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PJ09 DCB

DEMAND CAPACITY BALANCING

This PJ09 Final Project Report is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 731730 under European Union's Horizon 2020 research and innovation programme.

Abstract

In the S2020 concept, key for the improvement of Demand Capacity Balancing is the development of collaborative processes and common situation awareness facilitated by decision support tools at local and regional levels based on the principal "think global, act local".

Project PJ09 Advanced DCB addresses the performance driven balancing of traffic demand and ATM capacity in a collaborative process with all ATM stakeholders and Airspace Users involved. In this context, PJ09 acts as a bridge function between a number of S2020 projects (such as PJ01, PJ04, PJ07, PJ08) ensuring effective networking of local Airspace Users and ATM planning functionalities in the SESAR 2020 horizon.

The major objective of the PJ09 Advanced DCB concept is to evolve the existing DCB process to a powerful distributed network management function, which takes full advantage from the SESAR Layered Collaborative Planning, Trajectory Management principles and SWIM Technology to improve the effectiveness of ATM resource planning and the network performance of the ATM system in Europe.

Wave 1 validated the PJ09 concept from the perspective of three solutions:

- Network Prediction and Performance
- Integrated Local DCB Processes
- Collaborative Network Management Functions

The project identified considerable benefits for key ATM stakeholders and finalised all three solutions with the V2 maturity level.

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Executive Summary

The S2020 project “PJ09 Advanced DCB” evolves the existing DCB process to a powerful distributed network management function, which takes full advantage from the SESAR Layered Collaborative Planning, Trajectory Management principles and SWIM Technology to improve the effectiveness of ATM resource planning and the network performance of the ATM system in Europe.

Solution 1 developed shared situation awareness with respect to demand, capacity and performance impacts. Traffic and demand forecast have improved reliability based on complexity assessment and the computation of confidence indexes. Network Operations will be continuously monitored through Network Performance KPA/KPI to facilitate collaborative decision making processes.

The main findings from Solution 1 Network Prediction and Performance are as follows:

- The probabilistic demand prediction method based on time error (uncertainty) developed the preparatory activity has demonstrated to be a viable step forward in the effort to improve traffic demand prediction in the Network. This method, applied in the validation exercise and used by the FMPs raised positive feedback. Qualitative results showed an improvement of the situational awareness, with no negative impact on the workload.

- The complexity prediction results demonstrated that the Complexity prediction method based on Cognitive Complexity was a promising tool for FMPs.

- From the performance monitoring perspective, the consideration of impacted stakeholders’ performance indicators in the selection of candidate flights for DCB measure was appreciated among all the participants (FMPs, AUs and APT) in the validation exercise.

Solution 2 developed the core functionality of the INAP process (everything which can and should be decided locally. Solution PJ09-02 is the logical follow-up of the SESAR1 Local DCB toolset. It includes: INAP management, ASM integrated into DCB, reconciliation of DCB measures with local complexity management, ATC and Arrival Management. The solution addresses the integration of Local Network Management with extended ATC planning and arrival management activities in the short-term to execution in a seamless process.

The most relevant conclusions from Solution 2 Integrated Local DCB processes:

- INAP primary roles (namely LTM, EAP and SUP), do not drive the process in full isolation, secondary roles such as NM, AUs, APOCs and ATC strongly interact with INAP. LTM, EAP and SUP are closely coordinated and act as a group based on the existence of the abovementioned collaborative environment.

- The development and validation of INAP supporting tools are key to ensure an efficient INAP process in a collaborative environment. It has been proven that these tools need to have what-if and what-else functionalities to test different DCB Solutions. What-if to allow the operator to assess the efficiency of different measures and What-else meaning that a system or a role proposes alternative solutions to the operator.

- Information Sharing as a key element:
    - The most important feature about the information is that it is shared between all partners, leading to the consolidation of a shared situation awareness. Examples of information shared are: traffic information, ATFCM information, etc.
    - Connected tools between LTM and EAP with similar interfaces are requested, although these tools cannot fully replace live discussions
    - **Local FDPS data on EAP position**: necessary in order to be able to manage STAM efficiently. The most important for the EAP and the ATCOs on CWP is to share the same information about trajectory data.
    - **ATFCM information sharing**: ATFCM information sharing allowed the ATCO to better anticipate the traffic with hotspot information. Adjacent sector hotspot status should allow a better coordination anticipation and overall traffic. It was also successfully demonstrated that it is possible to coordinate measures with foreign centres in order to avoid setting a regulation and that STAM can be applied across borders in a very efficient way.

Solution 3 delivered subsidiary Network Management facilitated by a rolling NOP planning environment. Network Operations planning and Execution is managed by an agreed set of rules and procedures, guiding subsidiary DCB and UDPP measures under consideration of network impact and network performance targets. Collaborative constraints management integrates AUs Flight Delay Criticality Indicator and reconciles DCB measures with Airports, ACCs, AU and NM.

The key findings from Solution 3 Collaborative Network Management Functions:

Some topics related to this solution reached a higher maturity level than planned:

- **Flight Delay Criticality Indicator (FDCI) reactive mode** and **AOP/NOP departure information integrated in eFPL**, related to the OI DCB-0103-B demonstrated strong maturity along the validation. We consider them as **V3 maturity** level

- Constraint reconciliation, related to the OI AUO-0108, with the refinement on ATFCM slot allocation proposed by the **ECASA** improvement strategies, reached the **V2 maturity** level and is ready to continue V3 validation

Other did not fully achieved the V2 maturity:

- **Pro-active FDCI** and **AOP/NOP TTA information integrated in eFPL**, related to the OI DCB-0103-B, needs some tools and process refinements, that requires the validation work to continue, achieving at the end a **partial V2 maturity** level.

- **Network stability**, in relation to the OI DCB-0217, needs still some work and testing in summer traffic conditions. While being mostly at V2 level, it do not prevent the OI DCB-0217 to be at the targeted V2 maturity as a whole.

- The **DCB Collaborative Framework**, related to the OI DCB-0215, has shown operational acceptance and feasibility for the concept but needs the work on V2 to carry-on, achieving only a **partial V2 maturity** level.

We recommend one topic to go to exploratory research: Constraint optimisation that showed the feasibility to design a network optimised DCB solution.

1 Project Overview

1.1 Operational Context

This industrial research and validation continued the work carried out in SESAR1, mainly in projects P4.7.1, P7.6.1 and P13.2.3. Therefore, it developed the solutions PJ09-01 Network Prediction and Performance, PJ09-02 Integrated Local DCB Processes, and PJ09-03 Collaborative Network Management Functions to a higher V2 maturity level.

In the S2020 concept, key for the improvement of Demand Capacity Balancing is the development of collaborative processes and common situation awareness facilitated by decision support tools at local and regional levels based on the principal "think global, act local".

