Final Project Report

Deliverable ID:	**D1.2**
Dissemination Level:	**PU**
Project Acronym:	**PJ.04 - TAM**
Grant:	**733121**
Call:	**H2020-SESAR-2015-2**
Topic:	**Total Airport Management**
Consortium Coordinator:	**ADP (SEAC2020)**
Edition date:	**05 December 2019**
Edition:	**01.00.00**
Template Edition:	**02.00.01**

Founding Members
EUROPEAN UNION EUROCONTROL
SESAR JOINT UNDERTAKING

Authoring & Approval

Authors of the document

Name/Beneficiary	Position/Title	Date
O. DELAIN / ADP (SEAC2020)	PJ.04 Project Manager	04/10/ 2019
L. LAPTEVA / ADP (SEAC2020)	PJ.04 Contributor	04/10/ 2019
J.M. RÍSQUEZ/ENAIRE (INECO)	PJ04-01 Solution Leader	04/10/ 2019
M. RODRÍGUEZ/ENAIRE (INECO)	PJ04-01 Deputy Solution Leader	04/10/ 2019
F. PIEKERT / DLR(AT-ONE)	PJ04-02 Solution Leader	04/10/ 2019
A. MARSDEN / EUROCONTROL	PJ04 Deputy Project Manager	04/10/ 2019
A. INARD / EUROCONTROL	PJ04 Project Content Integration Lead	17/10/2019

Reviewers internal to the project

Name/Beneficiary	Position/Title	Date
O. DELAIN	ADP (SEAC2020) representative	24/10/2019
E. MIKLOS	LPS SR (B4) representative	-
M. STOJNIĆ CCL/COOPANS IAA/COOPANS LFV/COOPANS Naviair/COOPANS	On behalf of COOPANS SESAR Programme Manager	23/10/2019
J. FERNÁNDEZ	ENAIRE representative	-
J.M. RÍSQUEZ	ENAIRE representative and PJ.04-01 solution leader	-
M. RODRÍGUEZ	INECO representative	-
A. MARSDEN	EUROCONTROL representative	-
M.-T. MELONI	Ethics and Project Quality Leader	23/10/2019
A. INARD	PCIT Leader	-
F. ROUSSEAU	ATOS (FSP) representative	22/10/2019
G. QUILES	INDRA representative	-
D. KJENSTAD	SINTEF (NATMIG) representative	-
G. MARRAZZO	LEONARDO representative	-
F. CARLO	THALES AIR SYS representative	-
F. PIEKERT	DLR (AT-ONE) representative and PJ.04-02 Solution Leader	22/10/2019
H. KALITA	PANSA (B4) representative	-

E. DEROGEE	SNBV (SEAC2020) representative	-
D. SKOGLUND	Swed (SEAC2020) representative	-
A. GRIMM	MUC (SEAC2020) representative	24/10/2019
R. GROSMANN	NLR (AT-ONE) representative	-
F. HØLVOLD	Avinor-SEAC2020 representative	-
T. ROBINSON	HAL (SEAC2020) representative	-

Approved for submission to the SJU By - Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date
O. DELAIN	ADP (SEAC2020) representative	29/10/2019
E. MIKLOS	LPS SR (B4) representative	28/10/2019
M. STOJNIĆ CCL/COOPANS IAA/COOPANS LFV/COOPANS Naviair/COOPANS	On behalf of COOPANS SESAR Programme Manager	23/10/2019
J. FERNÁNDEZ	ENAIRE representative	28/10/2019
J.M. RISQUEZ	ENAIRE representative and PJ04-01 Solution Leader	28/10/2019
M. RODRÍGUEZ	INECO representative	28/10/2019
A. MARSDEN	EUROCONTROL representative	28/10/2019
M.-T. MELONI	Ethics and Project Quality Leader	28/10/2019
A. INARD	PCIT Leader	28/10/2019
F. ROUSSEAU	ATOS (FSP) representative	22/10/2019
G. QUILES	INDRA representative	28/10/2019
D. KJENSTAD	SINTEF (NATMIG) representative	28/10/2019
G. MARRAZZO	LEONARDO representative	28/10/2019
F. CARLO	THALES AIR SYS representative	28/10/2019
F.PIEKERT	DLR (AT-ONE) representative and PJ.04-02 Solution Leader	22/10/2019
H. KALITA	PANSA (B4) representative	28/10/2019
E. DEROGEE	SNBV (SEAC2020) representative	28/10/2019
D. SKOGLUND	Swed (SEAC2020) representative	28/10/2019
A. GRIMM	MUC (SEAC2020) representative	24/10/2019
R. GROSMANN	NLR (AT-ONE) representative	28/10/2019
F. HØLVOLD	Avinor-SEAC2020 representative	28/10/2019

T. ROBINSON	HAL (SEAC2020) representative	28/10/2019

Rejected By - Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date

Document History

Edition	Date	Status	Author	Justification
00.00.01	18/09/2019	Draft	Ludmila LAPTEVA	Initial draft
00.00.02	20/09/2019	Draft	Olivier DELAIN	Consolidated Draft
00.00.03	15/10/2019	Draft	Florian PIEKERT José Manuel RÍSQUEZ Anthony INARD Alan MARSDEN Ludmila LAPTEVA / Olivier DELAIN	Consolidation of PJ.04-02 section Consolidation of PJ.04-01 sections Consolidation of PCIT sections Consolidation of Communication sections Consolidation of the document for EPMB approval
00.00.04	22/10/2019	Draft	Florian PIEKERT José Manuel RÍSQUEZ Anthony INARD Alan MARSDEN Olivier DELAIN	Version for EPMB review and approval
00.01.00	29/10/2019	Proposed	Olivier DELAIN José Manuel RÍSQUEZ Anthony INARD Alan MARSDEN Olivier DELAIN	Version after EPMB review and approval
01.00.00	05/12/2019	Final	Olivier DELAIN	Final version after SJU feedback and comments.

Copyright Statement

PJ.04 - TAM

PJ.04 TOTAL AIRPORT MANAGEMENT

This Final Project Report is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 733121 under European Union's Horizon 2020 research and innovation programme.

Abstract

SESAR PJ04 project aka ***TAM Total Airport Management***, proposes the evolution toward a "performance-driven" airport through holistic monitoring of demand and capacity and the decision making based on more reliable information with enhanced decision impact assessment. The project aims at increasing predictability, flexibility and efficiency of airport operations as well as resilience through shorter recovery to normal operations.

The project PJ04 - TAM delivered two (2) SESAR Solutions through which dedicated tasks to support validation activities have been performed:

- Solution PJ.04-01 ***'Enhanced Collaborative Airport Performance Planning and Monitoring'*** builds on the work performed in SESAR1 specifically in relation to SESAR Solution #21 ('Airport Operations Plan and AOP-NOP Seamless Integration'). Solution PJ.04-01 seeks to further increase the 'quality' of the AOP through the inclusion of an increased set of data capturing the knowledge coming from a wider range of airport processes. (*V3 ongoing Solution maturity achieved*).

- Solution PJ.04-02 ***'Enhanced Collaborative Airport Performance Management'*** focuses on an enhanced collaborative airport performance management, facilitated by access to real-time information captured in the form of performance dashboards showing 'what has happened', 'what is happening' but importantly 'what is predicted to happen'. Work has been performed in the specific context of environmental impact planning and monitoring in order to ensure that environmental performance is fully integrated into the airport operations management process (*Partial V2 Solution maturity achieved*).

Table of Contents

List of Tables

Executive Summary[1]

One of the four key focus areas of the SESAR2020 Work Programme is on 'High Performing Airport Operations' and the TAM project is an integral element therein. As can be understood by the project title, TAM is concerned with taking a 'holistic' view of airport operations, including all of the key processes (aircraft, passengers, baggage, …) and importantly, the interaction between them, as it is the degree of synchronisation between these different processes which constitutes a significant contributory factor to punctual and predictable operations and ultimately therefore passenger satisfaction.

The entire scope of the PJ04 TAM project is encapsulated into two SESAR Solutions.

Solution PJ.04-01 ***'Enhanced Collaborative Airport Performance Planning and Monitoring'*** builds on the work performed in SESAR1 specifically in relation to SESAR Solution #21 ('Airport Operations Plan and AOP-NOP Seamless Integration'). Solution PJ.04-01 seeks to further increase the 'quality' of the AOP through the inclusion of an increased set of data capturing the knowledge coming from a wider range of airport processes.

Building on the framework of Airport Collaborative Decision Making (A-CDM), which is essentially focusing on the aircraft (departure) process, Solution PJ.04-01 additionally includes the monitoring of the landside processes to improve the predictability of the departure estimate. The inclusion of new processes into the AOP, such as Passenger with Reduced Mobility (PRM) and Baggage, has been used to see how these landside processes are performed and detect any impact in airside operations. The aim is to improve the monitoring of airport operations through the inclusion of aircraft, passengers and baggage processes, to ensure the maximum degree of synchronization between them and improve departure time predictability and stability. Further work has taken place in PJ04-01 in the area of turnaround process monitoring and including specifically the notion of automated milestone generation in an A-CDM (Airport Collaborative Decision Making) context which could provide sufficient motivation for regional airports to commit to deployment, generating both local performance benefits and improved network predictability. The integration of airports into the ATM network has been historically addressed to an extent through both the A-CDM initiative and also within SESAR1 program through the area of AOP/NOP (Airport Operations Plan / Network Operations Plan) data sharing and exchange. The further development of the collaborative management of both en-route and airport capacity constraints through target times has taken place leading to more flexible constraint management and with increased involvement of all key stakeholders.

Finally, the provision of tools supporting post-operations analysis and thereby 'closing the loop' between the historic airport performance and behavior of specific key performance indicators (KPIs) and the definition of the airport performance steering parameters as defined in SESAR1 has taken place. PJ04-01 developed and validated concepts and systems to support the recording and timely analysis of specific events and the ability to quickly find, merge, analyze and replay airport data with

[1] The opinions expressed herein reflect the author's view only. Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein.

linkage to other stakeholder tools (e.g. radar and r/t playback plus aircraft data) to assist the analysis of specific events.

One of the gaps identified through SESAR 1 was that all the results were mainly focused on Large Airports. To avoid this gap PJ04 has developed a deployment scenario where a whole type of airports will be taken into account.

Solution PJ.04-01 successfully achieved v2 maturity and conducted initial v3 activities through five exercises in 2019. The self-maturity assessment made at the end of this phase of the project provides confidence that V3 maturity level can be achieved in the next phase of the project.

Solution PJ.04-02 ***'Enhanced Collaborative Airport Performance Management'*** focuses on an enhanced collaborative airport performance management, facilitated by access to real-time information captured in the form of performance dashboards showing 'what has happened', 'what is happening' but importantly 'what is predicted to happen'. Work has been performed in the specific context of environmental impact planning and monitoring in order to ensure that environmental performance is fully integrated into the airport operations management process.

Solution PJ.04-02 builds on the SESAR 1 work and extends it to include managing impacts on the operation and carrying out post-ops analysis. The collaborative decision-making concept (CDM) is extended and validated in this solution. The concept is extended into the landside operation and considers total airport demand capacity balancing (TADCB), not just the runway. The concept it extended to include What-if analysis, as a tool to help solve the impacts on the operation. The monitoring of the operation and the display of the solutions are all included on a performance dashboard so that operations managers can see at a glance what the operational status is as well as how solutions to problems might change those key performance indicators. With a focus on Airside/Landside performance and how they are linked, MET, User Driven Prioritization Process (UDPP) and extending the airport management into proactive management of environmental factors the solutions aims to improve airport operations and efficiency.

The collaborative management of airport performance will also be facilitated by the inclusion of additional information into the AOP covering meteorological probabilistic forecasts. Continuing on the theme of integrating airports into the network and as part of the demand and capacity balancing approach, the Solution has been working with PJ07 to ensure that the process of airspace user oriented flight prioritisation (UDPP) is fully integrated into the APOC decision-making procedures.

Solution PJ.04-02 aims to holistically provide enhanced means of situation assessment, improving situation awareness, and enhanced collaborative decision making support, enabling the airport operational stakeholders to collaboratively plan airport operations on the best available information.

As with all SESAR2020 Industrial Research Projects, the focus is on a 'staged' development process creating a 'pipeline' toward deployment. The project performed a number of different concept development activities with increasing levels of maturity over time and at each stage provided evidence of the performance benefits to be expected as well as more transversal elements covering safety, security and associated costs and benefits. The aim is to ensure that the final operational concept delivered by the project is safe, cost effective and provides performance benefits, specifically in the areas of predictability, flexibility and efficiency.

Solution PJ.04-01 successfully reached v1 maturity and progressed towards achieving v2 maturity. According to self-maturity assessment, the Solution PJ.04-02 reaches partial v2 maturity at the end of

this phase so that all OIs, except environmental aspects ("environmental performance and restrictions accommodated in the Airport Operations Plan"), reach the v2 maturity.

Project partners have been analysing and come to the conclusion that the described grouping of operational improvements allocated to each PJ.04 Solution is not optimal to continue R&D activities in the next phase of this project which ultimately targets the optimal deployment scenario perspective. Therefore the TAM project in the next R&D phase is proposed to be structured in such a way that one operational work package will focus on the airport and its role in the Network, while another one will concentrate on airport centric operational issues.

'Network Connected Airports' work package will include:

- Solution 28.1 - Network-Connected Regional Airports (targeting V3 maturity)
- Solution 28.2 - Regional Airport(s) collaborative management (targeting V2 maturity)
- Solution 28.3 - Connected Large Airports (targeting V3 maturity)

'Digital Smart Airports' work package will include:

- Solution 29.1 - Airside/Landside Performance Management (targeting V3 maturity)
- Solution 29.2 - MET Performance Management (targeting V3 maturity)
- Solution 29.3 - ENV Performance Management (targeting V2 maturity)

1 Project Overview

1.1 Operational/Technical Context

The starting point for the Total Airport Management (PJ.04) project are the results and conclusions reached in the v3 maturity phase of Solution #21 at the end of SESAR1 program. This SESAR solution ("Airport Operations Plan and its seamless integration with the network operations plan") introduced means to manage operations in a collaborative and pro-active way, through the definition of an Airport Operations Plan (AOP) and the AirPort Operations Centre (APOC). Solution #21 was also linked with solution #20 'Collaborative NOP' due to the concept integration needed with the Airport Operations Plan.

Through the validation of this solution, primary performance improvements and benefits identified included an increase of predictability, flexibility and efficiency of airport operations as well as a better use of airport capacity and increased resilience through pro-active management. Validation activities also stressed the need to further develop the Performance Monitoring and Management services promoting the evolution from a reactive ("firefighting") approach toward one of pro-active collaborative decision making.

As a consequence the evolution towards a 'Total Airport Management' approach within this project shall be assured through a closer integration of both landside and airside performance monitoring as well as the development and validation of monitoring and decision support tools for the collaborative management between stakeholders. These tools have to be optimised according to the information requirements of the relevant ATM stakeholder users that are involved in the collaborative airport performance management. Further work has also to be conducted in the specific context of environmental impact planning and monitoring in order to ensure that environmental performance is fully integrated into the airport operations management process on planning and execution levels.

Therefore the project PJ04 - TAM proposes the evolution toward a "performance-driven" airport through holistic monitoring of demand and capacity and the decision making based on more reliable information with enhanced decision impact assessment. The project aims at increasing predictability, flexibility and efficiency of airport operations as well as resilience through shorter recovery to normal operations.

