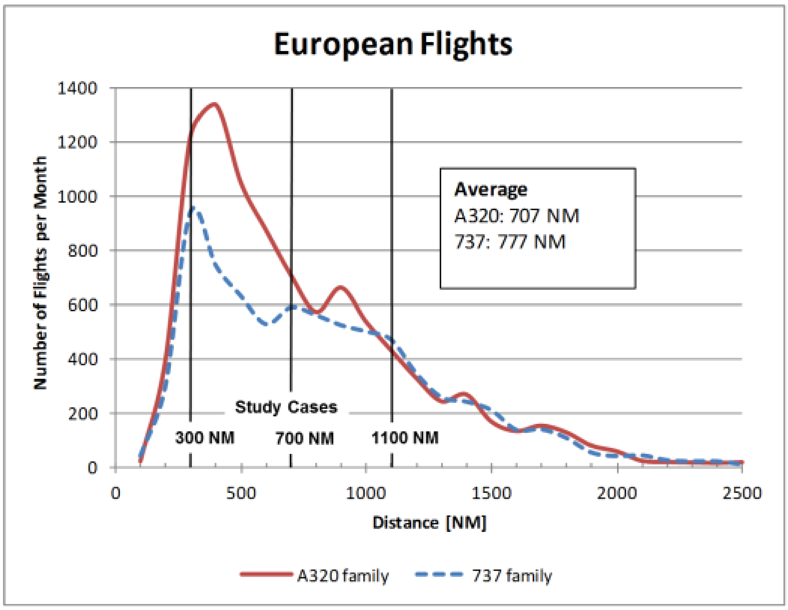


Figure 5

In order to preserve confidentiality of manufacturers' performance data, the results are presented as percentage values relative to trip fuel, where trip fuel is defined as take-off weight minus landing weight. For the same reason, the variation in speed is shown only for the cruise phase in form of Mach numbers; no correlation of CAS/Mach is made to cost index.

The cost-index weighted fuel burn is also provided. It is derived from the fuel burn through adding x kilos to the real fuel burn for each minute flown longer or reducing by x kilos for each minute flown less, where x is the value of the cost-index. An example is shown in the Figure 6.

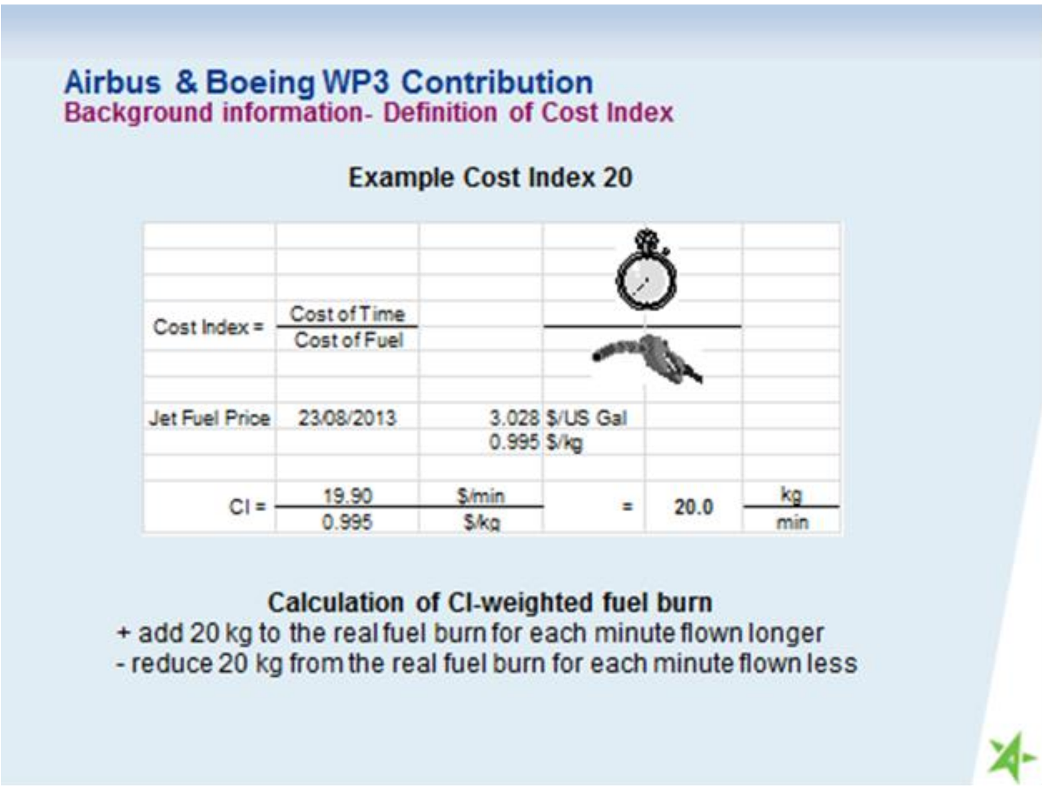


Figure 6

5.2 BADA 4 Tool

The BADA tool is available in the public aviation domain; this is why the results for variations in fuel burn can be shown as absolute values in kg. Variations in speed are shown in terms of Mach numbers for the cruise phase. However, BADA does not support cost-index sensitivity analysis. The BADA tool was used to calculate the following:

For a long range heavy jet and continental light jet 2

- Scenario 1 (TTA ab initio): 1 reference speed per aircraft category
  6 additional distances
- Scenario 2 (TTA from en-route): 1 reference speed per aircraft category
  7 distances (from en-route point till metering fix)
- Scenario 3 and 4 (shortcut and path-stretching): 3 reference speeds per aircraft category
  6 distances

An overview of all study cases is provided in Table 1.

	Manufacturers' tool	BADA 4 tool				
	Scenario 1		Scenario 2	Scenario 3 and 4		
	TTA ab initio		TTA from en-route	shortcut and path-stretching		
Continental Heavy Jet	CI = 0 CI = 20 CI = 40					
Continental Light Jet 1						
Long Range Heavy Jet		Ma 0.82		Ma 0.70	Ma 0.76	Ma 0.82
Continental Light Jet 2		Ma 0.76		Ma 0.66	Ma 0.70	Ma 0.76
		200	200			
	300		300	300		
			500	500		
		600				
Distance	700		700	700		
[NM]		1000	1000	1000		
	1100					
		1400				
			1500	1500		
		1800				
			2000	2000		
		2200				
	18 cases	12 cases	14 cases	36 cases		
	80 cases					

Table 1

6. General Assumptions

The following assumptions were taken for the simulations with manufacturers' and BADA tool:

- ISA - International Standard Atmosphere
- no wind
- optimum initial cruise level, remaining constant
- no vertical ATC constraints
- metering fix in arrival phase at FL100
- holding flown at FL100 at green dot speed

7. Results

All results are shown in graphical form.

7.1. General Observations

Figure 7 shows generically the influence of the cost index on a typical 'Delta fuel over TTG/TTL' curve. The shape of the curve doesn't change a lot, but it moves to the lower right with increasing cost index.

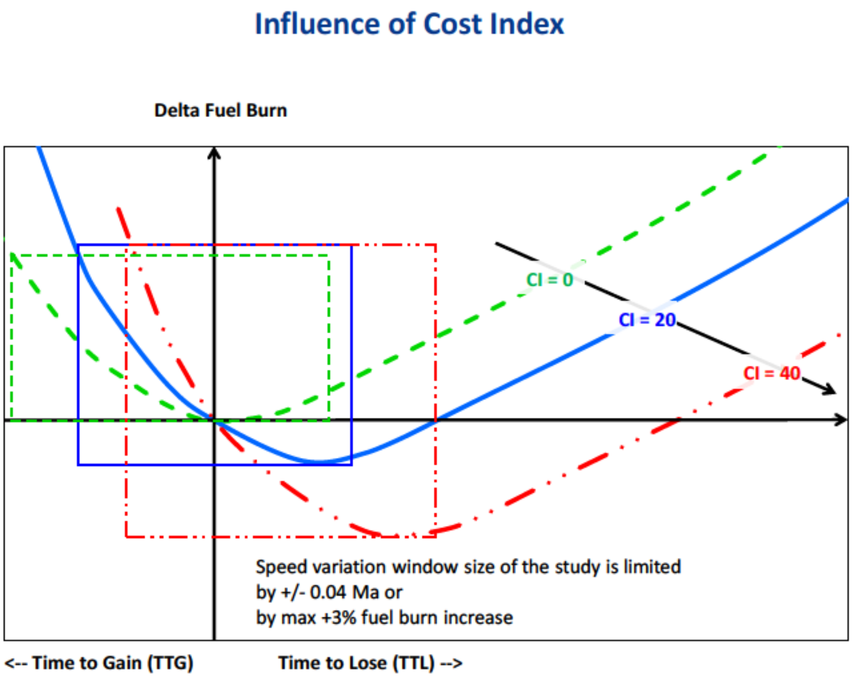


Figure 7

Figure 7 also shows qualitatively the zoom windows for this study. The windows are limited by either a +/- 0.04 Ma speed variation (if within the flight envelope) or by a maximum fuel burn increase of 3% (for calculation with manufacturers' tool).

6.1 Scenario 1 (TTA ab initio) – Manufacturers' tools

Figure 8 shows the change in fuel burn relative to trip-fuel and achievable time to lose as function of mission distance for a typical speed reduction by 0.02 Mach and a reference cost index of 20 for two different aircraft.

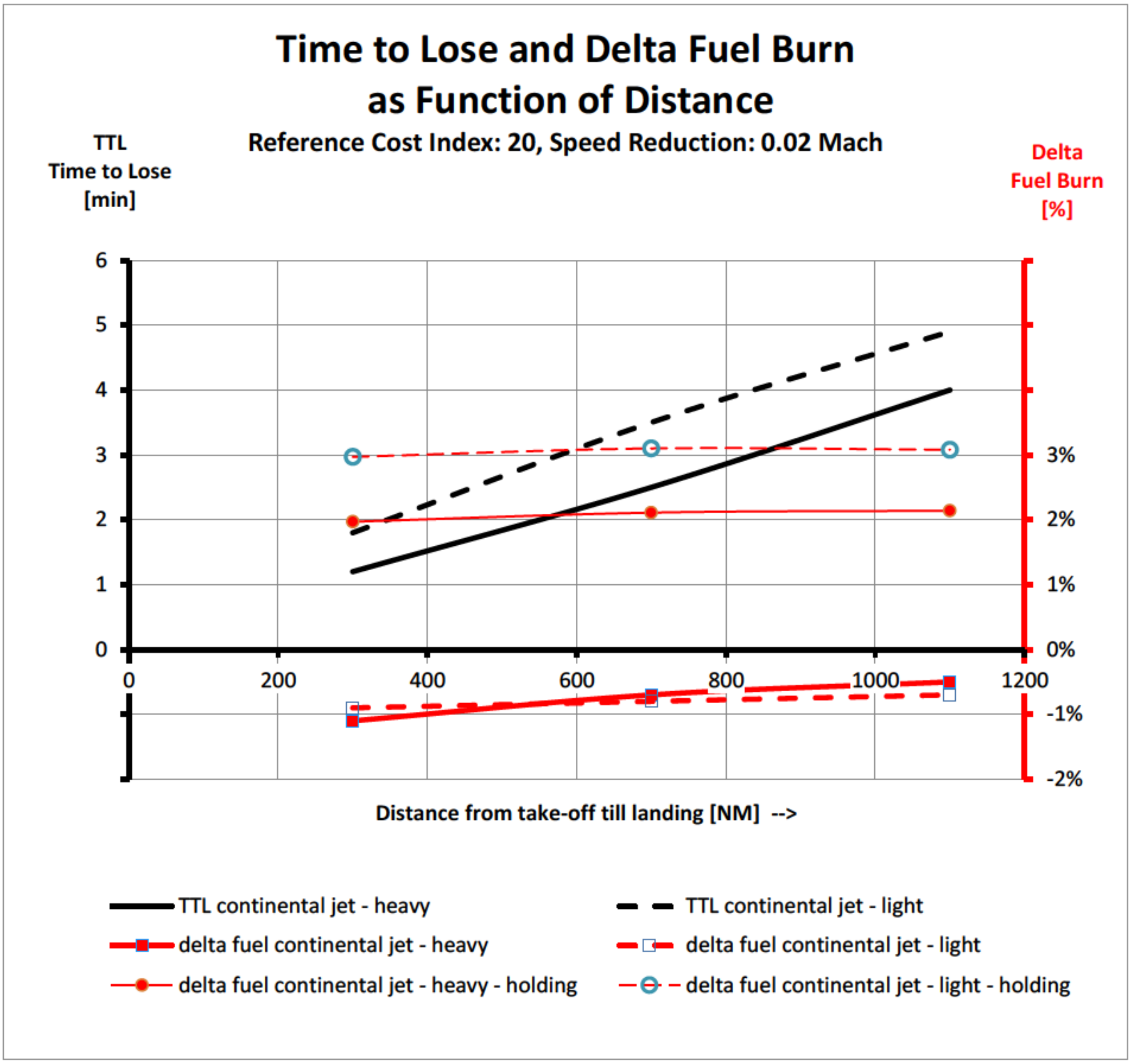


Figure 8

For a 300 NM mission (take-off till landing) around 1 to 2 min can be lost with a fuel saving of around 1% thanks to flying with a more fuel-efficient speed. For 1100 NM the potential to lose time is around 4 to 5 minutes with a fuel saving of about 0.5%.
Compared to the case where the delay is absorbed in a holding, the speed reduction is more fuel efficient by about 2.5% to 4%.
Results for other speed changes and cost indices can be obtained through the graphs in Annex A.

Annex A

Table 2 allocates a graph number to each of the cases studied for Scenario 1 (TTA ab-intio) with manufacturers' tool for three distances 300, 700 and 1100 NM and three CI values 0, 20 and 40.

Scenario 1 (TTA ab initio)		Manufacturers' Tool	
Graph N°	**Distance**	**CI**	**Content**
1	300	0	Mach over TTG and TTL
2			Delta fuel (%) over TTG and TTL
3		20	Mach over TTG and TTL
4			Delta fuel (%) over TTG and TTL
5			Delta CI-weighted fuel (%) over TTG and TTL
6		40	Mach over TTG and TTL
7			Delta fuel (%) over TTG and TTL
8			Delta CI-weighted fuel (%) over TTG and TTL
9	700	0	Mach over TTG and TTL
10			Delta fuel (%) over TTG and TTL
11		20	Mach over TTG and TTL
12			Delta fuel (%) over TTG and TTL
13			Delta CI-weighted fuel (%) over TTG and TTL
14		40	Mach over TTG and TTL
15			Delta fuel (%) over TTG and TTL
16			Delta CI-weighted fuel (%) over TTG and TTL
17	1100	0	Mach over TTG and TTL
18			Delta fuel (%) over TTG and TTL
19		20	Mach over TTG and TTL
20			Delta fuel (%) over TTG and TTL
21			Delta CI-weighted fuel (%) over TTG and TTL
22		40	Mach over TTG and TTL
23			Delta fuel (%) over TTG and TTL
24			Delta CI-weighted fuel (%) over TTG and TTL

Table 2

Remark: For CI=0, there are no 'Delta CI-weighted fuel over TTG and TTL' graphs because by definition they are identical with 'Delta fuel over time' (Cost of time = 0).
For any combination of distance and cost index, the graph 'Mach over TTG or TTL' provides the TTG or TTL value for a given speed change. The graph 'Delta fuel over TTG and TTL' then provides the impact on fuel burn for the corresponding TTL or TTG value.
Example:

a) Which is the speed reduction needed to lose 4 min on a 300 NM mission with a light jet flying usually with CI=40?
Graph 6: Speed to be reduced from Mach 0.735 to 0.696 i.e. by 0.039 Ma

b) Which is the associated change in fuel burn?
Graph 7: -2.8%

c) What is the difference in fuel burn compared with 4 min holding?
Graph 7: Holding: +1.7% per min i.e. 6.8 % for 4 min (linear extrapolation)
Difference of 9.6% (6.8% + 2.8%)

Figure 12 explains how to use the graphs in annex A for the reading of
- the speed change necessary to lose or to gain a given time
- the associated change in fuel burn relative to trip fuel
- the difference compared to losing the given time in a holding

See also Figure 1.

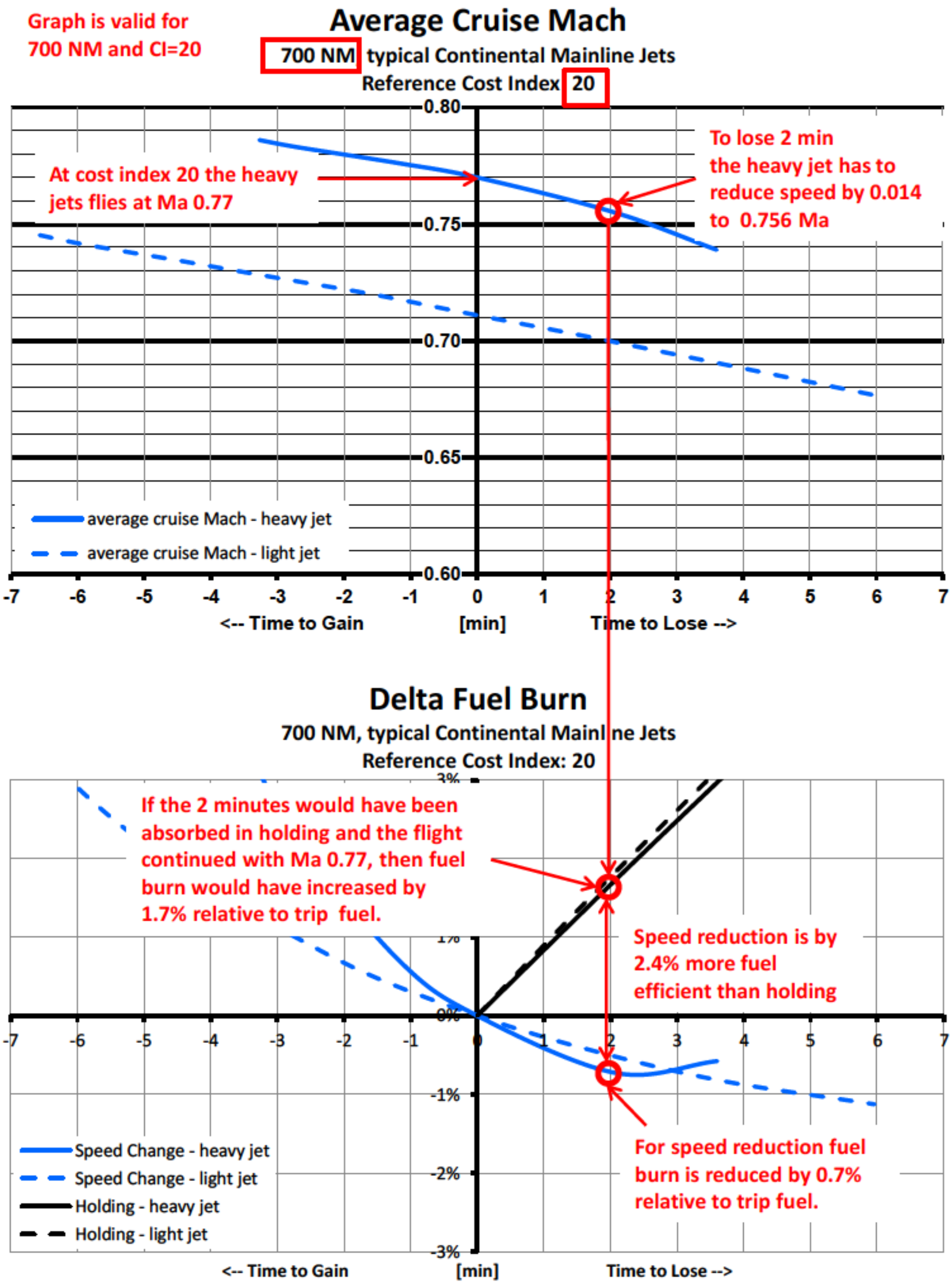


Figure 12

Figure 13 explains the transformation of the Delta Fuel Burn curve into the Delta CI-weighted Fuel Burn curve.
See also Figure 6.

