Demonstration Report

Document information	
Project Title	DFLEX
Project Number	02.03
Project Manager	Air France
Deliverable Name	Demonstration Report (D2)
Edition	00.01.00
Template version	01.00.00

Task contributors
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Abstract

In Paris-CDG airport (CDG), airport CDM since end of 2010, the Departure Flexibility (DFlex) project has achieved its objective which was to show that airlines can be given flexibility in the Pre Departure Sequence (PDS) during disrupted situations.

The main function (swap priority between 2 flights) is live since April 2013. This collaborative PDS is possible without impact on ATC operations.

During the project, airlines were rapidly convinced about the benefits but meanwhile realized the obstacles to reach these benefits. DFlex actions consist in making the right choice at the right time, implying coordination with different actors within the airline.

Since this project has reached its objectives, the CDM@CDG steering committee has decided to open the DFlex functions to all the aircraft operators of CDG. Any CDG operating airline could benefit from DFlex by Winter 2014/2015.

CDG being the first airport to successfully give flexibility to its aircraft operators, EUROCONTROL should promote DFlex as an enhancement of the A-CDM process.

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Document History

Edition	Date	Status	Author	Justification
00.00.00	31/08/2013	Draft		New Document – 1st flight trials
00.00.01	22/04/2014	2nd draft		Integration of 2nd flight trials results – new template
00.00.02	23/05/2014	3rd draft		First integration of partners' inputs
00.00.03	13/06/2014	Draft for validation by SESARJU		Second integration of partners' inputs - Finalization
00.01.00	09/07/2014	Final version for approval by SESARJU		Update following SJU assessment

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This deliverable consists of SJU foreground.

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Executive summary

Paris-CDG airport (CDG) has been performing Airport CDM since end of 2010. Airport CDM allows the improvement of airport operations with a particular focus on turnaround and pre-departure sequencing processes. It also enhances en-route sector planning. Within this context, each departure flight receives a departure time called a Target Start-Up Approval Time (TSAT) on a "first scheduled first served" (FSFS) basis.

In case of local ATC departure delay, that is to say the TSAT does not correspond to the time when the aircraft is ready to leave; airlines may prefer to see one flight scheduled later than another one leave before this last one. The answer to this need of flexibility is seen at CDG as the missing brick of the CDM concept.

The objective of Departure Flexibility Project (DFlex) is to provide airlines with greater flexibility in the Collaborative Pre Departure Sequence (PDS) to deal with disruptions, which normally lead to departure delays or cancelled flights.

The project was managed through 2 phases in a satisfactory manner. During the first phase in April 2013, the main flexibility function was tested, allowing airlines to swap the priority of 2 flights. Already more than 50 flights were involved, meeting the SESAR JU requirements. Based on the success of the first trials, it was decided to keep the functions open allowing at demonstrating the DFlex benefits in disrupted situations encountered during the summer 2013. By November 2013, more than 500 flights had been involved.

During the second phase from December 2013 to March 2014, the conclusions of the 1st phase were taken into account and 2 other features were tested: the prioritization of a flight among all the other flights of the airline, and the use of a departure slot belonging to a flight that the airline had previously cancelled. 1500 additional flights were involved in this second phase only.

The 3 different functions are now considered live at CDG. Air France and FedEx can use them every day through their own in-house developed HMIs or through the CDM@CDG website.

For the airlines, benefits are significant. First of all punctuality of prioritized flights is improved thanks to a reduction of local departure delay. Secondly, in some cases cancellation of flights can be avoided, for example when a flight has to leave before a time-limit corresponding to crew duty limits or a curfew at destination. Lastly DFlex helps to improve customers experience as it allows reducing misconnecting passengers/packages.

During the project, airlines were rapidly convinced about the benefits but meanwhile realized the obstacles to reach these benefits. DFlex actions consist in making the right choice at the right time, implying coordination between different actors within the airline, usually very busy especially in the case of disrupted situations. One option experienced with success at Air France was to invest in manpower and dedicate an OCC Deputy Manager to use DFlex and to get its benefits.

DFlex actions are made in a very tight window prior to departure but since few actions are performed in a same peak period, the risk of destabilizing the pre-departure sequence is very low. After more than one year of operations it is showed that this flexibility is transparent for ATC in terms of operations and does not impact negatively the airport capacity. Moreover it confirmed that no negative impact on other airlines has been identified.

Since this project has reached its objective, the CDM@CDG steering committee has decided to open the DFlex functions to all the aircraft operators of CDG. Any CDG operating airline could benefit from DFlex by Winter 2014/2015. For this purpose, the DFlex functions are available through the CDM@CDG website developed by ADP or through a mobile application developed by Airbus Prosky Metron.

As far as this concept outside Europe is concerned, the U.S. Surface CDM concept of operations took onboard from the beginning the airlines' need for flexibility, and features such as the Substitute functionality (that allows Aircrafts Operators to implement business rules during delay situations) or Cancel functionality (that allows Aircraft Operators to retain cancelled slots for implementation of their business rules). As partners of DFlex and leaders of US Surface CDM, FedEx and Delta airlines managed to cross-feed both initiatives.

CDG being the first airport to successfully give flexibility to its aircraft operators, EUROCONTROL should promote DFlex as an enhancement of the A-CDM process.

1 Introduction

1.1 Purpose of the document

This document provides the Demonstration report for DFlex. It describes the results of demonstration exercises defined in DFlex Demonstration Plan 00.01.00 delivered on October 26th, 2012 and how they have been conducted.

The results of the exercises will be described by Air France and FedEx. ADP will add some analysis as well as DSNA.

1.2 Intended readership

This document interests SJU, consortium's members, SESAR and FABEC members interested in the development of the concept of User Driven Priority Process (UDPP OFA Project 07.06.02).

1.3 Structure of the document

This document is organized in 8 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 and next steps.

1.4 Glossary of terms

Term	Definition
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.

1.5 Acronyms and Terminology

Term	Definition
ADP	Aéroports De Paris
AF	Air France
AOBT	Actual Off Block Time
ASAT	Actual Start up Approval Time
ATM	Air Traffic Management
CDG	Paris Charles de Gaulle airport
CDM	Collaborative Decision Making
CDM@CDG	CDM program at CDG
C-PDS	Collaborative Pre Departure Sequence (all tools and procedures)
CONOPS	Concept of Operations
CPDS flow	Specific dataflow delivered by the PDS tool containing pre-sequence flight information (TSAT, taxi time, QFU...)on SITA network
CTOT	Calculated Take Off Time
DFlex	Departure Flexibility application
DMAN	Departure Manager
DSNA	Direction des Services de la Navigation Aérienne
ED	Estimated time of Departure
EOBT	Estimated Off Block Time (flight plan off-block time)
FAA	Federal Aviation Administration
FABEC	Functional Airspace Block Europe Central
FDX	FedEx (Federal Express)
FOC	Flight Operations Centre, (see OCC)
FSFS	"First Scheduled – First Served" flight ordering principle
NEXTGEN	Next Generation Air Transportation System
NM	Network Manager
NOC	Network Operations Centre (FDX regional OCC)
OCC	Operations Control Centre, also named FOC
OFA	Operational Focus Areas
OSED	Operational Service and Environment Definition
PDS	Pre Departure Sequence (Sequencing tool owned by ADP)
RMAS	Ramp Management Advisory System (FDX Ramp Tower HMI)
RTO	Ramp Tower Operations (FDX Apron Management Services)
SARIA	ADP Airport Operational Database
SESAR	Single European Sky ATM Research
SESAR JU	SESAR Joint Undertaking
SITA	Société Internationale de Télécommunications Aéronautiques
SJU	SESAR Joint Undertaking
SOBT	Scheduled Off Block Time
TOBT	Target Off Block Time
TSAT	Target Start-up Approval Time
TTOT	Target Take-Off Time
UDPP	User Driven Prioritization Process
WP	Work Package

2 Context of the Demonstrations

The scope of the DFlex project is to give more flexibility in the PDS in order to take into account the airlines business requirements.

This project is intended to pre-industrialize the UDPP (SESAR project 07.06.02, formerly 07.06.04 User Driven Prioritization Process) Step 1 for departures at Paris-CDG airport. Its concept is developed in coordination with SESAR WP11.1, and aims to ensure interoperability with the U.S. concept through its coordination with the NextGen program.

2.1 Scope of the demonstration and complementarity with the SESAR Programme

Scope of the demonstration

The PDS system, managed by ADP, allocates an off block departure time (TSAT) to each flight.

DFlex features operate on the order in which the flight list is processed by the PDS algorithm: the flight list is initially ordered by scheduled departure time (FSFS rule), but will be reordered by the airlines using DFlex reordering requests.

The airlines will provide reordering requests on nominal or adverse conditions, concerning flights delayed due to a local airside restriction.

The demonstration delivers 3 new features to the airlines in order to act on the priority of their flights in the TSAT allocation:

- Reordering (reordering of two or more flights of the departure sequence)
- Prioritization ("ready to depart" reordering on one single flight of the sequence).
- Substitution (automated ownership of departure order after cancellation).

The successful implementation of these 3 features is intended to meet the following expectations:

- **Flexibility:** Demonstrate accommodation of airline reordering requests
- **Cost Effectiveness**-indirect costs to airlines: Demonstrate that indirect costs for participating airlines are reduced due to the reordering.
- **Equity:**

  Demonstrate that accrued flexibility on departure does not impact negatively the other airlines operating flights at CDG,

  Demonstrate that DFlex features are usable by all airlines operating flights at CDG.

- **Airport Capacity**: Demonstrate that accrued flexibility on departure doesn't deteriorate Airport Capacity.

Demonstration Exercise ID and Title	EXE-0203-01 : Re-order flight trials
Leading organization	AF
Demonstration exercise objectives	Get flexibility in the pre-departure sequence by performing partly the first feature provided by DFlex : Exchange flight order between two flights operated by the same airline
OFA addressed	OFA 5.3.6
Applicable Operational	PDS at CDG: TSAT is allocated to each flight by the PDS system

Context	managed by ADP. DFlex features operate on the order in which the flight list is processed by the PDS algorithm: the flight list is initially ordered by scheduled departure time (FSFS rule), but will be reordered by the airlines using DFlex reordering requests. The airlines will provide reordering requests on nominal or adverse conditions, concerning flights delayed due to a local airside restriction.
Demonstration Technique	The PDS has been improved in order to take into account the swap of priority between 2 flights
Number of trials	Minimum 10 flights involved. This corresponds to 5 reordering requests.

Table 1: Exercise N°1 overview

Demonstration Exercise ID and Title	EXE-0203-02 : Full-DFlex flight trials
Leading organization	AF
Demonstration exercise objectives	Get flexibility in the pre-departure sequence by performing all the features provided by DFlex : • Reordering • Prioritization • Substitution (ownership of departure order after cancellation)
OFA addressed	OFA 5.3.6
Applicable Operational Context	PDS at CDG. Compared to the context of the first exercise, this exercise will also : • be performed in disrupted situations, when the lack of capacity requires to cancel flights • use coordination between airlines (AF and Delta, AF and HOP! Regional) to perform reordering requests involving flights operated by different airlines
Demonstration Technique	The PDS has been improved in order to take into account the swap of priority between several flights, the prioritization of a flight and an automatic function that redistribute the priority of a cancelled flight to other flights of the same airline
Number of trials	Minimum 50 flights involved. This corresponds to less than 50 reordering requests.

Table 2: Exercise N°2 overview

Link with the SESAR Programme

As this project is intended to pre-industrialize the UDPP (SESAR project 07.06.02, formerly 07.06.04 User Driven Prioritization Process) Step 1 for departures, DFlex is a local implementation project of the Operational Improvement (OI) Step AUO-0102.

3 Programme management

3.1 Organisation

Air France leads the DFlex project. More precisely, within Air France, the DFlex project manager is the CDM@CDG project manager who belongs to the Air France Service ATM/CNS programs where most of the Air France SESAR related activities are developed. In addition, the Air France project manager gets active support from the Air France OCC and Hub Control staff (front office as well as back office) and the IT department.

In addition to Air France, the Airspace Users are heavily represented insuring that the DFlex project is Airspace User driven:

- HOP!Regional airline, one of the regional Air France subsidiary airline also uses DFlex for its own fleet management at CDG but also in conjunction with Air France fleet,

- Delta Air Lines, as a Sky Team airline, also uses DFlex for its own fleet management at CDG but also in conjunction with Air France and HOP!Regional in order to increase Flexibility opportunity at CDG,

- FedEx, another key aircraft operator at CDG since its European Hub is located at CDG and operating the majority of the CDG movements at night, will also use DFlex for its own fleet management (including its feeder airlines) at CDG.

The other categories of stakeholders are represented and provide a valuable technical and operational contribution to the project:

- Aéroports de Paris (Airport),

- DSNA (ANSP),

- Airbus ProSky/Metron Aviation (Industry),

- EUROCONTROL (Network Manager), insuring the success of the DFlex project.

The harmonization with the SESAR programme is carefully addressed:

- HOP!Regional airline, as key contributor in SESAR projects UDPP 7.6.4 as well as in WP11.1,

- EUROCONTROL, as project leader of UDPP 7.6.4,

- Airbus ProSky as member of the Fly4D consortium leading the WP11.1
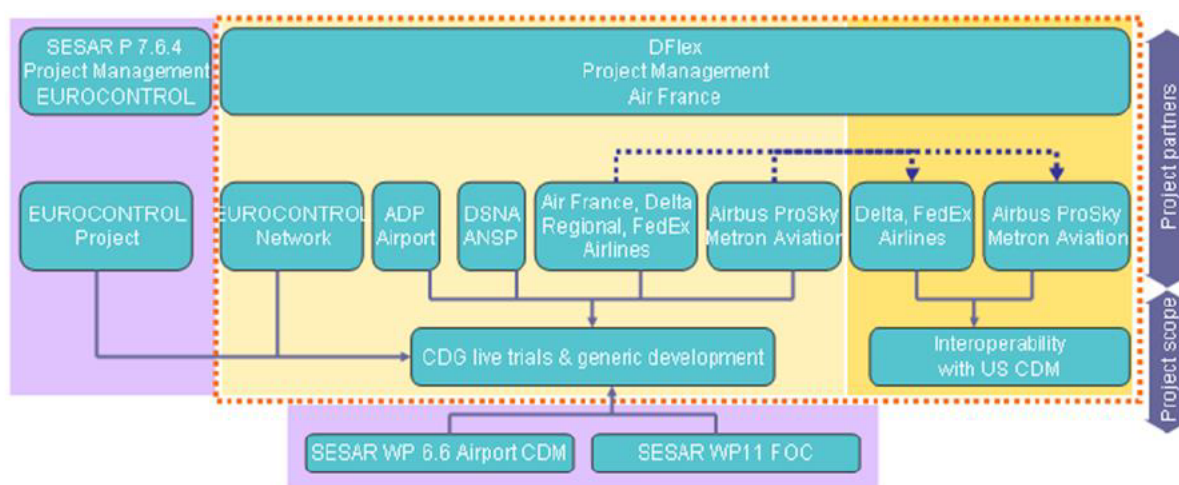
Figure 1: Project Organisation

Finally the harmonization with NextGen is also addressed:

- Delta and FedEx, as key airline contributors in US Surface CDM program,
- Airbus ProSky/Metron Aviation, as the key Industry FAA's partner for US Surface CDM and an important partner in NextGen.

3.2 Work Breakdown Structure

The DFlex work breakdown definition is in purpose and demonstration-oriented:

- WP0: project management,
- WP1: demonstration plan,
- WP2: design of the solution,
- WP3: development of the solution,
- WP4: preparation of the trials,
- WP5: performance of the flight trials,
- WP6: analysis of results and final report.

In addition, the DFlex work breakdown has been driven by the following principles:

- the need to directly feed the UDPP step 1, both the OSED (as part of WP2) and the Validation Plan (as part of WP4) in order to make sure that the DFlex specification will become a Norm & Standard for the European as well as for US Air Transport community,
- a step approach allowing a first flight demonstration as early as possible in March 2013 in order to give confidence to the solution and to allow readjustment if needed for the full solution that will be demonstrated during winter 2013-2014.

