Performance of flight trials validating solutions for the reduction of CO₂ emissions

Lot 2 – Terminal

DoWo – Down Wind Optimization @ CDG

FINAL REPORT (D2)
DOCUMENT REVIEW

Reference: SJU/LC/039-CTR/D2

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# TABLE OF CONTENTS

1. INTRODUCTION ..........................................................................................................................8
   1.1. Objectives of the document .................................................................................................8
   1.2. Structure of the document ......................................................................................................8
   1.3. References and acronyms ......................................................................................................8

2. Air operations environmental activities .....................................................................................10
   2.1. Introduction ...........................................................................................................................10
   2.1.1. Environmental initiatives .................................................................................................10
   2.1.2. DSNA initiatives ...............................................................................................................11
   2.1.3. National initiatives ............................................................................................................12
   2.2. AIRE European background ...............................................................................................13

3. AIRE 2010-2011 project ............................................................................................................13

4. Terminal operations demonstration PLAN ..............................................................................14
   4.1. Objectives of the project .......................................................................................................14
   4.2. Organization of the project ....................................................................................................14
     4.2.1. Organization of the participants ......................................................................................14
     4.2.1.1. DSNA project manager: ............................................................................................14
     4.2.1.2. Project coordinators ..................................................................................................15
     4.2.1.3. Location ....................................................................................................................15
   4.3. Work breakdown structure ...................................................................................................15
   4.4. Demonstration plan ..............................................................................................................16
     4.4.1. Demonstration and flight trials .......................................................................................16
     4.4.2. Planning ........................................................................................................................16
     4.4.3. Risks ..............................................................................................................................16

5. FLIGHT TRIAL IMPLEMENTATION AND RESULTS ............................................................17
   5.1. Baseline ...............................................................................................................................17
   5.2. Scenario ...............................................................................................................................19
     5.2.1. Period of demonstrations ...............................................................................................19
   5.3. Preparation of demonstrations ...........................................................................................20
     5.3.1. Instrument Flight Rules procedures ............................................................................20
     5.3.1.1. Optimized descent profile from IAF MERUE ..........................................................21
     5.3.1.2. Optimized descent profile from IAF LORTA ............................................................22
     5.3.1.3. Stripping and coordination .......................................................................................23
     5.3.2. Briefing to ATCo and Aircrews ....................................................................................23
   5.4. Performances of the demonstration flights .........................................................................24
   5.5. Results ...............................................................................................................................24
     5.5.1. Impacts on capacity .......................................................................................................24
     5.5.2. Impacts on safety ...........................................................................................................25
     5.5.3. RADAR data analysis ...................................................................................................26

5.5.3.2. Briefing to ATCo and Aircrews ....................................................................................23
5.5.3.3. Impacts on capacity .......................................................................................................25
5.5.4.1. Instrument Flight Rules procedures ............................................................................20
5.5.4.2. Optimized descent profile from IAF MERUE ..........................................................21
5.5.4.3. Optimized descent profile from IAF LORTA ............................................................22
5.5.4.4. Stripping and coordination .......................................................................................23
5.5.5.1. Impacts on capacity .......................................................................................................26
5.5.4. Fuel burn and CO2 analysis ........................................................................... 27
5.5.4.1. Expected Fuel Savings ........................................................................... 27
5.5.4.2. Overview of the method: ......................................................................... 27
5.5.4.3. Fuel savings DoWo from IAF LORTA: .................................................. 29
5.5.4.4. Fuel savings DoWo from IAF MERUE .................................................. 33
6. Communication ................................................................................................. 37
6.1. Introduction ................................................................................................... 37
6.2. Summary of dissemination activities ............................................................ 37
6.2.1. Objectives ................................................................................................. 37
6.2.2. Means ....................................................................................................... 37
6.2.3. Communication supports .......................................................................... 37
6.3. Exhibitions and conferences ......................................................................... 38
6.3.1. Participation to Paris Air Show .................................................................. 38
6.3.2. Participation to “Transports and mobility exhibition” in September 2011, in Paris ................................................................. 39
6.3.3. ATC Global ............................................................................................... 39
6.3.4. ANERS 2011 .......................................................................................... 39
6.4. General communication ................................................................................ 39
7. Conclusions .................................................................................................... 40

TABLE OF FIGURES

Figure 1: General optimization of air transport operations .................................... 12
Figure 2: Overall planning or AIRE 2010-2011 DoWo project ................................ 16
Figure 3: TMA Paris master plan ......................................................................... 17
Figure 4: STAR Runway 26 an 27, West configuration ......................................... 18
Figure 5: STAR Runway 08 an 09, East configuration .......................................... 18
Figure 6: Actual CDO procedure from IAF LORTA ............................................ 19
Figure 7: Timetable of the demonstrations .......................................................... 19
Figure 8: Procedures availability for demonstrations .......................................... 20
Figure 9: New STAR, new striping with DVL9G .................................................. 21
Figure 10: Optimized descent profile from MERUE ............................................ 21
Figure 11: New STAR, new striping with VEDUS9G .......................................... 22
Figure 12: Optimized vertical profile from LORTA ............................................. 22
Figure 13: Current and IARE TFL on STAR’s ...................................................... 23
Figure 14: Total number of demonstration flights .............................................. 24
Figure 15: Demonstration flight time slots ......................................................... 24
Figure 16: Number of arriving aircraft at CDG during period of demonstrations .... 25
Figure 17: Safety analysis .................................................................................. 26
Figure 18: Vertical profile and fuel consumption ................................................. 28
Figure 19: Vertical profile and parameters at 280 kts IAS ..................................... 29
Figure 20: Vertical profile and parameters at 340 kts IAS .................................................................30
Figure 21: Vertical profile baseline - B777- IAF LORTA.................................................................31
Figure 22: Optimized vertical profile - B777 - IAF LORTA..............................................................31
Figure 23: Vertical profile - B777 - 250 kts IAS ..............................................................................32
Figure 24: Vertical profile – A320 – IAF MERUE - Baseline ..............................................................33
Figure 25: Optimized vertical profile - A320 - IAF MERUE..............................................................33
Figure 26: Vertical profile - A320 - IAF MERUE - Baseline - 340 kts...............................................34
Figure 27: Vertical profile - B777 - IAF MERUE - 310 kts .................................................................35
Figure 28: Vertical profile - B777 - IAF MERUE - 310/250 kts ......................................................35
EXECUTIVE SUMMARY

The Atlantic interoperability initiative to Reduce Emissions (AIRE) program is designed to improve energy efficiency and lower engine emissions and aircraft noise in cooperation with the FAA. The SESAR JU is responsible for its management from a European perspective. Under this initiative ATM stakeholders conducted flight trials and demonstrations in 2010-2011 validating solutions for the reduction of CO2 emissions for surface, terminal, gate to gate and oceanic operations. Amongst the 4 contracts awarded by the SJU in 2010, this project (contract SJU/LC/039/CTR) was addressing the Terminal Operations perspective.

MEMBERS

The AIRE Terminal Operation project was conducted by a consortium involving the DSNA (Direction des Services de la Navigation Aérienne) acting as the manager of the project and Air France.

DESCRIPTION OF TRIALS

DSNA and Air France have proposed to develop the concept of Green STAR (Standard Arrival) combined with Green INA (Initial Approach) evaluating the possibility of improving the vertical profiles in a busy TMA and ACC. The concept of operations has considered all configurations at Paris-Charles de Gaulle airport were whatever the runways in use. Improvement was to enhance the downwind procedures which impose level off segment prior to intermediate and final approaches segments.

Altogether more than 200 commercial flights participated to the evaluations.

The evaluations began on November 16th, 2010 and ended on December 3rd, 2010

RESULTS

• Objectives and Evaluation context:

  Thanks to dedicated STAR’s designed at the occasion of the demonstration and flight trials, the objectives were to enhance the vertical profile from cruise to IAF and then optimized the downwind legs by raising the constraint at some waypoints. In addition, objectives were to assess all way of traffic management in the ACC sectors and in the terminal area in real traffic conditions.

