ECRA Demonstration Report

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Abstract

E-CRA proposed to translate SESAR Airport Operations concepts for use in regional size airports. A gaming platform used for SESAR Airport Operations validation was prepared and connected to the Network and Bordeaux Airport data bases. Two collaborative decision making exercises were prepared to demonstrate live the concepts: a runway closure incident and an adverse weather incident. Both scenarios were successfully run. E-CRA demonstrated the benefits of up to date data, common situational awareness and collaborative decision making at regional airports. Furthermore, a predictive "what-if" tool demonstrated the utility of being able to quickly model future demand in supporting the decision making process.

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This deliverable consists of SJU foreground.

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Executive summary

The European-Connected Regional Airport (E-CRA) LSD project proposes to introduce SESAR concepts and technologies within regional medium size airports by demonstrating solutions targeting capacity and cost-effectiveness improvements for the benefits of airspace users, including Business and General Aviation as well as rotorcraft operators.

The E-CRA project incorporated some core elements of the SESAR APOC concept and has demonstrated these elements and their potential benefits in a Regional Airport context to ATM stakeholders. Among the participants, E-CRA gathered airspace users, an Air Navigation Service Provider, Bordeaux airport operator, European Organisations and system manufacturers.

The E-CRA demonstration activities were the opportunity to show through gaming and in a live environment the benefits of Airport and Network solutions derived from SESAR in relation to Airport Operations Management, bridging R&D performed in the SESAR program and future Deployment activities.

E-CRA has produced results to create awareness and to engage operational users in SESAR to continue to identify and overcome technical and operational challenges for a deployment phase.

E-CRA demonstration activities are considered as a Research and Technology innovation tool to pave the way between R&D and deployment, contributing to reducing the time to market for services and systems dealing with medium and small Airport operations management.

The proposed solution consists of an affordable A-CDM system for Regional Airports, upgraded with AOP functionalities.

In summary:

E-CRA demonstrated:

Through 2 Large Scale Demonstration Exercises approved by the air navigation services authorities and Bordeaux airport stakeholders:

- **An exercise illustrating the collaborative management of meteorological adverse or disruptive runway conditions under nominal or exceptional traffic;**
- **A live trial illustrating the management of a runway disruption (runway closure) on the airport;**

that Bordeaux Airport stakeholders, and more generally a large range of Regional Airports stakeholders, can achieve the necessary optimized services through collaborative decision making that bring benefits to operations and efficiency, from SESAR solutions and results.

E-CRA has demonstrated the benefits of up to date data, common situational awareness and collaborative decision making at regional airports. Furthermore, a predictive “what-if” tool demonstrated the utility of being able to quickly model future demand in supporting the collaborative decision making process (see §8.1 to direct access to conclusions).

1 Introduction

1.1 Purpose of the document

This document is the **Demonstration Report for E-CRA** (European Connected Regional Airport) project. This report explains how the demonstrations have been organised, executed and describes the obtained results.

This document presents:

- The deviations from the Demonstration Plan,
- How the demonstrations have been organised,
- The features of each exercise,
- Obtained results,
- Conclusions and recommendations from E-CRA Demonstrations.

1.2 Intended readership

The intended audience of this document is the SESAR JU (SESAR Operational Focus Area – OFA 05.01.01) and the E-CRA consortium members and also others airspace users, Air Navigation Service Providers, and medium size airports operators and system manufacturers.

1.3 Structure of the document

The document will present the project describing the preparation, execution results analysis, reporting and finally conclusions and recommendations.

1.4 Glossary of terms

Term	Definition
Airport Operations Plan (AOP)	The Airport Operations Plan (AOP) is a single, common and collaboratively agreed rolling plan available to all airport stakeholders whose purpose is to provide common situational awareness and to form the basis upon which stakeholder decisions relating to process optimisation can be made. *(Extract from the European Commission regulation n°716/2014)* http://www.eurocontrol.int/lexicon/lexicon/en/index.php/Airport_Operations_Plan
Airport Transit View (ATV)	The ATV is composed of series of timestamps, updated in real-time, which represents the visit of an aircraft to the airport. The ATV is therefore both a historical and predicted timeline starting with the aircraft in the approach phase and finishing after the aircraft has departed the airport. The ATV is also the principal means by which the integration of airports into the overall ATM network will be achieved through the sharing of relevant timestamps between the network (NOP) and the airport (AOP). https://www.eurocontrol.int/lexicon/lexicon/en/index.php/Airport_Transit_View
Gaming	Gaming techniques involve exploration of real life situations where two or more parties must interact with a choice of action in order to meet their objectives. Players are assigned roles, employing the aims, motivations and doctrine that are expected of the role. Gaming can be played in real time or in rounds (where players' actions are carried out simultaneously). Gaming may be performed with little more than some players, a simple scenario and rule set, and recording medium, although an automated gaming facility may help increase realism.
Scenario	In the current context, a scenario is developed for the purposes of undertaking demonstration activities and to gather evidence relevant to the demonstration objectives. It is used to analyse the performance and interactions described or expected in the operational concept scenarios. It is necessarily derived from, and compatible with, the operational concept but is designed to focus on aspects of system behaviour which are of interest or concern and lie at the heart of the design of demonstration exercises.

1.5 Acronyms and Terminology

Term	Definition
A-CDM	Airport Collaborative Decision Making
ADBM	Aéroport De Bordeaux Mérignac
A-DPI	ATC - Departure Information
Airbus D&S	Airbus Defence and Space (Former name for Airbus Safran Launchers)
ALDT	Actual Landing Time
ANSP	Air Navigation Service Provider
AODB	Airport Operational Database
AOP	Airport Operations Plan
APOC	Airport Planning Operations Centre
ATHOS	Advanced TecHnology for Operational Supervision (SW provided by Airbus Safran Launchers)
ATC	Air Traffic Control
ATM	Air Traffic Management
ATOT	Actual Take Off Time
ATS	Air Traffic Service
BOD	Bordeaux
CAST	Comprehensive Airport Simulation Technology (SW provided by ARC GmbH)
CEF	Connecting Europe Facility
CDM	Collaborative Decision Making
DPI	Departure Information
DSNA	Direction des Services de la Navigation Aérienne (French ANSP)
E-CRA	European Connected Regional Airport
ELDT	Estimated Landing Time
ENAC	Ecole Nationale de l'Aviation Civile
ETOT	Estimated Take Off Time
EUROCONTROL	European Organisation for the Safety of Air Navigation
FOC	Flight Operations Centre
FUM	Flight Update Message
GH	Ground Handling
HMI	Human-Machine Interface
KPI	Key Performance Indicator
LSD	Large Scale Demonstration
LVP	Low Visibility Procedures
LVTO	Low Visibility Take-Off
METAR	Meteorological Aerodrome Report
MTTT	Minimum Turn-round Time
NMOC	Network Manager Operations Centre
NOP	Network Operations Portal
OFA	Operational Focus Areas
OSED	Operational Service and Environment Definition
RA-CDM	Regional Airport CDM
R&D	Research and Development
SESAR	Single European Sky ATM Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU	SESAR Joint Undertaking
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SDD	Scenario Description Document
SRD	System Requirement Document
SWIM	System Wide Information Management
TAF	Terminal Aerodrome Forecast
TAM	Total Airport Management
TOBT	Target Off-Block Time

Term	Definition
TSAT	Target Start up Approval Time
UDPP	User Driven Prioritisation Process
VLD	SESAR Very Large Demonstration

2 Context of the Demonstrations

The European-Connected Regional Airport (E-CRA) LSD project was proposed to introduce SESAR collaborative Airport concepts to regional airports by demonstrating the benefits of such adapted organisations, processes and solutions.

E-CRA Demonstrations took place in Bordeaux-Mérignac environment (simulated for gaming exercises) in active shadow-mode to real operations for live trials exercises.

The scope of the demonstration covers OFA05.01.01 Airport Operations Management concepts which are the key reference for the E-CRA project (Chapter 2.1 of E-CRA Demonstration Plan [1]). References were taken from A-CDM and Advanced Tower concepts already deployed in Europe.

E-CRA proposed to demonstrate the complementarity and applicability of the SESAR Airport Operations Centre (APOC) in the context of Regional Airports to show the strategic planning and tactical potential of information sharing and collaborative processes.

E-CRA addressed **SESAR Solution 21**: Airport Operations Plan and AOP-NOP Seamless Integration. This solution targets integration of airports into ATM (AOP-NOP Integration) through Monitoring of Airport Transit View and Collaborative Airport Performance Management.

In this context, E-CRA ensured data shared between AOP and NOP and successfully addressed two activities which were monitoring airport performance (adverse events – weather and runway closure) and managing airport performance (taking action to mitigate impact of the adverse events).

E-CRA also targeted **Solution 61**: CWP Airport - Low Cost and Simple Departure Data Entry Panel. This covers the use of a simple Airport Departure Data Entry Panel (ADDEP) improves the integration of small regional airports by providing a low-cost solution to compute and share aircraft electronic pre-departure data to the ATM network, between the tower and approach controllers, as well as the tower and the Network Manager. Whilst E-CRA goes much further with CDM, an underlying principle was a low cost approach. This was not addressed by the project and should be part of future work.

Demonstrations were structured on training and familiarisation activities in phase one (EXE-0201-001), live trials in phase two (EXE-0201-002) and closed on a reoriented gaming exercise covering management of bad weather operations in phase three (EXE-0201-003 which is a deviation from the Demonstration Plan due to the lack of bad weather at the airport during the demonstration period).

A summary of the exercises can be found below.

Demonstration Exercise ID and Title	**EXE-0201-001: Gaming demonstrations illustrating fog and runway maintenance events**
Leading organization	DSNA Services
Demonstration exercise objectives	• OBJ-0201-001 to OBJ-0201-004 (see §4) • Live Trials preparation (EXE-0201-002/003)
OFA addressed	OFA 05.01.01 Airport Operations Management
Applicable Operational Context	Gaming demonstration activities were based on a Bordeaux-Mérignac airport simulated environment. This was used to train and familiarise staff planned to participate in the trials. The gaming exercises simulated a typical operational day (June 2014 23rd) The exercises involved staff from the Airport Operator, Airlines, other Airspace Users and ATC.
Demonstration Technique	Gaming using a simulated Bordeaux airport APOC
Number of trials	Training and familiarisation over two days

Table 1: EXE-0201-001 summary description

Demonstration Exercise ID and Title	EXE-0201-002: Live demonstrations illustrating runway maintenance event after an A380 take-off
Leading organization	DSNA Services
Demonstration exercise objectives	OBJ-0201-001 to OBJ-0201-004 (see §4)
OFA addressed	OFA 05.01.01 Airport Operations Management
Applicable Operational Context	Live demonstration activities were performed in an active shadow mode at Bordeaux-Mérignac airport. The scenarios demonstrated in EXE-0201-002 covered: • Airport operations management after the occurrence of a short term disruptive event, e.g. a runway inspection and sweeping after take-off of an A380, and • Collaborative airport operations management between local airport stakeholders. The live demonstration involved the Airport Operator, Airlines and Airspace Users, ATC and the Network Manager (through B2B Web Services connection for Flight Update Messages).
Demonstration Technique	Live Demonstration
Number of trials	EXE-0201-002 – 4 demonstrations were executed

Table 2: EXE-0201-002 summary description

Demonstration Exercise ID and Title	EXE-0201-003: Live demonstrations illustrating the airport operations under adverse meteorological conditions (activation of METEO Alert)
Leading organization	DSNA Services
Demonstration exercise objectives	OBJ-0201-001 to OBJ-0201-004 (see§4)
OFA addressed	OFA 05.01.01 Airport Operations Management
Applicable Operational Context	Due to the lack of bad weather this demonstration was transformed into gaming exercises. EXE-0201-003 covered: • Activation of a “MET Alert Cell”, • Airport operations under meteorological adverse conditions (fog and storm), • Collaborative airport operations management between local airport stakeholders. Gaming involved the Airport Operator, Airlines and Airspace Users, ATC.
Demonstration Technique	Gaming
Number of trials	2 gaming exercises were executed (§4.3 deviation)

Table 3: EXE-0201-003 summary description

3 Programme management

3.1 Organisation

The E-CRA consortium consisted of partners representing airport operations, Air Traffic Control, Airlines operations, Research and Development institutions, aviation technology and airframe manufacturers. The list of partners and supporting contractors is in table 4 below.

E-CRA project partners	E-CRA sub-contractors and third parties
– Airbus Safran Launchers (project leader, WP0, WP2 and WP4 leader) – EUROCONTROL, – DSNA (WP3 leader), – FlyOps, – ENAC (WP1 leader).	– ADBM (Aéroport de Bordeaux Mérignac), – ARC Gmbh – AROBAN – HOP! – Isdefe – VELEANE

Table 4: List of Consortium Partners

Further consortium details can be found in E-CRA Demonstration Plan ([1] Chapter 2.2 and 3).

3.2 Work Breakdown Structure

The project was broken down into 5 Work Packages presented in figure 2 below.

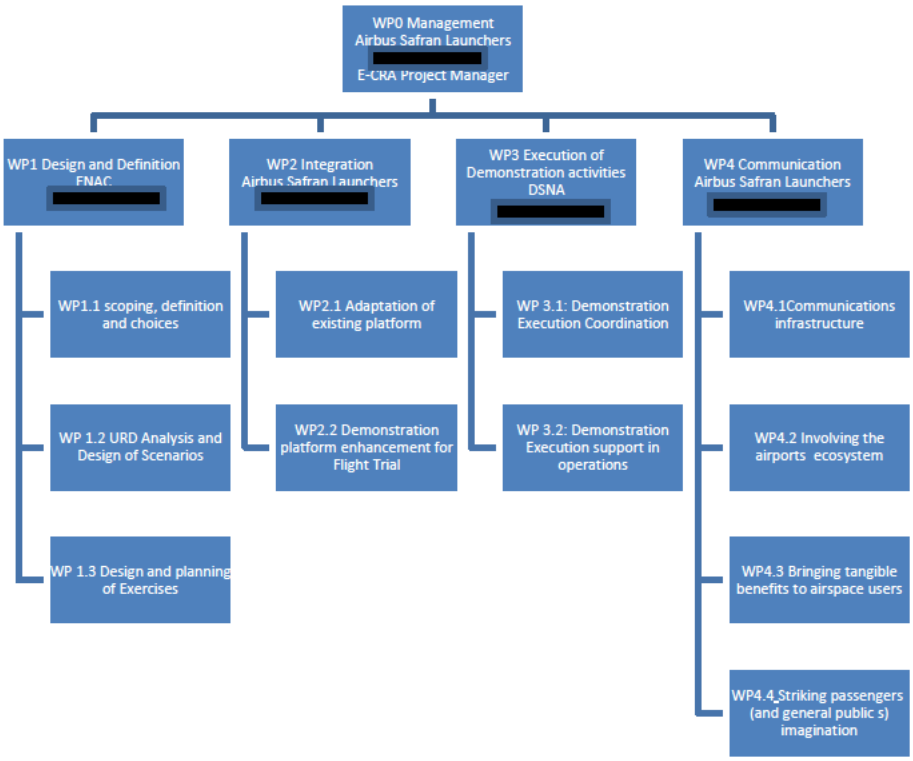


Figure 1: Work Breakdown Structure

A detailed description of the WPs identifying objectives, activities, leadership, key contributors and deliverables is provided in Appendix A.

3.3 Deliverables

The project deliverables include:

- **Demonstration Plan 1st release (24th February 2015):**

  This deliverable marked the end of the project planning phase and was the basis for the SJU go/no-go decision. It contained all elements essential to understand the plan of the project.

  The Demonstration plan highlighted the complementarily aspects with the SESAR programme (in particular SESAR Projects, OFA and prototypes developed/platforms) and was deployment oriented.

  The Demonstration plan also contained the communication plan.

- **Demonstration Plan 2nd release (29th October 2015):**

  Before the 1st trial, the Demonstration Plan was updated to include all elements essential to understand the design of the scenarios including information on procedures, software and hardware.

- **Demonstration Report (30th June 2016):**

  Acceptance from the SJU triggers project closure and the Demonstration report describes the results of demonstration exercises defined in the Demonstration Plan (2nd release) and how they have been achieved.

3.4 Risk Management

A risk plan was developed (Risk log Appendix B) and monitored during the project meetings.

The main risks identified concerned the ability to connect to the airport and network manager data bases and the safety implications of the demonstration i.e. potential impact on live operations.

The connectivity issues were resolved although the Departure Message was not connected to the Network Manager, reducing the ability to assess Network Benefits.

Safety was managed by undertaking demonstrations in a shadow mode approach and ensuring that the operational staff was not required to apply “E-CRA based decision” on real operations.

From a safety and system integrity perspective, none of the E-CRA systems were connected to update the operational systems but were operated in data reception mode only.

4 Execution of Demonstration Exercises

Demonstration objectives defined for E-CRA project are:

- OBJ-0201-001: To evaluate the benefits of a connection to the Network at regional airport level
- OBJ-0201-002: To evaluate the benefits of using alerts mechanisms in case of deviation from the planning of operations
- OBJ-0201-003: To evaluate the benefits of collaborative decision making between airport stakeholders in nominal situation
- OBJ-0201-004: To evaluate the benefits of collaborative decision making between airport stakeholders in adverse or disruptive conditions

See Demonstration Plan Chapter 4.3 for further details.

4.1 Exercises Preparation

An adapted gap analysis using the methodology defined in the European A-CDM Guidance material (see §9–References) was used to assess the current operational situation and data availability at Bordeaux Airport. This was then used to identify the roles and data requirements to be developed for the E-CRA Demonstrations.

Based on this analysis, it was decided to connect the demonstration platform to the Bordeaux Airport Operations Data Base (AODB) for the live demonstration. Moreover, since gaming exercises were planned to train the participants, one day of Bordeaux traffic and operational data (23rd June 2014) was obtained and prepared for use in the Gaming platform.

Since an important objective was the update of flight information, the platform was also connected to the Network manager B2B portal to obtain FUM data. This ensured the demonstration exercises were using the latest flight information.

The gap analysis led to the definition of different roles to be undertaken; once the roles were identified the different monitoring and collaborative processes were developed (see Appendix E and Appendix F). This implied to define what each actor is expected to do during a demonstration from a sequential task perspective.

The Demonstration platform included a “Chat” tool that was used as part of the collaboration between participants. To ensure that this tool was used as optimally as possible, a formal “chat language” was defined (See Appendix E and Appendix F).

Six demonstration scenarios (refer to *Demonstration Plan ([1])* were initially developed; however, these were refined to focus on two main events, a runway closure based on an A380 departure, and a bad weather event.

As a consequence, three exercises (first one used for training) were retained for the demonstration activity:

- EXE-0201-001: Used for Training and Familiarisation
- EXE-0201-002: Runway Maintenance following A380 Departure (Runway Closure)

  (A380 ferry flights back to Dubai following maintenance)
- EXE-0201-003: Adverse Weather Conditions

  (Adverse Meteorological conditions between November and March)

A number of analysis methods were developed to assess the demonstrations.

- Quantitative assessments were defined based on data that could be captured by the Demonstration platform to cover predictability and efficiency objectives (ref CH 5.2).
- Qualitative assessments were prepared through questionnaires and observation checklists (Annex D) to cover human performance objectives (ref CH 5.2).