The following table details the DFlex work breakdown showing:

- for each Work package, the task breakdown,
- and for each task, the role of each consortium member (L for Leader, C for Contributor, R for Reviewer).

activity Id.	Activity Name	ADP	AF	Delta	DSNA	FedEx	Metron	HOP!	ECTL
	DFlex project								
WP0	**Project Management & Communication**								
T0.1	Project Management Plan	R	L		R	R	R	R	R
T0.2	Overall Project Management and Coordination with SJU	R	L		R	R	R	R	R
T0.3	Coordination meetings	C	L	C	C	C	C	C	C
T0.4	Communication activities	C	L		C	C	C	C	C
WP1	**Refinement Technical Proposal**								
T1.1	Refinement of the technical Proposal	C	L	R	R	C	R	C	C
T1.2	Communication Plan	C	L		C	C	C	C	C
T1.3	Production of D1	R	L		R	R	R	R	R
T1.4	Meeting Presentation of D1	C	L	C	C	C	C	C	C
WP2	**Design of the solution**								
T2.1	Refinement of CONOPS	C	L	C	C	C	C	C	C
T2.2	Specification of Scenario, UC and HMI	C	L	R		C	C	C	C
T2.3	GLD System Requirement	L	R		R	R	R	R	
T2.4	CDM@CDG website System Requirement	L	R			R	R	R	
T2.5	Client OCC System Requirement	C	L	R		C	R	C	
T2.6	Client Mobile System Requirement	L	C	R		C	C	C	
T2.7	Message Specification	L	C			C		C	
T2.8	Alignment with SESAR P7.6.4 OSED	R	R		R	R		L	C
T2.9	CONOPS Interoperability with CDM US	R	C	C	R	L	C	R	C
T2.10	Impact Analysis on Network operations	R	C			L	C		C
WP3	**Development of the solution**								
T3.1	GLD System Upgrade	L							
T3.2	CDM@CDG website System Upgrade	L							
T3.2	Fedex Client System Development					L			
T3.3	Client OCC System Development		L						
T3.4	Client Mobile System Development	L					L		
WP4	**Preparation of Live Trails**								
T4.1	Measurement and Analysis Specification	C	L		C	C	C	R	C
T4.2	Validation Plan (in line with SESAR P7.6.4)	L	C		R	C		C	C
T4.3	Information to Airlines	L	C			C		C	
WP5	**Performance of Live Trails**								
T5.1	CDG Live trials	C	L	R	C	C	R	C	C
WP6	**Results and Final Report**								
T6.1	AF results analysis	R	L	R	R	R	R	R	R
T6.2	Regional result analysis	R	R		R	R	R	L	R
T6.3	Fedex results analysis	R	R		R	L	R	R	R
T6.4	Overall CDG Airport results analysis	L	R	R	C	R	R	R	R
T6.5	Impact on Network operations	R	R		L	R		R	C
T6.6	Production of D2	C	L		R	C	R	C	C
T6.7	Meeting Presentation of D2	C	L	C	C	C	C	C	C

Contribution (L:Lead ; C:Contributor ; R:Reviewer)

Figure 2: Work Breakdown Structure

3.3 Deliverables

The two DFlex formal deliverables are the Deliverable A.1 Demonstration plan and the Deliverable B.1 the Demonstration Report (this report).

Deliverable name	Date
Demonstration Plan (A.11)	26/10/2012
Demonstration Report (B.1)	09/07/2014

Table 3: Deliverables

3.4 Risk Management

The probability of occurrence of a risk and its potential impact are defined in a range from "very low" (1) to "very high" (5). Multiplying these two values provides a prioritization of risks to supervise and mitigate.

At the launch of the project, four domains of risk have been identified:

- Safety issue :

  The probability of occurrence is assessed to "low" since trials are performed on flights still at their parking stand. The impact has been set to "very high" since no compromise can be found for safety. Thus, either a solution would have to be found to increase safety or trials would have to be cancelled.

- Systems used are not available

  The planned available date for each system is:

  - **PDS v3**: 1st step (March 2013) ; 2nd step (Dec. 2013),
  - **CDM@CDG Website HMI**: 1st step – on the intranet of ADP only (March 2013) – This interface will be provided to ADP staff only, and will be available to others partners at the CDM cell (require presence of ADP staff); 2nd step (Dec. 2013),
  - **Metron mobile HMI**: 1st step (March 2013) ; 2nd step (Dec. 2013),
  - **AF and FedEx HMI**: 1st step (March 2013) ; 2nd step (Dec. 2013),

  The step approach that will allow a first flight demonstration as early as possible in March 2013 will give confidence in the solution very early is considered as a mitigation action regarding the "system used not available".

  As a consequence, the probability of occurrence is assessed to "low". As the occurrence of the risk would defer trials to a later date, the level of impact is set to "high". The mitigation action depends on the system not available:

  - **PDS v3 not available**: impossible to achieve trials.
  - **CDM@CDG Website HMI not available** : trial with other available HMIs
  - **Metron mobile HMI not available** : trial with other available HMIs
  - **AF or FedEx HMI not available** : trial with other HMIs
  - **All HMIs not available** : impossible to achieve trials

- Operational procedure not ready

  The probability of occurrence is set to "low". The trials will only be carried out by people involved in the DFlex project, so there is no need for detailed operational procedure. As the occurrence of the risk would defer trials to a later date, the level of impact is set to "high".

- Demonstration conditions not met:

  The probability of occurrence is set to "very low" as the period of trials was defined at a time where it is more likely to find disrupted situations (poor weather in winter,...). Should the risk occur (no disrupted situation during the winter season), trials could not be performed. Thus the risk impact is set to "high".

During the course of the project:

The risks were dismissed during the first trial and during the period between the first trial and the second trial.

- Safety issue :

As expected, this risk did not occur.

- Systems used are not available

The step approach allowed a first flight demonstration as early as possible in March 2013 and gave confidence in the solution very early. This was considered as a mitigation action regarding the "system used not available" and it was a success.

In addition, by developing several HMIs was also considered as a mitigation action regarding on HMI not ready.

As the systems were ready on-time, this risk was dismissed April 2013.

- Operational procedure not ready

The first trials in March 2013 were carried out by people involved in the DFlex project, so there was no need for detailed operational procedure.

Once being confident with DFlex, the people involved drafted the operational procedure to be used by the operational staff after March 2013 trials. So this risk was dismissed April 2013.

- Demonstration conditions not met:

During the first trials in March 2013, only FedEx experienced disrupted conditions (at night due to planned runway closure). Since the first trials was a success, the function stayed available the following months and Air France also experience disrupted situations in May and June (thunder storms, ATC strike). So this risk was dismissed June 2013.

Risks Vs flight trials	Risk assessment Occurrence Impact	Mitigation actions	Risk status
Safety issue	5 Very low (1) Very High (5)	None	no safety issue as expected
Systems used not available	8 Low (2) High (4)	Assessment during 1st trial in March 2013	Risk dismissed in April 2013 : system available on time
Operational procedure not ready	8 Low (2) High (4)	Assessment during 1st trial in March 2013	Risk dismissed in April 2013 : procedures ready
Demonstration conditions are not met	4 Very low (1) High (4)	No interruption of testing between 1st and 2nd trials	Risk dismissed in June 2013 (consequent ATC strike and storm) : conditions met several times between March 2013 and April 2014

Table 4: Risk Management

During the 1st trials another risk popped up: transparency issue for ATC especially in case of disrupted situations. Since we decided to continue testing DFlex between 1st and 2nd trials, that is to say that the use of the reorder function was possible and monitored during more than one year, this risk was dismissed several times as we have experienced various disrupted situations.

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 refine the scenarios. It involved experts from ANSPs, Airlines, Industry (Airbus) and EUROCONTROL (NMOC and SESAR experts).

Precisions for FedEx:

> The exercises were prepared through the briefing and training of a small group of NOC specialists comfortable enough with A-CDM principles, who then aimed to perform some DFlex trials whenever possible using either the FDX ramp tower HMI (RMAS), Metron's DFlex application for iPad (first set of trials) or ADP's CDM@CDG website (second set of trials).

> A dedicated "DFlex trials file" was created to report manually any DFlex action undertaken and its result, and a technical solution developed for the FDX ramp tower HMI (RMAS) which automatically generated "DFlex reports" containing the required data after any DFlex action undertaken via RMAS (either reordering or prioritization).

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 date
EXE-0203-01	Re-order flight trials	26/03/2013	19/04/2013	01/05/2013	31/08/2013
EXE-0203-02	Full-DFlex flight trials	02/12/2013	10/04/2014	01/05/2014	13/06/2014

Table 5: Exercises execution/analysis dates

The demonstration was performed by means of two sets of live trials, which gave to the airlines involved the possibility to send their reordering requests to the pre-departure sequencer.

The first set of trials was planned at the mid-point of the project: it is considered as the first exercise. This first exercise did not aim to assess the full functionality, but to give confidence in the developments already achieved and refine those remaining.

The second set of trials was planned for winter 2013-2014, to ensure we can play all kinds of scenarios (various weather conditions). These trials composed the second exercise.

Each exercise consisted of several trials; each trial corresponds to one reordering request. One reordering request concerns at least one flight (e.g. Prioritization), but can concern 2 or more flights (e.g. Reordering or Substitution).

4.3 Deviations from the planned activities

There was no deviation from the planned activities

5 Exercises Results

5.1 Summary of Exercises Results

Exercise ID	Demonstration Objective Title	Demonstration Objective ID	Success Criterion	Exercise Results	Demonstration Objective Status
EXE-0203-01	Reordering (flight sequence reordering)	OBJ-0203-01	TSAT update according to the airline request	OK	OK
EXE-0203-02	Prioritization ("ready to depart" reordering)	OBJ-0203-02	TSAT update according to the airline request	OK	OK
EXE-0203-02	Substitution (ownership of departure order after cancellation)	OBJ-0203-03	TSAT update according to the airline request	OK	OK

Table 6: Summary of Demonstration Exercise Results

The following graph shows the accumulated number of uses of the different functions during the 2 trials and in-between since the 1st function (reorder of flight) remained available for use by operational staff between the 2 trials. The number of 50 flights, required by SESARJU to be involved in the demo, was reached before the end of the 1st trial in April 2013.
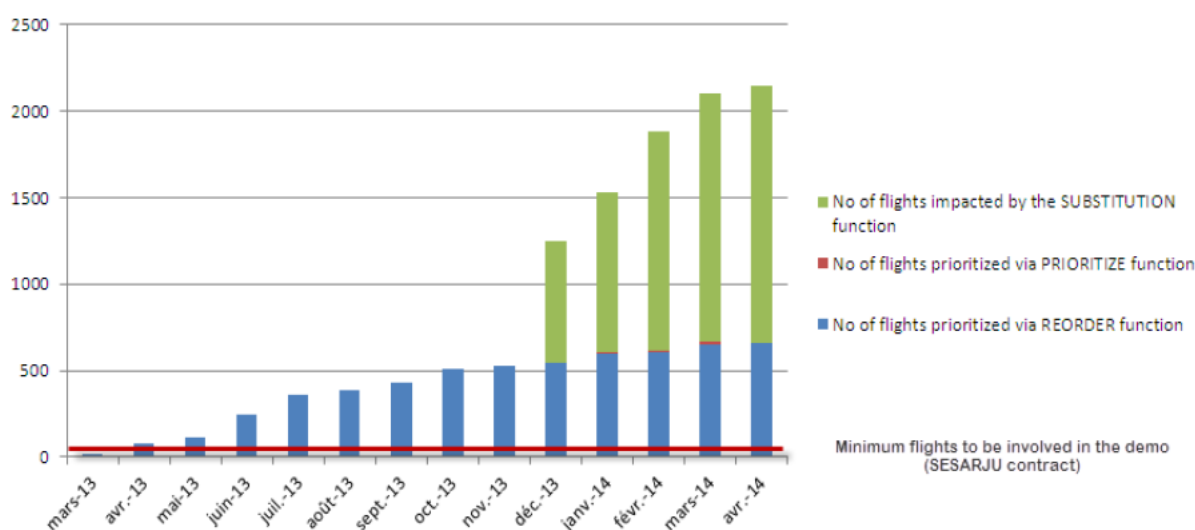

Figure 3: Number of flights involved in the DFlex flight trials

The following table shows the impact on TSAT for flights associated to a DFlex action and the impacted flights. The flight associated to a DFlex action got a significant improvement. And it is interested to notice that the other flights (so-called the "impacted flights") were not penalized.

	Flights associated to a DFlex action		Impacted flights	
	IMPROVMENT Total hours won	DETERIORATION Total hours lost	IMPROVMENT Total hours won	DETERIORATION Total hours lost
EXE-0203-01/OBJ-0203-01 REORDER - 1st trial and in-between 2 trials	52:03:34	30:54:41	33:41:00	40:02:14
EXE-0203-02/OBJ-0203-01 REORDER - 2nd trial	26:48:24	20:05:56	16:36:34	22:27:40
EXE-0203-02/OBJ-0203-02 PRIORITIZATION - 2nd trial	02:20:56	02:02:00	00:10:00	00:00:00
EXE-0203-02/OBJ-0203-03 SUBSTITUTION - 2nd trial	09:33:32	00:22:34	07:47:36	01:02:24
SUM of impact	+37:21:15		+03 :46 :34 *	

* Flights with CTOT excluded (see details in chapter 5.4)

Table 7: Global impact on TSAT

5.2 Choice of metrics and indicators

Objective ID	KPA (key SESAR Programme concepts and technical enablers)	Success Criterion / Expected Benefit	Result of the demonstration
OBJ-0203-01	Departure punctuality	TSAT update according to the airline request / Departure punctuality should improve on flights prioritized with DFlex	The departure punctuality is improved on prioritized flights (see details in chapter 6.1.3 and 6.2.3)
OBJ-0203-02	Local ATC delay improvement	TSAT update according to the airline request /Local ATC delay should improve by 5min or more on flights prioritized via DFlex.	The local ATC delay is improved on prioritized flights (see details in chapter 6.1.3 and 6.2.3)
For OBJ-0203-01 and OBJ-0203-02	Anticipation of DFlex action		See details in chapter 6.1.3 and 6.2.3

Table 8: Summary of metrics and indicators

KPI were defined during the first flight trials. It gave the partners the opportunity to have the tools to calculate the KPI before the beginning of the second flight trials.

Performance KPI:

- Departure punctuality on prioritized flights (before / after DFlex action)
- Local ATC delay improvement on prioritized flights (delta TSAT – TOBT on prioritized flight(s) before / after DFlex action).

Process KPI:

- Anticipation of DFlex action (delta TOBT – actual time of DFlex action)

5.3 Summary of Assumptions

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

Identifier	ASS-0203-10
Title	CDG is an A-CDM platform
Type of Assumption	system
Description	The CDM@CDG program got Airport CDM label from EUROCONTROL in Nov. 2010.
Justification	Need for a mature CDM process, with accurate and timely take off time predictions
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Identifier	ASS-0203-11
Title	Operational PDS tool
Type of Assumption	system
Description	The pre-departure sequence system allocates TSAT to each departing flight
Justification	Need for a pre-departure sequencing which determines the departure time for each flight
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Identifier	ASS-0203-12
Title	Departure sequence displayed to all users
Type of Assumption	system
Description	The CDM@CDG website displays the pre-departure sequence to all users
Justification	The airline must know the delay generated by the TSAT calculation
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Identifier	ASS-0203-13
Title	PDS connected to NM
Type of Assumption	system
Description	The Target Take Off Times are transmitted to the NM (DPI messages)
Justification	Accurate information for flow and capacity management
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Identifier	ASS-0203-14
Title	Connection between Airline SI and PDS tool
Type of Assumption	system
Description	This connection gives TSAT information to the airline SI (CPDS messages)
Justification	TSAT information needed for airline's own DFlex client interface
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Identifier	ASS-0203-15
Title	No DMAN evolution (DMAN is the PDS interface for ATC)
Type of Assumption	System
Description	DFlex shall not require any system evolution of DMAN
Justification	No additional evolution of DMAN can be planned for 2013
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Identifier	ASS-0203-16
Title	Access rights to DFlex features not managed
Type of Assumption	System
Description	The development of DFlex devices does not include the management of access rights
Justification	Not necessary for the trails which will only involve project partners
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Remark: access rights were actually developed for the 2nd trial in order to prepare the generalization of DFlex which we had in mind already at the end of the 1st trial

Identifier	ASS-0203-20
Title	Metering delay with the pre- departure sequence
Type of Assumption	Context
Description	Calculated TSAT generate a departure delay on some flights
Justification	Needed to see the impact on flight request (TSAT improvement)
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Identifier	ASS-0203-30
Title	Coordination between "partner" FOCs
Type of Assumption	Airlines process
Description	The FOC of partner airlines have a fast and efficient communication circuit
Justification	Needed to reorder flight managed by different FOC
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	The need of coordination may have reduced the number of performed DFlex actions

Identifier	ASS-0203-40
Title	No specific procedure for ATC and Network Management
Type of Assumption	ATC and ATFM process
Description	CDG departures as well as flow management in FMPs follow current established procedures
Justification	For CDG TWR and for En-route units, the trials will not require specific procedures application
Flight Phase	Departure
KPA impacted	NA
Impact on assessment	NA

Table 9: Demonstration Assumptions

5.3.1 Results per KPA

Safety:

No safety impact (see 3.4 Risk Management)

Airport Capacity:

No negative impact on Airport capacity

Punctuality:

Departure punctuality improvement on prioritized flights (before / after DFlex action)

Local ATC delay improvement on prioritized flights (delta TSAT – TOBT on prioritized flight(s) before / after DFlex action)

Cost Effectiveness (indirect costs to airlines):

Indirect costs for participating airlines are reduced due to the reordering since the cost of minutes of delay of prioritized flights is higher than the costs on the non-prioritized flights.