  Since the evaluation was planned during a long period of the day, and think to a supplement to AIP released, all aircraft were supposed to be cleared to proceed on the “Green” procedures with not constraints regarding active runways. Thus, all types of aircraft of different carriers than Air France have been involved by the demonstration and flight trials. However, Air France, as member of the consortium, was the only company to provide feed back and analysis.

• Benefits assessment:

  Due to the period of demonstration fixed by the consortium, which was low peak at CDG but still with a lot of aircraft, all the expected flights have performed the procedures as far as they were well sequenced by ACC inbound the IAF, with significant fuel savings. The expectations in terms of fuel saving have been verified after flight data analysis with respectively 40kg and 100kg saved for A320 and B777 aircraft.

  Despite the increase of coordination needed between ATC sectors, ATCo got quickly confident controlling such more optimized and less constrained trajectories and decided to open the flight trials to other time slots.

  On the pilot side, standard aeronautical information was enough to perform the flight trials, which explains why other air carriers were able to participate.

OUTLOOK

It must be stressed that benefits were obtained in low/medium traffic conditions and cannot be extend to peak period where demand is close or exceeds capacity since so far these procedures have a negative impact on capacity.

The project was supported by an excellent cooperation between DSNA and Air France respective staff, calling for increased cooperation to consolidate results, apply pragmatic procedures whenever possible and investigate new initiatives for reducing environmental footprint of the Air Transport Industry.

FURTHER PERSPECTIVES

More studies must be carried out for airspace and procedures designs, AIS have to be coordinated closely with FMS flight data providers before further implementation, but ATCC works on enhancing current procedures to provide a better service to airlines by studying the way to extend the “Green” mode to wider period in the IATA seasons.
The outcomes issued by the present demonstration and flight trials project have been part of the input in a wide SESAR project launch by DSNA with European partners and called PANAM which will take place in 2011 in order to experiment point merge systems in ACC sectors feeding the IAF.
1. INTRODUCTION

1.1. Objectives of the document

This document is the second deliverable of the project, split in two phases. Phase one was to detail the proposed experiments and related communication plan with SJU representative, and phase two was to implement the experiments accordingly with the demonstration and flight trials plan (D1). Demonstrations and flight trials took place in the TMA Paris, ACC Paris and Brest airspace.

The present document will address:

- The AIRE background and general objectives,
- The general context of the demonstrations,
- The implementation of the experiments,
- The analysis of the demonstrations and the result,
- How communication issues have been addressed through the project.

1.2. Structure of the document

- Section 1 is the introduction and objectives of the document,
- Section 2 “Background” of the project is a short recall of the national environmental activities held and an AIRE background,
- Section 3 “AIRE 2010 project” addresses the call of tender and the proposal from the consortium,
- Section 4 “Terminal operations demonstration plan” indicates consortium organization and highlight the demonstration plan,
- Section 5 “Flight trials implementation and results” provides detailed information on the implementation of the flight trials,
- Section 6 “Communication” reports on communication linked with the AIRE 2010 activities.

1.3. References and acronyms

- Invitation to tender, SJU/LC/0039-CFP dated on January 14, 2010
- Technical offer, Lot2-Terminal-Volume2-Technical offer dated on April 2nd, 2010
- Service contract, SJU/LC/0118-CTR dated on September 27, 2010
- Deliverable 1, Validation and communication plan dated on November 23, 2010

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<td>CDA</td>
<td>Continuous Descent Approach</td>
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<td>Paris-Charles de Gaulle airport</td>
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<td>CDO</td>
<td>Continuous Descent Operation</td>
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<td>Initial Approach Fix</td>
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2. AIR OPERATIONS ENVIRONMENTAL ACTIVITIES

2.1. Introduction

As demand for aviation services continues to grow, an increase in the industry’s emissions and noise impacts can be anticipated. This may happen against a backdrop of emission reductions from sources other than aviation, and as well, the rising values we place on environmental quality. If not successfully addressed, environmental issues may significantly constrain air transportation growth in the 21st century.

The Federal Aviation Administration (FAA) and the European Commission (EC) have recognized the value of cooperation to achieve global aviation objectives and meet the requirements of all airspace users. On the occasion of the 2007 Paris Air Show, on the 18th June 2007, the EC and FAA have formed a partnership called the Atlantic Interoperability Initiative to Reduce Emissions (AIRE) to explore opportunities focusing on research, development, and accelerated implementation of environmentally-friendly air traffic standards and procedures.

Simply put, the FAA and EC seek enhanced ATM interoperability, improved energy efficiency, reduced engine emissions, and lower aircraft noise. These are the AIRE Partnership objectives. Taking advantage of new technologies and air traffic procedures that offer the most immediate, near-term fuel consumption and emission reduction benefits, the AIRE partnership will:

- Accelerate development and implementation of environmentally friendly procedures for all phases of flight, from gate to gate;
- Capitalize on gateway airports already using advanced technology and best practices;
- Provide a systematic overall program approach with short, medium and long-term initiatives;
- Validate improvements with flight trials and demonstrations.

The AIRE Partnership focus includes all flight segments, beginning with the departure gate and terminating when an aircraft arrives at its destination gate. We will look at the entire flight, with a “phased approach” to flight demonstration initiatives.

Beyond these general considerations, Air France and DSNA have taken part to many initiatives, individually or grouped in consortium through previous AIRE contracts, (see & 2.2. below) or on behalf of the national environmental policy.

2.1.1. Air France initiatives

Worldwide, air transport generates 2-3% of global man-made CO\textsubscript{2} emissions, a factor in global warming. Growing demand and the absence of any alternative energy source in the short or medium term, mean that this figure is likely to rise. Because climate change is a crucial phenomenon for the future of the planet, Air France-KLM considers that the airline industry should take its share of the responsibility. The group has accordingly set out an ambitious program with a resolute, pragmatic approach in a number of convergent areas that should guarantee its effectiveness towards reducing greenhouse gas emissions. To combat Climate change, Air France-KLM put in place its Climate Action Plan:

- Air France supports the Kyoto Protocol and the principle of pragmatic, realistic inclusion of the air transport industry in the EU Emissions Trading Scheme
- Air France continues to renew our aircraft fleet and support aviation research into improving energy efficiency and reducing CO\textsubscript{2} emissions. We actively engage with our aircraft manufacturers.
- Air France provides our customers with information and a CO2 calculator that uses real operational data, and offers them opportunities for carbon compensation.
- Air France supports NGO environmental protection programs.
- Air France promotes research programs for renewable energy sources.
- Air France motivates the entire Air France-KLM group to follow on through environmental protection plans notably to reduce emissions generated by our ground operations.
In line with our second commitment here above, Air France sets up a Fuel Action Plan to reduce our fuel consumption and thus our greenhouse gas emissions. The Fuel Action Plan aims at identifying all useless fuel consumption and set up short and long-term actions while maintaining our high safety level of our flights and without modifying our business model. This Fuel Action Plan identified 4 domains:

- **Airspace Design and ATM tools**: Air France took an active part on FAB and SESAR since the beginning of these initiatives launched by the European Commissions. We expect to save more than 60,000 tons of CO\textsubscript{2} per year in 2013 and more than 150,000 tons of CO\textsubscript{2} per year in 2020.

- **Aircraft**: in addition of aircraft renewal, Air France keeps on improving aircraft performance by reducing aircraft weight through an optimization of the catering and a replacement of paper by electronic flight bag. Each kg saved per aircraft allows to save more 80 tons of CO\textsubscript{2} per year.

- **Fuel payload**: since extra fuel is needed to carry on more fuel than necessary, Air France undertook actions to optimize the Fuel payload based on the daily conditions of the flight.

- **Flight Management**: in the context of AIRE initiative, Air France is already involved with French (ADP and DSNA) and American (FAA) Service Providers in optimizing the Flight Efficiency through flight procedure improvement in all phases of the flight from take-off to landing and including taxiing, as described in the figure below.

![Figure 1: General optimization of air transport operations](image)

### 2.1.2. DSNA initiatives

In addition to its participation on the initiative AIRE in the year 2009, the DSNA is totally involved in delivering the engagements taken by the French government within the “Grenelle de l’environnement” framework (see § 2.2).