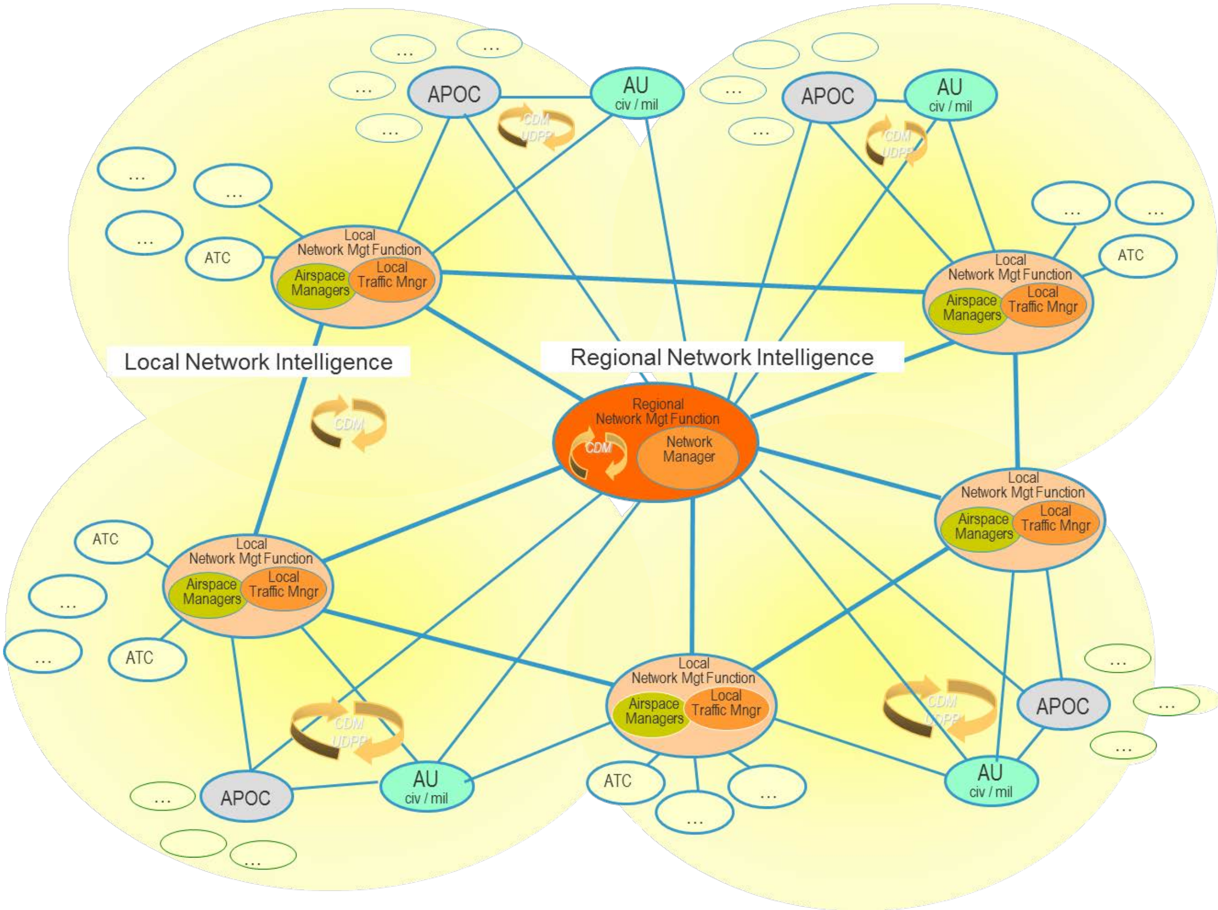

Figure 1: **PJ09 Subsidiary Network Management**

Although the proposal for S2020 PJ09 is decomposed into 3 solutions each of which focussing on a key area of improvement, particular attention has been drawn to the integration of the solution results into a common S2020 seamless, holistic and collaborative network management system.

In this context, the S2020 solution PJ09-01 played an important role to ensure that all network players are acting towards a common set of principles and targets.

1.2 Project Scope and Objectives

The scope of the project covers the process, tools stakeholder interactions for the European Demand Capacity Balancing at regional and local levels.

PJ09 Advanced DCB developed and validated the following three SESAR Solutions:

- PJ09-01 Network Prediction and Performance
- PJ09-02 Integrated Local DCB Processes
- PJ09-03 Collaborative Network Management Functions

The major objective of the PJ09 Advanced DCB concept is to evolve the existing DCB process to a powerful distributed network management function which takes full advantage from the SESAR Layered Collaborative Planning, Trajectory Management principles and SWIM Technology to improve the effectiveness of ATM resource planning and the network performance of the ATM system in Europe.

The **SESAR Solution PJ09.01 "Network Prediction and Performance"** develops the concept and the tools for the prediction and evaluation of network imbalances and performance. This concept aims at improving the local and regional network functions in their proactive involvement by increasing the shared situation awareness among all the stakeholders. This solution has dependencies with PJ09 Solution 2 for the exchange of the extensive local DCB data required with LTM/INAP; and with PJ09 Solution 3 for the improved and transparent Regional Network Management driven by network performance targets and supported by a dynamic and highly collaborative NOP.

The local DCB and Extended ATC Planning actors identify local hotspots through an assessment of evolving traffic patterns. They resolve the local hotspots through an evaluation of performance-based actions and opportunities in order to find the optimised solution, taken from a palette of available measures. These measures and means to identify local hotspots are covered by Solution 1:

- **Demand and DCB Imbalance Prediction:**

  The demand prediction is a critical input to the cost efficiency of ATM services. The earlier and more accurately traffic demand can be predicted, the earlier capacity issues can be forecast leading to more efficient ATM resources planning.

  The probabilistic demand forecast aims at solving this issue: better demand prediction over time horizon leads to an earlier identification of areas where the demand is higher or close to the available capacity. This can prevent the network and individual stakeholders' performances to be negatively impacted.

- **Complexity and Workload Assessment:**

  As for the demand prediction, the complexity and workload assessment is a critical input to the cost efficiency of ATM services, led by an improved planning of sectors capacity and ATM resources.

This improvement is managed by an effective and early detection of complex peaks and traffic (descending, climbing, etc.) in a sector; allowing the FMPs to better distribute the workload through time and to maintain the level of safety.

- **Network Performance:**

  The aim of this cluster is to manage and monitor the Network Performance in order to resolve hotspots by providing the best solution to all actors. Indeed, each stakeholder has an individual set of performance indicators which may varies from local to regional network scales. These performance indicators need to be translated into common and clear indicators to assist the stakeholders in easily understanding the interests and needs of the others.

  The stakeholders' needs must be regularly balanced by an arbitration process, which identifies the most pressuring performance needs on the regional or local network scale. The collaboration process considers the fair spread of advantageous and disadvantageous decisions for individual stakeholders. As a result, all relevant information are considered and consolidated to conduct a trade-off between stakeholder interests and performance needs.

  This topic convers both local (FMPs, AUs and APT) and regional areas (NM).

The **SESAR Solution PJ09.02 "Integrated Local DCB processes"** develops the concept and tools for the integration of all functionalities related to the Integrated Network and ATC Planning (INAP).

- This solution is the logical follow-up of the SESAR1 Local DCB toolset and addresses the integration of Local Network Management with ex-tended ATC planning and arrival management activities in the short-term to execution in a continuous process.
- It represents the core functionality for the Integrated Network ATM Planning (INAP) process through an enhanced Local DCB tool set. The solution improves the efficiency of ATM resource management, as well as the effectiveness of complexity resolutions by closing the gap between local network management and extended ATC planning.
- Local DCB actors and Extended ATC Planning actors are working within an INAP working environment providing access to all capacity and flow/trajectory management options and shared ATFCM/ATC situation awareness on both DCB and ATC sides.

The local roles within INAP (mainly Local Traffic Management and Extended ATC Planning) are able to assess and resolve local complex situations (e.g. hotspots) through assessment of dynamic traffic situation and evaluation of opportunities, in order to identify and manage the best performing option between Tactical Dynamic Airspace Configuration measures, flow management measures and trajectory measures (e.g. strategic de-confliction/synchronization).

The **SESAR Solution PJ09.03 "Collaborative Network Management Functions"** aims at delivering an improved and transparent Regional Network Management driven by network performance targets and supported by a dynamic and highly collaborative NOP. This solution has dependencies with PJ09 Solution 1 that develops the common set of indicators for the quantification of network performance and with PJ09 Solution 2 for the exchange of the extensive local DCB data required with LTM/INAP and for the joint elaboration of the Network Operational Plan. Additionally Solution 3 requires strong interaction with the rest of the Network stakeholders in particular with AU and airports through PJ07, PJ018 and PJ04.

Solution 3 is by nature an integrating solution that brings stakeholders together through a seamless process supported by the provided collaborative functions and frameworks.

The main topics covered by Solution 3 are:

- AOP/NOP Integration. An excellent example of a dynamic exchange of planning data between airport and Network to increase predictability and to improve operations at both sides. This topic that started in SESAR 1 continues in 2020 in two tracks:

  - To further integrate AOP & NOP data by including the exchange of new airport indicators providing the knock-on effect and AU preference. The main goal being to support local DCB operations in particular in the cherry picking flight selection process of STAM and target times.

  - To improve the quality of the predicted flight plans, currently exiting in NM systems but not active, so that they can be used to compensate for the missing traffic demand in the early hours of the tactical day before flight plan are submitted. This is a key enabler of the concept AOP-NOP. The issue was identified in SESAR 1.

- Integration of NOP (including the consolidated AOP/NOP data) with AU and FOC. The earlier and consolidated information in NOP (AOP/NOP data i.e. SID, STAR, TTA etc..) is exchanged and used by AU and FOC to improve their calculation of 4D trajectories. Thanks to this integration the created trajectories will be closer to RBT trajectory and also will reduce the gap between the NOP and AU trajectories. Hence aiming at improving predictability.

- Flow and Flight Planning Integration or support to FF-ICE aims at substantially increasing the integration between flight planning and flow management compared to current operations. With the early provision of FPL, the AU will benefit from planning their operations in a more predictable network, resulting in a AU/Network win-to-win approach. The AU will be notified of DCB constraints and measures affecting his SBT as well of opportunities in the evolving network DCB situation to support "less constraint or more network performing" trajectories. The system notifications upon initial submission or updates of the preliminary FPL or FPL itself can be tailored by AU to their business and system's needs. In support of the FF-ICE concept, DCB/NOP offers a new set of what-if services providing network DCB impact, constraints, hotspots and congestion indicators fully interoperable via SWIM with their FPL systems.

- Collaborative DCB framework and Constraint reconciliation.
  - The reconciliation within regional NM with fully transparent and agreed set of rules of multiple time-based constraints provided by different network actors. Reconciliation is supported by a dynamic and fully automated process. The different criticality of the hotspots -from an optimisation to a critical spot-, and its time horizon is a new key factor included in the reconciliation. All ensuring the stability of the network and maximising the network performance.

  - Explore the relationships between the DCB regulations and their interactions trough the flights to quantify the network effect of those interactions. Interactions bringing positive impacts to the network have been qualified as 'Protection', on the other hand interactions with negative impacts have been qualified as 'Penalization'.

- Network optimisation is an alternative approach to constraint reconciliation to deal with the increasing and competing actors' request. It is based on a mathematical model of the network that is optimised according to key functions known as ruling the network performance, such as reactionary delay and primary delay.