Flexibility:

Accommodation of airline reordering requests and prioritization requests.

Equity:

Accrued flexibility on departure did not impact negatively the other airlines operating flights at CDG (see Table 11: Analysis of the 2% of impacted flights and related section).

5.3.2 Impact on Safety, Capacity and Human Factors

No impact on Safety and Capacity was observed.

The flexibility granted to airlines is transparent for DSNA, the ANSP.

5.3.3 Description of assessment methodology

Exercise ID	Indicator	Method	Measure value
EXE-0203-01 EXE-0203-02	Impact on TSAT ofn flights associated with a DFlex action	Calculate the difference between TSAT just before the DFlex action and 1 min after the DFlex action for each flight concerned by the DFlex action	Seconds
EXE-0203-01 / OBJ-0203-01	Number of flights concerned by the OBJ	For each reorder action, one flight is taken into account (the prioritized one)	Number of flights prioritized via the reorder function
EXE-0203-02 / OBJ-0203-02	Number of flights concerned by the OBJ	For each prioritize action, one flight is taken into account (the prioritized one)	Number of flights prioritized via the prioritize function
EXE-0203-02 / OBJ-0203-03	Number of flights concerned by the OBJ	For each substitution automatic action (corresponding to cancellation of one flight), all the flight impacted by a modification of reference time are taken into account	Number of flights impacted via the substitute function

5.3.4 Results impacting regulation and standardisation initiatives

CDG being the first airport to successfully give flexibility to its aircraft operators, EUROCONTROL should promote DFlex as an enhancement of the A-CDM process (see chapter 8.2).

5.4 Analysis of Exercises Results

	Flights associated to a DFlex action		Impacted flights	
	IMPROVMENT Total hours won	DETERIORATION Total hours lost	IMPROVMENT Total hours won	DETERIORATION Total hours lost
EXE-0203-01/OBJ-0203-01 REORDER - 1st trial and in-between 2 trials	52:03:34	30:54:41	33:41:00	40:02:14
EXE-0203-02/OBJ-0203-01 REORDER - 2nd trial	26:48:24	20:05:56	16:36:34	22:27:40
EXE-0203-02/OBJ-0203-02 PRIORITIZATION - 2nd trial	02:20:56	02:02:00	00:10:00	00:00:00
EXE-0203-02/OBJ-0203-03 SUBSTITUTION - 2nd trial	09:33:32	00:22:34	07:47:36	01:02:24
SUM of impact	+37:21:15		+03 :46 :34 *	

* Flights with CTOT excluded (see details in chapter 5.4)

AF Analysis

The reorder function is a valuable function which can bring big benefits especially in adverse conditions.

Indeed benefits are significant. First of all punctuality of prioritized flights is improved thanks to a reduction of local departure delay. Secondly, in some cases cancellation of flights can be avoided, for example when a flight has to leave before a precise time corresponding to crew duty limits or a curfew at destination. Lastly DFlex helps to improve customers experience as it allows limiting misconnecting passengers/packages.

It is more difficult to use than initially expected. Some OCC staff can be reluctant to use it since there is no simulation possible ("what-if function") before making the decision; however it is possible to undo a reorder request and a dedicated HMI has been developed to help in the decision making process.

Generally we aim at prioritizing long haul flights over the priority of medium haul flights. Because of the structure of our flight schedule, if we want to really prioritize a flight we need to do a reorder action between flights with significantly different SOBTs, so this means to prioritize a long haul flight we really deprioritize a medium haul flight.

The reorder function of several flights is possible but never used. One of the lessons learned is that the reorder function between 2 flights is sufficient, for the rare cases when we need to reorder a bunch of flights we can easily use the "simple" reorder function several times.

The ready to depart function will be used very scarcely since we cannot estimate the impact on the flights affected by the prioritization, especially with regards to new CTOTs. There is no undo option for this function.

The need for the prioritization function corresponds to very particular situations.

Manual DFlex actions (reorder function and ready to depart function) have to be done in a very tight window prior to the actual departure, almost at the last minute. This is due to the uncertainty of the

TOBTs (still subject to potential revision until all doors are closed i.e. 5min prior to departure), and the usual uncontrollable delays.

The automatic Cancellation function was observed but its impact couldn't be really analyzed. We soon realized that its rules of triggering are not meeting airline's needs. So this feature is planned to be redesigned to better fulfill the air operator's expectations, as so far its horizon of application is too limited from our point of view.

FedEx Analysis

From an OCC perspective the DFlex features proved their efficiency and fulfill the initial objective which was to give airlines the possibility to indicate their business priorities to an A-CDM system, so that they are taken into account in the pre-departure sequence calculations.

Either the Reordering or Prioritization functionalities allow improving the departure punctuality on designated flights, without impacting the departure queue management aspect of A-CDM and its induced optimized taxi-times. So far all DFlex actions performed had little or no impact on the other flights of the FedEx departure sequence, which is positive.

Both the Reordering and Prioritization features have their own inconvenients and qualities:

- A Reordering demands a minimum of A-CDM expertise, and more time upfront to analyze the departure sequence and find a valuable reordering opportunity. However once done, the potential knock-on effect on the departure sequence is managed since it will impact only the two flights concerned.

- A Prioritization allows to get rid of any A-CDM expertise need, since in this case only one flight needs to be flagged, and no analyze of the departure sequence needed. However the knock-on effect on the other flights of the sequence is unknown and can't be anticipated, with the risk to see another prioritary flight deprioritized down the line.

During the second set of trials, FedEx tested as much Reorderings as Prioritizations. The need for Prioritization mainly lies in the fact that there isn't any decision support tool available in FDX OCC tools yet, i.e. all tasks aiming to identify a valuable reordering have to be performed "manually" by an OCC specialist upfront. The Prioritization feature doesn't require this analysis work upfront, hence people that have little or no A-CDM expertise can use it easily and more quickly as the Reordering.

However we could see that a Prioritization can result in some cases in cascade Prioritizations (e.g. Prioritization of one flight, then of another one and so on...), with the risk at some point that the remaining flights can't be prioritized anymore. So from an OCC perspective we decided to refrain the use of this feature as much as possible, reserving it for very sensitive cases spotted at last minute (e.g. flight crew duty time near to end), if not enough time to perform an analysis of the departure sequence for a Reordering.

Last, the Cancellation feature was observed but its impact couldn't be really assessed, since we could see some flights' reference times shifting automatically after the cancellation of one flight, but too early in advance to assess any precise TSAT improvement. This feature is anyway planned to be redesigned to better fulfill the air operator's expectations, as so far its horizon of application is too limited from our point of view.

ADP Analysis

DFlex features do allow improving local ATC delay on prioritized flights. Meanwhile it does not deteriorate local ATC delay as much the other flights impacted by the actions. Furthermore it nearly does not impact other flights, 98% of potentially impacted flights are not impacted by a change of

TSAT. Operational actions (TOBT update in case of "airline" delays) have more impact on the Pre Departure Sequence than DFlex actions.

That is why we are confident to conclude that the flexibility is transparent for the airlines not using DFlex.

Business rules and criteria used for this analysis

Perimeter of the results analysis:

The results are analyzed for two types of flights: flights directly involved in a DFlex action and impacted flights. The definitions are given below. Details are also given on how the impact has been measured and on the perimeter of flight taken into account for the results.

DFlex actions analyzed

All the DFlex actions available have been analyzed:

- REORDER: function available since the first version of the DFlex module. During the trial, the function was only available for Air France, FedEx, Delta, Hop!

- PRIORITIZE. This function has been released in December 2013 for the second phase of the DFlex trial. The function was only available for Air France, FedEx, Delta and Hop.

- SUBSTITUTE: This function has been released in December 2013 for the second phase of the DFlex trial. By contrast to the REORDER and the PRIORITIZE functions, the SUBSTITUTE function is automatic. The function was available for all the airlines (not only the airlines involved in the DFlex project).

Definition of the flight associated to a DFlex action

Flights associated to a DFlex action are flights that receive a change of their Reference Time because of the use of a DFlex action. Two different cases exist:

- Flights with an improvement of the Reference Time

- Flights with a deterioration of the Reference Time

Please note that the Reference Time can also be changed in case of change of SOBT or after that the flight has been put out of the sequence. Those specific cases are not taken into account because they do not correspond to a DFlex action.

Definition of the impacted flights

Flights impacted by a DFlex action are flights that are not associated to a DFlex action but which were planned next to a flight associated to a DFlex action.

Flights are considered as impacted flights if one minute before the DFlex action, their TTOT is within the 30 minutes before or after the TTOT of the flight associated to a DFlex action.

To get an exhaustive view of the impact, the results take into account:

- Impacted flights with a TTOT within the 30 minutes before or after the TTOT of the flight associated to a DFlex action before the DFlex action.

- Impacted flights with a TTOT within the 30 minutes before or after the TTOT of the flight associated to a DFlex action after the DFlex action.

Please note also that the measures are done for:

- Flights associated to a DFlex action with an improvement of their Reference Time

- Flights associated to a DFlex action with a deterioration of their Reference Time

Business rules for measuring the evolution of delay

The airside impact analysis focuses on the TSAT improvement or deterioration noticed within the minute that follows the DFlex action (R - REORDER, P - PRIORITIZE or S - SUBSTITUTE). It is assumed that TSAT changes within the minute after the DFlex action are the consequence of the DFlex action.

As the departure procedure at Charles de Gaulle airport gives a +5/-5 minutes tolerance around the TSAT, it is in a way possible to consider improvement or deterioration when they are superior or inferior to +5/-5min.

Both of the approach will be presented:

- Sum of all delays (even a delay of 1 min)
- Sum of delays only when they are superior/inferior to +5/-5min (ex : delay of 3 minutes are excluded).

Special cases

- Flights with TOBT: In some cases, a TOBT is sent within the minute before/after the DFlex action. We decide to exclude those flights from the results because the improvement or deterioration is not in that case due to a DFlex action but to an airline decision.

- First DPIs: In some cases, the first TDPI-s is sent to NM in the minute that follows a DFlex action (at TOBT-40min). We decide to exclude those flights from the results because the improvement or deterioration is not in that case due to a DFlex action.

Temporal perimeter of the analysis

The analysis takes into account all the DFlex actions that have been done from the 26/03/2013 to the 10/04/2014. Because of a technical problem on the ADP Information System, there are no data available for the 28/11/2013, 29/11/2013 and 30/11/2013.

Results

Results for flights involved in a DFlex action

The following table presents, for each airline, the results of the DFlex actions:

- R (1st phase) : REORDER actions done in the first phase of the trial (1st trial and in between 1st and 2nd trial)
- R (2nd phase) : REORDER actions done in the second phase of the trial
- P (2nd phase) : PRIORITIZE actions done in the second phase of the trial
- S (2nd phase) : SUBSTITE actions done in the second phase of the trial.

Number of DFlex actions

- 1319 flights have been involved in a REODER action
- 56 flights have been involved in a PRIORITIZE action
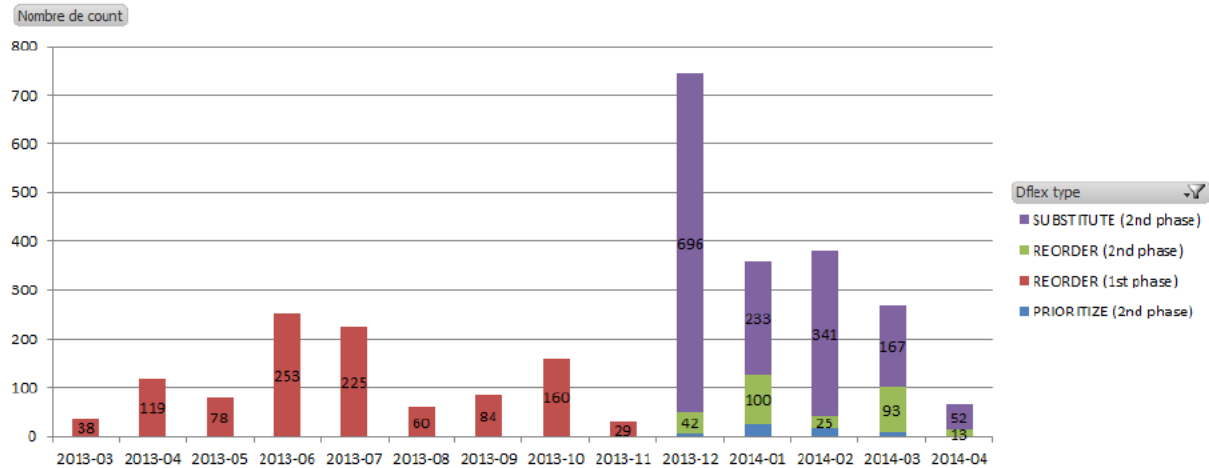- 1489 flights have been involved in a SUBSTITUTE action.

Figure 4: Number of DFlex actions

Results - all delays (from 0sec of delay)

By summing all the improvements and deteriorations, the DFlex module gives the following results:

airline	envoi_TOBT (Plusieurs éléments)									
	changement DPI (Plusieurs éléments)									
	PRIORITIZE (2nd phase) Delay imprmnt	Delay deter	REORDER (1st phase) Delay imprmnt	Delay deter	REORDER (2nd phase) Delay imprmnt	Delay deter	SUBSTITUTE (2nd phase) Delay imprmnt	Delay deter	Total Delay imprmnt	Total Delay deter
	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
AA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
AB	2:25:32	0:30:58	5:39:26	4:45:04	0:00:00	0:22:36	0:45:00	0:00:00	8:49:58	5:38:38
AF	0:00:00	0:00:00	47:00:26	26:08:29	27:06:18	20:20:16	9:23:50	0:29:36	83:30:34	46:58:21
AZ	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
BA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
BC	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
BE	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:37:00	0:00:00	0:37:00	0:00:00
DA	0:00:00	0:00:00	0:13:48	0:10:54	0:00:00	0:00:00	0:00:00	0:00:00	0:13:48	0:10:54
DL	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
EZ	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
FD	0:00:00	1:34:06	3:55:36	1:08:54	0:47:24	0:20:12	0:05:24	0:00:00	4:48:24	3:03:12
FP	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
JA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
KL	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
QT	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
SA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
SW	0:00:00	0:10:24	0:17:48	0:55:40	0:17:06	0:00:00	0:06:24	0:00:00	0:41:18	1:06:04
Total général	2:25:32	2:15:28	57:07:04	33:09:01	28:10:48	21:03:04	10:57:38	0:29:36	98:41:02	56:57:09

- Flights have improve their delay by : 98:41:02 seconds
- Flights have deteriorate their delay by : 56:57:09 seconds

Results – delays superior/inferior to +5/-5 minutes

At CDG, the departure procedure gives a -5/+5min tolerance around the TSAT.

By taking into account only the improvement/deterioration superior/inferior to -5/+5 minutes, the results are different. They are presented in the following table for each airline that has been involved in a DFlex action:

envol_TOBT	(Plusieurs élémer⊽									
changement DPI	(Plusieurs élémer⊽									

	Étiquettes de colc⊽									
	PRIORITIZE (2nd phase)		REORDER (1st phase)		REORDER (2nd phase)		SUBSTITUTE (2nd phase)		Total delay imp toler	Total delay det toler
airline ⊽	delay imp toler	delay det toler	delay imp toler	delay det toler	delay imp toler	delay det toler	delay imp toler	delay det toler		
	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
AA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
AB	2:20:56	0:23:12	5:39:26	4:25:28	0:00:00	0:22:36	0:37:12	0:00:00	8:37:34	5:11:16
AF	0:00:00	0:00:00	42:03:24	24:33:03	25:43:54	19:25:08	8:12:56	0:22:34	76:00:14	44:20:45
AZ	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
BA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
BC	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
BE	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:37:00	0:00:00	0:37:00	0:00:00
DA	0:00:00	0:00:00	0:15:48	0:07:48	0:00:00	0:00:00	0:00:00	0:00:00	0:15:48	0:07:48
DL	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
EZ	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
FD	0:00:00	1:28:24	3:49:08	0:59:06	0:47:24	0:18:12	0:00:00	0:00:00	4:36:32	2:45:42
FP	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
JA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
KL	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
QT	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
SA	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
SW	0:00:00	0:10:24	0:17:48	0:49:16	0:17:06	0:00:00	0:06:24	0:00:00	0:41:18	0:59:40
Total général	2:20:56	2:02:00	52:03:34	30:54:41	26:48:24	20:05:56	9:33:32	0:22:34	90:46:26	53:25:11

- Flights have improve their delay by : 90:46:26 seconds
- Flights have deteriorate their delay by : 53:25:11 seconds

Impact of CTOT

In some cases, flights associated to a DFlex action see a change in their TTOT. This can lead to a new DPI. In some cases, the NMOC can answer to that DPI with an improvement or deterioration of the CTOT (see example in chapter 6).

