[EN-A-023] Europe's next step in Airport Performance Management Research

[+]F. Piekert*, A. Marsden**, O. Delain***

*: DLR German Aerospace Center
Institute of Flight Guidance, 38108 Braunschweig, Germany
Florian.Piekert@DLR.DE

**: EUROCONTROL
Eurocontrol Experimental Center
Centre de Bois des Bordes BP 15, 91222 Brétigny / Orge Cedex, France
Alan.Marsden@EUROCONTROL.INT

***: Groupe ADP
3 place de Londres - Bâtiment 6061 / Uranus - BP 81007, 95931 Roissy / CDG Cedex, France
Olivier.DELAIN@adp.fr

Abstract: The paper describes the vision and work plan of SESAR2020's Total Airport Management project PJ.04 within the so-called Wave 1 that spawns 2016-2019. The project will work on two ATM Solutions that provide the answer to the existing deficiencies that have been assessed during the phase out of the SESAR 1 program. This paper focusses on the second ATM solution PJ.04 02 "Enhanced Collaborative Airport Performance Management".

The work will introduce into the deficiencies and research challenges that need to be addressed. Derived from these, specific key high level objectives have been set and an approach how to address these developed during the project's preparatory phases. To make this approach more transparent a set of example situations is provided that will guide the reader to a better understanding how this solution will be used in operational airport management.

The solution consists of six so-called operational improvements. These will be explained in more detail in the methodology section of this work, along with indications how the quality ensurance process along the project's life cycle is envisaged, following the European Operational Concept Validation Methodology.

A vision for the following Wave 2 activities (from 2019-2022) will conclude this work, together with a brief discussion around the potential for standardization of the project's results.

Keywords: SESAR, Total Airport Management, Airport Performance Management, Airport Collaborative Decision Making

1. Introduction

The SESAR (Single European Sky ATM Research) program is one of the most ambitious research and development projects ever launched by the European Community. The program is the technological and operational dimension of the Single European Sky (SES) initiative to meet future capacity and safety needs [1-3], in compatibility to the US initiative NextGen [4, 5] and Japan's CARATS [6].

The European Commission and EUROCONTROL [7, 8] founded a legal entity (the SESAR Joint Undertaking) to coordinate and concentrate all relevant research and development efforts in the European Community. The mission of the SESAR Joint Undertaking (SJU) is to develop a modernized air traffic management system for Europe that will ensure the safety and fluidity of air transport over the next thirty years, will make flying more environmentally friendly and reduce the costs of air traffic management.

During the phase out near the end of SESAR 1 it became evident that not all goals were accomplished. Further, results of research activities that were conducted outside of SESAR should additionally be explored. The SJU started the definition of a SESAR 2020 work program, basing on the lessons learned from the multitude of SESAR 1 projects and their and other research projects' results. SESAR 2020 [Section 3.2 of 9, section 3.5 of 10, 11] will be operated in two defined program waves, wave 1 will cover the years 2016-2019 and wave 2 will seamlessly follow and addresses 2020-2023.

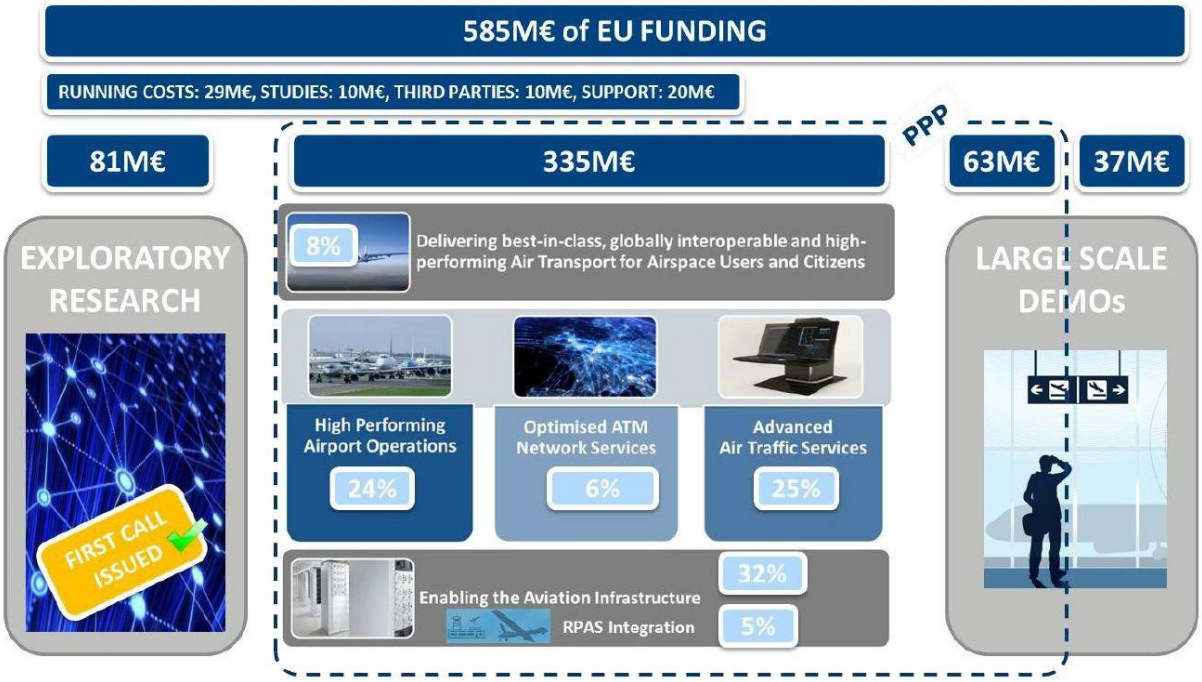

Figure 1 EU Funding Scheme of SESAR 2020 Research Activities

The focus will be on areas of the ATM value chain where the greatest performance gains are expected [12] and cover integrated aircraft operations, high capacity airport operations, advanced airspace management and services, optimized network service performance and a shared ATM infrastructure of operations systems and services [13]. The overall work program differentiates between three types of research and innovation actions: exploratory research, industrial research and validation, and very large scale demonstrations [10, 14]. This three pillar approach is, depicted below in Figure 1 [14, page 14]. Between Wave 1 and Wave 2 there is an approximate 65%-35% budget split anticipated.