4.2 Exercises Execution

The Gaming exercises and live demonstrations took place in the first 3 months of 2016.

This began with a 3-day gaming session (EXE-0201-001) to train and familiarise participants to prepare the live demonstrations.

The live demonstrations (EXE-0201-002) involved the runway maintenance scenario for the A380 departure. Four live demonstrations were completed (§6.2 for more details). During these demonstrations other airport stakeholders assisted through their daily operational tasks e.g. ATC staff working in the Bordeaux Tower and airport operations managers in the PC Air (operations control centre).

For the live demonstration EXE-0201-003 covering Adverse Weather Conditions, a "Met Alert Cell" was put in place from the end of January (21/01) until end of March (31/03) to warn the E-CRA team that adverse weather was expected and suitable for live demonstrations.

Unfortunately, no significant weather occurred during this period. Consequently the project team decided to undertake a gaming exercise on March 23rd, to assess the E-CRA Adverse Weather Conditions collaborative processes in a simulated environment.

The following table presents the list of exercises actually undertaken during E-CRA.

Exercise ID	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date
EXE-0201-001	Training	18/01/2016 19/01/2016 20/01/2016	18/01/2016 19/01/2016 20/01/2016
EXE-0201-002	A380	29/01/2016 16/02/2016 04/03/2016 22/03/2016	29/01/2016 16/02/2016 04/03/2016 22/03/2016
EXE-0201-003	Met Alert	23/03/2016	23/03/2016

Table 5: Exercise / Demonstration dates

4.3 Deviations from the planned activities

4.3.1 Local Airspace Management applications

Local Airspace Management applications were initially defined in the Demonstration Plan ([1] §4.1.1) to improve coordination of flights that would operate in shared use airspace. This was not addressed as it was not possible to bring together all the Bordeaux airport actors that were required and to ensure that their operational plans would be available.

Whilst key participants were available for the planned exercises, the original proposal included military and additional airline stakeholders. To have these stakeholders on board proved to be a difficult challenge and finally the exercise went ahead without their direct involvement as project partners.

This was due to the fact that airlines not based in Bordeaux have limited operational presence or outsource to a handling agent whilst their main flight/fleet planning is done at their home base. However, it should be noted that a major Airspace User (Air France/Hop!) participated to the trials as consortium member FlyOps' subcontractor, and that a FlyOps' representative acted as Low Cost and Business aviation actor during the trials.

From the military perspective the challenge was to achieve agreement through military hierarchy and no agreement fitting with project schedule and constraints of the French Army was reached. For future trials involving military actors, it is suggested to anticipate discussion to find an agreement compliant with project's schedule and constraints.

Whilst Dassault Aviation and Military were not directly involved in E-CRA, their aircraft operated normally in the Bordeaux airspace, including an A400M during the 29th January live trial. As an example of traffic operations during the live demonstrations, on the third demonstration, aircraft included the A380, 2 Dassault Business jets, the “Zero Gravity” aircraft, two military helicopter movements, three departures and four inbound aircraft. However, the number of movements was greater as the business jets were testing and undertook a number of runway operations.

Greater participation could have been achieved through a more targeted business approach to these stakeholders earlier on and this should be considered in future demonstrations of this nature.

4.3.2 “What if” assessment tool

A need for a “what-if” tool was identified by E-CRA partners to determine the optimum take off slot for the A380 to minimise the impact on scheduled traffic (EXE-0201-002) and to assess and prepare the traffic recovery plan following a period of adverse weather conditions (EXE-0201-003).

The what-if tool provided a simulation based on the actual airport situation and data at the moment the what-if request is made. It provided predicted flight planning information taking into account deviations and disturbances to the participants for their collaborative assessment and decision making.

This is considered as a positive deviation since the tool was an optional requirement for E-CRA platform, and has nevertheless been developed in time for the demonstration.

4.3.3 Evaluate Collaborative Decision Making in nominal situations

The goal of OBJ-0201-003 was to assess the benefits of collaborative decision making (updated data and collaborative processes) in nominal traffic situation.

This objective was not assessed. Normal traffic operations in Bordeaux as for all airports involve collaborative action between stakeholders e.g. the A380 departure time would normally involve agreement based on discussion around the traffic forecast.

Questionnaires assessing the participants' feedback were implicitly made against the "nominal" situation (participants working experience) and whilst the nominal situation with CDM was not played as part of the live demonstration exercise, it was actually part of all discussions and observations as participants compared their exercises to nominal situations.

The use of updated data required for E-CRA collaborative processes, an important aspect of A-CDM, was assessed in the gap analysis and deviations in the flight plan and estimates used at the airport were detected.

Gap analysis identified issues that an E-CRA deployment would need to consider. Data updated by the FUM from the NOP Portal is impacted if the right runway configuration is not known (FUM will give an estimate when the flight is airborne within 3hrs flying time of ELDT but will be more accurate if the RWY/STAR are correct). Also, radar vectoring or direct routing will change estimates (sometimes significantly) and unless automated monitoring is in place, estimates will not be revised.

For departures the TTOT accuracy was affected by local messages being sent too early which would be fine-tuned during a deployment phase.

From short manual data tests undertaken during the GAP analysis, FUMs generally gave accurate estimates providing the airport with instant awareness of flight Airborne status (AA=ATC Activated). For departures local fine tuning of information streams would ensure that accurate TTOTs could be provided with A-DPIs.

4.3.4 EXE-0201-003 Adverse Weather deviation

This live demonstration was transformed into a gaming exercise because there was no major weather event compliant with exercise EXE-0201-003 needs during the chosen demonstration period. The normal traffic at Bordeaux being not compliant with a LVP, a gaming was considered as the best workaround. Whilst a live demonstration could not be undertaken, the E-CRA project was still able to perform and assess the scenario.

4.3.5 Actor deviation

No Ground Handler role was specifically performed during exercises as planned. However, the ground handling processes were covered by the Airline role as the airline had ground handling related data. Therefore, impact of ground handling activities could still be represented.

4.3.6 Quantitative Indicators deviation

The introduction of a “what-if” tool to optimise the A380 take off plan provided an opportunity to develop new indicators to verify if the E-CRA could improve predictability and help stakeholders to make better decisions (see §5.2–Choice of metrics and indicators). This was a positive deviation bringing increased confidence in the demonstration output on the “what-if” tool.

5 Exercises Results

This chapter provides the summary of the results of the three E-CRA exercises.

5.1 Summary of Exercises Results

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

- OK: the concerned result fully achieved the expectations;
- OK: the concerned result globally achieved the expectations;
- NOK: the success criteria associated to the Validation Objective should be further investigated (output does not achieve expectations or no clear results).

Exercise ID	Demonstration Objective Tittle	Demonstration Objective ID	Success Criterion	Exercise Results	Demonstration Objective Status
EXE-0201-001	Training and familiarisation Exercise				
EXE-0201-002	To evaluate the benefits of a connection to the Network at regional airport level	OBJ-0201-001	• Successful connection to the Network through exchanges of data (mainly reception of FUM). • Positive qualitative assessment from collection of stakeholders' feedbacks. • Increased efficiency, capacity, and predictability.	See §6.2.3	OK OK, from a general tendency OK (for predictability efficiency)
EXE-0201-002	To evaluate the benefits of using alerts mechanisms in case of deviation from the planning of operations	OBJ-0201-002	• Benefits recognized through expert judgment based upon collection and analysis of raised alerts. • Increased efficiency, capacity, and predictability.	See §6.2.3	OK, from a general tendency OK (for predictability efficiency)
EXE-0201-002	To evaluate the benefits of collaborative decision making between airport stakeholders in nominal situation	OBJ-0201-003	• Positive qualitative assessment from collection of stakeholders' feedbacks, • Benefits recognized through expert judgment based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.	See §6.2.3	NOK (not assessed) NOK (not assessed) NOK (not assessed)
EXE-0201-002	To evaluate the benefits of collaborative decision making between airport stakeholders in adverse or disrupted conditions	OBJ-0201-004	• Positive qualitative assessment from collection of stakeholders' feedback, • Benefits recognized through expert judgment	See §6.2.3	OK OK

Exercise ID	Demonstration Objective Tittle	Demonstration Objective ID	Success Criterion	Exercise Results	Demonstration Objective Status
			based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.		 OK (for predictability efficiency)
EXE-0201-003	To evaluate the benefits of a connection to the Network at regional airport level	OBJ-0201-001	• Successful connection to the Network through exchanges of data (mainly reception of FUM). • Positive qualitative assessment from collection of stakeholders' feedbacks. • Increased efficiency, capacity, and predictability.	See §6.3.3	OK (assumed simulated connection) OK, from a general tendency OK (for predictability efficiency)
EXE-0201-003	To evaluate the benefits of using alerts mechanisms in case of deviation from the planning of operations	OBJ-0201-002	• Benefits recognized through expert judgment based upon collection and analysis of raised alerts. • Increased efficiency, capacity, and predictability.	See §6.3.3	- OK, from a general tendency - OK (for predictability efficiency)
EXE-0201-003	To evaluate the benefits of collaborative decision making between airport stakeholders in nominal situation	OBJ-0201-003	• Positive qualitative assessment from collection of stakeholders' feedback, • Benefits recognized through expert judgment based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.	See §6.3.3	NOK (not assessed) NOK (not assessed) NOK (not assessed)
EXE-0201-003	To evaluate the benefits of collaborative decision making between airport stakeholders in adverse or disrupted conditions	OBJ-0201-004	• Positive qualitative assessment from collection of stakeholders' feedbacks, • Benefits recognized through expert judgment based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.	See §6.3.3	OK OK OK (for predictability efficiency)

Table 6: Summary of Demonstration Exercises Results

5.2 Choice of metrics and indicators

Performance assessment in the E-CRA project relies on qualitative methods with selected quantitative methods.

5.2.1 Quantitative metrics

Exercises executed in the context of the Demonstrations were measured to support post exercise comparison between reference data when available and the solution exercise to assess possible benefits in terms of efficiency, capacity, and predictability.

The introduction of a "what-if" tool to optimise the A380 take off plan provided an opportunity to develop new indicators such as the Δ and KPI' (defined below) to verify if the E-CRA concept could improve predictability and help stakeholders to make better decisions.

The new indicators are in bold below:

$$KPI_L = ALDT - ELDT \qquad KPI_{TO} = ATOT - ETOT$$
$$\boldsymbol{\Delta_L = ELDT - ELDT'} \qquad \boldsymbol{\Delta_{TO} = ETOT - ETOT'}$$
$$\boldsymbol{KPI'_L = ALDT - ELDT'} \qquad \boldsymbol{KPI'_{TO} = ATOT - ETOT'}$$

L means *landing* and TO *take off*. The data with prime (') are related to the "what-if" output.

The goal of the original indicators assessment was to observe if an improved KPI_L and KPI_{TO} (a more accurate ELDT closer to ALDT and ETOT closer to ATOT, respectively) could be achieved during the live demonstrations due to the benefits of a connection to the Network at regional airport level.

The new indicators, Δ_i represents the difference between actual data and the "what-if" predictions (a trustworthy test), and KPI'_i is the indicator calculated based on the assumption that the "what-if" prediction was chosen in the post analysis to assess improvements in predictability.

Hence if $KPI'_L < KPI_L \; and/or \; KPI'_{TO} < KPI_{TO}$ then it can be said that predictability has been improved.

Objective ID	KPA (key SESAR Programme concepts and technical enablers)	Success Criterion / Expected Benefit	Result of the demonstration
OBJ-0201-001	Predictability Efficiency	• An accurate ELDT closer to ALDT. • An accurate ETOT closer to ATOT	Predictability and efficiency are improved by the FUM and recalculation of milestones
OBJ-0201-002	Predictability Efficiency	Allow GH/AO to trigger an alert after noticing that TOBT (target off-block time) will be different from [EIBT (estimated in block time) + MTTT (minimum turnaround time)] due to an incident.	Alerts were triggered automatically by the platform when TOBT>EIBT+MTTT supporting increased awareness.

Table 7: Quantitative metrics

5.2.2 Qualitative metrics

The table below presents the overall qualitative output obtained for E-CRA Demonstrations:

Objective ID		KPA (key SESAR Programme concepts and technical enablers)	Success Criterion / Expected Benefit	Result of the demonstration
OBJ-0201-003	To evaluate the benefits of collaborative decision making between airport stakeholders in nominal situation	Efficiency Predictability Participation	• Positive qualitative assessment from collection of stakeholders' feedbacks, • Benefits recognised through expert judgment based upon recording and analysis of taken actions and interactions	*This was not assessed since there were no exercises on nominal collaborative decision making (CH 4.3.3)*
OBJ-0201-004	To evaluate the benefits of collaborative decision making between airport stakeholders in adverse or disrupted conditions	Efficiency Predictability Participation	• Positive qualitative assessment from collection of stakeholders' feedbacks, • Benefits recognised through expert judgment based upon recording and analysis of taken actions and interactions	**OK** **OK**

Table 8: Qualitative metrics

5.3 Summary of Assumptions

The assumptions used in E-CRA are listed here and further detailed in Appendix C:

- 001 - Technical limitations
- 002 - Monitored processes
- 003 - Information exchange between stakeholders
- 004 - AOP maintenance
- 005 - AOP contents and access
- 006 - Operations during flight trials

5.3.1 Results per KPA

Note that E-CRA KPA assessment is mainly based on the qualitative feedback from participants so only general tendencies can be considered (§5.3)

Exercise	Object Identifier	Success Criterion	Result of the demonstration
EXE-0201-001	This was a training exercise.		
EXE-0201-002	OBJ-0201-001	•Increased efficiency, capacity, and predictability.	Positive feedback on Increased predictability due to FUM

Exercise	Object Identifier	Success Criterion	Result of the demonstration
	OBJ-0201-002	• Increased efficiency, capacity, and predictability.	Positive feedback on increased predictability and efficiency due to the E-CRA alerts
	OBJ-0201-003	• Benefits recognized through expert judgment based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.	No results (See §4.3 for details)
	OBJ-0201-004	• Benefits recognized through expert judgment based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.	Positive feedback on increased efficiency and predictability
EXE-0201-003	OBJ-0201-001	•Increased efficiency, capacity, and predictability.	Positive feedback on predictability (assumed the network connection was simulated)
	OBJ-0201-002	• Increased efficiency, capacity, and predictability.	Positive feedback on increased predictability and efficiency due to E-CRA alerts.
	OBJ-0201-003	• Benefits recognized through expert judgment based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.	No results (See §4.3 for details)
	OBJ-0201-004	• Benefits recognized through expert judgment based upon recording and analysis of taken actions and interactions, • Increased efficiency, capacity, and predictability.	Positive feedback on increased efficiency and predictability

Table 9: Results per KPA

5.3.2 Impact on Safety and Human Factors

Whilst the live demonstration (EXE-0201-002) focused on a runway application, this was oriented to coordination between stakeholders rather than to a tactically safety critical activity. Also, the trials were undertaken in an active shadow mode. As a consequence, no safety assessment was undertaken.

However, this should be revisited if such a concept leads to deployment when a local safety assessment should be considered.

As the live demonstration reused concepts and platform capability (see §2-Context of Demonstration and §6-Demonstration Exercise Report) to demonstrate situation awareness and collaborative decision making, no detailed design of the interface was available to undertake an interface assessment. However a Human Factors assessment was undertaken to observe the participants working in the conceptual context. This highlighted a potential overload in ATC operator workload in the “chat feature” (new to ATC) and considered that audio alarms could be additionally considered for the alerts (See §9 References, [3] and [4] for details). These issues should be addressed in future development and validation activities.

5.3.3 Description of assessment methodology

Qualitative metrics have been assessed by human factors specialists in collaboration with all E-CRA Consortium partners. Analysis and assessment are based on observations, feedback and remarks made during the various exercises.

Participants were informed before exercises that their activities would be observed and questionnaires would be used to collect their operational feedback. Questionnaires are presented in Appendix D.

During each exercise, each participating operational role/position has been monitored with one or several observers. After each exercise, questionnaires were submitted to the participants and debriefing sessions were organised.

Results were analysed separately for each exercise run and then consolidated to obtain results per exercise.

A Human Factors analysis was undertaken in parallel for both for the gaming and live demonstrations in addition to the E-CRA Demonstration objectives. Detailed results are available in separate documents (See §9 References, [3] and [4] for details).

No assistance was requested from WP16.

5.3.4 Results impacting regulation and standardisation initiatives

The E-CRA demonstration did not include objectives related to regulation and standards. Nevertheless, it is clear that development and deployment should take into account SWIM standards and guidance related to deployment of A-CDM and related APOC application.

Specifically, the milestone approach defined in A-CDM and adapted in the APOC provides key points at which flight data can be updated and analysed for improved decision making. A result of this is the ability to set alert thresholds that warn operators of changes to flight data and supporting a reassessment of plans e.g. gate allocation or in E-CRA, assessment of runway demand to decide best opportunity to close the runway.

Standardisation will be required for stakeholders participating in an E-CRA deployment to ensure data standardisation and availability based on SWIM, NOP (FUM and DPI) and Airport Data base access.

Whilst use of DPI was not fully demonstrated in E-CRA for operational and safety considerations[1]; the FUM connection was made through the NM B2B capability. Airlines and airport stakeholders will need to consider SWIM as the SESAR standard in the future.

More precisely E-CRA used the following services:

- FUM:
  - FlightServices =>FlightManagementService -> Flight List by Aerodrome [B2B/Release **19.0.0**]
- DPI (although no DPIs were sent to NM):
  - FlightServices =>FlightFilingService -> Flight Departure [B2B/Release **19.0.0**]
- AODB => interfaced the airport legacy system provided by the Airport to the platform

[1] DPIs were created but not send to the NOP due to Operational reasons (stakeholders didn't want to impact the "real" situation), and safety considerations (the platform has not been validated against safety requirements, cf. 3.4).

- MET => standard TAF & METAR services, from official aeronautical services provider (NOAA).

A detailed description of the platform used to support the E-CRA demonstrations is provided in sections 6.1.2.1 and 6.2.2.1 where the data and user presentations etc. are described.

Another consideration will be the need to undertake a cyber security risk assessment whilst any SESAR cyber related requirements should be incorporated during development, validation and deployment.

5.4 Analysis of Exercises Results

Table 8 provides a limited assessment of indicators based on qualitative feedback and there is limited quantitative output from the exercises. An analysis of the few indicators (where applicable) can be found in Chapter 6 for each exercise.

As a consequence, no consolidated quantitative and qualitative assessments are available here.

5.5 Confidence in Results of Demonstration Exercises

5.5.1 Quality of Demonstration Exercises Results

The E-CRA platform recorded actions of the participants during the demonstration exercises and a limited data set was analysed and the quality of this data is satisfactory. As the focus was live demonstration, a coherent demonstration plan supported multiple exercises in a repetitive manner.

None of the live demonstrations could be considered similar due to the variability of the live operations e.g. trials aircraft making ad hoc requests. From that perspective the results should be considered from a trend perspective only.

However, the operational variations that occurred did not pose any significant conceptual issues and did not constrain the participants' use of the E-CRA platform which shows a level of robustness.