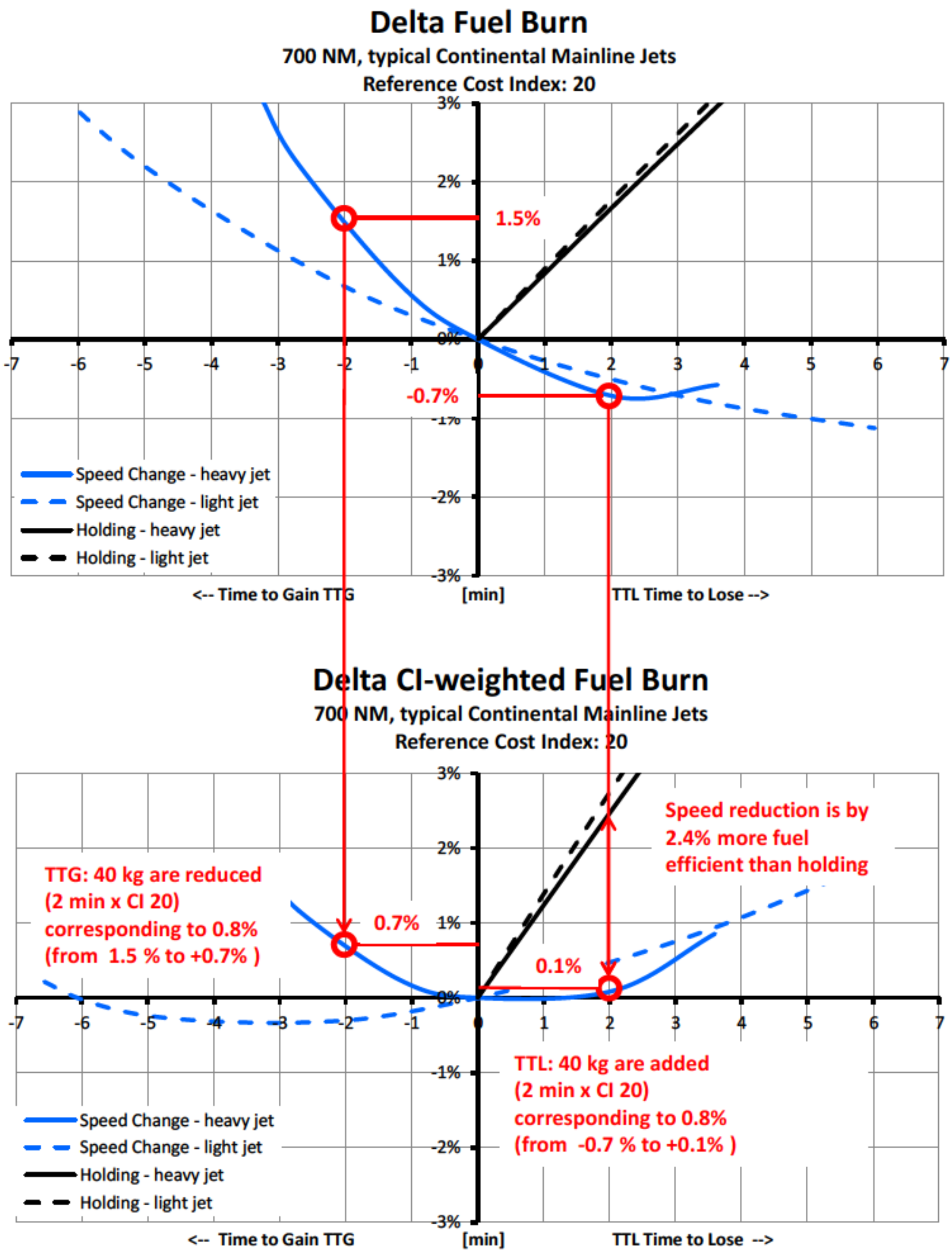
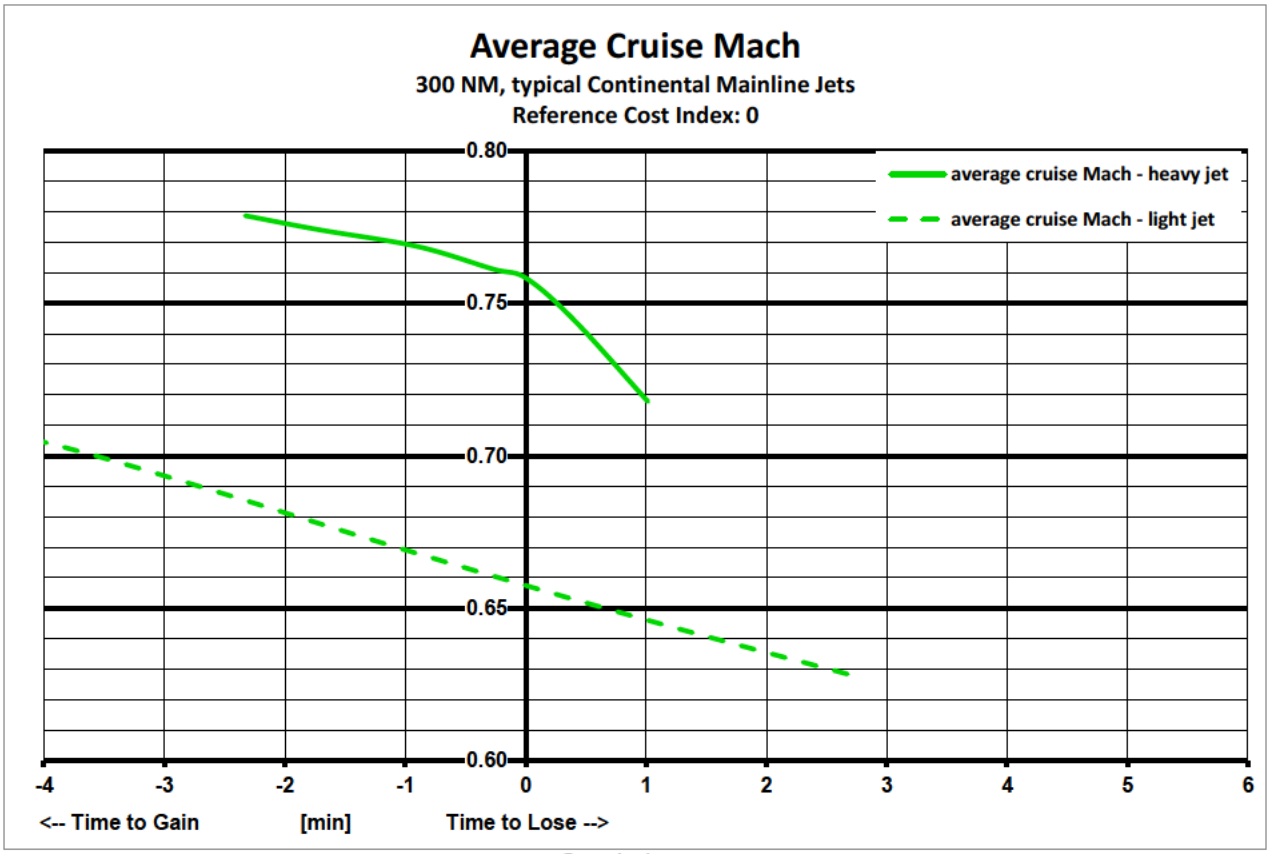
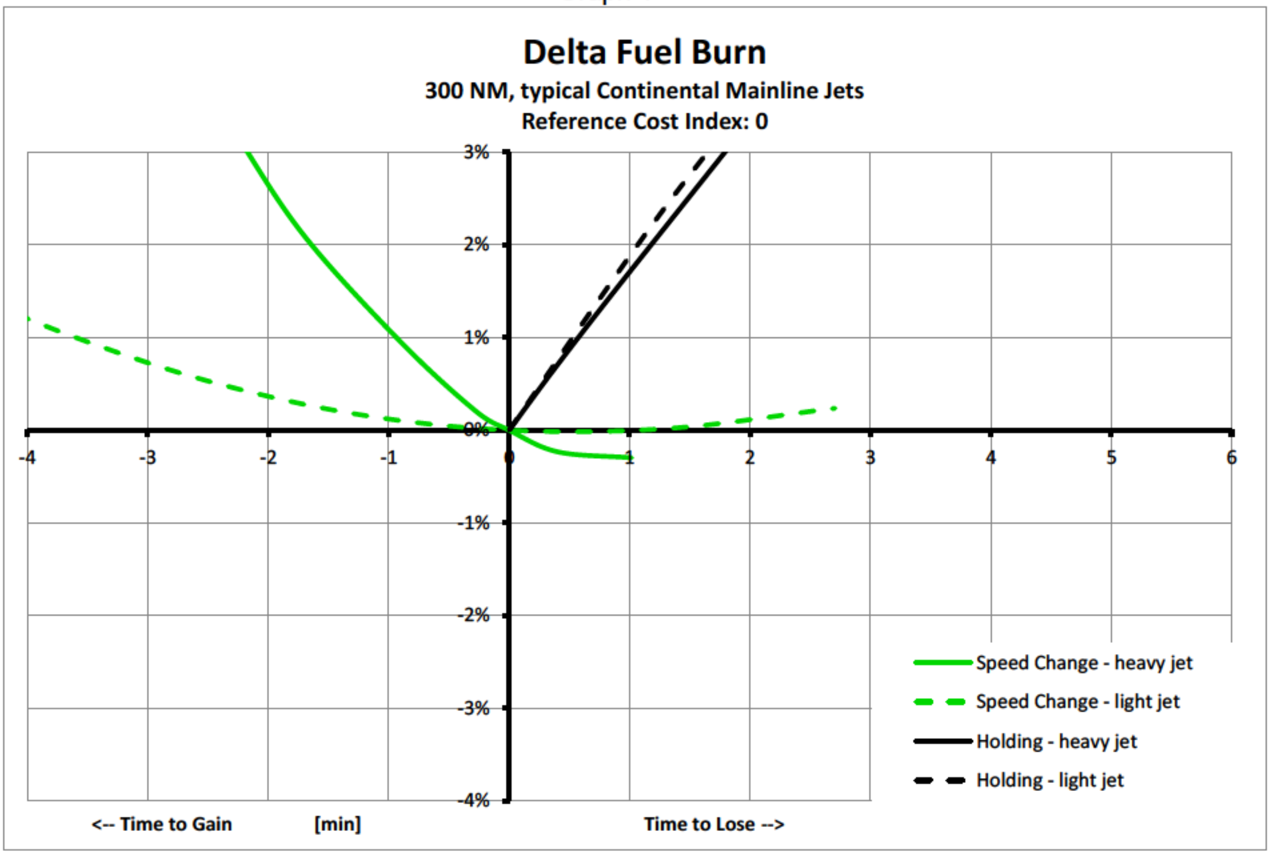