1.1 Projects, ATM Solutions & Maturity Control

Exploratory research covers fundamental scientific research. The 17 industrial research and validation projects address ATM application oriented research and the five very large scale demonstrations demonstrate SESAR solutions and support de-risking of the deployment [14]. The project 'PJ.04 Total Airport Management' presented here belongs to the industrial R&D group.

The industrial R&D projects are divided into manageable portions, the ATM solutions [15, page 11]. One project can consist of one or more Solutions. And every Solution addresses one or more so-called 'Operational Improvement steps'. The Solutions are structured around the so-called 'SESAR Release' process. Following the approach from the previous SESAR program, the release process is performed on an annual cycle and each Release comprises a number of validation exercises designed to prove the maturity of the individual building blocks of the overall SESAR concept and, as a result, their readiness for deployment. The transition between two levels of maturity is ensured by gate reviews [see 14, page 7].

The work carried out by the SESAR 2020 projects has to follow the established maturity assessment and quality assurance processes [16]. Operational concepts will be matured from V0 (definition of ATM needs) to V1 (Scope), V2 (Feasibility) until V3 (Pre-Industrial Development and Integration). This approach is advocated by the European Operational Concept Validation Methodology [E-OCVM; 17, 18]. The full sequence of the entire life cycle is depicted below in Figure 2 [14, page 6] and the corresponding technical prototypes are measured by their technological readiness level (TRL) and this approach mirrored in [14, page 7]. The SESAR prototypes are expected to range from pre-1, 1 and 2 for V0 and V1 related developments, and 3 to 6 for the industrial R&D around V2 and V3; and at TRL 7 for the very large scale demonstrations with V3+ [14].

The work itself is around the provision of the above mentioned Operational Improvements (OI), which are technically and operationally implemented by the introduction of so-called Enablers (EN). Enablers usually are tools, procedures and methods. One or more enablers can be associated to an OI and an enabler can be associated to several OIs. If all enablers of a given OI are implemented, the operational benefit that is credited to the OI is expected to manifest.

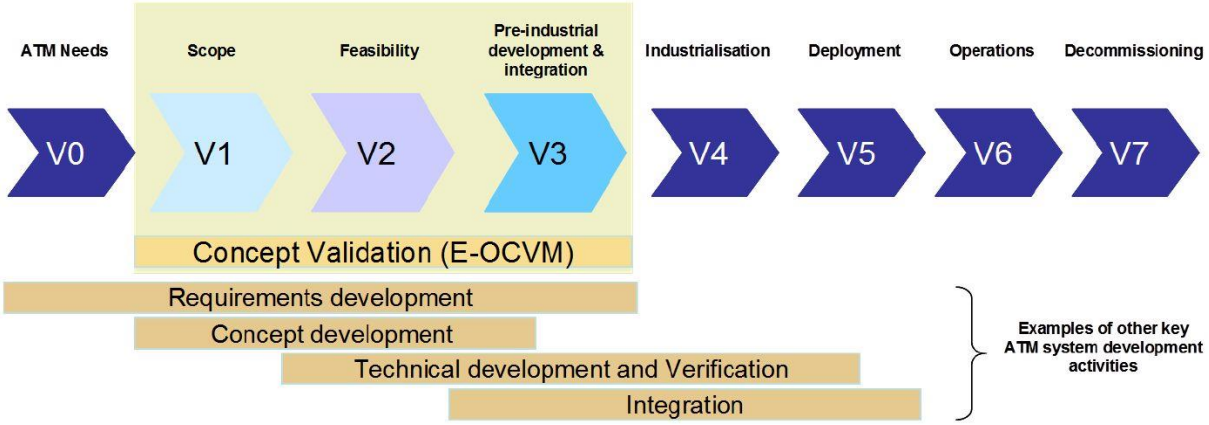

Figure 2 E-OCVM Methodology

Prescribing the structure of the project, the SESAR Joint Undertaking [19] grouped the above exemplified deficiencies and research challenges in terms of OIs by their already achieved maturity. As a result, the ten OI elements that will be addressed by PJ.04 have been grouped into two categories, those that achieved V2 and those that start in V1. This, consequently, resulted in the structure of PJ.04 and its two Solutions, "Enhanced Collaborative Airport Performance Planning and Monitoring" (Solution PJ.04-01) and "Enhanced Collaborative Airport Performance Management" (Solution PJ.04-02).

2. Deficiencies and Research Challenges

Concerning Total Airport Management, SESAR 1 focused on developing and validating key elements of the performance-based collaborative Airport Operations Management (AOM) concept [20-22]. The key areas that were addressed covered the definition and management of the Airport Operations Plan (AOP) and the description of the collaborative processes that are expected to be operated in the Airport Operations Centre (APOC) between the airport operational decision makers.

In SESAR 1's 'Airport Integration and Throughput' priority business area that framed the previous research on Total Airport Management (TAM) via the major work thread Operational Focus Area (OFA 05.01.01), the scope of the research covered [23]:

- The development and validation of an Airport Operations Plan (AOP) and Airport Operations Center (APOC) for managing airport operations in nominal, adverse and/or exceptional operating conditions;
- Full integration and consistency with the Network Operations Plan (NOP) through Collaborative Decision Making (CDM), including the definition of all suitable interfaces and inter-relations between the AOP/APOC and NOP;
- Landside integration into A-CDM (Passenger Flow);
- All management phases, for example long term, medium/short term planning, execution (including monitoring and mitigation procedures) and post-operations processes.