5.5.2 Significance of Demonstration Exercises Results

As said above, the results should be considered from a trend perspective. The operational environment was reflective of the Bordeaux ATC and Airport Operations perspective necessary to ensure operational realism in a live demonstration.

5.5.3 Conclusions and recommendations

The participants found that the benefits of connection to the Network for updates, alert mechanisms for deviation to plan and collaborative decision making between airport stakeholders in adverse or disrupted conditions in both EXE-0201-002 (A380) and EXE-0201-003 (adverse weather) achieved expectations.

As explained earlier, the benefits of collaborative decision making between airport stakeholders in nominal situation were not assessed.

This is a positive result although not surprising, considering that these concepts are both deployed and bringing significant benefits to 20 major European airports or subject to significant validation in SESAR. It provides confidence in the transferability of the concepts to regional airports.

The trends are supported by the quantitative assessment for predictability and efficiency. Connection to the Network and reception of the FUM data is the main driver for these positive comments. Participants were able to see the difference between the updated and non-updated estimates which on occasion were quite significant (Gap Analysis assessment).

The "participation" assessment was also positive. The availability of information and ability to provide input to an operational planning decision compared to the normal operation clearly drives this outcome.

In conclusion, E-CRA demonstrates the transferability of SESAR collaborative concepts in planning and monitoring airport operations. It has demonstrated the feasibility of using such concepts and shows a positive trend for being connected to the Network, using alerts to warn actors of deviations to plan and being able to share a common situational awareness and collaboratively input into decisions despite not being present in the same physical location.

However, this output was obtained from a limited number of exercises that were subject to the hazards of live operations and a lack of definition of operational concepts directly applicable to regional airports.

Considering this, it is recommended to undertake development and validation on a regional airport TAM concept and complete proving through a VLD.

6 Demonstration Exercises reports

6.1 Demonstration Exercise EXE-0201-001

6.1.1 Exercise Scope

EXE-0201-001 was used to train and familiarise the participants in the sharing of information and collaborative decision making in airport operations management. The exercise used the following operational scenarios:

- SCN-0201-004: A short term disruptive event, e.g. runway maintenance.
- SCN-0201-002: Occurrence of an unexpected disruptive event, e.g. severe fog at the airport.

EXE-0201-001 used **gaming techniques** and was tailored to support the preparation of EXE-0201-002 and EXE-0201-003.

The operational concept being addressed in E-CRA is applicability of the SESAR Airport Operations Centre (APOC) in the context of Regional Airports to show the strategic planning and tactical potential of information sharing and collaborative processes. This also takes account of aspects of A-CDM and Advanced Tower concepts currently deployed or being deployed at over 20 major European Airports.

Specifically, two APOC services were covered:

- Monitor Airport Performance and
- Manage Airport Performance.

The services applied to a runway maintenance event (SCN-0201-004) after an A380 departure, and an adverse weather event (SCN-0201-002) involving low visibility.

For the runway maintenance event collaboration involved agreeing the most appropriate departure time for the A380 aircraft with a minimum impact on scheduled flights. This was achieved through prevision of up to date information on runway demand, the use of a “what-if” tool to assess and define best departure window and a collaborative tool to permit all participants to share the same information and to discuss and agree the most appropriate plan.

For the adverse weather event, a similar approach to information and collaboration was applied as for the runway maintenance event, but with the objective to understand the impact of the weather (airport closure, opening and capacity reduction) and to discuss and agree the recovery strategy, supported by the “what-if” covering which flights would have priority and which flights would be subject to cancelation.

Further operational details for each exercise will presented in the exercise reports below.

Also, further details of the Demonstration Exercise Plan can be found in Chapter 5.1.

6.1.2 Conduct of Demonstration Exercise EXE-0201-001

6.1.2.1 Exercise Preparation

The gaming platform used in EXE-0201-001 (and EXE-0201-002 & 003) is derived from an existing APOC simulation platform provided by Airbus Safran Launchers for EUROCONTROL in the context of project 06.03.01 validation in SESAR). This platform was adapted to connect to the Bordeaux airport operations data and the Network Managers B2B service for FUM.

The platform integrates three main ‘building blocks’:

- The AOP Airport Model, composed of a representation of Bordeaux airport and an air traffic sample derived from Bordeaux air traffic (or live data feed for the live demonstrations),

- ATHOS, the core of the platform[2]. It acts as supervisor and provides the user interface for the stakeholders, as well as general services like data archiving and post-processing. This tool is developed by Airbus Safran Launchers,
- CAST, the simulation kernel required by the simulation platform. This tool is developed by ARC GmbH and embeds the Bordeaux airport model (infrastructures and traffic data).

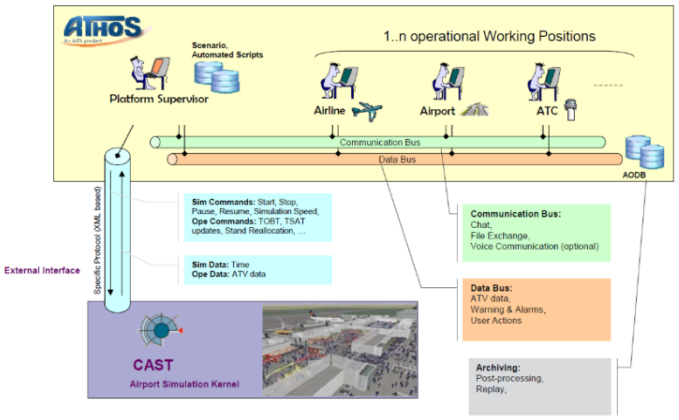


Figure 2: E-CRA Gaming Platform

The airport model fully represents the airport operations and included:

- Arrival sequences,
- Departure procedures (SIDs, taxi and take off sequences),
- Runways configuration (nominal and LVP/LVTO configurations), taking into account separations and occupancy times,
- Aircraft parking stands and associated allocation rules (as defined by Bordeaux airport),
- Pushback procedures, as defined by LFBD AIP,
- An air traffic sample, derived from a typical day of traffic. The chosen reference for the Demonstration exercises is inspired from the traffic handled by the airport on June 23th, 2014.

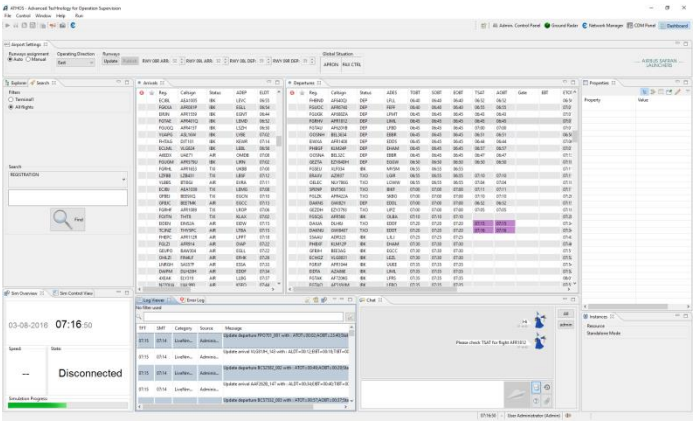


Figure 3: E-CRA Airport Operation Plan View

The HMI supplied to each participant during the Gaming Demonstrations (and live demonstartions) provides the following elements:

- Information related to aircraft arrival, turn round and departure,
- Information about the current situation at the simulated airport for all flights (Airport Transit View - ATV) with associated time stamps and status of each planned flight, and
- Current airport performance monitoring through KPIs, defined in the WP1.3.

Based on the participants decisions in reaction to disruptions, these information were updated in real time during the run of the exercise.

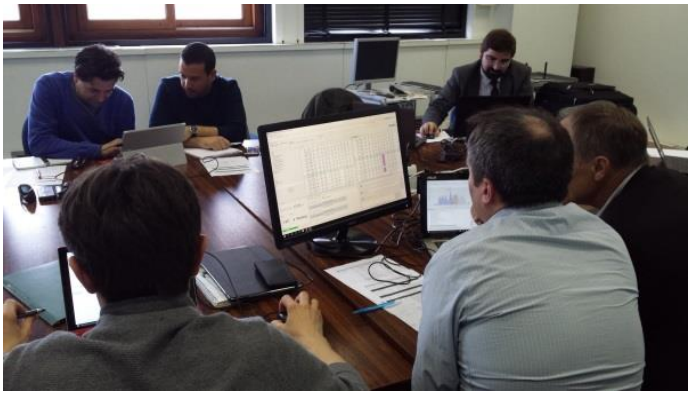


Figure 4: E-CRA "Hub" Control

[2] This platform is not specific to regional airports. For instance, the same platform can be used with the large airports model instead of a regional airport model.

6.1.2.2 Exercise execution

Detailed planning

EXE-0201-001 has been executed between the 18th to the 20th January 2016 in three runs using the adverse weather or runway maintenance event following an A380 departure.

The detailed planning is presented below.

	EXE-0201-001 actual planning		
	SCN: MET event	SCN: RWY maintenance and A380 departure	SCN: RWY maintenance and A380 departure
1. Preparatory activities			
Activity 1.1 Planning	Up to early January 2016	Up to early January 2016	Up to early January 2016
Activity 1.2 Technical preparation	15 January 2016	15 January 2016	15 January 2016
Activity 1.3 Training	18 January 2016 (AM)	18 January 2016 (AM)	18 January 2016 (AM)
2. Execution activities			
Activity 2.1 Exercise initialisation	19 January 2016 (AM)	19 January 2016 (PM)	20 January 2016 (AM)
Activity 2.2 Exercise running	19 January 2016 (AM)	19 January 2016 (PM)	20 January 2016 (AM)
Activity 2.3 Data recording	19 January 2016 (AM)	19 January 2016 (PM)	20 January 2016 (AM)
3. Post-execution activities			
Activity 3.1 Data collection	19 January 2016 (AM)	19 January 2016 (PM)	20 January 2016 (AM)
Activity 3.2 Data analysis	25 January 2016	25 January 2016	25 January 2016
Activity 3.3 Preliminary results analysis	28 March 2016 to 29 April 2016	28 March 2016 to 29 April 2016	28 March 2016 to 29 April 2016

Approach

This exercise was training and preparation for the live demonstrations (EXE-0201-002 and EXE-0201-003). Participants gained familiarity with information sharing and collaborative processes during training. The Operational roles used included:

- Airport Operator,
- Air Traffic Controller,
- Airline Flight Operations Manager, covering a limited perimeter of Ground Handler responsibilities (TOBT updates in the simulation),
- Operational Coordinator.

Reference and solution scenarios

As the Demonstration Platform is designed specifically for collaboration, information updating, information sharing and collaborative processes, it was not possible to undertake a reference scenario.

6.1.2.3 Deviation from the planned activities

Played scenarios

Operational scenarios fully played were:

- SCN-0201-002: Unexpected disruptive event (fog)
- SCN-0201-004: Short term disruptive event (runway maintenance after an A380 departure)

The other scenarios that were proposed in the demonstration plan, i.e. SCN-0201-001 (Nominal Situation) and SCN-0201-005 (Disruptive event under exceptional traffic conditions, e.g. Euro 2016, VinExpo) were not addressed as such due to planning constraints: participants preferred to focus on training for actual forecast live trials' scenarios involving disruptive events (A380 departure). Moreover SCN-0201-001 was partially played as explained in section 4.3.3.

6.1.3 Exercise Results

6.1.3.1 Summary of Exercise Results

As EXE-0201-001 was used for training and preparation of live demonstrations, no qualitative or quantitative assessments were undertaken.

Nevertheless, observations and questionnaires were used and the qualitative opinions regarding exchange of information, alerts relevance and efficiency of the decision process reviewed to ensure no significant issues were detected during the training.

6.1.3.1.1 Results per KPA

Training, not relevant.

6.1.3.1.2 Results impacting regulation and standardisation initiatives

Training, not relevant.

6.1.3.1.3 Unexpected Behaviours/Results

Training, not relevant.

6.1.3.1.4 Quality of Demonstration Results

Training, not relevant.

6.1.3.1.5 Significance of Demonstration Results

Training, not relevant.

6.1.4 Conclusions and recommendations

6.1.4.1 Conclusions

The training and familiarisation exercise was considered useful as the participants agreed on the need to improve the communication between them in real operations. The chat functionality embedded in the demonstration platform was considered to be simple to use and useful, significantly enhancing common situational awareness.

All participants noted an increase in workload when communicating through the chat and considering the constraints of live operations so a chat phraseology mechanism will require refining in order to decrease workload. E.g. The Provision of Automated messages of flight data updates (TSATs, TOBTs, etc.) were not active in the platform and would significantly reduce chat.
After collecting the operational needs, the Athos platform was improved, providing colour changes for TSATs and TOBTs triggered upon values changes, which increased awareness. Nevertheless, such information was available in "message log tab", that few participants checked. This automated "feedback"/"awareness" from colour changes was active for the other exercises.

6.1.4.2 Recommendations

Based on the E-CRA experience, it is recommended that the planned training period before live demonstrations should be extended to at least one week and should cover different scenarios (nominal and non-nominal) to increase the trust and acceptance of the platform.

6.2 Demonstration Exercise EXE-0201-002

6.2.1 Exercise Scope

EXE-0201-002 was a **live demonstration** and addressed the operational scenario:

- SCN-0201-004: Airport operations management after the occurrence of a short term disruptive event, e.g. a runway closure, inspection and sweeping after an A380 departure,

Operational concepts being addressed are the same as EXE-0201-001 (see §6.1.1).

In addition, Bordeaux has a crossing runway configuration meaning both runways are closed following the A380 departure. The priority to inspect the runway intersection and clean it first to ensure one runway is operational as quickly as possible following the A380 departure.

The second runway added an additional dimension for coordination since aircraft could be planned to use this runway thus ensuring continuity of operations.

It should also be noted that the A380 was tugged to the runway and only started up once on the runway. It was parked in the maintenance area which also held Dassault new aircraft that used the same runway for trials as did the ZERO G trials aircraft. This added a level of operational complexity to the collaborative discussion.

Arrival and departure demand together with the ad hoc traffic meant that the what-if assessment had additional aspects to consider of which only the tower was aware and which had to be introduced into the discussion.

Figure 5: A380 tug to runway and Dassault Trial Aircraft

6.2.2 Conduct of Demonstration Exercise EXE-0201-002

6.2.2.1 Exercise Preparation

The demonstration platform used in EXE-0201-002 is as described in §6.1.2.1with connection to the Bordeaux AODB and the Network FUM.

Its configuration **in live demonstration mode** used in the exercise is the following:

For this exercise the A-CDM Cell (1) was located at Bordeaux Technowest (Veleane's premises). It hosted the main platform connected to four data sources to feed the demonstration platform: the NMOC via a B2B connection for the reception of FUMs, Bordeaux airport database, a MET Server and Flight Radar 24 to display aircraft positions in the HMIs.

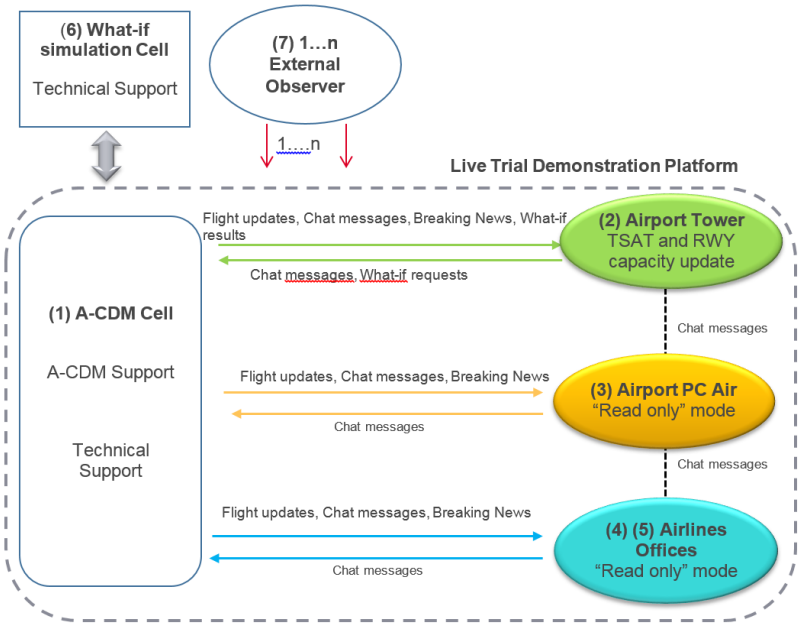


Figure 6: E-CRA platform configuration for EXE-0201-002

The A-CDM Cell was remotely connected to various positions: ATC Tower (2), Airport Operations Management cell (PC Air) (3), Airlines Operations Management cells (4) and (5). These operational roles and the A-CDM Cell could share, update AOP information and communicate via the Chat and Breaking News functionalities through the demonstration platform.

The "E-CRA A-CDM system" embedded in the E-CRA Demonstration platform in live trial mode incorporated the same components as in EXE-0201-001 with an AOP information derived from the direct connection to Bordeaux AODB, and proposed the following:

- An additional "what-if simulation" tool (see §4.3.2 for description),
- A B2B connection with the NMOC for reception of FUM messages and ELDT updates.

6.2.2.2 Exercise execution

Detailed planning

EXE-0201-002 was executed four times. Below is the detailed planning:

EXE-0201-002 planning				
	#1	#2	#3	#4
1. Preparatory activities				
Activity 1.1 Planning	Up to early January 2016	Up to early January 2016	Up to early January 2016	Up to early January 2016
Activity 1.2 Technical preparation	15 January 2016	15 January 2016	15 January 2016	15 January 2016
Activity 1.3 Training	During EXE-0201-001	During EXE-0201-001	During EXE-0201-001	During EXE-0201-001
2. Execution activities				
Activity 2.1 Exercise initialisation	29 January 2016 (AM)	16 February 2016 (AM)	04 March 2016 (AM)	22 March 2016 (AM)
Activity 2.2 Exercise running	29 January 2016 (AM)	16 February 2016 (AM)	04 March 2016 (AM)	22 March 2016 (AM)
Activity 2.3 Data recording	29 January 2016 (AM)	16 February 2016 (AM)	04 March 2016 (AM)	22 March 2016 (AM)
3. Post-execution activities				
Activity 3.1 Data collection	29 January 2016 (PM)	16 February 2016 (PM)	04 March 2016 (PM)	22 March 2016 (PM)
Activity 3.2 Data analysis	01 February 2016	22 February 2016	07 March 2016	28 March 2016
Activity 3.3 Preliminary results analysis	28 March 2016 to 29 April 2016	28 March 2016 to 29 April 2016	28 March 2016 to 29 April 2016	28 March 2016 to 29 April 2016

The Operational roles implemented in this live demonstration were:

- Airport Operator,
- Air Traffic Controller,
- Airline Flight Operations Manager, covering a limited perimeter of the Ground Handler responsibilities (TOBT updates in the simulation),
- Operational Coordinator.

Exercise approach

EXE-0201-002 was refined with the feedback gained during training and this included:

- The provision of a checklist describing the steps to follow during the execution of the live demonstration. This material was made available to the participants during the exercise and helped in its successful execution. See Appendix E for details.
- A common phraseology to be used in the chat for more efficiency and to ensure that all the stakeholders were following the same rules, such as, the use of UTC time or the use of flight callsigns instead of A/C registration (see Appendix E).