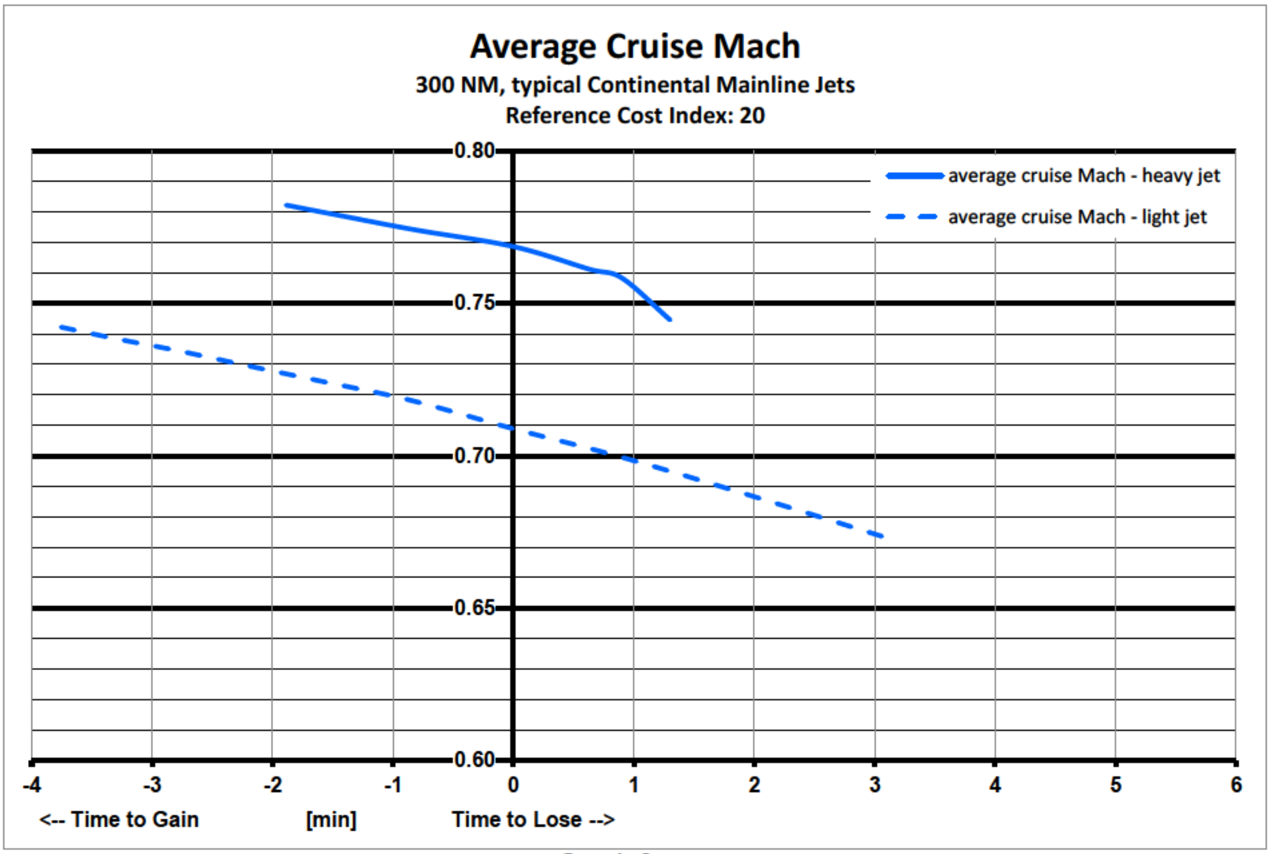
Figure 13



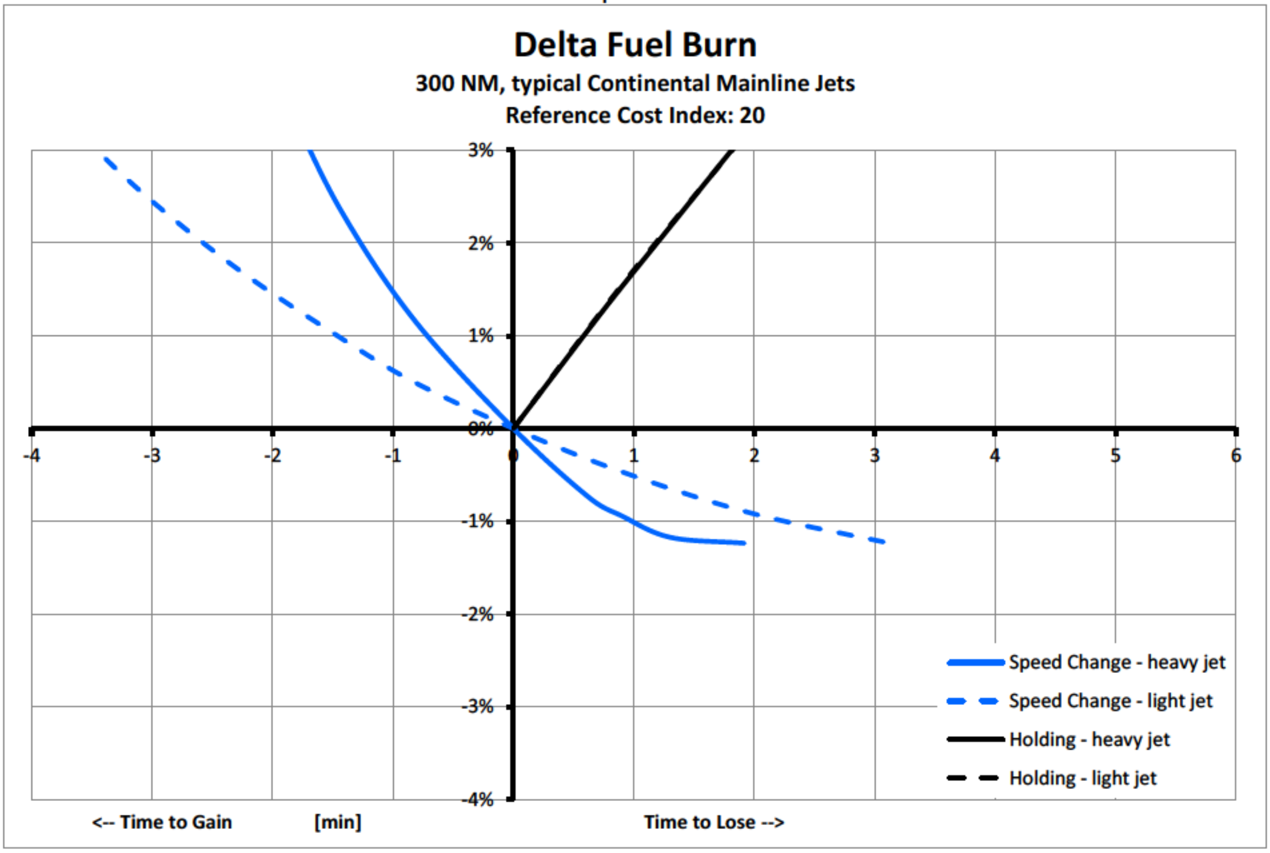
Graph 1



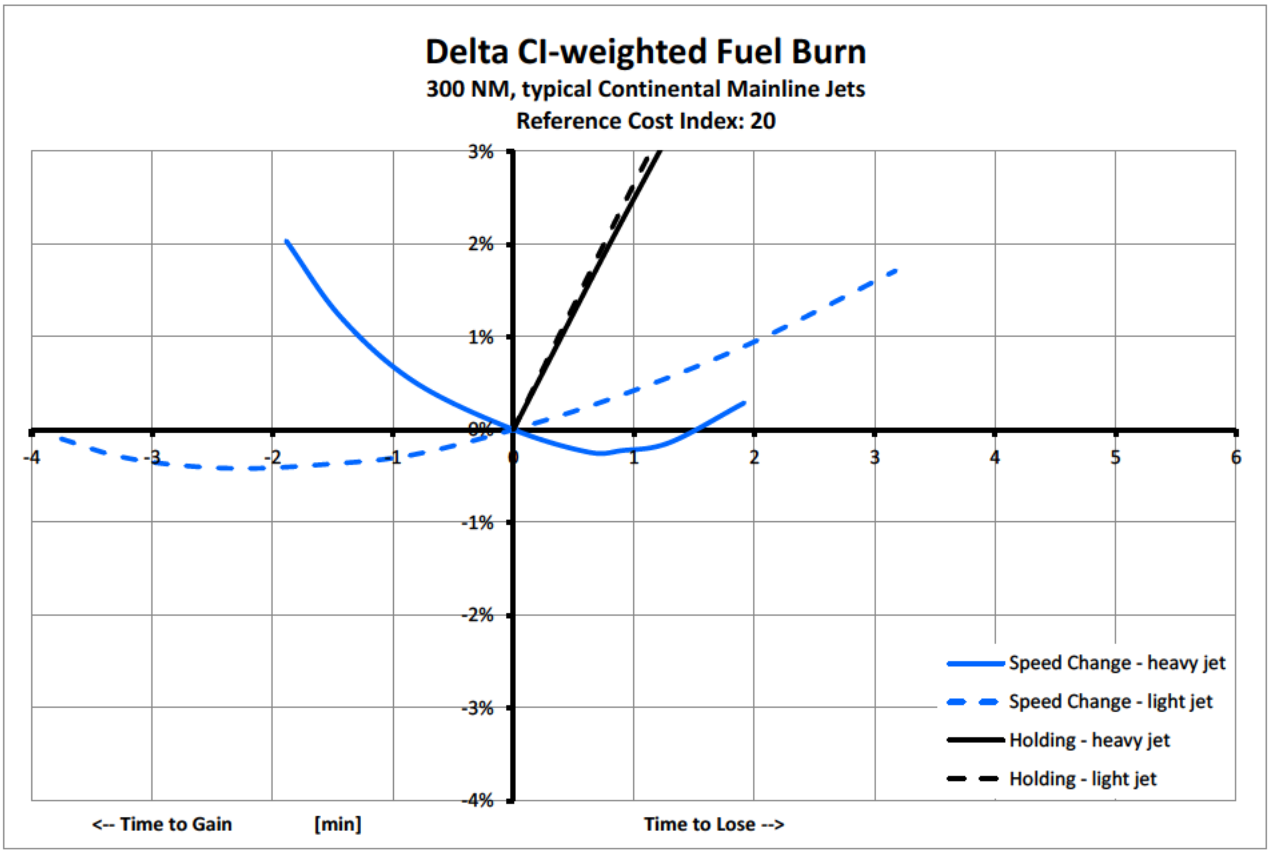
Graph 2



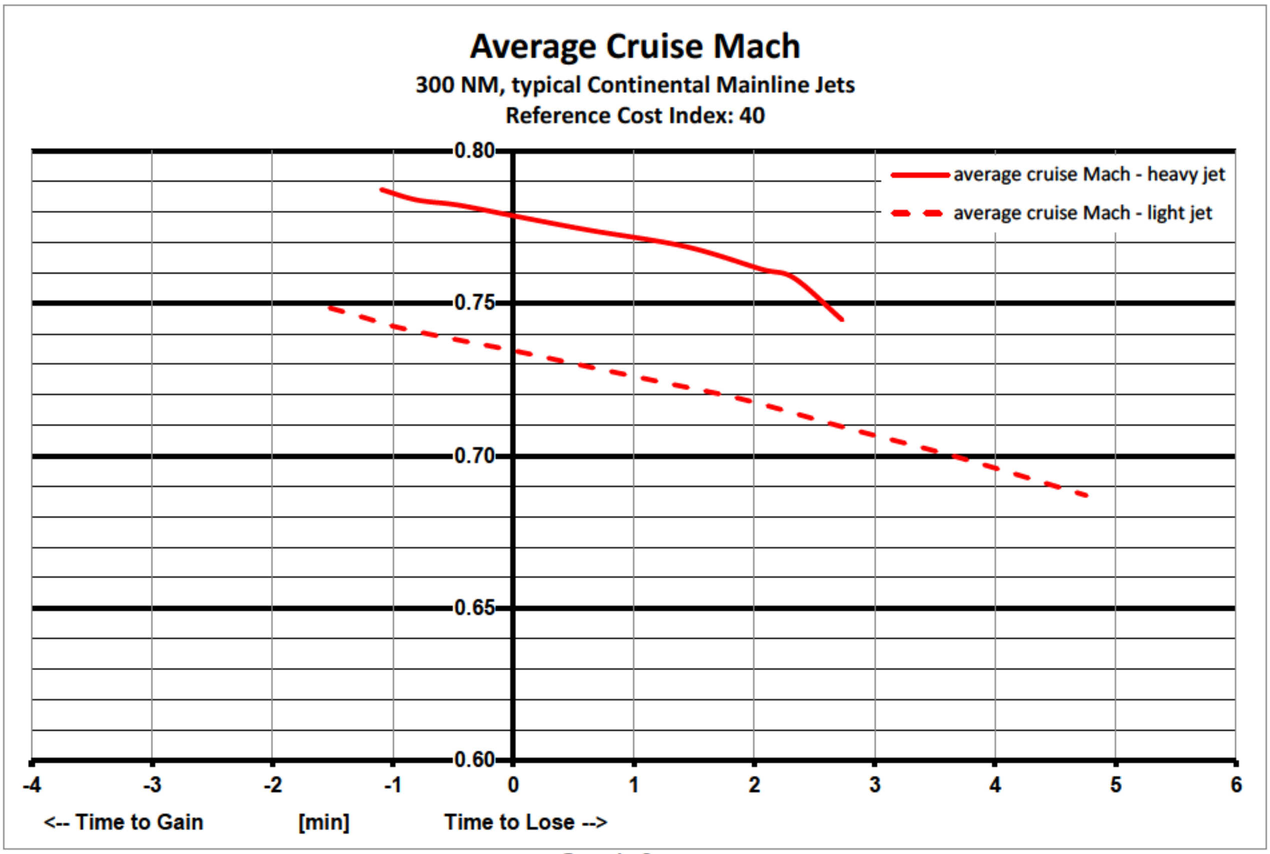
Graph 3



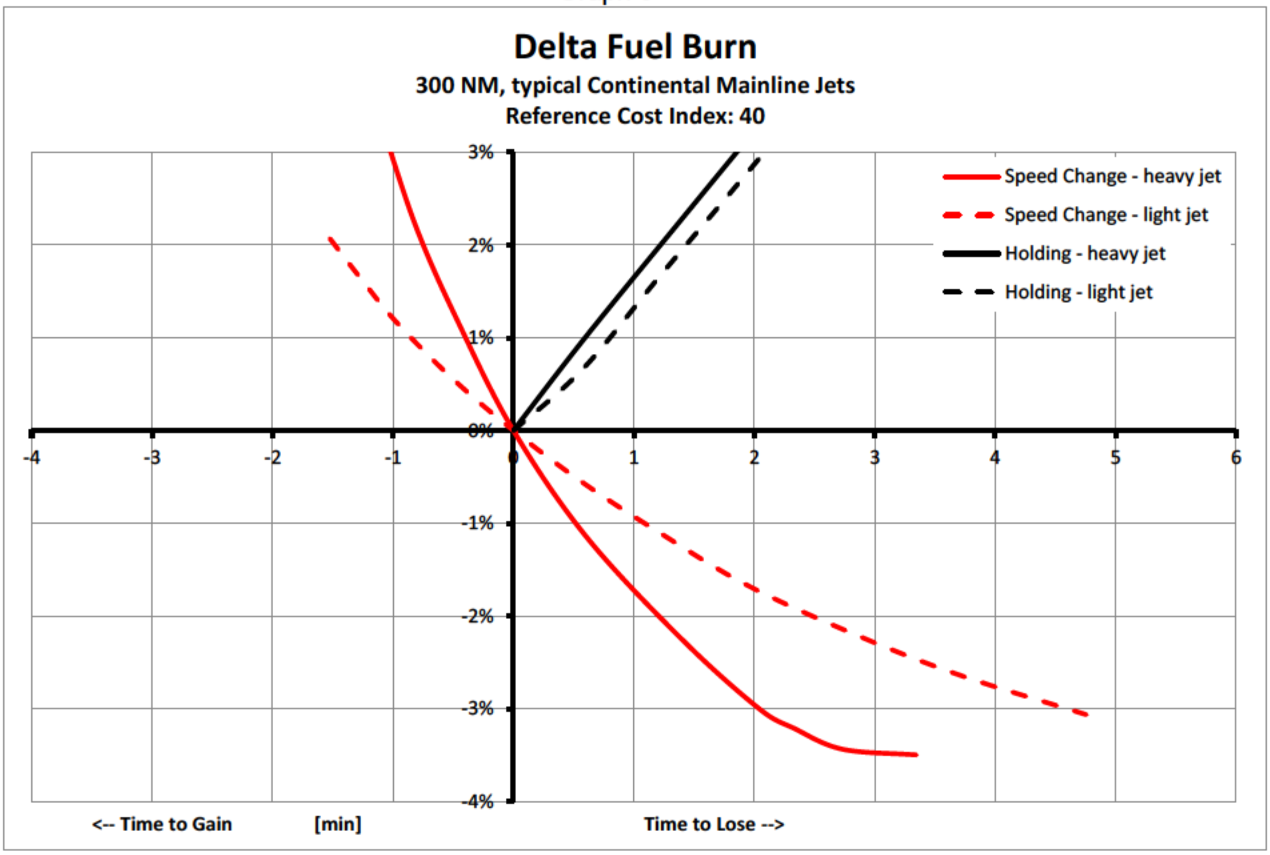
Graph 4


Delta CI-weighted Fuel Burn
300 NM, typical Continental Mainline Jets
Reference Cost Index: 20
3%
2%
1%
0%
-1%
-2%
-3%
-4%
-4
-3
-2
-1
0
1
2
3
4
5
6
Speed Change - heavy jet
Speed Change - light jet
Holding - heavy jet
Holding - light jet
<-- Time to Gain
[min]
Time to Lose -->

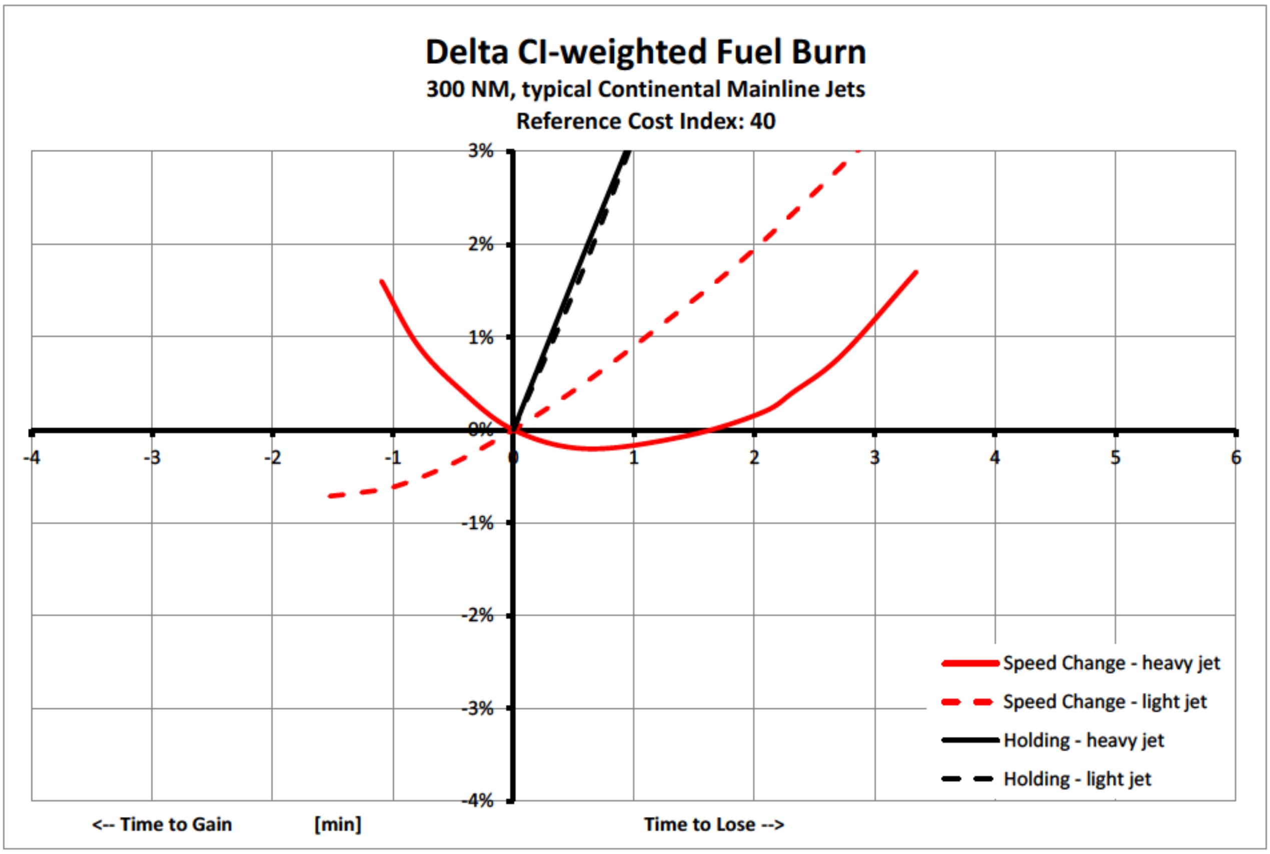
Graph 5



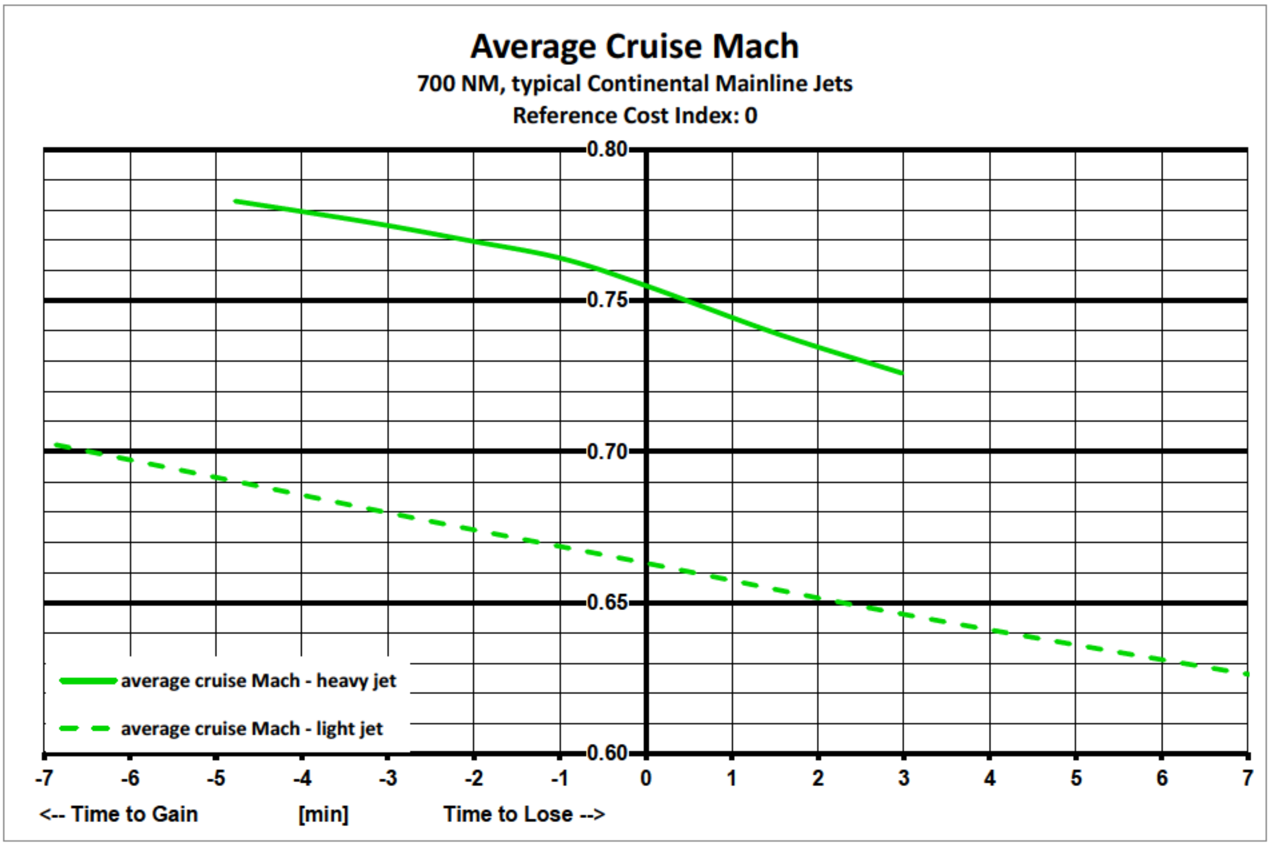
Graph 6



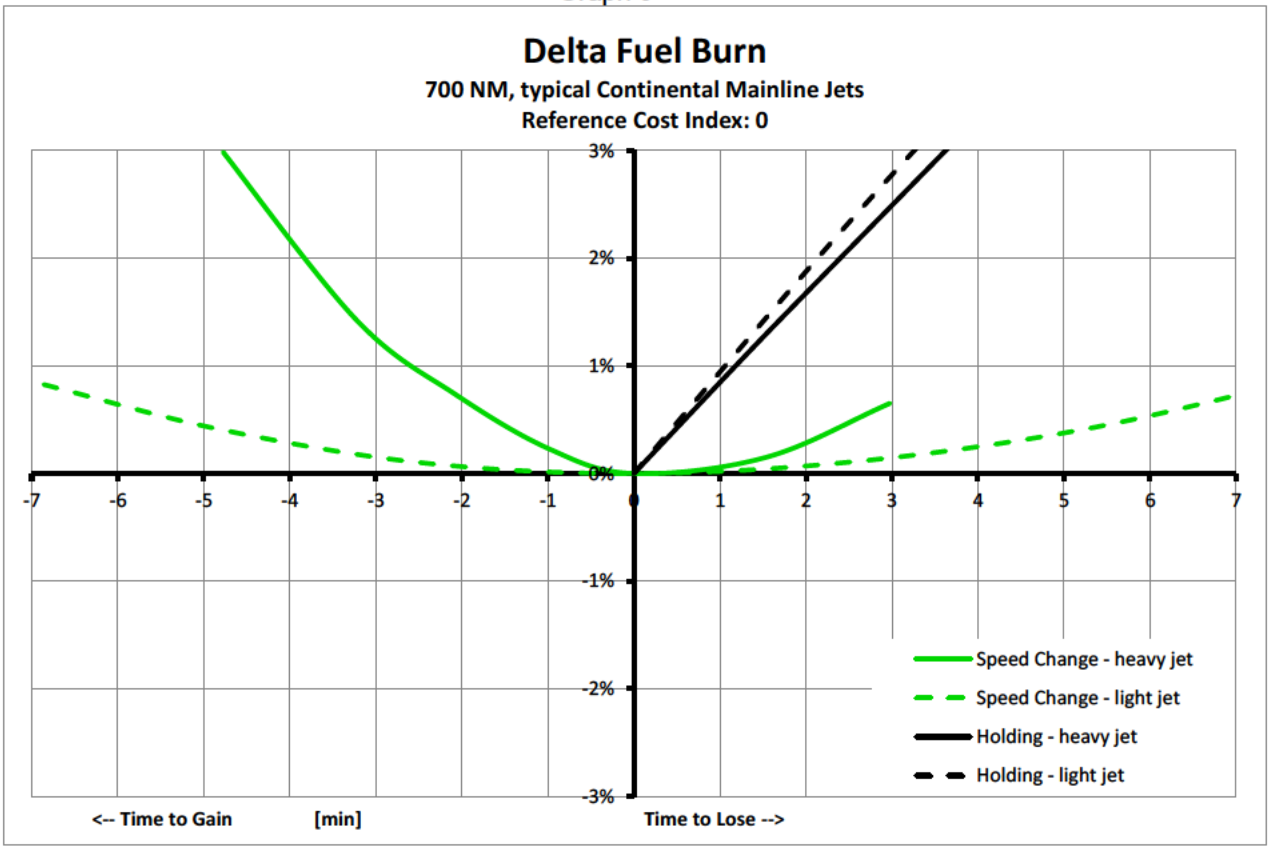
Graph 7


Delta CI-weighted Fuel Burn
300 NM, typical Continental Mainline Jets
Reference Cost Index: 40
3%
2%
1%
0%
-1%
-2%
-3%
-4%
-4
-3
-2
-1
0
1
2
3
4
5
6
Speed Change - heavy jet
Speed Change - light jet
Holding - heavy jet
Holding - light jet
<-- Time to Gain
[min]
Time to Lose -->