This includes, the study of the raising altitudes during the ILS interception phases for noise reduction purposes, the approach procedures publications limiting the level flights phases or the design of a specific airways network adapted to the conditions of air traffic by night in order to reduce fuel consumption and gas emissions.

According to the AIRE concepts, procedures have been evaluated for months in partnership with several airline companies and airports. CDA are in evaluation at Marseille, Strasbourg, CDG and Toulouse, while DSNA continue its initiatives through the CDA implementation plan. A new evaluation should start at Lyon-Saint Exupéry and CDA is to be published soon and available for every air carrier, at Paris-Orly in the spring of 2010.

Outcomes of the demonstration and flight trials conducted in AIRE 2009 activities regarding terminal operations have permitted to implement new arrival procedures to CDG for the Atlantic inbound morning flow. They are in use today, and every coming aircraft may perform CDO from the Top of Descent to the IAF with no horizontal segments on a daily basis.
2.1.3. National initiatives

Within the “Grenelle de l’environnement” framework initiative, the French government welcomed major actors of air transport on January 28, 2008 to assess the situation in relation to sustainable development issues. Mr. Jean-Louis Borloo (State Ministry), Mr. Dominique Bussereau (Secretary of state for transports), Mrs. Nathalie Kosciusko-Morizet (Secretary of state for Ecology), Mr. Pierre Graff (ADP, Chairman and CEO), Mr. Jean-Cyril Spinetta (Air France-KLM group, CEO) participated to the event. Three major topics were identified:

- CO₂ emissions and their impacts on climate change,
- Emissions of nitrogen oxides and their impacts on local air quality,
- Noise pollution suffered by the neighboring residents.

All players recognized that, while the development of air transport and its infrastructure is economically and socially desirable, it has to be considered in controlling its environmental impacts. The proposals and ambitious goals they have selected for the future demonstrate their willingness to act together at all levels of the chain air transport. This agreement aimed to formalize the commitments made at that time and to organize the monitoring of their implementation. Ten commitments (along with quantitative objectives) have been endorsed and signed on in a convention:

- Reduce emissions of new aircraft; by 2020, reduce fuel consumption and emissions of carbon dioxide (CO₂) by 50% per passenger-km, reduce emissions of nitrogen oxides (NOx) by 80%, reduce perceived noise by 50%.
- Establish a board for French civil aviation research;
- Continue aircraft fleet modernization;
- Improve environmental performance of merchant aviation companies;
- Inform the passenger about air transport impact;
- Support the European project to include air transport in the trading system emission scheme;
- Improve environmental performance of air navigation:
  - In 2008, altitudes have been raised by 1000 ft for nightly flights arriving at Le Bourget, airport (east wind conditions);
  - This year, raising altitudes (4000 ft) for arrival flights at Paris Orly airport are on going,
  - In 2011 again: raising altitudes to 4000ft and 5000 ft for arrival flights at Roissy Charles de Gaulle airport (instead of resp. 3000ft and 4000ft at current); raising altitudes to 3000ft for all arrival flights at Le Bourget airport; raising altitudes to 5000ft for a subset of arrival flights at Orly airport.
- Improve the environmental performance of airports; in that respect, Aéroports de Paris is committed to:
  - Reducing the mean aircraft taxi time by 10% at Roissy Charles de Gaulle airport by 2015;
  - Applying HEQ standards for all its new buildings. The T2G and S4 terminals at Paris-Charles de Gaulle, as well as the future Coeur d’Orly international business centre, will all conform to these demanding standards.
  - Slashing down its own internal energy consumption per passenger, by 20% by 2020 and by 40% by 2040, taking the 2004 level as the baseline;
  - Launching a program oriented towards renewable energy (geothermal, biomass, ..);
  - Undertaking to reduce the emissions of its fleet of cars and light utility vehicles by 30% per kilometer travelled by 2012;
  - Contributing with airlines to limit the use of Auxiliary Power Units (APUs);
  - Promoting a car-sharing web site for the 120,000 people working at Paris airports.
- Improve the provision of individual soundproofing grants to households located within the areas defined by special noise inconvenience maps.
- Ensure an annual follow up of the convention.

Thus, the principles and the objectives of the project promoted by the SJU, aiming at highlighting the benefits that the application of new procedures can permit in terms of noise and gas emissions can join those defined by the French government policy and supported by Air France and DSNA, as well as all air transport stakeholders.
2.2. AIRE European background

The initiative AIRE was presented to the director of the DSNA by the administrative of the FAA at the time of a visit of a French delegation in Washington in April 2007. At the time of the Air Show of Le Bourget in June 2007, French Government announced that it joined on the international initiative launched by the European Commission and the FAA.

Consequently working groups were organized in the control units in order to establish the lines and the initiatives which could be taken within the framework of AIRE. These discussions were held in partnership with airports managers (ADP), and Air France Company.

For months the DSNA and Air France took part in 2008-2009 in several meetings organized by the European Commission (DGTREN) in a “bottom up” reflection intended to share the respective experiments of the European stakeholders to the AIRE project as regards reduction of the gas emissions and noise.

After the SESAR JU took the lead of the initiative on the east side of the Atlantic Ocean, SESAR JU launched a call for proposal in order to select a number of flight trials and demonstration projects to evaluate and to validate solutions to reduce CO$_2$ emissions in three domains such as, ground, terminal and oceanic operations.

DSNA and Air France have, jointly or separately, bid for this call for proposal, and were altogether involved in 3 contracts out of the 6 contracts awarded by SJU in November 2008:

- Air France was involved in the three domains through 3 contracts,
- DSNA was involved in 2 projects related to ground and terminal operations.

3. AIRE 2010-2011 PROJECT

In response to the Invitation to tender, Air France and DSNA, "the consortium", have submitted a technical, financial and administrative offer for the performance of flight trials and demonstrations validating solutions for the reduction of CO$_2$ emissions in the context of the Terminal area framework (called Lot2).

- Invitation to tender, SJU/LC/0039-CFP dated on January 14, 2010

The proposal (SJU039-Tender-DSNA-Lot 2) has been send to SJU on April 26th, 2010 and in response a service contract (SJU/LC/0118-CTR) was signed by the consortium and SJU on September 27th, 2010.

A consortium agreement has been signed by Air France and DSNA on November 25th, 2010.

The kick-off meeting was held on September 28, 2010 at DSNA premise in Paris-Charles de Gaulle Control Center.

The validation and communication plan (D1) was delivered on November 23rd, 2010 after acceptance review meeting held by the consortium and the SJU. The service contract phase 1 was ended by SJU after acceptance of the D1.

Afterwards, Phase 2 of the contract has begun until acceptance by SJU of the present document (D2).
4. TERMINAL OPERATIONS DEMONSTRATIONS PLAN

4.1. Objectives of the project

Air navigation service provider activity is to ensure on all occasions the safety of the flights, in a fluid system, while satisfying the criteria of capacity, efficiency and sustainable development. Arriving traffic flows converge through busy airspace towards runways.

In the current context, some demonstrations have been carried out in 2009 accordingly with the SJU/LC/019-CTR service contract in the terminal operations domain. On this occasion demonstration and flight trials have been performed from top of descent to IAF and/or runways. They have proven the expected benefits of the concept of operations by highlighting significant fuel saving and reduction of emissions.

From the conclusions of this experience, it was obvious that follow up of this very first set of trials, that involved CDO from TOD to IAF and from IAF to the runway (by night) had to be continued through further steps in order to validate the evaluated solutions.

First, the key issue is to perform CDO flight trials in high density traffic on day time operations at Paris-Charles de Gaulle with enhanced coordination processes between all relevant ATC sectors with the aim of standardization for daily operations. DSNA and Air France have a great experience on conducting such operations and they are ready to share their knowledge and practices with all air carriers operating at CDG during the period of the proposed validation project. The first proposed project aims at defining enhanced procedures for the arriving aircraft flown from the north-west (Waypoint MERUE) to CDG.

Second, the other key issue is to perform flight trials regarding CDO, in night time period, based on RNAV procedures during wider period than previously evaluated with adequate coordination processes between the stakeholders. The second proposed project is to define enhanced RNAV procedures, techniques and phraseology for night time traffic coming in CDG from the waypoint LORTA.