Impacted flights

For the impacted flights, we consider that a flight has a TSAT/TTOT deterioration/improvement if there is a change within the minute that follows the DFlex action.

Results

		Flights associated to a Dflex		Impacted flights	
		IMPROVMENT	DETERIORATION	IMPROVMENT	DETERIORATION
Delay impact at 0 min	REORDER - 1st phase	57:07:04	33:09:01	64:48:40	87:28:37
	REORDER - 2nd phase	28:10:48	21:03:04	30:12:17	47:29:45
	PRIORITIZE - 2nd phase	02:25:32	02:15:28	00:44:12	00:13:00
	SUBSTITUTE - 2nd phase	10:57:38	00:29:36	13:54:32	03:45:00
	Sum of impact + %impact	+ 41:43:53 (27%)		- 29:16:41 (19%)	
Delay impact at 5 min	REORDER - 1st phase	52:03:34	30:54:41	33:41:00	40:02:14
	REORDER - 2nd phase	26:48:24	20:05:56	16:36:34	22:27:40
	PRIORITIZE - 2nd phase	02:20:56	02:02:00	00:10:00	00:00:00
	SUBSTITUTE - 2nd phase	09:33:32	00:22:34	07:47:36	01:02:24
	Sum of impact + %impact	+ 37:21:15 (17%)		- 5:17:08 (2%)	

Table 10: Summary of results of the different flight trials

- All delays: By summing all the potential improvement/deterioration of TSAT for the whole period (26th March 2013 – 10th of April 2014), the DFlex module gave 29:16:41 seconds of deterioration for the whole period on the impacted flights. 19% of the flights have a delay (for the other rest, the impact is null).

- Delays superior/inferior to +5/-5 minutes: In that case, the DFlex module only gives a 05:17:08 seconds deterioration shared by 2% of the flights within the perimeter. For the other flights of the perimeter, the delay is less than 5 minutes.

Analysis of the 2% of impacted flights (when only delay > 5 min is considered)

The origin of deterioration and improvement are CTOT and CPDS behavior.

	IMPROVMENT	DETERIORATION
Impact of CTOT (12%)	11:28:30	20:32:12
C-PDS behaviour (88%)	46:46:40	43:00:06
Sum of impact + %impact	- 5:17:08	

Table 11: Analysis of the 2% of impacted flights

- CTOT (12%): In some cases a DPI is sent to NMOC to inform about the new TTOT issued locally. A new CTOT is received within the minute that follows the DFlex action. The new CTOT can increase or decrease the delay. In this analysis, we have not taken into account the NMOC process in place which aims at enhancing the situation in case of CTOT (improvement of CTOT occurs in the majority of the cases). That is why we have excluded the flights with CTOT in the presentation of the global results.

- C-PDS behavior (88%): In some cases the delay can also increase or decrease after a DFlex action because of the new environment and the internal C-PDS rules.

5.4.1 Unexpected Behaviors/Results

There was no unexpected behavior or result.

5.5 Confidence in Results of Demonstration Exercises

5.5.1 Quality of Demonstration Exercises Results

The trials were performed on real flights. DFlex features are integrated to the FOC station for AF and to the apron management system for FDX.

5.5.2 Significance of Demonstration Exercises Results

We have a great confidence in the significance of the results since the analysis and monitoring of the DFlex actions were done for more than one year (March 2013 to April 2014). Numerous and different disrupted situations were encountered.

5.5.3 Conclusions and recommendations

The project has reached its objectives: flexibility can be given to airlines without impacting operations and capacity and with respecting equity among airlines

After the end of the 1st exercise, the CDM@CDG steering committee decided to extend the DFlex reordering evaluation until the live trials of the 2nd exercise (winter 2013-2014).

After the end of the 2nd exercise, the steering committee decided the generalization of DFlex for all airlines.

The DFlex features are now fully integrated in our systems (AF, FedEx, CDM@CDG website).

The functions are to be used by OCC since a global picture of the situation is needed: knowledge of crew duty limits, airport curfews, VIP on board, knock-on effect on system form etc…. If one wants to prioritize a flight, other flights need to be de-prioritized. In Air France and FedEx, only the OCC has the right to de-prioritize a flight.

The use of DFlex options by an airline for which the airport is not a hub or at least is not a significant base, seems complicated. Several reasons can be given: not enough opportunities, not enough staff.

The fact that airlines can group themselves to use DFlex together is an option that could allow this kind of airlines to use DFlex more often.

Delta has a staff at CDG that focuses mostly on customer service. Operational issues concerning a Delta flight at CDG are typically relayed through our local management team but handled by AF or by the Operational Control and Customer Centre in Atlanta, GA.

The ability to swap PDS slots requires a dedicated person to monitor all flights, evaluate their assigned TSATs, evaluate flight priorities (see above) and execute a swap when priority is warranted. As aforementioned, the Delta staff on hand is unable to accomplish this in addition to their other duties.

Several options could be available:

- Have a dedicated staff position to serve that function – this would be preferable but could be cost prohibitive. More discussion with station management would be required.

- Have an established agreement with AF to perform this function – while this may work for minor substations, the issue around operational control and a dispatcher's ability to manage a flight comes in to play. AF may not have full exposure to issues such as crew duty limits or other factors affecting the flight.

- Have a remote position in Delta's OCC in Atlanta to handle this function – given the time these slot substitutions were to occur, this may or may not be a viable function for Delta's strategic planning team to coordinate.

In conclusion, we recommend exporting the concept to other CDM airports since we have a great confidence in the results of the project.

6 Demonstration Exercises reports

6.1 Demonstration Exercise EXE-0203-01 Report

6.1.1 Exercise Scope

This set of trials enabled the validation of the PDS tool first upgrade, and aims to give confidence for the development of the complete features.

This first set of trials addressed the objective OBJ-0203-01: Reorder the flight departure sequence on airline request.

In case of departure delays generated by the Pre-departure sequencing (PDS calculation), TSATs are greater than TOBTs. The objective is to distribute differently the delay on two flights operated by the same airline in order to reduce the overall operational impact of the global delay.

The airline submits a reordering request involving these two flights. The objective is that the PDS system exchanges the order of these two flights for the TSAT calculation processing. The flight processed first (the one prioritized) should have a better TSAT than when it was processed later. The downgraded flight may have a worse TSAT.

6.1.2 Conduct of Demonstration Exercise EXE-0203-01

6.1.2.1 Exercise Preparation

Aéroports de Paris PDS engine – DFlex module

The PDS system has been updated to receive from an external system the reordering request of the airline: development of the DFlex Dataflow

The PDS algorithm has been updated to take into account, in its TSAT calculation, the modified flight order provided by DFlex requests.

The participating airlines have been provided with an interface to send their reordering requests to the PDS system.

Aéroports de Paris HMI

For the purpose of this first trial, Aéroports de Paris has developed an internal HMI available as a backup solution of the other interfaces developed by the airlines involved in the DFlex trial.

This HMI in this first trial is very basic:

- A screen allows the user to make some REORDER requests
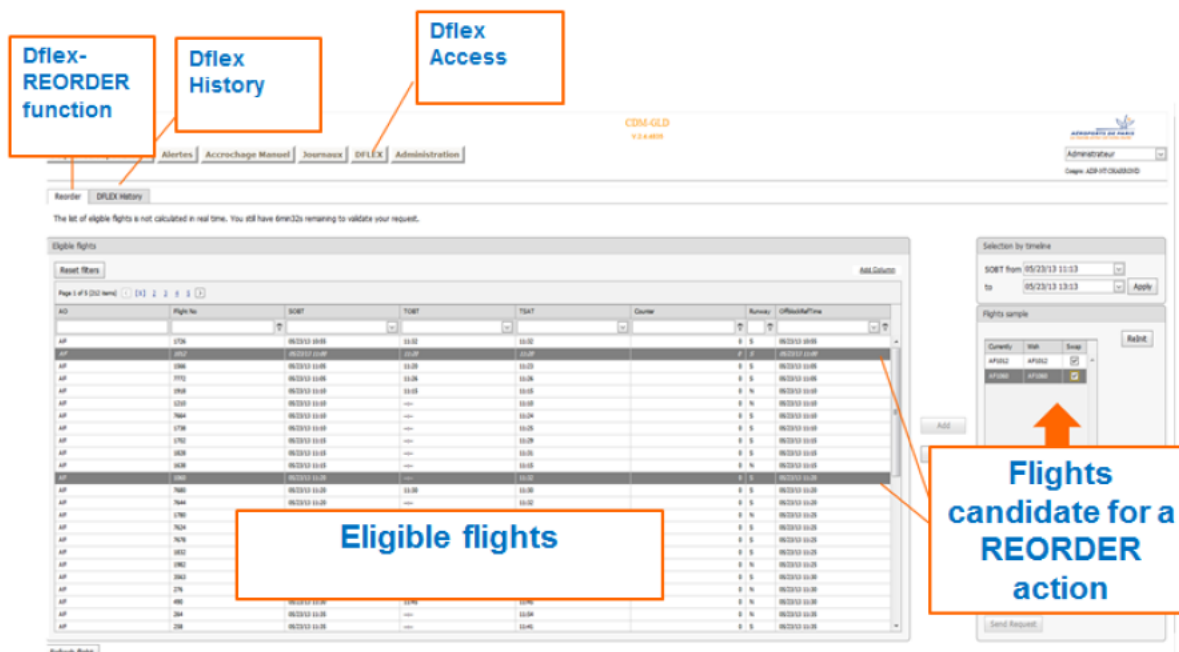- A screen allows the user to access to the history of the REORDER action

Figure 5: ADP HMI

- The flight list has also been updated to show if a flight has been associated to a DFlex action or not.

Figure 6: ADP HMI

Air France interface

On AF SI, a dedicated DFlex HMI provides OCC and Hub staff decision support for the pair of flights to reorder:

- If the airline operator identifies the prioritized flight, the HMI will suggest a list of "deprioritizable" flights, according to its operational and business constraints

- If the airline operator identifies the "deprioritizable" flight, the HMI will suggest a list of "prioritizable" flights, according to its operational and business constraints

Séléction des vols candidats au swap(DFlex normal)

Numéro de vol	AF 008			Date	14-05-2013		Même QFU ☑		Priorisation optimum ☐
🔍 Rechercher	DFlex normal<->DFlex inversé								

Vol à prioriser

Href	Vol com	Dest	SOBT	TOBT	TSAT	QFU	Ecart CFMU/TOBT	Ecart TSAT/Butée PN	Marge BdL
17:10	AF 008	JFK	17:10	-	17:10	26R	-	-	+ 00:29

Total : 1

Vol(s) à déprioriser

Href ↓	Vol com	Dest	SOBT ↕	TOBT	TSAT	Même QFU	Ecart CFMU/TOBT	Ecart TSAT/Butée PN	Marge BdL
15:00	AF 536	OUA	15:00	18:15	18:15	Oui	-	-	- 00:15
15:00	AF 536	OUA	15:00	18:15	18:15	Oui	-	-	- 00:15
16:20	AF1076	BIO	16:20	16:30	16:30	Oui	-	-	+ 00:05
16:50	AF7748	BSL	16:50	16:55	16:55	Oui	-	-	- 00:05
16:55	AF1390	IST	16:55	-	16:55	Oui	-	+ 02:55	+ 06:10
16:55	AF7626	BOD	16:55	-	16:55	Oui	-	+ 03:45	- 00:05
17:05	AF7648	LYS	17:05	17:10	17:10	Oui	-	+ 03:55	+ 00:10

Figure 7: Air France HMI

The operator chooses the second flight in the displayed list. Its validation triggers the reordering message to the PDS systems, which returns an acceptance / rejection message, and potentially calculates new TSATs.

The result of the operator reordering request can be seen on the AF DFlex HMI:

Validation du swap

Situation avant swap

	Href	Vol com	Dest	SOBT	TOBT	TSAT	QFU	Ecart TSAT/TOBT	COBT	Ecart CFMU/TOBT	Ecart TSAT/Butée PN	Marge BdL
Vol à prioriser	05:10	AF 076	LAX	05:10	-	05:10	27L	+ 00:00	-	-	-	+ 00:00
Vol à déprioriser	02:55	AF1118	FRA	02:55	-	02:55	27L	+ 00:00	-	-	-	+ 00:05

Total : 2

Réponse ADP

✓ Proposition de swap envoyée

Date swap	Vol com priorisé	Dest vol priorisé	Vol com dépriorisé	Dest vol dépriorisé	Code retour	Raison retour	Commentaire
14/05/2013 16:56:00	AF076	LAX	AF1118	FRA	-	-	-
↻ rafraîchir							

Total : 1

Situation après swap

	Href	Vol com	Dest	SOBT	TOBT	TSAT	QFU	Ecart TSAT/TOBT	COBT	Ecart CFMU/TOBT	Ecart TSAT/Butée PN	Marge BdL
Vol à prioriser	05:10	AF 076	LAX	05:10	-	05:10	27L	+ 00:00	-	-	-	+ 00:00
Vol à déprioriser	02:55	AF1118	FRA	02:55	-	02:55	27L	+ 00:00	-	-	-	+ 00:05

Figure 8: Air France HMI

FedEx interface

A DFlex reordering feature was developed for the FedEx Ramp Tower HMI used by the FDX Apron controllers & launch advisors, which is interfaced with CDG Airport database (SARIA).

To reorder a pair of flights, the apron controller or launch advisor just selects the flight giving up its priority; either on the RMAS map view or the RMAS flights list, and assigns it a "LOW" priority. The apron controller then selects the flight that needs to be prioritized and assigns it a "HIGH" priority. This triggers a DFlex reorder request which is automatically sent to CDG's A-CDM system for processing. The result of this transaction (OK/KO) is displayed on the RMAS status screen, and the resulting new TSATs are displayed on the map and aircraft lists
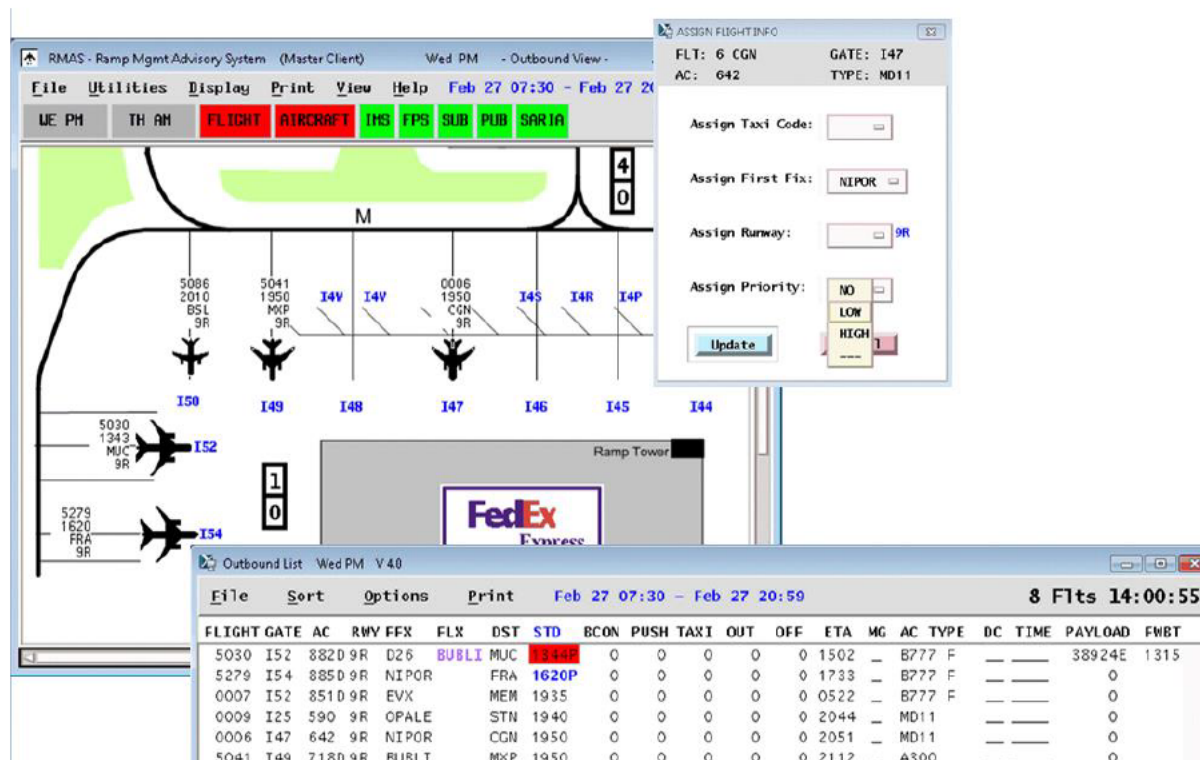
Figure 9: FedEx HMI

At the CDG Hub, Ramp Tower Operations (apron management services) are integrated to NOC (Network Operations Centre) and apron control duties are performed by NOC specialists. When a service recovery specialist needs to prioritize a sensitive flight, or identifies in the pool of flights under his/her control a prioritary flight experiencing an A-CDM delay (TSAT > TOBT), he/she will look for a reordering opportunity in the CDM@CDG departures list (i.e. less prioritary flight delayed but having an earlier RefTime). The other way round, if a recovery specialist identifies a delayed flight, he will look if any opportunity to give the priority of this flight to a flight ready to depart but having a later RefTime (thus a delayed TSAT).