The A380 departure followed specific procedures at Bordeaux. The operations process observed in the exercise was as follows:

- Sabena communicates the A380 expected time of departure to the ATC Tower Supervisor.
- When approaching the expected time of A380 departure and if RWY 23 is in use, there is a configuration change to anticipate the A380 departure: RWY 23 is closed and RWY 29 is used for all traffic except A380.
- The A380 takes-off on RWY 23. The effective time of A380 departure is decided by the ATCO on duty, depending on arriving and departing commercial traffic.
- All RWYs are closed for sweeping and inspection.
- Once the runway intersection is clean, RWY 29 is reopened.
- Inspection and sweeping activities are performed on RWY 23.
- Once RWY 23 is clean, there is a configuration change with the reopening of RWY 23.
- Commercial traffic is handled by the ATCO according to the progress of A380 operations.

Operational participants monitored these different steps via the demonstration platform connected to Bordeaux AODB and the NMOC to acquire FUM information. The actors interacted through the chat while sharing the same situational awareness including AOP information and alerts. They were able to propose what-if configurations to consider potential solutions in reaction to the runway maintenance and A380 departure to assess possible impact on commercial traffic.

For the exercise runs #2, #3 and #4, the A380 departure was expected at 12:15 (local time), and the following what-if requests were made:

What if the A380 takes-off at…

#2	#3	#4
12:25	11:25	12:05
12:50	11:35	12:15
	11:45	12:20
	11:50	12:30

Due to the what-if outputs and considering the commercial traffic tendency, operational participants were aware in advance of the potential impact of the A380 departure on their operations.

As a consequence, they were able to discuss and consider an appropriate A380 departure time slot.

Reference and Solution scenario

See E-CRA Demonstration Plan [1] for details.

6.2.2.3 Deviation from the planned activities

SCN-0201-006 (Nominal situation with flight tests and/or military traffic within the airspace) was not observed in EXE-0201-002.

6.2.3 Exercise Results

6.2.3.1 Summary of Exercise Results

A total of 133 flights (amongst them 111 commercial and 3 military) were involved during the 4 live trials included in this exercise.

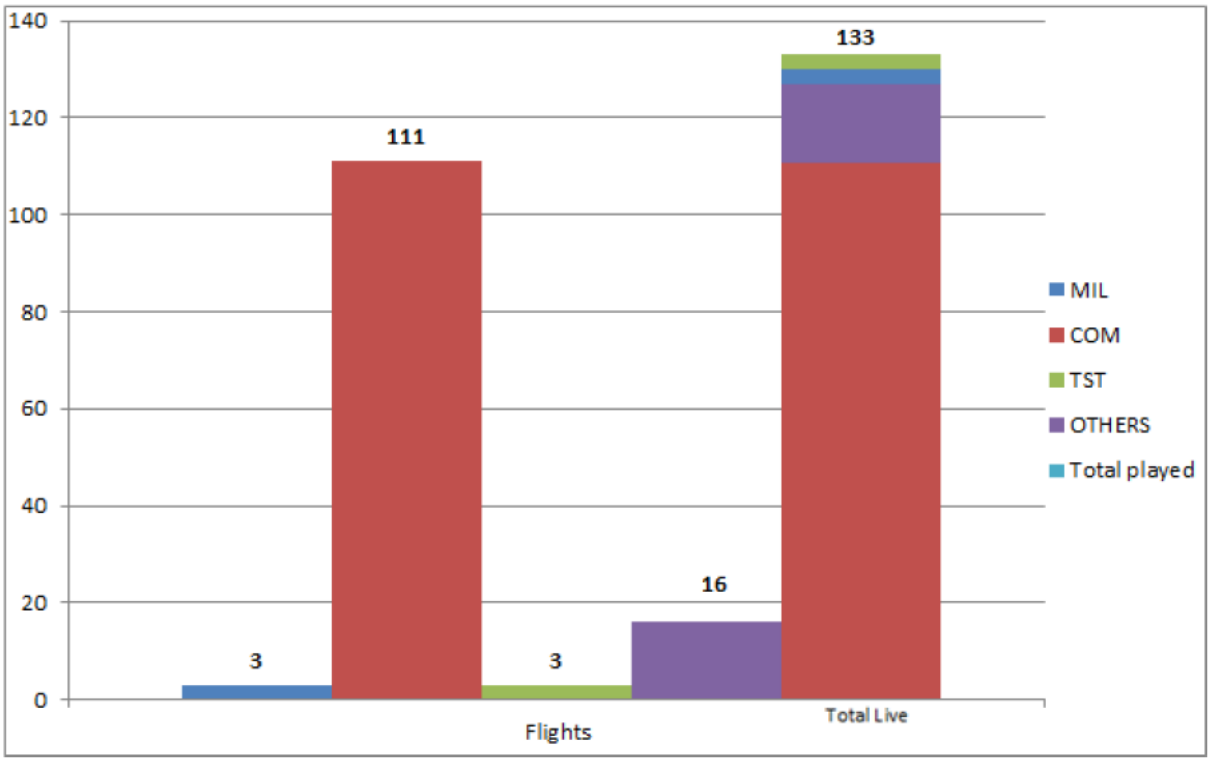


Figure 7: Flights by category during live trials

Quantitative metrics

The A380 departure at Bordeaux is scheduled by the ATC during a period of low commercial traffic to limit disturbance. Below are the observed impacts on arrivals and departures during the live demonstrations:

Run #	A380 ATOT	# of impacted arrivals	# of impacted departures	Arr delay (min)	Dep delay (min)	RWY 29-RWY 23 closure duration (min)
1	11:25	0	1	0	11	7-16
2	11:21	0	1	0	7	4-19
3	10:52	0	1	0	26	2-17
4	11:36	0	1	0	16	8-12

Table 10: Impacted operations for A-380 take off

Only one departing flight was impacted by the observed disruptive event in each EXE-0201-002 run. As a consequence, quantitative outputs should be viewed as tendencies in consideration with qualitative results.

Indicators calculated in post-exercise analysis for real operations and retained "what-if" propositions are summarised below:

	Real observed operations	"what-if" simulation analysis

	$ATOT_{A380}$	Impacted departure	KPI (ALDT-ELDT)	Proposed A380 departure time	KPI'_{to} (ALDT-ELDT')
Run #2	11:21	KLM1316	-0:07	11:25	-0:03
Run #3	10:52	AF261YO	-0:26	10:50	-0:03
Run #4	11:36	CTM1306	-0:16	11:30	-0:05

Table 11: KPI vs KPI'

KPI'_{to} and **KPI** results show an improvement of ETOT predictability in all cases. This is due to the use of updated AOP information thanks to the merge of the information derived from the NMOC and local AODB leading to increase the accuracy of ELDT. The "what-if" simulation tool can be considered as an asset to support decision making in hypothetical situations.

Further quantitative outputs are detailed in Appendix E.

Qualitative metrics

A brief description of the assessment methodology is described in §5.2.2.

Below is the summary of results obtained through the post-exercises questionnaires submitted to the operational participants:

EXE-0201-002	
Topic	Questionnaires outputs
Role definition – responsibilities in collaborative processes	**OK** There was a checklist available for EXE-0201-002 to define the roles and responsibilities of each actor. Due to this and the training, participants were comfortable carrying out the exercise.
Exchange of information	**OK** After each run of EXE-0201-002, the global tendency of exchanged chat messages concerning the operations was increasing: #1: 66, #2: 94, #3: 35, #4: 103 There were also chat messages to submit what-if requests and analyse the outputs collaboratively. Note that participants couldn't individually update AOP information in the exercise, which partially explains the high number of exchanged messages. However, this shows the need for airport stakeholders e.g. airlines, to have the means to fully support all relevant information exchanges, in particular prioritising their schedule changes (in SESAR, it's UDPP).
Relevance of information	**OK** 27% of the participants feedback strongly agree and 67% agree that the information shared trough the chat was relevant to perform operations.
Alerts information	**OK** The majority of participants (94%) agreed that the alert information was relevant, although the agreement is lower for the airlines representatives than for the others.
Decision process efficiency	**OK** A satisfactory decision process efficiency was achieved due to: • The exercise checklist, defining actions and responsibilities of each participant, and • The intense use of the chat functionality and what-if functionality.

Participants feedback on the information used was also collected, and below is the output:

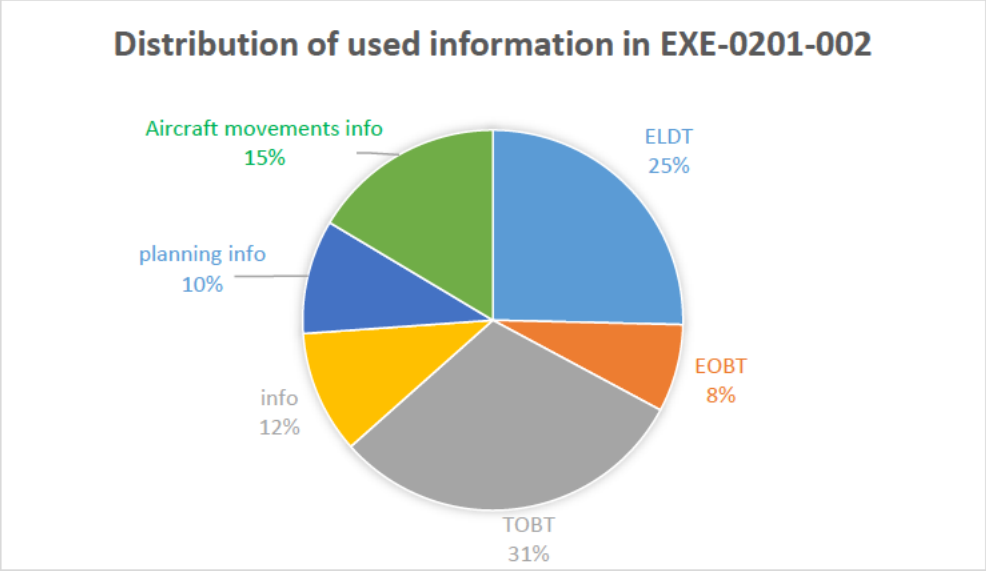


Figure 8: Distribution of information used in EXE-0201-002

The main AOP information used was TOBT and ELDT.

In this exercise, the TOBT was calculated by the demonstration platform and virtually updated by the Flight Operations Manager roles. This information does not currently exist so this tendency highlights the strong interest of having and sharing TOBTs between airport actors.

The ELDT was obtained from the Network Manager through the B2B connection and according to the participants, this is an information relevant to their daily operations.

6.2.3.1.1 Results per KPA

Predictability and efficiency were assessed and improved in EXE-0201-002.

6.2.3.1.2 Results impacting regulation and standardisation initiatives

Non applicable.

6.2.3.1.3 Unexpected Behaviours/Results

None identified.

6.2.3.1.4 Quality of Demonstration Results

The comments made in section 5.5.1 are equally applicable to this exercise.

The quality of the results achieved in the Demonstration Exercise may be considered to be accurate with a good confidence as they were collected through observation and formal questionnaires. Nevertheless, the variability of traffic and the limited number of exercises mean that the results should be interpreted as trends requiring further development and validation activity.

6.2.3.1.5 Significance of Demonstration Results

The comments made in section 5.5.2 are equally applicable to this exercise.

The operational significance should be considered positively in light of the traffic and use of the E-CRA platform by actors. It was sufficiently representative for live demonstration.

6.2.4 Conclusions and recommendations

6.2.4.1 Conclusions

EXE-0201-002 output highlighted the benefits of updated AOP information derived from the Network FUM and local AODB ensuring that participants were working with updated data supporting their critical assessments of demand when discussing the A380 departure plan.

Being aware of potential deviations and their impact on operations supported the actors' situation awareness; they were able to significantly assess short-term arrival and departure strategies based on the updated ELDT (from the NMOC) and TOBT.

The use of the "what-if" simulation tool brought improved predictability supporting the definition of an appropriate plan to limit impact on scheduled traffic and to be informed when deciding the A380 departure time, limiting potential impact on commercial operations.

The need to improve communication between airport actors and to share the same situational awareness was supported by the high number of chat exchanges. Nevertheless, having all the participants communicating through chat would appear to increase workload.

Communication aspects will have to be refined and alternative solutions will have to be defined in order to decrease the workload, as the possibility of using automated messages in the chat.

6.2.4.2 Recommendations

Based on the trends from this exercise, future work should refine the communication mechanisms used by actors to discuss scenarios. This could include the use of automatic updates to data and automated or predefined messages to reduce unnecessary communication.

The "chat" mechanism is an interesting communication means which should be further developed and validated from a formal use and with regard to potential workload issues.

The implementation of updated ELDT and TOBT milestones in daily operations clearly contributed to the participant's situational awareness for decision making and so development of a regional concept should proceed on the basis of network connectivity.

A what-if tool merits further development and validation as a predictive support to helping actors assess demand in relation to a specific operational need such as runway closure / opening.

6.3 Demonstration Exercise EXE-0201-003

6.3.1 Exercise Scope

EXE-0201-003 was originally planned as a live demonstration but then transitioned into a gaming exercise due to the lack of bad weather during the demonstration period (see §4.3.4 for details on this deviation).

A "MET Alert Cell", was organised - DSNA SO (E-CRA LSD partners) were designated as "Responsible for MET alert triggering". Two ATCOs were assigned to monitor weather forecasts alerts received at the tower from Meteo France, 36 hours and 24 hours in advance. If the MET alert received the evening before the potential day of occurrence (at 18:00) is relevant for EXE-0201-003, the alert to E-CRA LSD Consortium was triggered at 18:30 for an execution of the exercise the following day (in the live trial mode).

As no relevant bad weather was forecast, the live demonstration was turned into a gaming exercise.

In order to run the exercises under conditions as close as possible to the live environment, participants to the exercise were fed with very limited information before gaming: only the type of event, and an approximation of duration/severity.

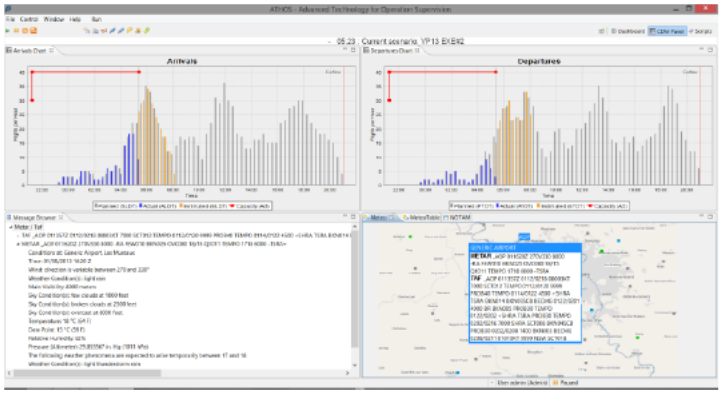


Figure 9: E-CRA MET View

The messages representing the meteorological situation evolution (TAF and METAR) were prepared for the scenario, but made available to the participants (through the platform) in similar conditions as real ones. Except the "real" moment of the day (for the fog, impact of chronobiology may be different) and the fact the played traffic was simulated, the conditions were representative of real meteorological events.

The exercise addressed the operational scenario:

- SCN-0201-002: Airport operations under meteorological adverse conditions (fog and storm),

Operational concepts being addressed are the same as EXE-0201-001 (see §6.1.1).

6.3.2 Conduct of Demonstration Exercise EXE-0201-003

6.3.2.1 Exercise Preparation

The demonstration platform configuration **in gaming mode** used in this exercise is the same as EXE-0201-001 with the addition of the what-if functionality (see §6.1.2.1). The implemented organisation between operational actors is described in §6.2.2.1

6.3.2.2 Exercise execution

Detailed planning

EXE-0201-003 was executed on March 23rd, 2016 addressing two operational scenarios related to adverse weather events (fog and storm).

EXE-0201-003 planning	
1. Preparatory activities	
Activity 1.1 Planning	Up to early January 2016
Activity 1.2 Technical preparation	
Activity 1.3 Training	During EXE-0201-001

2. Execution activities	
Activity 2.1 Exercise initialisation	23 March 2016 (AM)
Activity 2.2 Exercise running	23 March 2016 (AM)
Activity 2.3 Data recording	23 March 2016 (AM)
3. Post-execution activities	
Activity 3.1 Data collection	23 March 2016 (PM)
Activity 3.2 Data analysis	28 March 2016
Activity 3.3 Preliminary results analysis	28 March 2016 to 29 April 2016

Exercise approach

EXE-0201-003 was refined with the feedback gained during training and this included:

- The provision of a checklist describing the operational steps to follow during the execution of the exercise (see Appendix F).
- A common phraseology to be used in the chat for more efficiency and to ensure that all the stakeholders were following the same rules (see Appendix F).

The gaming exercise was prepared as follows:

- First Meteo Event: **Fog** - the event was planned in the simulated airport environment to last 1h during the morning traffic peak. An LVP was activated during this period and the RWY capacity was adapted to the low visibility.
- Second Meteo Event: RWY closure due to **thunderstorm** – this event was triggered under ATC recommendations following the reception of MET alerts leading to negative impact on TOBTs likely to cause strong delays and/or cancellations. Event duration was around 15 minutes in a traffic peak from 12h55 to 13h10.

During the exercise execution, participating stakeholders interacted via the chat and updated AOP information on the basis of deviations identified due to monitoring mechanisms (the alerts and KPIs).

Participants requested several "what-if" predictions to be able to assess potential recovery strategies in reaction to the MET alert disturbances.

The "What-if" requests were as follows:

- What if LVP lasts 30 minutes?
- What if LVP lasts 60 minutes?
- What if LVP lasts 90 minutes?
- What if airfield closure lasts 40 minutes?

Based on the results from the different what-if requests and the progression of the simulated MET conditions (fog and storm, unknown by the participants), the "what-if" outputs helped the participants to have advance awareness of the potential impact on their operations, supporting the collaborative definition of a recovery plan.

Reference and Solution scenario

See E-CRA Demonstration Plan [1] for details.

6.3.2.3 Deviation from the planned activities

EXE-0201-003 was originally planned to be a live demonstration but was finally executed as a gaming exercise due to the lack of bad weather at Bordeaux (see §4.3.4).

For EXE-0201-003, the demonstration platform was upgraded with the "what-if" tool. The exercises were also run as planned for the live demonstration to assess the expected benefits of using the what-if tool to enhance collaborative decision making.

6.3.3 Exercise Results

6.3.3.1 Summary of Exercise Results

Quantitative metrics

Since the platform is not connected to the NOP in gaming mode, quantitative metrics were not considered to be relevant for this exercise.

Qualitative metrics

Observations and questionnaire were used to highlight qualitative opinions regarding responsibilities in collaborative processes, exchange of information, alerts relevance and efficiency of the decision process.

A brief description of the assessment methodology is described in §5.2.2.