Finally, the last key issue is that the trials have been be available for all airlines operating at CDG during the periods of evaluation in order to validate the chosen solutions jointly evaluated by AFR and DSNA in terms of:

- Coordination process
- Phraseology
- Aeronautical information
- Spread flight techniques to ATC

Proposed demonstrations:

- Down wind optimization to RWY 26/27 from IAF MERUE at day time
- Down wind optimization to RWY 09/08 from IAF LORTA at day time
- Enhanced CDO ILS 09/08 from IAF LORTA by night

4.2. Organization of the project

4.2.1. Organization of the participants

Client: The SJU project manager for the contract SJU/LC/0118-CTR is Celia Rodrigues

Consortium member: The consortium structure is defined as follows:

<table>
<thead>
<tr>
<th>Name of the involved companies</th>
<th>Acronyms</th>
<th>Contract Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction des Services de la Navigation Aérienne</td>
<td>DSNA</td>
<td>Coordinator</td>
</tr>
<tr>
<td>Air France</td>
<td>AFR</td>
<td>Contractor</td>
</tr>
</tbody>
</table>

4.2.1.1. DSNA project manager:

As Consortium coordinator and project manager, Alain BOURGIN (DSNA), has taken overall responsibility for ensuring the project meets its technical and timing objectives. His responsibilities involve:

- Representing the consortium towards SESAR Joint Undertaking;
Co-ordination of all development tasks activities between teams involved in the project, in order to ensure maximum effectiveness;
Development of the project organization and work brakedown and all necessary procedures, orders, and directives to ensure that all project tasks are accomplished timely and effectively;
Implementation of necessary reporting and control functions in all areas and analysis of data received through the study reporting and documentation and control system;
Ensuring compliance of the programme activity by enforcing established quality assurance standards and procedures, and interfacing with project partners;
Maintaining financial control of the project.

4.2.1.2. Project coordinators
A partner coordinator has benne nominated for Air France. Mr Laurent RENOU was in charge of:

- Co-ordination of all development tasks activities within his team;
- Management of the WPs for which his company is responsible (if any) and liaison with the Project Manager. He is particularly in charge of the WP deliverables, incorporating internal comments as well as review comments from SJU.
- Execution of all necessary procedures, orders, and directives to ensure that all project tasks are accomplished timely and effectively;
- Implementation of necessary reporting and control functions in all areas and analysis of data received through the study reporting and documentation and control system.

As project coordinators, Robin ONGHEN (DSNA), Sylvain GROELLY (DSNA) and Hélène CARAES (DSNA) have assisted the DSNA project manager in his task. In particular they were responsible of:

- Co-ordination of all development tasks activities within their teams,
- Management of the work packages and tasks for which they are responsible,
- Execution of all necessary procedures and actions to ensure that all project tasks are accomplished on due time,
- Implementation of necessary reporting and control functions.

4.2.2. Location
Each partner involved has worked in their own premises:
Paris XV DSNA head quarters and Athis-Mons (Paris ACC), Paris-CDG control centers. However, all of the flight trials have been carried out at Paris-CDG by Air France.

4.3. Work breakdown structure

<table>
<thead>
<tr>
<th>WP0</th>
<th>WP1 Management &amp; coordination</th>
<th>WP2 Communication plan</th>
<th>WP3 Preparation of experiments</th>
<th>WP4 Operational demonstrations</th>
<th>WP5 Demonstration and results analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consolidation of the proposed demonstration plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.4. Demonstration plan

4.4.1 Demonstration and flight trials

Accordingly with the contract SJU/LC/0118-CTR terms of reference, the demonstration and flight trials plan covers terminal activities, mainly in the Paris TMA and in the Flight Information Region FRANCE. The project aims at optimizing the flight trajectories of the aircraft operating the procedures from IAF LORTA and MERUE, and in particular their vertical profiles.

The overall objectives of the demonstration flights are to:

- Take advantage of the results of the AIRE 2009 campaign of trials and outcomes by carrying on the experiments with the aim of implementation.
- Validate ATM solutions
- Quantify operational benefits
- Assess environmental and economics benefits

4.4.2. Planning

The demonstration were planned to commence on November 17th, 2010 and to end on December 16th, 2010, but for more detailed reasons addressed in §5, they have been stopped on December 6th, for safety issues.

4.4.3. Risks

Risks have been evaluated in the D1. Despite high peak activities, all planned slots for demonstrations have been used without drop of capacity.

DSNA and airlines were faced to unexpected safety issues regarding FMS flight database from which the published procedures (STAR’s and INI) were removed for unknown reasons and still under investigations. Consequently, the last week of demonstrations have been canceled.
5. FLIGHT TRIAL IMPLEMENTATION AND RESULTS

5.1. Baseline

The general organization of the airspace in the TMA considers the TMA as a square where the outbound flights leave from the side of the airspace and the inbound flights come in through the corners, and the airports are in its center.

This organization imposes some procedures with downwind legs. For example, when CDG is facing west the traffic coming from North West overfly the dedicated IAF to an easterly base leg prior to be vectored to the RWY 27 or 26. The airspace design takes in account the need of strategic separations with departing flows, and in that case, with the northbound flow to UK and the transatlantic network.

- Current baseline procedure from North West when CDG is facing west:
  - DPE FL240, SOKMU 150, MERUE 110 – CRL RWY 26/27,
  - DVL FL240, SOKMU 150, MERUE 110 – CRL RWY 26/27,
  - Radar vectors after CRL,
  - This includes a 26 nm segment at FL110 between MERUE and CRL,
  - The departure flow crosses the arrivals at FL 100 to the North, or may be vectored through when no conflicting traffic is detected.
- Current baseline procedure from North East when CDG is facing East:
  - MOPI FL260, XERAM FL180, DIVEL FL140, LORTA FL140, BUNOR FL110,
  - DINAN FL240, XERAM FL180, DIVEM 140, LORTA 140 -> BUNOR 110,
  - VEDUS FL280, XERAM FL180, DIVEM 140, LORTA 140 -> BUNOR 110,
  - Radar vectors after BUNOR,
  - Long level off segments from IAF’s until BUNOR.
5.2. Scenario

Main objectives of the demonstration and evaluation flights were to propose enhanced IFR procedures in order to improve the vertical profiles of arriving aircraft, in busy TMA and at high peak period of traffic. At the occasion of previous evaluations or services contracts held in 2008-2010, some demonstrations flights have been conducted in the TMA to evaluate the benefits of such improvements and the question was how to implement them on a standard daily basis. Answering, the consortium has proposed to develop standard procedures with Air Information Service publications to the air operators. In order have a maximum of opportunities to have demonstrations flights occurrences, the consortium have decided to propose several procedures improvements in both configurations East and West.

5.2.1. Period of demonstrations

<table>
<thead>
<tr>
<th>Dates</th>
<th>Configurations</th>
<th>Timing (UTC)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>From November 18, 2010</td>
<td>West</td>
<td>04h00-06h00</td>
<td>DoWo from IAF MERUE</td>
</tr>
<tr>
<td></td>
<td>West</td>
<td>14h00-16h00</td>
<td>DoWo from IAF MERUE</td>
</tr>
<tr>
<td>To December 17, 2010</td>
<td>East</td>
<td>23h30-04h00</td>
<td>DoWo from IAF LORTA Enhanced CDO from IAF LORTA</td>
</tr>
<tr>
<td></td>
<td>East</td>
<td>14h00-15h00</td>
<td>DoWo from IAF LORTA</td>
</tr>
</tbody>
</table>

5.2.2. Airlines

The consortium member Air France is the main contributor to the demonstration flights but the evaluated procedures were instructed to the other companies operating CDG during the time of operation. No selected flights were required for the demonstrations, except those dedicated to feedback and analysis provided by Air
France. This method of control was necessary mainly for safety reasons in order to have the same way of traffic management during the period of evaluations. So, all aircraft were due to receive to same clearances by ATC in order to fly the evaluated procedures, with no dissimilar profiles or tracks in the TMA.