In the specific case of adverse weather conditions, further development is needed concerning the impact on airport and ATM Network performance. With the availability of enhanced meteorological forecast information, planning uncertainties shall be reduced by improved impact assessment tools that deliver occurrence and impact probabilities and shall be used to create impact scenarios that act as necessary decision support inputs to the multi-stakeholder collaborative decision-making process. In parallel, the procedures and information requirements for multiple stakeholders, including the ATM Network Manager, related to the collaborative recovery from such adverse conditions shall be further developed.

The management of airport operations in both adverse and normal operations has to be optimised through the further development of 'what-if' decision support tools, self-learning airport business intelligence predictive tools and user-defined performance dashboards.

Furthermore, the project also considers the specific needs of smaller or regional airports by ensuring that the concept is scalable as a function of the traffic and potential network impact. Such airports are often key drivers of the local economy and it is important to note that there is not a 'one size fits all' approach. The concept must be scalable so that only those elements bringing most benefit at an affordable level will be implemented locally. The Total Airport Management concept shall be deployable at any airport of the whole ECAC area. This does not mean that every single enabler needs to be deployed at every single airport. PJ.04 shall provide a well-grounded, smart approach by identifying which OI steps, and in particular which technological enablers should be implemented. The solutions are validated by the PJ.04 consortium in a set of airports which represent relevant types of operating environments and airport sizes.

The project was thus articulated around two 'SESAR Solutions', emphasising all of the key airport processes.

1.1.1 Solution PJ.04-01 "Enhanced Collaborative Airport Performance Planning and Monitoring"

The Solution PJ.04-01 builds on the work performed in SESAR1 programme specifically in relation to SESAR Solution #21 ('Airport Operations Plan and AOP-NOP Seamless Integration'). This solution focused on demonstrating how the Airport Operations Plan (AOP) improved the situation awareness of Airport Stakeholders, through common information sharing, and how the exchange of information between AOP and the Network Operations Plan (NOP) improved the integration of airports in the overall ATM network.

The main operational limitations and issues identified during SESAR 1 programme included:

- The need for an efficient interface between AOP (Airport Operations Plan) and NOP (Network Operations Plan) in terms of parameters to be sent and quality of information. The current limitation is that data exchanged might not be reliable, especially regarding time data (e.g. Target Off Block Times (TOBT) and Target Times of Arrival (TTA);
- The poor knowledge of impact of landside activities on the airside performance of the airport and thus on the ATM Network. The inclusion of outputs from landside processes (in particular passenger and baggage) are then expected to provide improved accuracy and predictability of airport operations.
- The need to provide airport stakeholders with early warning indicators of possible delays along the turn-round critical path. This will not alter the ownership if the turnaround on the ramp, activities or decision making but to provide stakeholders with alert(s) so that the appropriate authority can pro-actively manage the situation.
- The requirement to better integrate regional airports in the Network. Currently the integration of airports into the ATM Network is achieved through either the A-CDM concept or the Advanced Tower concept. A third category of airport (regional airports) is proposed where a reduced set of A-CDM milestones is implemented and calculated in a quasi-automatic fashion - reducing the need for Airline / Ground Handler inputs. Such an approach relies on the stability and predictability of taxi-times which is considered as feasible in such airports. This is an opportunity to simplify the work needed to manually update A-CDM milestones and enable the connection of regional airports to the Network Operations Centre (NMOC).

- The need for automation of post operations analysis activities

The identified improvements built upon Airport Collaborative Decision Making process covered:

- Increased information sharing through the introduction of the airport transit view concept (ATV) which is the local set of data describing the path and operations linked to an aircraft during its "visit" to the airport, passenger flow and MET data;
- Improvement of turn around process by connecting the data update process to flight status instead of fixed times (event based) and increased anticipation prior to flight execution;
- Connection of the airport with the Network Manager, and
- Improvement of pre-departure sequence through integration of passenger flow related milestones.

The Solution PJ.04-01 aims to keep improving the 'quality' of the AOP information through the inclusion of an increased set of data, captured from a wider range of airport processes. Building on the framework of Airport Collaborative Decision Making (A-CDM), which is essentially focussing on the aircraft (departure) process, this solution additionally includes the monitoring of the landside processes to improve the predictability of the departure estimate. The inclusion of new processes into the AOP, such as Passenger with Reduced Mobility (PRM) and Baggage, is used to see how these landside processes are performed and detect any impact in airside operations. The aim is to improve the monitoring of airport operations through the inclusion of aircraft, passengers and baggage processes, to ensure the maximum degree of synchronisation between them and improve departure time predictability and stability.

Specific work took place in this solution in the area of turnaround process monitoring and including specifically the notion of automated milestone generation in an A-CDM context which could provide sufficient motivation for regional airports to commit to deployment, generating both local performance benefits and improved network predictability.

The integration of airports into the ATM Network has been historically addressed to an extent through both the A-CDM initiative and also within SESAR1 through the area of AOP/NOP data sharing and exchange. The further development of the collaborative management of both en-route and airport capacity constraints through target times took place leading to more flexible constraint management and with increased involvement of all key stakeholders.

Finally, the provision of tools supporting post-operations analysis and thereby 'closing the loop' between the historic airport performance and behaviour of specific KPIs and the definition of the airport performance steering parameters as defined in SESAR1 took place. The Solution PJ.04-01 develops and validates concepts and systems to support the recording and timely analysis of specific events and the ability to quickly find, merge, analyse and replay airport data with linkage to other stakeholder tools (e.g. radar and r/t playback plus aircraft data) to assist the analysis of specific events.

1.1.2 Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management"

The primary objective of the Solution PJ.04-02 is to provide the framework to enable airport stakeholders to efficiently conduct overall impact assessments and collaborative decision-making, taking into account the most up to date information available and predict future situations.

The Solution PJ.04-02 builds on the SESAR 1 work of Total Airport Management and extends the work to include managing impacts on the operation ('Manage Airport Performance' service) and carrying out post-operations analysis ('Perform post operations analysis service) which did not reach v3 maturity level.

The main operational limitations and issues identified during SESAR 1 programme included:

- The requirement to better anticipate future airport landside/airside performance in order to collaboratively limit the magnitude of any anticipated airport performance deterioration. The impacts of landside processes are not considered at present but need to be and these also have an impact on the predictability and stability of the Target Off Block Time (TOBT) that the ATM operations rely on. The ability to predict and detect problems in the airport using post-operations and machine learning could be the key innovations that bring increased predictability to the operations.
- The limited capability of the airport to assess how future (forecast) meteorological conditions are going to affect performance, and decide how to react in advance. There is no indication with that weather forecast of what the impact might be on the operations of the airport. As a result the airport is not able to prepare adequately to take mitigating actions as there is no connection between a forecast weather event and the associated operational risk.
- The need for new collaborative procedures between airspace users, airports and air navigation service provides. If some manual collaborative processes for recovery management exist, these need to be supported by tools to better manage disruptions, consider airspace users' preferences and priorities as well as to speed up the recovery to normal operations.
- The requirement for all ATM stakeholders (Airspace Users, Air Navigation Service Providers and Airport Operators) to take into account the (typically local) environmental restrictions and considerations in all stages of operational planning and execution. Environmental sustainability is a well-recognised restriction for both the operation and growth of Airports. There is a need to bring environmental performance metrics into the tactical planning and operation of an airport as a key driver for operational planning decisions.

The collaborative decision-making concept (CDM) is extended and validated in this solution. The concept is extended into the landside operation and considers total airport demand capacity balancing (TADCB), not just the runway. The concept it extended to include What-if analysis, as a tool to support the identification of impacts on the operations and find suitable mitigation actions. The monitoring of the operation and the display of the solutions are all included on a performance dashboard so that operations managers can see at a glance what the operational status is as well as how solutions to problems might change those key performance indicators (KPIs). With a focus on Airside/Landside performance and how they are linked, MET, User Driven Prioritization Process (UDPP) and extending the airport management into proactive management of environmental factors the solutions will improve airport operations and efficiency.

This solution, based on four operational improvements, provides holistically enhanced means of situation assessment, improving situation awareness, and enhanced collaborative decision making support, enabling the airport operational stakeholders to collaboratively plan airport operations on the best available information. Specific functionalities can be unlocked by each individual operational

improvement or by the combination of the four operational improvement steps. Beyond this, each operational improvement offers individual functionalities that will further provide benefits to the stakeholders, depending on the different airport types that are addressed.

1.2 Project Scope and Objectives

1.2.1 Solution PJ.04-01 "Enhanced Collaborative Airport Performance Planning and Monitoring"

Five operational improvements are addressed by the Solution PJ.04-01 which are:

- **Collaborative airport planning interface (AO-0801-B)**
  This operational improvement addresses the maintenance of the evolving content of the Airport Operations Plan (AOP) including:
    - Finalization of AOP-NOP information sharing that would ultimately lead the European standardization;
    - Procedures to support AOP-NOP collaborative process, including AOP-NOP information quality requirements,
    - Exchange of AOP-NOP information through System Wide Information Management (SWIM), and
    - Integration of local business rules of the airports if and where necessary.
- **A-CDM process enhanced through integration of landside (passenger and baggage) process outputs (AO-0802-B)**
  This operational improvement addresses the enhancement of the airside process with the inclusion of landside (passenger and baggage flow) process outputs that can affect ATM performance e.g. through delayed departures. This concept builds upon A-CDM to describe the functional and technical requirements for inclusion of landside processes at an airport in both the planning and execution timeframe
- **Extended turn-round monitoring within the APOC (AO-0818)**
  This operational improvement addressed the turn-round of an individual airframe which is under the control of Airspace Users. By monitoring key aspects of the turnaround process, the Airport Operations Centre (APOC) shall get an early warning indicator of process and infrastructure inefficiencies / issues / failures, resulting in possible delays.
- **Post-operations analysis support solutions and reporting capabilities (AO-0821)**
  Timely analysis of specific events and post operations reporting through a coherent set of support tools are expected to support a continuous learning environment.
- **Network connected regional airports (AO-0824)**
  This operational improvement addresses the connectivity between regional airports and the Network Operations Centre (NMOC) through the provision of Departure Information Messages (DPI). Those DPIs are based on target times and a reduced set of turnaround milestones compared to the full A-CDM implementation.

1.2.2 Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management"

Four operational improvements are addressed by SESAR PJ04 Solution 2 which are:

- **Enhancement of Airside/Landside Performance Management (AO-0814)**
  This operational improvement addresses Airport Airside/Landside Performance Management which can be enhanced through incorporation of a rationalised dashboard fed with all landside and airside. This is expected to lead key performance indicators covering Total Airport Management processes such as passenger, baggage or stand, and achieved thanks to:
    - Awareness on potential airport performance degradation (through integrated models that forecast future performance);
    - Impact assessment and evaluation of predefined solution scenarios trading-off KPIs (supported by previously-performed post-analysis activities, and possibly by machine learning capabilities, integrated models that permit stakeholders to model what-if scenarios);
    - Collaborative Demand and Capacity Balancing (DCB) decision-making between airport stakeholders for potential re-evaluation of solution scenarios and selection of the one that would consist in the best trade-off between key performance areas (KPAs) and best limit the overall airport performance deterioration;

- **Pro-active management of meteorological impacts (AO-0819)**
  This operational improvement addresses the anticipation of impacts of a potential meteorological condition will allow to limit possible airport performance deterioration, i.e. limiting the degradation of key performance indicators as best as possible.

  The pro-active management of meteorological impacts will be achieved thanks to:
    - Awareness on probability of occurrence intensity and time of various predicted meteorological conditions, especially potentially disruptive weather events;
    - Traffic data including flight plan trajectory (with the help of big data and machine learning);
    - Impact assessment of those key predicted weather events on airport performance (through integrated models that forecast future performance, permitting stakeholders to possibly model what-if scenarios);
    - Evaluation of pre-defined solution scenarios (e.g. specific runway-in-use scheme, rerouting strategy) possibly supported by previously-performed post-analysis activities and machine learning capabilities;
    - Collaborative DCB decision-making between airport stakeholders for selection of the scenario that would best limit the overall airport performance deterioration.

- **Pro-active Collaborative Management of Predicted Performance Deterioration via UDPP (AO-0820)**
  This operational improvement addresses collaborative recovery procedures and associated predictive and decision support tools - limited to User Driven Priority Process (UDPP)). These will support Airport, Airspace Users, Network and Air Navigation Service Providers to anticipate,

understand and collaboratively manage disruptive adverse events at the airport to reduce impact and knock-on effect, optimising solutions whilst ensuring that users' end-to-end processes are managed.

- **Enhancement of Environmental Performance Management (AO-0822)**
  This Operational Improvement is intended to bring the question of environmental performance into the demand capacity balancing decision-making process. The inclusion of environmental parameters into the Airport Operations Plan is expected to permit:
    - During the planning phase (performance steering), the definition of targets covering specifically environmental performance
    - During the execution phase, an accurate monitoring of environmental performance included in the overall airport performance dashboard as well as alerts relating to the degree of conformance to the environmental targets identified during the planning phase.
    - An increased focus during the post-operations analysis phase on environmental performance including an enhanced understanding of the reasons behind any deviations.

1.3 Work Performed

1.3.1 Solution PJ.04-01 "Enhanced Collaborative Airport Performance Planning and Monitoring"

The Solution PJ04.01 was led by ENAIRE with the contribution of the following PJ.04 partners: ADP (SEAC2020), LPS SR (B4), EUROCONTROL, INDRA, LEONARDO, THALES AIR SYS, DLR (AT-One), SNBV (SEAC2020), Swed (SEAC2020), MUC (SEAC2020), AVINOR -SEAC2020), HAL (SEAC2020) and NLR (AT-One).

1.3.1.1 Solution scope definition

PJ.04-01 work formally started at the beginning of December 2016 by reviewing both the regulatory framework in link with the Solution scope and the work performed in SESAR 1 program since the foundations of the Solution PJ.04-01 are rooted in the SESAR 1 material such as Solution #21" Airport Operations Plan (AOP) and its seamless integration with the Network Operations Plan (NOP)", Solution #18 "CTOT to TTA for ATFCM" and Solution#20" Collaborative NOP".

The PJ.04-01 partners refined the high level solution description and clarified its content as being made of five Operational improvements (OIs), each of them being supported by enablers. The following table provides the list of operational improvement and associated enablers covered by solution PJ.04-01, taking the European ATM Architecture Data Set 19 (DS19) as the reference.