After having identified this pair of flights the recovery specialist forwards the reorder request to the ramp tower controller who takes care of executing the reordering request in RMAS.

When the Launch Advisor position is manned at ramp tower, he/she also monitors the CDM@CDG Departures List and can propose some Reorderings to the recovery desk for launch optimization, or comply with to comply with some crew requests in real time for TSATs improvement when possible.

Metron interface

The relative order of flights can be swapped using Metron's DFlex Mobile application. This is performed by selecting a flight (touch the screen on the flight and holding it there until selected) and then dragging it and dropping it on top of another flight. When the initial flight is released, both flights are highlighted in a blue-green color as shown in the figure on the right. If these are not the desired flights, then hit the "Reset" button and the flights will be deselected and the highlighting removed.

If these are the desired flights, then the "Swap" button can be tapped. When this occurs, the Swap command containing the highlighted flights is sent to the C-PDS system. If the swap is valid from C-PDS' perspective, then an OK message will be returned, otherwise a NOK message is received. The success or failure is used to update the status at the bottom of the screen. If the Swap command was accepted, then the highlighted rows go from blue-green to a dark gray (as shown in figure below). They are still highlighted, waiting for updated information like TREFs and TSATs from C-PDS. When an update is received for the flight, then the highlighting is removed.

Additionally, information about the last swap performed by this user is stored in the Log Status buffer. This is displayed by pressing the Status icon ("C with an Arrow"). This log status will show the flights swapped, the status from C-PDS and any reason provided by C-PDS, as shown in the figure on the right

Figure 10: Metron HMIs

6.1.2.2 Exercise execution

Air France:

During scheduled period of DFlex activation (from March 26 to Apr 19), AF had only the opportunity to evaluate one demonstration scenario: reorder flights in nominal situation. These periods of DFlex activation didn't meet local capacity restriction, so there were only a few TSAT delays that could justify Reorderings.

However, these trials gave the opportunity:

- to validate the system developments and to improve AF HMI for decision support

- to train operational people (OCC and Hub) on DFlex reordering

- to define the operational process : coordination between AF actors, coordination between OCCs for Reorderings mixing flights operated by AF and HOP!Regional.

The complementary days gave the opportunity:

- to improve punctuality on flights delayed by their TSAT(even for small delay) : the flight that gives its priority is a flight which cannot depart on time because of operational constraints (TOBT), and thus does not use its priority.

- to solve operational constraints and reduce operational costs in adverse situations which generate departure capacity reduction : reduce delay on sensitive flights (D0 directives, crew duty limits), avoid curfews, save passengers connections...

The reordering requests were performed by operational staff (OCC and Hub), on their work stations, assisted by a DFlex expert.

When flight operated by Regional were involved in the reordering, coordination with HOP! Regional OCC staff was carried out by phone.

On average, 6 Reorderings were made per day of DFlex use.

HOP! Regional:

Few reordering were performed during the first set of trials, from March 26th to April 18th 2013 due to nominal situations without really penalizing CTOT or TSAT.

Before each reordering, there was coordination between AF's OCC and HOP! Regional's OCC.

As the Reorderings concerned "wet lease" AF flights (under AF OCC responsibility in terms of commercial and operational decisions), they were performed via AF DFlex tool.

No negative feedback was received from our crews, nor from ground dispatchers.

The trials were an opportunity to initiate OCC's D-day flights staff on DFlex project. And since end of May, OCC of HOP! Airlinair and HOP! Britair are informed as well.

FedEx:

The scheduled period of DFlex activation (0330-0500LT) allowed testing the feature in a context of reduced capacity:

At night time, specific DMAN parameters are used by ATCT for the FDX launch to reflect the particular constraints of this timeframe (0330-0500LT) such as the closure of one runway for daily works, Environmental Protection Airways constraints or specific night SIDs and procedures impacting the take-off rate and threshold holding time. Consequently, the DMAN capacity parameter (hourly departure rate) is reduced to 23 dep/h on one runway vs. standard 38 dep/h on two runways in

nominal situation, with a variable max threshold holding time (pressure parameter) varying depending the runway in use.

A-CDM delays (TSAT > TOBT) are thus generated on some flights of the FedEx launch since at some point the demand exceeds the offered runway capacity.

FedEx did not perform any DFlex trial during day time, as no need for it until then (standard capacity and nominal situations).

The FedEx trials involved 3 different Airspace Users operating under the same Commercial ID (FX): FedEx (FDX), Air Contractors (ABR) & Swiftair (SWT).

Some DFlex Reorderings mixing these different AO identifiers were performed, however it didn't require any particular coordination from FedEx NOC as the ABR and SWT flights operating for FDX are under the operational control of the FedEx EMEA Network Operations Control Centre located at CDG (e.g. delays approvals & any other tactical decisions such as re-routes, etc...).

The reordering requests were performed by some NOC specialists specifically trained for the DFlex trials or supported by DFlex SMEs when available, either from an RMAS workstation (FDX Ramp Tower HMI) or via Metron's DFlex application for iPad during the first phase of live trials (29Mar-19Apr).

- 16% of the total volume of flights operating when some DFlex trials were made was subject of a reordering request, and 14% obtained a TSAT revision $\geq$ 5min.
- Highest proportion of Reorderings performed during a departure sequence: 36% of volume (average around 11% of the volume of a departure sequence).

This first set of trials on the scheduled period (March 26 to April 19) allowed to:

- Validate the specifications of the reordering feature.
- Check that the Reorderings performed didn't jeopardize the other flights of the night sequence.
- Familiarize the operational staff with this new feature.
- Evaluate & start fine tuning the internal operational processes linked to it (coordination Recovery desk / Ramp Tower operations).

The complementary trials gave the opportunity to experiment in live conditions different use-cases:

- Prioritization of a wide body, long-haul flight connecting another FedEx regional Hub, to limit the impact on the world line haul system and associated extra costs & service impacts (e.g. FDX38-19Apr CDG-DEL-PVG, TSAT improved by 15min allowing an on-time departure).
- Prioritization of a flight with tight crew duty flex, to limit the risk of cancellation related to crew legalities (e.g.: FDX8017-18Apr CDG-SXF-GDN, A-CDM delay reduced from 25min to 13min).
- Prioritization of a flight subject to D-Zero directives, due to sensitive market at destination & system particularities (e.g.: FDX8020-30Mar CDG-PRG, TSAT improved by 17min allowing an on-time departure).
- Prioritization of a multi-legs flight ready to depart on time but delayed by TSAT (e.g.: FDX8028-05Apr CDG-LYS-MRS, TSAT improved by 17min).

Delta:

For this first exercise, a technical problem was encountered; the mobile application did not work in all locations because of Wi-Fi access. Metron will try to solve the problem for the second exercise.

Two swaps were done on non-delayed flights (performed by Guilhem Tardieu (AF staff in charge of handling for other airlines)

ADP:

Operational staff (PDS operator) wasn't involved at this first step. CDM Team has monitored the PDS system and validated technically the Reordering function.

DSNA:

An Operational Instruction was delivered to the controllers covering the DFlex evaluation and a specific presentation was made to TWR supervisors and APP supervisors.

During the scheduled period, activation periods for the next day were confirmed to APP-SPVR during the daily CDM evening teleconference. Then the APP-SPVR forwarded the information (via e-mail) to all partners involved, including Network Manager (NMOC).

The last message sent to all partners was the extension of the DFlex evaluation resulting in a permanent activation of DFlex feature.

A template for feedback was made available to all APP and TWR SPVR in order to collect quickly information on any disturbance or incident in the departure process DFlex might have contributed to.

6.1.2.3 Deviation from the planned activities

There was no deviation from the planned activities

6.1.3 Exercise Results

6.1.3.1 Summary of Exercise Results

Airlines analysis

The DFlex reordering feature allowed the airline FOC to tactically manage its business priorities in a reduced capacity context with A-CDM delays, thus to improve the quality of service and customer experience down the line (e.g. prioritize flights subject to D-Zero focus or of high-value vs. less sensitive flights).

Concerning the first of these potential benefits though (decision making on flights priorities), it has to be reminded that it's just a partial return to normal situation for FOCs: when operating in non-CDM environment an AO's FOC has the complete capability to tactically manage its business priorities and to decide which flight of its pool should depart before another one when there are some delays (e.g. deicing). This is a situation that makes sense as never will any algorithm developed by the NM or an Airport Manager be able to tactically manage the business priorities of an AO. Hence the importance to give back to AOs operating in A-CDM environment this capability, via this kind of features.

From the AO operations perspective, these trials were useful as it allowed AOs to realize that this new feature induced a substantial additional workload for FOC staff, as it demands some focus and decision making in the choice of flights to be reordered (a poor choice can result in a significant additional A-CDM delay on a flight, for only very little gains on the prioritized flight).

The trials also demonstrated that the reordering feature (and probably the "prioritize" feature that will be tested in the second exercise) is most of time used in a very tight window prior to the actual departure, almost at the last minute. This is due to the uncertainty of the TOBTs (still subject to potential revision until all doors are closed i.e. 5min prior to departure), and the usual uncontrollable delays.

This is an interesting observation to put in perspective to the wishes of ATC to avoid the reordering of flights shortly prior to departure. From our AO operations perspective, we could observe that Reorderings made too early (e.g. prior to TOBT-10/15min) had a poor reliability which led most of time to do another reordering to correct the situation, since the initial TOBTs on which the first reordering was done had changed in the meanwhile.

Hence our assumption, which is that Reorderings made too early would most of time have a more negative impact on the stability of the departure sequence, than a reordering made shortly prior to ASAT.

No remarks received from crews : totally transparent process for pilots, who aren't informed if they are "reordered" or not. Purpose being to avoid adding useless R/P communications to the current amount of communications linked to A-CDM processes (TSATs questionings, requests for improvement, etc.). The feasibility of such a thing in the field (i.e. inform crews that their flight is subject of a DFlex reorder) is moreover questionable, as well as the added value of doing it since down the line what matters to pilots is the time they'll be authorized to leave the stand. The means to potentially improve a TSAT are not their concerns: they know that their operations are taking care of this part of the process.

DSNA analysis

Local impacts of DFlex actions were closely monitored by APP Supervisor and by TWR Supervisors during the whole period of evaluation. No side effect was reported and all actions were transparent to ATC.

No adverse impact on the management of departure flow performed by the TWR:

- no unusual TSAT behavior
- no unusual number of calls between TWR-spvr and ADP and/or OCCs

However, need to make RefTime visible to ATC, at least on CDM website GLD page, and ideally in DMAN.

Anyway, it must be kept in mind that during this first phase of evaluation, only few DFlex actions were performed and most of them in no delay conditions. DFlex impacts during adverse condition with poor throughput capacity and major delays for many flights should provide a better illustration and more relevant conclusions.

EUROCONTROL analysis

- DPI performance criteria related to the trial timeframe :

   No complaint from the OPS room and the Post-Ops manager: no changes observed to the DPI behavior of LFPG departures.

ADP analysis

Global analysis is provided in chapter 5.

Operational staff feedback after the end of 1st trial:

	Advantage	**Drawback**	**Risk**	**Mitigation actions**
Airlines	Proper functioning of the concept Great potential for use Give real opportunity to reduce TSAT delay on sensitive flights	Complex internal process: requires coordination between different actors Requires availability and increased attention from operational staff	Anticipation is difficult : a reordering made too far in advance can be a bad choice ultimately	
DSNA	Contribution to better service to customer		Departure sequence might become unstable if too many DFlex actions are performed too close to departure, then likely to be inconsistent with TWR controller late optimization and fine tuning of departure flow	After 1st trial, reorder function stayed live to monitor this risk. This risk was dismissed after several days in June 2013 of extensive use of DFlex
ADP	Establish a flight list accordingly to the wishes of Airlines Increase coordination between stakeholders	Stakeholders need to be more reactive in case of no anticipation	Lack of anticipation can destabilize the sequence Difficulties to coordinated landside/airside actors	After 1st trial, reorder function stayed live to monitor this risk. This risk was dismissed after several days in June 2013 of extensive use of DFlex

Table 12: Operational staff feedback after 1st trial

6.1.3.1.1 Results per KPA

Results concerning the trials addressing SCN-0203-01:

performed when the departure capacity is nominal.

For AF, HOP! Regional and Delta, these trials were performed during the 4 weeks scheduled period: between March 26 and April 21.

	AF	**Delta**	**FedEx**
Number of evaluation days	21 days including 2 days mixing AF and HOP!Regional flights	2 days	0
Number of reordering requests	118 accepted Including 13 rejected	2 accepted 0 rejected	0

Table 13: Results from trials addressing SCN-0203-01

Results concerning the trials addressing SCN-0203-02:

performed when the departure capacity is reduced

These trials involved FedEx (most of the time operating in reduced departure capacity) and AF flights.

The reduced departure capacity produced delayed TSAT which justify flight prioritizations.

The causes of the capacity reduction were:

- Weather : fog
- Runway closure
- ATC strike

	AF	Delta	FedEx
Number of evaluation days	7	0	23
Number of reordering requests	77 accepted Including 3 rejected		51 accepted 7 rejected
Number of reorderings generating TSAT revision > 5 min			**45** (includind 3 regulated flights)
Departure punctuality* obtained on prioritized flights	During 1st exercise, accurate KPI not available		**88.1 %**
Anticipation* of DFlex action (average)			**TOBT – 8.8 min** Max prior TOBT : - 51 min Max after TOBT : 20 min
A-CDM delay* before prioritization			**763 min** (on 45 flights) Span of delays ; 6 - 31 min
A-CDM delay* after prioritization			**296 min** (on 45 flights) Span of delays ; 0 - 25 min
A-CDM delay improvement*			**467 min (-61.2%)** Avg delay on prioritized flight : 6.5 min (vs 17 min before DFlex action)

Table 14: Results from trials addressing SCN-0203-02

Anticipation of DFlex action:	$TOBT_{prioritized\ flight}$ - DFlex request time
* Departure punctuality:	% of flights with (AOBT – SOBT)< 15 min
* A-CDM delay	= TSAT – TOBT on non-regulated flights
	= $TTOT_{T\text{-}DPI\text{-}s}$ – (TOBT+ Taxi time) on regulated flights
* A-CDM delay before prioritization:	span of A-CDM delays observed on flights that were prioritized, before reordering
* A-CDM delay improvement:	span of A-CDM delays improvement obtained on prioritized flights, after reordering

The delay improvement is appreciated 1 minute after the DFlex action. It cannot be done later otherwise other factors may influence the TSAT (TOBT, change in capacity...).

6.1.3.1.2 Results impacting regulation and standardisation initiatives

CDG being the first airport to successfully give flexibility to its aircraft operators, EUROCONTROL should promote DFlex as an enhancement of the A-CDM process.

6.1.3.1.3 Unexpected Behaviors/Results

There was no unexpected behavior or result.

6.1.3.1.4 Quality of Demonstration Results

The trials were performed on real flights. DFlex features are integrated to the FOC station for AF, and to the apron management system for FDX.

6.1.3.1.5 Significance of Demonstration Results

We have a great confidence in the significance of the results since the analysis and monitoring of the DFlex actions were done during more than one year (March 2013 to April 2014). Numerous and different disrupted situations were encountered.

6.1.4 Conclusions and recommendations

6.1.4.1 Conclusions

This first new function "DFlex reordering" allowed the airline to tactically manage its business priorities in a reduced capacity context with A-CDM delays. Achieve punctuality on some sensitive flights is possible thanks to DFlex.

From the airline perspective, these trials were useful for different reasons. Several identified risks were rapidly dismissed. Moreover, they allowed airlines to realize that this new feature induced a substantial additional workload for FOC staff, as it demands some focus and decision making in the choice of flights to be reordered.