The concept was expected to be scalable in order to permit its implementation across the broadest possible spectrum of Airport environments present in Europe and was articulated around four Services [23]:

- The ***Steer Airport Performance*** service sets the Airport Performance Framework (for example targets, thresholds, trade-off criteria and priorities) in a mutually agreed and collaborative manner between the airport stakeholders.
- The ***Monitor Airport Performance*** service maintains surveillance over airport operations, airport performance, airport environment, supervising airport related information and any information that can impact the airport performance, providing observations, forecasts, alerts and warnings against predefined thresholds (and against Key Performance Areas and Indicators).
- The ***Manage Airport Performance*** service consists of the operational procedures and decision support processes required to support the reaction to the airport monitoring and performance steering.
- The ***Perform Post-Operations Analysis*** service provides a facility for fully understanding the airport performance against the performance plan and identification of the root causes of any deviations.

2.1 Deficiencies

It was assessed by SJU experts that specific aspects were considered insufficiently for deployment purposes, based on the provided validation reports by the operational SESAR 1 projects. The SESAR Joint Undertaking [19] defined the scientific research challenge in the call for SESAR 2020 proposals:

"The full integration between Airport and Network Operations has still to be achieved (airport Performance strongly depends on the performance of the Network). Management of predicted airport performance deterioration therefore needs to be aligned with the Network. Collaborative recovery procedures and support tools in coordination with all the relevant ATM stakeholders are required to facilitate the pro-active management of predicted performance deteriorations. Total Airport Demand and Capacity Balancing processes and tools require further integration with the execution tools (Arrivals and Departure Management systems and Advanced Surface Movement Guidance & Control Systems) and resource allocation planning tools (Stand/Gate Allocation Planner). Airport landside/airside performance monitoring and management processes need to be integrated refining as well the turnaround monitoring within the Airport Operations Centre (APOC) in coordination with the Airspace Users. Environmental impacts and all aspects of de-icing are currently not integrated into the planning and execution timeframes of the Airport Operations Plan (AOP). Impact assessment tools available to the APOC need to better integrate information about MET forecast uncertainty…"

For example, the integration of airports into Air Traffic Flow and Capacity Management processes, especially during the execution phase of flight operations, and the benefit of Short Term ATFCM Measures (STAM) combined with Target Time Management (TTM) were considered to be of high importance in the wake of the anticipated deployment [16, 24, 25], but were covered in a reduced scope. Environmental performance was unaccounted for in the decision makers' support systems, and what-if sandbox tooling only available in a very rudimentary version. Demand and capacity balancing at the airport is limited to the runways and does not cover all possibly relevant bottleneck areas, like taxiways or stand/gate position availability.

The deployment of the results is expected to have a large application scope, addressing large, medium and small/regional airports in Europe. Despite its scalability, the AOM concept was mainly focusing on the needs of large hub airports and therefore needs to be adapted and scoped to the needs of small regional and medium airports.

Table 1 List of PJ.04-02 Challenges and anticipated derived Impacts

CH#	Challenge Name	Derived Improvement
1	Insufficient system support for multi-stakeholder decision making.	Improve resource management efficiency and capacity utilisation.
2	Insufficient utilisation of available ground surveillance data.	Improve resource management efficiency, punctuality, predictability and stability.
3	Collaborative decision making procedures inadequate for current State of the Art (SoA).	Improve resource management efficiency, better collaboration, and better workload management in adverse conditions.
4	Limited pro-activity due to insufficient KPI availability.	Improve resource management efficiency, punctuality, predictability and stability.
5	Insufficient system support for the translation of MET events into ATM impacts.	Improve resource management, capacity utilisation, predictability and stability.
6	Collaborative decision making procedures inadequate for current SoA.	Improve resource management, better collaboration, better workload management in adverse conditions.
7	Insufficient collaborative decision making procedures between airport and network.	Improve resource management, capacity utilisation, punctuality, predictability, stability and resilience.
8	Insufficient system support for environmental performance, restrictions and impact assessment.	Improve resource management, measure environmental impact and environmental impact reduction.
9	Extraction of pertinent information from aggregations of post operations data.	Increase efficiency.
10	Avoidance of non-appropriate or incomplete datasets.	Increase efficiency.
11	Observable transitions and reveal hidden states of airport operations.	Increase efficiency.
12	Avoid too specific datasets that prevent learning curves and application to other airports.	Increase efficiency.
13	The intelligent airport learning environment.	Increase efficiency, capacity utilisation, planning stability.
14	Insufficient system support for a holistic airport resource planning and plan implementation.	Improve capacity utilisation, resource management, predictability and stability.

2.2 Research Challenges

Analyzing all those aspects, a list of challenges (see Table 1 above) for PJ.04 and Solution 2 was compiled by the project partners and was submitted as a part of the answering project proposal.

3. Project and Solution Objectives and Approach

The evolution from the SESAR 1 AOM towards the TAM approach [26] within PJ.04 shall develop and validate monitoring and decision support tools for the collaborative management between stakeholders. The monitoring tools will mainly be addressed in Solution PJ.04-01, while the management tools will be focused on in Solution 2. The management tools will rely on the information in the monitoring tools and there is a strong inter-dependency.

Both sets of tools shall be optimized according to the information requirements of the relevant ATM stakeholder users that are involved in the collaborative airport performance management. Further work shall 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.