Regarding the experiment of the enhanced CDO from LORTA some airlines have been identified to be part of the demonstrations with Air France and their flights were planned as follow:

SRR 6316, AFR 277, BCS 6765, BCS 6848, UPS 218, AFR 111, AFR 185

5.3. Preparation of demonstrations

Within the consortium, including Air France, the following bodies were involved:

✓ Paris-Charles de Gaulle Air Traffic Control Center (CDG APP)
✓ Paris-Athis Mons Control Center (Paris ACC)

5.3.1. Instrument Flight Rules procedures

The consortium members have decided to design dedicated procedure as standard arrival (STAR) and initial approach (INA) procedures with the aim to publication to AIP and input in the FMS of the Airlines. They were both on RNAV method with enhanced vertical profiles and specific identification for the pilots.

<table>
<thead>
<tr>
<th>Enhanced procedures</th>
<th>CDG runways available</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAR RNAV MOPIL 9G</td>
<td>RUNWAY 08L-08R-09L-09R</td>
</tr>
<tr>
<td>STAR RNAV DINAN 9G</td>
<td></td>
</tr>
<tr>
<td>STAR RNAV VEDUS 9G</td>
<td></td>
</tr>
<tr>
<td>[INA] LORTA 9G-RADAR</td>
<td></td>
</tr>
<tr>
<td>STAR RNAV DPE 9G</td>
<td>RUNWAY 26L-26R-27L-27R</td>
</tr>
<tr>
<td>STAR RNAV DVL 9G</td>
<td></td>
</tr>
<tr>
<td>[INA] MERUE 9G-RADAR</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8: Procedures availability for demonstrations

The procedures were all released in Supplement to AIP:

SUP AIP N° 149/10 dated on Oct 14, 2010
SUP AIP N° 150/10 dated on Oct 14, 2010
5.3.1.1. Optimized descent profile from IAF MERUE

Paris ACC calls CDG APP half an hour prior to the IAF estimated time in order to activate Green STAR in the local traffic management system via XSALGOS. ATCo Clears pilots on DVL9G or DPE9G at first contact. Strips are files with mention of the dedicated STAR and FL.

After the STAR DPE9G or DVL9G is completed, Paris ACC handover the flights to CDG APP who clears again the flight with the connected [INA] MERUE 9G procedure in order to have a full optimized vertical profile from FL 280 down to FL150 over MERUE, then CRL at FL110, as illustrated below:
5.3.1.2. Optimized descent profile from IAF LORTA

Paris ACC calls CDG APP half an hour prior to the IAF estimated time in order to activate Green STAR in the local traffic management system via XSALGOS. ATCo clears pilots on DINAN 9G, VEDUS 9G or MOPIL 9G at first contact. Strips are printed with mention of the dedicated STAR and FL 170 over LORTA then BUNOR at FL110.

The “green” STAR 9G is instructed by ATCo to pilots, then cleared on the [INA] LORTA 9G by CDG APP or on the LORTA 1S (CDO) by night. In both cases the vertical profiles are optimized and may be illustrated as follow:

- **Figure 11: New STAR, new stripping with VEDUS9G**

- **Figure 12: Optimized vertical profile from LORTA**

Briefly, the profile is optimized, and the new flight is at FL170 instead of current FL140.
5.3.1.3. Stripping and coordination

- **Stripping**

  During the AIRE evaluation the standard stripping are modified as follows within the timeframe of the flight trials.

<table>
<thead>
<tr>
<th>Standard STAR and TFL</th>
<th>AIRE STAR and TFL</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVL 4W FL110</td>
<td>DVL 9G FL150</td>
</tr>
<tr>
<td>DPE 4W FL110</td>
<td>DPE 9G FL150</td>
</tr>
<tr>
<td>MOPIL 4E FL140</td>
<td>MOPIL 9G FL170</td>
</tr>
</tbody>
</table>

*Figure 13: Current and AIRE TFL on STAR's*

During evaluations, the FPMS add points at the different flight plans and the correct STRIP will be printed to the positions of control, with the dedicated TFL.

- **Coordination**

  The launch of evaluation is coordinated and approved by ACC and APP operation room management 30 minutes prior to the beginning.

  ACC will call APP with the callsign of the first and the latest aircraft of the sequence by the same method of the runway configuration changes. Aircraft are instructed on the “green” STARs by ACC.

  When transferred from ACC to APP, the aircraft will be instructed to proceed on the green mode through one of the dedicated [JNA] procedures, MERUE 9G or LORITA 9G. The message will be the following:

  “AFR XYZ, cleared MERUE 9G approach, RADAR ILS 27R, Descente FL110”

  Initial Approach Coordinator has to coordinate with Departure Coordinator at the beginning and at the end of each trial. It is because of northbound departing traffic conflicting with the inbound MERUE traffic flow.

5.3.2. Briefing to ATCo and Aircrews

Dedicated letters of agreement defined the conditions of coordination and management of the demonstration flights and each stakeholder delivered special orders for aircrews and ATCo’s.

*This dedicated procedure is defined in the local ATCC temporary documents:*

  - *For CDG APP: COT N° 37/C/09 dated on November 12, 2010*
  - *For Paris ACC: CTO N° 09CTO006 date on October 10, 2010*
  - *For AFR: AFR Notice to pilots*

Prior to evaluation, briefings were organized by ATC operation management cells to ATCo teams with support of special presentation and documents. In addition, files sheets were released to control position in order to have direct controllers feedback from experimentation.
5.4. Performances of the demonstration flights

The demonstrations have begun on November 18, 2010, as planned and have ended on December 6th, 2010, ten days before the end of the expected and planned period. Reasons of the interruption of the trials are described later in section 5.5.

During the timeframe of the demonstrations, a total of 219 flights have been recorded, including 69 Air France flights.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Green STAR</th>
<th>Green Approaches</th>
<th>Runway configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 18</td>
<td>2</td>
<td>2</td>
<td>West</td>
</tr>
<tr>
<td>November 19</td>
<td>8</td>
<td>6</td>
<td>West</td>
</tr>
<tr>
<td>November 20</td>
<td>No trials on WE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November 21</td>
<td>2</td>
<td>1</td>
<td>West</td>
</tr>
<tr>
<td>November 22</td>
<td>14</td>
<td>8</td>
<td>West</td>
</tr>
<tr>
<td>November 23</td>
<td>19</td>
<td>12</td>
<td>West</td>
</tr>
<tr>
<td>November 24</td>
<td>21</td>
<td>16</td>
<td>West</td>
</tr>
<tr>
<td>November 25</td>
<td>14</td>
<td>9</td>
<td>West</td>
</tr>
<tr>
<td>November 26</td>
<td>7</td>
<td>5</td>
<td>West</td>
</tr>
<tr>
<td>November 27</td>
<td>15</td>
<td>13</td>
<td>East</td>
</tr>
<tr>
<td>November 28</td>
<td>18</td>
<td>12</td>
<td>West and East</td>
</tr>
<tr>
<td>November 29</td>
<td>16</td>
<td>13</td>
<td>East</td>
</tr>
<tr>
<td>November 30</td>
<td>23</td>
<td>18</td>
<td>East</td>
</tr>
<tr>
<td>December 1</td>
<td>16</td>
<td>15</td>
<td>East</td>
</tr>
<tr>
<td>December 2</td>
<td>14</td>
<td>10</td>
<td>East</td>
</tr>
<tr>
<td>December 3</td>
<td>8</td>
<td>4</td>
<td>West and East</td>
</tr>
<tr>
<td>December 4</td>
<td>4</td>
<td>2</td>
<td>West</td>
</tr>
<tr>
<td>December 5</td>
<td>5</td>
<td>3</td>
<td>East</td>
</tr>
<tr>
<td>December 6</td>
<td>13</td>
<td>10</td>
<td>East</td>
</tr>
</tbody>
</table>

Figure 14: Total number of demonstration flights

During the performance of the trials all the airlines arriving at CDG were instructed to fly the published “Green” procedures unless they were not input in their FMS. In that case they were instructed to proceed on standard procedures with RADAR vectors to the runways.