Below is a summary of results obtained at the post-exercises questionnaires submitted to the operational participants:

EXE-0201-003	
Topic	Comments and results
Role definition – responsibilities in collaborative processes	**OK** The task checklist used in EXE-0201-002 to define the roles and responsibilities of each actor was used. Participants were well prepared and the benefits of collaborative processes were evident.
Exchange of information	**OK** The number of exchanged chat messages was: • Fog scenario: 31 • Storm scenario: 37 In this exercise, participants managed their operations by communicating through chat. They could also update AOP information in the demonstration platform, which facilitates information sharing (and decreases the number of exchanged request messages through chat).
Alerts information	**OK** Most of the participants (63%) agreed that the alert information was relevant, although agreement was lower for ATCOs than for the others.
Decision process efficiency	**OK** The decision process efficiency was considered to be satisfactory, due to: • The exercise checklist, defining the actions and responsibilities of each participant • The efficient use of the chat functionality combined with the AOP updates, and • The use of the what-if functionality.

6.3.3.1.1 Results per KPA

Predictability and efficiency KPA were positive in EXE-0201-003.

6.3.3.1.2 Results impacting regulation and standardisation initiatives

Not applicable.

6.3.3.1.3 Unexpected Behaviours/Results

None identified.

6.3.3.1.4 Quality of Demonstration Results

The comments made in section 5.5.2 and 6.2.3.1.4 are equally applicable to this exercise although the gaming environment ensured that there were fewer ad hoc events and therefore less variability.

6.3.3.1.5 Significance of Demonstration Results

The comments made in section 5.5.2 and 6.2.3.1.5 are equally applicable to this exercise although, as said above, the gaming environment ensured that there were fewer ad hoc events and therefore less variability leading to higher confidence.

6.3.4 Conclusions and recommendations

6.3.4.1 Conclusions

EXE-0102-003 output demonstrated the benefits of the use of updated AOP information derived from the Network FUM and local AODB ensuring that participants were working with updated data supporting their critical assessments of demand when discussing the management of disrupted situations.

Critically, the ability to update the AOP changes reduced the chat unlike for EXE-0201-002, which remained a popular communication method for many participants.

The use of the “what-if” simulation tool brought improved predictability to ATCO decision making. Being aware of potential deviations and their impact on operations, the prediction of future demand through what-if and sharing of accurate information on the management of a disrupted airport situation helped the actors develop strategic solutions to address the changing weather conditions.

6.3.4.2 Recommendations

The recommendations made for EXE-0201-002 are equally relevant for EXE-0201-003.

In the case of strong disruption such as weather events, the use of the what-if prediction tool was considered to be a real asset for operational actors. Accordingly, it is recommended that a what-if tool is further developed and validated as a predictive support to helping actors at regional airports assess demand in relation to a specific operational need such as strong weather disruption.

7 Summary of the Communication Activities

7.1 Deviations from Demonstration plan

7.1.1 Video

The video intended to show the main objectives of the project, the expectations of attenders, the results, as well as testimonies supporting the project, and meant to be displayed in the E-CRA website (https://www.e-cra.net/) was not performed, due to the instable live trials schedule, generating difficulty to organise the access to the different physical locations to record.

7.1.2 Schedule

The main deviation from planned communication activities is related to events schedule. No Gaming or Live Trial has been scheduled by E-CRA partners in April, and only two (first event 3rd and 4th of March, second event 22nd of March) were the subject of a live "virtual" attendance through the dedicated website.

7.1.3 Articles

The main article shared on the social networks and the articles published through channels of partners or subcontractors were not submitted to the SJU before publishing.

A final E-CRA news article describing the objectives trials, partners and results has been prepared for dissemination via partner's web sites.

7.2 Achievements

7.2.1 Internal

During each live trial, people from most of involved actors in Bordeaux airport operations or E-CRA stakeholders have been invited and present. Moreover, a "guest" account has been created allowing a direct connection to the E-CRA platform in order to allow selected people (mainly Eurocontrol and ANSP people) to connect and assist to the live trials. Such a "guest" account has only read-only rights on data, but is allowed to communicate through the platform chat capability.

The demonstration activities and preliminary results have also been disseminated through channels of partners or subcontractors, e.g. Airbus Safran Launchers "Intranet news Report", DSNA/SO internal communication, AirFrance/HOP! …

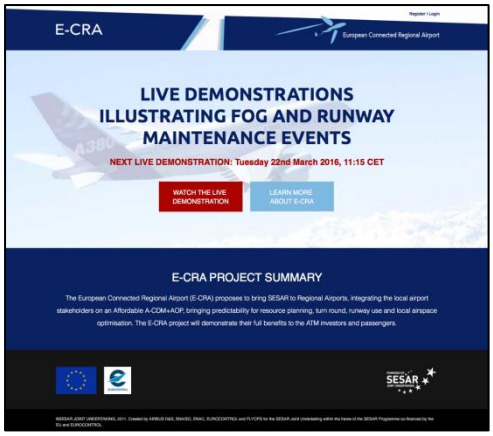
7.2.2 WAC

E-CRA platform was running on the Airbus stand during the whole WAC in Madrid (8th to 10th 2016). This led dozens of people to have a direct approach of E-CRA concept, by example. Amongst these people, there were for example top management official from ADP or specialists from INDRA.

In order to capitalize on this audience, as planned in the Demonstration Plan, hundreds of flyers and business cards with SESAR JU and E-CRA partners' logo have been printed and delivered during the WAC. This material focussed on the "virtual attendance" through the dedicated E-CRA website

7.2.3 Live events and dedicated demonstrations

7.2.3.1 Live events



A dedicated website (https://www.e-cra.net/) has been created in order to demonstrate widely the E-CRA concept and platform capabilities.

This website is using the E-CRA brand with a design aligned with SESAR. The landing page's key objective is to inform visitors of the next event details, and allows watching the current live demonstration (access to live demonstration being restricted to authenticated visitors) and to learn more about the E-CRA project.

In order to perform post-analysis, a tracking functionality has been implemented, in order to follow every visitor's activity on the site.

The website allows visitors to access (read only) to most of the live data, and the way they are used by the exercises' participants.

All the visitors of the website were invited to register themselves in order to access the whole content. From March 1st to March 22nd, the number of verified registered users grew from 6 to 30. The visitors were either invited directly by a personalised e-mailing, or informed by the flyers and business cards delivered during the WAC event.

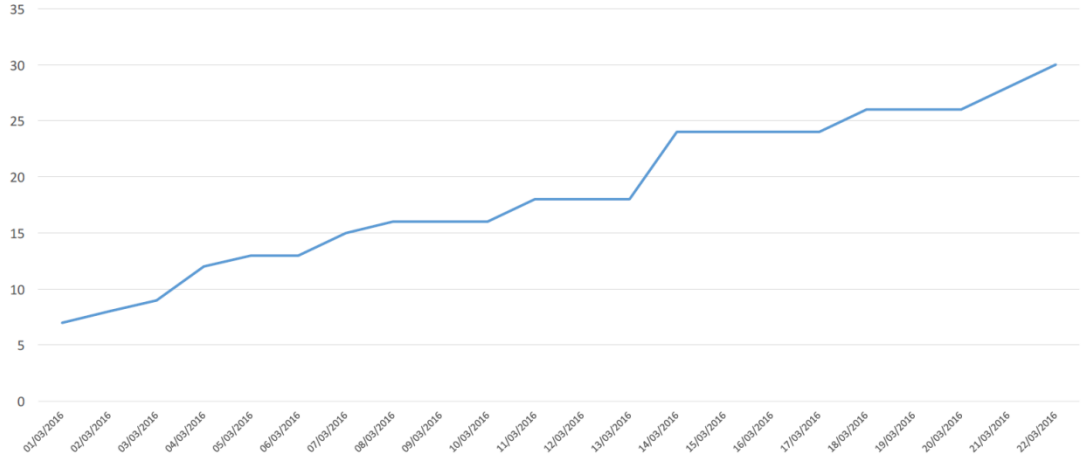


Figure 10: Progression of registered users' number – March 2016)

4 key "events" were identified for March 2016:

- The "Calibration event", displaying live data with testers interacting;
- The "First event", displaying data from two demonstration exercises;
- The WAC, the website displaying BOD live data without interaction;
- The "Main live trial event", displaying data from one demonstration exercise.

The "Calibration event", March 1st and 2nd, was dedicated to calibrate the web site, and to prove capability of such a web access. This event was successful, with 15 different people connected the two days, generating hundreds of page views.

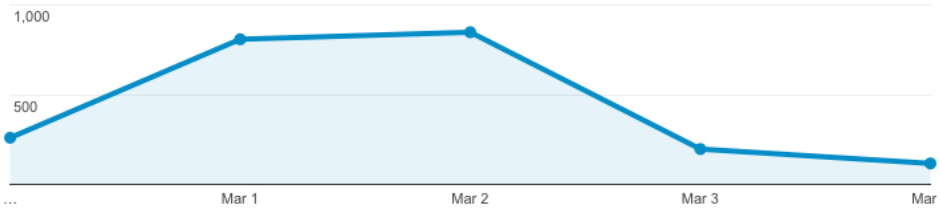


Figure 11: Page views – Calibration event (March 1st and 2nd)

During the first event with web access, i.e. March 3rd Live Trial and March 4th Gaming, the site was used in order to demonstrate the relevance of such web access. An average of 10 active users by day were connected,

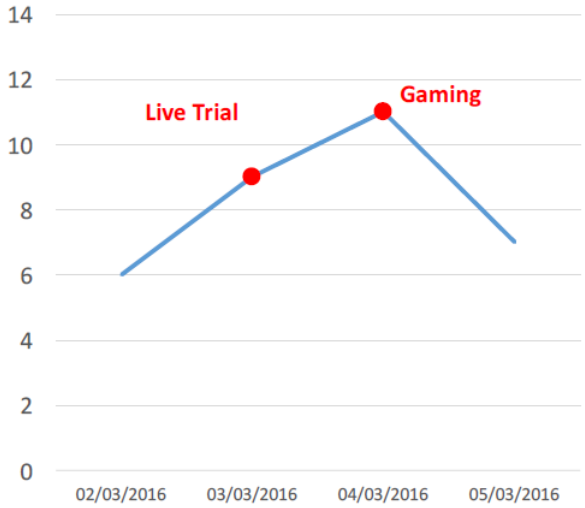


Figure 12: Active users – First event (March 3rd and 4th)

During the WAC in Madrid, flyers with the landing URL were distributed, and the website made available for every registered user. Live data from BOD were displayed during the whole WAC.

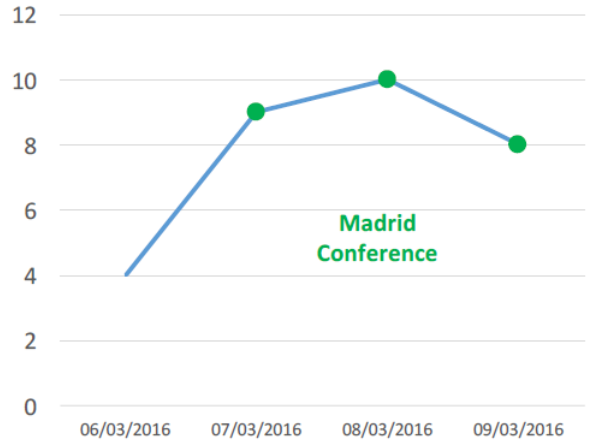


Figure 13: Active users – WAC in Madrid (March 7th to 9th)

Unfortunately, the event expected to be the main live-trial with web access has been held the same day the Brussels Zaventem terrorist attack (22nd of March), which had a strong negative impact on the expected web audience: a lot of invited and having confirmed people not being able to connect during the live trial... Nevertheless, the audience was twice the audience of the other events.

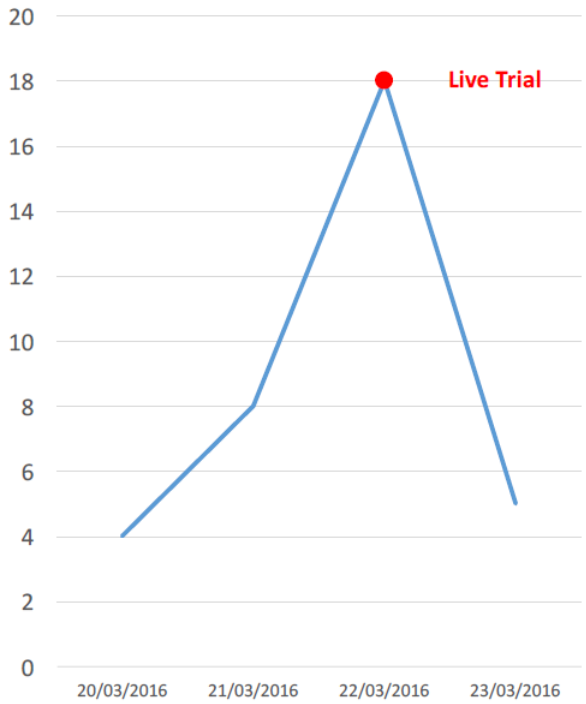


Figure 14: Active users – Second event (March 22nd)

The main result of this initiative is that such a live following platform may be used to allow many people to attend to an experiment without interfering with it, but nevertheless allowing them reacting “in live” to decisions made, giving a feedback that may be taken into account in the experimentation lessons learned.
The ‘analytics’ used may be enhanced and improve to analyse better the audience behaviour, but some participants used this platform as a first “self-learning” tool to prepare further exercises.

Figure 15: Snapshot of the operational data accessible through e-cra.net

7.2.3.2 Dedicated demonstrations

In order to increase the awareness and outreach about SESAR and its demonstration projects, and to demonstrate the impact of E-CRA concept on ATM real day-to-day operations, some demonstrations have been made beside E-CRA exercises.

These direct demonstrations of E-CRA concept and platform capabilities have been proposed and performed to potentially interested people. The most noteworthy are people from Alicante airport operator.

7.2.4 Social networks

A Linked-In E-CRA group has been created (E-CRA group on LinkedIn), initially opened to E-CRA partners but now opened to people involved in airports operation or IT topics.

An article describing the ECRA project has been published on LinkedIn Pulse: www.linkedin.com/pulse/ECRA-successful-bordeaux

This article was split in three parts to fit LinkedIn restrictions and be published in the ECRA group:

Who are the participants of the E-CRA project? ,

E-CRA: first adaptation of SESAR concept to Regional Airports, and

Successful E-CRA Demonstrations have been performed in Bordeaux Airport during 2016-Q1.

This article was also shared on other LinkedIn groups (notably SESAR: 5257 members, ENAC: 1 413 members, and Airport Planners: 6 490 members), and reached more than 166 views.
The E-CRA group will continue to be feed with flash news (e.g. Demonstration Report hand-over, other regional airports embarking on implementing A-CDM concepts…).

The social networks' communication will be harmonized with the SJU', in order that articles published on E-CRA LinkedIn group may be reused as-is by the SJU.

7.2.5 Final Communication

As agreed with the SJU, the E-CRA partners will disseminate a final communication ("news" item) using different media to explain the project, the results and partners contribution, linking to SESAR 2020 where in PJ04 further development and validation work will be undertaken on the Regional Airport CDM concept.

8 Next Steps

The E-CRA project was proposed on the basis of being able to translate SESAR development and validation work to be affordable and exploitable by regional airports.

During project development, Airport Collaborative Decision Making (A-CDM) and Advanced Tower were both identified as baseline opportunities on which to build the regional approach taking account of the prototype Airport Operations Centre (APOC) validation platform provided by Airbus Safran Launchers for EUROCONTROL's contribution to SESAR APOC validation.

The key challenges were to identify the validation scenarios for live trials, to translate the SESAR and A-CDM material to suit E-CRA and to connect the APOC platform to both the airport operations data base (AODB) and to the European Network Manager's Network portal.

A number of issues led to the project being focused on three exercises:

1. Training based on nominal operations, a runway incident and low visibility operations;
2. A live trial covering a runway incident (runway closure following an A380 departure), and
3. A live trial covering restricted operations due to bad weather.

By project closure, the APOC platform was successfully connected to the Bordeaux AODB and the Network B2B connection was achieved for reception of the Flight Update Messages.

Due to the lack of relevant adverse meteorological conditions at Bordeaux, the second live trial was managed as a gaming exercise.

In the first live trial, E-CRA successfully demonstrated the creation of a common situational awareness and collaborative decision making with trial participants actively involved in the runway closure trial activities. This was confirmed in the third exercise involving managing an adverse weather event.

E-CRA LSD achieved a strong level of interest from the participating Bordeaux airport stakeholders and the results were sufficiently encouraging to drive the need to continue the development and validation of a regional connected airport concept.

Despite the comparative success of the E-CRA demonstration it is clear that further development and validation work is required before envisaging a deployment phase.

8.1 Conclusions

- Wider participation of airlines and military was not achieved in time for the demonstration exercises. This was partly due to the lack of understanding of benefits accrued from collaborative process and the cultural changed needed to enjoy such benefits.

  An early targeted business approach explaining the cultural change and highlighting potential benefits might have persuaded stakeholders to join.

- As stated previously, E-CRA relied on the adaptation of SESAR APOC, EUROCONTROL A-CDM and Advanced Tower guidance material developed for major European airports for use at a Regional Airport.

  Nevertheless, the E-CRA team had to redevelop and align the material to fit it to the scenarios to be demonstrated at the regional airport. In conclusion, a dedicated regional airport collaborative decision making (RA-CDM) concept of operations would have been of great value, providing guidance and clarity regarding the different procedures to be applied.

- E-CRA demonstrated the transferability of SESAR collaborative concepts in planning and monitoring airport operations. It has demonstrated the feasibility of using such concepts and shows a positive trend for being connected to the Network, using alerts to warn actors of deviations to plan and be able to share a common situational awareness and collaboratively input into decisions despite not being present in the same physical location.

- The Flight Update Messages (FUM) obtained through the Bordeaux APOC connection to the Network portal ensured that flight plans and flight estimates were up to date. During the gap analysis, it was identified that many of the flight estimates were significantly out of date compared to network updates. This is a challenge to planning and managing airport operations.

- The network connection for FUM confirmed the utility of reliable arrival flight information and ELDT and that the FUM is an easy and cost efficient method to ensure this. The benefits of Network connection were clearly identified in both EXE0201-002 and EXE0201-003.
- Departure Information (DPI messages) were created and displayed by the E-CRA platform, nevertheless, in order to avoid any negative impact[3], it has been decided not to provide the DPI messages to the Network Manager.

  The DPI (A-DPI message) ensures that the Network Manager is up to date regarding departures and is an important part of ensuring the predictability and allocation of resources En-Route. The benefits could not be assessed to complement those of A-CDM and Advanced Tower.
- Pre-defined roles and responsibilities backed up by a common information set defined through the “exercise checklist” ensured participants shared a common situational awareness.

  It can be concluded that ensuring an in-depth analysis and time spent of defining roles linked to information needs is critical to a successful deployment of Regional Airport-CDM.
- The “chat” mechanism provided in the Bordeaux APOC platform was intensely used by all participants. The chat mechanism also used a level of language formalism to reduce possible issues of understanding. The use of chat increased significantly for each exercise.

  The use of “chat” as a “formal” or “informal” communication mechanism clearly enhanced the participant’s situational awareness and ability to plan or influence decisions.
- It was commented that “chat” was a new task for ATC and should be assessed for workload implications and to ensure which role should be responsible for “chat” consolidation in decision making.