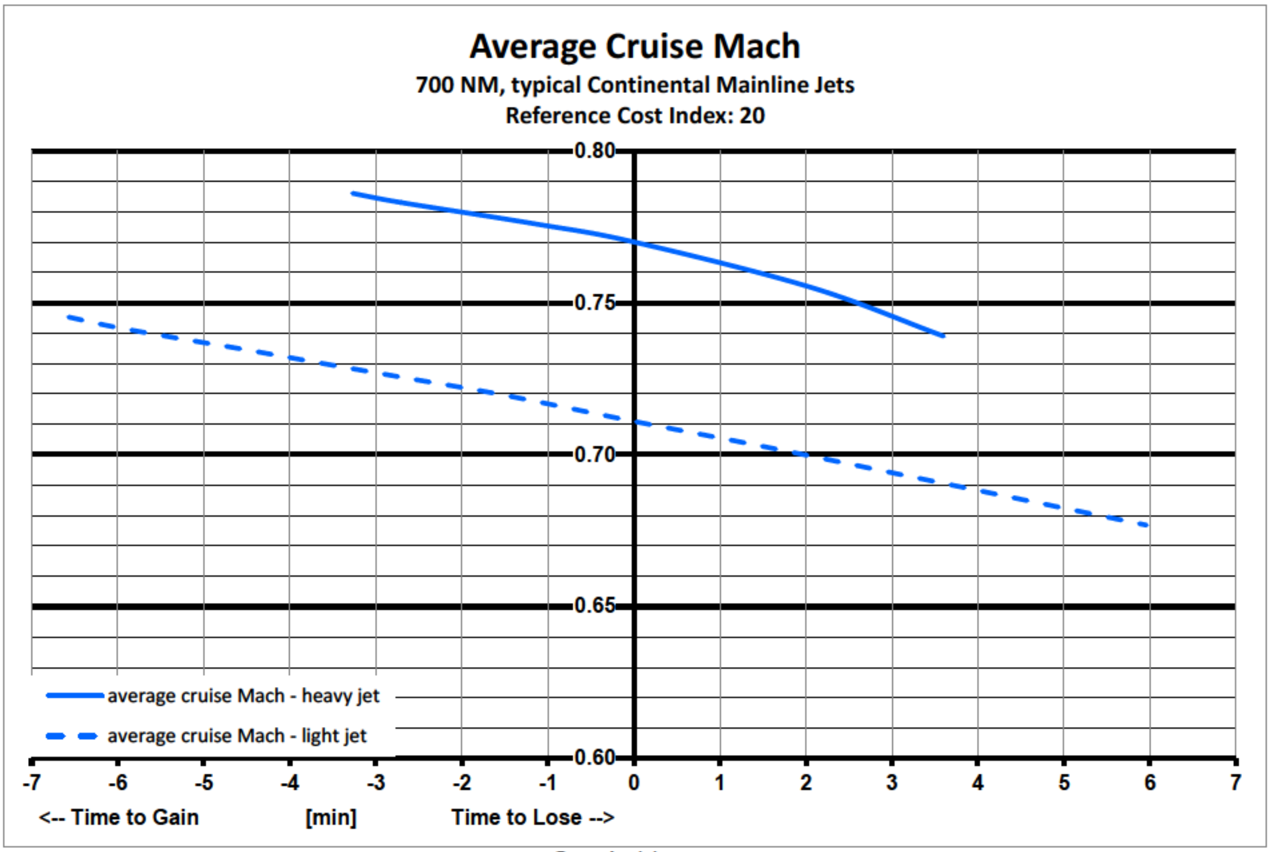
Graph 8



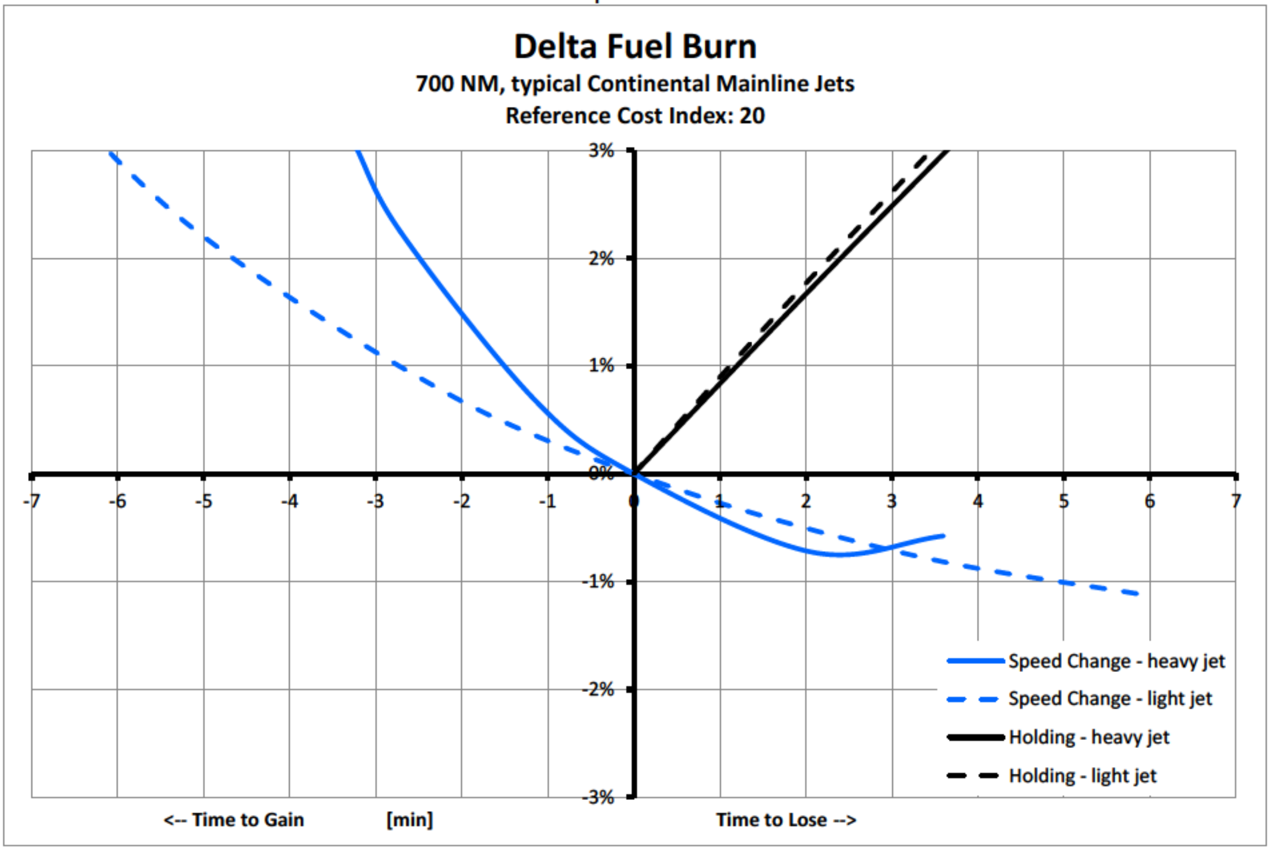
Graph 9



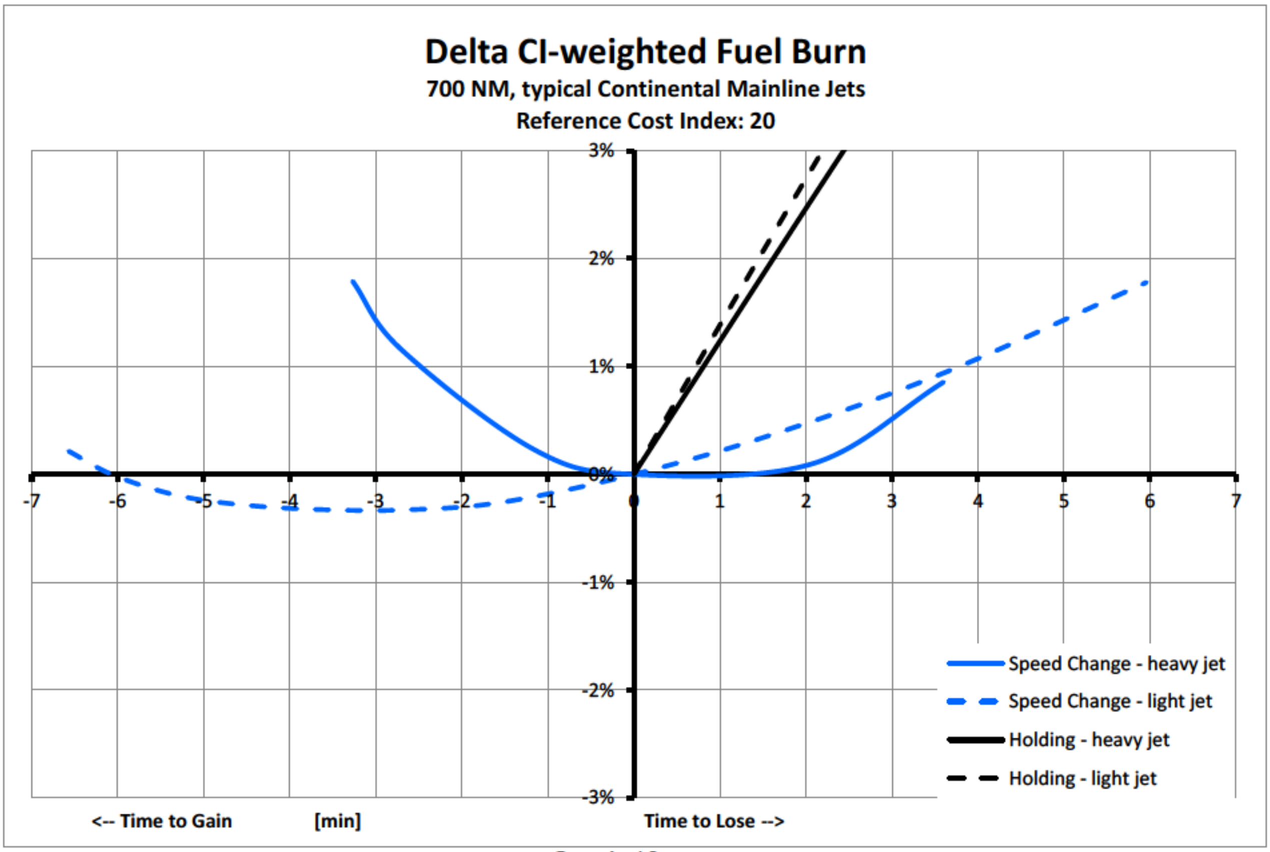
Graph 10



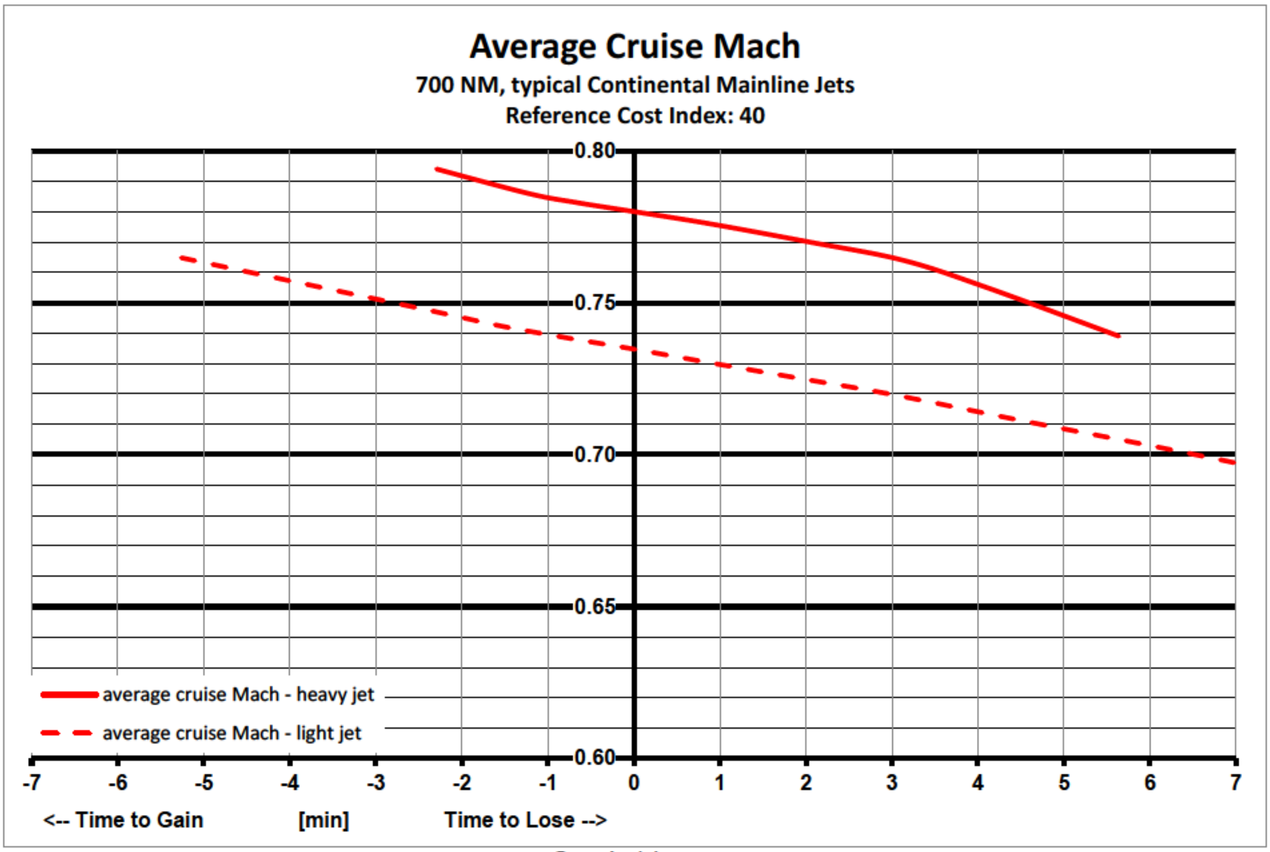
Graph 11



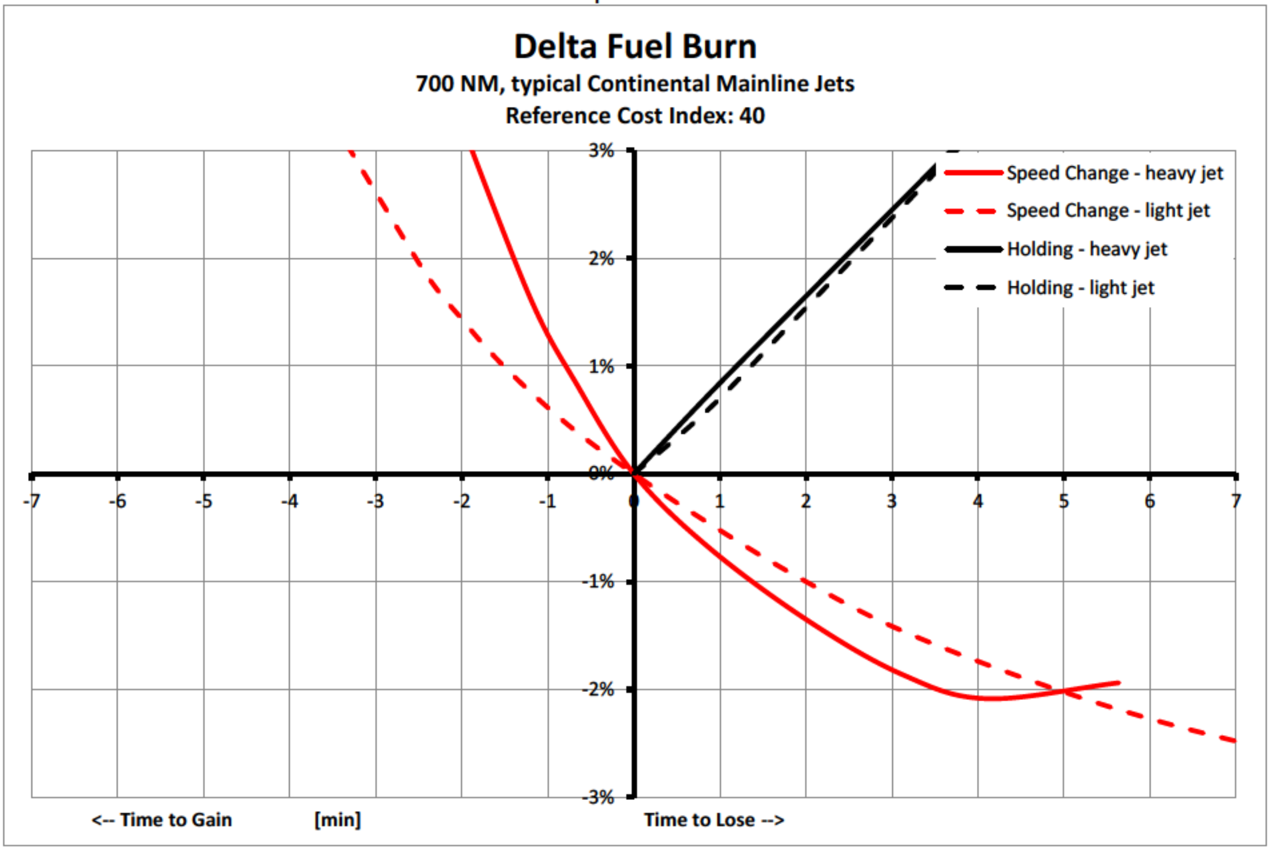
Graph 12


Delta CI-weighted Fuel Burn
700 NM, typical Continental Mainline Jets
Reference Cost Index: 20
3%
2%
1%
0%
-1%
-2%
-3%
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
Speed Change - heavy jet
Speed Change - light jet
Holding - heavy jet
Holding - light jet
<-- Time to Gain
[min]
Time to Lose -->

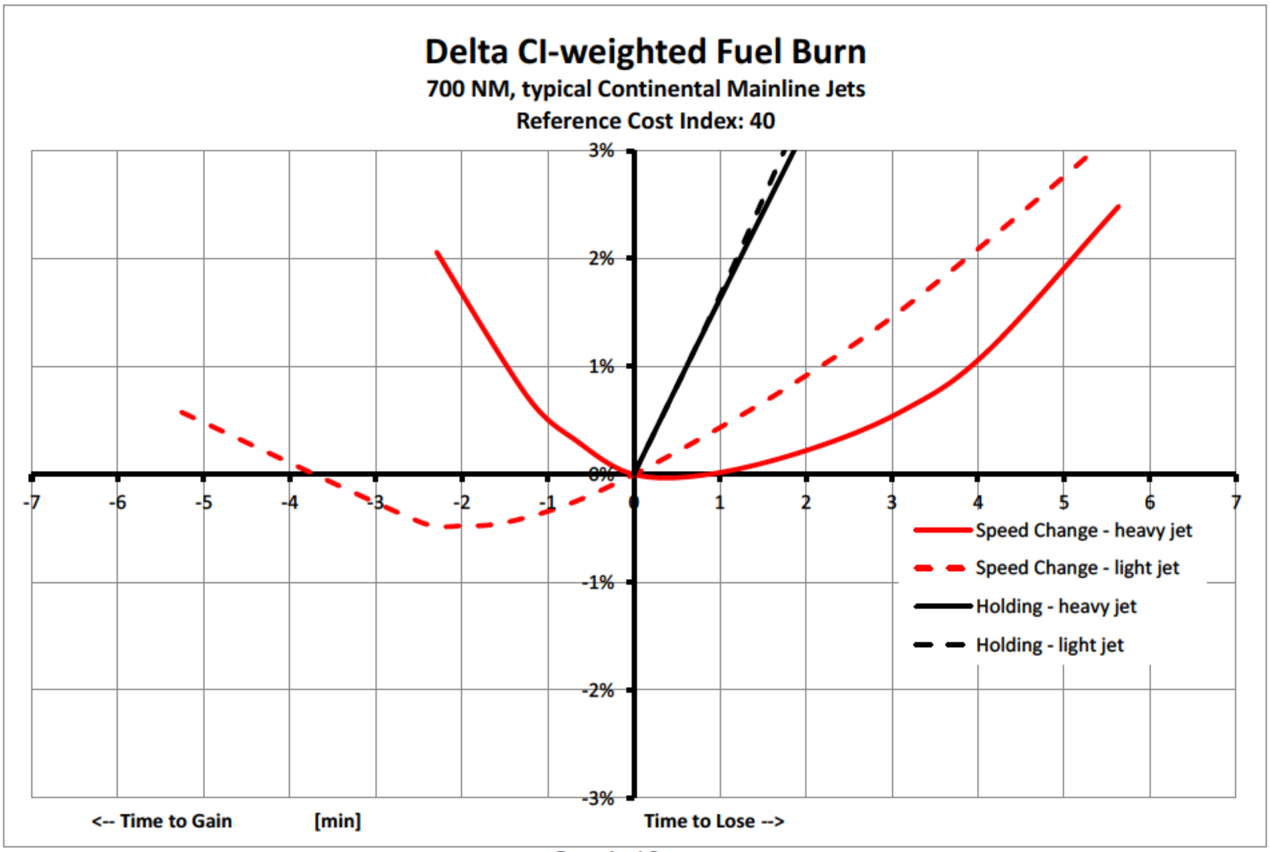
Graph 13



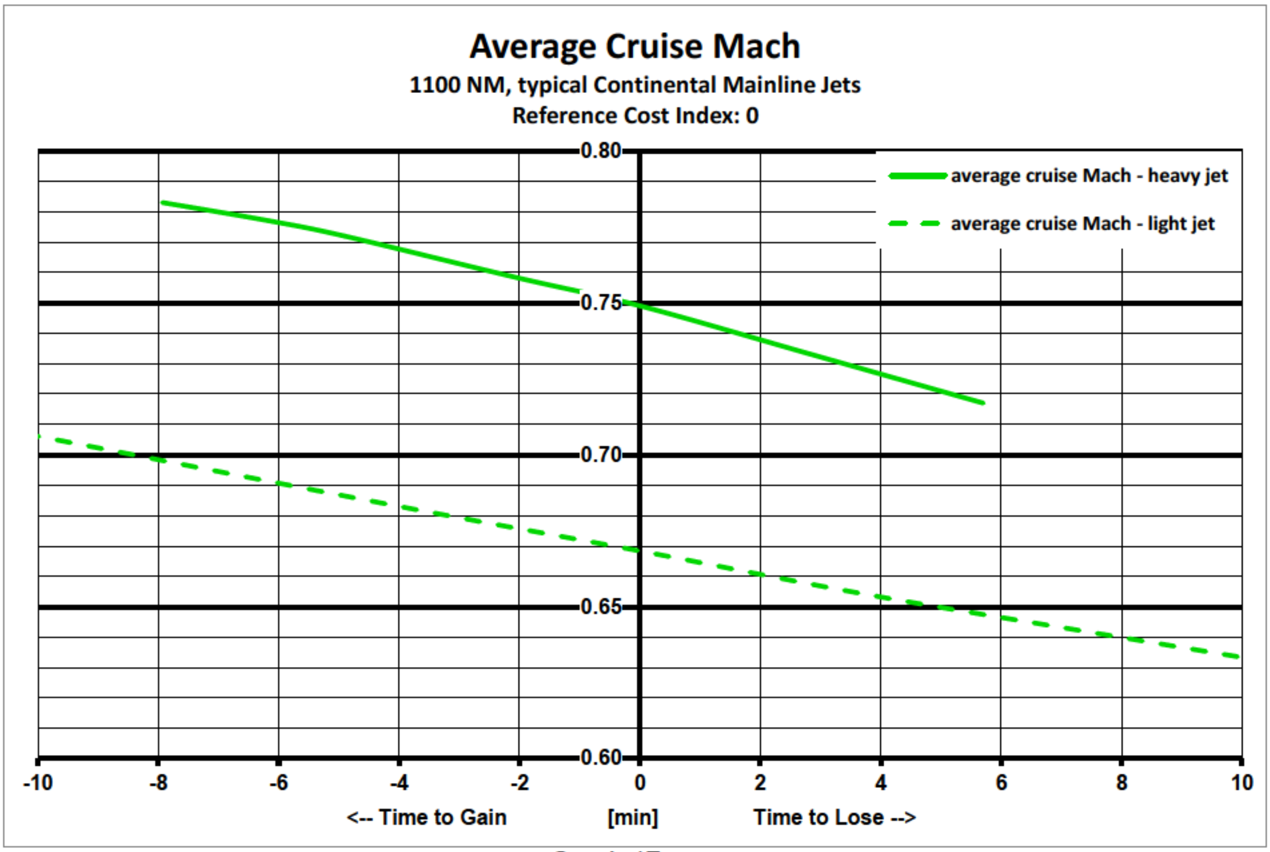
Graph 14



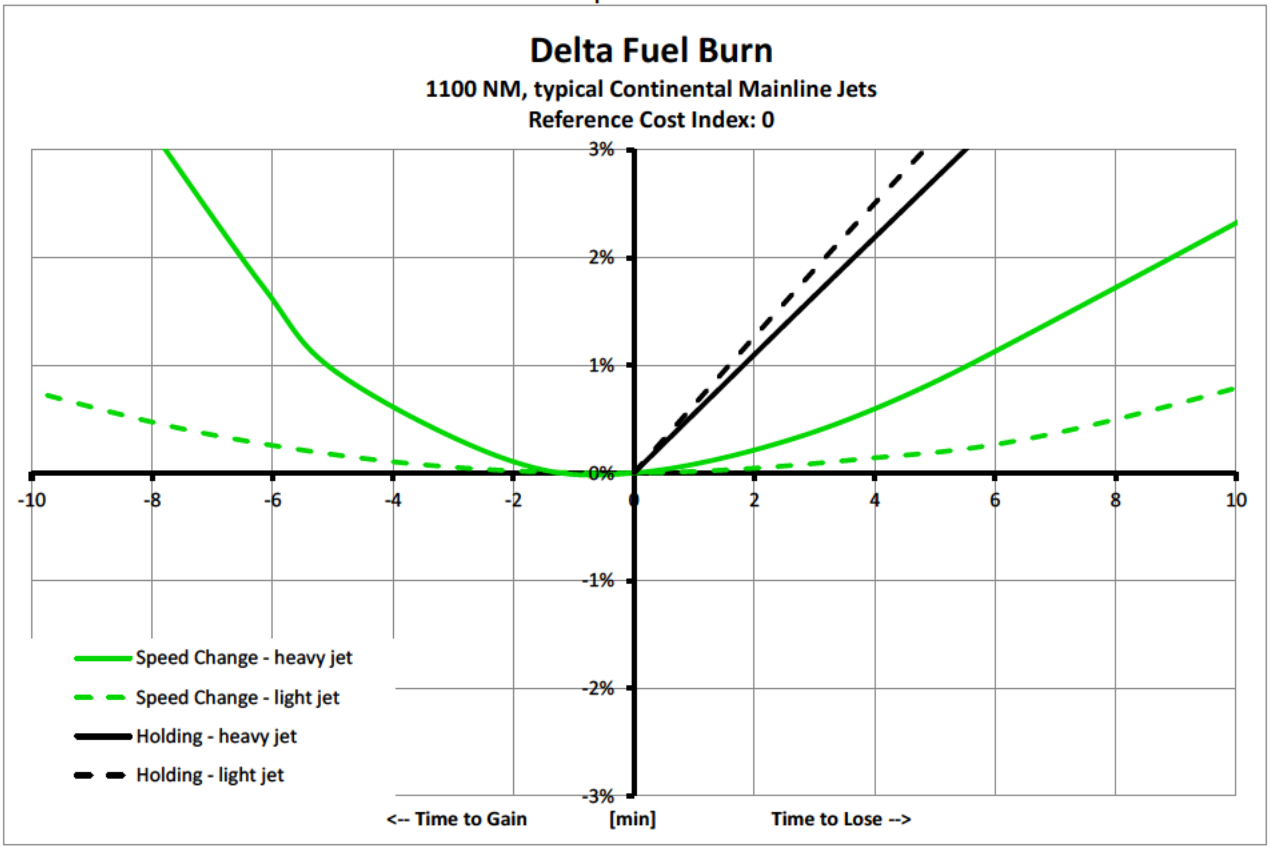
Graph 15


Delta CI-weighted Fuel Burn
700 NM, typical Continental Mainline Jets
Reference Cost Index: 40
3%
2%
1%
0%
-1%
-2%
-3%
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
Speed Change - heavy jet
Speed Change - light jet
Holding - heavy jet
Holding - light jet
<-- Time to Gain
[min]
Time to Lose -->