5.5. Results.

5.5.1. Impacts on capacity

The period of evaluations has been selected to focus on traffic in day time operations, but not at peak hours regarding CDG operations. The timing for evaluations was as follow:

<table>
<thead>
<tr>
<th>Configurations</th>
<th>Timing (UTC)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>04h00-06h00</td>
<td>DoWo from IAF MERUE</td>
</tr>
<tr>
<td>West</td>
<td>14h00-16h00</td>
<td>DoWo from IAF MERUE</td>
</tr>
<tr>
<td>East</td>
<td>23h30-04h00</td>
<td>DoWo from IAF LORTA Enhanced CDO from IAF LORTA</td>
</tr>
<tr>
<td>East</td>
<td>14h00-15h00</td>
<td>DoWo from IAF LORTA</td>
</tr>
</tbody>
</table>

Figure 15: Demonstration flight time slots

The planned capacity program allowed to perform demonstrations during all the periods selected. At those periods, the demand in capacity was below the offer. Nevertheless, the arriving traffic at CDG in the winter
season have been recorded during the reference week from 7 to 13 Feb 2011, very close to the period of evaluations held in Dec 2010.

![Bar chart showing number of arriving aircraft at CDG during the demonstration period.]

Figure 16: Number of arriving aircraft at CDG during period of demonstrations

The amount of traffic managed by ATC during the evaluations was significant (around 30 flight per hour) regarding the goals of the demonstrations, and no drops of capacity, or flow management regulations have been necessary or imposed to the airlines.

5.5.2. Impacts on safety

During the first weeks of the trials no significant issues have been noticed by ATCo and coordination between ACC and APP was optimum. During evaluation ACC sectors were merged, so the coordination process inside ACC has not been evaluated between sector UK-TP and AP-TE.

The general feedback from ATCo has been extracted from the feedback sheets released on the control position during the demonstration flights and 17 of them may be summed up as follow:
Feedback analysis

<table>
<thead>
<tr>
<th></th>
<th>(-)</th>
<th>(0)</th>
<th>(+)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload</td>
<td>16</td>
<td>1</td>
<td></td>
<td>No significant changes from standard</td>
</tr>
<tr>
<td>Safety</td>
<td>17</td>
<td></td>
<td></td>
<td>No impacts except when removal of FMS databases occurred (see below)</td>
</tr>
<tr>
<td>Impacts on neighbouring traffic</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Configuration changes from and to “green” mode</td>
<td>3</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From RADAR position</td>
<td>17</td>
<td></td>
<td></td>
<td>Some speed limits given for separation to pilots when workload increases</td>
</tr>
<tr>
<td>From Depart position</td>
<td>17</td>
<td></td>
<td></td>
<td>No conflict between departures and arrivals proceeding “green”</td>
</tr>
<tr>
<td>AIS publication</td>
<td>17</td>
<td></td>
<td></td>
<td>Release of charts in AIP was more comfortable for coordination processes with ACC and pilots</td>
</tr>
</tbody>
</table>

**Figure 17: Safety analysis**

Despite the positive safety results, ATCo faced two safety issues:

- Confusion from the pilots regarding naming of the procedures and runways in use:
  
  The “green” procedures were named:

  - **MOPIL 9G** for the STAR
  - **LORTA 9G** for the Initial Approach

  And the clearance was to ILS 9L for the runway **09 L** (Gauche in French and Golf in ICAO) in use at CDG.

  The “9G” used on the frequency was confusing pilots, mainly the French speaking one’s. In case of further temporary evaluation, attention will be more accurate on the phraseology and the naming of the procedures.

- Database collection erased from FMS:

  Then, by the end of the demonstration period, CDG APP noticed that some pilots didn’t follow the procedures by having some anticipated turns on the tracks. After some preliminary investigations, it appeared that, for unknown reasons, the standard and green mode procedures were removed form the FMS database, and the only procedure available was the LOR1G, the CDO procedure basically used by night.

  NOTAM was released by CDG to cancel the demonstration, and investigations are still in progress to find out the reasons of the removal of the procedures from the FMS database in coordination with AIS providers.

**5.5.3. RADAR data analysis**

As shown figure 14, § 5.4, 219 flights have been cleared on the “Green” mode by ATC and 159 have been analysed from the RADAR data records as operating optimized descent profiles. Reasons why the aircraft have not the same continuous descent profile are not completely know by ATC. The great number of aircraft and companies participating to the “Live” trails is part of this lack of feedback from the pilots. Nevertheless, all Air France aircraft had successfully completed continuous descent profile from the STAR to final approach.
5.5.4. Fuel burn and CO2 analysis

5.5.4.1. Expected Fuel Savings

The fuel savings expected are actually smaller than presented in D1.

The reason is that in D1, the fuel savings expected was the additional fuel burn during the level off segments. Actually the fuel savings are the difference of the fuel burn during the level segments at 2 different altitudes: at the level segment itself and at cruise altitude.

Expected Fuel savings DoWo from IAF LORTA:

The fuel savings expected ranges from 50 kg for 2-engine medium haul aircraft (like A320 or B737), between 100 and 120 kg for a 2-engine Long-haul aircraft (like A330 or B777), and up to 150 kg for a 4-engine aircraft (like A380 or B747).

Expected Fuel savings DoWo from IAF MERUE:

The same order of magnitude is expected: the fuel savings expected ranges from 50 kg for 2-engine medium haul aircraft (like A320 or B737), between 100 and 120 kg for a 2-engine Long-haul aircraft (like A330 or B777), and up to 150 kg for a 4-engine aircraft (like A380 or B747).

5.5.4.2. Overview of the method:

The fuel savings were assessed by using the flight data analysis system. We were allowed to extract from the flight data base for every 4 seconds the following information: Time, Altitude, Lat/long, Speed (CAS, Mach, TAS, GS, Vs), Engine Thrust (in %), Fuel consumption, Wind (Speed and Direction), A/C Weight.

Based on the actual flight data, we are able to calculate for each flight assessed the actual fuel consumption. We can also calculate the optimum fuel consumption for the same flight in the same condition (weather, weight).
So for each flight, the additional fuel burn is derived from the actual fuel consumption and the optimum fuel consumption. This allows estimating both:

- The fuel savings by comparing the additional fuel burn from both Baseline flights and Flight Trials flights,
- The fuel savings that remains still possible to achieve an optimum vertical profile.

**Figure 18: Vertical profile and fuel consumption**

Since the scope of DoWo LORTA is within Paris ACC down to BUNOR in CDG Approach via LORTA, the fuel savings estimated is limited to this portion of the flight. Fuel savings has been estimated neither before Paris ACC nor after BUNOR.

Since the scope of DoWo MERUE is within Paris ACC either from DVL or DPE down to CRL in CDG Approach via MERUE, the fuel savings estimated is limited to this portion of the flight. Fuel savings has been estimated neither before Paris ACC nor after CRL.
5.5.4.3. Fuel savings DoWo from IAF LORTA:

The fuel savings is calculated only for the portion of the flight trajectory included in Paris ACC and in CDG Approach down to BUNOR, as described in section (x,y) related to Expected Benefits.

The fuel savings depend on the aircraft type. Two different aircraft type (A320 family and B777) have been assessed:

**Aircraft type A320 family:**

**Fuel savings:**

The fuel savings observed is around 40kg close to what was expected (~50kg).

From 16Nm before XERAM to BUNOR (about 80Nm), the fuel consumption observed for the Baseline is around 380kg, while for the Flight Trials it is around 340kg and for an optimum flight it is estimated at around 300kg. The fuel savings that still remain possible is around 40kg.

Speed management is a key factor as it could significantly alter the fuel savings:

The following 2 examples show how speed management could increase the fuel consumption and remove any fuel savings from the vertical profile optimisation.

Despite no level off, a lower IAS (between 220kt and 250kt) would have saved up to 40kg between LORTA and BUNOR in the example below:

![Figure 19: Vertical profile and parameters at 280 kts IAS](image-url)
Despite no level off, a lower IAS (between 280kt before LORTA and 220kt approaching BUNOR, as planned instead of 340kt all the way down to BUNOR) would have saved up to 100kg in the example below. This flight saved 2 minutes thanks to this acceleration. So in this case, there should be a trade-off between fuel savings and time savings.