OI	OI description	Enablers (Dataset 19)	Enabler description
AO-0801-B	Collaborative Airport Planning Interface (Airport Operations Plan (AOP) fully integrated	AIRPORT-02b	Enhanced Airport Impact Assessment Tool
		AIRPORT-03b	Enhanced Airport Operation Plan Tool
		AOC-ATM-20	Sharing of trajectory data between AOC/WOC and the ATM world using B2B web services

OI	OI description	Enablers (Dataset 19)	Enabler description
	with Network Operations Plan (NOP) and local business rules)	HUM-010	New role of APOC representative from Ground Handling Agent
		NIMS-25	Integration of Airport CDM data into Network DCB sub-system
		NIMS-46	Integrated local DCB working position
		NIMS-48	Integrated Network Working Position (iNWP)
		NIMS-52	Enhancement of ETFMS for including airport constraints
		PRO-095	Airline Operational Procedures for modifying RBT/ATV including agreed TTA to accommodate selected priorities
		PRO-096	Airline Operational Procedures for modifying RBT/ATV including agreed TTA to accommodate selected priorities
		SWIM-APS-03b	Provision of ASM-ATFCM information services for STEP 2
		SWIM-APS-04b	Consumption of G/G and initial A/G ASM-ATFCM information services on wide area communications
		SWIM-INFR-05b	General SWIM services infrastructure support and connectivity
AO-0802-B	A-CDM process enhanced through integration of landside (passenger and baggage) process outputs	AIRPORT-35b	Airport CDM (level 4 – CDM integrated with landside processes)
		AOC-ATM-13	Participating of the FOC/WOC in the airport triggered CDM process
AO-0818	Extended turn-around monitoring	AIRPORT-03	Airport Operation Plan (AOP) tool
		AIRPORT-35a	Airport CDM (level 4 – CDM integrated with passenger processes)
		AIRPORT-40b	Enhanced Airport Performance Monitoring System (Airside/Landside dashboard)
AO-0821	Post-Operations Analysis support solutions and reporting capabilities	AIRPORT-51	Airport Data Recording System
		AIRPORT-54	Airport Data Analysis System (Post-Ops based on recording)
		AIRPORT-09	Airport Data Replay System
AO-0824	Network Connected Airports	AIRPORT-03c	Light Airport Operations Plan (AOP) Management Tool (for regional airports)
		AIRPORT-38	Airport/ATFCM Extended Data Interface
		AIRPORT-50	Airport Operational Business Model database for determination of CDM event milestones
		AOC-ATM-13	Participating of the FOC/WOC in the airport triggered CDM process
		HUM-014	New interactions and communication patterns for the integration of landside process outputs into the A-CDM process

OI	OI description	Enablers (Dataset 19)	Enabler description
		HUM-015	New working methods for the integration of the landside processes outputs into the A-CDM process
		HUM-016	New working methods for the integration of the airport transit view (ATV) into the A-CDM process
		SWIM-APS-04a	Consumption of G/G and initial A/G ASM-ATFCM information services on wide area communications

Table 1: PJ.04-01 Operational Improvements and Enablers covered by Solution PJ.04-01

1.3.1.2 Validation activities

PJ.04.01 partners refined their plan for the v2 validation exercises from May 2017, based on the operational concept supported by the solution. Prototypes and tools were developed, leading to availability notes (availability of platform and prototypes) for each exercise.

The following table provides a synthetic view of PJ.04-01 v2 validation exercises.

Exercise Id.	Exercise Title	Maturity level & Validation Technique	Airport environment	Exercise location	Date
PJ04-01. v2.01	Integration of impact of passenger and baggage process on aircraft process	V2 (live trial)	Palma de Mallorca Airport	Palma de Mallorca	03/10/2017 to 26/10/2017
PJ04-01. v2.02	Regional airport A-CDM	V2 (shadow mode)	Alicante Airport	Alicante	23/10/2017 to 27/10/2017
PJ04-01. v2.03	Airport Post Operations Analysis Tools	V2 (real time simulation)	Madrid Airport	Madrid	05/04/2018 to 15/06/2018
PJ04-01. v2.04	Landside integration in A-CDM process, Turnaround monitoring and optimisation	V2 (real time simulation)	Lyon Saint-Exupéry airport	Lyon	13/06/2018 to 26/06/2018
PJ04-01. v2.05	Network security and cyber protection of TAM solutions	V2 activity	Lyon Saint-Exupéry airport	Lyon	13/06/2018 to 26/06/2018
PJ04-01.v2.06	Validations of recording and replay system performance and parameters	V2 (real time simulation)	Bratislava M. R. Štefánik airport	Bratislava	18/01/2018 to 30/03/2018

In parallel, WP2 partners updated the project documentation and started SE-DMF and EATMA modelling of the solution using MEGA (EATMA diagrams NOV-2 (node), NOV-5 (activity) and NSV-4 (function).

After finalisation of v2 validation activities, modelling activities and solution documentation (concept, validation, technical specification and cost benefit analysis) were consolidated.

Following SJU successful maturity assessment of the solution, further validation activities were organised and conducted in 2019 at V3 maturity level.

Exercise Id.	Exercise Title	Maturity level & validation technique	Airport environment	Exercise location	Date
PJ04-01. v3.01	Landside process integration in A-CDM and Turnaround Monitoring	V3 (shadow mode)	Lyon Saint-Exupéry airport	Lyon	18/06/2019 to 01/07/2019
PJ04-01. v3.02	Integration of impact of landside processes on aircraft process (large airport)	V3 (live trial)	Palma de Mallorca Airport	Palma de Mallorca	10/09/2019 to 17/09/2019
PJ04-01. v3.03	Rolling AOP/NOP advanced Airport/Network DCB collaborative processes in planning and execution	V3 (shadow mode)	Madrid Airport	Madrid	14/03/2019 to 18/03/2019
PJ04-01. v3.04	Post Operations at large airports	V3 (real time simulation)	Palma de Mallorca Airport	Palma de Mallorca	08/07/2019 to 19/07/2019
PJ04-01. v3.05	Regional Network Integration	V3 (live trial)	Alicante Airport	Alicante	10/04/2019 to 12/04/2019

Table 2: Synthesis of PJ04-01 V&V activities

Note: V2 validations were supplemented by an activity led by THALES LAS France around "Network security and cyber protection of TAM solutions".

1.3.1.3 Solution deliverables

The final v2 Solution's documentation was released in 2018, and included:

- The **V2 Validation Report** providing full details on V2 exercises conducted.

- The **V2 Cost-Benefit Analysis** which, based on the benefit impact mechanisms described in the conceptual documentation, provides a first magnitude of cost estimates and an initial quantitative assessment of benefits.
- The **V2 SPR-INTEROP/OSED** document which contains the operational, safety, performance and interoperability requirements of the SESAR Solution PJ.04-01, including a human performance assessment report and a performance assessment report of the solution.
- The final **V2 TS/IRS** which contains the technical requirements of the Solution, including the architecture modifications of the technical artefacts covering the solution.
- The **V3 validation roadmap** that describes how stakeholder's needs are intended to be validated for the solution PJ.4-01 to reach maturity V3 at the end of the next R&D activities.
- The **V2 Contextual Note** has been finalised in coordination with Project management so that it can be used as communication material and support for further coordination with the SJU.

The solution reached V2 maturity following SJU maturity assessment (February 2019). V3 activities started, refining V3 validation roadmap in a V3 on going validation plan covering 5 exercises in 2019. Prototypes and tools were developed, exercises were conducted leading to deliver the following documentation.

- A V3 ongoing Consolidated VALR, in October 2019
- A V3 ongoing Contextual Note, in October 2019
- A V3 ongoing self-maturity assessment, performed in October 2019.

1.3.2 Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management"

The Solution PJ04.02 was led by DLR (AT-One) with the contribution of the following PJ.04 partners: ADP (SEAC2020), LPS SR (B4), CCL/COOPANS, ENAIRE, EUROCONTROL, ATOS (FSP), SINTEF (NATMIG), LEONARDO, THALES AIR SYS, PANSA (B4), ACG/COOPANS, SNBV (SEAC2020), Swed (SEAC2020), MUC (SEAC2020), AVINOR-SEAC2020, HAL (SEAC2020), NLR (AT-One).

PJ.04.02 formally started at the beginning of December 2016 by reviewing both the regulatory framework in link with the Solution scope and the work performed in SESAR 1;

The PJ.04-01 partners refined the high level solution description and clarified its content as being made of five Operational improvements (OIs), each of them being supported by enablers. The following table provides the list of operational improvements and associated enablers covered by the solution PJ.04-02, taking the European ATM Architecture Data Set 19 (DS19) as the reference.

OI	OI description	Enablers (Dataset 19)	Enabler description
AO-0814	Enhancement of airside/landside performance management	AIRPORT-03b	Enhanced Airport Operation Plan Tool
		AIRPORT-40b	Enhanced airport performance monitoring system (airside/landside dashboard)
		AIRPORT-41	Airport Operations Centre support tools (dashboard)

OI	OI description	Enablers (Dataset 19)	Enabler description
		AIRPORT-42	Tactical Capacity Planning Tools (Airside/Landside)
		AIRPORT-54	Airport Data Analysis System (Post-Ops based on recording)
		HUM-008	Role of APOC supervisor
		HUM-009	New role of APOC representative from Airport Operator
		HUM-010	New role of APOC representative from Ground Handling Agent
		HUM-011	New role of APOC representative from Airspace User
		HUM-012	New role of APOC representative from ANSP
		PRO-249	Procedures linked to Collaborative Airport Performance Management
		AERODROME-ATC-05	Surface movement information processing enhancements to support Total Airport DCB and collaborative airport planning
		AERODROME-ATC-64	Medium short term runway management capacity planning support tool
		AERODROME-ATC-65	Tactical runway management capacity planning support tool
		AIRPORT-07	Decision support processes/tools for airport operations management
		AIRPORT-09	Airport Data replay system
		AIRPORT-12	Airport business intelligence system (machine learning based on historical data)
		AIRPORT-31	Airport CDM (Level 1,2,3)
		AIRPORT-35b	Airport CDM (level 4-CDM integrated with landside processes)
AO-0819	Pro-active management of meteorological impacts	AIRPORT-03c	Light Airport Operational Plan Management Tool (for regional airports)
		AIRPORT-10	Meteo Impact Assessment Tool
		PRO-249	Procedures linked to collaborative airport performance management
		AERODROME-ATC-05	Surface movement information processing enhancements to support Total Airport DCB and collaborative airport planning
		AERODROME-ATC-64	Medium short term runway management capacity planning support tool
		AERODROME-ATC-65	Tactical runway management capacity planning support tool
		AIRPORT-03b	Enhanced Airport Operation Plan Tool
		AIRPORT-07	Decision support processes/tools for airport operations management
		AIRPORT-09	Airport Data replay system
		AIRPORT-11	Meteo Advisory Tool
		AIRPORT-12	Airport business intelligence system (machine learning based on historical data)
		AIRPORT-31	Airport CDM (Level 1,2,3)
		AIRPORT-35b	Airport CDM (level 4-CDM integrated with landside processes)
		AIRPORT-41	Airport Operations Centre support tools (dashboard)
		AIRPORT-42	Tactical Capacity Planning Tools (Airside/Landside)
		AIRPORT-54	Airport Data Analysis System (Post-Ops based on recording)
		HUM-008	Role of APOC supervisor
		HUM-009	New role of APOC representative from Airport Operator
		HUM-010	New role of APOC representative from Ground Handling Agent
		HUM-011	New role of APOC representative from Airspace User
		HUM-012	New role of APOC representative from ANSP

OI	OI description	Enablers (Dataset 19)	Enabler description
AO-0820	Pro-active collaborative management of predicted performance deterioration via UDPP	AIRPORT-03b	Enhanced Airport Operation Plan Tool
		AIRPORT-07	Decision support processes/tools for airport operations management
		AIRPORT-48	Advanced Airport UDPP integrated with AOP monitoring
		AIRPORT-52	DPI/API revision triggered by airport capacity constrained situations
		HUM-008	Role of APOC supervisor
		HUM-009	New role of APOC representative from Airport Operator
		HUM-010	New role of APOC representative from Ground Handling Agent
		HUM-011	New role of APOC representative from Airspace User
		HUM-012	New role of APOC representative from ANSP
		SWIM-APS-03b	Provision of ASM-ATFCM information services for STEP 2
		AOC-ATM-18	FOC adaptation to support UDPP
AO-0822	Enhancement of environmental performance management	AIRPORT-03b	Enhanced Airport Operation Plan Tool
		AIRPORT-34	Airport equipped with (real-time) environmental monitoring systems
		AIRPORT-51	Airport data recording system
		AIRPORT-54	Airport data analysis system (post ops based on recording)
		ENV-05	Guidance for community relations at airports
		ENV-06	Central environmental guidance web portal
		ENV-07	(local) monitoring of environmental performance
		HUM-008	Role of APOC supervisor
		HUM-009	New role of APOC representative from Airport Operator
		HUM-010	New role of APOC representative from Ground Handling Agent
		HUM-011	New role of APOC representative from Airspace User
		HUM-012	New role of APOC representative from ANSP
		PRO-249	Procedures linked to collaborative airport performance management
		AERODROME-ATC-64	Medium short term runway management capacity planning support tool
		AERODROME-ATC-65	Tactical runway management capacity planning support tool
		AIRPORT-07	Decision support processes/tools for airport operations management
		AIRPORT-09	Airport Data replay system
		AIRPORT-12	Airport business intelligence system (machine learning based on historical data)
		AIRPORT-31	Airport CDM (Level 1,2,3)
		AIRPORT-35b	Airport CDM (level 4-CDM integrated with landside processes)

Table 3: Operational Improvements and Enablers covered by Solution PJ.04-02

1.3.2.1 Validation activities

PJ.04-02 partners initiated workshops in V1 maturity phase to test and assess the concept of the solution. Following successful V1 maturity assessment of the solution in January 2018, they refined validation exercises' plans from February 2018, based on the operational concept supported by the solution. Prototypes and tools were developed, leading to availability notes (availability of platform and prototypes) for each exercise.

The following table provides a synthetic view of PJ.04-02 v2 validation exercises.

Exercise Id.	Exercise Title	Maturity level & Validation Technique	Airport environment	Exercise location	Date
PJ04-02. v2.01	Exploiting performance dashboards and what if functionality in the Airport Performance Management	V2 (shadow mode)	Paris Orly Airport	Orly	25/02/2019 to 01/03/2019
PJ04-02. v2.02	Airspace user prioritisation of flights (UDPP) in the framework of collaborative airport performance management	V2 (real time simulation)	Paris CDG Airport	Brétigny-sur-Orge	17/09/2018 to 20/03/2019
PJ04-02. v2.03	Airport learning environment based on post operations analysis	V2 (fast time simulation)	Paris Orly Airport	Orly	25/02/2019 to 01/03/2019
PJ04-02. v2.04	Total Airport DCB incorporating Meteo impact assessment and advisories	V2 (real time simulation)	Oslo airport	Braunschweig	28/01/2019 to 01/02/2019
PJ04-02. v2.05	Airport performance management including what if and environmental parameters in the AOP	V2 activity	Madrid Airport	Madrid	20/05/2019 to 24/05/2019
PJ04-02. v2.06	Pro-active management of Meteo information impacting airport operations	V2 (real time simulation)	Bratislava M. R. Štefánik airport	Bratislava	19/02/2019 to 21/02/2019
PJ04-02. v2.09	Exploiting airport performance management and total airport DCB incorporating environmental considerations	V2 (real time simulation)	Oslo airport	Braunschweig	28/01/2019 to 01/02/2019

Table 4: Synthesis of PJ04-02 V&V activities

In parallel, WP3 partners updated the project documentation and started SE-DMF and EATMA modelling of the solution using MEGA (EATMA diagrams NOV-2 (node), NOV-5 (activity) and NSV-4 (function).

After finalisation of v2 validation activities, modelling activities and solution documentation (concept, validation, technical specification and cost benefit analysis) were consolidated.

1.3.2.2 Solution deliverables

The v1 Solution's documentation was released in early 2018, and included:

- The V1 SPR-INTEROP/OSED document which contains the operational requirements of the SESAR Solution PJ.04-01.
- The V2 validation roadmap that describes how stakeholder's needs are intended to be validated for the solution PJ.4-01 to reach maturity V2.
- The V1 Contextual Note has been finalised in coordination with Project management so that it can be used as communication material and support for further coordination with the SJU.

The solution reached V1 maturity following SJU maturity assessment (January 2018). V2 activities then started, refining V2 validation roadmap in a V2 validation plan. Prototypes and tools to support the exercises were developed, exercises were conducted and analysis reported in a V2 validation report.