In the specific case of adverse weather conditions, further development shall take place concerning the impact investigation and integration of de-icing planning and management into the AOP. 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 shall be optimized through the further development of 'what-if' decision support tools, self-learning airport business intelligence predictive tools and user-defined performance dashboards. The Reference Period 2 airport performance metrics [27] shall be taken into account and the metrics shall be aligned accordingly for the KPI related activities within PJ.04's dashboards and the PJ.04-02 performance management decision making process.

Furthermore, the project shall also consider the specific needs of smaller or regional airports by ensuring that the SESAR 2020 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 TAM concept shall be deployable at any airport of the whole ECAC area. PJ.04-02 shall provide a well-grounded, smart approach by identifying which OI steps, and in particular which technological enablers should be implemented. The solutions shall be validated by the PJ.04-02 consortium in a set of airports which will represent all relevant types of operating environments and airport sizes, from large to medium/small.

The solution is based on system integration and large exchange of data, both locally and with the Network via SWIM (System Wide Information Management). The central data repository is the AOP.

All of the above requirements are now derived into the following **main objectives** of Solution PJ.04-02, stated by the SESAR Joint Undertaking [14, pages 159ff] similarly. These encompass:

- the **enhancement of the collaborative management** of airport performance, especially in degraded situations.
- the development of **decision support functionalities**, notably in the domains of '**what-if' scenario capabilities** and trends prediction in an airp**ort learning environment**. Essentially this covers the notion of **identifying the performance impact** at different time horizons of any action taken.
- the inclusion of additional information into the AOP covering MET (**meteorological probabilistic forecasts**) and **environmental parameters** to further facilitate the collaborative management of airport performance.
- the continuation on the theme of **integrating airports into the network**, the project will collaborate with 'PJ.09 Advanced Demand & Capacity Balancing' in order to **develop collaborative procedures between the airport and Network Manager** in the event of predicted performance deterioration. Essential to this is the **increased common situation awareness the stakeholders** will achieve with the exploitation of the AOP information. This will be complemented by new developments from this solution's OIs and by using the previously developed SESAR 1 tools, especially those that allow the airspace users to influence the plan based on their intentions (in collaboration with 'PJ.07 Optimised Airspace Users Operations').
- taking a **holistic approach towards a Total Airport Demand and Capacity Balancing** (DCB). The

weather and network related impacts affect the entirety of the airport's resource capacities. Currently only the runway capacity is addressed by airport DCB. Especially in the case of adverse weather or winter situations, the most constraining factor may not be the runway itself, but a secondary resource, for example de-icing capacities. The **impact** of these conditions will be further **investigated** and appropriately included **in the collaborative planning and decision making processes** between the stakeholders. The relevant information in the AOP is then **shared with the Network Manager** and other NOP users as appropriate.

- By **orchestrating the tactical execution support tools** (arrival, departure and surface management systems) via the AOP, the **implementation of the collaborative planning into the real-time execution** is ensured.

3.1 R&D Approach

PJ.04 will follow a modular approach in such a way that the two solutions will be complementary to but not interdependent to each other. The SESAR TAM concept is formed by a number of concept elements, which have been distributed into the two solutions. From a R&D perspective, all concept elements are necessary to fully describe and validate the SESAR TAM concept. From a deployment perspective, the Cost Benefit Assessment (CBA) will be key to understand which OIs or combinations of OI steps from one or both solutions will provide the key benefits pursued at each type of airport (Large or Medium/Small). Development and validation of the different enablers focusing on either large or medium-small airports will allow the SJU and the community to obtain the necessary evidences to evaluate what are the most relevant OI steps to be included in future ATM Master Plan updates.

Synergies between solutions will be explored to provide maximum benefits while targeting highest efficiency levels of the use of the different enablers to be developed. Dashboard, what-if applications will be enablers to be developed within both solutions. Possible gaps and overlaps will be coordinated at project level to ensure avoiding duplication of work and to facilitate a smart system architecture approach. The requirements derived from the Solution 2 OI steps and their new functionalities and corresponding to be developed enablers will be used by Solution 1 to incorporate these into an enhanced evolution of the AOP.

3.2 Methodology

In [28, page 14ff] an example is provided that allows insight into how the operations will be conducted (in the APOC) with the availability of PJ.04 results (Solution 1 and 2). Such scenario based approaches including use case exemplified interactions between stakeholders and systems will be employed in the validation of the concept elements.

To draw a picture how the airport of the future can be understood, which improvements the solution will operationally bring, the high level vision for Solution 2 is that an airport that deploys the solution will be one which is at the forefront of performance-based management with operational decisions being taken based on the information contained in high precision performance dashboards providing problem identification (and prediction) capabilities. The information being used by the airport in the decision-making processes will cover all key infrastructure elements and processes.

As mentioned above in the introduction, quality assurance is very important in the maturity development of the operational concept elements. To illuminate the ambitious approach that will be undertaken a look into the maturity roadmap will be provided. An important part of this

Table 2 Maturity Level Plan of Solution 2 OIs

SESAR Solution PJ.04-02 Enhanced Collaborative Airport Performance Management	**Maturity**				
		SESAR 2020			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		2017	2018	2019	
①**AO-0813** Enhanced Collaborative Airport Performance Management	N/A	V1		V2	V3
②**AO-0819** Pro-active management of MET impacts on the Airport Operations Plan	N/A	V1		V2	V3
③**AO-0820** Pro-active collaborative Airport/Network management of predicted performance deterioration	N/A	V1		V2	V3
④**AO-0822** Environmental performance and restrictions accommodated in the Airport Operations Plan	N/A	V1		V2	V3
⑤**DCB-0311** Total Airport Demand/Capacity Balancing	N/A	V1		V2	V3
⑥**AO-0823** Airport learning environment based on post operations analysis	N/A	V1		V2	V3

methodological approach is the validation of the concept elements by a large variety of required validation activities that need to be completed to ensure sufficient evidence of the maturity at each V stage.