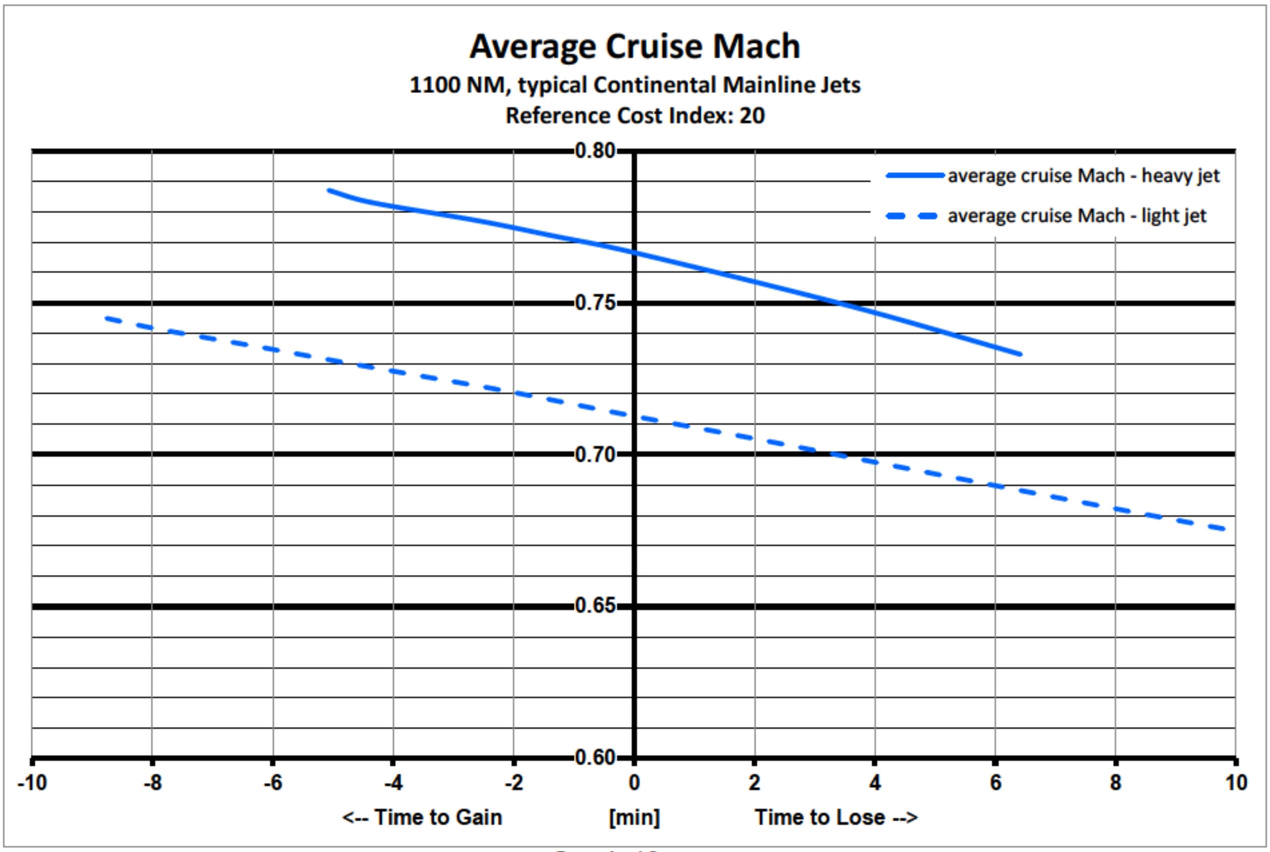
Graph 16



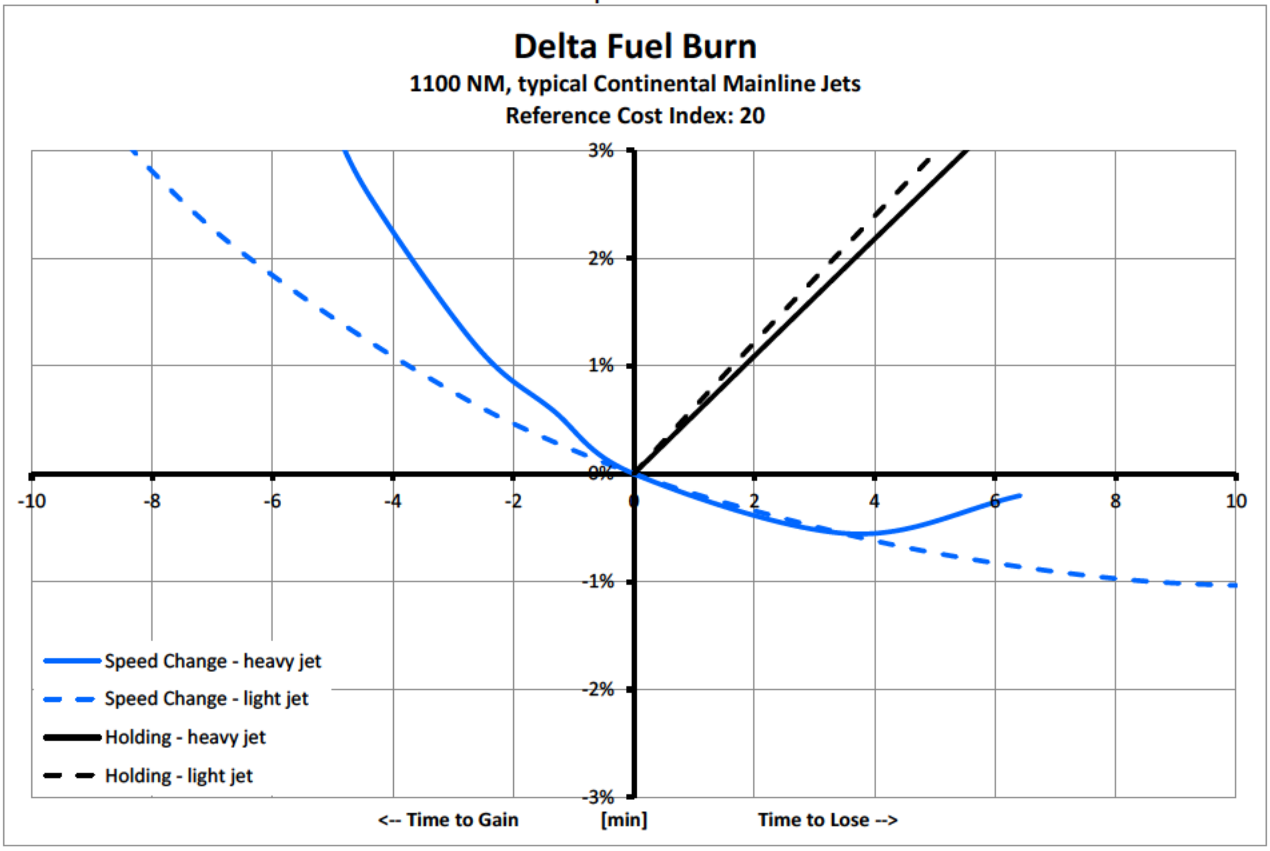
Graph 17



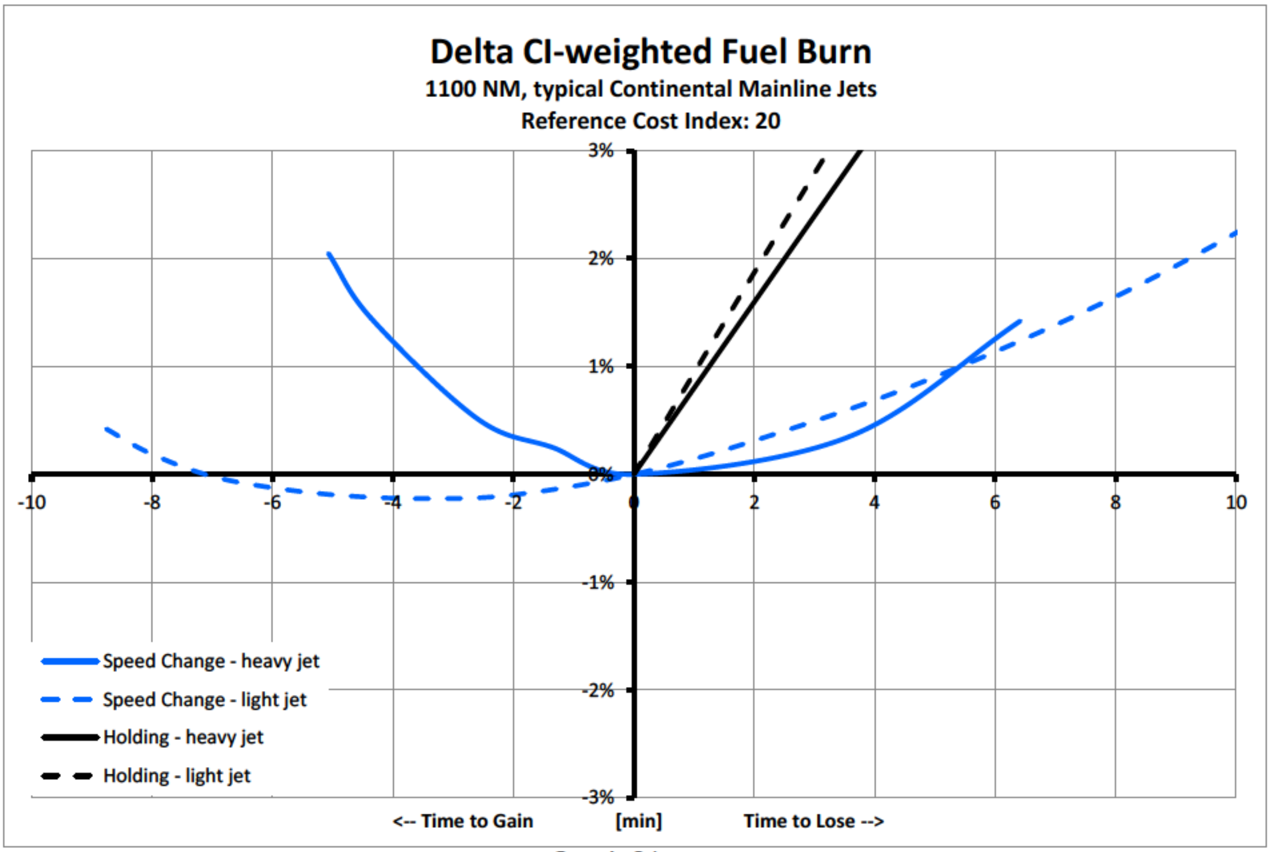
Graph 18



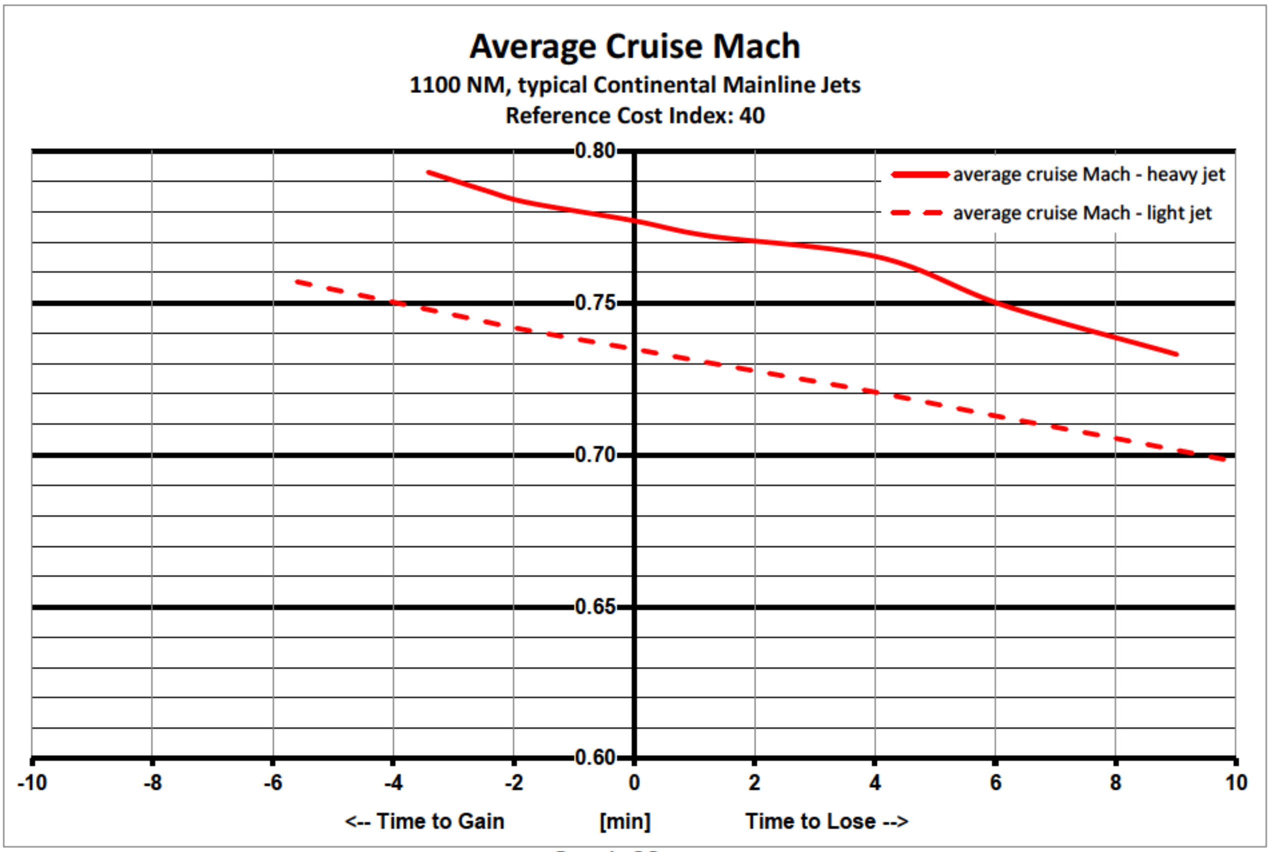
Graph 19



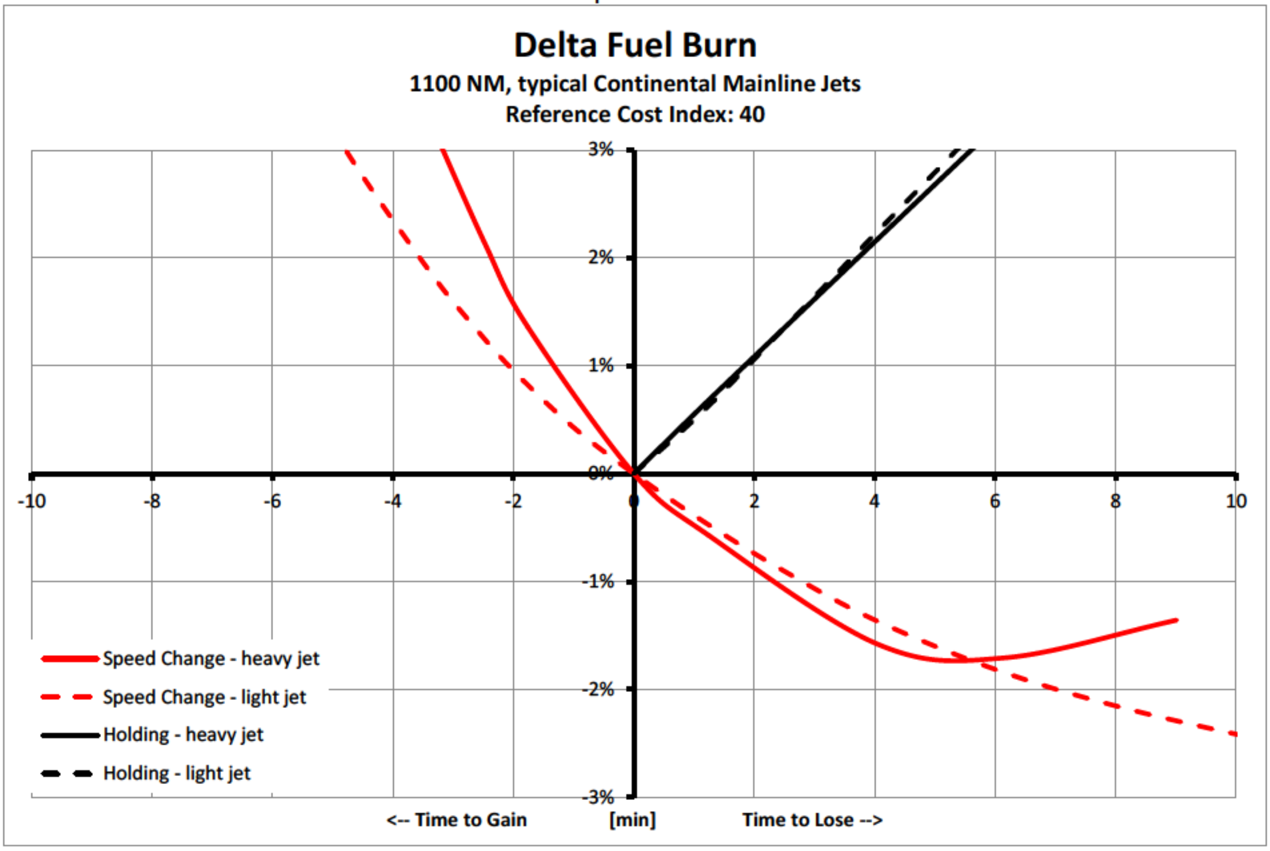
Graph 20


Delta CI-weighted Fuel Burn
1100 NM, typical Continental Mainline Jets
Reference Cost Index: 20
3%
2%
1%
0%
-1%
-2%
-3%
-10
-8
-6
-4
-2
0
2
4
6
8
10
Speed Change - heavy jet
Speed Change - light jet
Holding - heavy jet
Holding - light jet
<-- Time to Gain
[min]
Time to Lose -->