The v2 Solution's documentation was released in October 2019 and included:

- The V2 Validation Report providing full details on V2 exercises conducted.
- The V2 Cost-Benefit Analysis which, based on the benefit impact mechanisms described in the conceptual documentation, provides a first magnitude of investment and operating costs required and an initial quantitative assessment of benefits.
- The V2 SPR-INTEROP/OSED document which contains the operational, safety, performance and interoperability requirements of the SESAR Solution PJ.04-0. It also includes a human performance assessment report, a safety assessment report and a performance assessment report of the solution.
- The final V2 TS/IRS which contains the technical requirements and technical architectural elements for PJ.04 Solution 2 underpinning the Total Airport Management concept. The Technical Specification covers all the system Enablers apportioned to PJ.04.02 in the SESAR Roadmap and serves as a blueprint for development of systems and applications for airport performance management.
- The V3 validation roadmap that describes how stakeholder's needs are intended to be validated for the solution PJ.4-02 to reach maturity V3 at the end of the next R&D activities.
- The V2 Contextual Note has been finalised in coordination with Project management so that it can be used as communication material and support for further coordination with the SJU.
- A self-maturity assessment of PJ.04-02 solution against V2 maturity.

1.4 Key Project Results

1.4.1 Solution PJ.04-01 "Enhanced Collaborative Airport Performance Planning and Monitoring"

1.4.1.1 Solution Key Results

The main findings from validation exercises are reported in the PJ.04-01 V2 validation and PJ.04-01 V3 on going validation reports.

Achievements of the solution at V2 maturity level were obtained through validation exercises conducted in different airport environments and using various validation techniques (real time simulation, shadow mode and live trial):

- A live trial at Palma de Mallorca airport validating the landside integration into the Airport Collaborative Decision Making (A-CDM) processes;
- A shadow mode exercise at Alicante airport validating the A-CDM processes in the regional airport settings;
- A real time simulation at Madrid airport validating the Airport Operations Centre (APOC) Post Operations Analysis System (POAS) support solutions and reporting capabilities;
- A real time simulation at Lyon Saint Exupery airport validating the landside integration into the A-CDM process and turn-round monitoring and optimization;
- A real time simulation at Bratislava airport validating the Post Operations Analysis Recording and Replay System for small regional airports.

The key results drawn from validations provided evidence that:

- The integration of the landside into the A-CDM processes improved accuracy and predictability of the airside operations,
- Sharing knowledge on key landside processes improved the predictability and flexibility of the landside operations, with a positive effect on airside operations,
- Predictability and punctuality could be improved due to information sharing. The joint use of AOP-NOP - AMAN has great potential for future implementation in real operations
- Post-operations processes could be used to refine the benefit mechanisms and to establish a performance baseline.

Following successful V2 maturity achievement, V3 validation exercises were conducted using either shadow mode or live trial validation techniques:

- A shadow mode exercise validating the transfer passenger and a subset of turnaround flows at Lyon Saint-Exupery Airport;
- A live trial addressing the impact of integrating landside processes with aircraft process at Palma de Mallorca airport;
- A shadow mode validation about advanced Airport/Network demand and capacity balancing collaborative processes in planning and execution from the airport side;
- A shadow mode simulation validating the Airport Operations Centre (APOC) Post Operations Analysis support solutions and reporting capabilities;
- A live trial validating a simplified and semi-automated approach to A-CDM milestones generation is feasible at regional airport (Alicante Airport).

These exercises addressed stakeholders' needs and assessed the Key Performance Area targets of Airport Operator Efficiency, Predictability and Punctuality. Additional activities to complement and further support the development and validation of the Operational Improvements have been conducted within the transversal performance assessments, most notably the safety, security, and human performance assessments.

1.4.1.2 Solution Maturity

The V2 maturity of the Solution was self-assessed using the maturity assessment tool provided by the SJU. The assessment criteria covered operational, performance, program, standards and regulations, system, transversal and validation threads. The overall results obtained from the assessment of the Solution confirmed the achievement of the V2 maturity level in February 2019. An illustration of the assessment per thread is illustrated in the appendix **Erreur ! Source du renvoi introuvable.**. V3 activities started and five validation exercises were conducted in 2019. The self-maturity assessment made at the end of this phase of the project provides confidence that V3 maturity level could be achieved in the next phase of the project, recognising that such self-assessment has not been reviewed by the SJU in a maturity assessment.

1.4.2 Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management"

1.4.2.1 Solution Key Results

Operational workshops were conducted in V1 maturity phase to assess and consolidate the operational concept associated to this solution.

Achievements of the solution at V2 maturity level were obtained through validation exercises conducted in different airport environments and using various validation techniques (real time simulation, shadow mode and live trial):

- A shadow mode exercise at Paris Orly airport (ICAO code *LFPO*, IATA code *ORY*) validating performance dashboards in the Airport Performance Management. This was completed by an airport learning environment to assess landside and airside predictions based on machine learning technics to support decision making;
- A real time simulation exercise validating airspace User Driven Prioritisation of flights (UDPP) in the framework of collaborative airport performance management using Paris Charles-de-Gaulle airport environment;
- A real time simulation validating total airport Demand and Capacity Balancing (DCB) incorporating meteorological (MET) impact assessment and advisories in Oslo Airport environment ;
- A Real Time Simulation validating airport performance management including 'what-if' parameters in the Airport Operations Plan (AOP) at Madrid Barajas airport;
- A real time simulation validating pro-active management of MET information impacting airport operations at Bratislava airport (ICAO code LZIB, IATA code BTS);

- A real time simulation validating airport performance management and Total Airport DCB (TADCB) incorporating environmental considerations.

The key project results, mostly coming from the V2 validation exercises, are reported in the PJ.04-02 V2 validation report. They can be summarised as follows:

Three operational improvements assessed during the different PJ.04-02 validation exercises:

- Enhancement of Airside/Landside Performance Management [AO-0814];
- Pro-active management of meteorological impacts on the Airport Operations Plan [AO-0819];
- Pro-active collaborative airport/Airspace Users management of predicted performance deterioration via User Driven Priority Process (UDPP) [AO-0820];

However it was not possible to validate whether AO-0822 -"Environmental performance and restrictions accommodated in the Airport Operations Plan (AOP)" has reached V2 maturity level. Further work needs to be done to come to a consensus on that particular aspect of environmental performance in the AOP.

PJ.04 Solution 2 without AO-0822 is V2 mature, and the lack of maturity for AO-0822 shall not prevent progressing the maturity of this solution on the other OIs which have demonstrated their beneficial impacts.

The different exercises have:

- Confirmed the validity of the developed use cases (documented in "SESAR Solution PJ.04-02 SPR-INTEROP-OSED for V2 — Part I. Edition 00.00.05 [2019-07-17]"), especially as far as collaborative decision making is concerned;
- Shown that the dashboard was useful to improve the stakeholders' situational awareness and better understand general situation at the airport and the influence on their particular operations;
- Indicated that collaborative decision making should be made simple and needs not to be overly formal unless required (for history logging and/or traceability for instance). This would reduce the workload of the operators and give them more time to focus on the operational aspects of the situation;
- Highlighted that the training requirements for such a complex new operational concept should not be underestimated and sufficient training needs to be included in the deployment strategy and accounted for in the cost/benefit analysis;
- Confirmed the technical feasibility of PJ.04 Solution 2 and that building operational systems according to the technical requirements is feasible.
- Concluded that indeed PJ.04-02 significantly improves Resilience, and provides benefits for Predictability and Punctuality of airport operations.

It became obvious that further work in the area of predictive analytics including machine learning in support of airport operations management and the collaborative decision-making process between stakeholders must be performed, preferably in Wave 2 follow up projects.

Machine Learning has demonstrated its benefits during the shadow mode exercises, and its potential to predict some airport operation situations. The efficiency of the machine learning process should be increased, through wider access to a larger variety of airport operations parameters, complemented

by an assessment of those parameters to ascertain their usefulness and reliability, and supported by an improvement in modelling the different airport flows.

Human factors may affect how indicators are used by operational users, on the dashboards. Further improvement should be sought on the way the data is presented depending on the user, the usage and purpose.

1.4.2.2 Solution Maturity

The V1 maturity of the Solution was self-assessed using the maturity assessment tool provided by the SJU. The overall results obtained from the assessment of the Solution confirmed the achievement of the V1 maturity level in January 2018.

V2 activities were then conducted. According to self-maturity assessment, the Solution PJ.04-02 reaches partial V2 maturity at the end of wave 1 so that all operational improvements, except environmental aspects ("environmental performance and restrictions accommodated in the Airport Operations Plan") would have reached V2 maturity. An illustration of the assessment per thread is illustrated in the appendix B.2. Nevertheless the "V2 partial" maturity claimed has not been reviewed by the Sesar Joint undertaking in a maturity assessment process.

1.5 Solutions' gaps and limitations

Project partners came to conclusion that current solutions are wide in their scope, focussed on more than one specific airport type, covering both a local and network perspective, encompass different maturity levels. In addition the current grouping of operational improvements is not optimal from a deployment perspective. Therefore an update of the project structure has been proposed for the next project phase to cope with those gaps and limitations. A 'Network Connected Airports' work package will focus on the airport and its role within the Network while a 'Digital Smart Airport' work package will focus on airport-centric issues. Each of them will address three distinct solution , offering significant advantages from a deployment perspective in so far as the OI Steps contained in each solution have a harmonised maturity level, are focussing on specific airport or airport/network issues and finally are harmonised in terms of their applicability to a given airport type.

'Network connected airports' solutions:

- Regional network integrated airports (target V3 finalised)
- Regional airport(s) collaborative management (target V2 on going)
- Connected large airports (target V3 finalised)

'Digital smart airports' solutions:

- Airside/Landside performance management (target V3 finalised)
- MET performance management (target V3 finalised)
- ENV performance management (target V2 finalised)

1.6 Technical Deliverables

1.6.1 Project Management and Ethics

All the Project Management and Ethics deliverables identified in the Grant Agreement have been submitted to the SJU as planned in the PJ.04 project management plan.

Reference	Title	Delivery Date[2]	Dissemination Level[3]
	Description		
D1.1	**Project Management Plan**	29/04/2017	CO
This document provides the planning of the project: the deliverables to be submitted, the exercises to be performed, the communication activities, the maturity gate and the associated deadlines.			
D1.3	**Quarterly Progress Report 01 Q4 2016**	31/01/2017	CO
This document provides a summary of the project activities from the beginning to December 2016.			
D1.4	**Quarterly Progress Report 02 Q1 2017**	29/04/2017	CO
This document provides a summary of the project activities from January to March 2017.			
D1.5	**Quarterly Progress Report 03 Q2 2017**	28/07/2017	CO
This document provides a summary of the project activities from April to June 2017.			
D1.6	**Quarterly Progress Report 04 Q3 2017**	31/10/2017	CO
This document provides a summary of the project activities from July to September 2017.			
D1.7	**Quarterly Progress Report 05 Q4 2017**	31/01/2018	CO
This document provides a summary of the project activities from October to December 2017.			
D1.8	**Quarterly Progress Report 06 Q1 2018**	30/04/2018	CO
This document provides a summary of the project activities from January to March 2018.			
D1.9	**Quarterly Progress Report 07 Q2 2018**	31/07/2018	CO
This document provides a summary of the project activities from April to June 2018.			
D1.10	**Quarterly Progress Report 08 Q3 2018**	30/10/2018	CO
This document provides a summary of the project activities from July to September 2018			
D1.11	**Quarterly Progress Report 09 Q4 2018**	31/01/2019	CO
This document provides a summary of the project activities from October to December 2018.			
D1.12	**Quarterly Progress Report 10 Q1 2019**	30/04/2019	CO
This document provides a summary of the project activities from January to March 2019.			

[2] Delivery data of latest edition
[3] Public or Confidential

D1.13	**Quarterly Progress Report 11 Q2 2019**	26/07/2019	CO
This document provides a summary of the project activities from April to June 2019.			
D1.14	**Quarterly Progress Report 12 Q3 2019**	31/10/2019	CO
This document provides a summary of the project activities from July to September 2019.			
D1.2	**Final Project Report**	31/10/2019	PU
The Final project report summarizes project's goals and achievements and highlights the link between the project activities and SESAR outcomes.			
D4.1	**OEI - POPD - Requirement No. 1**	12/04/2018	CO
This deliverable provides with Applicants' details on personal data collection, incidental findings, protection, retention and destruction and the "data protection consent form" which regulates anonymity in a more stringent manner than that before, in full compliance with the national guidelines/law and new EU legislation.			
D4.2	**M - Requirement No. 2**	12/04/2018	CO
This deliverable provides with Applicants' specific and detailed risk mitigation measures to avoid potential data malevolent/criminal/terrorist misuse.			

Table 5: PJ.04 Project Management and Ethics Deliverables

1.6.2 Solution PJ.04-01 "Enhanced Collaborative Airport Performance Planning and Monitoring"

The following PJ.04-01 documents were submitted to the SJU as planned in the PJ.04 Project Management Plan.

Reference	Title	Delivery Date[4]	Dissemination Level[5]
	Description		
D2.1.050	**V2 VALP**	30/05/2018	CO
The V2 Validation Plan (VALP) document described the validation activities planned for the PJ.04-01 solution to achieve V2 level of maturity.			
D2.1.061	**PJ.04-01.V2.01 Availability Note**	25/05/2018	CO
The document provided the description of the Validation Platform and Prototype implemented by INDRA for the validation exercise PJ04.01.v2.01 Integration of impact of passenger and baggage process on aircraft process (Large Airport) to assess the specification related to AO-0802-B.			

[4] Delivery data of latest edition
[5] Public or Confidential

D2.1.062	**PJ.04-01.V2.02 Availability Note**	30/08/2018	CO
The document provided the description of the Validation Platform and Prototype implemented by EUROCONTROL for the validation exercise PJ04.01.v2.02 Regional airport A-CDM (Medium/small Airport) to assess the specification related to AO-0801-B.			
D2.1.063	**PJ.04-01.V2.03 Availability Note**	30/05/2018	CO
The document provided the description of the Validation Platform and Prototype implemented by CRIDA for the validation exercise PJ04.01.v2.03 Airport Post Operations Analysis Tools (Large Airport) to assess the specification related to AO-0821.			
D2.1.064	**PJ.04-01.V2.04 Availability Note**	27/06/2018	CO
The document provided the description of the Validation Platform and Prototype implemented by THALES for the validation exercise PJ04.01.v2.04 Landside integration in A-CDM process, Turnaround monitoring and optimisation (Medium / small Airport) to assess the specification related to AO-0802-B and AO-0818.			
D2.1.065	**PJ.04-01.V2.05 Availability Note**	25/05/2018	CO
The document provided the description of the Validation Platform and Prototype implemented by THALES for the validation exercise PJ04.01.v2.05 Network security and cyber protection of TAM solutions (Medium / small Airport) to assess the specification related to AO-0802-B and AO-0818.			
D2.1.013	**V2 Contextual Note**	06/02/2019	PU
This is the final version of the contextual note which introduces Solution PJ.04-01. This document complements the technical data pack. It is also public and provides to any interested reader an introduction to this PJ.04-01 SESAR Solution.			
D2.1.031	**V2 MAT Assessment**	15/04/2019	CO
The V2 Maturity Assessment Tool was delivered to the SJU as evidence that V2 maturity level had been achieved by Solution PJ.04-01, with links to the documents demonstrating that the various V2 maturity criteria had been met.			
D2.1.040	**V2 SPR-INTEROP/OSED**	18/01/2019	CO
This document is the final version of V2 SPR-INTEROP/OSED, Parts I, IV and V. This document is part of mandatory documents required for the public V2 data pack. This final document is submitted to the SJU as part of the data pack protocol.			
D2.1.070	**V2 VALR**	16/04/2019	CO
This document is the final version of V2 VALR which updates the precedent version (deliverable D2.1.071) after SJU review. This document is part of mandatory documents required for the public V2 data pack. This final document is submitted to the SJU as part of the data pack protocol.			
D2.1.080	**V2 TS/IRS**	18/01/2019	CO
This document is the final version of V2 TS/IRS which updates the precedent version (deliverable D2.1.083) after SJU review. This document is intended to be a part of mandatory documents required for the public V2 data pack.			