The trials also demonstrated that the reordering feature (and probably the "prioritize" feature that will be tested in the second exercise) is most of time used in a very tight window prior to the actual departure, almost at the last minute.

All actions were transparent to ATC, airport and NMOC operations.

6.1.4.2 Recommendations

Global recommendations are provided in chapter 8.

6.2 Demonstration Exercise EXE-0203-02 Report

6.2.1 Exercise Scope

In addition to further addressing objective OBJ-0203-01 from the first set of trials, this second set of trials also addressed these objectives:

OBJ-0203-02: ready to depart reordering on airline request.

OBJ-0203-03: ownership of departure order on cancellation

In case of departure delays generated by the Pre-departure sequencing (PDS calculation), TSATs are greater than TOBTs. The first objective is to distribute the delay differently across several flights operated by the same airline by prioritizing one flight in order to reduce the operational impact of the global delay.

6.2.2 Conduct of Demonstration Exercise EXE-0203-02

6.2.2.1 Exercise Preparation

Aéroports de Paris PDS engine – DFlex module

The PDS system has been updated to receive from an external system the PRIORITIZE request in addition of the REORDER request.

The SUBSTITUTE function has also been released in the second phase of the DFlex module.

The PDS algorithm has been updated to take into account, in its TSAT calculation, the modified flight order provided by the new DFlex request and the new SUBSTITUTE function.

The DFlex agreement management module has also been included in that release.

Aéroports de Paris HMI

Agreement management interface

A specific interface has been developed to manage Dflex agreements.
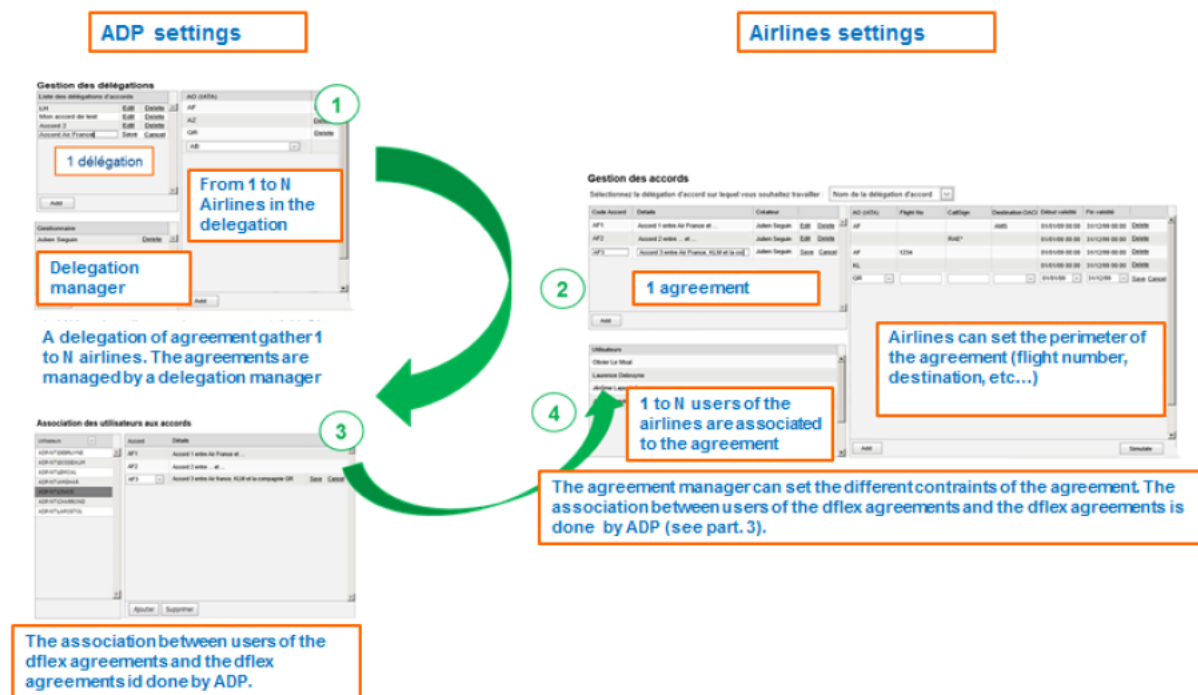
Figure 11: Agreement management interface

CDM@CDG website – DFLEX HMI

New screens have also been developed for the CDM@CDG website to allow users to send DFlex requests: REORDER and PRIORITIZE requests. Through the website, users can also define the parameter of an agreement: destination, flight number, airlines involved in the agreement.

AF preparation

Before the beginning of the second flight trials, a tool was developed to produce KPI more easily. The concerned KPI are related to the use of the reorder function.

For this exercise, Air France chose not to develop specific HMI to use the new function "Ready to depart reordering". The idea was to experiment with the functionality using the ADP HMI to better design a specific AF HMI which could include decision making tools.

FedEx preparation

For the second exercise, FedEx developed for its Ramp Tower HMI (RMAS) a Prioritization feature that completes the functions developed for the Reorder feature for the first exercise:
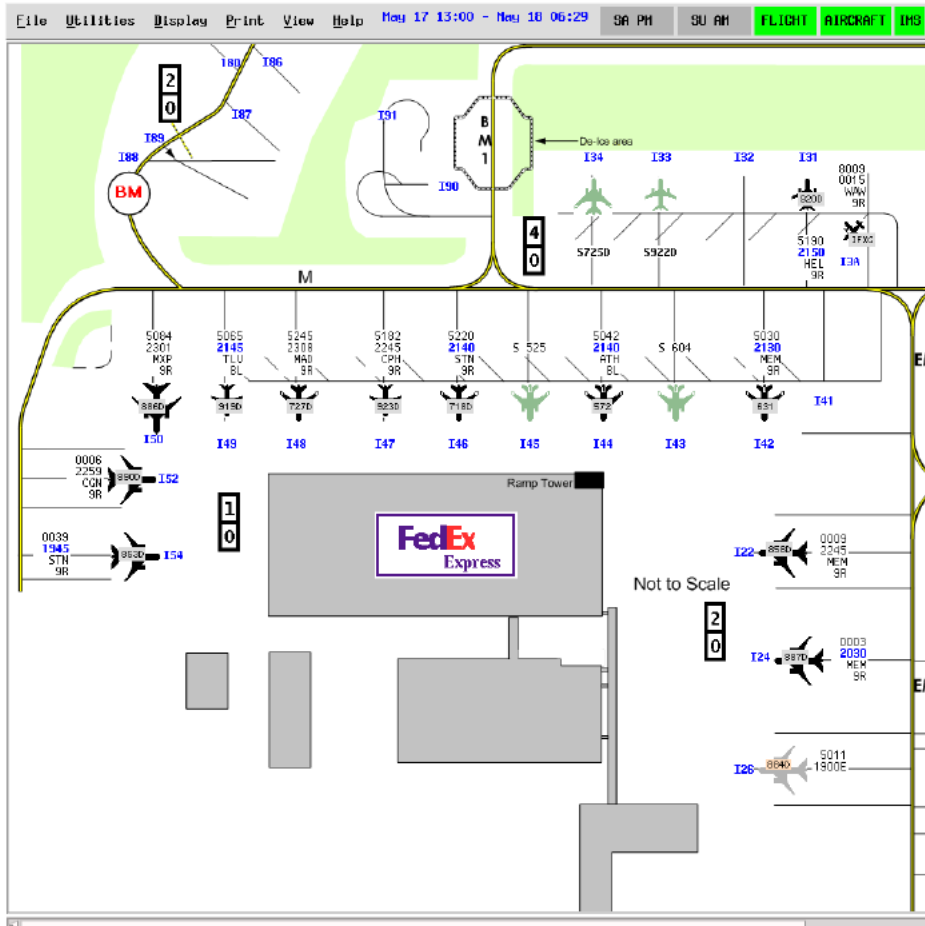
A "TOP" priority button was added to the priority dropdown list of the "Assign Flight Info" window.

If a NOC specialist needs to prioritize a sensitive flight, the request is passed to Ramp Tower and the RTO controller will just assign the concerned flight a TOP priority in his/her RMAS interface.

Clicking the "Update" button will then trigger a Prioritize request, sent to SARIA via CPDS message format.

If accepted by PDS system, the flight will automatically shift to the top of the FDX pre-departure sequence, taking the earliest RefTime available among the list of FDX flights that aren't radar activated yet (i.e. flights with no ATC start-up clearance).

Metron preparation

The HMI of the mobile application was updated to provide the additional functionality provided as part of this exercise. Since multiple flights could be selected and re-ordered, it was felt that highlighting various rows on potentially separate pages would not be intuitive to the user. Therefore, a new column with a check box was added. The rows with a check in this column represent the selected rows.

Then, to reuse the common interface, it was decided to enable functionality based on the number of flights were selected. If no flights were selected, then the user can only view the flights and their flight event times. If a single flight was selected, then that flight could be "Prioritized". As shown in the figure, selecting a single flight enables the "Prioritize" button. When pressed, the prioritize command is sent to the server to elevate the relative priority of this flight. The status line at the bottom of the window will be updated to state that the response to the command is pending from the server. When the response is received the status line is updated, and the status window will contain the response from the server.

If 2 or more flights were selected, then the action button on the bottom becomes "Reorder". After the user has selected the flights which they want to reorder, the "Reorder" button can be pressed. This action will take the selected flights, and place them in a new window displayed to the user. Until the order of the selected flights is changed, then Cancel is the only available option. Cancel will take the user back to the previous screen without submitting the Reorder command.

The user would then manipulate the order of the flights by selecting a flight (touch the screen on the flight and holding it there until selected) and then dragging it and dropping it into the preferred order on the screen. When the flights are in the desired order, the user hits the submit button at the bottom of the screen. This sends the Reorder command to the server. Similar to the Prioritize command, the user is returned to the flight list screen and the status line at the bottom of the window will be updated to state that the response to the command is pending from the server. When the response is received the status line is updated, and the status window will contain the response from the server.
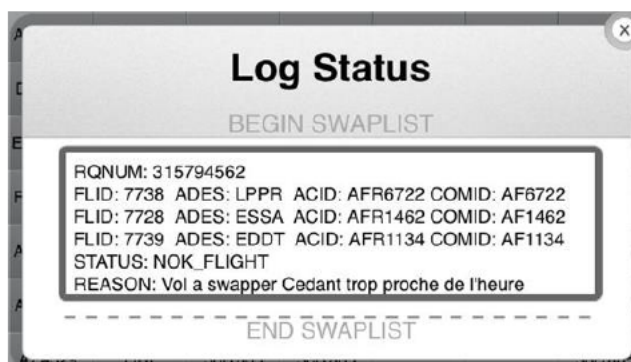
6.2.2.2 Exercise execution

Air France:

During the scheduled period of new DFlex activation (from Dec 2nd to Apr 30th), AF had the opportunity to evaluate all the demonstration scenarios: reorder flights in nominal situation, reorder flights in adverse situations, and prioritize flights. We also observed the automatic execution of the cancellation function.

The DFlex requests were performed by operational staff (OCC and Hub), on their work stations, assisted by a DFlex expert only for the beginning.

A test of reorder between 2 airlines has been made (Delta and Air France), it is technically working. It is a possibility offered to several airlines with little traffic in CDG to conclude agreements together to use DFlex

The new Metron HMI was tested successfully.

FedEx:

A small group of specialists and managers (6 people) were specifically briefed and trained, so that at least one person able to use DFlex or to explain its use to his/her colleagues was on shift 24/7 and could perform some trials when required/possible.

The introduction of the Prioritization feature allowed staff less expert in A-CDM processes to perform some trials and see their results, which helped to vulgarize and promote the use of DFlex within the department.

Like for the first set of trials, all DFlex actions were performed at night time (0330-0500LT) as this is the typical constrained period for FedEx with demand exceeding offered runway capacity, i.e. A-CDM delays on some flights for the sake of departure queue management.

DSNA:

The new functions were activated from Dec 2nd. Because of the great confidence in the system we decided to activate these functions once for all, and inform all the parties of this fact.

6.2.2.3 Deviation from the planned activities

There was no deviation from the planned activities

6.2.3 Exercise Results

6.2.3.1 Summary of Exercise Results

AF analysis

During the first exercise, we realized that the new feature is difficult to use and that it introduces a substantial additional workload for FOC staff.

One of the conclusions of the use of the reorder function (possible during the first exercise and after) was the need of a dedicated person to use the DFlex tool in the case of adverse conditions day.

This dedicated person in the FOC staff is really justified since coordination between all the FOC persons in charge of different sectors is very important. Moreover, the CDQA in charge of DFlex has a global understanding of the situation

The second exercise allowed us to really try and define precisely the process and strategy for the use of DFlex, procedures were defined and communicated to the FOC staff. We decided to avoid the use of DFlex for flights with CTOTs since we cannot simulate the impact of a new TSAT on these types of flights.

For some days during this second exercise, a FOC staff person was dedicated to optimize the pre departure sequence by using DFlex functionalities.

In March, there was a day which allowed us to further define the process and highlight to the FOC staff some actions to avoid.

The automatic cancellation function was observed several times. We have realized that this function was not properly designed since it only applies when flights are cancelled within the 3 hours preceding the departure. For now this function is not very useful since we always try to avoid cancelling flights at the last moment. Even in the cases where we have to cancel a flight at the last minute (occurring generally due to technical reasons upon departure) , there is no real benefits for the flights which inherit of the priorities of cancelled flights since most of them are gone already.

FedEx analysis

The second exercise allowed further vulgarizing and promoting the use of DFlex within the NOC department. Introduction of the Prioritization feature allowed some staff not expert in A-CDM processes to perform some trials and observe their results:

- 13 flights were subject of a Prioritization, which allowed to reduce their global A-CDM delay from 219min to 63min (-71%), and the average delay per flight from 17min to 5min.
- 16 flights were subject of a Reordering, which allowed to reduce their global A-CDM delay from 200min to 80min (-60%), and the average delay per flight from 12.5min to 5min.
- On total 29 flights prioritized with DFlex during the second set of trials, the average delay per flight decreased from 15min to 5min, and their global A-CDM delay from 419min to 143min (-66%).

- 11 flights that had an initial delay of 5min and above could depart early or on time after a DFlex action (38% of targeted flights)

The results confirmed the observations made during the first exercise and the added value of DFlex in an A-CDM environment, allowing to achieve punctuality on some sensitive flights where this shouldn't have been possible without DFlex.

However, it also confirmed the fact that DFlex is not an easy process and is time consuming (for the Reordering request at least). Even though the FedEx volume at night isn't huge (30 departures scheduled in a 65min timeframe), its structure is pretty dense and the lack of decision support tool implies an additional workload for the OCC staff.

It can explain why less DFlex actions were performed during the second exercise (DFlex used only during 19 nights out of 95 possible for the period of trials), as it was held mainly during winter period which is a pretty busy period for OCCs (more traffic, and more potentially hectic operations due to weather constraints).

Also a number of DFlex actions couldn't be performed due to external reasons linked to ATC not strictly following A-CDM procedures at night : a flight isn't eligible to DFlex as soon as it is ATC activated (start-up approval), which normally shall occur at TSAT-5min. But we could observe in many occasions that some flights were activated by ATC well before that (e.g. TSAT-20min), which results in a frozen TSAT and in the impossibility for NOC staff to perform some DFlex actions that had been identified, It reminds us that A-CDM is a collaborative process that works properly only if all stakeholders do play the game.

ADP analysis

Global analysis is provided in chapter 5.

This global analysis provided by ADP takes into account all the DFlex actions that have been done from the 26/03/2013 to the 10/04/2014. Because of a technical problem on the ADP Information System, there are no data available for the 28/11/2013, 29/11/2013 and 30/11/2013. The results are given for two types of flights: flights directly involved in a DFlex action and flights impacted by flights associated to a DFlex action. The figures are given in chapter 5.

During the second trial we have studied how DFlex actions can impact flights not directly associated to DFlex action. 98% of potentially impacted flights are not impacted; there is no change of TSAT. So operational actions (TOBT update in case of "airline" delays) have more impact on the Pre Departure Sequence than DFlex actions.