All previous activities help to progressively refine the operational concept. Concept Validation is performed sequentially, with each exercise providing information to the next. Gaming and Fast-Time Simulation techniques support in the early phase of concept elaboration, this is the case for "Collaborative DCB framework and Constraint reconciliation" and "Network optimisation". Shadow mode techniques develop and refine the scope and establish its operational viability, this is the case of "AOP/NOP Integration", "Integration of NOP (AOP/NOP) with AU/FOC" and "FF-ICE" .

1.3 Work Performed

1.3.1 SESAR Solution 1: Network Prediction and Performance

This solution was defined as a supporting solution for PJ09.02 and PJ09.03, focused on further development and validation of the critical local and network functions, namely the following 3 important elements:

- Demand and DCB imbalance prediction
- Complexity and workload assessment
- Network performance monitoring

The work was conducted in the following tasks:

- OSED: Elaboration of the concept elements through a series of concept brainstorm sessions, EATMA modelling, stakeholder consultations, identification of requirements (safety, performance, interoperability) and writing of specific OSED contributions. The OSED task was one of the main overarching tasks taking place in the project, as it also had to coordinate and finally include a set of important appendices, namely Safety assessment report (SAR) and Human performance assessment report (HPAR). This task included also the development of the Security Assessment Report (SecAR) which analysed the impact of cyber security threads in the context of PJ09.
- VALP/VALR: Once the initial version of OSED was drafted, the validation team started to prepare the first version of the validation plan, drafting the stakeholder expectations, benefit impact mechanisms, defining the high-level validation objectives for the entire PJ09.01 validation roadmap. The subsequent iterations of the VALP focused on more detailed planning of each validation activity/exercise, defined the lower level validation objectives, validation exercise planning, platforms, metrics etc. All exercises have been conducted as planned, analysed and documented in the validation report (VALR).
- Technical specification: Elaboration of the Technical Specification and Availability Notes for the simulation platforms used in EXE-09-01.02 and EXE-09-01.05. The work includes organisation and participation in coordination and technical meetings, as well as the elaboration of contributions, their review and the final edit of the deliverable.

- Prototyping: The following new functions have been integrated in the prototypes developed for EXE-09-01.02 and EXE-09-01.05 (tools developed by EUROCONTROL, CRIDA and DLR):
    - Probabilistic demand forecast algorithm and visualisation
    - Probabilistic flight list
    - Confidence index
    - Weighted density (aka complexity) algorithm and visualisation
    - List of contributing factors to complexity incl. complexity value
    - Heatmap of potential flight interactions
    - Integration of Planta and cognitive complexity model integrated in eCommet
    - Sharing of consolidated performance indicators among the main DCB stakeholders (NM, FMPs, AUs, APTs)
    - Foreign impact measure
    - Network Impact Display
    - Turnaround impact margin
    - Stand impact margin
    - Network states monitoring
    - Network resilience monitoring (recovery time, magnitude of disruption)

- The validation roadmap execution: The Solution has been validated through a series of activities including Fast Time Simulation, shadow-mode trials, and data mining, focusing on a range of objectives from the operational acceptability of the Probabilistic demand forecast, to the operational acceptance of performance indicators. A high-level summary of each validation is presented hereafter:

    - Data mining:
        - First activity to develop a Probabilistic Demand Prediction forecast, based on historical data and uncertainties (ACT-09-01.01)
        - Second activity define the Network Performance Management by providing performance indicators reflecting the needs of all the network stakeholders (ACT-09-01.04)
    - Fast Time Simulation:
        - First exercise to assess the Traffic Complexity and to determine the best methodology and indicator to assess the air traffic complexity from short term planning phase to execution phase (EXE-09-01.03)
        - Second exercise to assess the operational feasibility of a more active role of NM in case of non-nominal situations (EXE-09-01.05)

- Real Time Simulations – shadow mode exercises:
  - One exercise to validate the benefits of an improved Demand and Imbalance Prediction to FMPs in their decision-making process (EXE-09-01.02)
  - One exercise to assess the Network Performance Monitoring and Supervision in order to improve the coordination in finding the most efficient measure between the impacted stakeholders when solving a hotspot (EXE-09-01.05)

- Cost Benefit Analysis (CBA): Leadership and coordination of the overall CBA task. This includes the coordination of the overall task, inputs from all main partners, concept, validation and CBA experts, participation in cost & benefit assessment meetings, as well as the elaboration and review of the appropriate contributions.

- Human Performance Assessment: Contribution to the project's Human Performance Assessment. This includes the participation in technical meetings, as well as the elaboration and review of the appropriate contributions.

- Safety Assessment: Contribution to the project's Safety Assessment. This includes the participation in technical meetings, as well as the elaboration and review of the appropriate contributions.

- Security / Cyber-Security assessment: Contribution to the project's assessment. This includes the participation in technical meetings, as well as the elaboration and review of the appropriate contributions. It must be pointed out that, since PJ09 was a non-prioritised project, it was not necessary to perform Threat Assessment, Vulnerability Assessment, threat Combination Assessment, Controls Selection or definition or residual risk, etc

- Solution Management: Monitor and control of the project execution. Organisation and hosting of coordination meetings. Contribution to the project's reporting requirements.

1.3.2 SESAR Solution 2: Integrated Local DCB Processes

This solution forms the core functionality of the INAP process. It includes:

- INAP management,

- ASM integrated into DCB (including Dynamic Airspace Configurations),

- Reconciliation of DCB measures with local complexity management, ATC and Arrival Management.

To accomplish these objectives, the Solution has performed work in the following areas:

- OSED: Contribution to the identification, definition and description of the operational concept elements related to the objectives. The contribution includes participation in brainstorm meetings, organisation and performance of specific serious games to elicit requirements and the writing of the appropriate contributions. This task included also the development of the Security Assessment Report (SecAR) which analysed the impact of cyber security threads in the context of PJ09.

- VALP / VALR: Elaboration of the Validation Plan (VALP) and corresponding Validation Report (VALR). This includes organisation and participation in coordination and technical meetings, as well as the elaboration of contributions, their review and the final edit of the deliverables.

- Technical Specification: Elaboration of the Technical Specification and Availability Notes for the simulation platforms used in EXE-09-02.02 and EXE-09-02.03. The work includes organisation and participation in coordination and technical meetings, as well as the elaboration of contributions, their review and the final edit of the deliverable.

- Prototyping: The following functions have been implemented

  - INAP Responsibilities, Accountability, Communication and Interest (RASCI) model
  - eCOMMET
    - MCP Ground Delay
    - MCP Flight Level Capping
    - Horizontal re-routing (ground)
    - B2B services with NM
  - iACM
    - MCP Ground Delay
    - MCP Flight Level Capping
    - Horizontal re-routing (ground)
    - RE-SECTORISATION
    - B2B services with NM
  - IDS ATFCM
    - MCP Ground Delay
    - MCP Flight Level Capping
    - B2B services with NM
  - CRYSTAL
    - MCP Ground Delay
    - MCP Flight Level Capping
    - B2B services with NM
  - ECOSystem
    - Take-off not before
    - MCP Flight Level Capping
    - B2B services with NM
  - SALTO 2020
    - MCP Flight Level Capping
    - Trajectory Prediction
    - B2B services with NM
  - COFLIGHT (CWP)
    - Integration with SALTO
  - INNOVE
    - B2B services with NM
  - NMVP
    - B2B services with NM

- Organisation and Performance of validation exercises: Design, implementation and performance of three validation exercises (EXE-09-02.01, EXE-09-02.02 and EXE-09-02.03). The work includes the design of the experiments, their planning, overseeing and performance, as well as the analysis of the collected results. The work includes organisation and participation in coordination and technical meetings, as well as the elaboration of contributions to the VALR. It also includes the development of the software and systems required to put the required validation platforms into operation for the simulations.

- Cost Benefit Analysis (CBA): Contribution to the project's CBA. This includes the participation in costing and technical meetings, as well as the elaboration and review of the appropriate contributions.

- Human Performance Assessment: Contribution to the project's Human Performance Assessment. This includes the participation in technical meetings, as well as the elaboration and review of the appropriate contributions.

- Safety Assessment: Contribution to the project's Safety Assessment. This includes the participation in technical meetings, as well as the elaboration and review of the appropriate contributions.

- Security / Cyber-Security assessment: Contribution to the project's assessment. This includes the participation in technical meetings, as well as the elaboration and review of the appropriate contributions. It must be pointed out that, since PJ09 was a non-prioritised project, it was not necessary to perform Threat Assessment, Vulnerability Assessment, threat Combination Assessment, Controls Selection or definition or residual risk, etc

- Solution Management: Monitor and control of the project. Organisation and hosting of coordination meetings. Contribution to the project's reporting requirements.

1.3.3 SESAR Solution 3: Collaborative Network Management Functions

The work was conducted in the following tasks:

- OSED: Elaboration of the concept elements through a series of concept brainstorm sessions, EATMA modelling, stakeholder consultations, identification of requirements (safety, performance, interoperability) and writing of specific OSED contributions. The OSED task was one of the main overarching tasks taking place in the project, as it also had to coordinate and finally include a set of important appendices, namely Safety assessment report (SAR) and Human performance assessment report (HPAR). This task included also the development of the Security Assessment Report (SecAR) which analysed the impact of cyber security threads in the context of PJ09.