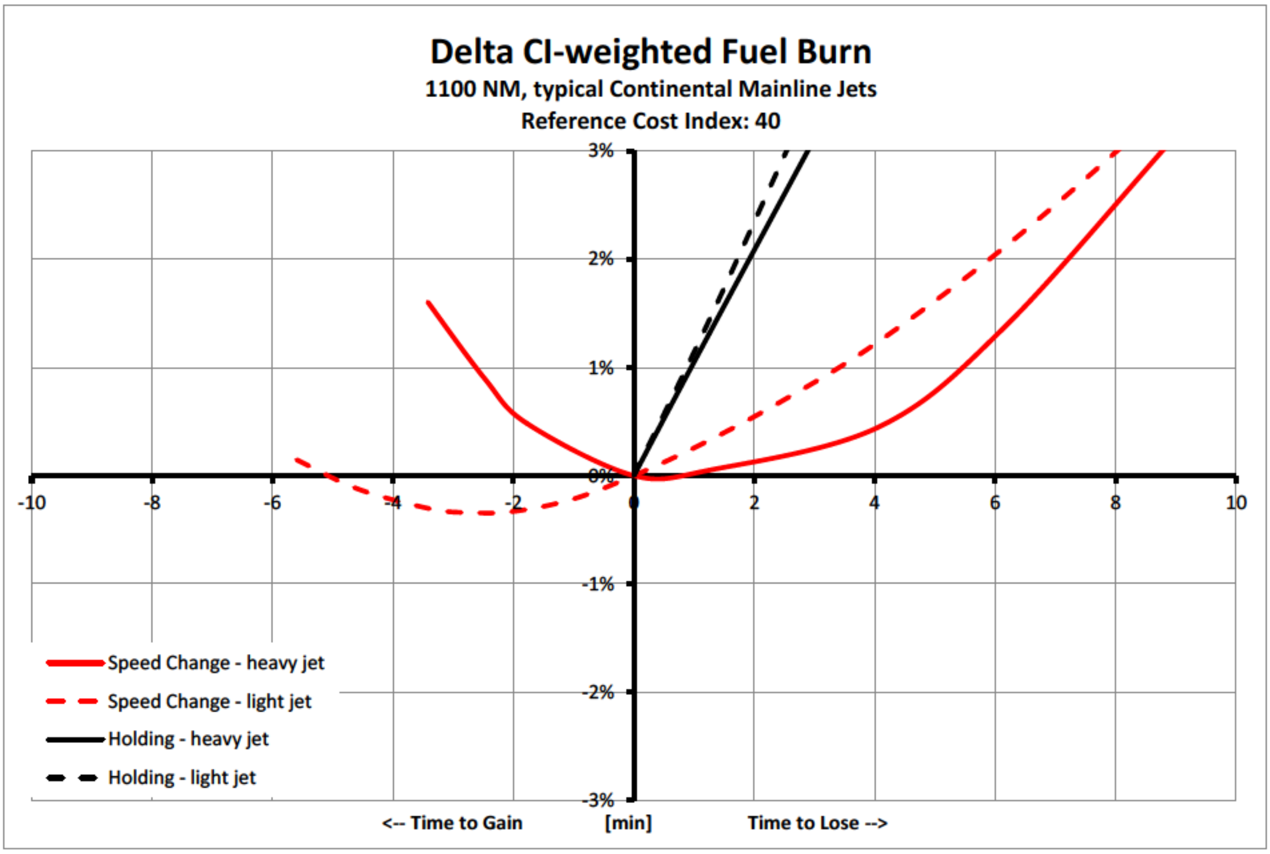
Graph 21



Graph 22

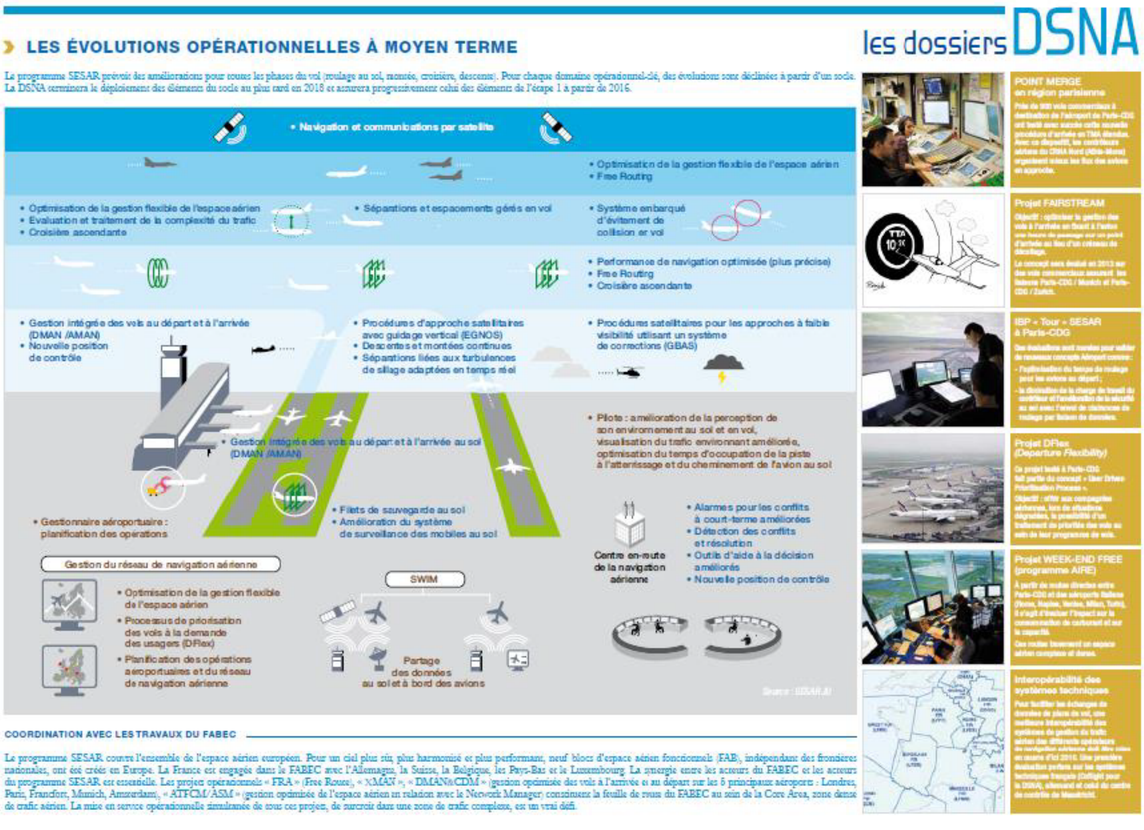


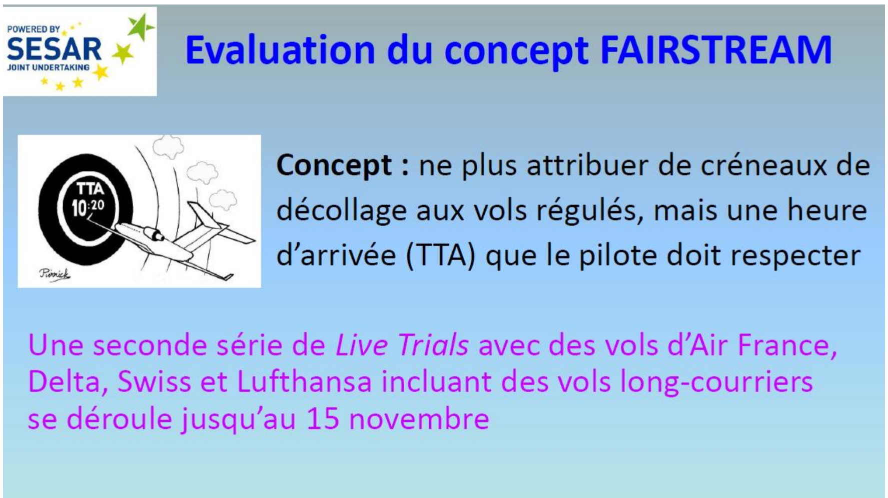
Graph 23

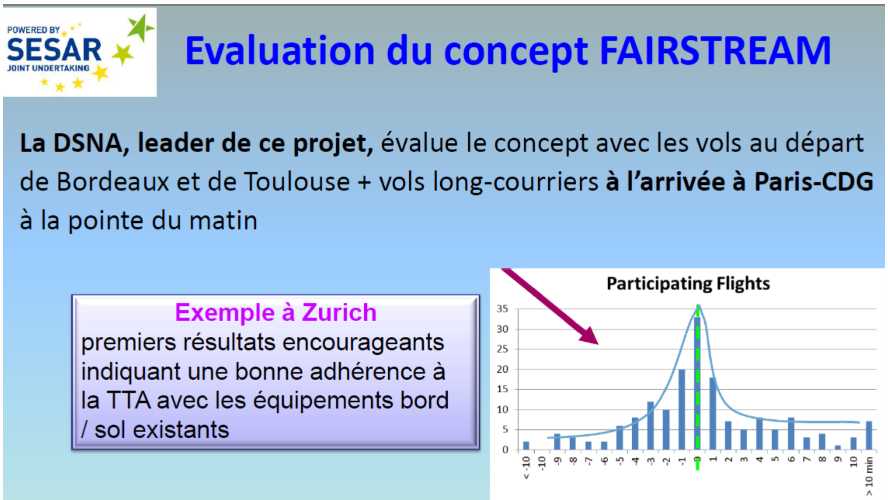

Delta CI-weighted Fuel Burn
1100 NM, typical Continental Mainline Jets
Reference Cost Index: 40
3%
2%
1%
0%
-1%
-2%
-3%
-10
-8
-6
-4
-2
0
2
4
6
8
10
Speed Change - heavy jet
Speed Change - light jet
Holding - heavy jet
Holding - light jet
<-- Time to Gain
[min]
Time to Lose -->

Graph 24

Appendix C Supplement: Communication Material




POWERED BY SESAR JOINT UNDERTAKING
Evaluation du concept FAIRSTREAM
TTA 10:20
Concept : ne plus attribuer de créneaux de décollage aux vols régulés, mais une heure d'arrivée (TTA) que le pilote doit respecter
Une seconde série de Live Trials avec des vols d'Air France, Delta, Swiss et Lufthansa incluant des vols long-courriers se déroule jusqu'au 15 novembre


POWERED BY SESAR JOINT UNDERTAKING
Evaluation du concept FAIRSTREAM
La DSNA, leader de ce projet, évalue le concept avec les vols au départ de Bordeaux et de Toulouse + vols long-courriers à l'arrivée à Paris-CDG à la pointe du matin
Exemple à Zurich
premiers résultats encourageants indiquant une bonne adhérence à la TTA avec les équipements bord / sol existants
Participating Flights
35
30
25
20
15
10
5
0


POWERED BY SESAR JOINT UNDERTAKING
Evaluation du concept FAIRSTREAM
Le rapport sur la faisabilité technique du concept FAIRSTREAM sera remis fin mars 2014 à la SESAR JU


2012
ANNUAL REPORT
DSNA
The French Air Navigation Service Provider

PREPARING FOR THE FUTURE IN THE NEW EUROPEAN AIR NAVIGATION ENVIRONMENT

The SESAR JU stand at the World ATM Congress in Madrid / February 2013

Today, there are more than 30 air navigation services in Europe of various sizes. In an effort to improve these services, the European States, under the umbrella of the European Commission, have launched the creation of the Single Sky, based on a single regulator (EASA) pillar, a technology (SESAR) pillar and the functional airspace blocks (FABs) pillar, which are organised to meet operational needs by doing away with national frontiers and establishing performance targets.

The European Commission has appointed the Eurocontrol agency as the European Network Manager, in an effort to make the best possible use of this new airspace (network of routes, management of traffic flows, control of rare resources, such as radio frequencies).

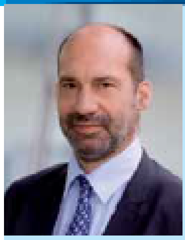
DSNA is actively participating in the creation of this new European environment, which will usher in technical and operational changes.

The SESAR programme will introduce the future European air traffic management system, which will help FABs meet their performance targets. It is essential that FABEC's operational projects are taken into consideration in the first deployments for this new system. These plans include Free Routing (FRA), the optimised management of incoming and departure flights (XMAN & CDM) at the five main airports (Paris, London, Frankfurt, Munich, Amsterdam) and the optimised management of airspace capacity (ATFCM/ ASM) in cooperation with the Network Manager. The nine partners FAIRSTREAM project (*FABEC ANSPs and AIRlines in SESAR Trials for Enhanced Arrival Management*), which is led by DSNA, illustrates this new synergy between the SESAR programme and FABEC's initiatives. In 2013, in the framework of this project, live trials with commercial flights with evaluate a new concept that consists in fixing a time at a point of arrival, rather than allocating a take-off slot.

DSNA is a member of FABEC, the SESAR JU, the A6 Alliance and the civil air navigation services organisation (CANSO).

34

dgac
DSNA
Info DSNA n° 39
Août 2013
Lettre d'information de la Direction des services de la Navigation aérienne



Maurice Georges
Directeur des services de la Navigation aérienne

L'année 2013 est une année particulière pour la DSNA. Alors que le contexte économique reste difficile, le trafic aérien fluctue de façon contrastée. Le niveau global de trafic reste en volume inférieur à celui de l'année 2012, elle-même en recul par rapport à 2011, tandis que le trafic de survol connaît une nette reprise depuis avril.

Il est d'autant plus stratégique pour la DSNA de concilier une grande rigueur de gestion sur l'ensemble de ses postes de coût et un effort intense de préparation de l'avenir, notamment sur le plan technique mais aussi pour moderniser l'ensemble de notre organisation et de nos méthodes de travail en confortant notre modèle orienté vers la sécurité de l'aviation et les valeurs du service public. Les usagers et clients de la DSNA sont prêts à soutenir ces efforts dès lors que nous aurons défini clairement les enjeux, les objectifs et les moyens nécessaires pour répondre à leurs attentes, au niveau du réseau européen comme pour le service rendu sur le territoire national.

La nouvelle démarche sécurité intégrée de la DSNA est désormais lancée, avec le concours d'un consultant spécialiste du secteur aérien et des facteurs humains. La participation des acteurs opérationnels (ICNA, IESSA, TSEEAC, OE) sera essentielle.

Le programme d'investissement est consolidé. De nouvelles ressources financières seront dégagées pour 2014, ce qui nous permettra de mener à bien les programmes stratégiques 4-Flight, Data-Link, CSSIP, ERATO et SYSAT sans mettre en péril la modernisation des infrastructures, ni certains investissements tout aussi stratégiques tels que le système RWSL de sécurisation de la circulation au sol de Paris-CDG ou encore les systèmes d'information ATIS automatisés.

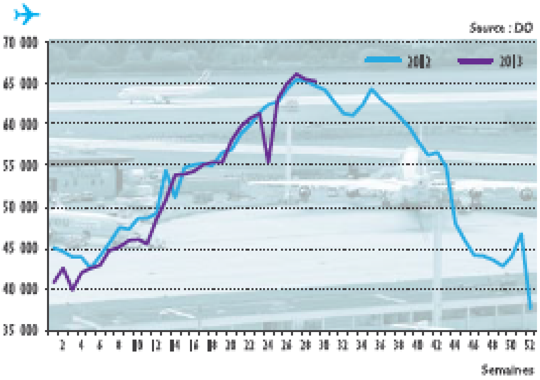
Sur le plan social, le protocole DGAC a fait l'objet depuis presque un an de travaux intenses, vifs, et constructifs dans la recherche du consensus pour clarifier les enjeux de modernisation et de restructuration de la DGAC et accompagner socialement ceux-ci dans un contexte général de réduction des effectifs. Ces restructurations auront aussi un impact sur nos partenaires du système aéronautique national, notamment lorsque la DSNA se désengagera de certains aéroports locaux. Il est alors de notre responsabilité collective de démontrer par l'exemple que ces efforts ont pour seul but de stabiliser et préparer à l'avenir notre système de navigation aérienne.

Dans le cadre du ciel unique européen, la négociation de la deuxième phase de régulation de la performance 2015-2019 est sensible pour l'équilibre économique à moyen terme de la DSNA. Les représentants des personnels sont à juste titre vigilants sur son impact social. Les programmes techniques de la DSNA constituent pour leur part le préalable du déploiement du programme SESAR. Les fonctions d'Eurocontrol en tant que gestionnaire de réseau et de services centralisés seront étendues, et la DSNA s'y prépare. L'EASA développe par ailleurs ses compétences en matière de navigation aérienne, ce qui constitue un nouveau cadre de réglementation et de surveillance auquel nous nous préparons également. Le FABEC et la coopération avec tous nos partenaires majeurs des services de navigation aérienne sont les vecteurs de succès du ciel unique européen, et il ne tient qu'à nous d'être collectivement moteurs de cette construction.

Ensemble, nous devons nous préparer à vivre ces évolutions majeures. Je m'emploierai résolument avec tous les managers de la DSNA à soutenir et accompagner les personnels dans leur action pour mener à bien la conduite de ces changements.

TRAFIC AÉRIEN

Baisse du trafic contrôlé en France au 1[er] semestre 2013 mais reprise des survols depuis avril



STRATÉGIE TECHNIQUE

Préparer l'avenir dans le nouvel environnement européen de la navigation aérienne

Le plan stratégique 2013 – 2015 porte les valeurs que souhaite mettre en avant la DSNA : la sécurité et le service public, l'humain et le collectif, la compétitivité et le service aux clients, l'innovation et la technologie, la construction européenne.
Son objectif : définir un programme cohérent et ambitieux d'investissements en termes d'outils opérationnels et d'infrastructures de nouvelle génération, permettant aux ICNA, IESSA et TSEEAC de la DSNA d'offrir une qualité de services en adéquation avec les attentes de nos usagers, partenaires et clients.

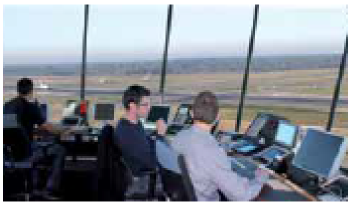
Sur cette période, il nous faudra assurer la transition entre le système actuel CAUTRA et le socle technique SESAR de modernisation du système de gestion du trafic aérien malgré un contexte budgétaire et de ressources humaines contraint. Avec les programmes Coflight, 4-Flight et ERATO, le contrôleur aérien disposera d'outils très performants avec une IHM stripless (ni strip papier, ni strip électronique), un suivi précis de trajectoires 4D, une prise en compte des nouveaux concepts opérationnels (Free route, Point Merge…). Ces programmes doivent s'appuyer, d'une part sur des réseaux de télécommunication rénovés utilisant les nouvelles technologies (IP) pour construire un réseau « Extranet » global et sécurisé (SWIM) et d'autre part, sur des liaisons de données numériques (Datalink) performantes entre avions et systèmes au sol. La modernisation des systèmes Approches & Tours sera lancée, en parallèle, dans le cadre du programme SYSAT. Sur les grands aéroports, le partage d'informations opérationnelles en temps réel entre les différents utilisateurs est essentiel, en particulier lors de situations dégradées. La DSNA participe activement aux évaluations de nouveaux concepts SESAR pour consolider la structure du CDM à Paris-CDG.
Les années 2013 – 2015 s'annoncent donc comme une période-clé pour la modernisation de nos systèmes techniques.

Lettre d'information de la Direction des services de la Navigation aérienne • N° 39 • Août 2013

ÉTUDES ET DÉVELOPPEMENT

Évaluer de nouveaux concepts opérationnels avec les équipements sol-bord existants

Dans le cadre du programme SESAR, la DSNA participe à deux évaluations de nouveaux concepts opérationnels :
- l'un sur l'optimisation des départs à Paris-CDG (projet DFlex),
- l'autre sur l'optimisation des arrivées à Paris-CDG (projet FAIRSTREAM).



Contrôle d'aérodrome à Bordeaux-Mérignac / 2012

Le projet DFlex (Departure Flexibility) a pour but d'offrir aux compagnies aériennes, lors de situations dégradées, la possibilité de réaménager les priorités des vols au départ au sein de leur programme sans dégrader la sécurité, la prédictabilité et la capacité. Depuis avril 2013, Air France et FedEX participent à la première phase d'évaluation opérationnelle de ce concept dont le but est de tester différents critères pour favoriser un vol. Le rôle de la DSNA est de s'assurer à travers l'outil de Gestion Locale des Départs (GLD) que tout changement n'impacte pas les départs des vols des autres compagnies et que la prévision des charges de trafic des centres de contrôle en-route n'est pas déstabilisée. Les conditions d'exploitation difficiles rencontrées en juin ont permis d'évaluer tout l'intérêt de ce nouveau concept. La prochaine évaluation est prévue fin 2013 avec davantage de scénarios.

Avec le projet FAIRSTREAM, il n'est plus attribué de créneaux de décollage aux vols régulés mais une heure d'arrivée que le pilote doit respecter. Pour la compagnie aérienne, le vol sera plus économique et l'impact de la régulation sur la ponctualité du vol sera minimisé, offrant ainsi un meilleur service au passager ; pour le contrôle aérien, une plus grande confiance est attendue dans le système de régulation des vols qui permettrait d'optimiser la capacité des secteurs de contrôle.
Des premiers vols commerciaux d'Air France sur Toulouse / Bordeaux – Paris CDG ont évalué la faisabilité technique du concept.
D'autres évaluations seront menées à l'automne avec des vols long-courriers. Les aéroports de Zurich et de Munich participent également à ces *Live Trials*.

EUROPE

Services centralisés : un projet de nouvelle architecture globale basé sur une idée déjà éprouvée

Dans le cadre du Ciel unique européen, Eurocontrol propose de créer neuf services centralisés pour améliorer la gestion du trafic aérien en Europe, sur le principe de ce qui existe déjà avec le gestionnaire de réseau (Network Manager) ou avec le modèle européen de base de données pour l'information aéronautique (European AIS Database). Un consortium-prestataire serait désigné après appel d'offres pour le développement et la maintenance du système, et un autre pour l'exploitation.
Du 25 juin au 10 juillet 2013, Eurocontrol a organisé un atelier thématique par service afin de répondre aux différentes questions soulevées par cette initiative. De nombreux professionnels de la navigation aérienne, dont la DSNA, y ont participé. L'Agence estime que ce projet facilitera le déploiement des travaux du programme SESAR et permettra des économies d'échelle significatives.
Pour sa part, la DSNA serait concernée par ces services, à la fois comme client et comme prestataire potentiel. La DSNA est plus particulièrement intéressée par les enjeux des services centralisés concernant les trajectoires 4D, la surveillance, la gestion flexible avancée de l'espace aérien, la gestion de l'information aéronautique (AIM) et le réseau de télécommunication. Une réunion d'échanges avec les représentants des personnels de la DSNA sera organisée en septembre.
Cette initiative d'Eurocontrol est également débattue au sein du FABEC et de l'Alliance A6 qui demandent des analyses coûts/bénéfices convaincantes.

Pour plus d'information :
www.eurocontrol.int/centralised-services

Tour de contrôle de l'aéroport de Brest-Guipavas

RÉALISATION TECHNIQUE

Une étape importante franchie pour le programme Coflight

Le nouveau système de traitement des données de vol Coflight sera le cœur du futur système de gestion du trafic aérien de la DSNA (4-Flight). Développé en commun par la France, l'Italie et la Suisse, Coflight permettra au contrôleur aérien d'avoir une prédiction plus précise des trajectoires des vols.
La version 2 livrée par le consortium industriel franco-italien Thales / Selex a été acceptée. Elle sera utilisée dans la version intermédiaire de 4-Flight dite « Build Inter », permettant de mener les premières évaluations opérationnelles dans les centres-pilotes du CRNA Est et du CRNA Sud-Est.
Par ailleurs, un groupe d'utilisateurs Coflight va être mis en place. Cette initiative innovante permettra aux prestataires de services de navigation aérienne d'échanger sur les évolutions du produit et de partager les coûts de développement.

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Fly by the rules: FAIR STREAM live testing of a new concept for flight arrival management

Between May and June 2013 skyguide will participate in the first wave of live trials of SESAR project FAIR STREAM (FABEC ANSPs and AIRlines in SESAR TRials for Enhanced Arrival Management). The trials shall verify a concept thanks to which flight arrival management could see a paradigm shift from calculated take off time (CTOT) to target time of arrival (TTA). For this project, skyguide, Swiss International Air Lines united to help improve the overall aviation system of the future.

Reliability due to predictability
Aviation is a highly reliable transport system. The mechanism of the system is overall well known, information sharing among the different stakeholders is a fact and the predictability thanks to interconnected information systems very high. In principle it should be possible for all flights to be punctual. Why then are delays still a daily occurrence and why does the ATC system need so much human decision making?

Better punctuality, less fuel burn
Delays and the ensuing consequences such as increased fuel burn and CO2 emissions are often created by malfunction of traffic prediction. In spite of centralised air traffic flow management which has the ability to leverage local problems such as capacity issues before take off, even departure slots do not guarantee that a flight is progressing as planned. The currently practices principle of departure regulation does not work well.

From CTOT to TTA
Today, if a pilot takes off with a departure delay of 10 minutes due to an ATM regulation, he should normally land with the same delay. However, since he knows that there is some slack in the system he will try to gain the 10 minutes he lost at departure by increasing his flight speed and asking ATC for more direct routings than what he filed in his flight plan. If all goes well and the arrival airport has the necessary capacity, he will indeed be able to catch up the delay. More often than not, however, he will have to wait in holding. As a consequence, he does not touch down earlier and burns much more fuel, first because he flew faster and second because he was held in a holding.

Adherence to planning is beneficial for the system
The SESAR project FAIR STREAM is an initiative which tries to verify if a new approach in flight arrival planning could lead to higher predictability in aviation, thus reducing unnecessary CO2 emissions and fuel consumption. The project could lead to quick wins not by implementing new technology but by introducing a new way of planning flights. Instead of planning them from take off to landing, and regulating the take off if there is a capacity shortage at arrival airport, the focus is inverted. With FAIR STREAM the arrival time is regulated. This means that the pilot receives a guarantee that he will be able to land according to schedule if he manages to be at a defined point near his arrival airspace at a defined time. The so-called Target Time of Arrival (TTA) will be calculated using the best flight profile and thus improving the environmental impact of a flight.