  Whilst “chat” clearly brings benefit it is also “new” in the context of ATC and airport operations and should be assessed accordingly.
- Regional Airport Collaborative Decision Making (RA-CDM) mechanisms were focused on E-CRA scenarios which involved disrupted Bordeaux airport operations (real or simulated). As such, there was no analysis done to understand basic sharing of information to enhance nominal operations.

  Whilst the RA-CDM capability functioned well in disrupted operations, a “light” system enhancing communication and situational awareness (the FUM being a good example of a background enhancement) was not tested.
- Information that could be shared by partners and available in the system includes updated flights TOBT and ELDT, airport operations status, activities on runways (inspections, cleaning, etc.) and information on particular and local events, as well as MET events.

  Being aware of potential deviations and their impact on operations supported the actors’ situation awareness; they were able to significantly assess short-term arrival and departure strategies based on the updated ELDT (from the NMOC) and TOBT.

  Airlines companies connected to E-CRA should also be able to undertake an UDPP concept to prioritise their schedule.
- Connecting different instances of E-CRA platform showed that the need to adapt systems to be SWIM compliant will significantly help system and data integration and consequently, SWIM should be seen as the enabling standard.
- A “simple” what-if tool brought predictability and provided participants with information to support decision making on the best time for the A380 departure to minimise the impact on planned arrival, departures and ad-hoc movements (test flights, military and training).

[3] Potential negative impact is the outcome of two different kind of reasons: Operational reasons (stakeholders didn't want to impact the "real" situation), and safety considerations (the platform has not been validated against safety requirements, cf. 3.4).

In the adverse weather exercise EXE-0201-003, the tool supported the re-planning of traffic priorities following the weather event (cancellation, reduction of capacity and priority for departure on re-start of operations).

Participants agreed on the interest of such a tool in the management of disrupted situations, to support an accurate collaborative assessment when the progression of a disturbance is uncertain and short-term strategies are difficult to consider.

At this moment in time, an early deployment of a RA-CDM concept would more likely to be linked to current mature knowledge coming from Advanced Tower than the results of E-CRA.

E-CRA clearly demonstrated the potential operational benefit to stakeholders of a wider collaboration through specific applications such as those proposed in SESAR and, as demonstrated in Bordeaux, the runway closure and adverse weather event applications.

One of the original reasons for proposing E-CRA was to demonstrate the cost benefits of A-CDM and APOC type concepts at regional airports from an affordable cost perspective. Unfortunately this was not addressed. Since cost is a significant issue such an assessment should be part of any future work.

Whilst E-CRA has shown potential of RA-CDM, more work is required to clarify and validate the concept and to convince airports of the business case.

8.2 Recommendations

The following recommendations are proposed by E-CRA:

- Whilst SESAR has rightly focused on major airports in SESAR 1, it is now important to bring focus to regional sized airports that play a significant economic and social role. It is recommended that a Regional Airport-Collaborative Decision Making (RA-CDM) Concept and Guidance Material be developed. This guidance should also assess if there are significant variances in different regional airport operations and consider the actors and cultures that need to be addressed.
- It is recommended that a comprehensive development and validation programme based on the RA-CDM be undertaken to assess basic information sharing and specific applications to manage commonly shared situations (the runway closure, runway configuration, bad weather etc.) and airport inter-stakeholder system connectivity and connection to the ATM Network. This activity should include a SESAR Very Large Demonstrations (VLD).
- Cost is a significant aspect of Regional Airports operations with subsidies being withdrawn, increasing need to adhere to European and National regulations and to be competitive, in particular with regard to low cost airline operations. It is recommended that:
    - A coherent and understandable cost benefit analysis be undertaken to highlight the advantages for regional airports to be connected to the network and to ensure airport stakeholders share a common situation awareness of the airports' operations and can work in a collaborative manor;
    - Modern technologies such as cloud computing, application based working and social networks be considered as the basis for developing an affordable RA-CDM either for deployment by an airport or as a service that can be exploited by an airport.

As airports are able to deploy new technology relatively quickly once business cases are clear and since industry has a number of suitable A-CDM products in development, early deployment of RA-CDM at early adaptor Regional Airports with focus on connection to the ATM Network is possible, although this will be significantly facilitated by a formal concept and validated requirements.

9 References

9.1 Applicable Documents

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

9.2 Reference Documents

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

[1] E-CRA Demonstration Plan, v2.0, Edition 5

[2] OFA 05.01.01 Operational Service and Environment Definition, Edition 00.03.00 (P06.05.04-D16-OFA05.01.01 Consolidated OSED Edition 3 Document)

[3] E-CRA D3 HF Gaming Report (ISDEFE's contribution to E-CRA gaming results analysis), [ISECRE-162011-1IL], date 19/04/2016

[4] E-CRA D5 HF Live Trial Report (ISDEFE's contribution to E-CRA live demonstrations results analysis), [ISECRE-162300-2IL], date 13/05/2016

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

[6] Operational Focus Area, Programme Guidance, Edition 03.00.00, date 04/05/2012

[7] Large Scale Demonstration Projects Communication Guidelines, Edition 02.00.0, 2014

[8] EUROCONTROL Airport CDM Implementation Manual, Edition 04.00.00, March 2012

[9] OFA 05.01.01 Safety and Performance Requirements, Edition 00.01.00 (P06.05.04-D19-OFA05.01.01 SPR V2)

[10]OFA 05.01.01 Interoperability Requirements (INTEROP) Document, (DEL_06.05.04-D20-OFA05.01.01-INTEROP Edition 2 Document)

[11] EUROCONTROL Advanced ATC Tower Implementation Guide, Edition 1.200 2015

Appendix A E-CRA Work Packages description

A.1 WP0 - Project management & coordination

Work package number	WP0	Start date or starting event: T0			Duration: 20 months
Work package title	Project management, quality control & risk management				
Activity Type	MGT				
Work package leader number & name	WP0 – Airbus Safran Launchers [redacted]				
Participant number & name	Airbus Safran Launchers	EUROCONTROL	DSNA	Flyops	ENAC	**Total**
Hours per participant:	1050	-	-	-	-	1050

Description of work

The following tasks are proposed to achieve the project management and the coordination:

- **T0.1 - Quality control & risk management –**

The inputs that will be considered for the quality control & risk management during the project are the following:

- Project management organisation
- Consortium agreement
- Project Contract
- Project technical annex
- Project technical deliverables and dissemination documents
- Scientific progress reports
- Management progress reports
- Audited cost statements
- Recommendations from Project Management Committee

Airbus Safran Launchers as the coordinating company, is responsible for the following tasks:

- Organise and chair the kick-off meeting and yearly project meetings, associated to key milestones.
- Ensure that the meeting minutes are kept and reports are written and supplied to all concerned entities.
- Report to the SESAR JU about the overall project performance, both on financial and technical aspects.
- Organize the communication within the consortium and ensure efficient dialogue between the consortium and SESAR JU.
- Supervise the financial and technical situation of the project, and follow up with the initial project plan.
- Generate the cost statements for the whole project, based on the financial statements received from the partners and of the costs that have been incurred in achieving the project goals.
- Ensure that the technical information within each work package and between work packages is communicated in a timely manner.

- Obtain audit certificates from the consortium members when necessary.

- **T0.2 – Administrative management -**

This task related to the administrative management can be decomposed as follows:

1. Quality and Management implementation and follow-up

- Airbus Safran Launchers proposes the Project Management Plan, which includes in particular :
  - Exhaustive list of deliverables, with traceability and numbering methods
  - project schedule deliveries and partners manpower consumption monitoring methods
  - risk management methods
  - publication (dissemination) policy and methods
  - communication plan methods
  - Definition and management of the pre-existing know how coming from project partners

- Airbus Safran Launchers implements, supervises and updates (if needed) the Project Management Plan covering the following activities (not exhaustive):
  - Help the project partners to implement PMP,
  - Provide assistance to partners via “hot line” media on problem occurrence,
  - Monitor & follow up all activities described in the PMP:
    - Writing up management meeting agendas and management work time schedules,
    - Preparing the minutes of Project Management Committee meetings minutes (management progress)
    - Implementing the decisions taken in management meetings
    - Preparing needed documents to help the Management Committee decision making process
    - Proposing a set of project performance metrics, implementing them, and taking appropriate actions in case of discrepancies
    - Insuring the day to day administrative management

2. Administration and finances follow-up

- Airbus Safran Launchers:
  - supervises the Consortium Agreement signature and insures its evolutions (in partnership, in particular),
  - maintains the consortium agreement, creates and maintains the Project directory,
  - obtains audit certificates by each of the participants when needed,
  - assumes the preparation of Project Cost Statements,
  - prepares the submission to SESAR JU of financial and administrative deliverables,
  - is to collect, check, validate, improve (if necessary) every administrative and financial deliverable and material of the project in order to insure the Project consistency.

3. Maintenance of the Contract

- Airbus Safran Launchers:
  - prepares administrative documents for Partners leaving the Partnership and Partners joining the Partnership,
  - prepares documents for contract amendments.

Deliverables

- **D0.2.x Management Quarterly report (T0, T0+3, T0+6, T0+9, T0+12, T0+15, T0+18)**

All deliverables listed hereafter are provided to the Coordinator for approval and diffusion to the consortium:

- Demonstration Plan and updates
- Consortium agreement updates
- Project cost statements
- Drafts of financial and administrative documents
- Project management reports (administrative part)
- Project directory
- Contract amendments documentation (if necessary)
- Management Committee meeting agendas and Minutes of Meeting (for administrative tasks)

Table 12: WP0 - Project management & coordination

A.2 WP1 - Demonstration Definition and Design

Work package number	WP1	Start date or starting event: T0				Duration: 12 months
Work package title	Demonstration Definition and Design					
Activity Type	TSK					
Work package leader number & name	1 – ENAC [redacted]					
Participant number & name	Airbus Safran Launchers	EUROCONTROL	DSNA	Flyops	ENAC	**Total**
Per Hours per participant:	350	1100	580	500	1680	4210

Objectives

This work package aims to provide the demonstration plan for the LSD project:

Description of work

WP 1 deals with the Definition (WP 1.1) and Design of the Demonstration Scenarios (WP1.2) and Exercises (WP1.3):

- WP1.1 deals with scoping, definition and choices.
  - It gathers and consolidates the stakeholder needs and objectives while analyzing the "gap" between current situation and the forecasted steps of progressive deployment of an affordable A-CDM.
  - Consolidated needs are submitted to the Stakeholders for validation.
  - The data and concepts that are handled by Stakeholders are identified
  - The scope of Demonstration is decided by selecting most important (weighted) objectives and needs.
  - Work product :
    - User/Stakeholder Requirements Document (URD)
- WP 1.2 deals with the URD Analysis and Design of Scenarios

- Each Scenario and its variants reflects real Stakeholder problems and needs. Analysis of URD leads to the identification of expected Services (for instance an Off Block Detection Service) that satisfy the Stakeholders' Requirements, but without considering their technical Solution(s). Scenarios are designed to use these Services in operational situations, and follow a standard template.
- Each Scenario is traced to upstream needs (Stakeholders' Requirements), Objectives, Services and the Handled Data those Services manipulate.
- The success criteria of each Scenario are defined, using measurements and KPIs based on involved Handled Data.
- Each Scenario and its success criteria are validated by Stakeholders
- Work Products:
  - Scenario Description Document (SDD),
  - List of identified Services & Handled Data: the structure of a possible System Requirements Document (SRD), which will be detailed by WP 2.1.

- WP 1.3 deals with the Design and planning of Exercises
  - Each Exercise is designed as a collection of scenarios (possibly one) and the associated planning of human resources and means (enabling systems …).
  - Each Exercise may have pre and post conditions and has to be scoped, justified and planned. Its level of representativeness and its limitations must be identified, as well as the safety issues must be assessed.
  - The way how Exercise results will be analyzed has to be specified.

Deliverables

- **D1.1 Demonstration Plan (T0+2months):** first release, necessary updates will come from WP 2 outcomes).
- **D1.2 Demonstration Plan (T0+11months):** final version.

WP1.1, 1.2 and 1.3 will be repeated in the frame of the preparatory activity of the live trials to produce D1.2

Table 13: WP1 - Demonstration Definition and Design

A.3 WP2 - Demonstration Platform Integration

Work package number	WP2	Start date or starting event: T0+2 months			Duration: 10 months
Work package title	Demonstration Platform Integration				
Activity Type	TSK				
Work package leader number & name	1 – Airbus Safran Launchers [redacted]				
Participant number & name	Airbus Safran Launchers	EUROCONTROL	DSNA	Flyops	ENAC	**Total**
Hours per participant:	1200	500	350	170	400	2620

Objectives

This work package aims to provide the demonstration platform for the LSD project:

1. WP2.1 Adaptation of existing platform: a high fidelity APOC simulation platform will be provided (based on an existing APOC gaming platform, developed by Airbus Safran Launchers).
2. WP2.2, Demonstration platform: in addition, the platform will be enhanced and connected to existing 'real' data sources, including the network via FUM (B2B web service), so that all exercises defined by WP3 can be supported. In this configuration, the simulator may still be used to support What-If analysis.

   This enhanced platform will be installed at Bordeaux Airport premises for the duration of the project.

Description of work

The current platform if build on top of a simulator.

For the LSD project, this simulator will be replaced by real external data-sources. Three main data-sources have been identified:

- NOP: the network will provide the FUM messages, that will feed the platform with updates in real-time,
- AODB: some information about on-going and forecasted flight plans and flight schedule will be provided by existing airport database,

For each external interface, a specific driver will be developed, so that the platform can acquire and process the corresponding data.

License

Three SW license are required and will be provided:

- CAST: this tool is the simulation kernel required by the simulation platform. This tool is developed by ARC GmbH.
- ATHOS: this tool is the core of the platform. It acts as supervisor and provides the user interface for the stakeholder, as well as general services like data archiving and post-processing. This tool is developed by Airbus Safran Launchers.

The WP includes the provision of those licenses for the whole duration of the project.

Deliverables (non contractual)

- **D2.1 Gaming platform (t0+6months):** this first version is a standalone platform (not connected to external systems, built on top of a high fidelity simulator); it includes A-CDM and AOP concepts, and can be used to simulate, prepare and refine the exercises as well as to train the stakeholder,
- **D2.2 Demonstration platform (t0+11months):** this version is the demonstration platform, connected and able to interact will existing and real systems (NOP – AODB); it supports all exercises defined in WP3.

The WP includes also on-site and off-site support during the execution of the exercises.
Note: The platform will be provided for the duration of the project, but will remain Airbus Safran Launchers property.

Table 14: WP2 - Demonstration Platform Integration

A.4 WP3 - Demonstration Activities

Work package number	WP3	Start date or starting event: T0+12 months				Duration: 8 months
Work package title	Demonstration Activities					
Activity Type	TSK					
Work package leader number & name	1 – DSNA [redacted]					
Participant number & name	Airbus Safran Launchers	EUROCONTROL	DSNA	Flyops	ENAC	**Total**
Hours per participant:	500	515	1450	800	600	3865

Objectives Description of work

WP 3 deals with the proper execution of demonstration, its conclusions but also its support.

- WP 3.1: Demonstration Execution (at top level). It involves many coordination activities, such as (non limitative):
  - Involving and training stakeholders (rehearsals)
  - Organizing the Demonstration Exercise sessions
  - Setting the Exercise preconditions
  - Executing the Demonstration according to selected Demonstration Methods
  - Logging and measuring performances, producing KPIs
  - Debriefing involved stakeholders, gathering their findings just after execution of demonstration
  - Analyzing outcomes and producing Result Analysis Report.
  - Validating report and final debriefing with stakeholders ("cold debrief")
  - Performing communication actions according to WP4 techniques and means.
  - Closing the demonstration activities
- WP 3.2: Demonstration Execution support in operations (at enabling systems level), including final deactivation. This will be split between enabling systems and particularly but not only for the Gaming Platform.

Deliverables

D3.1 Results analysis Demonstration Report (t0+18months): including phase 1 (Gaming) and phase 2 activities (Flight Trials)

Table 15: WP3 - Demonstration Activities

A.5 WP4 – Communication activities

Work package number	WP4	Start date or starting event: T0+12 months				Duration: 8 months
Work package title	Communication activities					
Activity Type	TSK					
Work package leader number & name	1 – Airbus Safran Launchers [redacted]					
Participant number & name	Airbus Safran Launchers	EUROCONTROL	DSNA	Flyops	ENAC	**Total**
Hours per participant:	400	200	200	200	240	1240

Objectives

The general objective is to establish the visibility of E-CRA within the airports as an innovative flexible and affordable solution for small / medium airports to :

1. connect to the ATM network
2. and meet their operational and business objectives' within the airports eco-system

Description of work

The following tasks are proposed to achieve these objectives:

WP4.1Key message to enforce –

- Defining the general message and refining it for each targeted audience
- Producing editorial and visual content
- Preparing the first presentation materials for E-CRA
- Delivering the E-CRA content as well as printed materials

WP4.2 Teasing/invitation to live event –

- A landing web page that presents the project benefits, the full-day programme, and a registration form will be used as invitation.
- Invitations will be sent by a personalised e-mailing.
- At the same time, an article on the event will be broadcasted through all partners' communication channels (sites, newsletters, Linked In posts)

WP4.3 The live event -

- A prezi presentation will detail the project and how it forms part of SESAR strategy.
- A trial demo of the tool will be held by combining pre-recorded screencasts and live software demonstration.
- The A380 exercise will be presented and followed on large screen, showing software interaction and decision makers.
- Video capture will be done during the event, and testimonies will be recorded.

WP4.4 Dissemination -

- First, a video will show the main objectives of the project, the expectations of attenders, the results, as well as testimonies supporting the project.
- A responsive website will focus communication on two main axes:

1. The overall presentation of the project and how it fits into SESAR strategy.
2. The tool presentation and its current and future capabilities. Emphasis will be put on the capacity of the tool to be setup quickly, and that it brings interesting insights and outlooks.

- The website will at least feature:

1. The video of the project
2. A page gathering the testimonies of people showing interest in the project in order to bring reinsurance and reinforce the human side of the project
3. A contact / click to call form

- An article on the event will recall the assets of the tool in the SESAR strategy will be broadcasted through all partners' communication channels (sites, newsletters, Linked In posts)
- An emailing will be sent to targeted people in order to create awareness on the project, inviting them to go further through the website, and contact the project's team.