- VALP/VALR: Once the initial version of OSED was drafted, the validation team started to prepare the first version of the validation plan, drafting the stakeholder expectations, benefit impact mechanisms, defining the high-level validation objectives for the entire PJ09.03 validation roadmap. The subsequent iterations of the VALP focused on more detailed planning of each validation activity/exercise, defined the lower level validation objectives, validation exercise planning, platforms, metrics etc. All exercises have been analysed and documented in the validation report (VALR).

- Technical specification: Elaboration of the Technical Specification and Availability Notes for the simulation platforms used in EXE-09-03.02 and EXE-09-03.03. The work includes organisation and participation in coordination and technical meetings, as well as the elaboration of contributions, their review and the final edit of the deliverable.

The validation exercises addressed the following topics:

- Integration of NOP (including the consolidated AOP/NOP data) with AU and FOC. The earlier and consolidated information in NOP (AOP/NOP data i.e. SID, STAR, TTA etc..) is exchanged and used by AU and FOC to improve their calculation of 4D trajectories. Thanks to this integration the created trajectories will be closer to RBT trajectory and also will reduce the gap between the NOP and AU trajectories. Hence aiming at improving predictability.

- Flow and Flight Planning Integration or support to FF-ICE aims at substantially increasing the integration between flight planning and flow management compared to current operations. With the early provision of FPL, the AU will benefit from planning their operations in a more predictable network, resulting in a AU/Network win-to-win approach. The AU will be notified of DCB constraints and measures affecting his SBT as well of opportunities in the evolving network DCB situation to support "less constraint or more network performing" trajectories. The system notifications upon initial submission or updates of the preliminary FPL or FPL itself can be tailored by AU to their business and system's needs. In support of the FF-ICE concept, DCB/NOP offers a new set of what-if services providing network DCB impact, constraints, hotspots and congestion indicators fully interoperable via SWIM with their FPL systems. Additionally the airspace user are able to notify critical flights to the Network Manager and INAP using the Flight Delay Criticality Indicator feature as a mean to express airspace user preferences. INAP use the information provided to priories identified critical delayed flight in a relevant timeframe and more accurately than the current process. It provides full transparency amongst the different AU and enables the possibility for NMOC in coordination with all DCB actors to support the FDCI flight by reducing/minimising its delay

- Improve the quality of the predicted flight data (PFD) , currently exiting in NM systems but not active, so that they can be used to compensate for the missing traffic demand in the early hours of the tactical day before flight plan are submitted. This is a key enabler of the concept AOP-NOP. The issue was identified in SESAR 1. Solution 3 making use of machine learning technique aims at improving the quality of predicted flight data in EUROCONTROL Network Manager's by first analysing the deviations and mismatches between the current prediction from PFDs and the first filed flight plan.

- Collaborative DCB framework and Constraint reconciliation.
  - The reconciliation within regional NM with fully transparent and agreed set of rules of multiple time-based constraints provided by different network actors. Reconciliation is supported by a dynamic and fully automated process. The different criticality of the hotspots -from an optimisation to a critical spot-, and its time horizon is a new key factor included in the reconciliation. All ensuring the stability of the network and maximising the network performance.

- Explore the relationships between the DCB regulations and their interactions trough the flights to quantify the network effect of those interactions. Interactions bringing positive impacts to the network have been qualified as 'Protection', on the other hand interactions with negative impacts have been qualified as 'Penalization'.

- Network optimisation is an alternative approach to constraint reconciliation to deal with the increasing and competing actors' request. It is based on a mathematical model of the network that is optimised according to key functions known as ruling the network performance, such as reactionary delay and primary delay.

All previous activities help to progressively refine the operational concept. Concept Validation is performed sequentially, with each exercise providing information to the next. Gaming and Fast-Time Simulation techniques support in the early phase of concept elaboration, this is the case for "Collaborative DCB framework and Constraint reconciliation" and "Network optimisation". Shadow mode techniques develop and refine the scope and establish its operational viability, this is the case of "AOP/NOP Integration", "Integration of NOP (AOP/NOP) with AU/FOC" and "FF-ICE" that integrated LIDO and FOC/PLANTA prototypes with NMVP.

1.4 Key Project Results

1.4.1 SESAR Solution 1: Network Prediction and Performance

The main findings from the overall validation exercises can be summarised as follows:

- The probabilistic demand prediction method based on time error (uncertainty) developed the preparatory activity has demonstrated to be a viable step forward in the effort to improve traffic demand prediction in the Network. The methods developed for demand prediction and probabilistic counts showed positive results when comparing the probabilistic forecast against the actual counts. The ability to detect overloads correctly has been proved.

- This method, applied in the validation exercise and used by the FMPs raised positive feedback. It seemed to provide relevant information (probabilistic demand forecast, and probabilistic flight list) in support of the current forecast for traffic assessment and elaboration of the DCB solution. Qualitative results showed an improvement of the situational awareness, with no negative impact on the workload. Concerning the current Probabilistic Confidence Index definition, this index was perceived as the "worst case" scenario however, as currently defined, the FMPs did not consider it relevant.

- The complexity prediction results demonstrated that the Complexity prediction method based on Cognitive Complexity was a promising tool for FMPs. The Cognitive Complexity indicator was considered as the most promising complexity indicator and its calibration has been automatized.

- The use of a simplified Complexity algorithm, weighted density forecast, by the FMPs in the validation exercise demonstrated high interest in Complexity information. Common agreement was made regarding the improvement of situational awareness and decision-making process.

- From the performance monitoring perspective, the consideration of impacted stakeholders' performance indicators in the selection of candidate flights for DCB measure was appreciated among all the participants (FMPs, AUs and APT) in the validation exercise. The performance indicators provided helpful information, improving the situational awareness on the negative impacts of DCB measure. It can be concluded that the Performance monitoring based on Individual Performance indicators is a promising concept for the FMPs and all the other stakeholders, at the condition that workload must remain at a manageable level to be operationally accepted.

- NM showed interest in having additional performance indicators to monitor the network state and to obtain a more active role in case of (partial) non-nominal situation in the network. The network resilience and network state indicators are promising features that need to be further developed.

1.4.2 SESAR Solution 2: Integrated Local DCB Processes

The most significant results obtained by Solution 02 as regards the integration of Local DCB Processes can be summarised as follows:

- Reduced need for regulations on high-demand periods. Obtained through the use of coordinated STAM supported by specific Local tools. Confirmed in the validation by Local Traffic Managers

- A human centred design facilitates STAM solution implementation. The validation results show that workload is either reduced or maintained, and that it is possible for the Local Traffic Manager to identify ahead of time the impact of a proposed STAM through the use of dedicated what-if tools.

- Automation supports and enhances the effectiveness of STAM. Automation supports decision-making based on the provision of the right information at the right time. The use of advance dashboards and of the Local Tools, allows for structured information.

- Air Traffic Complexity is a useful tool to optimise Capacity. It facilitates decision-making, provides insight into prediction and increases the common situational awareness.

	Solution Level	ECAC Level
CAP APT	N/A	N/A
CAP TMA	N/A	N/A
CAP ER	3%-11.4%	7.2%
PUN	4%-13%	2.5%
FEFF	1.9%	0.1%
CEFF	2%-11.4%	4.0%
FLX	N/A	N/A
HP	*	*
SAF	Not degraded **	Not degraded **
PRD	8%	0.27%

* See detailed HPAR

**See detailed SAR

ECAC extrapolation considering ENR-VHC and ENR-HC

Figure 2: Results of the Benefit Assessment

1.4.3 SESAR Solution 3: Collaborative Network Management Functions

Solution 3 has been designed around one activity and two validation exercises as described below. Following we provide the main outcomes for each of them.

- ACT-09.03.01, a gaming/expert judgement activity to explore the DCB Collaborative Framework,
- EXE-09.03.02, a series of three shadow-mode trials including sub-sessions a simulation and a study. They cover the NOP collaborative functionalities (integration of AOP/NOP data SID,STAR and TTA in eFPL), the integration of DCB and Flight in support to FF-ICE(enhanced DCB information, What-If& What-Else for AU)), and the improvement of traffic demand predictions , by a simulation focused on Preliminary flight plan and a study focused on predicted flight data
- EXE-09.03.03, two modelling simulations to address DCB constraints reconciliation and optimisation at network level.

From the ACT-09.03.01 Collaborative Framework validation outcomes, we retain that the PJ09 hotspot DCB delegation from INAP to APOC, is a mechanism that foster the coordination; allowing them to have the same view on the identified hotspot. The activity investigated the roles and associated procedures depending the mode of collaboration (i.e. limited and/or full). INAP is the main trigger, and its decision depends on the operational situation driven mainly by the look-ahead time and the hotspot severity. The PJ09 concept was refined from the results of ACT-09.03.01 gaming specifying the rules and conditions on which INAP and APOC would agree before delegating. We observed the main limit of this appreciated feature, the closer we are from the beginning of the DCB hotspot, the less the delegation mechanism is applicable as it endangers the safety of network operations.