Solution 2 governs the R&D over six new Operational Improvements. These are listed in Table 2, with their expected maturity developments during SESAR 2020. At the beginning of Wave 1, the OIs in this solution have reached a V0 maturity (the ATM needs have been identified) and thus do not need to be addressed in the Exploratory Research call. The 'N/A' applies to the enablers that are associated to the OIs. Some enablers that provide to the OIs may be more mature, but the entirety for each OI is still considered to be too immature to declare any maturity beyond N/A or V0 with regard to the ambitious goals that have been set. Within this first SESAR2020 wave, all six OIs will be developed to allow for feasibility and performance assessments of the underlying conceptual elements, as per V2 maturity considerations. The individual development progress speed may be different, depending on the existing previous work that has been accomplished.

Each of the OIs that are addressed within this solution will deliver its part in the situation assessment and option evaluation or collaborative decision making and implementation process:

1. **AO-0813 "Enhanced Collaborative Airport Performance Management"** will enable the stakeholders to conduct performance management in a more efficient approach compared to the results delivered by SESAR 1. The supporting enablers will use dashboards to deliver more precise input data or data that previously was not available for consideration in the multi-stakeholder collaborative decision making process, especially in conjunction with the airspace users' requirements or preferences (known as User Driven Prioritization Process – UDPP – and addressed by the partner project PJ.07). The basic support for What-If sandbox analysis from SESAR 1 will be significantly enhanced to include new areas that can be assessed and predicted based on the OIs addressed within solution 2.
2. **AO-0819 "Pro-active management of MET impacts on the Airport Operations Plan"** will provide enhanced information around weather and its implication or impact on operations at the airport, further supporting the decision making process.
3. **AO-0820 "Pro-active collaborative Airport/ Network management of predicted performance deterioration"** will extend the set of collaborative procedures between airports and the network to strengthen the coordination of both entities in deteriorated performance situations and in conjunction with the What-If functionality of AO-0813 it will enable the airport-airport and airport-network coordinators to find the optimal situation mitigation approach.
4. **AO-0822 "Environmental performance and restrictions accommodated in the Airport Operations Plan"** addresses the necessity of including environmental considerations into the decision making process, allowing the balance of environmental aspects against the operational needs or performance achievements in a more precise approach, allowing to weight different options in conjunction with the What-If probing.
5. **DCB-0311 "Total Airport Demand/Capacity Balancing"** will build on the SESAR 1 Airport Demand Capacity Balancing approach that addressed the resource runway and extends it to incorporate additionally important resource areas such as the taxiway, apron, stand and gate and terminal capacities. Together with the What-If analysis, different options concerning resource prioritization and balancing can be explored prior operational implementation.
6. **AO-0823 "Airport learning environment based on post operations analysis"** creates an Airport Business Intelligence System that will allow to further enhance the provision of data for the decision making process itself, as well as to provide guidance based on past experience in an automated way.

As a whole, the individual parts will intertwine neatly to allow the airport stakeholders to efficiently and jointly balance and implement their decisions based on holistic assessments and what-if analyses, covering different resource areas at the airport, relevant environmental aspects and given or developing network constraints.