Deliverables (Non contractual with SJU)

Table 16: WP4 – Communication activities

Appendix B Risk management

Risks Identifier	Risk description	Severity (Low/Medium/ High/Very high)	Probability (Low/Medium/ High/Very high)	Mitigation actions	Owner
R-001	Connection to ELVIRA tool not possible. The radar track could not be taken from ELVIRA due to DAKOTA parameters setting. Possible impact on the Demonstration platform maturity	Low	High	Refinement of the live trials EXEs, the real time information about on-going traffic, aircraft position, trajectory more specific to aircraft position is not needed. Needed information to support the scenario will be provided by AODB and the NMOC **The mitigation action was put in place.**	Airbus Safran Launchers
R-002	Connection with AODB is not feasible: (see R-002) mandatory to have access to airport real data	High	High	If the connection with AODB is disabled the airport real data will be introduced manually. **The mitigation action was put in place.**	Airbus Safran Launchers
R-003	Connection with NMOC is not possible: this connection is mandatory to ensure the reception of FUM	High	Low	The connection will be established via B2B web service. This connection needs to be requested to the Network Manager by the local Service provider DSNA. The web service will provide all the FUM as necessary for E-CRA. (Connection obtained and web service under development) **No mitigation needed for live trials.** EXE-0201-002 and EXE-0201-003 **No connection for the gaming** EXE-0201-001	Airbus Safran Launchers

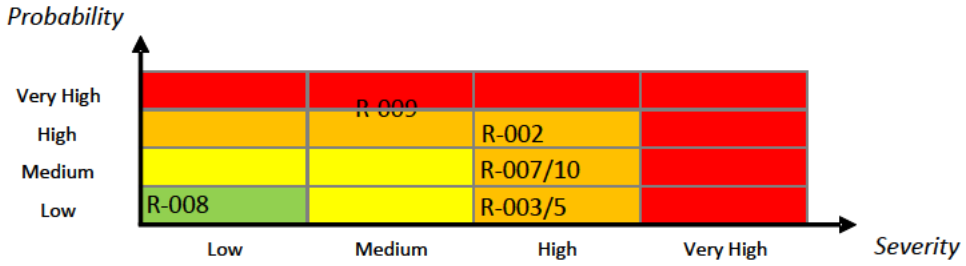
R-004	Connection with NMOC to send DPI messages is not possible: need to be established to ensure the sending of DPI. The DPI connection requires ensuring that the connection has a reliable data flow from the airport (such as automated inputs regarding key events such as push back etc. or connection to a tower electronic strip system offering such capability) and should be based on agreed operational concepts and procedures.			DPI connection will not be established for the E-CRA demonstration as this requires too much time. The A-DPI messages will be generated by the demonstration Platform to ensure the analysis of results but they will not be sent to NMOC.	Airbus Safran Launchers
R-005	Inefficient safety monitoring during live trials exercises	High	Low	Implementation of a safety control process for the flight trials. DSNA and ADBM declared during the 1st critical review that the respective Safety Management Plans will not be impacted.	[redacted] (DSNA)
R-006	Inadequate safety assessment			**No more valid considering R-005 mitigation**	[redacted] (DSNA)
R-007	No adherence of one or several stakeholders to exercise configuration	High	Medium	Exercise preparation through gaming, information Communication and surveillance during the trials. **Better preparation of EXE 2&3 has been performed in 07 and 08 2015**	[redacted] (DSNA)

[4] Flight trial supervisor is in charge of the overall coordination during Flight Trials

R-008	Impact on airline operations	Low	Low	Test Procedure should be reviewed by applicable stakeholders (Done); Test platform is in "shadow mode" to ensure acceptable conditions in terms of safety **No test needed as exercises were not safety-related (sse R-005)**	Flight Trials manager (DSNA)
R-009	Occurrence of a real disruptive event during the exercise	Medium	High (Very High depending on the event characteristics)	Create an annex to the Test Procedure that describes a standard action plan in response to an unplanned disruptive event during a Flight Trial (to be done after the acceptation of the demonstration plan Version 2) **No action plan needed as exercises were not safety-related (sse R-005)**	[redacted] (DSNA)
R-010	Available time to achieve all objectives due to late start and requirement to close out in June 2016	High	Medium	Gaming schedule updated: Gaming preparation activities performed more in parallel than initially planned to avoid further schedule slip. New possibilities to extend project duration **Objectives finally achieved**	Airbus Safran Launchers

Table 17: Risk Log

The following figure shows the prioritization of the identified risks. The proposed mitigation strategies focus in general on reducing the likelihood of a risk occurring but for the most critical one R-007 the proposed mitigation strategy lowers both likelihood and impact.



Appendix C Demonstrations assumptions

Demonstrations assumptions as defined in E-CRA LSD Demonstration Plan:

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
001	Technical limitations		The scenarios and exercises could be reviewed and implemented depending on the existing technical systems capabilities existing at the time the demonstrations will be conducted.		N/A	N/A			All	OBJ-0201-001 OBJ-0201-002 OBJ-0201-003 OBJ-0201-004
002	Monitored processes		Demonstrations will focus on the following: - overall airport performance - aircraft processes		Arrival Turnround Departure	N/A			All	OBJ-0201-002
003	Information exchange between stakeholders		The AOP is the exclusive data exchange platform to exchange information amongst all airport stakeholders and with the network.		Arrival Turn-round Departure	N/A			All	OBJ-0201-003
004	AOP maintenance		The AOP is initialised by the Airport Operator but the content will be maintained and updated by the responsible stakeholders when appropriate to do so.		All	N/A			All	OBJ-0201-003
005	AOP contents and access		The AOP contains the latest information on the planned airport operations. All the airport stakeholders have access to the		All	N/A			All	OBJ-0201-001 OBJ-0201-002 OBJ-0201-003 OBJ-0201-004

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment
			elements of the AOP relevant to their operations and business needs.							
006	Operations during flight trials		Every procedures, organisation (ATS Services) and operations are running in nominal situation		Arrival Turn-round Departure	N/A			All	OBJ-0201-001 OBJ-0201-002 OBJ-0201-003 OBJ-0201-004

Table 18: Demonstration Assumptions

Appendix D Qualitative Results assessment: Questionnaires

D.1 Gaming questionnaires

Different types of questionnaires have been developed to address all the HF issues and objectives (E-CRA LSD project and HF objectives):

Simulation Questionnaires

These questionnaires have been given to every actor involved in the gaming session after each simulation. They are focused on gathering data related to the characteristics of the simulation scenarios.

The main goal is to obtain information about specific alerts and pre-defined solutions and evaluate the suitability of the information presented to the user to undertake specific tasks.

0. Simulation environment					
0.1 The exercise details (traffic characteristics, traffic flow, taxi times…) were...	Not realistic at all	Far from reality	Adapted to reality	Very realistic	//
1. Distribution/delivery of alerts					
1.1 (Bad weather scenario) Weather alerts are properly presented.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.2 (Runway Maintenance Scenario) Runway status data in the alerts is properly presented.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.3 (Runway Maintenance Scenario) Runway maintenance data in the alerts is properly presented.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.4 (High Traffic Demand Scenario) Capacity modification data in the alerts is properly presented.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.5 (High Traffic Demand Scenario) Maximum Capacity alerts are properly presented.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
2. Timeliness and prioritization of the data.					
2.1 Pre-defined solutions prioritize airport resources in adverse conditions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3. Accessibility of the commands and functions					
3.1 The number and sequence of actions to be undertaken to manage alerts is adequate	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3.2 The number and sequence of actions to be undertaken to manage pre-defined solutions is adequate	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4. Automation and decision making					
4.1 You were ahead of the traffic, able to predict the evolution of the traffic	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4.2 Your overall situation awareness increase during this exercise.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4.4 The alerts help you to have a better understanding of the situation.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

5. Concept Operation					
5.1 Decisions have been discussed and agreed in a collaborative way	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5.2 Regarding the pre-defined solutions available, you believe that they are….	Inadequate	Not very adequate	Adequate	Optimum	//

Daily Questionnaires

These questionnaires have been given to every actor involved in the gaming session only one time at the end of the session.

They are focused on collecting feedback related to generic characteristics of the solution.

The main goal is to obtain general aspects about the management of the platform and the alerts and solutions.

0. Simulation environment					
0.1 I think the training and information received to carry out this exercise was...	Very inadequate	Inadequate	I needed help	Adequate	Optimum
0.2 I only use the Platform and I do not need any other tool to perform my job.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	//
1. Distribution/delivery of alerts					
1.1 Alerts are easy to find and intuitive.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.2 You did not have any difficulty finding an item of information you need	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Would you like to include any improvement in the delivery of alerts/data/information. Which ones?					
2. Coherence and consistency of the presented information					
2.1 The presentation of the new features (alerts, impacts, solutions, FUM messages,…) is concise, comprehensive and eases to work in a collaborative way.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
2.2 The information presented is not contradicted by any information displayed to other actors.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
2.3 Alarm information is relevant for me to perform my job.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3. Timeliness and prioritization of the data.					
3.1 Alerts provide information in a timely manner, easing decision-making process.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3.2 Impacts of alerts are received in a timely manner.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3.3 Alert management is quick and easy.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4. Accessibility of the commands and functions					
4.1 It was difficult to access significant or important information	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

4.2 The data input is performed in a simple manner	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4.3 The interaction with graphical objects is easy and quick	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5. Automation and decision making					
5.1 You were able to better plan and organise your work	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5.2 The tasks defined in the new procedures are suitable to run operations efficiently.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5.3 The new procedures improve the collaborative work in an efficient way	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
What are the positive characteristics of automation (alerts) in the platform that will increase your confidence in it?					
6. Workload & Trust					
6.1 Based on your of experience please indicate your overall amount of trust in the system.	No trust	Barely trust	Trust	Completel y trust	//
6.2 The platform permitted to work properly in adverse situations	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
6.3 The number of alerts are only the necessary ones	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
6.4 Your workload decrease during the exercise in peak or adverse traffic situations	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
7. Concept Operation					
7.1 Communications/coordinations between you and the team have improved	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
7.2 Communications with NMOC have been improved	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Additional remarks					

Final Questionnaires

The last type of questionnaires has been given to every actor involved in the gaming session only the last day of the simulations[5].

They are focused on collecting feedback related to three important HF goals for the project: Situational Awareness. Workload and Acceptance and Trust

The main goal is to obtain an overall picture about those three relevant aspects using standard ATM questionnaires.

Simulation and Daily questionnaires share the same structure and questions are grouped according to relevant HF issue and project categories:

- Simulation environment

[5] Acceptance and Trust questionnaire has been delivered to the actors before using the platform and at the end of the demonstration session.

- Distribution/delivery of Alerts
- Timeliness and prioritization of the data
- Accessibility of the commands and functions
- Automation and decision making
- Concept operation
- Additional remarks

Final questionnaires are standard questionnaires used by the ATM community to assess common important issues such as workload, situational awareness and acceptance and trust.

Acceptance and Trust (SATI)

SATI questionnaire provides a trust measure. SATI questionnaire is part of the SHAPE questionnaires developed by EUROCONTROL to assess the effect of automation on controller workload, situation awareness, teamwork and trust in the system.

The SHAPE questionnaires have many advantages: they are easy to use, not highly demanding on the participants, and they can be easily analysed.

Workload (Bedford Workload Scale)

The Bedford Workload Scale is a modification of the Cooper-Harper rating scale, originally developed for pilots and it is a scale that rates the following aspects: task completeness, acceptable workload and performance appropriateness.

Situational Awareness

In order to assess situational awareness we have chosen a decision tree diagram which was developed in the VINTHEC and used in several other projects like ADAHR. The actor basically answered a yes/no-statement, which in case of a negative evaluation leads to an index of situational awareness, or in case of a positive evaluation to the following yes/no-statement.

D.2 Live Trials questionnaires

Two questionnaires have been made to cover the chat functionality and the quality/type of information showed in the E-CRA Live trial Platform. These questionnaires covered the main issues available in the Platform. They were delivered to all the stakeholders using the platform.

In addition, other three different types of questionnaires were developed and delivered depending on the human role performed in the demonstrations. These questionnaires were focused in the What-if analysis functionality:

- One questionnaire was delivered to the ECRA Controller/Airport operator supervisors. This questionnaire was focused in the planner and decision making role of these supervisors in the demonstration session. It consisted of several questions regarding the What-if analysis functionality.
- Another questionnaire was delivered to both ECRA Platform supervisors (i.e. ECRA Controller and ECRA Airport Operator). This questionnaire was focused on the level of acceptance and trust on the functionality.
- A questionnaire related to the level of workload perceived by the ECRA Supervisor using the platform was also done. This workload questionnaire let assess in a primary approach if the workload s feasible to future implementations in real operations by a real stakeholder operator.

These questionnaires were based on standard questionnaires used by the ATM community to assess acceptance and trust and workload: SATI and Bedford Workload Scale. Below more information about them is included. They were delivered at the end of the live trial demonstration session.

Acceptance and Trust (SATI)

SATI questionnaire provides a trust measure. SATI questionnaire is part of the SHAPE questionnaires developed by EUROCONTROL to assess the effect of automation on controller workload, situation awareness, teamwork and trust in the system.

The SHAPE questionnaires have many advantages: they are easy to use, not highly demanding on the participants, and they can be easily analysed.

Workload (Bedford Workload Scale)

The Bedford Workload Scale is a modification of the Cooper-Harper rating scale, originally developed for pilots and it is a scale that rates the following aspects: task completeness, acceptable workload and performance appropriateness.

Information						
1. You did not have any difficulty finding an item of information you need	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
2. The information presented in the platform is not contradicted by any other information displayed to other actors or other available tools.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
3. Information contained in the chat is relevant for me to perform my job.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
4. It was difficult to access significant or important information	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
5. The interaction with graphical objects is easy and quick	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--

6. I only use the Platform and I do not need any other tool to be aware of the current situation.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
7. Your overall situation awareness increase during this exercise.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
8. Communications/coordinations between you and other stakeholders have improved	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
9. I think the training and information received to carry out this exercise was...	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
10. In case an alert occurred, the information contained was relevant for me to perform my job.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
11. In case an alert occurred, the alert was easy to find and intuitive.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--
12. Which of the following piece of information have been more useful to you?	ELDT	EOBT	TOBT	MET Info	Stand Info	Map view
13. Which additional information would you like to have?						--
14. Did you notice the automatic update of the ELDT (Estimated Landing Time)?	Yes	No	--	--	--	--
15. The updated ELDT is useful to me to perform my job	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	--

Chat functionality					
1. The chat functionality facilitate decision making.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
2. The chat functionality helps you to have a better understanding of the situation.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3. Chat messages are easy to find and intuitive.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4. Chat messages are received in a timely manner.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5. Chat functionality management is quick and easy.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
6. Would you like to include any improvement in the chat functionality? Which ones?					

What-if functionality					
1. I think the training and information received to carry out this exercise was...	Very inadequate	Inadequate	I needed help	Adequate	Optimum
2. I only use the Platform and I do not need any other tool to perform my job.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3. The What-if analysis functionality enables the decision–making process	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4. Based on your of experience, please indicate your overall trust on the what-if analysis functionality provided by the platform.	Untrustful	Barely trustful	Trustful	Highly trustful	--
5. Regarding the available what-if solutions, you believe that they were… Why ?	Inadequate	I needed help	Adequate	Optimum	--
6. The What-if solutions were concise and comprehensive.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
7. The What-if solution information was relevant to me to take a decision.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
8. The ECRA Platform provided the what-if solutions in a short period of time.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
9. The number of what-if solutions was appropriate enabling me to find out the best option.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
10. The What-if solutions prioritise airport resources in no nominal conditions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

Appendix E EXE-0201-002 details

E.1 EXE-0201-002 Checklist

Step #	Time Limit	Actor	Action
D Day			
1	EOBT - 3hr	Network Manager	Send FUMs concerning flights from and to Bordeaux airport
		Ground Handler	Plan resources and teams depending on flight times updates
		E-CRA Demonstration Platform	Receive FUMs and update information (Flight planning and AOP fields depending on received estimates
2	Step1 + 15 min	E-CRA Demonstration Platform	Update and send to stakeholders of estimated times (ELDT) and AOP fields depending on received FUMs and other data
		ANSP (Airport Tower Supervisor)	Optimise departure and arrival sequence, and: Adjust runway capacity Adjust runway configuration Change runway from 05/23 to 11/29 depending on MET information
		Airport Operator (Airport Duty Officer)	Update resources planning, in reaction to MET information and arrival and departure sequences planned by ATC
		Airport Operator (Stand Planner)	Manage teams depending on ELDT updates
3	T-Time – 1h	Each involved Airline	Define flights preferences internal to its own fleet (Optional Action)
		Ground Handler	Update TOBT
		E-CRA Demonstration Platform	Receive flights preferences and send it to different stakeholders (ground handler, ANSP)
		Maintenance Center (SABENA)	Mobilisation of an aircraft towing vehicle (human and material resources) up to targeted times
4	T-Time -5min	ANSP	Handle the expected very large aircraft for ATS (operations on the principal runway)
			Optimise arrivals and departure sequences, depending on estimated TO or landing time, taking into account runway in use. Update TSATs via TOBTs
		E-CRA Demonstration Platform	Update of AOP fields Update of MET data
5	T-Time + 5min	ANSP	A380 TO clearance

Step #	Time Limit	Actor	Action
6	T-Time +10mn	Airport Operator (Airport Duty officer)	Mandatory runway scanning, and runway sweeping in case of a departure (or if necessary for an arrival) Update of runway maintenance duration
		Ground Handler	Perform ground handling operations and update TOBTs
		E-CRA Demonstration Platform	Update of AOP fields
7	T-time + 30mn	ANSP	Operations recovery once the runway 23 is available
		Airlines	Manage departures and arrivals depending on AOP updates
		E-CRA Demonstration Platform	Record DEPARTURE INFORMATION on the Demonstration Platform.

E.2 EXE-0201-002 chat phraseology

Step#	Time	Actor	Action	Chat
1	T-2h	E-CRA DP	Live Trials estimated start time	"@All Estimated start time XX:XX. Let us know when you are ready"
		ANSP	Ready status confirmation	"@All ANSP READY"
		Airport	Ready status confirmation	"@All Airport READY"
		Airlines	Ready status confirmation	"@All Airline READY"
		ANSP	"What-if" situation preparation	
		ANSP	RWY change information	"@All Estimated time for RWY change XX:XX."
		ANSP	Adjust RWY capacity (continuous action)	
		Airport	Aircraft stands update	
2	T-1h	ANSP	Send "What-if" situation to E-CRA DP	
		ANSP	A380 take off info (continuous action)	"@All ETOT for A380 XX:XX."
		Airlines	Flight preferences (continuous action)	
		Airlines	Update TOBT (if necessary)	
		E-CRA DP	Change TOBT on the platform info (if necessary)	
		ANSP	Switch RWY from 23 to 29	"@All RWY switched from 23 to 29"
		ANSP	A380 status info	"@All A380 push back"
3	T-30m	E-CRA DP	Send "What-if" results to ANSP	
		ANSP	Update TSAT after "What-if" results study (if necessary)	
		ANSP	A380 status info	"@All A380 lined up"
		ANSP	A380 ETOT update	"@All ETOT for A380 XX:XX."
4	T	**A-380 TAKE OFF**		

Step#	Time	Actor	Action	Chat
5	T+1m	ANSP	A380 Take off confirmation, close all RWY's	"@All A380 is off, RWY's are closed"
		ANSP	Update end of cleaning operations time (continuous action)	"@All RWY inspection will finish at XX:XX"
		ANSP	Update TSAT	
		Airlines	Update TOBT	
		E-CRA DP	Change TOBT on the platform info	
		Airport	Aircraft stands update (if necessary)	
		ANSP	Update RWY 29 opening info	"@All RWY 29 reopened"
		ANSP	Update RWY 23 opening info	"@All RWY 23 reopened"
6	T+30m	E-CRA DP	Live Trials end time	"@All Live trial is OVER, thanks all"
		ANSP	End of trial confirmation	"@All ANSP STOP"
		Airport	End of trial confirmation	"@All Airport STOP"
		Airlines	End of trial confirmation	"@All Airline STOP"

Table 19: Actors-Actions-Chat check list EXE-0201-002

E.3 EXE-0201-002 results: Quantitative metrics

Quantitative outputs

Landing and take-off indicators defined in §5.2.1 are indicated below for each EXE-0201-002 run and associated what-if simulations. Tables are expressed in UTC times and in *hh:mm* format.
Reminder:

$$KPI_L = ALDT - ELDT \qquad KPI_{TO} = ATOT - ETOT$$
$$\Delta_L = \boldsymbol{ELDT - ELDT'} \qquad \Delta_{TO} = \boldsymbol{ETOT - ETOT'}$$
$$\boldsymbol{KPI'_L = ALDT - ELDT'} \qquad \boldsymbol{KPI'_{TO} = ATOT - ETOT'}$$

L means *landing* and TO *take off*. The data with prime (') are related to the "what-if" output.