On the DCB constraints reconciliation and optimisation concept topics, we demonstrated the feasibility of designing a network optimised DCB solution; taking into account business criteria like primary (ATFCM) and reactionary delays for the stakeholders. Optimisation techniques, embedded within the EXE-09.03.03 CRO module in RNEST, succeeded in finding acceptable solutions, bringing performance benefits, ranging from 39% up to around 56% of delay reduction, within a reasonable computing time. The ATFCM slot allocation refinement proposed by the EXE-09.03.03 ECASA improvement strategies, "prevent flights from entering into large tension zones" and "overloading of slots", showed that promising performance benefits in ATFCM delay reduction, around 26%, could be obtained with small changes in the current system (innovative approach). An assessment of combining both strategies options show an observed total delay reduction about 40%. While we observed a delay reduction, we also measured a decrease in flight delayed in summer period by 14%, demonstrating a better usage of available network capacity and a direct benefit to airspace user operations. This translate in a positive impact on the Punctuality KPA showing a 20% reduction of the flights delayed by more than 3 minutes.

The validation activities in EXE-09.03.02 outcomes:

- Regarding DCB in support to FF-ICE , showed a mature concept, paving the basis to start working on the next phase. The DCB What-If and What-Else services provide airspace users with additional capabilities to react to DCB issues occurring across the network, allowing them to avoid rerouting in already identified DCB hotspots. The performed shadow-mode trials allowed the identification of pertinent DCB information to share with airspace users to enhance the situational awareness of all stakeholders and enhanced the NMF/AUs coordination. Operational feasibility of the planning service negotiation mechanism related to DCB measures was shown, still some automation to decrease additional workload linked to new tasks to perform was highlighted. In EXE-09.03.02, the airspace users were able to notify critical flights to the Network Manager and INAP using the Flight Delay Criticality Indicator feature as a mean to express airspace user preferences. INAP use the information provided to priories identified delayed flight in a relevant timeframe and more accurately than the current process. It provides full transparency amongst the different AU and enables the possibility for all DCB actors to support or act -in coordination with NMOC- on the FDCI flight. The FDCI shows its highest value within the last two hours before airborne, before the ATFCM delay is still varying significantly so performing an FDCI action like force-slot could be counteractive For early use of FDCI, the pro-active FDCI would be used for which clearer proactive procedures need to be elaborated

- On the integration of AOP/NOP data SID,STAR and TTA in eFPL), focusing in trajectory predictability. It has demonstrated that better and earlier alignment between network predicted and last planned/before airborne, trajectories in terms of SID and departure runway can be achieved by the integration of dynamic SID updates - provided by AOP/NOP - in the AU eFPL trajectory. These eFPL trajectory updates are consequently shared with NM increasing the alignment of NM and AU trajectories and the predictability of the NM planned trajectories. STAR updates integration also demonstrated an increase of predictability but not conclusive effect on the alignment. The TTA is considered useful for awareness but not for triggering a change in the flight plan.

- Demand Prediction Improvement topic was addressed through two studies on predicted flight data and preliminary fight plans.

- The predicted flight data study aimed to improve the quality of preliminary flight data (PFD) in EUROCONTROL Network Manager's by first analysing the deviations and mismatches between the current prediction PFD and the first filed FPL. The analysis was aggregated by clusters (i.e. groups of city-pairs) that shared common behaviour, concluding that improvements can be obtained and modelled at cluster level but a general predicted model for all network appeared ambitious. Additionally the study highlighted the difficulties to model changes of AIRAC and seasons.

- The Preliminary Flight Plans study showed an improved accuracy of demand predictions up to 10 hours before entry time of the flights. The model was applied to a nominal day, a heavy strike day and weather disruptive day, In general with PFP, an overall stable demand is achieved (up to 10 hours) with only some 10% prediction error .This would increase the confidence that INAP could create efficient DCB measures earlier.

1.5 Technical Deliverables

Reference	Title	Delivery Date	Dissemination
D2.1.023	V2 Final OSED/SPR/INTEROP (including SAR, HPAR, PAR)	10/09/2019	PU
This document describes the operational environment and the detailed operating methods for PJ09 Demand Capacity Balancing (DCB). The document includes the specification of the requirements, covering functional, non-functional and interface requirements related to SESAR PJ09. It covers the three PJ09 solutions aiming at providing a single document with a more consistent and integrated PJ09 view.			
D2.1.041	V2 Final TS/IRS Solution 1	24/06/2019	PU
The Technical Specification presented here is part of PJ09 for Advanced DCB and documents the technical requirements for PJ09 Solution 1: Network Prediction and Performance. Overall, Project PJ09 Advanced DCB is addressing the performance driven balancing of traffic demand and ATM capacity in a collaborative process with all ATM stakeholders and Airspace Users involved. In Solution 1, the goal is to provide an improved Trajectory Forecast based on the quantification of uncertainties and probabilistic approaches along with more advanced performance measures. Improvement will be based on the use of extra data sources that are not currently considered as part of flight planning (such as historical flight/archived data). This document aims to provide a consolidated set of technical requirements allowing the network prediction and performance tools to reach the aforementioned advanced capabilities. Specifically, it presents the technical architecture needed for this. Note that there are no significant changes from the baseline architecture.			
D2.1.070	V2 VALR Solution 1	10/09/2019	PU
This document provides the Validation Report for PJ09 Solution 1 "Network Prediction and Monitoring" in the context of SESAR2020 Wave 1. The exercises and activities were focused on			

validating the concept described in the OSED, related to the detection of imbalances with probabilistic and complexity forecasts and the monitoring and management of Network state based on Performance indicators. In more details, this document details the results of the work described in the Validation Plan: ACT-09-01.01: Preparatory Activity to develop a Probabilistic Demand Prediction EXE-09-01.02: Validation Exercise to validate the benefits of an improved Demand and Imbalance Prediction EXE-09-01.03: Validation Exercise to assess the Traffic Complexity ACT-09-01.04: Preparatory Activity to define the Network Performance Management EXE-09-01.05: Validation Exercise to assess the Network Performance Monitoring and Supervision The exercise results are based on expert group judgement with qualitative feedback about the concept presented as a process in terms of data, tools, workflow and timeline, and data logs for quantitative results.			
D3.1.023	V2 Final OSED/SPR/INTEROP (including SAR, HPAR, PAR)	10/09/2019	PU
This document describes the operational environment and the detailed operating methods for PJ09 Demand Capacity Balancing (DCB). The document includes the specification of the requirements, covering functional, non-functional and interface requirements related to SESAR PJ09. It covers the three PJ09 solutions aiming at providing a single document with a more consistent and integrated PJ09 view.			
D3.1.041	V2 Final TS/IRS Solution 2	24/06/2019	PU
This Technical Specification PJ09 for Advanced DCB documents contains the high-level technical requirements of PJ09 Solution 2 - Integrated Local DCB Processes (PJ09-020). Here, Local DCB and Extended ATC Planning actors manage demand-capacity imbalances, such as Hot/Opti spots, applying massive Target Times and other Short Term ATFCM Measures (STAM). The Integrated Network Management and (Extended) ATC Planning (INAP) functions support this management with a set of advanced capabilities, including synchronised measures to minimise the constraints interferences (overlaying), DCB Collaborative Decision Making (CDM) and the Complexity Reduction Service (CORSE). This documents aims to provide a consolidated set of technical requirements allowing the INAP tool to reach the aforementioned advanced capabilities. Specifically, it presents the technical architecture needed for this. Note that there are no significant changes from the baseline architecture.			
D3.1.070	V2 VALR Solution 2	10/09/2019	PU
This VALR presents the results of the different V2 validation activities carried out under the umbrella of PJ09.02. One Role-Game exercise plus five RTS were performed in order to validate the PJ09.02 operational concept. Results are described at Exercise Level and they are then aggregated at solution level. Deviations from PJ090.02 VALP, as well as conclusions and recommendations for the next			

phase (following V2-V3 activities) are provided. Short descriptions of each exercise and results are presented below: EXE09.02-01 was a Role-Based Gaming, led by CRIDA/ENAIRE, where the whole PJ09.02 operational concept was validated. Different sessions addressing the concept in an incremental manner were organised involving the whole spectrum of stakeholders related to the concept. The four OIs were addressed delivering qualitative feedback in terms of performance and operational feasibility. EXE09.02-02 was a RTS led by DSNA and focused on the EAP role as key figure of the INAP process, in VHC and HC sub-operating environments. DCB concept and measures, from their elaboration until their implementation on Control Working Positions, were validated involving LTMs (acting as EAP) and ATCOs (acting as PC/EC), each of them working on dedicated HMIs. Results demonstrated the concept is operationally and technically feasible, although some aspects need further development. Recommendations and new requirements were identified as result of the exercise. EXE09.02-03 was split into four different exercises, each one led by a different ANSP (CRIDA/ENAIRE, ENAV, SKYGUIDE, COOPANS). In each of the exercise, local systems connected successfully via B2B with the NM system. Hotspots and DCB measures were assessed and implemented correctly. LTMs and ATCOs participated actively during the execution of the exercises and assess the scenarios and traffic as quite realistic and appropriate for the exercises purpose. Results achieved successfully the validation objectives.			
D4.1.023	V2 Final OSED/SPR/INTEROP (including SAR, HPAR, PAR)	10/09/2019	PU
This document describes the operational environment and the detailed operating methods for PJ09 Demand Capacity Balancing (DCB). The document includes the specification of the requirements, covering functional, non-functional and interface requirements related to SESAR PJ09. It covers the three PJ09 solutions aiming at providing a single document with a more consistent and integrated PJ09 view.			
D4.1.041	V2 Final TS/IRS Solution 3	24/06/2019	PU
This Technical Specification presented here is part of PJ09 for Advanced DCB and documents the technical requirements for PJ09 Solution 3: Collaborative Network Management Functions. Here, a variety of collaborative mechanisms are introduced, including a distributed decision-making system and a collaborative NOP. This document aims to provide a consolidated set of technical requirements allowing these collaborative tools to reach the aforementioned advanced capabilities. Specifically, it presents the technical architecture needed for this. Note that there are no significant changes from the baseline architecture.			
D4.1.070	V2 VALR Solution 4	10/09/2019	PU
This document presents the results of the different V2 validation activities carried out under the umbrella of PJ09 Solution 03 “Collaborative Network Management Functions”. The exercises and activities focused on validating the concept described in the OSED, related to the collaborative DCB framework, the Reconciliation of DCB measures in case of multiple conflicting constraints and the			