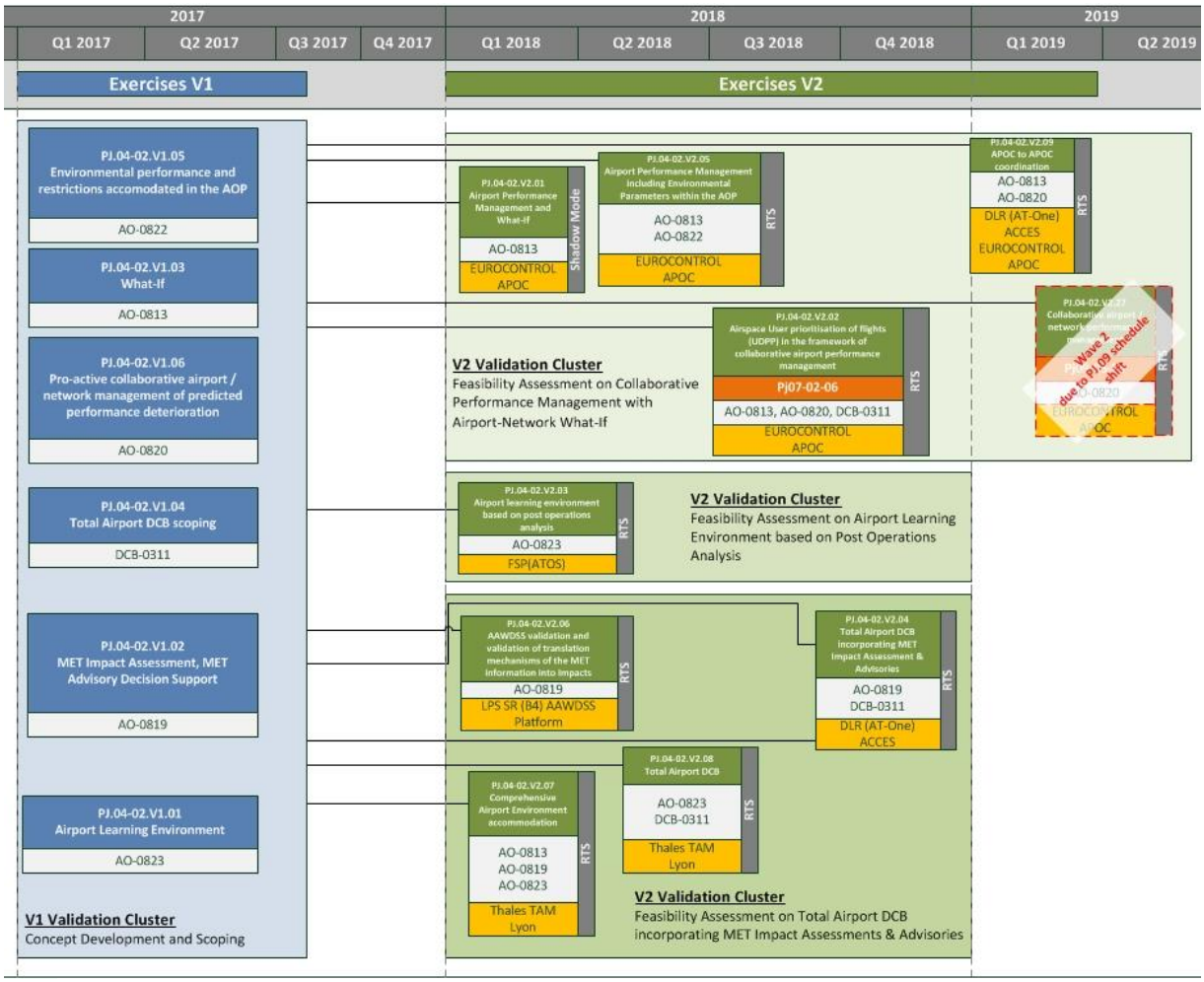

Figure 3 Validation Roadmap and Exercise Dependencies in Solution PJ.04-02

At the beginning of the project, a concept definition phase further details the specific scopes that the OIs will cover. The OI scopes and the SESAR 2020 TAM concept of operations will be captured in an Operational Service and Environmental Description (OSED). The concept elements that deal with cross-project aspects, for example the UDPP integration into the collaborative management or the airport-network interaction, will be discussed and revised with the corresponding partner projects PJ.07 and PJ.09 to ensure coherency between their and this solution's concept that will be developed based on the previous OFA 05.01.01 concept by R&D and operational experts and will describe the new operating method that will be enabled by the results of this project.

The definition phase will include V1 validation activities (executed as a series of expert workshops) in an iterative manner, where the preliminary OSED elements will be presented to operational experts from airport stakeholders and jointly the key aspects will be discussed and revised if necessary. The results of the final sets of expert workshops will then complete the preliminary into an OSED V1 and additionally result into a preliminary Validation Plan (VALP) for the V2 exercises that will be executed once the V1 maturity gate has been successfully passed.

The validation exercises are represented by blocks in the above Figure 3. Two pillars group the exercises, according to their maturity levels. The leftmost pillar groups the six activities that are associated to the V1 maturity phase (scoping), the other pillar includes the ten V2 activities. The blocks in the V1 validation cluster have two fields, the topic of the exercise (in this case the OI step itself) and the OI code. In V2, the blocks have several fields, providing the topic focus of the exercise, the OI step that is or that are addressed, the type of conduction and the platform where the exercise is staged. The V1 validation exercises are considered to be expert workshops, where the concept will be presented to operational experts to obtain feedback that will be used to further refine the concept elements. In V2, Solution 2 will only conduct Real Time Simulation (RTS). The two blocks in the "V2 Validation Cluster: Feasibility Assessment on Collaborative Performance Management with Airport-Network What-If" identify the validation exercises that are conducted jointly with PJ.07 and PJ.09 (in Wave 2).

The outcome at the end of a maturity step will be documented by so-called "Data Packs". In addition to the Data Packs, enabled or enhanced validation platforms or environments, prototypes that were used for the validation exercises will become available. The Data Packs consist of a variety of documents [14, page 173], ranging from the Operational and Service Environment Definition (OSED) concept document to Cost and Benefit Assessment documentation (CBA) and Technical Specifications/ Interface Requirement Specifications (TS/IRS).

4. Outlook

The outlook covers to a degree the above sketched work and its schedule over the project's duration, until 2019 when the project closure of the Wave 1 activities has to be completed. During 2017, Solution 2 will conduct the proper scoping of the concept elements and the V1 validation expert workshops and plans to deliver the first Data Pack at the End of Octobre 2017. Following the successful maturity gate passing, Solution 2 will continue in 2018 and 2019 with the V2 validation activities and the development of platforms and prototypes that will be used for the feasibility assessment, based on the results of the V1 validation workshops. 2019 will be dominated by the wrap up of the project, conclusion of the validation activities, conduct of the final V2 maturity gate assessments and the preparation of the follow-up Wave 2 project.

4.1 SESAR 2020 Wave 2

In the second wave of the SESAR 2020 Industrial Research & Development program, PJ.04 will continue the work and resume where the Wave 1 activities ended. In theory it should be a seamless transition. It is expected that a set of V3 validation activities will be conducted, some in live trials, some in artificial environments [22].

Regarding Solution 2, the previous conceptual development in the V2 OSED will be complemented by lessons learned from the V2 validation assessments and will be wrapped up into an OSED V3. After preparation of the corresponding V3 Validation Plan, the V3 validation activities will start with preparation of platforms, further development of prototypes and the execution of the exercises. The provision of fully V3 mature elements is planned at the end of Wave 2.

4.2 Approach to Standardization

During Wave 1 and Wave 2 activities, contact to standardization bodies that drive European or World Wide standardization (for example EUROCAE or IATA) will be established. The technical specification documents TS/IRS, System Service Definitions (SDD) and Interoperability Requirements (INTEROP) that will be developed by both PJ.04 solutions will address interface and interoperability aspects. These will be introduced to these organizations to drive a harmonization and standardization around Total Airport Management, in continuation of what has been started with the A-CDM community specifications [29].