As a consequence, speed management should be included in any vertical profile optimisation. Additional distance flown is another key factor as it could significantly alter the fuel savings:

It is obvious that any additional distance would alter the fuel savings. The Down-Wind Optimisation has been designed in such a way that no additional distance flown was needed when optimising the vertical profile. This was a pre-requisite.

However it is important to verify that this is also the case after BUNOR in CDG Approach. Without any wind effect, it is considered that any additional Nm will generate ~6kg in Paris ACC and 8kg in CDG Approach. So any lateral deviation of about 7Nm in Paris ACC or about 5Nm in CDG Approach due to DoWo would jeopardize the benefit of DoWo.

In the same spirit, any possible reduction of the distance flown via a “direct to”, should be envisaged even if this might imply to interrupt DoWo and generate a level off.
Aircraft type B777 family:

Fuel savings:

The fuel savings observed is around 100kg as expected (~100kg).

From 16Nm before XERAM to BUNOR, the fuel consumption observed for the Baseline is around 780kg, while for the Flight Trials it is around 680kg and for an optimum flight it is estimated at around 590kg. The fuel savings that still remain possible is around 90kg.

Figure 21: Vertical profile baseline - B777- IAF LORTA

Figure 22: Optimized vertical profile - B777 - IAF LORTA
Speed management is a key factor as it could significantly alter the fuel savings:

Like for A320, the Speed management could increase the fuel consumption and remove any fuel savings from the vertical profile optimisation.

In the example (Baseline) just above, a lower IAS (around 280kt instead of 310kt) would have saved up to 50kg of fuel.

On the contrary, a lower IAS than expected (250kt instead of 280), as this is the case for AF277 from NRT that flies slowly in purpose in order not to arrive before 04:30 am local time, would have saved up to about 100kg of fuel for a Baseline flight (see example below) or about an additional 50kg for a DoWo flight. The additional flight time is around 2min30 for the descent. Again, there should be a trade-off between fuel savings and time savings.

Additional distance flown is another key factor as it could significantly alter the fuel savings:

Like for A320, it is obvious that any additional distance would alter the fuel savings. The Down-Wind Optimisation has been designed in such a way that no additional distance flown was needed when optimising the vertical profile. This was a pre-requisite. However it is important to verify that this is also the case after BUNOR in CDG Approach.

Without any wind effect, it is considered that any additional Nm will generate ~15/20kg in Paris ACC and 20/25kg in CDG Approach. So any lateral deviation of about 5Nm in Paris ACC or about 4Nm in CDG Approach due to DoWo would jeopardize the benefit of DoWo.

In the same spirit, any possible reduction of the distance flown via a “direct to”, should be envisaged even if this might imply to interrupt DoWo and generate a level off.
5.5.4.4. Fuel savings DoWo from IAF MERUE:

The fuel savings is calculated only for the portion of the flight trajectory included in Paris ACC and in CDG Approach down to CRL, as described in section (x,y) related to Expected Benefits.

The fuel savings depend on the aircraft type. 2 different aircraft type (A320 family and B777) have been assessed:

**Aircraft type A320 family:**

**Fuel savings:**

The fuel savings observed is around 50kg as expected (~50kg).

From DPE to CRL (about 80Nm), the fuel consumption observed for the Baseline is around 340kg, while for the Flight Trials it is around 290kg and for an optimum flight it is estimated at around 250kg. The fuel savings that still remain possible is around 40kg.

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**Figure 24: Vertical profile – A320 – IAF MERUE - Baseline**

**Figure 25: Optimized vertical profile - A320 - IAF MERUE**
Speed management is a key factor as it could significantly alter the fuel savings:

Again, the Speed management could increase the fuel consumption and remove any fuel savings from the vertical profile optimisation.

In the example (Baseline) just above, a higher IAS (around 340kt than planned 280kt) increase the additional fuel burn (+160kg instead of 90kg).

![Figure 26: Vertical profile - A320 - IAF MERUE - Baseline - 340 kts](image)

Additional distance flown is another key factor as it could significantly alter the fuel savings:

Like for DoWO LORTA, It is obvious that any additional distance would alter the fuel savings. The Down-Wind Optimisation has been designed in such a way that no additional distance flown was needed when optimising the vertical profile. This was a pre-requisite. However it is important to verify that this is also the case after CRL in CDG Approach.

Without any wind effect, it is considered that any additional Nm will generate ~6kg in Paris ACC and 8kg in CDG Approach. So any lateral deviation of about 7Nm in Paris ACC or about 5Nm in CDG Approach due to DoWo would jeopardize the benefit of DoWo.

In the same spirit, any possible reduction of the distance flown via a “direct to”, should be envisaged even if this might imply to interrupt DoWo and generate a level off.

It has been observed that:

- Very often flight from DPE receives a Direct to MERUE and reduces the distance flown by ~9Nm. This leads to about 50kg of additional fuel saving as much as the fuel savings of the DoWo MERUE Flight Trials itself. The positive point is that this direct did not interrupt the flight trials. So it was often observed a actual fuel savings of about 100kg compared with the Standard approach.

- Unfortunately, it was also observed additional distance flown after CRL from 3 up to 10Nm, leading to an additional fuel burn of about 50kg, removing all the benefit of DoWo MERUE.
Aircraft type B777 family:

Fuel savings:

The fuel savings observed is around 90kg as expected (~90kg).

From 30Nm before SOKMU to CRL (about 75Nm), the fuel consumption observed for the Baseline is around 590kg, while for the Flight Trials it is around 500kg and for an optimum flight it is estimated at around 450kg. The fuel savings that still remain possible is around 50kg.

Speed management is a key factor as it could significantly alter the fuel savings:

Again, the Speed management could increase the fuel consumption and remove any fuel savings from the vertical profile optimisation.

In the example (Flight Trials) just below, a higher IAS (constant around 310ktdown to CRL than a progressive reduction from 310kt to 220kt) increase the additional fuel burn by 100kg.

Figure 27: Vertical profile - B777 - IAF MERUE - 310 kts

Figure 28: Vertical profile - B777 - IAF MERUE - 310/250 kts
Additional distance flown is another key factor as it could significantly alter the fuel savings:

Like for DoWo LORTA, it is obvious that any additional distance would alter the fuel savings. The Down-Wind Optimisation has been designed in such a way that no additional distance flown was needed when optimising the vertical profile. This was a pre-requisite. However, it is important to verify that this is also the case after CRL in CDG Approach.

Without any wind effect, it is considered that any additional Nm will generate 15/20kg in Paris ACC and 20/25kg in CDG Approach. So any lateral deviation of about 5Nm in Paris ACC or about 4Nm in CDG Approach due to DoWo would jeopardize the benefit of DoWo.

It has been observed an additional distance flown after CRL from 3 up to 10Nm, leading to an additional fuel burn of 100/150kg, removing all the benefit of DoWo MERUE.

Wind impact:

The situation is not symmetric between DoWo LORTA and DoWo MERUE due to the wind. Indeed, whatever the runway configuration at CDG (facing East or facing West) the wind at high altitude in Paris ACC and even in CDG Approach in the downwind leg is actually mainly coming from West. So for the flight trials assessed:

- For flights arriving via LORTA, the wind observed ranges from (-55kt)/(-10kt) at XERAM (FL250) and (-30kt)/(-3kt) at BUNOR (FL110).
- While for flights arriving via MERUE, the wind observed ranges from (-6kt)/(+50kt) at DPE or DVL (FL250) and (+1kt/+25kt) at CRL (FL110).

As a consequence,

- The actual fuel consumption via MERUE is smaller than via LORTA as detailed in the paragraphs above.
- However, the difference between the fuel consumption for the Baseline and the DoWo flight profile and thus the potential fuel savings from DoWo is similar whatever the origin: about 50kg for A320 and about 100kg for B777. The reason is that MERUE-CRL is a level segment of 26Nm at constant FL (FL110), while LORTA-BUNOR is a segment of 29Nm (3Nm longer) and with a descent from FL140 to FL110.
- But the remaining fuel to save is smaller via MERUE than via LORTA.