Collaborative NOP that supports and reflects the result of the ATM planning process. Brief description of the conducted validation activities below: • **ACT-09-03.01** "Collaborative DCB Framework". A preparatory activity to investigate the Collaborative Framework as a unified process that improves decision making for the Network Management function. • **EXE-09-03.02** "Rolling AOP/NOP Core Functions". An investigation of the NOP Collaborative functionalities mainly supported in wave 1 of SESAR 2020, by the enhanced integration of AOP/NOP, including the integration of AOP/NOP data with eFPL, the integration of Flow management with Flight Planning and trajectory preferences in support of FF-ICE. In addition, to assess DCB improvements related to better demand predictions within the collaborative NOP especially by the use of the preliminary flight plan and to address NOP what-if capabilities. The exercise is a joint validation activity with PJ04, PJ07-01 & PJ18-02. • **EXE-09-03.03** "Constraint Reconciliation algorithm". An assessment of a Constraint Reconciliation mechanism (i.e. algorithm) in the framework of Collaborative Network management. The reconciliation mechanism considers all DCB measures including Airspace, Airport and Airspace Users constraints.

Table 1: Project 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
			V1	**V2**
DCB-0211	Traffic & Demand Forecast in 4D trajectory Management Context	Development and validation of probabilistic traffic prediction (occupancy counts) algorithm, confidence index, flight proximity heatmap (potential interactions); integration into the FMP tool	V1	V2
DCB-0212	Network Performance Assessment	Definition and validation of high-level concept of collaborative network performance and monitoring; Network resilience (network states, recovery time, magnitude of disruption), consolidation of shareable performance indicators between main DCB actors (ANSPs, NM, AUs, APT);	V1	V2
CM-103-B	Automated Support for Traffic Complexity Assessment	Evaluation of complexity indicators, threshold definition, calibration, validation of complexity indicator integrated in the FMP tool	V1	V2
NIMS-22	Enhanced performance management sub-system	Initial validation prototype developed, user driven design initiated	TRL-4	TRL-5
NIMS-30	ATFCM scenario management equipped	Not addressed	TRL-4	TRL-4

	with tools for assessing the impact of DAC and capacity changes on trajectory efficiency			
NIMS-36	Enhanced Complexity assessment tools	Integration of complexity assessment algorithm into the FMP tool	TRL-4	TRL-5
NIMS-23	Capacity planning and scenario management equipped with tools integrating SB/MT information, to assist ATS in optimising the use of	Not addressed	TRL-4	TRL-4
SWIM-APS-04b	Consumption of ATFCM Information Services	Integration of B2B data in the validation prototype	TRL-2	TRL-3
NIMS-34	Civil-Military performance measurement system	Not addressed		
SWIM-APS-03b	Provision of ATFCM Information Services	Integration of B2B data in the validation prototype	TRL-4	TRL-5
METEO-06c	Generate and provide Meteorological information relevant for Network related operations	Not addressed		
			V1	**V2**
CM-0104-B	Automated support to INAP (Integrated Network Management and ATC Planning) function	Prototype supporting validation. Definition of activities, roles and responsibilities.	V1	V2
CM-0302	Ground based Automated Support for Managing Traffic Complexity Across Several Sectors	Prototype supporting validation. Definition of activities, roles and responsibilities.	V1	V2
DCB-0210	Full integration of Dynamic Airspace	Prototype supporting validation. Definition of activities, roles and	V1	V2

	Configurations into DCB	responsibilities.		
DCB-0213	Consolidation and facilitation of Target Times between local DCB, Airport CDM and E-AMAN	The validation technique is based on expert judgement and serious role gaming sessions. As consequence, no system enabler was developed under the umbrella of this OI step in PJ09.02.	V1	V1
AAMS-02	Dynamic Airspace Configuration tools for the Integrated Network Working Position	Prototype supporting validation	V1	V2
ER APP ATC 17	Enhance Traffic and Flow Management sub-systems to support dynamic flow management in co-ordination with local, regional, and European levels	Prototype supporting validation	V1	V2
FOC-002	Assessment of real time ASM data	Not addressed		
METEO-06c	Generate and provide Meteorological information relevant for Network related operations, Step 2	Prototype supporting validation	V1	V2
NIMS-09	Capacity planning and scenario management equipped with tool to assess the impact of requested flight level changes	Prototype supporting validation	V1	V2
NIMS-23	Capacity planning and scenario management equipped with tools integrating SB/MT information, to assist ATS in optimising the use of airport and airspace usable capacity	Prototype supporting validation	V1	V2

NIMS-30	ATFCM scenario management equipped with tools for assessing the impact of DAC and capacity changes on trajectory efficiency	Prototype supporting validation	V1	V2
NIMS-46	Integrated local DCB working position	Prototype supporting validation	V1	V2
SWIM-APS-03b	Provision of ATFCM Information Services for Step 2	Functionality tested partially	V1	V1
SWIM-APS-04b	Consumption of ASM-ATFCM Information Services for Step 2	Functionality tested partially	V1	V1
SWIM-INFR-05b	General SWIM Services infrastructure Support and Connectivity	Prototype supporting validation	V1	V2
SWIM-SUPT-01b	SWIM Supporting Registry	Functionality tested partially	V1	V1
SWIM-SUPT-03b	SWIM Supporting Security	Functionality not addressed		
			V1	**V2**
AUO-0108	Penalizing Delay based on reconciliation between DCB and Airport CDM	Has validated by two different approaches: ECASA has successfully validated	V1	Partial V2
DCB-0103-B	Collaborative NOP for Step 2		V1	V2
DCB-0214	DCB What-if Network Impact Assessment		V1	V2
DCB-0215	Consolidation of imbalances and arbitration of Trajectory Management solutions		V1	Partial V2
DCB-0217	DCB Support to FF-ICE		V1	V2

Table 2: Project Maturity

2.2 Contribution to Standardisation and regulatory activities

In SESAR 2020, V3 maturity level, solutions must ensure that the services required for the implementation of their new concepts are properly modelled and described in EATMA (NSV-4 models (*System Functionality and Flow diagram*) and NSV-1 models (*Resource Connectivity diagram*)).

At the end of Wave 1, for PJ09 solutions reaching V2 maturity, only preliminary contribution to regulation and standardisation has been performed.

In this context, the project developed for all three solutions

- System Functionality and Flow Diagram (NSV-4) models for all use cases listed in the OSED;
- Resource Connectivity Diagram (NSV-1) models for most of the 49 use cases listed in the OSED.

3 Conclusion and Next Steps

3.1 Conclusions

3.1.1 Conclusions derived from PJ09.01 :

The key outcomes of the solution can be summarised as follows:

- **Demand and DCB imbalance prediction** - The concept of probabilistic demand prediction (in Wave 1 limited to tactical time horizon) introduced complementary information for the FMPs and NM, thereby enriching the information currently available. The minor improvements in the accuracy and precision of traffic count prediction are complemented by new elements, such as probabilistic flight list (focusing on the structure of the counts rather than counts themselves). All of this has been positively validated in the human-in-the-loop validation exercises as well as through the data mining activity. Nearly 80% of the V2 maturity criteria have been met fully or partially (while 21% were considered as non-applicable). This matches the V2 maturity gate criteria. The next steps shall focus on expanding the traffic prediction horizon into the pre-tactical and strategic phases, as well as introduce more innovative AI based techniques.

- **Complexity and workload assessment** - The traffic complexity research has progressed well in the solution despite the persisting challenge of identification of a generic and sufficiently accurate complexity metric. The evaluation of different complexity metrics in multiple sectors lead to the conclusion that none of the metrics is good enough to perform very well in all sectors and conditions. The cognitive complexity method led to most acceptable performance, therefore it has been integrated in the INAP tool and evaluated positively by FMPs. It further improves the overall network traffic situation and helps the FMPs to cherry pick the most suitable flights for the DCB measures. Due to the fragmentation of European airspace and different nature of traffic patterns, a choice of a single (standardised) complexity metric for multiple ANSPs remains a challenge. Because of this, there was a conceptual agreement to focus on standardisation of the shareable complexity indicator, translating the outcome of the local complexity assessment into a shareable complexity status information with other DCB actors (FMPs, NM) and thus further improving the network traffic awareness. Nearly 80% of the V2 maturity criteria have been met fully or partially (while 20% were considered as non-applicable). This matches the V2 maturity gate criteria. Further work shall focus on shareable complexity indicator and integration of DCB with DAC tools in Wave 2.