Further it can be expected that the outcome of all the SESAR 2020 projects, not only of Solution 2 and PJ.04 Total Airport Management, will be analyzed by the SJU and the European Commission. Those elements of the ATM value chain where the greatest performance gains [12] have been proven by validation and CBA can be subject to the next PCP call. Similarly to the SESAR 1 results and the first PCP [16, 25], this will then force the implementation on stakeholders organizations.

5. ACKNOWLEDGMENTS

SESAR 2020 Project "PJ.04 Total Airport Management" is co-funded by the European Commission and the SESAR Joint Undertaking under Grant ID 733121, subject to Horizon 2020 legislation. Project Coordinator is Groupe ADP, Solution 1 Management is conducted by ENAIRE and Solution 2 Management is conducted by DLR (AT-One). Deputy Coordinator and primary point of Communications is provided by EUROCONTROL.

The authors would like to thank the entire project team that contributed during the proposal phase of the call. Portions of this work have been taken from the Grant Proposal that has been submitted by the PJ.04 project partners.

The PJ.04 partners are ACG (COOPANS), ADP (SEAC2020), ATOS (FSP), Avinor (SEAC2020), CCL (COOPANS), DLR (AT-ONE), ENAIRE (INECO), EUROCONTROL, HAL (SEAC2020), INDRA, LEONARDO, LPS SR (B4), MUC (SEAC2020), NLR (AT-ONE), Naviair (B4), PANSA (B4), SINTEF (NATMIG), SNBV (SEAC2020), Swed (SEAC2020), THALES AIR SYS.

For more information please visit the SESAR Joint Undertaking's website at http://www.sesarju.eu or refer to SESAR Joint Undertaking [12].

6. REFERENCES

[1] European Commission, Accelerating the implementation of the Single European Sky, European Commission, Brussels, Belgium, 2013, pp. 11.

[2] European Parliament, European Council, REGULATION (EC) No 549/2004 OF THE EUROPEAN PARLIAMENT AND THE COUNCIL of 10 March 2004

laying down the framework for the creation of the single European sky, in: European Parliament (Ed.), European Parliament, Brussels, Belgium, 2004, pp. 8.
[3] European Commission, REGULATION (EC) No 551/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 10 March 2004 on the organisation and use of the airspace in the single European sky (the airspace Regulation), in: E. Commission (Ed.), European Commission,, Brussels, Belgium, 2004, pp. 5.
[4] Federal Aviation Authority, SESAR Joint Undertaking, State of Harmonisation Document, Luxemburg, Luxemburg, 2014, pp. 20.
[5] P. Brooker, SESAR and NextGen: Investing in new paradigms, J Navigation, 61 (2008) 195-208.
[6] Study Group for the Future Air Traffic Systems, CARATS Collaborative Actions for Renovation of Air Traffic Systems - Long-term Vision for the Future Air Traffic Systems ~ Changes to Intelligent Air Traffic Systems ~, 2010, pp. 56.
[7] European Council, COUNCIL REGULATION (EC) No 219/2007 of 27 February 2007 on the establishment of a Joint Undertaking to develop the new generation European air traffic management system (SESAR), in: E. Council (Ed.), European Council,, Brussels, Belgium, 2007, pp. 18.
[8] European Council, COUNCIL REGULATION (EC) No 1361/2008 of 16 December 2008 amending Regulation (EC) No 219/2007 on the establishment of a joint undertaking to develop the new generation European air traffic management system (SESAR), in: E. Council (Ed.), European Council,, Brussels, Belgium, 2008, pp. 6.
[9] European Commission, REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL on the implementation and progress of the Single European Sky during the 2012-2014 period (Text with EEA relevance), European Commission, Brussels, Belgium, 2015, pp. 14.
[10] SESAR Joint Undertaking, Annual Work Programme* 2015, SESAR Joint Undertaking, Brussels, Belgium, 2016, pp. 183.
[11] European Council, COUNCIL REGULATION (EU) No 721/2014 of 16 June 2014 amending Regulation (EC) No 219/2007 on the establishment of a Joint Undertaking to develop the new generation European air traffic management system (SESAR) as regards the extension of the Joint Undertaking until 2024 (Text with EEA relevance), in: E. Council (Ed.), European Council,, Brussels, Belgium, 2014, pp. 8.
[12] SESAR Joint Undertaking, SESAR 2020 membership reflects growing Europe-wide commitment to ATM modernisation, SESAR Joint Undertaking, Brussels, Belgium, 2016.
[13] European Commission, SESAR 2020: developing the next generation of European Air Traffic Management, Brussels, Belgium, 2014, pp. 2.
[14] SESAR Joint Undertaking, SESAR 2020 Multi-annual Work Programme, SESAR Joint Undertaking, Brussels, Belgium, 2015, pp. 565.
[15] SESAR Joint Undertaking, SESAR SOLUTIONS CATALOGUE, SESAR Joint Undertaking, Brussels, Belgium, 2016, pp. 96.
[16] European Commission, COMMISSION IMPLEMENTING REGULATION (EU) No 409/2013 of 3 May 2013 on the definition of common projects, the establishment of governance and the identification of incentives supporting the implementation of the European Air Traffic Management Master Plan (Text with EEA relevance), in: European Commission (Ed.) L 123/1, European Commission, Brussels, Belgium, 2013, pp. 7.
[17] EUROCONTROL, E-OCVM Version 3.0, in: EUROCONTROL (Ed.) European Operational Concept Validation Methodology, EUROCONTROL, Brussels, Belgium, 2010, pp. 76.
[18] EUROCONTROL, E-OCVM Version 3.0 Annexes, in: EUROCONTROL (Ed.) European Operational Concept Validation Methodology, EUROCONTROL, Brussels, Belgium, 2010, pp. 144.
[19] SESAR Joint Undertaking, Total Airport Management in: SESAR Joint Undertaking (Ed.) CALL: SESAR2020 IR-VLD WAVE1, European Commission, Brussels, Belgium, 2015.
[20] H. Bogers, M. Linde, J.R. Matas Sebatia, I. Álvarez Escotto, J.I. Martin Espinosa, B. Ciprián Tejero, C. Druce, A. Knight, A. Von Eckartsberg, D. Bourguignat, O. Delain, R. Ten Hove, R. Grosmann, R. Wyss, A. Marsden, A. Wennerberg, N. Halwachs, D. Fuchs, A. Arvidsson, R. Dekker, R. Breuer, S. Foetsch, E. Goni Modrego, J.A. Ubeda Torres, D16 - OFA 05.01.01 Consolidated OSED, Part 1, SESAR Consortium, Brussels, Belgium, 2015, pp. 608.
[21] H. Bogers, M. Linde, J.R. Matas Sebatia, I. Álvarez Escotto, J.I. Martin Espinosa, B. Ciprián Tejero, C. Druce, A. Knight, A. Von Eckartsberg, D. Bourguignat, O. Delain, R. Ten Hove, R. Grosmann, R. Wyss, A. Marsden, A. Wennerberg, N. Halwachs, D. Fuchs, A. Arvidsson, R. Dekker, R. Breuer, S. Foetsch, E. Goni Modrego, J.A. Ubeda Torres, D16 - OFA 05.01.01 Consolidated OSED, Part 2, SESAR Consortium, Brussels, Belgium, 2015, pp. 244.
[22] F. Piekert, N. Carstengerdes, S. Schier, R. Suikat, A. Marsden, A HIGH-FIDELITY ARTIFICIAL AIRPORT ENVIRONMENT FOR SESAR APOC VALIDATION EXPERIMENTS, Journal of Air Transport Studies, 8 (2017) 20.
[23] A. Marsden, Airport Operations Management, SESAR Factsheet, EUROCONTROL, Brétigny/Orge Cedex, 2014, pp. 6.
[24] European Commission, 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 Text with EEA relevance, in: European Commission (Ed.) L 190/21, European Commission, Brussels, Belgium, 2014, pp. 26.
[25] European Commission, COMMISSION IMPLEMENTING REGULATION (EU) No 970/2014 of 12 September 2014 amending Regulation (EU) No 677/2011 laying down detailed rules for the implementation of air traffic management (ATM) network functions (Text with EEA relevance), in: European Commission (Ed.) L 272/11, European Commission, Brussels, Belgium, 2014, pp. 4.
[26] Y. Günther, A. Inard, B. Werther, M. Bonnier, G. Spies, A. Marsden, M. Temme, D. Böhme, R. Lane, H. Niederstraßer, Total Airport Management - Operational Concept & Logical Architecture, DLR, Braunschweig, Germany, 2006, pp. 44.
[27] European Commission, COMMISSION IMPLEMENTING DECISION (EU) 2015/348 of 2 March 2015 concerning the consistency of certain targets included in the national or functional airspace block plans submitted pursuant to Regulation (EC) No 549/2004 of the European Parliament and of the Council with the Union-wide performance targets for the second reference period, in: E. Commission (Ed.), European Commission,, Brussels, Belgium, 2015, pp. 13.
[28] F. Piekert, O. Delain, E. Martin Dominguez, A. Marsden, EUROPE'S NEXT STEP IN TOTAL AIRPORT MANAGEMENT RESEARCH, ATRS 2017, ATRS, Antwerp, Belgium, 2017, pp. 32.
[29] European Telecommunications Standards Institute, Airport Collaborative Decision Making (A-CDM); Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 (ETSI EN 303 212 V1.1.1 (2010-06)), European Telecommunications Standards Institute, Paris, France, 2010, pp. 59.