This final document is submitted to the SJU as part of the data pack protocol.			
D2.1.090	**V2 CBA**	16/04/2019	CO
This document is the final version of V2 CBA which updates the precedent version (deliverable D2.1.092) after SJU review. This document is part of mandatory documents required for the public V2 data pack. This final document is submitted to the SJU as part of the data pack protocol.			
D2.1	**V2 Data Pack**	06/02/2019	PU
The V2 data pack provides the pack of mandatory documents required to the v2 maturity gate which are: SPR-INTEROP/OSED V2: • SPR-INTEROP-OSED V2- Part I at V2 level. • SPR-INTEROP-OSED V2- Part IV Human Performance Assessment Report at V2 level. • SPR-INTEROP-OSED V2- Part V Performance Assessment Report at V2 level. TS-IRS V2: The Technical Specification document contains requirements on architecture, functions and capabilities of the technical systems enabling Solution PJ.04-01 validation targets at V2 level. VALR V2: This document provides the results regarding the different validation exercises and how the contribute to the validation of the solution as a whole. CBA V2: This document provides the Cost Benefit Analysis (CBA) at V2 level. The objective is to identify the main elements and assumptions that will support the development of a CBA Model and to quantify and monetize the costs and benefits of the solution.			
D2.1.100	**V3 ongoing VALP**	19/06/2019	CO
The V3 ongoing Validation Plan (VALP) document describes in details the validation activities planned for the solution to achieve V3 ongoing level of maturity. The consolidated VALP gives a comprehensive overview of validation activities planned and provides detailed information on the plans proposed by the five (5) validation exercises from PJ04-01.V3.01 to PJ04-01.V3.05.			
D2.1.111	**PJ.04-01.V3.01 Availability Note**	10/06/2019	CO
The document provided the description of the Validation Platform and Airport Operations Plan prototype implemented by THALES for the validation exercise PJ04.01.v3.01, an exercise addressing the transfer passenger and a subset of turnaround flows at Lyon Saint Exupéry airport.			
D2.1.112	**PJ.04-01.V3.02 Availability Note**	23/09/2019	CO
The document provided the description of the Validation Platform and Airport Operations Plan prototype implemented by INDRA for the validation exercise PJ04.01.v3.02, an exercise addressing the impact of landside processes on aircraft process at a large airport (Palma de Mallorca airport).			
D2.1.113	**PJ.04-01.V3.03 Availability Note**	09/05/2019	CO
The document provided the description of the Validation Platform and prototypes implemented by INDRA (Airport Operations Plan (AOP) and Arrival MANager (AMAN)) and EUROCONTROL (Prototype of Local And Network Tool for Air traffic flow and capacity Management (PLANTA), Network Manager			

	Validation Platform (NMVP)) for the validation exercise PJ04.01.v3.03. This exercise aimed at validating collaborative processes linked to Airport/Network demand and capacity balancing.		
D2.1.114	**PJ.04-01.V3.04 Availability Note**	27/06/2019	CO
	The document provided the description of the Validation Platform and post operations analysis prototype implemented by ENAIRE/CRIDA for the validation exercise PJ04.01.v3.04. The exercise aimed at validating the Airport Operations Centre (APOC) post operations analysis support solutions and reporting capabilities.		
D2.1.115	**PJ.04-01.V3.05 Availability Note**	09/05/2019	CO
	The document provided the description of the Validation Platform and Airport Operations Plan (AOP) prototype implemented by INDRA for the validation exercise PJ04.01.v3.05. The exercise aimed at validating a simplified and semi-automated approach to A-CDM Milestone generation at a regional airport (Alicante Airport).		
D2.1.120	**V3 ongoing VALR**	31/10/2019	CO
	This validation report describes the results coming out of the V3 ongoing validation activities undertaken through the following exercises: • PJ04-01.V3.01: a Shadow Mode exercise validating the transfer passenger and a subset of turnaround flows. The exercise took place at Lyon Saint-Exupery Airport; • PJ04-01.V3.02: a Live Trial addressing the impact of integrating landside processes with aircraft process .The exercise took place at Palma de Mallorca airport; • PJ04-01.V3.03: a Shadow Mode validation of the Demand Capacity Balancing collaborative processes in planning and execution from the airport side. The exercise took place at Barcelona airport; • PJ04-01.V3.04 – A Shadow Mode simulation validating the APOC Post Operations Analysis support solutions and reporting capabilities. The exercise took place at Madrid airport. • PJ04-01.V3.05 – A Live Trial validating that a simplified and semi-automated approach to A-CDM Milestone generation is feasible in a regional airport. The exercise took place at Alicante airport.		
D2.1.130	**V3 ongoing Contextual Note**	31/10/2019	PU
	This contextual note introduces the SESAR Solution PJ04-01. This Solution already achieved a V2 maturity level at the end of 2018. In addition, along 2019, additional activities were performed by giving some first steps towards the V3 maturity level. This report provides to any interested reader an introduction to the SESAR Solution in terms of its scope, main operational and expected performance benefits, relevant system impacts as well as additional activities to be conducted during the following validation phases. This contextual note complements the technical data pack comprising the SESAR deliverables required for further V3 validation		
D2.1.140	**V3 ongoing MAT Assessment**	31/10/2019	CO
	The V3 self-maturity assessment was delivered to the SJU to identify which V3 maturity criteria had been met in this V3 ongoing phase and those which need further activities in subsequent validation phases to reach V3 maturity.		

Table 6: PJ.04-01 Technical Deliverables

1.6.3 Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management"

The following PJ.04-02 documents were submitted to the SJU as planned in the PJ.04 PMP in order to refine the Solution specifications and progress towards V1 maturity (achieved in February 2018), then V2 maturity of the solution.

Reference	Title	Delivery Date[6]	Dissemination Level[7]
	Description		
D3.1.022	**V1 Contextual Note**	22/12/2017	PU
This contextual note introduced the SESAR Solution PJ04-02 which achieved a V1 maturity level at the end of 2017 as foreseen in the H2020 Grant Agreement n°733121. It provided to any interested reader (both external and internal to the SESAR programme) an introduction to the SESAR Solution in terms of its scope, main operational and expected performance benefits, relevant system impacts as well as additional activities to be conducted during the following validation phases foreseen until 2019. This contextual note complemented the technical data pack comprising the SESAR deliverables required for further validation.			
D3.1.043	**V1 SPR-INTEROP/OSED**	28/11/2017	CO
This document presented the PJ.04 TAM Solution 2 ("Enhanced Collaborative Airport Performance Management") concept document, which grouped together six new Operational Improvement steps. The primary objective of this SESAR Solution was to provide the framework to enable airport stakeholders to efficiently conduct collaborative decision making taking into account the most up to date information available. The document presented the scope (E-OCVM maturity level V1) of the individual operational improvements against the context of the 'previous operating method', namely the SESAR1 baseline relating to airport operations management. The proposed benefit measurement mechanisms defines the intended approach to providing evidence about the benefits of Solution 2 across the three different airport environments that are addressed.			
D3.1	**V1 Data Pack**	22/12/2017	PU
The V1 Data Pack consisted of the V1 SPR-INTEROP/OSED document (D3.1.043) and V2 Validation Roadmap (D.3.1.012)			
D3.1.012	**V2 Roadmap**	27/02/2018	CO
This document was the V2 validation roadmap provided at the end of v1 maturity phase. Solution PJ.04-02 targets a V2 maturity level of the solution at the end of SESAR 2020 Wave 1.			

[6] Delivery data of latest edition
[7] Public or Confidential

D3.1.030	**V1 MAT Assessment**	17/01/2018	CO
This deliverable was the process of delivery to the SJU checkpoint			
D3.2.040	**V2 VALP**	09/07/2019	CO

This validation plan described the V2 validation activities planned for solution PJ04-02 – 'Total Airport Management', and covered the following nine exercises:

- PJ04-02.V2.01 : Shadow mode at Paris CDG Airport validating Performance Dashboards in the Airport Performance Management
- PJ04-02.V2.02 : A Real Time Simulation validating Airspace User prioritisation of flights (UDPP) in the framework of collaborative airport performance management , based on CDG airport environment
- PJ04-02.V2.03 : A Fast Time Simulation validating Airport learning environment based on post operations analysis
- PJ04-02.V2.04 : A Real Time Simulation validating Total Airport DCB incorporating MET impact assessment and advisories in Oslo Airport environment
- PJ04-02.V2.05 : A Real Time Simulation validating Airport Performance Management including 'what-if' and environmental parameters in the AOP at Madrid Barajas Airport
- PJ04-02.V2.06 : A Real Time Simulation validating Pro-active management of MET information impacting airport operations in Bratislava Airport
- PJ04-02.V2.09 : A Real Time Simulation validating Airport Performance Management and TADCB incorporating environmental considerations

The VALP consisted of three parts:

- Part I: main document
- Part II: Safety Plan (SAF)

Part IV: Human Performance Assessment Plan (HPAP)

D3.2.040	**V2 VALP**	09/07/2019	CO

This validation plan described the V2 validation activities planned for solution PJ04-02 – 'Total Airport Management', and covered the following nine exercises:

- PJ04-02.V2.01 : Shadow mode at Paris CDG Airport validating Performance Dashboards in the Airport Performance Management
- PJ04-02.V2.02 : A Real Time Simulation validating Airspace User prioritisation of flights (UDPP) in the framework of collaborative airport performance management , based on CDG airport environment
- PJ04-02.V2.03 : A Fast Time Simulation validating Airport learning environment based on post operations analysis
- PJ04-02.V2.04 : A Real Time Simulation validating Total Airport DCB incorporating MET impact assessment and advisories in Oslo Airport environment
- PJ04-02.V2.05 : A Real Time Simulation validating Airport Performance Management including 'what-if' and environmental parameters in the AOP at Madrid Barajas Airport
- PJ04-02.V2.06 : A Real Time Simulation validating Pro-active management of MET information impacting airport operations in Bratislava Airport

- PJ04-02.V2.09 : A Real Time Simulation validating Airport Performance Management and TADCB incorporating environmental considerations

The VALP consisted of three parts:

- Part I: main document
- Part II: Safety Plan (SAF)
- Part IV: Human Performance Assessment Plan (HPAP)

D3.2.050	**PJ.04-02.V2.01 Availability Note**	15/04/2019	CO

This document is the Availability Note of the platform supporting an exercise (PJ04.02-V2.01) in the airport of Paris Orly (ORY) focusing on performance management and including predictive analytics based on machine learning.

This document was submitted following the satisfactory conclusion of both the exercise itself and the associated development and verification activities. The platform described herein was physically located in ORY for the duration of the verification testing and the exercise execution. Verification involved operational experts from SEAC, and the platform development team was coordinated by EUROCONTROL.

D3.2.060	**PJ.04-02.V2.02 APOC Platform Availability Note**	08/02/2019	CO

This document is the Availability Note of the APOC-UDPP Integration Validation Platform jointly developed by PJ.04.02 and PJ.07.02 solution partners, based on PJ04.02 V1 SPR-INTEROP/OSED document, PJ04.02 Validation Plan (VALP) for V1, and prepared in support of the joint validation exercise PJ04.02.v2.02/PJ.07.02.06.

This document was submitted after passing satisfactorily the validation platform testing which involved operational experts from SEAC, participating airspace users and the platform development team coordinated by EUROCONTROL.

D3.2.070	**PJ.04-02.V2.03 Availability Note**	27/03/2019	CO

This document is the Availability Note of the platform supporting an airport learning environment in support of the PJ04.02-V2.03 validation exercise.

This document was submitted after passing satisfactorily the validation platform testing which involved operational experts from SEAC, participating airspace users and the platform development team coordinated by ATOS.

D3.2.080	**PJ.04-02.V2.04 Availability Note**	24/01/2019	CO

This document is the Availability Note of the ACCES Validation Platform developed by DLR with tools integrated from Leonardo and SINTEF, based on PJ04.02 V2 SPR-INTEROP/OSED (Interim) document, PJ04.02 Validation Plan (VALP) for V2 and PJ04.02 TS/IRS (Interim) and prepared in support of the combined validation exercise PJ04.01.v2.04/v2.09. The same document was delivered as D3.2.80 and D3.2.130 as originally two separate exercises and two separate availability notes were planned.

This document was submitted after passing satisfactorily the validation platform testing which involved operational experts from the airports of Oslo and Stockholm and the platform development team coordinated by DLR.

D3.2.090	**PJ.04-02.V2.05 Availability Note**	29/08/2019	CO

This document is the Availability Note of the platform supporting an exercise (PJ04.02-V2.05) at Madrid Barajas (MAD) focusing on performance management and including a what-if' predictive capability in support of the decision-making process.

This document was submitted following the satisfactory conclusion of both the exercise itself and the associated development and verification activities. The platform described herein was physically located in MAD for the duration of the verification testing and the exercise execution. Verification involved operational experts from Aena airports, and the platform development team coordinated by EUROCONTROL.

D3.2.100	**PJ.04-02.V2.06 Availability Note**	27/03/2019	CO

This document is the Availability Note of the AAWDSS Validation Platform developed by LPS SR (B4) and MicroStep-MIS (linked third party of LPS SR (B4)), based on PJ04.02 V2 SPR-INTEROP/OSED (Interim) document, PJ04.02 Validation Plan (VALP) for V2 and PJ04.02 TS/IRS (Interim) and METforTAM Service tailored for Bratislava airport based also on PJ.18.04b TS/IRS both prepared in support of validation exercise PJ04.02.V2.06.

This document was submitted before validation exercise to confirm that the validation platform and service prototype are ready to support validation exercise PJ04-02.V2.06.

D3.2.130	**PJ.04-02.V2.09 Availability Note**	24/01/2019	CO

This document is the Availability Note of the ACCES Validation Platform developed by DLR with tools integrated from Leonardo and SINTEF, based on PJ04.02 V2 SPR-INTEROP/OSED (Interim) document, PJ04.02 Validation Plan (VALP) for V2 and PJ04.02 TS/IRS (Interim) and prepared in support of the combined validation exercise PJ04.01.v2.04/v2.09. The same document was delivered as D3.2.80 and D3.2.130 as originally two separate exercises and two separate availability notes were planned.

This document was submitted after passing satisfactorily the validation platform testing which involved operational experts from the airports of Oslo and Stockholm and the platform development team coordinated by DLR.

D3.2.150	**V2 VALR**	14/10/2019	CO

VALR V2: This document provided the results regarding the different validation exercises and how the contribute to the validation of the solution as a whole.

D3.2.160	**V2 SPR-INTEROP/OSED**	09/08/2019	CO

SPR-INTEROP-OSED V2- Part I: This document defined the operational methods, environments scenarios, uses cases and requirements for the operation concept of the Total Airport Management (TAM) but also the performance requirements associated to the Predictability, Efficiency and Flexibility Key Performance Areas (KPAs) impacting mostly in Airport Operations management and other KPAs impacting in a second stage like Safety, Security and Human Performance besides also interoperability requirements based upon the information Exchange requirements (IERs).