Details of an analysis: REORDER action at 09h45'39 the 30/01/2014

Before Dflex				After Dflex					
numatc	TTOT	ETOT	HREF	gainTTOT	gainTSAT	numatc	TTOT	ETOT	HREF
AEA1034	10:08:00	10:05	09:25	0	0	AEA1034	10:08:00	10:05	09:25
AFR1742	10:10:30	10:05	09:25	0	0	AFR1742	10:10:30	10:05	09:25
AFR422	10:13:00	10:08	09:40	3300	2400	AFR514	10:13:00	10:13	09:30
AFR121C	10:15:30	10:06	09:45	-150	-210	AFR422	10:15:30	10:08	09:40
AFR976	10:18:00	9:58	09:45	-150	-210	AFR121C	10:18:00	10:06	09:45
AFR690	10:20:30	10:19	09:35	0	-240	AFR690	10:20:30	10:19	09:35
AFR1620	10:23:00	10:04	09:50	-300	-300	AFR976	10:23:00	09:58	09:45
JAT311	10:25:30	10:24	09:15	0	0	JAT311	10:25:30	10:24	09:15
AFR456	10:28:00	10:24	09:30	0	-120	AFR456	10:28:00	10:24	09:30
ETD032	10:30:30	10:19	09:55	-450	-510	AFR1620	10:30:30	10:04	09:50
AFR368	10:33:00	10:26	09:55	-150	-270	ETD032	10:33:00	10:19	09:55
AFR3846	10:35:30	10:15	10:00	-150	-150	AFR368	10:35:30	10:26	09:55
SWR65H	10:38:00	10:15	10:00	-150	-210	AFR3846	10:38:00	10:15	10:00
GFA018	10:40:30	10:22	10:00	-150	-210	SWR65H	10:40:30	10:15	10:00
AF652QI	10:43:00	10:42	09:55	0	-60	AF652QI	10:43:00	10:42	09:55
AFR724	10:45:30	10:29	10:00	-300	-360	GFA018	10:45:30	10:22	10:00
SIA333	10:48:00	10:39	10:00	-150	-210	AFR724	10:48:00	10:29	10:00
AFR192	10:50:30	10:50	09:40	0	-60	AFR192	10:50:30	10:50	09:40
MEA210	10:53:00	10:52	09:30	0	-60	MEA210	10:53:00	10:52	09:30
AFR958	10:55:30	10:12	10:00	-450	-510	SIA333	10:55:30	10:39	10:00
LZB432	10:58:00	10:56	09:20	0	0	LZB432	10:58:00	10:56	09:20
AFR1258	11:00:30	11:00	09:30	300	300	XLF044	11:00:30	10:57	09:40
AFR226	11:03:00	11:03	09:35	0	-60	AFR226	11:03:00	11:03	09:35
XLF044	11:05:30	10:57	09:40	-300	0	AFR1258	11:05:30	11:00	10:00
AFR514	11:08:00	10:13	10:00	-750	-750	AFR958	11:08:00	10:12	10:00
SVA126	11:10:30	10:23	10:10	0	60	SVA126	11:10:30	10:23	10:10
DAH1003	11:13:00	10:18	10:10	0	0	DAH1003	11:13:00	10:18	10:10
CRC101	11:15:30	11:14	09:00	0	0	CRC101	11:15:30	11:14	09:00

Figure 12: detailed analysis of Re-order function

Flight with increase of priority (AFR514):

- Before the REORDER, the TTOT of AFR514 was 11:08:00, eventhough it was ready for a takeoff at 10:13 (ETOT=10:13). The PDS gave it a TTOT=11:08:00 because of the FSFS rule: the other flights before were also candidates for the previous slots but they had a better priority.

- After the REORDER, the HREF of the flight AFR514 is 09:30. The PDS assigned it the slot of 10:13:00 because it was the flight available to that slot with the higher priority (JAT311 had a better priority, 09:15, but it was available to slots superior or equal to 10:24). The flight won 2400 seconds of punctuality at the gate.

Flight with decrease of priority (AFR1258):

- Before the REORDER, the TTOT of AFR1258 was 11:00:30 and it was ready for a takeoff at 11:00 (ETOT=11:00). The PDS gave it a TTOT for 11:00:00 because it was the flight available to that slot with the higher priority (FSFS rule)

- After the REORDER, its HREF decreased and the TTOT of the flight AFR514 was 11:05:30.

Flight impacted (AFR958)

- Flight AFR958 was not associated to a DFlex action

- Before the REORDER, the TTOT of AFR958 was 10:55:30 and it was ready for a takeoff at 10:12 (ETOT=11:00).

- After the REORDER the flight available to the slot of 10:55:30 was SIA333. The SIA has been "pushed" by AFR514. Other flights LZB432, XLF044, AFR226, and AFR1258 were after that available to the same slot as the flight AFR958, but as they had a higher priority so they were planned before by the PDS. The consequence is 750 seconds of delay at the gate for the AFR958.
- Remark: in other cases, the delay of the impacted flights decreased because of the same First Scheduled First Serve mechanism (ex: XLF044).

Example of NMOC impact on a flight associated to a DFlex action : AF1148 on the 30/01/2014 at 05:40:58

- At 05:40:58 : Reference Time (priority) = 2014/01/30 06:20 G --> 2014/01/30 06::15 R (the priority increase)
- At 05:40:59 : TSAT = 30/01/2014 06:51:00 (previous value=30/01/2014 07:21:00)
- At 05:40:59 : TTOT = 30/01/2014 07:03:00 (previous value=30/01/2014 07:33:00)
- At 05:41:29 : PDS system send a DPI TO NMOC
- At 05:41:45 : a SRM message is received from NMOC containing CTOT = 30/01/2014 08:38:00 (previous value =30/01/2014 06:50:00)
- At 05:41:59 : TSAT = 30/01/2014 08:28:30 (previous value=30/01/2014 06:51:00)
- At 05:41:59 : TTOT = 30/01/2014 08:40:30 (previous value=30/01/2014 07:03:00)

In that case, NMOC answers to the TTOT improvement contained in the DPI sent after the DFlex action with a deterioration of the CTOT. The origin of this deterioration seems to be the "Most Penalizing Rule" implemented in the ETFMS. This behavior is not correlated with DFlex as it also occurs when DFlex is not used.

DSNA analysis

As for the first trial, no side effect reported:

- no unusual TSAT behavior
- no unusual number of calls between TWR supervisor and ADP and/or OCCs.

6.2.3.1.1 Results per KPA

AF KPA

Let's detail KPA for the January days of the trials where a person was dedicated to the use of DFlex (this person only used the reorder function)

	AF
Number of evaluation days (with dedicated person using DFlex)	2 disrupted days (Jan 30th : ATC strike Jan 31st : fog)
Number of reordering requests	45 Including 3 rejected
Number of reorderings generating TSAT revision > 5 min	27
Departure punctuality before DFlex actions	38%

Departure punctuality* on prioritized flights	64%
Anticipation* of DFlex action (average)	19 min Max prior TOBT : 104 min Max after TOBT : 18 min
A-CDM delay* before prioritization	764 min (on 41 flights) Span of delays : 0 min to 61 min
A-CDM delay* after prioritization	361 min (on 41 flights) Span of delays : 0 min to 36 min
A-CDM delay improvement*	Span of improvement : -10 min to 40 min

Anticipation of DFlex action	$TOBT_{prioritized\ flight}$ - DFlex request time
* Departure punctuality:	% of flights with (AOBT – SOBT) < 15 min
* A-CDM delay	= TSAT – TOBT on non-regulated flights
	= $TTOT_{T-DPI-s}$ – (TOBT+ Taxi time) on regulated flights
* A-CDM delay before prioritization:	span of A-CDM delays observed on flights that were prioritized, before reordering
* A-CDM delay improvement:	span of A-CDM delays improvement obtained on prioritized flights, after reordering

The delay improvement is appreciated 1 minute after the DFlex action. It cannot be done later otherwise other factors may influence the TSAT (TOBT, change in capacity…).

FDX KPA

For the nights where DFlex was used (during the 0330-0430 LT timeframe on D2345).

	FDX
Number of evaluation nights	19 (out of 95 possible)
Number of Reordering requests	19 accepted 3 rejected
Number of Reordering generating TSAT revision > 5 min	19
Number of Prioritization requests	13 accepted 5 rejected
Number of Prioritization generating TSAT revision > 5 min	13

Departure punctuality before DFlex actions	Pie chart: 5, 4% — 1, 3% — 44, 6% — 48, 7% Legend: EARLY OR ON TIME / 0-5 MIN / 6-15 MIN / 16-29 MIN / 30 MIN AND ABOVE
Departure punctuality on prioritized flights After DFlex actions	Pie chart: 6, 7% — 2, 7% — 33, 8% — 36, 5% — 20, 3% Legend: EARLY OR ON TIME / 0-5 MIN / 6-15 MIN / 16-29 MIN / 30 MIN AND ABOVE
Anticipation* of DFlex action (average)	**-7.6 min** Max prior TOBT : -51min Max after TOBT : 20min
A-CDM delay* before prioritization	**419 min (on 29 flights)** Span of delays : 5 min to 27 min
A-CDM delay after prioritization	**143 min (on 29 flights)** Span of delays : 5 min to 16 min
A-CDM delay improvement*	**276 min (-66%)** Avg delay per flight : 5 min (vs 15 min before prioritization)

Anticipation of DFlex action	$TOBT_{prioritized\ flight}$ - DFlex request time
* Departure punctuality:	% of flights with (AOBT – SOBT) < 15 min
* A-CDM delay	= TSAT – TOBT on non-regulated flights = $TTOT_{T-DPI-s}$ – (TOBT+ Taxi time) on regulated flights
* A-CDM delay before prioritization:	span of A-CDM delays observed on flights that were prioritized, before reordering
* A-CDM delay improvement:	span of A-CDM delays improvement obtained on prioritized flights, after reordering

The delay improvement is appreciated 1 minute after the DFlex action. It cannot be done later otherwise other factors may influence the TSAT (TOBT, change in capacity...).

6.2.3.1.2 Results impacting regulation and standardisation initiatives

CDG being the first airport to successfully give flexibility to its aircraft operators, EUROCONTROL should promote DFlex as an enhancement of the A-CDM process.

6.2.3.1.3 Unexpected Behaviors/Results

There was no unexpected behavior or result.

6.2.3.1.4 Quality of Demonstration Results

The trials were performed on real flights. DFlex features are integrated to the FOC station for AF and to the apron management system for FDX.

6.2.3.1.5 Significance of Demonstration Results

We have a great confidence in the significance of the results since the analysis and monitoring of the DFlex actions were done during more than one year (March 2013 to April 2014). Numerous and different disrupted situations were encountered.

6.2.4 Conclusions and recommendations

6.2.4.1 Conclusions

The second exercise allowed us to really try and define precisely the process and strategy for the use of DFlex, procedures were defined and communicated to the FOC staff. We decided to avoid the use of DFlex for flights with CTOTs since we cannot simulate the impact of a new TSAT on these types of flights.

The results confirmed the observations made during the first exercise and the added value of DFlex in an A-CDM environment, allowing to achieve punctuality on some sensitive flights where this shouldn't have been possible without DFlex.

For some days during this second exercise, a FOC staff person was dedicated to optimize the pre departure sequence by using DFlex functionalities.

The automatic cancellation function was observed several times. We have realized that this function was not properly designed since it only applies when flights are cancelled within the 3 hours preceding the departure. For now this function is not very useful since we always try to avoid cancelling flights at the last moment. Even in the cases where we have to cancel a flight at the last minute (occurring generally due to technical reasons upon departure) , there is no real benefits for the flights which inherit of the priorities of cancelled flights since most of them are gone already.

However, it also confirmed the fact that DFlex is not an easy process and is time consuming (for the Reordering request at least). Even though the FedEx volume at night isn't huge (30 departures scheduled in a 65min timeframe), its structure is pretty dense and the lack of decision support tool implies an additional workload for the OCC staff.

It can explain why less DFlex actions were performed during the second exercise (DFlex used only during 19 nights out of 95 possible for the period of trials), as it was held mainly during winter period which is a pretty busy period for OCCs (more traffic, and more potentially hectic operations due to weather constraints).

Also a number of DFlex actions couldn't be performed due to external reasons linked to ATC not strictly following A-CDM procedures at night : a flight isn't eligible to DFlex as soon as it is ATC activated (start-up approval), which normally shall occur at TSAT-5min. But we could observe in many occasions that some flights were activated by ATC well before that (e.g. TSAT-20min), which results in a frozen TSAT and in the impossibility for NOC staff to perform some DFlex actions that had been identified, It reminds us that A-CDM is a collaborative process that works properly only if all stakeholders do play the game.

CDM partners have already agreed to design again the function "Substitution" in order to encourage airlines to cancel flights as earlier as possible and to allow those airlines to use the priority of the cancelled flight for other flights.

6.2.4.2 Recommendations

Global recommendations are provided in chapter 8.

7 Summary of the Communication Activities

7.1 CDM@CDG monthly meeting: May 16, 2013

DFlex features and the trials performed: by ADP, FedEx and Air France were presented during the CDM@CDG monthly meeting of May 2013 (oral presentation). Any airline operating at CDG can attend this meeting which aims at discussing CDG global performance and new projects.

7.2 Presentation to APP supervisors and TWR supervisors

DFlex features and the trials performed were presented to the APP supervisors and TWR supervisors of CDG (oral presentation during a meeting).

7.3 Publication of an instruction to all Air Traffic Controllers

DFlex features were presented to all Air Traffic Controllers of CDG via the publication of an instruction distributed to all of them

See instruction in Appendix

7.4 Presentation to workshop "DMAN GLD"

DFlex features were presented during a workshop between DSNA, ADP and Air France (oral presentation). The aim of the workshop is to discuss the evolutions of the system constituted of DMAN and GLD (system that handles the departure sequence at CDG)

7.5 Meeting with AOC: June 10, 2013

DFlex features and the trials performed: by ADP, FedEx and Air France were presented during a meeting with all the airlines operating at CDG, meeting held by ADP and DSNA.

Presentation not available in Appendix, was similar to the presentation done for COHOR and DTA

7.6 Meeting with COHOR and DTA: July 4, 2013

DFlex features and the trials performed: by ADP, FedEx and Air France were presented during a special meeting organized with COHOR and DTA

See presentation in Appendix

7.7 EUROCONTROL AU-NET workshop: Sept 4, 2013

It was organized by EUROCONTROL at the experimental Centre.

DFlex demonstrations were performed by ADP, FedEx, METRON and Air France

See pictures in Appendix

7.8 SESAR Forum in Lisbon: November 2013

See the presentation in Appendix

7.9 SESAR France/DSNA forum March 2014

Presentation of DFlex features by DSNA, FedEx and Air France

The presentation was the same as the one made in Lisbon

7.10 Article in SESAR Magazine March 2014

See article in Appendix.

8 Next Steps

8.1 Conclusions

DFlex is considered as a success by all the partners. Flexibility can be given to airlines without impacting operations and capacity and with respecting equity among airlines.

The project was managed through 2 phases in a satisfactory manner. During the first phase in April 2013, the main flexibility function was tested, allowing airlines to swap the priority of 2 flights. Already more than 50 flights were involved, meeting the SESAR JU requirements(minimum 30 flight trials, as defined in the technical specifications of the CFP SJU/MC/0070-CFP). Based on the success of the first trials, it was decided to keep the functions open allowing at demonstrating the DFlex benefits in disrupted situations encountered during the summer 2013. By November 2013, more than 500 flights had been involved.

During the second phase from December 2013 to March 2014, 2 other features were tested: the prioritization of a flight among all the other flights of the airline, and the substitution (use of a departure slot belonging to a flight that the airline had previously cancelled). 1500 additional flights were involved in this second phase only.

Since it has reached its main objective : give flexibility to the airlines in the Pre Departure Sequence while having no impact on safety, ATC operations, airport capacity and equity, the DFlex features are available in the CDG PDS. The DFlex features are now fully integrated in Air France and FedEx systems as well as in the CDM@CDG website. FedEx and Air France and its partners (HOP!, Delta) can take advantage of the benefits of the functionalities on a daily basis.

The functions are to be used by OCC since a global picture of the situation is needed: knowledge of crew duty limits, airport curfews, VIP on board, knock-on effect on system form etc…. If one wants to prioritize a flight, other flights need to be de-prioritized. In Air France and FedEx, only the OCC has the right to de-prioritize a flight.

However, the demonstrations allowed Air France and FedEx to realize that this new feature induced a substantial additional workload for FOC staff, as it demands some focus and decision making in the choice of flights to be reordered. The second exercise allowed Air France to really try and define precisely the process and strategy for the use of DFlex, procedures were defined and communicated to the FOC staff. For some days during this second exercise, a FOC staff person was dedicated to optimize the pre departure sequence by using DFlex functionalities.

The demonstrations also allowed Air France and FedEx to realize that the reordering feature is most of time used in a very tight window prior to the actual departure, almost at the last minute.

The automatic cancellation function was observed several times. It was realized that this function was not properly designed since it only applies when flights are cancelled within the 3 hours preceding the departure. For now this function is not very useful since airlines always try to avoid cancelling flights at the last moment. Even in the cases when we a flight at the last minute (occurring generally due to technical reasons upon departure) has to be cancelled, there is no real benefits for the flights which inherit of the priorities of cancelled flights since most of them are gone already.

CDM partners have already agreed to design again the function "Substitution" in order to encourage airlines to cancel flights as earlier as possible and to allow those airlines to use the priority of the cancelled flight for other flights.