- **Network performance monitoring** - From the performance monitoring perspective, the consideration of impacted stakeholders' performance indicators in the selection of candidate flights for DCB measure was appreciated among all the stakeholders (NMOC, FMPs, AUs and APT). The performance indicators provided helpful information, improving the situational awareness on the negative impacts of DCB measure. It can be concluded that the Performance monitoring based on Individual Performance indicators is a promising concept for the FMPs and all the other stakeholders, at the condition that workload must remain at a manageable level to be operationally accepted. NMOC showed interest in having additional performance indicators to define and monitor the network state and to obtain a more active role in case of (partial) non-nominal situation in the network. Nearly 80% of the V2 maturity criteria have been met fully or partially (while 20% were considered as non-applicable). This matches the V2 maturity gate criteria. The network performance monitoring, network resilience and network state indicators are promising features that need to be further developed and validated in Wave 2.

3.1.2 Conclusions derived from PJ09.02 :

The most relevant conclusions on the INAP Concept are:

- INAP primary roles (namely LTM, EAP and SUP), do not drive the process in full isolation, secondary roles such as NM, AUs, APOCs and ATC strongly interact with INAP and can be responsible for supporting, coordinating, being informed or even accountable for implementation of certain measures. INAP is a collaborative framework where different stakeholder preferences and needs are taken into consideration when deciding the most suitable solution to fix the issues.
- LTM, EAP and SUP are closely coordinated and act as a group based on the existence of the abovementioned collaborative environment. The SUP is the Head of Operations in the Ops Room, therefore s/he is accountable of everything that occurs in the room. In nominal conditions, the SUP can delegate all or part of the responsibilities to LTM and EAP for INAP.
- The timeframe for LTM or EAP active participation cannot be deterministic. It depends on the local organization and scenarios. In general, it can be said that LTM for the INAP function, starts the monitoring activities 6 hours in advance. EAP initiates activities -45’ before the situation but depending on the local organization, the EAP might initiate activities even –2H to support LTM.
- LTM responsibility is to take care of predictable/structural problems of the ACC (even for sub-regional and E-TMA levels). EAP will follow the LTM analysis with more accurate information and will fix the last-minute changes or pending issues identified by the LTM. EAP is the bridge between the ATFCM plan and unplanned and non-structural situations that might have been undetected in LTM timeframe and analysis granularity, to be solved by ATC. LTM deals mostly with SBTs and EAP with RBTs. In summary, the LTM drafts and starts the implementation of the plan, the EAP refines it and continues with its implementation, and ATC executes it.
- The development and validation of INAP supporting tools are key to ensure an efficient INAP process in a collaborative environment. It has been proven that these tools need to have what-if and what-else functionalities to test different DCB Solutions. What-if to allow the operator to assess the efficiency of different measures and What-else meaning that a system or a role proposes alternative solutions to the operator.
- Any tool supporting the INAP process should include:
    - Monitoring Information on Entry Counts (with information from NM), Weather situation, Military activity situation, ATFCM Situation, Flight List (SBTs), Flows for potential interactions within the area of responsibility and airport status (runways, reactionary delay, etc). Complexity information should contribute to reflect situational awareness at a glance.
    - Configurable Thresholds for the abovementioned information items to alert when a situation requires the INAP awareness (DCB Imbalances and Hotspots)

- What-If functionalities to test if any measure of the catalogue solves the issue
- What-else functionalities incorporating solutions from NM
- Measures Synchronisation if measures are compatible locally.
- Local Impact assessment
- Centralised connection through NOP to NM, APOC and FOCs
- Connection with implementing actors different from LTM/EAP (namely NM and ATC)

- The hotspot prediction concept is fully matured. The concept of automatic notification of the local hotspot to the network was validated and the LTMs validate its maturity.

- **STAM operating methods and HMI:** the proposed HMI suited the needs of the STAM processes. The ATCO expressed the need for a flexible operating method to cope with the variability of traffic configuration regarding STAM implementation. The LTM used an operating method allowing them to cope with STAM request answer uncertainty. With the new local tools, the concept to detect and declare hotspots, as well as to analyze, prepare, coordinate and implement DCB measures to solve them was clarified. The STAM measures usability to support Demand and Capacity Balancing has been established by the LTMs during the trial. They successfully managed to minimize the impact of some regulations and sometimes to cancel them.

- **Complexity indicators**: Complexity gauges gave the EAP/LTM a better efficiency for analysing traffic and preparing STAM measures. Along with the ASD and the local FDPS data, complexity indicators allowed the LTM to quickly target relevant flight(s) for STAM requests, which in turn should allow balancing the complexity over airspace layers and avoiding complexity peaks. Any system should show complexity bars including total complexity value.

- **Information Sharing as a key element:**
  - The available information and its reliability are key for the process's definition. In general terms, the information is requested for two purposes: one to get a general Situational Awareness, second for preparing solutions. The information retrieved might be increasingly detailed and accurate as the issues are discovered. This implies that the information provided initially can be high-level and with low granularity. Once an issue has been detected, the system should provide additional information relevant to the specific issue, providing additional insight into it. The most important feature about the information is that it is shared between all partners, leading to the consolidation of a shared situation awareness. Examples of information shared are: traffic information, ATFCM information, etc.
  - Connected tools between LTM and EAP with similar interfaces are requested, although these tools cannot fully replace live discussions. Shared information needs to be consistent between both interfaces.

    Local FDPS data on EAP position: necessary in order to be able to manage STAM efficiently. The most important for the EAP and the ATCOs on CWP is to share the same information about trajectory data. STAMs should be sent on this basis from EAP to ATCOs.

- **ATFCM information sharing**: ATFCM information sharing allowed the ATCO to better anticipate the traffic with hotspot information. Adjacent sector hotspot status should allow a better coordination anticipation and overall traffic. It was also successfully demonstrated that it is possible to coordinate measures with foreign centres in order to avoid setting a regulation and that STAM can be applied across borders in a very efficient way.

- **Operational Methodology**:
  - LTM methodology first aim at solving the imbalance trying to minimize negative impact for AUs and for ANSPs out of their Area of Responsibility. Therefore capacity measures are always tried first.
  - Re-sectorization changes are usually assessing demand with the Entry Counts at 60' indicator.
  - Ground Delay is not often applied in A-CDM airports.

3.1.3 Conclusions derived from PJ09.03 :

Some topics, under validation exceed the expected maturity at the end of wave 1:

- **FDCI reactive mode** and **AOP/NOP departure information integrated in eFPL**, related to the OI DCB-0103-B demonstrated strong maturity along the validation. We consider them as **V3 maturity** level

- Constraint reconciliation, related to the OI AUO-0108, with the refinement on ATFCM slot allocation proposed by the **ECASA** improvement strategies, reached the **V2 maturity** level and is ready to continue V3 validation

Other did not fully achieved the V2 maturity:

- **Pro-active FDCI** and **AOP/NOP TTA information integrated in eFPL**, related to the OI DCB-0103-B, needs some tools and process refinements, that requires the validation work to continue, achieving at the end a **partial V2 maturity** level.

- **Network stability**, in relation to the OI DCB-0217, needs still some work and testing in summer traffic conditions. While being mostly at V2 level, it do not prevent the OI DCB-0217 to be at the targeted V2 maturity as a whole.

- The **DCB Collaborative Framework**, related to the OI DCB-0215, has shown operational acceptance and feasibility for the concept but needs the work on V2 to carry-on, achieving only a **partial V2 maturity** level.

We recommend one topic to go to exploratory research: Constraint optimisation that showed the feasibility to design a network optimised DCB solution.

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

Next Steps for PJ09 Advanced DCB solutions:

The Wave 1 scope of the solutions is changing for the work programme of the Wave 2. The V3 phase of the main PJ09 Wave 1 conceptual elements will be covered in the following PJ09 Wave 2 solutions:

- **Traffic prediction** – Solution 45 – introducing and validating the multi-layer traffic prediction, improving the quality of the pre-tactical traffic forecast to allow extending with confidence the planning in pre-flight phase for all network stakeholders. The solution will address this challenge by further integrating in a rolling and dynamic process the local tools, in particular, AU, Airport and ANSP (FMP/INAP) with the Network Management and internally by providing improved forecast using data science techniques. Solution 45 also aims at improving the accuracy of the network traffic demand and traffic load in the EAP timeframe to support very short term, airborne and arrival DCB measures by exploring the integration of two data sources in the NM traffic prediction: INAP/EAP intentions and Extended Projected Profile. The PJ09.01 outcome will be complemented by the outcome of the Wave 1 PJ09.03 and due to its V3 focus it will be done in close collaboration with NM Digilab. A close coordination will also take place with traffic prediction related ER4 projects.

- **Traffic complexity** – Solution 44 (48) for integration and further validation of local complexity assessment into the DCB/DAC toolset. In the short-term / tactical phase, the prediction of imbalances or DCB constraints is much influenced by a traffic complexity that adds in the equation to traffic demand and capacity that are the basis in pre-tactical phase. Solution 45 shall aim to consolidate the outcome of local traffic complexity assessment via agreed common shareable complexity indicator in order to improve a network (regional) complexity assessment.