SPR-INTEROP-OSED V2- Part IV: This document contained the Human Performance (HP) assessment report for V2 maturity phase which captures the results of the HP activities conducted according to the HP validation plan and assessment process, newly identified issues and the HP recommendations and requirements.

SPR-INTEROP-OSED V2- Part V: This document provided the Performance Assessment Report for the solution at V2 level.

D3.2.170	**V2 TS/IRS**	29/08/2019	CO
TS-IRS V2: The Technical Specification document contained requirements on architecture, functions and capabilities of the technical systems enabling Solution PJ.04-02 validation targets at V2 level.			
D3.2.180	**V2 CBA**	08/10/2019	CO
CBA V2: This document provided the Cost Benefit Analysis (CBA) at V2 level. The objective was to identify the main elements and assumptions that will support the development of a CBA Model and to quantify and monetize the costs and benefits of the solution.			
D3.2	**V2 Data Pack**	31/10/2019	PU
The V2 data pack provides the pack of mandatory documents required to the v2 maturity gate which are: D3.2.150 V2 VALR, D3.2.160 V2 SPR-INTEROP/OSED, D3.2.170 V2 TS/IRS V2, D3.2.180 V2 CBA.			
D3.2.020	**V2 Contextual Note**	29/10/2019	CO
This contextual note introduced the SESAR Solution PJ04-02 which achieved a V2 maturity level at the end of 2019 as foreseen in the H2020 Grant Agreement n°733121. It provided to any interested reader (both external and internal to the SESAR programme) an introduction to the SESAR Solution in terms of its scope, main operational and expected performance benefits and relevant system impacts. This contextual note complemented the technical data pack comprising the SESAR deliverables required for further validation in follow up SESAR activities			
D3.2.030	**V2 MAT**	29/10/2019	CO
It is the delivery checkpoint of for the submission to the SJU and the deliverable is the V2 maturity self-assessment documentation and it documents the solution's answers to the maturity criteria prescribed for the V2 maturity phase.			
D3.2.010	**V3 Roadmap**	29/10/2019	CO
Solution PJ.04-02 'Enhanced Collaborative Airport Performance Management' focused on an enhanced collaborative airport performance management, facilitated by access to real-time information captured in the form of performance dashboards showing 'what has happened', 'what is happening' but importantly 'what is predicted to happen'. Work was performed in the specific context of environmental impact planning and monitoring in order to ensure that environmental performance is fully integrated into the airport operations management process. This document is the V3 validation roadmap provided at the end of V2 maturity phase. Solution PJ.04 02 targeted a V2 maturity level of the solution at the end of SESAR 2020 Wave 1.			

Table 7: PJ.04-02 Technical Deliverables

2 Links to SESAR Programme

2.1 Contribution to the ATM Master Plan

Code	Name	Project contribution	Maturity at project start	Maturity at project end
PJ.04-01	Enhanced Collaborative Performance Planning and Monitoring	Definition and validation of the v2 operational, performance, technical specification, cost benefit analysis and alignment of EATMA (Release DS19) with project outcomes. a. V2 phase completed (Maturity Gate was passed in February 2019); b. V3 phase initiated, that will be completed in the next SESAR2020 wave 2 phase. Note: only a maturity self-assessment has been performed. Therefore the maturity claimed has not been reviewed by the SJU in a maturity assessment process.	V1 finalized	V3 (on going)
PJ.04-02	Enhanced Collaborative Airport Performance Management	Definition and validation of the V1 and V2 Operational, performance, technical specification, cost benefit analysis and alignment of EATMA (Release DS19) with project outcomes. a. v1 phase completed (Maturity Gate was passed in January 2018); and b. v2 phase partially completed. note: only a maturity self-assessment has been performed. Therefore the maturity claimed has not been reviewed by the SJU in a maturity assessment process.	V1	V2 Partial

Table 8: Project Maturity

2.2 Contribution to Standardisation and regulatory activities

- **Solution PJ.04-01 "Enhanced Collaborative Airport Performance Planning and Monitoring**

Standardization Framework Considerations

It was expected that standardisation will be limited to the definition of the interfaces between those specific data elements needed in the deployment of PJ04-01 and with existing operational systems, as is the case for the EUROCAE (ED145) interface regulation relating to A-CDM. PJ04-01 might therefore lead to an evolution of existing data interface standards.

Any future Standard would therefore be developed with the aim of ensuring that a common approach to implementation can be achieved provided that ATM actors adhere to the prescribed data exchange elements (for information exchange between stakeholders), that data is exchanged in the prescribed format (i.e. using SWIM); and the new airport performance services are introduced following the principle of achieving increased situational awareness and collaborative management of deviations from the operating plan.

It is expected that RNI will be added to the A-CDM Manual for regional airports at a further stage.

Considerations of Regulatory Oversight and Certification Activities

No activity was identified at this stage of the project.

- **Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management**

Standardization Framework Considerations

None of the validation exercises addressed possible regulatory or standardisation aspects, nor depended on changes to the current regulations. It is assumed that standardization beyond what PJ.04-01 provides is not required or the aspects related to the standardization and the regulatory framework could be considered when PJ.04-02 Solution follow up projects are at V3 maturity.

Considerations of Regulatory Oversight and Certification Activities

No activity was identified at this stage of the project.

3 Conclusion and Next Steps

3.1 Conclusions

After having taken into account several CRs regarding the modifications of initials OIs, the project PJ.04, composed of two Solutions addressed a total of 9 Operational Improvements (12 Operational Improvements (OIs) were initially planned). They have been reshaped and finally structured as follows:

Solution PJ.04-01 "Enhanced Collaborative Airport Performance Planning and Monitoring":

- AO-0801-B Collaborative Airport Planning Interface
- AO-0802-B A-CDM process enhanced through integration of landside (passenger and baggage) process outputs
- AO-0818 Extended turn-round monitoring within the APOC
- AO-0821 Post Operations Analysis support solutions and reporting capabilities
- Network connected regional airports (AO-0824)

At the end of Wave 1 it can be stated that all OIs have reached V2 Maturity level as concluded from the V2 Maturity Gate performed in February 2019. On-going V3 activities then took place culminating in the execution of some V3 exercises, paving the way for the next phase of the project. Elements about the maturity assessment of this solution are provided in Annex.

Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management":

- AO-0814 Enhancement of Airside/Landside Performance Management
- AO-0819 Pro-active management of MET impacts
- AO-0820 Pro-active collaborative management of predicted performance deterioration via UDPP
- AO-0822 Enhancement of Environmental performance Management

According to self-maturity assessment, the Solution PJ.04-02 reaches partial V2 maturity at the end of wave 1 so that all OIs, except AO-0822, reach the V2 maturity. Indeed the OI AO-0822 finishes the wave 1 at V1 maturity level and will target V2 in the wave 2. Elements about the maturity assessment of this solution are provided in Annex.

3.2 Plan for next R&D phase (Next steps)

Through the whole life cycle of the project, PJ04 partners have been analysing and come to the conclusion that the described grouping of OIs allocated to each PJ04 Solution (Solutions 1 and 2) is not the optimal to continue R&D activities in the next phase of this project which ultimately target the optimal deployment scenario perspective.

This analysis has identified that each Operational Improvement can be considered as pertaining to a specific airport type (major hub, regional, and secondary) and relating to either a ‘local’ airport operations management perspective or more from the perspective of the role of the airport in the overall ATM network.

Both current solutions - as they are composed now - are:

- Wide in their scope;
- Focused on more than one specific airport type;
- Covering both a local and network perspective;
- Encompassing different maturity levels.

Referring to the direction to be taken on the related solutions towards their further development, the PJ.04 partners suggested to structure the TAM project in the next R&D phase in such a way that one operational work package will focus on the airport and its role in the Network, while another one will concentrate on 'airport centric' operational issues. Furthermore, the allocation of OIs was made so that operationally related OIs within a Solution are grouped together targeting a same maturity level.

Based on the work achieved in PJ.04 in Wave 1 (PJ.04-01 and PJ.04-02 solutions), the key objective is to further develop and validate the operational improvements and main technical enablers to a V3 maturity level in Wave 2, except for the OI AO-0822 which achieves a V1 maturity level at the end of project wave 1 and will target V2 in Wave 2.

The suggested plan for next R&D phase will offer significant advantages from a deployment perspective in the way that the future OI Steps contained in each future solution should have a harmonised maturity level, should be focussing on airport-centric or airport/network issues and clearly facilitate deployment.

- **Network Connected Airports**

Three solutions of conceptually distinct topics will cover this area:

- **Solution 28-1 – Network-Connected Regional Airports (targeted V3 maturity)**

  Currently the integration of airports into the ATM Network is achieved through either the A-CDM concept or the Advanced Tower concept. A third category of airport (regional airports) is proposed where a reduced set of CDM milestones is implemented and calculated in a quasi-automatic fashion - reducing the need for Airline / Ground Handler inputs.

  The connectivity between regional airports and the NMOC is improved thanks to the provision of DPI messages based on target times and a reduced set of turnaround milestones compared to the full A-CDM implementation. The applicability to regional airports is reliant on the high degree of predictability of airport parameters including taxi-times, turnaround times and passenger boarding times. Ground handler workload is reduced as a result of automatic determination of the aircraft-ready time (TOBT) based on the aircraft event-based milestones and the status of the passenger boarding provided by the local airport system.

- **Solution 28-2 - Regional Airport(s) collaborative management (targeted V2 maturity)**

  There is a need to improve the collaboration between different airports and airport stakeholders through the introduction of a simplified or centralised APOC for regional airports.

  The introduction of a centralised, multi-stakeholder command and control facility (APOC) has shown to improve airport resilience in larger airports. It may be possible to provide similar benefits for regional airports – or groups of regional airports whose operations are closely related – at a lower deployment cost through use of automation (including machine learning techniques) and innovative approaches to information sharing including through a more decentralised approach.

- **Solution 28-3 - Connected Large Airports (targeted V3 maturity)**

  Sharing of AOP content with the Network is vital for having a complete picture of the expected time of traffic in the network. This include data to determine TOBT, TTA and the risk of changes to these time through use of UDPP in disruption and a measure of that disruption with the Airport IMpact Assessment (AIMA) index. The operational issue is that for an efficient interface all nodes feeding into the NOP need a common data exchange in terms of parameters to be sent and data quality. The current data exchange standard developed in SESAR1 Solution 21 needs to be finalised so that a European Standard can be agreed. This standard will support the Implementing Regulation IR716/2014 (section 4.1.2) which states that "The Network Manager shall implement a Collaborative NOP consisting of increased integration of NOP and Airport Operations Plan (AOP) information".

  In addition, there is a need to ensure compatibility between Airport and NM Systems as well as develop airport system and improve the capability of those Network Manager systems with which data will be exchanged.

  Maintenance of the evolving content of the Airport Operations Plan (AOP) will include:

  - The finalization of AOP-NOP information sharing that would ultimately lead the European standardisation;
  - The procedures/services/applications to support AOP-NOP collaborative process, including AOP-NOP information quality requirements;
  - The exchange of AOP-NOP information through SWIM;
  - The integration of local business rules of the airports if and where necessary taking into account the airlines business priorities (Airport Impact Assessment - AOP logic).

  The main performance improvement brought about by the above features will be better demand predictability so that airport slots are not wasted un-necessarily which will lead to much needed increased capacity both at the airport and in the network. Other improvements include delay reduction, especially the reactionary delay resulting in increased capacity, resilience to disruption and faster recovery to normal operations.

  In addition, monitoring of operational performance and some manual collaborative processes for recovery management exist already. However, there is a need for new collaborative operational procedures between the Airport and the Network that should be developed. These need to be supported by procedures/services/applications available to both NM and APOCs, to better manage disruptions, encouraging flexibility and speeding up of the recovery to normal operations.

  Collaborative information exchange and recovery procedures and associated predictive and decision support tools are put in place in order to support the APOC in anticipation, understanding and collaboratively managing large scale disruptive adverse events to reduce impact and knock-on effect to airports, Airspace Users, ANSP and network stakeholders. By inclusion of existing airport-AU coordination into the procedures, an overall optimisation ensures that users' end-to-end processes are managed.

- **Digital Smart Airports**

Three solutions of conceptually distinct topics will cover this area:

- **Solution 29-1 - Airside/Landside Performance Management (targeted V3 maturity)**

  Based on work achieved during this phase, this solution will concentrate on the following aspects:

  - The enhancement of the airside processes with the inclusion of landside (passenger and baggage flow) process outputs (shared in the AOP via the TOBT update) that can affect ATM performance.
  - The question of intermodality can cover the notion of an 'integrated' passenger experience for example a journey with a combined rail and flight ticket issued at a single point of sale. In addition, the passenger experience linked to a flight journey also encompasses the question of both access to and egress from the airport before and after the journey. Different modes of transport (road, rail, …) can be used for airport access and therefore the flight element of the journey is part of an overall multi-modal process. The work performed in this area will address how an increased knowledge of transport performance of covering airport access can be made available to airport stakeholders as a means of identifying potential access issues likely to have ramifications on the punctuality of operations.
  - There is a need to enhance the information sharing and collaborative decision making between the airside and landside processes in an airport. These two processes have traditionally been managed in isolation, but in reality, there is a significant degree of 'coupling' between these two processes with the performance of one process having a potential for a significant impact on the other. For example, a landside process performance issue can have an impact on punctuality (passengers not being at the gate on time) which in turn can have ramifications on the parking stand utilisation. The work performed in Wave 1, which focussed on the construction of performance dashboards at both the individual process level, and holistic level will be further developed and possibly supported by local and/or network-based services/applications. Similarly, the support to decision-making will be enhanced by the further development of tools such as 'what-if' functionality as well as the use of enhanced predictions through techniques such as machine learning. Business intelligence/machine learning should help stakeholders to share the same vision and collaborate in root cause analyses incorporating real-time information presenting both "what has happened" and also "what is predicted to happen" through forecast or predicted future airport performance and what-if capabilities enabling the proactive management of situations.
  - The management of the turnaround process is fundamental to the punctuality performance of an airport and to the predictability of its operations. Work will focus on a detailed monitoring of the different processes relating to the turnaround to provide an early warning indicator of process and infrastructure inefficiencies / issues / failures, resulting in possible delays.

- **Solution 29-2 - MET Performance Management (targeted V3 maturity)**

  This solution will focus on pro-active management of MET impacts on the AOP, based on work achieved during this phase.

  Meteorological impacts on the AOP are pro-actively managed by decision support functionalities that can assess the impact of key meteorological conditions on airport performance and that can propose pre-defined solution scenarios. Local and/or network-based business intelligence/machine learning and "what-if" should support this whole decision process.

- **29-3 - ENV Performance Management (targeted V2 maturity)**

  This solution will address based on work achieved during this phase (V1 maturity)

  Environmental parameters (performance and restrictions) are integrated into the Airport Operations Plan in planning, monitoring, execution and post-operations phases. Local and/or network-based business intelligence/machine learning and “what-if” may support this process.