A behavioural change
For this concept to work, no new technology is necessary but strict adherence by pilots to the flight plan. This implies that a pilot does not ask for direct routings and that ATC does not propose them spontaneously. The «quick wins» of FAIR STREAM come from a behavioural change. Although in the individual case direct routings may shorten flights, «improvised» improvements have a negative impact on the system as a whole. An increase of

predictability will in the long run enable the main stakeholders airlines, airports and air traffic control to make the system more fluid, more punctual and thus greener and cheaper.

Raimund Fridrich
DCP

Short interview with [redacted]

What is the role of skyguide in FAIR STREAM?
The FAIR STREAM project is performed in the frame of FABEC, it involves France, Germany and Switzerland. DSNA, Air France, Delta Airline, DFS, Lufthansa, Airbus/Boeing and Eurocontrol NM are participating in the FAIR STREAM trials project. The project is lead by DSNA, and skyguide is in charge of trials that take place in Zurich in partnership with SWISS. Skyguide is also responsible for the flight trials design activities for the whole project.

Who works in the team and with whom at skyguide?
Operational staff (ATCOs, FMPs), operational experts and safety experts are involved in the project. The core team is composed of [redacted] (OOE), [redacted] (OZD), [redacted] (OZD), [redacted] (OZT) and myself.

When will the results be known?
A second set of trials is planned in September/October and therefore the final report is expected by beginning of 2014. The results of the Fair Stream trials will be presented in the frame of the SESAR live trials activities at next World ATM Congress in March 2014.

Do you expect an impact on the behaviour of ATCOs thanks to FAIR STREAM?
No major impact is foreseen on the behaviour of ATCOs. The pilot will try to comply with his TTA and therefore manage his flight accordingly. He should stick more closely to his flight plan and then improve flight adherence, some direct proposals from ATCOs could be refused by the pilot to comply with the objective. When TTA will be linked to the AMAN tool, the impact will be the reduction of holdings as time of arrival to the runway will be more accurate, in that case the ATCO work should be facilitated.

Pressemeldung Projekt FAIR STREAM:

Gemeinsame Vorgehensweise zur Effizienzsteigerung

13.12.2012.- Im Herbst des Jahres 2012 begann das FAIR STREAM-Konsortium, ein Zusammenschluss großer europäischer Fluggesellschaften, Flugsicherungsorganisationen und Herstellerfirmen, mit der konkreten Arbeit an Flugversuchen, um die Vorhersagbarkeit und Flugeffizienz an größeren europäischen Flughäfen zu verbessern. FAIR STREAM steht für "FABEC ANSPs and AIRlines in SESAR TRials for Enhanced Arrival Management" und ist eines der Projekte, die von SESAR im Jahr 2012 aufgesetzt wurden.

Das Projektkonsortium wird von der französischen Flugsicherungsorganisation DSNA (Direction des Services de la Navigation Aérienne) angeführt, und es verbindet die Expertisen der Flugsicherungsorganisationen DFS und skyguide sowie der Fluggesellschaften Air France, Swiss, Lufthansa, Regional und Delta. Darüber hinaus sind Airbus Pro Sky und Eurocontrol mit ihrem Spezialwissen in den Bereichen Flugverhalten und Netzwerkmanagement eingebunden. Die Flugversuche werden mit bestehenden Systemen auf kommerziellen Flügen an den Flughäfen München, Paris und Zürich im Mai/Juni sowie im September/Oktober 2013 durchgeführt.

[redacted] DSNA, sagte: "Es ist jetzt wichtig, die starken Synergien des SESAR-Programms und der FABEC-Initiativen zu bündeln. Das Projekt FAIR STREAM ist ein gelungenes Beispiel für diese Zusammenarbeit. Ich hoffe, dass mit diesem neuen Betriebskonzept und dem gleichmäßigeren Flugprofil vom Abflug bis zur Ankunft wirklich Fortschritte in den Bereichen Sicherheit, Kapazität und Umwelt erzielt werden können."

Konkretes Ziel des FAIR STREAM-Projekts ist es, die Voraussetzungen für die Nutzung der Zielankunftszeit (Target Time of Arrival, TTA) anstelle der kalkulierten Startzeit (Calculated Take-off Time, CTOT) zu schaffen. Mit dieser Maßnahme, die darauf abzielt, Nachfrage und Kapazität auszugleichen (Demand-Capacity Balancing, DCB) sollte es möglich sein, die Kapazitätsauslastung während eines Fluges sowie am Zielflughafen zu verbessern. Das Projekt FAIR STREAM wird den Nutzen des TTA-Konzepts im Hinblick auf Vorhersagbarkeit und Flugeffizienz bewerten, die Leistungsfähigkeit von Bord- und Bodensystemen validieren und dabei auch untersuchen, wie Crews, Fluglotsen, örtliche und regionale Flow Manager mit dem Verfahren und den Auswirkungen auf die Verkehrskomplexität und die Arbeitslast der Mitarbeiter umgehen.

[redacted], A380-Kapitän bei Air France:
"Mit dem Projekt FAIR STREAM werden die ersten Flugversuche unternommen, um vom derzeitigen ATFM-Abflugslot (CTOT) zu einer Zielankunftszeit zu gelangen, die die tatsächlichen Kapazitätsprobleme aufzeigen soll. Von einer derartigen Änderung im Bereich Verkehrsflussregelung (ATFM) erhofft sich Air France den Beweis dafür, dass die Vorhersagbarkeit von Flügen mit der bestehenden Bordausrüstung ausreichend verbessert werden kann, um die zur Verfügung stehende Flugsicherungskapazität durch die Flow Management Position zu optimieren. Wenn dieses Konzept erst einmal überall in Europa angewendet wird, sollten die heutzutage üblichen ATFM-Verspätungen signifikant sinken."

[redacted], Deutsche Lufthansa, Frankfurt:
"FAIR STREAM bietet eine großartige Möglichkeit, sich an der Entwicklung eines effizienteren Flugverkehrsmanagementsystems zu beteiligen. In einem Umfeld wirtschaftlicher und infrastruktureller Herausforderungen, denen heutzutage Airlines ausgesetzt sind, möchten wir mögliche Entwicklungsfelder für Treibstoffeinsparungen und größere Vorhersagbarkeit bei Flugplänen aufzeigen."

[redacted], DFS Deutsche Flugsicherung GmbH, sagte: "FAIR STREAM ist ein Gemeinschaftsprojekt der Fluggesellschaften und Flugsicherungsorganisationen im Herzen Europas. Die Flugversuche, die wir durchführen, konzentrieren sich auf die Vorhersagbarkeit von Anflügen und die Effizienzsteigerung. Das Projekt ist ein Beitrag zu SESAR. Mit Hilfe der Live-Tests wird es möglich sein, die Realisierbarkeit einer Zielankunftszeit sowie den Informationsaustausch zwischen Flugsicherungsorganisationen und Luftraumnutzern zu validieren und die Risiken vor dem anschließenden SESAR-Probebetrieb abzuklären."

[redacted], skyguide:
"Dieses Projekt eignet sich hervorragend dazu, den Beweis anzutreten, wie wertvoll die Zusammenarbeit zwischen Fluggesellschaften, Flugzeugherstellern und Flugsicherungsorganisationen bei der Effizienzsteigerung des Gesamtsystems ist."

DFS Deutsche Flugsicherung

DFS Deutsche Flugsicherung GmbH – Am DFS-Campus 10 – 63225 Langen

Verteiler gemäß Verteilerliste

Ihr Zeichen, Ihre Nachricht vom	Mein Zeichen, meine Nachricht vom	☎ (06103) 707-0 oder 707-	Datum
[redacted]	OA/F	Tel.: 1043	07.08.2013

Gültig ab: 05.09.2013
Gültig bis: 25.10.2013

Zusätzliche Vorschrift zur Betriebsanweisung Flugverkehrsdienste
gemäß BA-FVD Punkt 111.7
„FAIR STREAM Trial"
Lfd.Nr. 10/2013

Sehr geehrte Damen und Herren,

auf Grundlage der Betriebsanweisung Flugverkehrsdienste (BA-FVD), hier Punkt 111.7, gilt mit Wirkung vom 05.09.2013 bis 25.10.2013 folgende zusätzliche Vorschrift:

1. Allgemeines

Die DFS beteiligt sich vom 05.09.2013 bis 25.10.2013 am „FAIR STREAM* Trial". Während des Feldversuches wird auf ausgewiesenen ATS-Strecken den Flügen zusätzlich zur „CTOT" (Calculated Take-Off Time) eine „TTA" (Target Time of Arrival) vom Network Manager zugewiesen. Zielsetzung ist eine Validierung der nachfolgenden Verfahren und eine Evaluierung der Arbeitsabläufe für die Flugverkehrsdienste, die Luftfahrunternehmen und den Network Manager.

*(FABEC ANSPs and **AIR**lines SESAR **TR**ials for **E**nhanced **A**rrival **M**anagement)

DFS Deutsche Flugsicherung

Die DFS wird zusammen mit der Deutsche Lufthansa AG und der Air France ausschließlich auf der Strecke von LFPG (Paris Charles de Gaulle) nach EDDM (München) am Feldversuch teilnehmen.

Eine TTA wird zugewiesen, wenn VFRM am Zielflugpatz implementiert sind. Sie bezieht sich auf einen definierten Punkt (im Trial auf den letzten Punkt der Strecke im Feld 15 des FPL) und stellt den Zeitpunkt zwischen CTOT + EET bis zum definierten Punkt dar.

2. Verfahren

Im Rahmen des Feldversuches wird die Einhaltung der zugewiesenen TTA erprobt.

Die Flugverkehrskontrolle wird gebeten, zur Einhaltung der TTA dem Flug soweit wie möglich keine Anweisungen zu geben, die ihn von der geplanten Streckenführung abweichen lassen bzw. beschleunigen oder verspäten. Sollte es notwendig sein, zu Staffelungszwecken Anweisungen zu geben, haben diese Vorrang vor der Einhaltung der TTA. Die Piloten reduzieren oder beschleunigen die Geschwindigkeit nur im Rahmen des veröffentlichten 5% Limits. So soll die Effektivität einer TTA sichergestellt werden.

Zwei Stunden vor EOBT wird durch den Network Manager zusätzlich zu einer CTOT eine TTA für ausgewählte Flüge der Deutsche Lufthansa AG und der Air France auf der Strecke von LFPG nach EDDM zugewiesen. Die TTA wird in der Flugliste mittels des Network Operations Portal (NOP) an der FMP dargestellt und identifiziert. Die TTA sieht eine Zeit-Toleranz von -3/+3 Minuten vor. Die in der Flugliste dargestellten Flüge mit TTA sollen vom Flow Koordinator den beteiligten Lotsen als Information zur Kenntnis gebracht werden. Gesonderte Maßnahmen sind nicht zu ergreifen.

ATM teams from Airbus and EADS to participate in seven SESAR JU Integrated Flight Trials

Paving the way for reduced emissions and optimising airspace capacity throughout the North Atlantic and Continental Europe

8 NOVEMBER 2012 PRESS RELEASE

Airbus and its air traffic management (ATM) subsidiaries – Airbus ProSky, Quovadis and Metron Aviation – together with the EADS division Cassidian, have all been selected to participate in the upcoming SESAR Joint Undertaking (SESAR JU) Integrated Flight Trials. The SESAR JU programme involves a large number of stakeholders in key locations across the North Atlantic and Continental Europe.

The seven integrated flight trials involving these Airbus/EADS teams will commence in early 2013 and conclude by the end of 2014. Together they form part of the SESAR JU's on-going 'Atlantic Interoperability initiative to Reduce Emissions III (AIRE III) SESAR Integrated Flight Trials.' AIRE is the joint European Commission and Federal Aviation Administration (FAA) programme which aims to reduce CO2 emissions and accelerate the uptake of ATM best practices and to capitalise on today's aircraft technology. These integrated flight trials will validate technology and procedures to deliver innovative ATM solutions which will be immediately operational, and allow stakeholders to take direct advantage of the benefits.

Eric Stefanello, CEO of Airbus ProSky commented: "Airbus, EADS and our ATM subsidiaries are pleased to support the coordination between airlines, airports and Air Navigation Service Providers (ANSPs) in these upcoming SESAR JU flight trials." He adds: "By contributing our teams' collective expertise in air transport and ATM, the trials will help not only to pave the way for further reducing emissions, but also to optimize capacity and demand throughout the North Atlantic and Continental European airspace."

The seven SESAR JU Integrated Flight Trials projects in which Airbus/EADS teams are taking part, comprise:

• "ATC Full Datalink" (AFD) will demonstrate how commercial flights can be conducted seamlessly through controlled airspace by making extensive use of FANS B+ equipped aircraft allowing voiceless Controller-Pilot-Data-Link-Communications (CPDLC) for routine operations like clearances, hand over and routing instructions. The AFD trials extend the use of CPDLC even below Flight Level 285, which is currently the limit in some European Upper Airspace. AFD is led by ENAV, with consortium members Airbus ProSky, NATS, easyJet, Air France, Boeing, SELEX-SI and SITA. Subcontractors include Airbus.

• "New Bridge" is a project designed to sequence air traffic earlier than current operations. The operation is to extend on current airline practices to schedule any aircraft type movements and to provide extended coordination between airlines operation centres and related air traffic control sectors, once movements have actually departed. New Bridge will increase flight efficiency through improved management of sector loads and arrival traffic sequencing by using the maximum time horizon available for the business trajectory. In particular New Bridge will consider the exchange of 4D trajectory information for Unmanned Aerial Vehicles (UAV) with a Civil Air Traffic Centre.

New Bridge is led by LFV, with consortium members Airbus ProSky, Swedavia, Estonian ANS, SAS, Novair, Estonian Air, Malmö Aviation, Rockwell Collins France, NLR and Egis Avia. Subcontractors include Airbus and the EADS division, Cassidian.

• "Fair Stream" will pave the way for the use of 'target-time-of-arrival' instead of 'calculated-take-off-time' as a capacity/demand balancing measure coupled with traffic sequencing and 'required-time-of-arrival' exchanges. The evaluation and validation will be performed on commercial flights arriving at Paris, Munich and Zurich during time periods when traffic load exceeds capacity and the delays are significant. Led by DSNA, Fair Stream's consortium members include Airbus ProSky, DFS, Skyguide (Functional Airspace Block Europe Central [FABEC] members), Air France, Régional, Delta Air Lines, Lufthansa and SWISS. Subcontractors include Airbus.

• "Topflight" will develop new procedures designed to allow transatlantic flights from London Heathrow to follow a trajectory as close as possible to their 'reference business trajectories' while remaining de-conflicted and meeting their Arrival Manager sequenced times of arrival. Led by the UK's NATS, Topflight includes consortium members NAV Canada and British Airways. Subcontractors include Airbus ProSky, Airbus and Quovadis.

• "CANARIAS" (CO2 and Noise Approach Reduction for International Aviation Sustainability) will take full advantage of RNP capabilities for a large variety of aircraft to demonstrate reduction of track miles, fuel consumption and CO2 emissions through the implementation of Required Navigation Performance with Authorization Required (RNP-AR) approaches at Lanzarote and La Palma airports. The project is led by Quovadis, with consortium members AENA, easyJet, Thomas Cook Airlines and Air Berlin.

• "AMBER" (Arrival Modernisation for Better Efficiency in Riga) will demonstrate green flights using the Bombardier Q400: a first in Europe with a regional aircraft flying RNP-AR procedures. The Vilnius to Riga and the Warsaw to Riga routes will be used to quantify the reduction of the CO2 emissions when comparing conventional navigation with direct routings applying Performance Based Navigation (PBN) procedures in the terminal airspace. Amber is led by Air Baltic, with consortium members Quovadis and LGS.

• "DFlex" will demonstrate enhanced flexibility to the C-PDS (Collaborative Pre-Departure Sequence) process currently in operation at Paris Charles De Gaulle Airport, by allowing flight reordering based on airline's business requirements. Live trials will be performed to validate slot substitution. DFlex is led by Air France, with consortium members Régional, Delta Air Lines, FedEx, Aéroports de Paris, DSNA and Airbus ProSky. Subcontractors include Metron Aviation.

Airbus is the world's leading aircraft manufacturer offering the most modern, innovative and efficient family of passenger airliners on the market, ranging in capacity from 100 to more than 500 seats. Airbus has design and manufacturing facilities in France, Germany, the UK, and Spain as well as subsidiaries in the US, China, Japan and in the Middle East. Headquartered in Toulouse, France, Airbus is an EADS company.

Time is on their side

The SESAR program to modernize air traffic management in Europe is picking up pace. In this process, Airbus is playing a leading role in developing and validating technology and procedures. With the introduction of time as the fourth dimension in flight management and an emphasis on giving greater decision-making power to airlines, the countdown towards the single European sky has begun.

Every flight crossing Europe's skies covers on average 50 kilometers more than if it could follow a direct route. In 2010 this resulted in 19.4 million minutes of en-route delays, the equivalent of around 13,472 days or just less than 37 years; practically half a lifetime. It is precisely time and making this a less 'relative concept' within air traffic management (ATM) that is now at the heart of the current system's modernization process.

The stopwatch for reform is now running, particularly since Airbus and its partners completed the world's first flight with 4D trajectory technology in an A320 on 10 February 2012. A 4D trajectory is made up of three dimensions (lateral, longitudinal and vertical) plus target times defined at very specific points during the flight where these dimensions converge. This makes time the fourth dimension. In this new approach, aircraft data is transmitted in real time to ground systems, thereby increasing coordination and allowing the aircraft to fly a more efficient trajectory. After the Initial-4D trial flight, as the project is known, Airbus test pilot [redacted] said that "eventually, planes will not be held on the ground because of congested airspace. Before and during approach, it will be possible to sequence smoothly the flow of traffic heading to the same runway. The expectation is to get rid of holdings, reducing fuel burn and carbon emissions, as well as the noise footprint of each flight."

This pioneering I-4D trial is the spearhead of the quiet revolution embodied by the SESAR program (Single European Sky ATM Research), the technological arm of the Single European Sky initiative backed by the European Commission. SESAR brings together all of Europe's leading air transport companies and organizations, including airlines, manufacturers, airports and air navigation service providers. "This is the first time that all the stakeholders have been involved in the definition, development and deployment of a pan-European project to modernize the sector," says [redacted] at Airbus.

Through technology upgrading with the associated business cases, SESAR is contributing to the overall objectives of the Single European Sky initiative: to triple air traffic management capacity, increase safety levels by a factor of 10, halve airspace users' costs and reduce the environmental impact per flight by 10%. According to the latest forecast, these targets are expected to be achieved from 2030, when air traffic will have doubled. "We're talking about a global improvement to the system, with the aircraft acting as a node in an interconnected network. The idea is to advance towards a much greater level of interdependence, integration and automation," explains [redacted] Airbus ProSky, a subsidiary that offers innovative ATM solutions together with the further Airbus subsidiaries Metron Aviation, Quovadis and ATRiCS.

Easing 'rush hour' traffic

On peak days, more than 33,000 flights cross the 10.8 million square kilometers of Europe's airspace. This figure is growing at a rate of around five percent per year, with estimates indicating that by 2020 up to 50,000 aircraft could be flying in a single day – more than one take-off every two seconds. "Simply doing nothing is not an option," stresses [redacted], who points to the need to develop ATM based on solid cost analyses and clear business benefits for airspace users. The implementation of SESAR would have a positive impact on job creation and the GDP of the European Union, especially compared to a 'do-nothing' scenario where growth would be constrained by ATM, leading to inefficiency and lost opportunities for airlines.

The improvements proposed also aim to address the current fragmentation of European airspace. Unlike the US, there is no single agency in Europe responsible for air navigation, but rather 37 air navigation service providers (ANSPs) and more than 60 air traffic control centers. These ANSPs – which represent one or various nations and can be public or private – each have their own rules and procedures, and their investment levels and provision costs vary enormously. The resulting inefficiencies and fragmentation bring extra costs of more than €4 billion per year for airlines and their customers.

The process of transforming European airspace into functional airspace blocks (FAB) that transcend national borders is taking longer than expected and currently only two of a planned total of nine FABs have been implemented. "The synchronization of investment in the aerial and ground segments is vital in order to launch industrial initiatives," says [redacted]. "That's why we're working with Boeing under both SESAR and NextGen [its US counterpart] on the standardization of on-board systems which guarantee interoperability and ensure there are no interruptions when passing from one country's airspace to another's," he adds.

Into the fourth dimension

Airbus is contributing its industrial leadership to resolve the complex equation of increasing flight efficiency and reducing delays while at the same time lessening the environmental impact. The company is one of the 15 members of the SESAR Joint Undertaking (SJU). This public-private partnership cofounded by the Commission and EUROCONTROL has a budget of €2.1 billion and is responsible for coordinating and financing the SESAR program's current development phase (2009-2016). This involves development and validation of the technological systems, components and operational procedures contained in the ATM Master Plan roadmap. Airbus' contribution is threefold: at a technical level, it is developing the aerial segment through work packages; at program management level, it is providing industrial backing (together with Airbus Defence and Space and Astrium; see box); and it is participating in demonstration activities.
"In previous years, the emphasis was on improving the capacity of air traffic management. Now we are more concerned with fuel efficiency and profitability," says [redacted]. The 4D flight trial mentioned above forms part of this new focus. Currently, air traffic controllers provide pilots with heading and altitude instructions and clearance limit. Separation from other traffic along the flight planned route is predicted based on current position and speed vector, which on-board surveillance systems transmit to Air Traffic Control. "However, this information is not systematically shared among all stakeholders, and the ground systems' capability to precisely predict the aircraft's position along its trajetory is limited. This leads to sub-optimum management of the traffic flow," [redacted] explains.
Transmitting data between the aircraft and ground systems via datalink in real time using 4D trajectory management makes it easier to predict traffic flows. "This constant exchange of information allows airlines to optimize their flight plans and trajectories," he continues. This does away with the need for vectoring instructions – the different headings and altitudes air traffic controllers send to ensure sufficient separation between aircraft – and facilitates more fuel-efficient continuous descent operations at airports. The result is a considerable reduction in delays and an improvement in predictability of the system with a better adherence to schedule.