All actions were transparent to ATC, airport and NMOC operations.

It was decided to avoid the use of DFlex for flights with CTOTs since there is no possibility to have a "what-if" function showing the impact of a new TSAT on these types of flights.

Finally, after the end of the 2nd phase, the CDM@CDG steering committee decided to offer the service to all the airlines operating at CDG. By Winter 14/15, other airlines will be able to use DFlex at least via the CDM@CDG website or through a mobile application developed by Metron Aviation.

The use of DFlex options by an airline for which the airport is not a hub or at least is not a significant base, seems complicated. Several reasons can be given: not enough opportunities, not enough staff.

The fact that airlines can group themselves to use DFlex together is an option that could allow this kind of airlines to use DFlex more often.

8.2 Recommendations

Project methodology:

To manage this project the project team decided to have a step approach since it was addressing new concepts.

So on a project and process point of view, the project team strongly recommends striving for simple functions and iterative ways of working, especially when a new concept like flexibility needs to be addressed and evaluated.

First of all, this allows various risks to be dismissed quickly. Moreover operational staff can be more easily involved while experiencing a function on real flights. In addition, if a project releases, rapidly after its launch, a concrete enhancement of a system, operating procedures can be defined efficiently and the new functions can be refined in a second step of the project to better meet the real needs experienced on the field.

Flexibility Concept:

On the concept point of view, since the benefits for airlines are very interesting while being transparent for the ATC operations and other airlines not using the service, the project team recommends to export the concept in other CDM airports.

The need for flexibility is an essential airline requirement but the need is limited in volume; with flexibility on very limited number of flights, aircraft operators get high added value. As DFlex has showed it for more than one year of regular use, this airspace user's need of flexibility should not frighten ATC and does not jeopardize airport performance.

Maturity and suitability for deployment of the 3 DFlex functions:

Both functions "Re-order" and "Prioritize" are considered mature and are actually deployed at CDG.

Regarding the "Substitute" functions, it has to be redesigned in order to encourage airlines to cancel flights as earlier as possible and to allow those airlines to use the priority of the cancelled flight for other flights.

Airline staff workload:

As it has been highlighted during the trials, the DFlex functions require a substantial additional workload for FOC staff. The process and strategy for the use of DFlex needs to be clearly defined and depends on each airline.

Today, there is no business case that supports to have a dedicated FOC staff using DFlex functions on a daily basis, even if for some particular situations, it could be useful to have to optimize the pre departure sequence as it has been demonstrated twice in January 2014.

However, in the near future, airlines could expect to have the same Flexibility facilities for the Arrival Sequence as it will be demonstrated in the i-STREAM Large Scale Demonstration. And once it will be possible to optimize the Arrival and Departure sequences at CDG, since CDG is Air France hub (i.e; Air France operations at CDG are a succession of arrival traffic followed by departure traffic), the Business Case to have a dedicated FOC staff to optimize the arrival sequences and departure sequences alternatively could become positive. This will be investigated through the i-STREAM Large Scale Demonstration.

Airline decision making tool:

Air France developed a decision making tool and demonstrations proved the need to have one due to the high number of flights involved (i.e. potential candidates for re-ordering). On the other side, it will be useless to have one for another airline having only few flights. So it is recommended to implement a decision making tool to optimize the benefit of DFlex, but only for the hub carrier at the airport.

CTOT flights and integration with Network Operational Procedures

It is recommended so far to avoid involving a flight having a CTOT. There is no "what-if" function to see the impact on the Network level. However it is recognized that the Business Case for a "what-if" function might not be positive. The priority should be first to improve the integration of PDS with Network Operational Procedures.

Indeed, Integration of PDS with Network Operational Procedures is doing through the DPI message exchange. However there are still some on-going improvements to be developed through R&D project.

It is recommended to embark in this R&D project the impact of the DFlex functions on the link between PDS and Network Operational Procedures. And it is proposed this R&D activity to be addressed by the UDPP 07.06.02 project.

Dissemination of DFlex at other A-CDM airports

CDG being the first airport to successfully give flexibility to its aircraft operators, we encourage the other airports in Europe, at least the one where a PDS is in place, to include DFlex.

However, it is important to note that airlines gets the maximum benefits of DFlex at CDG since the CDG PDS is based on the "First-Scheduled, First Served" (FSFS) principle. Actually, that was the argument to decide to implement the FSFS principle back in 2009 when the PDS was developed at CDG.

An airport that decided to implement the PDS based on the "First Planned First Served" (FPFS) principle or based on the "Best Planned Firs Served" (BPFS) principle could still implement the DFlex functions but the "Re-order" function will provide less benefit as it could deliver with the FSFS principle.

In addition, the PDS at CDG already includes the departure traffic in the next 3 hours. This is an advantage compared to some PDS developed at other A-CDM airports that only includes the departure traffic in the next 20 minutes. However, as it has been showed for the "Substitute" functions, 3 hours is not enough and it is recommended that the PDS includes actually all the departure traffic of the day of operations.

As a consequence of all of what was written, the project team recommends that EUROCONTROL should promote DFlex as an enhancement of the A-CDM process.

9 References

9.1 Applicable Documents

[1] Airport CDM implementation Manual

[2] Document of specifications of DFLEX (A525_CDM_GLD_DFLEXmsg)

[3] SESAR Demonstration Report Template

9.2 Reference Documents

[4] 7.6.4 Step 1 UDPP OSED

[5] 7.6.4 Step1 UDPP Validation Plan

10 Appendix

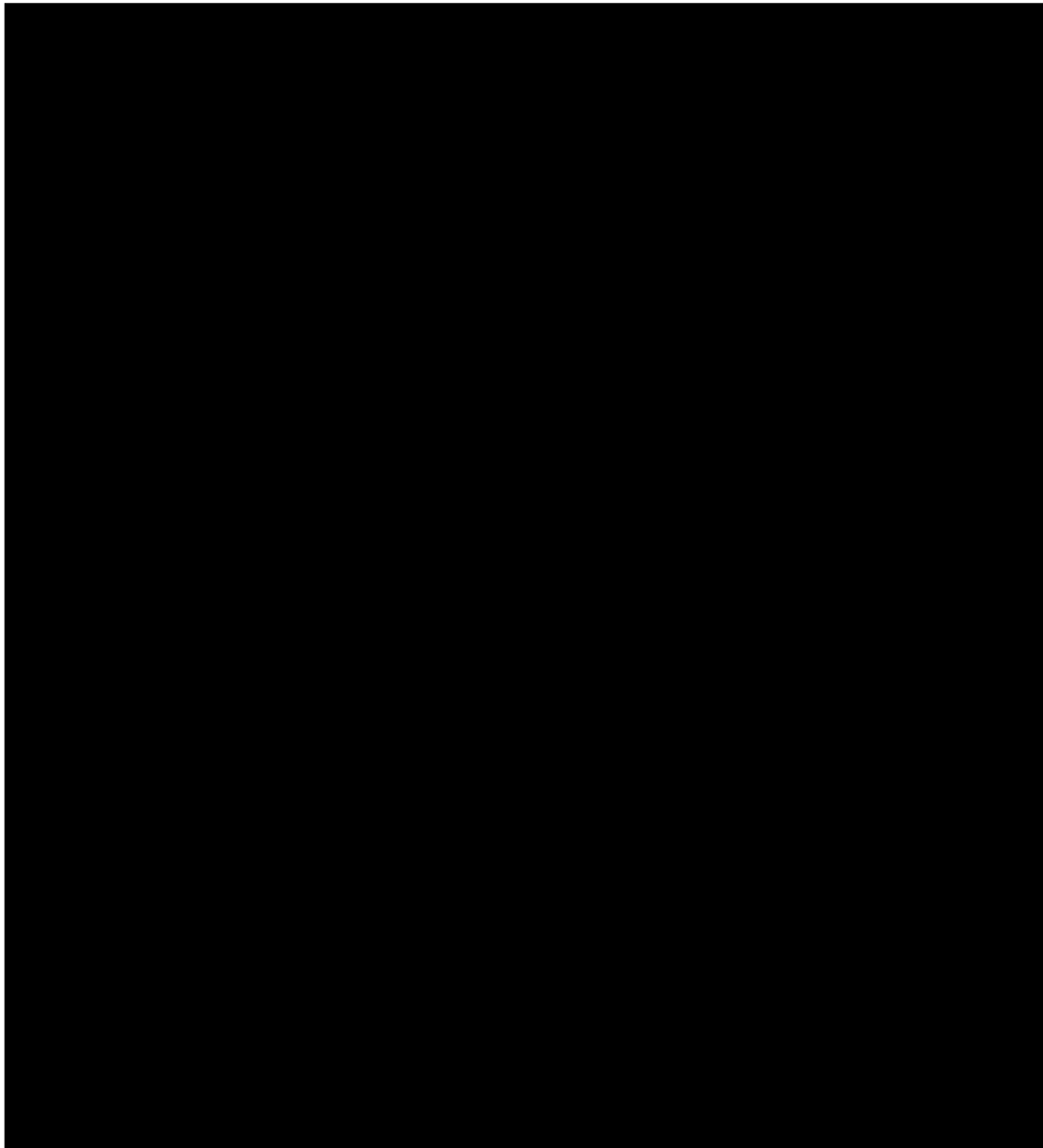## 10.1 Example of indicators produced each month by AF OCC

Won minutes KPI calculated since july 13

Jan 14 : big benefits possible with dedicated person using Dflex during 2 adverse condition days
Mar 14 : non significant benefits since Dflex actions were made too early compared to the departure of flights

10.2 Pictures from EUROCONTROL AU-NET workshop: Sept 4, 2013

10.3 Presentation done at SESAR Forum in Lisbon: November 2013

FROM INNOVATION TO SOLUTION

DFLEX (DEPARTURE FLEXIBILITY)

When Airport CDM becomes a reality!

SESAR
JOINT UNDERTAKING

founding members
EUROPEAN UNION EUROCONTROL

1

Click on the image to read the presentation

10.4 Article in SESAR magazine

SESAR in depth: DFlex

Providing greater flexibility to airspace users on departure

> The objective of DFlex is to provide airlines with greater flexibility to deal with disruptions, which normally lead to departure delays or cancelled flights

Like a dozen other European airports, including Frankfurt and London Heathrow, Paris-Charles de Gaulle (CDG) implements Airport CDM. This means that all actors involved (airport operators, aircraft operators, ANSPs, handlers, Network Manager) work together more efficiently and transparently in a collaborative spirit. DFlex, a SESAR Demonstration Project, co-funded by the SESAR Joint Undertaking, aims to take the Airport CDM concept to another level by introducing a new collaborative pre-departure sequence management system.

Airport CDM allows for the improvement of airport operations with a particular focus on turnaround and pre-departure sequencing processes. It also enhances en-route sector planning. Within this context, each departure flight receives a departure time called a Target Start-up Approval Time (TSAT) on a "first-scheduled, first-served" basis. The DFlex Demonstration Project aims to go one step further by demonstrating enhanced flexibility in the Collaborative Pre-Departure Sequence (C-PDS) process currently in operation at Paris-CDG, allowing flight reordering based on an airline's business requirements.

In other words, the objective of DFlex is to provide airlines with greater flexibility to deal with disruptions,

which normally lead to departure delays or cancelled flights. The first operational improvement is to allow an airline to reorder its departure flights according to its operational or commercial requirements. DFlex also aims to achieve further operational improvements, such as enabling an airline to use a departure slot belonging to a flight that the airline had previously cancelled. Live trials will be performed at Paris-CDG in order to validate this slot substitution. By upgrading the Airport CDM, DFlex will offer airlines the ultimate CDM experience.

Project stakeholders

The three main stakeholders in the project - Aéroports de Paris, Air France and Direction des Services de la Navigation Aérienne (DSNA) - have been joined by: Hop!, Delta Air Lines, FedEx, Eurocontrol, Airbus Prosky/ Metron Aviation. Enlarging the circle of stakeholders involved will:

* Create more opportunities for departure flexibility within a group of airlines (HOP! and Delta Air Lines), and extend the experience to other aircraft operators such as FedEx.

* Ensure that what is developed at Paris-CDG is aligned with the SESAR concept and can be applied at any European airport using CDM, as well as American CDM airports (Delta Air Lines, FedEx, Metron Aviation).

Partnering for smarter aviation | 7

Timeline and planning

The first operational improvement was developed in the first quarter of 2013, with an assessment of commercial flights taking place from April 2013. The second operational improvement was developed in the fourth quarter of 2013, with an assessment of commercial flights taking place from December 2013.

Results

To date, the DFlex trials have not had to deal with any disruptions due to snow or other bad weather conditions. However, they have encountered and handled other types of disruptions that typically lead to departure delays and cancellations. The benefits of the DFlex concept were clearly seen during a number of incidents. For instance, in May 2013 it helped avoid a curfew and more than two hours of delay due to a runway closure, allowing around 30 passengers to make their connecting flight without any further disruptions.

In June 2013, flight delays were halved (11 compared to 20 hours) thanks to DFlex. In addition, around 10 long-haul flights were able to depart on time, while other flights had an initial departure delay of around 80 minutes. In December 2013, departure delays for 40 flights was reduced because the airline was able to use the departure slot of a departing flight that the airline had previously cancelled.

Lessons learned

DFlex is very promising in the case of disruptions, since it reduces the loss of revenue for airlines and mitigates passenger dissatisfaction. The risk of destabilising the departure sequence is very low as the number of DFlex flights at any given time is limited and any DFlex action requires careful analysis from the airline's Operational Control Centre.

Considerations for implementation

The DFlex operational improvements are still under evaluation, but could already be used in operations with commercial flights for the airlines involved in the project.

Other airlines have expressed their interest in using the operational improvements brought about by DFlex. As a result, work is underway to make these operational improvements available to other airlines operating at Paris-CDG. In 2014, the project will further disseminate the benefits of DFlex among aircraft operators and other CDM airports.

For more information about the DFlex project, contact Laurent Renou at larenou@airfrance.fr

Some Air France examples of savings achieved through use of DFlex in disrupted situations (preliminary results)				
Date	Number of reordering	Total delay before reordering	Total delay after reordering	DFlex Benefits
May 28	3	182 min	125 min	31% fewer delays 1 curfew avoided 30 pax made connecting flights
June 11	2	128 min	59 min	54% fewer delays 2 long-haul flights depart on time
June 12	9	1,273 min	541 min	54% fewer delays 3 medium-haul flights cancelled 7 long-haul flights depart on time

10.5 Instruction published to all Air Traffic Controllers in December 2013

MINISTÈRE DE L'ÉCOLOGIE, DU DÉVELOPPEMENT DURABLE,
ET DE L'ENERGIE

Direction générale de l'aviation civile

Direction des services de la Navigation aérienne
Direction des opérations
Services de la Navigation aérienne région parisienne
Organisme Roissy-Le Bourget
Service exploitation
Subdivision Contrôle

Référence : SNA-RP/CDG/SE/2013/COT95/13/EM

Affaire suivie par : Aurore BIBARD
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Tél. : 0174378603 – **Fax :** 0174378619

Roissy, le 3 décembre 2013

CONSIGNE OPERATIONNELLE TEMPORAIRE 95/C/13

A L'ATTENTION DE Tous les CT (mail)
Copies : tous les ICNAs+ SE +
subdivisions Q/I/E/S + Chef de Prog.
CDM, CDG-R (mail)

Objet : Evaluation DFLEX phase 2
Validité : du mardi 3 décembre 2013 au 27 décembre 2013

CONTEXTE

DFLEX permet aux compagnies de prioriser certains vols par rapport à d'autres au sein de leur propre programme. Cette fonction est surtout utilisée en cas de dérives des TSAT.

L'évaluation, qui a commencé en début d'année 2013, s'est avérée positive et de nouvelles fonctionnalités sont offertes aux compagnies à compter du 3 décembre. Les compagnies concernées sont les mêmes que lors de la première évaluation : AFR, RAE et DELTA (=DAL) et FDX

L'algorithme GLD a été modifié (nouvelle version GLD 3.0). Il est en service depuis le 2 décembre.

NOUVELLES FONCTIONNALITES

Echange de priorité (« reorder ») :
Possibilité pour la compagnie de changer les priorités de plusieurs de ses vols.

Priorité :
Possibilité par une compagnie de donner la priorité à un de ses vols (retarde les autres vols de cette compagnie)

Substitution :
Possibilité de garder la priorité d'un vol annulé par la compagnie pour les autres vols de la compagnie. A noter seuls les créneaux des 3-4 prochaines heures sont dans l'horizon de cette fonctionnalité. Par exemple, un vol annulé le matin ne profite pas aux vols de l'après-midi.

Les règles fondamentales telles que : respect du plan de vol, de la SOBT, des CTOT, des TSAT, restent toujours en vigueur.

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