4 References

[1] https://www.sesarju.eu

[2] https://www.atmmasterplan.eu

[3] https://stellar.sesarju.eu/

[4] https://www.se-dmf.eu

[5] Commission Implementing Regulation (EU) No 716/2014 of 27 June 2014 on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan

[6] https://cordis.europa.eu/project/rcn/206845/factsheet/en

[7] Solution #21 SPR/INTEROP-OSED, D145, Part 1a, (v00.04.02, 25/11/2016)

[8] Project Handbook, v 01.00.01, 27 April 2017

[9] SESAR integrated dictionary (https://ext.eurocontrol.int/lexicon/index.php/SESAR)

[10] Airport CDM Implementation Manual, v 5.0, 31 March 2017

[11] PJ.09 OSED-SPR-INTEROP PART I, v00.02.01, 03 June 2019

[12] https://www.mega.com/en/product/enterprise-architecture

4.1 Project Deliverables

All project public (PU) deliverables are intended to be published on the European Commission CORDIS website [6]. The confidential ones (CO) were delivered to Horizon 2020 and to the SESAR JU. Please refer to the column 'dissemination level' into the tables of section 1.6.

SESAR 2020, **PMP**, D1.1, V01.00.00, April 2017

SESAR 2020, **FPR**, D1.2, V01.00.00, November 2019

SESAR 2020**, QPR 01** Q4 2016, D1.3, V00.01.00, January 2017

SESAR 2020, **QPR 02** Q1 2017, D1.4, V01.00.00, April 2017

SESAR 2020, **QPR 03** Q2 2017, D1.5, V01.00.00, July 2017

SESAR 2020, **QPR 04** Q3 2017, D1.6, V01.00.00, December 2017

SESAR 2020, **QPR 05** Q4 2017, D1.7, V01.00.00, January 2018

SESAR 2020, **QPR 06** Q1 2018, D1.8, V01.00.00, April 2018

SESAR 2020, **QPR 07** Q2 2018, D1.9, V00.01.00, August 2018

SESAR 2020, **QPR 08** Q3 2018, D1.10, V00.01.00, October 2018

SESAR 2020, **QPR 09** Q4 2018, D1.11, V00.01.00, January 2019

SESAR 2020, **QPR 10** Q1 2019, D1.12, V00.01.00, April 2019

SESAR 2020, **QPR 11** Q2 2019, D1.13, V00.01.00, July 2019

SESAR 2020, **QPR 12** Q3 2019, D1.14, V00.01.00, October 2019

SESAR 2020, PJ04-01 **V2 VALP**, D2.1.050, V00.00.14 , 30/05/18

SESAR 2020, **PJ04-01.V2.01 Availability note**, D2.1.061, V00.01.00, 25/05/18

SESAR 2020, **PJ04-01.V2.02 Availability note**, D2.1.062, V00.01.00, 30/08/18

SESAR 2020, **PJ04-01.V2.03 Availability note**, D2.1.063, V00.01.01, 30/05/18

SESAR 2020, **PJ04-01.V2.04 Availability note**, D2.1.064, V00.01.00, 27/06/18

SESAR 2020, **PJ04-01.V2.06 Availability note**, D2.1.065, V00.01.00, 25/05/18

SESAR 2020, **PJ04-01 V2 VALR**, D2.1.070, V00.01.00, 16/04/19

SESAR 2020, **PJ04-01 V2 SPR-INTEROP/OSED**, D2.1.040, V01.02.00, 18/01/19

SESAR 2020, **PJ04-01 V2 TS/IRS**, D2.1.080, V00.02.00, 18/01/19

SESAR 2020, **PJ04-01 V2 CBA**, D2.1.090,V00.01.00, 16/04/19

SESAR 2020, **Solution PJ.04-01: V2 Data Pack**, D2.1, V01.00.00, 06/02/19

SESAR 2020, **PJ04-01 V2 Contextual Note**, D2.1.013, V00.00.01, 06/02/19

SESAR 2020, **PJ04-01 V2 MAT**, D2.1.031, V00.00.01, 15/04/19

SESAR 2020, **PJ04-01 V3 Roadmap**, D2.1.010, V00.00.05, 18/12/18

SESAR 2020, **PJ04-01 V3 ongoing VALP**, D2.1.100, V00.01.00, 19/06/19

SESAR 2020, **PJ04-01.V3.01 Availability note**, D2.1.111, V00.01.00, 10/06/19

SESAR 2020, **PJ04-01.V3.02 Availability note**, D2.1.112, V00.01.00, 23/09/19

SESAR 2020, **PJ04-01.V3.03 Availability note**, D2.1.113,V00.01.00, 09/05/19

SESAR 2020, **PJ04-01.V3.04 Availability note**, D2.1.114, V00.01.00, 27/06/19

SESAR 2020, **PJ04-01.V3.05 Availability note**, D2.1.115, V00.01.00, 09/05/19

SESAR 2020, **PJ04-01 V3 ongoing VALR**, D2.1.120, V00.01.00, 31/10/19

SESAR 2020, **PJ04-01 V3 Ongoing Contextual Note**, D2.1.130, V00.01.00, 31/10/19

SESAR 2020, **PJ04-01 V3 Ongoing MAT**, D2.1.140, V00.01.00,31/10/19

SESAR 2020, **PJ04-02 V1 SPR-INTEROP/OSED**, D3.1.040, V00.01.02, December 2017

SESAR 2020, **PJ04-02 V1 Contextual Note**, D3.1.020, V00.02.02, March 2018

SESAR 2020, **PJ04-02 V2 Roadmap**, D3.1.010, V00.01.02, December 2017

SESAR 2020, **PJ04-02 V2 VALP, D3.2.040**, Part I, V00.01.06, June 2019

SESAR 2020, **PJ04-02 V2 VALP, D3.2.040**, Part II Safety Plan (SAF), V00.01.02, June 2019

SESAR 2020, **PJ04-02 V2 VALP, D3.2.040**, Part IV Human Performance Assessment Plan (HPAP), V00.01.02, June 2019

SESAR 2020, **PJ04-02 V2.01 Availability Note**, D3.2.050, V00.01.01, April 2019

SESAR 2020, **PJ04-02 V2.02 APOC Platform Availability Note**, D3.2.060, V00.02.01, February 2019

SESAR 2020, **PJ04-02 V2.03 Availability Note**, D3.2.070, V01.00.01, March 2019

SESAR 2020, **PJ04-02 V2.04 Availability Note**, D3.2.080, V00.01.00, January 2019

SESAR 2020, **PJ04-02 V2.05 Availability Note**, D3.2.090, V00.01.00, August 2019

SESAR 2020, **PJ04-02 V2.06 Availability Note**, D3.2.100, V00.01.00, February 2019

SESAR 2020, **PJ04-02 V2.09 Availability Note**, D3.2.130, V00.01.00, January 2019

SESAR 2020, **PJ04-02 V2 VALR**, D3.2.150, V00.01.00, October 2019

SESAR 2020, **PJ04-02 V2 SPR-INTEROP/OSED, D3.2.160, Part I**, V00.01.00, August 2019

SESAR 2020, **PJ04-02 V2 SPR-INTEROP/OSED, D3.2.160, Part II** Safety Assessment Report (SAR), V00.01.00, August 2019

SESAR 2020, **PJ04-02 V2 SPR-INTEROP/OSED, D3.2.160, Part IV** Human Performance Assessment Report (HPAR), V00.01.00, August 2019

SESAR 2020, **PJ04-02 V2 SPR-INTEROP/OSED, D3.2.160, Part V** Performance Assessment Report (PAR), V00.01.00, October 2019

SESAR 2020, **PJ04-02 V2 TS/IRS, D3.2.170**, V00.01.04, August 2019

SESAR 2020, **PJ04-02 V2 Cost Benefit Analysis**, D3.2.180, V00.01.00, October 2019

SESAR 2020, **PJ04-02 V2 Contextual Note**, D3.2.020, V00.01.00, October 2019

SESAR 2020, **PJ04-02 V3 Roadmap**, D3.2.010, V00.01.00, October 2019

4.2 Project Communication and Dissemination papers

The following communication events and dissemination papers were produced during the course of the project. PJ.04 completed 17 validation exercises which were an opportunity for the project

and beneficiaries to communicate on PJ.04 activities to both internal and external audience, through open days, videos or dissemination papers.

1. SESAR 2020, SESARJU e-news "Getting to Grips with Airport Operations Management", COM.120, January 2017
2. SESAR 2020, Press Release on TAM project kick-off (Jane's Airport Review), COM.130, March 2017
3. SESAR 2020, ACI-E/SJU workshop on Airport Operations Management (Brussels, Belgium), COM.050, June 2017
4. SESAR 2020, Press Release on ATM project kick-off and objectives (International Airport Review), COM.140, June 2017
5. SESAR 2020, Conference Publication at ATRS (Air Transport Research Society) world conference, (Antwerp, Belgium), COM.160, July 2017
6. SESAR 2020, Presentation / round table discussion at AIRPORT IT 2017 (Vienna, Austria), COM.170, September 2017
7. SESAR 2020, Open day of PJ.04-01.V2.01 exercise (Palma de Mallorca, Spain), COM.230, October 2017
8. SESAR 2020, Open day of PJ.04-01.V2.02 exercise (Alicante, Spain), COM.240, October 2017
9. SESAR 2020, TAM solution presentation at EIWAC 2017 (Tokyo, Japan), COM.190, November 2017
10. SESAR 2020, PJ.04-02 Solution V1 Contextual Note, COM.030, November 2017
11. SESAR 2020, Open day of PJ.04-01.V2.06 exercise (Bratislava, Slovakia), COM.241, January 2018
12. SESAR 2020, Presentation of Automated Aircraft Milestones and Turnaround Monitoring at WAC (Madrid, Spain), COM.252, March 2018
13. SESAR 2020, Regional A-CDM (RA-CDM) walking tour at WAC (Madrid, Spain), COM.260, March 2018
14. SESAR 2020, Leaflet on turnaround monitoring in support of regional airports, COM.090, March 2018
15. SESAR 2020, Open day of PJ.04-01.V2.03 exercise (webex), COM.253, June 2018
16. SESAR 2020, Open day of PJ.04-01.V2.04 and PJ.04-01.V2.05 exercises, COM.242, June 2018
17. SESAR 2020, TAM solution presentation at Passenger Terminal EXPO conference (Stockholm, Sweden), COM.180, March 2018
18. SESAR 2020, Paper submission to 7th Transport Research Arena event (Vienna, Austria), COM.220, April 2018

19. SESAR 2020, Project presentation at EUROCONTROL Airport Operations Team, COM.200, June 2018

20. SESAR 2020, From CDM to TAM: Presentation at Paris Orly Management & Operational Staff, COM.070, August 2018

21. SESAR 2020, TAM presentation at Global Airport and Passenger Symposium GAPS (Athens, Greece), COM.074, October 2018

22. SESAR 2020, Preparation of ICAO working paper on Total Airport Management, COM.078, October 2018

23. SESAR 2020, TAM in SESAR at Airport Operational Excellence and Automation Conference (Frankfurt, Germany), COM.270, January 2019

24. SESAR 2020, PJ.04-01 Solution V2 Contextual Note, COM.010, February 2019

25. SESAR 2020, Open day of PJ.04-02.V2.06 exercise organized by LPS/SR (B4), February 2019

26. SESAR 2020, Open day of PJ.04-02.V2.04/V2.09 exercise by DLR (AT-ONE), COM.429, February 2019

27. SESAR 2020, Regional Airport / Network Integration at Passenger Terminal Expo (London, UK), COM.280, March 2019

28. SESAR 2020, Production of video EXE PJ.04-02.V2.01 and PJ.04-02.V2.03 (Orly), COM.291, April 2019

29. SESAR 2020, Production of video EXE PJ.04-02.V2.02 and PJ.07-02, COM.292, May 2019

30. SESAR 2020, Production of video EXE PJ.04-02.V2.04 and PJ.04-02.V2.09 (Braunschweig), COM.294, July 2019

31. SESAR 2020, Open day of PJ.04-01.V3.01 exercise by THALES, COM.1301, July 2019

32. SESAR 2020, Open day of PJ.04-01.V3.02 exercise by AENA, COM.1302, September 2019

33. SESAR 2020, Press Release on TAM project progress (Jane's Airport Review), COM.150, September 2019

34. SESAR 2020, PJ.04-02 Solution V2 Contextual Note, COM.040, October 2019

35. SESAR 2020, PJ.04-01 Solution V3 On-going Contextual Note, COM.020, October 2019

36. SESAR 2020, TAM solution 2 exercises V2.04/V2.09 and results summary presentation “Dealing with Adverse Weather Conditions by Enhanced Collaborative Decision Making in a TAM APOC“ at EIWAC 2019 (Tokyo, Japan), October 2019

37. SESAR 2020, Paper submission to Journal of Air Transport Management "Machine learning and operational predictions at airports: lessons learnt, November 2019

Appendix A Glossary of Terms, Acronyms and Terminology

A.1 Glossary of terms

Term	Definition	Source of the definition
Adverse conditions	Any event within the operational envelope of the airport, which has a significant negative impact on operational performance unless appropriate actions are organised. Note: This definition encompasses adverse weather conditions. In most cases, the airport capacity will be affected. However, other Key Performance Areas may also be impacted (e.g. the predictability of operations may decrease). The consequence of adverse conditions at an airport may be arrival and departure delays and / or flight cancellations. In many cases, the ATM Network will also suffer from the disruption.	[9]
Airport Collaborative Decision Making (Airport CDM)	Airport Collaborative Decision Making is the concept which aims at improving Air Traffic Flow and Capacity Management (ATFCM) at airports by reducing delays, improving the predictability of events and optimising the utilisation of resources. Implementation of Airport CDM allows each Airport CDM Partner to optimise their decisions in collaboration with other Airport CDM Partners, knowing their preferences and constraints and the actual and predicted situation. The decision making by the Airport CDM Partners is facilitated by the sharing of accurate and timely information and by adapted procedures, mechanisms and tools. The Airport CDM concept is divided in the following Elements: • Information Sharing • Milestone Approach • Variable Taxi Time • Pre-departure Sequencing • Adverse Conditions • Collaborative Management of Flight Updates	[10]
Airport Impact Assessment (AIMA)	Assessing the impact of TTA (Target Time of Arrival) data provided by Network for advanced ATFCM processes in a rolling NOP-AOP (Network Operations Plan - Airport Operations Plan) environment. This can be carried out by a	[7]

Term	Definition	Source of the definition
	specific tool, which interacts with a number of airport services and systems, mainly with the AOP. The main purpose is to consider the airport CDM partners business needs within the ATFCM processes.	
Airport Operations Centre (APOC)	A platform / operational structure which pro-actively manages the performance of present and short-term airport operations, giving relevant airport stakeholders a common operational overview of the airport, and allowing them to communicate, coordinate and collaboratively decide on their progress.	[9]
Airport Operations Plan	The AOP (Airport Operations Plan) is the single, common and collaboratively agreed rolling plan used by all involved stakeholders whose purpose is to provide common situational awareness. It requires individual stakeholders to make changes within their own sphere of operations. The AOP interacts with a number of services, systems and also external stakeholders (e.g. Network).	[9]
Airport Performance Framework	The Airport Performance Framework is the set of definitions and terminology describing the building blocks used by a group of the Airport community (i.e., airport stakeholders) to collaborate on performance management activities. This set of definitions includes the levels in the airport performance hierarchy, the key performance areas, a set of process capability areas, focus areas, performance objectives, indicators, targets, supporting metrics, lists of dimension objects, their aggregation hierarchies and classification schemes. The framework is in line with the ICAO 9883 (Manual on Global Performance of the Air Navigation System) standard document.	[7]
B4	B4 is a consortium of four partners: PANSA (Poland), ANS CR (Czech Republic), LPS SR (Slovak Republic) and Valstybes imone „Oro navigacija" (Lithuania)	[1]
Demand Capacity Balancing (DCB)	Local DCB: Integrated Local DCB (Demand and Capacity Balancing) Processes see the seamless integration of local network management with extended ATC planning and arrival management activities in short-term and execution phases. It represents the core functionality for the Integrated Network ATM Planning (INAP) process through an enhanced Local DCB tool set. The solution will improve the efficiency of ATM	[11]