7. COPYRIGHT

Copyright Statement

The authors confirm that they, and/or their company or institution, hold copyright of all original material included in their paper. They also confirm they have obtained permission, from the copyright holder of any third party material included in their paper, to publish it as part of their paper. The authors grant full permission for the publication and distribution of their paper as part of the EIWAC2017 proceedings or as individual off-prints from the proceedings.

8. DISCLAIMER

Authors consulted the SESAR Joint Undertaking source material [10, 12, 14, 15, 19].

The SESAR Joint Undertaking source material [10, 12, 14, 15, 19] has been developed by the SJU, SESAR members and SESAR 2020 member for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. It is provided "as is", without warranty of any kind, either express or implied, including, without limitation, warranties of merchantability, fitness for a particular purpose and non-infringement. Therefore, the document after review of the SJU may change, improve, be updated or replaced by another version without notice.

The SESAR Joint Undertaking source material [10, 12, 14, 15, 19] has been provided for informative purposes only. Under no circumstances shall the SJU be liable for any loss, damage, liability or expense incurred or suffered that is claimed to have resulted from the use of this document, including, without limitation, any fault, error, omission, interruption or delay with respect thereto.

This document may contain advice, opinions and statements of its authors. The SJU does not represent or endorse the accuracy or reliability of any advice, opinion, statement or other information provided by any information provider or any other person or entity involved in the drafting of this document.

Any reprint of this document or other use that the ones defined above requires the prior written approval of the authors of this document and the SJU.


TAM


AT-One
DLR
nlr


B4
CONSORTIUM
LPS SR
POLSKA AGENCJA ŻEGLUGI POWIETRZNEJ
POLISH AIR NAVIGATION SERVICES AGENCY
www.pansa.pl


COPANS
REAL COOPERATION, REAL RESULTS


ENAIRE


EUROCONTROL


FREQUENTIS
SESAR
PARTNERS
Frequentis • Atos • HungaroControl
Atos


indra


LEONARDO


NATMIG
SINTEF


SEAC


THALES