In addition, it will be interesting to investigate whether the additional distance flown observed for flight coming from North West (MERUE) is just a coincidence or is a consequence of the wind.
6. COMMUNICATION

6.1. Introduction
In the context of AIRE project, communication was understood as the objective to reach overall comprehension by a wide audience of environmental gains expected and measured due to innovative procedures regarding Terminal operations dedicated to capitalize on present avionics technologies for the reduction of CO2 emissions.

Communication has focused on two targets:
- General communication,
- Project external buy-in
- Project internal buy-in.

6.2. Summary of dissemination activities

6.2.1. Objectives
The General Communication plan targeted a high level communication on the Project across the whole air transport community (ATM Community, Member States and Institutions) and the General Public. From a national point of view, airports neighbouring, protection of environment associations and legal representatives are parts of the air transport community targets and they have been closely associated to communication reports.

6.2.2. Means
The Consortium intended to take advantage of some major events organized in the year 2011. Principal means used by the Consortium for communication purposes were:
- 101\textsuperscript{th} Paris Air Show at Paris Le Bourget held on June 2011,
- 6\textsuperscript{th} fête des transports and mobility at Paris held on September 2011,
- TV production released on ARTE in 2011
- ATC Global held in Amsterdam in March 2011
- ANERS 2011 in Marseille on October 2011.

6.2.3. Communication supports
The Consortium developed dedicated or generic communication tools applicable for different purposes such exhibition, press and or conference.

It has been released:
- Multi média films on CDROM with information on the AIRE activities, the demonstration flights, the partnership with SJU and the expected or/and realized benefits of the trials performed by the stakeholders.
- A leaflet for press release and general distribution to public which explain the AIRE activities.
- And a dedicated stand to show the AIRE activities at the occasion of exhibitions.
- Leaflets and articles for internal an external buy in
- Presentation to conferences
6.3. Exhibitions and conferences

6.3.1. Participation to Paris Air Show

The first Show was held in 1909 at the Grand Palais, Paris. From 1909 to 1949, the Show took place between November and December at the Grand Palais. The first flying displays were seen in Orly in 1949, then at Le Bourget in 1951. From 1953, the Show was rescheduled to take place in June at Le Bourget.

This year the Paris Air Show has performed:

- 132,464 sq. m. of exhibition area sold (halls, village, chalets, external buildings),
- 192,000 sq. m. of static aircraft display area,
- 360 chalet units,
- 150 aircraft on display, including Solar Impulse,
- 2,100 exhibitors from 42 countries,
- Over 354,000 visitors in total (trade, public, official delegations, press, exhibitors),
- 150 official defense delegations from 60 countries,
- 40 transport/civil aviation delegations from 20 countries,
- Over 3,000 registered journalists.

Taking advantage of the venue of this Major aeronautical exhibition in the world, the Consortium Members has set up a dedicated part of the DGAC stand at the Paris Air Show to promote the AIRE activities through tools, posters, leaflets, and specific briefings to the public. At this occasion, many visitors were briefed on the AIRE activities.

On the stand, a dedicated leaf let was distributed to the public, professional and general. Air traffic controllers from Paris-Charles de Gaulle control center were required to answer the public about the AIRE activities during the Airshow. They were helped with videos which were created for the occasion. They were describing the Green shuttle, Down wind Optimization and Transatlantic AIRE projects to permit illustrations of the demonstration and flight trials organized by the consortium.

Video may be downloaded on the following website:

http://www.developpement-durable.gouv.fr/Le-projet-AIRE.html
6.3.2. Participation to “Transports and mobility exhibition” in September 2011, in Paris

Founded in 2003 by Gérard Feldzer, manager of the Le Bourget Aeronautic and Airspace museum, the Transport association Passion aims at promoting transport to the general public and to the mass media, through national demonstrations such as the “Fête des Transports”.

The exhibitions are organized downtown Paris (Grand Palais, Champs Elysées or Trocadéro) and in Lyon as well. They are totally free, opened to general public, and access to stands widely facilitated.

This event aims at addressing all transports modes and of course air transport under a sustainable growth point of view. The consortium members have set up a stand at this exhibition in order to promote the AIRE. The stand was built in the Ministry of Transportation chalet in the core area of the exhibition. During several sunny days, thousands of visitors have attended the exhibition where a static display of the AIRE activities were shown and explain by DGAC staff, as well as paper leaflet were released.

6.3.3. ATC Global

- The exhibition was the occasion for the FABEC member to set up a common stand. It was the occasion for AIRE project manager to have meeting and exchanges with ATC Global visitors and attendant companies.
- Meanwhile, the consortium have presented the AIRE transatlantic green flight, with a dedicated video, at the SJU AIRE workshop.
- FABEC news letter released in March 2011 was supporting communication on AIRE acitivites.

6.3.4. ANERS 2011

The next Aircraft Noise and Emissions Symposiaums (ANERS) will be held in Marseille in October 25-27, 2011. This symposium is jointly organised by:

- Association Aéronautique et Astronautique de France (3AF)
- American Institut of Aeronautics and Astronautics (AIAA)

A speech and presentation relating AIRE activities are planned to be performed by the AIRE project managers on behalf of the whole bodies of the consortium.

6.4. General communication

Internal communication is seen as internal buy-in process to air traffic controllers, pilots and their unions in one hand, and general communication to consortium staff (administrative and support staff) in the other hand.

As planned initially, news letters were released in order to inform administrative and support staff. More communication to staff and public has been issued in June 2011 through the corporate newspaper “Aviation civile magazine” in which more information on the AIRE activities have been detailed.

But more important in terms of communication to operational staff and ATCo’s is the way of the AIRE activities were prepared and conducted in the air traffic control centers. From the beginning of the operations, the ATCo’s were fully involved in the demonstration and flights trials, with a very positive approach to the concept of the demonstrations. Dissemination of the need for more and better flight efficiency by experiencing new procedures was fully agreed and managed by ATCo’s. So that, more evaluations are actually requested by ATCo’s in order to improve the coordination processes assessed during AIRE activities in order to expect implementation of Tailored arrivals, continuous climb departure or CDO’s when possible in ACC sectors or TMA’s.

The DSNA news letter was one of the means for dissemination to the control centers:

- First release News letter 28
On the Airline side, buy-in is not an issue since a Fuel savings policy has been adopted and all actors included pilots are doing their best to save fuel and reduce CO2 emissions. As a consequence, all of the pilots are keen on following a more optimized flight profile. Internal communication was performed through communication papers sent to all pilots and dedicated presentations to head of flight divisions. The aim was to show them that ANSP also participate to their extent possible to the improvement of air transport initiative to reduce CO2 emissions.

7. CONCLUSIONS

The flight trials shows the potential benefit of the implementation on a daily basis of the Down Wind optimisation for arrival flights to CDG coming from North West (MERUE) and North East (LORTA). Safety was not impacted and feedback received from Air Traffic Controller positive.

The expected results in terms of fuel saving have been reach during the demonstrations, even if the consortium has highlighted some potential extra gains (60 to 80kg) according to the pure ideal profiles.

Even through flight trials were initially planed during low traffic period\(^1\), controller from Paris ACC and CDG Approach were keen on extending the time slot of the day to perform the flight trials with more traffic. This is very promising and there is a common agreement to continue towards the implementation. The next steps will be to extend the process to wider timeframe in day time operation until progressively the same flight trials during peak hours. However this cannot be done in the coming months and should be envisaged not before 2012, due to the complete reorganisation of Paris Area in Nov 2011, decision from the "Grenelle de l’environnement".

The project have involved the all the ATCo of Paris ACC and CDG APP, so the concept of operation have been widespread across the whole staff to increase the awareness of Green operations in ATM management. In addition, the occasion of the Paris Air Show was a major opportunity the reach the general public with direct contact between ATCo present on the stand and visitors.

Thanks to the AIRE projects and their outcomes, awareness of the environmental issues have increased in ATM policies and staff. They input this experience in new ATM projects, such as ambitious exercise to be held in extended TMA, exercise 427, linked to SESAR WP 5.6.7 and named PANAM-MACAO.

\(^1\) At low peak period at Paris-Charles de Gaulle, the remaining traffic is much above high peak traffic than smaller airport. Within the period of demonstration rate of arrivals at CDG was with an average of 40 per hours.