Term	Definition	Source of the definition
	resource management, as well as the effectiveness of complexity resolutions by closing the gap between local network management and extended ATC planning.	
EATMA	European ATM Architecture The common architecture framework for SESAR 2020, means of integrating the ATM operational and technical content developments produced by SESAR 2020 Projects in a consistent and coherent way. The modelling concerns: information systems, processes, actors and operations involved and exchanges between them.	[2]
Enabler	New or modified technical system/infrastructure, human factors element, procedure, standard or regulation necessary to make (or enhance) an operational improvement.	[2]
Impact Assessment	Impact assessment aims to quantify the effects of a certain event on specific stakeholders or organizations. It is often referred to the impact on e.g. Key Performance Indicators of the Airport Performance Framework.	[7]
Information Service	An information service is a service delivering information or data to actors and/or systems without transformation of the underlying data. Information services can include filtering and/or combining of information. They are the only responsible for system data exchange, they can be considered as interfaces among systems.	[7]
Key Performance Area	Key Performance Areas (KPAs) are a way of categorising performance subjects related to high-level ambitions and expectations. ICAO Global ATM Concept sets out these expectations in general terms for each of the 11 ICAO defined KPAs.	[9]
Key Performance Indicator	Key Performance Indicators (KPIs) are defined in the SESAR performance framework and relate to performance benefits in specific Key Performance Areas (KPAs). Validation targets are assigned to KPIs. SESAR Solutions projects use the results of validation exercises to report performance assessment in terms of the KPIs, reporting the expected positive and negative impacts. All KPIs for which there is non-null target are mandatory for measurement, while reporting remains mandatory on all KPIs.	[8]

Term	Definition	Source of the definition
MEGA	A collaborative tool to support EATMA (European ATM Architecture) modelling.	[12]
Network Operations Plan (NOP)	A set of information and actions derived and reached collaboratively both relevant to, and serving as a reference for, the management of the Pan-European network in different timeframes for all ATM stakeholders, which includes, but is not limited to, targets, objectives, how to achieve them, anticipated impact.	[9]
Operational Process	A process is composition of activities that are triggered by an event and transforms a specific input into a meaningful output.	[7]
Operational Service	An operational service is a product of a sequence of operational processes on request of an actor to another actor who will execute the service with clear identification of an output. A service is offered by an operational entity, (i.e. an organisational actor (e.g. Air navigation Services Provider) or a human actor (e.g. Air Traffic Controller). There are several levels of operational service, depending on the level of granularity required. At lower level an operational service can be supported by: Information service(s) to carry out information needed by the operational service without transforming the information, and/or Application service(s) to use this information in order to provide an output via automation / computation, i.e. with transformation of the information	[7]
Operational Steering Board (OSB)	Regularly (monthly) scheduled board that produces detailed steering parameters (KPIs and PDIs for the Key Performance Areas defined by the APB (Airport Performance Board) and performance values that should trigger warnings and alerts)	[7]
Performance Assessment	The assessment of past, current and/or planned solution performance. The process of assessing past and current performance is called the performance review. Planned performance is assessed during the research and development phases of the life cycle, using validation techniques.	[9]

Term	Definition	Source of the definition
Performance Driver Indicator (PDI)	A Performance Driver Indicator (PDI) is a measure that directly affects an outcome or achievement of a Key Performance Indicator (KPI). PDI is a performance metric that is associated with a preceding step in a value stream or business process. It will contribute directly to a KPI and may be a component in the way the KPI is calculated.	[9]
SEAC 2020	SESAR European Airports Consortium which gather Amsterdam Schiphol Airport, Oslo Avinor Airports, Paris Groupe ADP, Heathrow Airport, Munich Airport, Swedavia Airports, Zürich airport.	[1]
SE-DMF	The System Engineering Data Management Framework (SE-DMF), part of SESAR transversal activities, aims to support the proper management of the information and outputs produced by the SESAR solution projects, with particular regards to the Requirement Management.	[4]
SESAR	Single European Sky ATM Research is the technological pillar of the Single European Sky. It aims to improve Air Traffic Management (ATM) performance by modernising and harmonising ATM systems through the definition, development, validation and deployment of innovative technological and operational ATM solutions. These innovative solutions constitute what is known as the SESAR concept of operations.	[1]
SESAR Solution	SESAR Solutions relate to either an Operational Improvement (OI) step or a group of OI steps with associated Enablers (technical system, procedure or human), which have been designed, developed and validated in response to specific Validation Targets and that are expected deliver operational and/or performance improvements to European ATM, when translated into their effective realisation. SESAR Technological Solutions relate to verified technologies proven to be feasible and profitable, which may therefore be considered to enable future SESAR Solutions.	[8]
STELLAR	SESAR Tool Enabling coLLaborative ATM Research A collaborative SharePoint for SESAR projects contributors and SJU.	[3]

Term	Definition	Source of the definition
SWIM (System Wide Information Management)	1) SWIM consists of standards, infrastructure and governance enabling the management of ATM information and its exchange between qualified parties via interoperable services. 2) SWIM is a distributed processing environment which replaces data level interoperability and closely coupled interfaces with an open, flexible, modular and secure data architecture totally transparent to users and their application	[9]
Total Airport DCB	TADCB describes the individual types of demand (as intentional demand, adjusted demand, cumulative demand and reference demand) and capacity (for runway and taxiway: declared capacity, ultimate capacity, practical capacity) and the dependencies between these and other parameters and how the demand and the capacity can be determined. TADCB is achieved through: • Pro-active assessment of the available total airport capacity including terminal, stand, manoeuvring area, taxiway and runway capacities, given the prevailing and/or forecast weather and other operational conditions. • Comparison of the available capacities with the most up to date demand information Reference or Shared Business Trajectories (RBT/SBT). • Pro-active identification of imbalances and identification of the affected timeframe, trajectories, location of the imbalance.	Enabler DCB-0311
User Driven Prioritisation Process (UDPP)	A CDM-based process which permits Airspace Users to reflect a prioritisation of flights which best respects the business interests of AU stakeholders.	[9]

Table 9: Glossary

A.2 Acronyms and Terminology

Acronym	Definition
A-CDM	Airport Collaborative Decision Making
A-DCB	Airport Demand and Capacity Balancing
AIMA	Airport Impact Assessment
AMAN	Arrival MANager
ANSP	Air Navigation Services Provider
AOP	Airport Operations Plan
APB	Airport Performance Board
API	Arrival Planning Information
APOC	Airport Operations Centre
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATV	Airport Transit View
AU	Airspace User
CBA	Cost Benefit Analysis
CDM	Collaborative Decision Making
CO	Confidential
CONOPS	Concept of Operations
DCB	Demand and Capacity Balancing
DPI	Departure Planning Information message
DS	Data Set
EATMA	European ATM Architecture
ECAC	European Civil Aviation Conference
ENV	Environment
E-OCVM	European Operational Concept Validation Methodology
EPMB	Extended Project Management Board

EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
EXE	Exercise
FOC	Flight Operations Centre
HP	Human Performance
HPAP	Human Performance Assessment Plan
ICAO	International Civil Aviation Organisation
IER	Information Exchange Requirement
INAP	Integrated Network ATM Planning
INTEROP	Interoperability Requirements
IRS	Interface Requirements Specification
KPA	Key Performance Area
KPI	Key Performance Indicator
MET	Meteo
NM	Network Manager
NMOC	Network Manager Operations Centre
NMVP	Network Manager Validation Platform
NOP	Network Operations Plan
OFA	Operational Focus Area
OI	Operational Improvement
OPS	Operational
OSB	Operational Steering Board
OSED	Operational Service and Environment Definition
PCIL	Project Content Integration Leader
PCIT	Project Content Integration Team
PDI	Performance Driver Indicator
PJ	Project

PMB	Project Management Board
PMP	Project Management Plan
POAS	Post Operations Analysis Support
PRM	People with Reduced Mobility
PU	Public
PUN	Punctuality
R&D	Research and Development
RBT	Reference Business Trajectory
SBT	Shared Business Trajectory
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SPR	Safety and Performance Requirements
SWIM	System Wide Information Model
TADCB	Total Airport Demand and Capacity Balancing
TAM	Total Airport Management
TOBT	Target Off Block Time
TS	Technical Specification
UDPP	User Driven Priority Process
VALP	Validation Plan
VALR	Validation Report
WP	Work Package

Table 10: Acronyms and Terminology

Appendix B Final Project maturity self-assessment

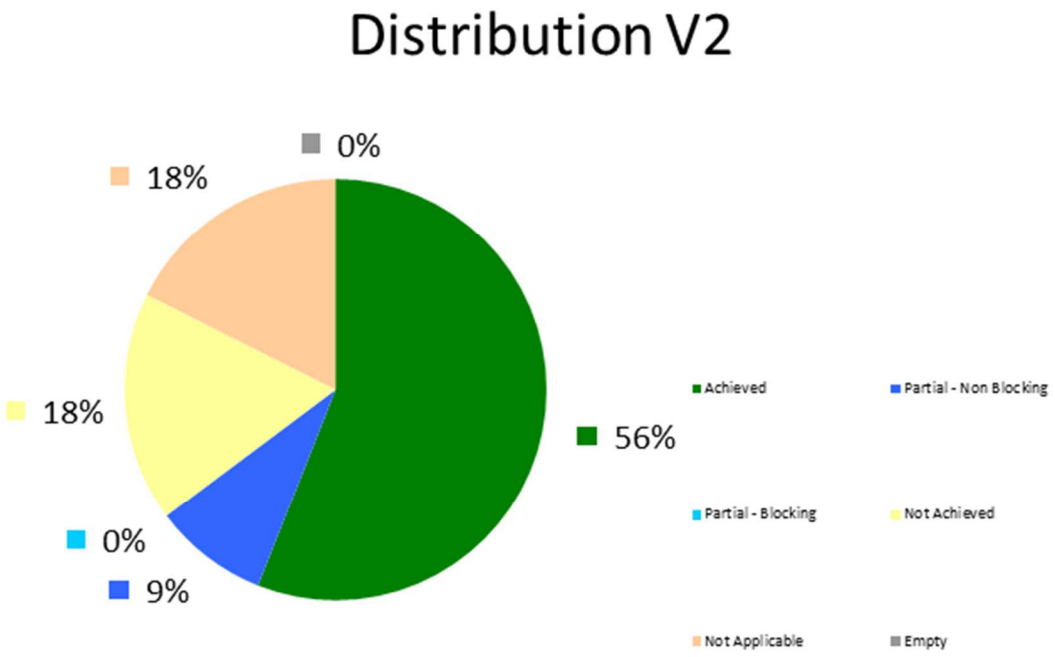
B.1 Solution PJ.04-01Maturity Self-Assessment

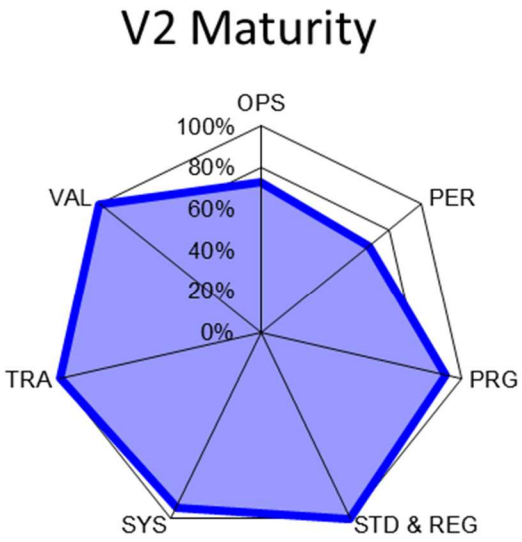
The Self-Assessment analysed 67 parameters from seven different topic fields and reported the analysis result into 5 different responses “Achieved”, “Partial – Non Blocking”, “Partial – Blocking”, “Not Achieved” and “Not Applicable”.

The majority of the 67 parameters were assessed as “Achieved” and “Partial - Non Blocking”, providing a good indication of the assumed V2 maturity as an outcome of the self-assessment process.

	OPS	PER	PRG	STD & REG	SYS	TRA	VAL
V3	73%	67%	92%	100%	94%	100%	100%

Table 11: PJ.04-01 V2 Self-Assessment Satisfaction Distribution





Based on this self-assessment, it can be concluded that the Solution is providing some V3 criteria as achieved, but there are still a number of not achieved criteria, that will need to be addressed in Wave2. The maturity assessment has not been reviewed by the SJU in a maturity assessment process.

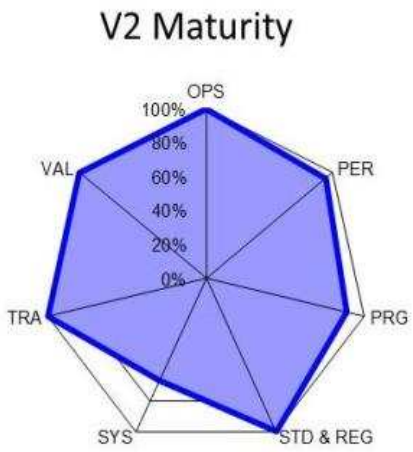
B.2 Solution PJ.04-02 Maturity Self-Assessment

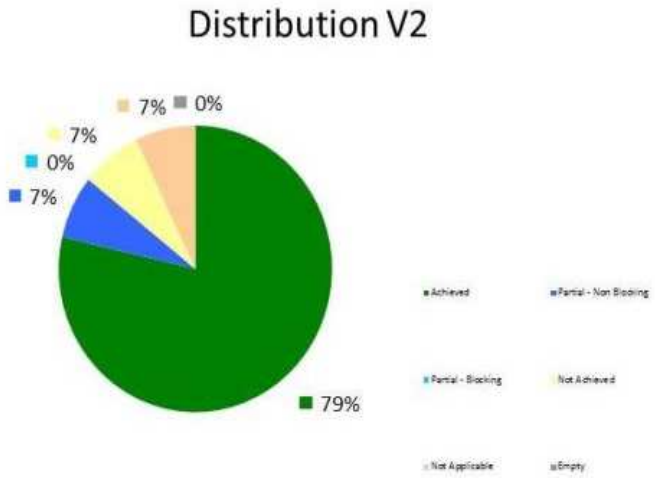
The Self-Assessment analysed 67 parameters from seven different topic fields and reported the analysis result into 5 different responses “Achieved”, “Partial – Non Blocking”, “Partial – Blocking”, “Not Achieved” and “Not Applicable”.

The majority of the 67 parameters were assessed as “Achieved” and “Partial - Non Blocking”, providing a good indication of the assumed V2 maturity as an outcome of the self-assessment process.

	OPS	PER	PRG	STD & REG	SYS	TRA	VAL
V2	100%	94%	89%	100%	67%	100%	100%

Table 12: PJ.04-02 V2 Self-Assessment Satisfaction Distribution





PJ.04-02 Solution has not provided sufficient evidence for reaching a "V2 finalized" maturity status. Self-maturity assessment of the Solution provides sufficient evidence that AO-0814, AO-0819 and AO-0820 operational improvements have achieved v2 maturity, while AO-0822 is considered to have achieved V1 maturity only. Therefore the proposed status of PJ.04-02 solution after self-maturity assessment is "V2 partial". The maturity claimed has not been reviewed by the SJU in a maturity assessment process.