Change takes to the skies

Besides developing 4D technology, Airbus is also working in other interesting research areas. In November 2012, one of the company's dedicated test aircraft and an Air France airliner notched up another first for test flights. This trial demonstrated the technical viability of a system that accelerates automated management of aircraft separation calculations by air traffic controllers. In addition, the teams at Airbus are validating new technology and procedures for regular operations through seven integrated flight trials (see graphic on previous page). Most of these flights seek to demonstrate greater predictability by sequencing air traffic earlier than current operations, granting higher flexibility to airlines and allowing them to choose how they manage delays. "Each project consists of 30 up to 100 flights, in one or two trial periods and we are overall at more than two thirds. We test how these new concepts work using regular commercial flights with existing avionics on board aircraft. Alongside air traffic controllers working on current operations, in some flight trials there is a 'shadow team' testing the new concept," explains [redacted].
The Fair Stream project is being trialed on commercial flights arriving in Paris, Munich and Zurich during time periods when traffic load exceeds capacity and take-off delays are significant. These flights use the 'target-time-of-arrival' instead of 'calculated-take-off-time' to balance capacity and demand. "We eliminate the restriction of the departure time and give airlines the flexibility to take off when they want within reason, but in exchange they undertake to arrive at the time assigned by the network manager for a waypoint near the arrival airport, the so-called metering fix," explains [redacted].
Fair Stream contributes to the validation of an operational concept, where the ANSP receives the information in advance and is able to make better decisions to optimize arrival sectors and workloads. "The preliminary results of the first trials seem to confirm the expectations that the predicted arrival times over the metering fix are remarkably more precise," he adds. "The second trials planned this winter will allow us to confirm the exact time adherence." Flexibility is also the goal of the DFlex

project being tested on departure sequences at Paris Charles de Gaulle Airport. “It is based on allowing flight reordering. For example, when two aircraft have their take-off delayed, airlines can decide whether to substitute one departure for another depending on their business requirements,” says [redacted].

Poised for take-off

For some of these projects, Airbus is promoting large-scale demonstrations involving 100 to 300 commercial flights to reach more solid conclusions regarding the results and, where applicable, progress with future industrialization. These technologies are then released in blocks via the SJU. As a next step, a first batch will be implemented through the Pilot Common Project, which is to be approved by the end of 2013. This outlines the main steps and drivers required to ensure the practical deployment of SESAR solutions in the timeframe of 2014-2020. [redacted], confirmed at the World ATM Congress in 2013 that tangible results are already being achieved: “Depending on the strategic performance objective, SESAR has already delivered anywhere between 20% and 75% of its commitments thanks to its performance-driven approach.”

Together, these tests pave the way for the introduction of 4D trajectory management and, in the longer term, the concept of trajectory-based operations, which will enable an exponential increase in real-time information exchange in all flight phases. However, this will have to wait a few years until the SESAR deployment phase starts delivering, which will involve large-scale production and implementation of a new air traffic management infrastructure composed of fully harmonized and interoperable components at an overarching level.

“Although we still speak different languages, we are integrating a new common language based on situational awareness and a culture of information sharing. We are changing the controllers and pilots’ mindset,” [redacted] stresses. And [redacted] adds: “Modernization of air traffic management, particularly the ground segment, is a very long process that will take up to 25 years in all. In order not to lose sight of the horizon, we must demonstrate that SESAR is already achieving real results.” A time delay which, in this case, is worth the wait.

FAIR STREAM
Common approach to increase flight efficiency

In autumn 2012, the FAIR STREAM (**F**ABEC ANSPs and **AIR**lines in **S**ESAR **TR**ials for **E**nhanced **A**rrival **M**anagement) consortium involving major European airlines, air navigation service providers and suppliers started the concrete work on flight trials to improve predictability and flight efficiency towards major European airports. The project is one of the projects launched by SESAR in 2012. The project consortium is led by DSNA (Direction des Services de la Navigation Aerienne) and combines the expertise from both the air navigation service providers DFS Deutsche Flugsicherung, DSNA and skyguide as well as the airlines Air France, Swiss, Lufthansa, Regional and Delta. In addition, Airbus Pro Sky and EUROCONTROL are contributing with their special knowledge on aircraft behaviour and network management. The flight trials will be performed with commercial flights and existing technical systems involving the airports of Munich, Paris and Zurich. They will be conducted in May/June and September/October 2013.

Maurice Georges, CEO DSNA, stated: "It is essential now to have a strong synergy between the SESAR programme and the initiatives of FABEC. The FAIR STREAM project illustrates perfectly this cooperation. I hope that this new operational concept will make possible real progress in terms of safety, capacity and environment due to a smoother flight profile from departure to arrival".

Concretely, the objective of the FAIR STREAM project is to pave the way for the use of target time of arrival (TTA) instead of calculated take off time (CTOT). This demand capacity balancing (DCB) measure should allow better management of the capacity all along the flight and at the destination airport. The FAIR STREAM project will evaluate the benefits of the TTA concept on predictability and flight efficiency, validate the capability of on-board and ground systems and evaluate how flight crews, air traffic controllers, and local and regional flow managers can handle the procedure as well as the impact on traffic complexity and staff workload.

Air France:
Jacques Verrière, A380 Captain and VP Flight Operations Technical Support "The FAIR STREAM project will perform the first flight demonstrations moving from the existing ATFM slot departure (Calculated Take Off Time – CTOT) to a target time to meet where the ATC congestion is actually. With such a change of the ATFM procedure, Air France expects to demonstrate that the predictability of the air traffic will sufficiently be improved with the existing airborne equipment, allowing Flow Management Position to optimise the declaration of the available ATC capacity. Once applied everywhere in Europe, ATFM delays currently encountered every day should be significantly reduced."

Deutsche Lufthansa, Regina Klotz, Vice President Cockpit Capacity & Operation Support Frankfurt:
„FAIR STREAM is a great opportunity to engage in the evolution of a more efficient air traffic management system. In today's challenging economic and infrastructural environment for airlines we expect to show possible areas of development in areas like fuel saving as well as higher predictability of flight schedules."

DFS, Robert Schickling, desg. COO:
"FAIR STREAM is a common project of airlines and air navigation services providers in the core area of Europe. The flight trials we are conducting will concentrate on arrival predictability and efficiency. The FAIR STREAM project will contribute to SESAR: the live trials will allow to validate the feasibility of the use of a Target Time of Arrival (TTA), the information exchange between service providers and airspace users and to have a better idea of the risks before the subsequent SESAR trial."

skyguide, Alex Bristol, COO:
"This project is an excellent opportunity to prove the value of collaboration among airlines, aircraft manufacturers and other air navigation service providers to improve the efficiency of the network."

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FAIR STREAM Communication

Common Material – March 2014

Key-Messages to promote the FAIR STREAM Project

All of our partners are welcome to use the following **common material** to talk about the FAIR STREAM project in a pro-active communication, even if project details can be given at the national level and/or as a function of each individual field of activity. The information has been extracted from the final FAIR STREAM report. After its presentation to SESAR JU, a Press Release will be sent out in April 2014.

▶ Description of the project and the key-messages

▪ What is the context of this project ?

The SESAR program works on "gate-to-gate" operations. The SESAR JU launched 7 Integrated Flight Trials in 2012 to validate new operational concepts revolving around flight efficiency with the aim of delivering ready-to-be-operational, innovative ATFCM solutions.

Amongst them, the FAIRSTREAM project "FABEC ANSPs and Airlines in SESAR Trials for Enhanced Arrival Management" aims at validating the Target Time of Arrival concept to enhance flight predictability and therefore increase the fluidity of air traffic in the arrival control sectors. FAIR STREAM introduces a time-based operation in situations where the arrival sector needs to be regulated due to capacity shortage.

This concept is part of "Traffic Synchronisation" and "Network Operation" key features defined in the ATM Master Plan. It can also be seen as an initial step towards the i4D concept.

FAIR STREAM is also an initiative to develop synergies between FABEC and SESAR JU activities. This project is integrated into the FABEC XMAN program in which Point Merge is a strategic airspace design project ; FAIR STREAM a pre-tactical ATFCM project ; and XMAN/AMAN a tactical ATC project.

▪ Who participated ?

Members of the consortium : DSNA, DFS, skyguide, Air France, SWISS, Lufthansa, Airbus ProSky (Airbus' ATM subsidiary)

Nota : DSNA, DFS and skyguide are members of FABEC (Functional Airspace Block Europe Central)

Third Party : Hop! and Delta ; Sub-contractor : Boeing ; Support : Eurocontrol

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Stakeholders		Role
ATC	DSNA *Leader of FAIR STREAM WP 0, 2, 3, 4, 5, 6* Co-lead of FAIR STREAM WP7	Project Manager ; Leader of Safety Case; Leader of *"Performance Assessment"* Operational units involved : Paris ACC – Bordeaux ACC – Brest ACC – Reims ACC ; Bordeaux TWR & APP (SNA South-West), Toulouse TWR & APP (SNA South), Paris-CDG TWR & APP (SNA Paris)
	DFS Co-lead of FAIR STREAM WP7	Operational units involved : Langen ACC – Munich ACC – Karlsruhe UAC ; Munich TWR & APP
	Skyguide Leader of FAIR STREAM WP1	Operational units involved : Geneve ACC – Zurich ACC ; Zurich TWR & APP
	Eurocontrol *Leader of SESAR WP 7 "Network Operations"*	NMOC supports for TTA transmission
Airlines	Air France, Lufthansa, Swiss	Involvement of AOC : OCC & Dispatch ; Flights Ops Commercial flights operating as already planned in its own present fleet with current embedded equipment
	Delta	Involvement of Dispatch ; Flight Ops Commercial flights operating as already planned in its own present fleet with current embedded equipment
Manufacturers	Airbus ProSky and Boeing	Study on increasing pilot and ATCO working cooperation even without direct datalink or RTA FMS

▪ What did the project experiment ?

FAIR STREAM paves the way for the use of a "Target Time of Arrival (TTA)" instead of or complementary to a "Calculated Take-Off Time (CTOT)" as a capacity/demand balancing measure coupled with traffic sequencing. FAIR STREAM is a first step that aims to validate the feasibility of the use of a TTA with current equipment and with a level of safety at least equivalent to that of the current situation.

A common understanding of the concept

Scenario: a commercial aircraft is scheduled to arrive to a precise and known by all time at a large European airport during peak hour when traffic load exceeds capacity.

The current situation: 3 hours before the Estimated Off Block Time, the Network Manager Operations Centre (NMOC) of EUROCONTROL calculates sequenced times of arrival according to the declared capacity and accordingly allocates a take-off slot (Calculated Take-Off Time). The flight has to take-off within a time window [-5', +10'] around the CTOT, then flies as any usual flight.

With the CTOT, the aircraft takes off… but the constraint of ATFCM delay is not taken into account in the management of the flight.

The flight reaches the arrival airport at a time significantly different from the one originally planned by NMOC.

With the FAIR STREAM project :

- 3 hours before the Estimated Off Block Time, the NMOC determines a Target Time of Arrival (TTA) that reduces arrival flows according to expected landing capacity, and the corresponding CTOT. This TTA is sent to the Airline Centres (OCC) and available for ATC units (Dep TWR, ACCs FMP, Arr APP).
- 30' before the Estimated Off Block Time, the OCC sends the TTA to the pilot by ACARS. Then the pilot calculates a Target Take-Off Time (TTOT) and a Target Off Block Time (TOBT) with the FMS taking into consideration air traffic parameters (QFU and SID confirmed by ATCO), taxi time and airline requests (actual weight of aircraft, actual wind, cost-index…) in order to reach the TTA fix at the requested time.

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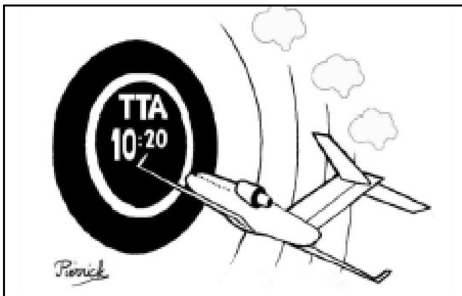
- At TOBT, the pilot requests push-back and informs the tower about its TTOT.
- After take-off, the pilot adapts aircraft speed in order to respect the TTA and to optimize his flight efficiency. ATCOs handle the flight like any other. With a TTA used by all stakeholders, the effectiveness of network solutions to saturated airspace will be improved

See the meaning of acronyms in the final report.

▪ Live Trials : main results and limitations



Picture designed for the project

Total Live Trials : 825 flights
Arrivals at Zurich airport: 469
Arrivals at Paris-CDG airport: 349 (128 short/medium-haul flights and 221 long-haul flights)

The evaluation and validation were performed in 2013 on commercial flights arriving at:
▪ **Paris-CDG** (2 city-pairs "Toulouse-Paris CDG" and "Bordeaux-Paris CDG" + long-haul flights from North America to Paris CDG)
▪ **Zurich** (For the first trial period : 4 city-pairs "Paris CDG – Zurich", "Geneve-Zurich", "Dusseldorf-Zurich", "Stuttgart-Zurich" ; for the second trial period all SWISS flights during two peak arrival waves including long-haul flights)
▪ **Munich** (city-pair "Paris CDG – Munich")
During peak hours when traffic load exceeded capacity and delays were significant. Some non-regulated flights were also included in order to increase the number of eligible flights.
Nota : these 3 airports are located in the Core Area in Europe.

▪ Main Results

A baseline was defined as a reference period which is specific to each exercise. For example, all eligible flights arriving at Paris-CDG from 18th of February 2013 to 13th of May 2013 for the first period and from 14th of July to 17th of September 2013 for the second period.

For instance, the figure below shows that 51% of short-haul flights arriving at Paris-CDG using FAIR STREAM reached the TTA at plus or minus three minutes, compared to 26% in the baseline.

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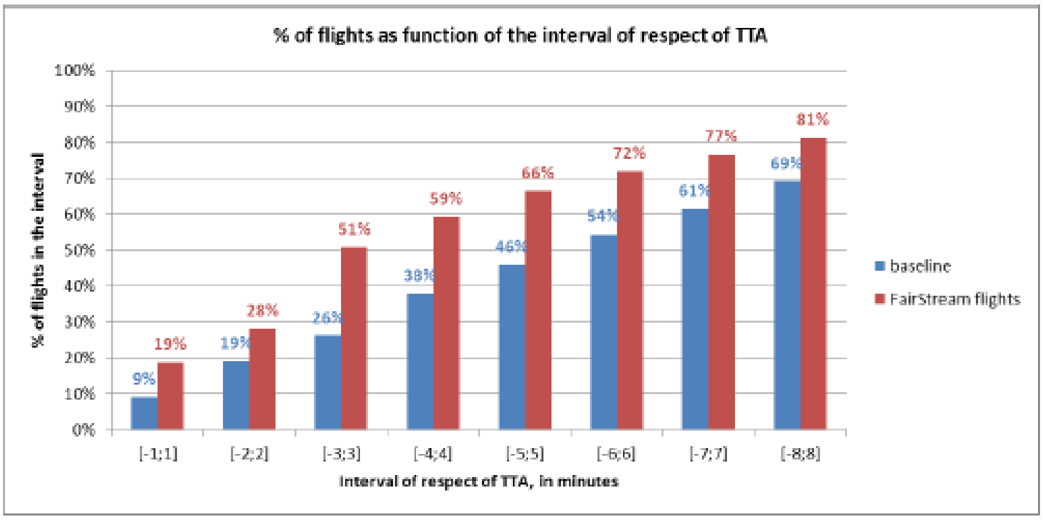
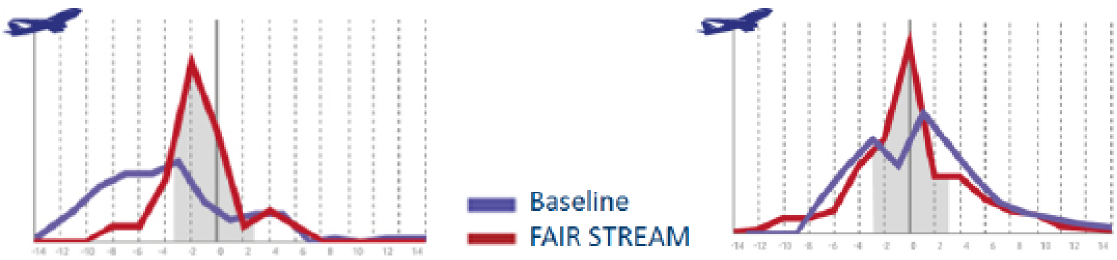


Source: short-haul flights to Paris-CDG

The adherence to the TTA was clearly better during the trials.



Toulouse > Paris-CDG

Zurich Arrivals

Baseline : Estimated Time Over TTA-Fix adherence
FAIR STREAM : TTA-Fix adherence

<u>Analysis</u>

✓ Aircrews tend to take-off at the beginning of their assigned CTOT slot. But in the FAIR STREAM live trials, they tried to take-off closer to the TTOT to respect their assigned TTA.

✓ The use of TTA could offer more flexibility to airlines. Depending on the situation, aircrews can leave the gate earlier and fly more « fuel efficiently ».

✓ Some direct routes have been given during the trials with an impact on the adherence to the TTA.

✓ Flights departing from Paris-CDG, an airport-CDM where the off-block and the take-off time are managed, succeeded in respecting their TTA: CDM and TTA concepts are compliant.

✓ For short-haul flights, a TTA can be met when the estimated elapsed time is well calculated and the Actual Take-Off Time lies within smaller tolerance around the CTOT than current operations.

✓ No significant workload increase due to the use of TTA was reported by ATCOs and flight crews.

✓ During the flight, speed adjustments come with a possible extra fuel burn for airlines.

Benefits expected

✓ **Predictability**

Initial flight trial results indicate that the time window in which the aircraft arrives at the TTA metering fix is much smaller than in current operations : arrival traffic flow management should be easier to handle thanks to better predictability, which means less holding or radar vectoring in the air, so less fuel consumption and carbon emissions.

✓ **Flexibility**

Operators feel that this concept brings more possibilities to optimize flight departure and speed profile, according to flight needs.

✓ **Trials provide hands-on experience**

Live trials have provided all operational actors the opportunity to familiarize themselves with the application of time based operations with existing aircraft technology.

✓ **Towards a modernized ATM system**

The FAIR STREAM trials are one of many concrete steps towards making i4D navigation a reality: i4D flight trials will include all necessary technological enablers including datalink to apply time-based operations on a large scale

Main limitations

✓ **For ATC**

NMOC has met difficulties in applying a TTA to long-haul flights.

The fixing of the TTA in the AMAN in the Paris-CDG exercise was not adequate in the current working context. A recommendation would be to work further on a way to ensure flights make the effort to comply with TTA and are not penalized after the TTA fix.

✓ **For airlines**

Crew can meet landside operational difficulties that generate last minute departure delays. The analysis of the impact of take-off time deviation on the adherence to TTA proved that making the effort to comply with a TTA is easier for flights ready on time than for flights that have a tendency to be late at departure.

DELTA's dispatch and SWISS AOC's workload has increased significantly to take into account quite complete flows (2nd period of live trials): a specific software was developed by SWISS to automate the process.

▪ **Next steps**

To validate the practicability of the TTA concept in real operations, it seems advisable to repeat live trials with the following points taken into consideration:

- testing on quite complete flows ;
- finding a way to give a TTA to long-haul flights ;
- studying synergies between TTA and AMAN ;
- studying how to manage flights which will not comply with their TTA, voluntary or not.

FAIR STREAM paves the way for better predictability of flights leading to smoother flight management while preserving a high level of safety. Live trials keeping all the actors in the loop have demonstrated the feasibility of this concept: Crew with the standard equipment on board can respect a Target Time of Arrival much better than in current operations. Moreover, ATCOs' and crews' workload was not impacted.

But to obtain full validation of this innovative ATFCM procedure, new exercises have still to be undertaken.

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▶ PowerPoint Presentation

From this information, slides have been prepared including a short video of an ATCO and a pilot's speeches who have participated in the FAIR STREAM Project Team.

[redacted] FAIR STREM Project Team "Before evaluating this new operational concept with live trials, we made a safety case study. Then we led two series of trials in 2013 and as far as we are concerned, around 300 flights arriving at Paris-CDG have tested this innovative ATM procedure. From air traffic controller's point of view, we can note that first of all, no problem of safety occurred on the control sector. For the short haul flights, the procedure was understandable by all the operational staff. The TTA was quite always given to the controller. Our workload was unchanged even if sometimes pilots have taken unusual speed to reach the TTA, but they always reported the speed. Commercial flights testing the FAIRSTREAM concept were integrated in air traffic without specific ATC priority. However, for the long haul flights, we would have to find a good way to transmit the TTA, including Network Manager of Eurocontrol because we had sometimes some problems to get the TTA information. As an operational actor, I can say that these trials have successfully demonstrated the feasibility of the FAIRSTREAM concept regarding the TTA adherence with existing technical onboard and ground equipment".	[redacted] FAIR STREM Project Team "At our home base ZRH we have to deal with several constraints which reduce the capacity of the aerodrome. Especially during our peak arrival periods, our operation relies on an efficient traffic flow. FAIR STREAM is an attempt to optimize the arrival sequence and to reduce delays in the air, which is in the interest of both the airlines and the environment, as it reduces fuel burn, CO_2 and noise emissions. The trials have shown that the use of the target times of arrival brought about a somewhat increased workload mainly in the pre-flight phase. This is when we calculate our optimal take-off time as well the corresponding off-block time. Once airborne, we can adapt our speed to some extent in order to reach the target at the right time, but only very little can be done to gain time; so the take-off time is key, especially within Europe where flying times are rather short. The experience so far shows that the workload is manageable without affecting the safety of the operation. The FAIR STREAM trials have demonstrated that the time accuracy over a target can be significantly improved as long as the departure airport enables a timely take-off. In order to have a real effect on arrival efficiency, the TTA should be incorporated into the arrival management."

In coordination with SESAR JU Communication, the first official presentation about the results on the FAIR STREAM concept was presented by DSNA [redacted] during the workshop "Demonstrating SESAR" in WAC Madrid on 5th of March 2014.

▶ A short educational video

Information described in this paper will also be used to write a story board of a short video explaining the concept, its advantages and the main limitations of this first step.

-END OF DOCUMENT-