The goal of the original indicators assessment was to observe if an improved KPI_L and KPI_{TO} (a more accurate ELDT closer to ALDT and ETOT closer to ATOT, respectively) could be achieved during the live demonstrations due to the benefits of a connection to the Network at regional airport level.

The new indicators, Δ_i represents the difference between actual data and the "what-if" predictions (a trustworthy test), and KPI'_i is the indicator calculated based on the assumption that the "what-if" prediction was chosen in the post analysis to assess improvements in predictability.

Hence if $KPI'_L < KPI_L \; and/or \; KPI'_{TO} < KPI_{TO}$ then it can be said that predictability has been improved.

Execution #1

Collected data are not accurate enough to be taken into account in quantitative outputs conclusions.

Execution #2

ArrCallSign	ELDT	ALDT	KPI	ΔL (11:50)	ΔL (11:25)	KPI'L(11:50)	KPI'L(11:25)
KLM1315	10:34	10:48	-0:14	0:00	0:00	0:14	0:14
AF258AG	11:04	10:53	0:10	0:00	0:00	-0:10	-0:10

Table 20: Execution #2 - Landing indicators

DepCallSign	ETOT	ATOT	KPI	ΔTO (11:50)	ΔTO (11:25)	KPI'TO(11:50)	KPI'TO(11:25)
AF625GY	10:13	10:29	-0:16	0:00	-0:20	0:16	-0:03
EZY82KW	10:23	10:33	-0:10	0:00	-0:14	0:10	-0:03
AF261YO	10:38	10:39	-0:01	0:00	-0:05	0:01	-0:03
AF627ZW	11:18	11:20	-0:02	0:00	-0:24	0:02	-0:21
UAE2558 (A380)	11:23	11:21	0:02	-0:35	-0:02	-0:36	-0:03
KLM1316	11:33	11:40	-0:07	0:00	-0:04	0:07	-0:03

Table 21: Execution #2 – Take off indicators

Outputs of observations and indicators analysis are:

- Any arrival flight is impacted by the event while only one departure is (KLM1316).
- The accuracy of the demonstration platform is verified: outputs from the "what-if" simulation with an A380 departure at 11:25 are the closest to the real operations ($ATOT_{A380}$: 11:21).
- Indicators for KLM1316 are: **KPI'_{TO} (11:25)** = -0:03 and **KPI** = -0:07. This shows an improvement of predictability.

Execution #3

ArrCallSign	ELDT	ALDT	KPI	ΔL (10:25)	ΔL (10:35)	ΔL (10:45)	ΔL (10:50)
AF622YB	10:05	10:26	-0:21	0:00	0:00	0:00	0:00
KLM1315	10:31	10:38	-0:07	-0:17	0:00	0:00	0:00
EZY108Y	10:36	10:45	-0:09	-0:17	-0:22	0:00	0:00
AF258AG	11:05	11:07	-0:02	0:00	0:00	0:00	0:00

ArrCallSign	ELDT	ALDT	KPI	KPI' (10:25)	KPI' (10:35)	KPI' (10:45)	KPI' (10:50)
AF622YB	10:05	10:26	-0:21	0:21	0:21	0:21	0:21
KLM1315	10:31	10:38	-0:07	-0:17	0:00	0:00	0:00
EZY108Y	10:36	10:45	-0:09	-0:17	-0:22	0:00	0:00
AF258AG	11:05	11:07	-0:02	0:00	0:00	0:00	0:00

Table 22: Execution #3 – Landing indicators

DepCallSign	ETOT	ATOT	KPI	ΔTO (10:25)	ΔTO (10:35)	ΔTO (10:45)	ΔTO (10:50)
EZY82KW	10:23	10:25	-0:02	0:00	0:00	0:00	0:00
BAW75U	10:23	10:29	-0:06	0:00	0:00	0:00	0:00
EZY53EM	10:28	10:41	-0:13	-0:20	0:00	0:00	0:00
EZS67XF	10:38	10:48	-0:10	-0:19	-0:25	-0:05	-0:05
UAE2558	11:23	10:52	0:30	0:21	0:15	0:15	0:25
AF261YO	10:38	11:04	-0:26	-0:15	-0:20	0:00	-0:30

DepCallSign	ETOT	ATOT	KPI	KPI' (10:25)	KPI' (10:35)	KPI' (10:45)	KPI' (10:50)
EZY82KW	10:23	10:25	-0:02	0:02	0:02	0:02	0:02
BAW75U	10:23	10:29	-0:06	0:06	0:06	0:06	0:06

DepCallSign	ETOT	ATOT	KPI	KPI' (10:25)	KPI' (10:35)	KPI' (10:45)	KPI' (10:50)
EZY53EM	10:28	10:41	-0:13	-0:06	0:13	0:13	0:13
EZS67XF	10:38	10:48	-0:10	-0:09	-0:15	0:05	0:05
UAE2558	11:23	10:52	0:30	-0:09	-0:15	-0:15	-0:05
AF261YO	10:38	11:04	-0:26	0:10	0:06	0:26	-0:03

Table 23: Execution #3 – Take off indicators

Outputs of observations and indicators analysis are:

- Any arrival flight is impacted by the event while only one departure is (AF261YO).
- The accuracy of the demonstration platform is verified: outputs from the "what-if" simulation with an A380 departure at 10:50 are the closest to the real operations ($ATOT_{A380}$: 10:52).
- Indicators for AF261YO are: **KPI'_{TO}(10:50)** = -0:03 and **KPI** = 0:26. This shows an improvement of predictability.

Execution #4

ArrCallSign	ELDT	ALDT	KPI	ΔL (11:05)	ΔL (11:15)	ΔL (11:20)	ΔL (11:30)
N977SA	10:08	9:52	0:15	0:00	0:00	0:00	0:00
AF622YB	10:03	10:14	-0:11	0:00	0:00	0:00	0:00
KLM1315	10:26	10:31	-0:05	0:00	0:00	0:00	0:00
AF258AG	11:02	11:09	-0:07	0:00	0:00	0:00	0:00
RYR7707	12:16	12:26	-0:10	0:00	0:00	0:00	0:00
AF260NV	12:43	13:07	-0:24	0:00	0:00	0:00	0:00

ArrCallSign	ELDT	ALDT	KPI	KPI' (11:05)	KPI' (11:15)	KPI' (11:20)	KPI' (11:30)
N977SA	10:08	9:52	0:15	-0:15	-0:15	-0:15	-0:15
AF622YB	10:03	10:14	-0:11	0:11	0:11	0:11	0:11
KLM1315	10:26	10:31	-0:05	0:05	0:05	0:05	0:05
AF258AG	11:02	11:09	-0:07	0:07	0:07	0:07	0:07
RYR7707	12:16	12:26	-0:10	0:10	0:10	0:10	0:10
AF260NV	12:43	13:07	-0:24	0:24	0:24	0:24	0:24

Table 24: Execution #4 – Landing indicators

DepCallSign	ETOT	ATOT	KPI	ΔTO (11:05)	ΔTO (11:15)	ΔTO (11:20)	ΔTO (11:30)
RYR6655	10:08	10:22	-0:14	0:00	0:00	0:00	0:00
EZY82KW	10:23	10:35	-0:12	-0:01	-0:01	-0:01	-0:01
AF261YO	10:38	10:37	0:00	0:00	0:00	0:00	0:00
AF625GY	10:24	10:47	-0:23	-0:06	-0:06	-0:06	-0:06
AF627ZW	11:14	11:15	-0:01	-0:02	0:08	0:08	0:08
KLM1316	11:23	11:25	-0:02	0:00	-0:05	-0:10	0:00

DepCallSign	ETOT	ATOT	KPI	ΔTO (11:05)	ΔTO (11:15)	ΔTO (11:20)	ΔTO (11:30)
UAE2558	11:23	11:36	-0:13	0:19	0:19	0:04	-0:06
CTM1306	11:38	11:54	-0:16	0:00	0:00	0:00	-0:05
AF263PE	12:03	12:01	0:01	0:00	0:00	0:00	0:00

DepCallSign	ETOT	ATOT	KPI	KPI' (11:05)	KPI' (11:15)	KPI' (11:20)	KPI' (11:30)
RYR6655	10:08	10:22	-0:14	0:00	0:00	0:00	0:00
EZY82KW	10:23	10:35	-0:12	-0:01	-0:01	-0:01	-0:01
AF261YO	10:38	10:37	0:00	0:00	0:00	0:00	0:00
AF625GY	10:24	10:47	-0:23	-0:06	-0:06	-0:06	-0:06
AF627ZW	11:14	11:15	-0:01	-0:02	0:08	0:08	0:08
KLM1316	11:23	11:25	-0:02	0:00	-0:05	-0:10	0:00
UAE2558	11:23	11:36	-0:13	0:19	0:19	0:04	-0:06
CTM1306	11:38	11:54	-0:16	0:00	0:00	0:00	-0:05
AF263PE	12:03	12:01	0:01	0:00	0:00	0:00	0:00

Table 25: Execution #4 – Take off indicators

Outputs of observations and indicators analysis are:

- Any arrival flight is impacted by the event while only one departure is (CTM1306).
- The accuracy of the demonstration platform is verified: outputs from the "what-if" simulation with an A380 departure at 11:30 are the closest to the real operations ($ATOT_{A380}$: 11:36).
- Indicators for CTM1306 are: **KPI'_{TO}(11:30)** = -0:05 and **KPI** = 0:16.

Conclusions

Quantitative outputs show that the predictability on departures is improved due to the sharing of AOP information update (with local and NMOC information) and the use of a "what-if" simulation tool.

Appendix F EXE-0201-003 details

F.1 EXE-0201-003 operational sequence

The operational procedure prepared for this gaming is as follows:

Step #	Time Limit	Actor	Action
0	METEO Alert	ANSP	48h before, the MET Alert Cell monitors TAFs and METARs evolution and if the disruption is confirmed, an Alert is triggered
1	5:25	E-CRA DP	Live Trials estimated start time
		ANSP	Ready status confirmation
		Airport	Ready status confirmation
		Airlines	Ready status confirmation
2	5:30	Airlines	Flight preferences
			Update TOBT (if necessary)
		E-CRA Demonstration Platform	Set TOBT on the platform info (if necessary)
		ANSP	"What-if" parameters request preparation (if necessary)
		Airport	Aircraft stands update
3	5:35	ANSP	Send "What-if" parameters request to E-CRA DP (if necessary)
4	5:40	E-CRA Demonstration Platform	Send "What-if" results to ANSP (if necessary)
		ANSP	Set new TSAT after "What-if" results study (if necessary)
5	5:50	**LVP ON**	
6	5:51	Airlines	Flight preferences (continuous action)
7	6:00	ANSP	Set RWY capacity (4 Arrivals / h) (4 Departures/h)
			Set new TSAT (if necessary)
		Airlines	Update TOBT (for each impacted flight)
		Airport	Aircraft stands update (if necessary)
		E-CRA DP	Set new TOBT and stands on the platform info (for each impacted flight)
8	6:50	ANSP	Set RWY capacity (6 Arrivals / h) (6 Departures/h)
			Set new TSAT (if necessary)
		Airlines	Update TOBT (for each impacted flight)

Step #	Time Limit	Actor	Action
8	6:50	Airport	Aircraft stands update (if necessary)
		E-CRA DP	Set new TOBT and stands on the platform info (for each impacted flight)
9	7:10	**LVP OFF**	
10	7:35	ALL	Back to normal situation
11	12:40	ANSP	Prevent all stakeholders about the thunderstorm alert
12	12:45	ANSP	"What-if" parameters request preparation (if necessary)
13	12:55	**THUNDERSTORM START**	
13	12:56	ANSP	Close all RWY's (Report to all)
			Set the RWY's capacity to 0
14	13:10	**THUNDERSTORM END**	
15	13:11	ANSP	Update RWY's opening info (Report to all)
			Set the new RWY's capacity
		Airlines	Flight preferences
			Update TOBT (Following airlines procedures, there will be a delay due to no-boarding and no-flight movement on the platform during thunderstorm, this delay should be added to the RWY's closure one. No flight should have TOBT before 13h25
		Airport	Aircraft stands update
		E-CRA DP	Set new TOBT and stands on the platform info (for each impacted flight)
16	14:00	ALL	Back to normal situation
17	14:01	E-CRA DP	Gaming session end time
		ANSP	End of gaming confirmation
		Airport	End of gaming confirmation
		Airlines	End of gaming confirmation

Table 26: EXE-0201-003 Procedure for gaming

The procedure was planned under the following criterion:

- First Meteo Event: **Fog** - the event is planned in the simulated airport environment during 1h around the morning traffic peak. An LVP is active during this period and the RWY capacity is adapted to the low visibility
- Second Meteo Event: RWY closure due to **thunderstorm** – this event is triggered under DSNA recommendations after the reception of MET alerts and airlines procedures will impact TOBTs to cause strong delays and/or cancellations. Event duration is around 15 minutes, in a traffic peak from 12h55 to 13h10.
- It will be time enough between events to return to normal situation.
- The simulation speed can be accelerated/decelerated when it is necessary.

Time	05:50	06:00	06:50	7:10
RVR (m)	600	100	200	950
Action	LVP ON (T_i)	4 Arr,Dep/h	6 Arr,Dep/h	LVP OFF (T_f)

Table 27: MET events timeline

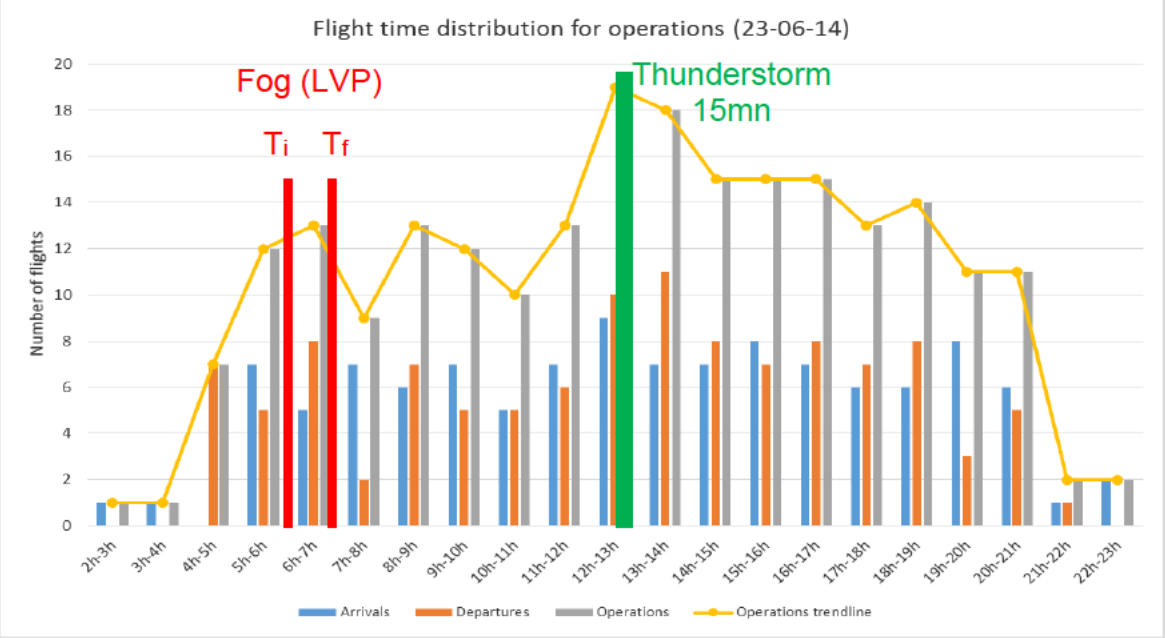


Figure 16: MET events timeline regarding flights distribution

The chosen day is the 23rd of June 2014, the nominal day selected for the tests and during this day, the most crowded periods were selected to verify if the stakeholders were real adapted to the platform interface and use.

F.2 EXE-0201-003 chat phraseology

Step#	Time	Actor	Action	Chat
0	T-48h	ANSP	48h before, the cell monitor TAFs and METARs evolution and if the disruption is confirmed, an Alert is triggered	
1	T-1h30	E-CRA DP	Live Trials estimated start time	"@All Estimated start time XX:XX. Let us know when you are ready"
		ANSP	Ready status confirmation	"@All ANSP READY"
		Airport	Ready status confirmation	"@All Airport READY"
		Airlines	Ready status confirmation	"@All Airline READY"
2	T-1h20	Airlines	Flight preferences	
		Airlines	Update TOB's (if necessary)	
		E-CRA DP	Set TOBT's on the platform info (if necesary)	

Step#	Time	Actor	Action	Chat
		ANSP	"What-if" parameters request preparation	
		Airport	Aircraft stands update	
3	T-1h	ANSP	Send "What-if" parameters request to E-CRA DP	
		ANSP	Close all RWY's for airside inspection before LVP is activated (if it has not been performed before).	"@RWY's are closed for airside inspection"
		ANSP	Set the RWY capacity to 0	
		ANSP	Update RWY's opening info (Set the new RWY capacity)	"@All RWY's reopened"
4	T-30m	E-CRA DP	Send "What-if" results to ANSP	
		ANSP	Set new TSAT's after "What-if" results study (if necessary)	
5	T	**LVP STARTS**		
6	T+1m	ANSP	Set RWY capacity following procedure	"@All RWY capacity is XX aircraft movements per h"
		Airlines	Flight preferences (continuous action)	
		Airlines	Update TOBT's (for each impacted flight)	
		Airport	Aircraft stands update (if necesary)	
		ANSP	Set new TSAT's (if necessary)	
		E-CRA DP	Set new TOBT's and stands on the platform info (for each impacted flight)	
7	T+1h	E-CRA DP	Live Trials end time	"@All Live trial is OVER, thanks all"
		ANSP	End of trial confirmation	"@All ANSP STOP"
		Airport	End of trial confirmation	"@All Airport STOP"
		Airlines	End of trial confirmation	"@All Airline STOP"

Table 28: Actors-Actions-Chat check list EXE-0201-003

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