- **Network performance** – The Wave 2 Solution 49 Collaborative Network Performance Management will improve the current monitoring process by refining the network state monitoring methodology that combines collected local performance indicators and the use of advance data science and prediction techniques allowing the identification and anticipation of disruptive operational situation across the network. By developing the Network Performance Management Dashboard, the Solution 49 shall enable the Network Manager to build a network performance view allowing focusing on areas of particular interest subject to performance degradations. The Solution 49 shall further enable the identification of the most appropriate stakeholder to drive the DCB solution design, local solution in case of nominal status and network oriented in case of critical situation. The network-oriented solutions will build upon the successful regulation optimisation work undertaken in the PJ09.03 (ECASA activity). The PJ09.03 constraint optimisation work (CRO activity) shall be tackled within the framework of ER4 call (due to its low maturity and longer-term NM system upgrade focus).

  Lastly, the Solution 49 shall address the integration of network and airport operations by investigating that the connection of the airport and network performance dashboard ease the design of collaborative recovery procedures and participate to the pro-active management of predicted performance deteriorations.

- **Integrated Local DCB Processes (INAP) -** The Wave 1 projects PJ.09 Advanced DCB and PJ08 Advanced Airspace Management initially planned to achieve an integration of DAC to DCB. However, as this turned out to be challenging in the scope of Wave 1, a decision has been made by PJ09-W2 consortium partners to avoid parallel solutions on these two important subjects and rather prepare a common approach on integrating DAC with the DCB/INAP. This decision is seen as strategic in the current times when airspace capacity is becoming a bottleneck and more integrated solutions are essential for unlocking the required capacity improvements. Thus, the next steps required for further evolution of the INAP processes and INAP tools will be done within the PJ09-W2 Solution 44 – Dynamic Airspace Configurations – as part of the DAC/DCB integration V3 research work programme.

4 References

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[2] S2020 Project Handbook v01.00.01 June 2017

[3] PJ19 Concept of Operations 1 Dec 2017

[4] PJ19 Operational Concept Document (OCD) 2018 Mar 2019

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[6] EATMA Community pages

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[10] 08.01.01 D49: SWIM Compliance Criteria

[11] 08.01.03 D47: AIRM v4.1.0

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[28]European Operational Concept Validation Methodology (E-OCVM) - 3.0 [February 2010]

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[34] 16.06.05 D 27 HP Reference Material D27

[35] 16.04.02 D04 e-HP Repository - Release note

[36] SESAR, Environment Reference Material, alias, "Environmental impact assessment as part of the global SESAR validation", Project 16.06.03, Deliverable D26, 2014.

[37] ICAO CAEP – "Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes" document, Doc 10031.

[38] 16.06.02 D103 SESAR Security Ref Material Level

[39] 16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[40] 16.06.02 D131 Security Database Application (CTRL_S)

4.1 Project Deliverables

	Project	Title	Id Code	Edition	Date
[1]	PJ09 DCB	Project Management Plan	D1.1	V1.16	Fri 31-03-17
[2]	PJ09 DCB	Quarterly Progress Report Q4 2016	D1.3	V1.0	Tue 31-01-17
[3]	PJ09 DCB	Quarterly Progress Report Q1 2017	D1.4	V1.0	Sun 30-04-17
[4]	PJ09 DCB	Quarterly Progress Report Q2 2017	D1.5	V1.0	Mon 31-07-17
[5]	PJ09 DCB	Quarterly Progress Report Q3 2017	D1.6	V1.0	Tue 31-10-17
[6]	PJ09 DCB	Quarterly Progress Report Q4 2017	D1.7	V1.0	Wed 31-01-18
[7]	PJ09 DCB	Quarterly Progress Report Q1 2018	D1.8	V1.0	Mon 30-04-18
[8]	PJ09 DCB	Quarterly Progress Report Q2 2018	D1.9	V1.0	Tue 31-07-18
[9]	PJ09 DCB	Quarterly Progress Report Q3 2018	D1.10	V1.0	Wed 31-10-18
[10]	PJ09 DCB	Quarterly Progress Report Q4 2018	D1.11	V1.0	Thu 31-01-19
[11]	PJ09 DCB	Quarterly Progress Report Q1 2019	D1.12	V1.0	Tue 30-04-19
[12]	PJ09 DCB	Quarterly Progress Report Q2 2019	D1.13	V1.0	Wed 31-07-19
[13]	PJ09 DCB	Final Project Report	D1.2	V1.0	Sat 30-11-19
[14]	PJ09 DCB	H - Requirement No. 1	D5.1	V1.0	Fri 31-03-17

[15]	PJ09 DCB	POPD - Requirement No. 2	D5.2	V1.0	Fri 31-03-17
[16]	PJ09 DCB	NEC - Requirement No. 3	D5.3	V1.0	Fri 31-03-17
[17]	PJ09 DCB	EPQ - Requirement No. 4	D5.4	V1.0	Fri 31-03-17
[18]	PJ09 DCB	M - Requirement No. 5	D5.5	V1.0	Fri 31-03-17
[19]	PJ09 DCB	V2 Final OSED/SPR/INTEROP (including SAR, HPAR, PAR)	D2.1.023	V2.1	Tue 10-09-19
[20]	PJ09 DCB	V2 VALP Solution 1	D2.1.032	V1.0	Wed 30-01-19
[21]	PJ09 DCB	V2 Final TS/IRS	D2.1.041	V2.0	Mon 24-06-19
[22]	PJ09 DCB	AN Demand prediction prototype	D2.1.080	V1.0	Tue 30-10-18
[23]	PJ09 DCB	AN Network Performance prototype	D2.1.081	V1.0	Tue 12-02-19
[24]	PJ09 DCB	V2 VALR	D2.1.070	V1.0	Tue 10-09-19
[25]	PJ09 DCB	D2.1 Solution 1 Intermediate V2 Data Pack	D2.1	V1.0	**Tue 01-10-19**
[26]	PJ09 DCB	V2 Final OSED/SPR/INTEROP (including SAR, HPAR, PAR)	D3.1.023	V2.1	Tue 03-09-19
[27]	PJ09 DCB	V2 VALP Solution 2	D3.1.031	V1.0	Mon 16-07-18
[28]	PJ09 DCB	V2 TS/IRS for initial V2 Data Pack	D3.1.041	V1.0	Wed 12-06-19
[29]	PJ09 DCB	AN 9.2.2 prototype DSNA	D3.1.080	V1.0	Fri 14-12-18
[30]	PJ09 DCB	AN 9.2.3 prototype ENAIRE	D3.1.081	V1.0	Sun 31-03-19
[31]	PJ09 DCB	AN 9.2.3 prototype Skyguide	D3.1.082	V1.0	Sun 31-03-19
[32]	PJ09 DCB	AN 9.2.3 prototype Thales	D3.1.083	V1.0	Sun 31-03-19
[33]	PJ09 DCB	AN 9.2.3 prototype ENAV	D3.1.084	V1.0	Sun 31-03-19
[34]	PJ09 DCB	V2 VALR	D3.1.070	V1.0	Thu 12-09-19
[35]	PJ09 DCB	V2 Initial CBA for Solution 2+1	D3.1.071	V1.0	Wed 17-07-19
[36]	PJ09 DCB	D3.1 Solution 2 Intermediate V2 Data Pack	D3.1	V1.0	Tue 01-10-19
[37]	PJ09 DCB	V2 Final OSED/SPR/INTEROP (including SAR, HPAR, PAR)	D4.1.023	V2.1	Tue 03-09-19
[38]	PJ09 DCB	V2 VALP Solution 3 (second iteration)	D4.1.031	V1.0	Tue 30-10-18
[39]	PJ09 DCB	V2 VALP Solution 3 (Final Iteration)	D4.1.032	V1.0	Tue 30-04-19
[40]	PJ09 DCB	D4.1 V2 TS/IRS for initial V2 Data Pack	D4.1.041	V2.0	Wed 12-06-19
[41]	PJ09 DCB	AN 9.3.2 prototype ECTL	D4.1.081	V1.0	Fri 12-04-19
[42]	PJ09 DCB	V2 VALR	D4.1.070	V1.0	Tue 03-09-19
[43]	PJ09 DCB	V2 Initial CBA for Solution 3+1	D4.1.071	V1.0	Tue 03-09-19
[44]	PJ09 DCB	D4.1 Solution 3 Intermediate V2 Data Pack	D4.1	V1.0	Mon 30-09-19

4.2 Project Communication and Dissemination papers

Appendix A Glossary of Terms, Acronyms and Terminology

A.1 Glossary of terms

Term	Definition	Source of the definition
Actor	An actor is an individual that interacts with a system. An actor has a specific role and must be able to make decisions. An actor is representative of a stakeholder. (e.g. LHR, Air France…)	VALR PJ09.01
Air Traffic Flow and Capacity Management (ATFCM)	A service complementary to Air Traffic Control (ATC), the objective of which is to ensure an optimum flow of air traffic to or through areas within which traffic demand at times exceeds the available capacity of the ATC system.	EUROCONTROL, CFMU (2002), Air Traffic Flow Management Operations: ATFM Users' Manual, Edition 8.0, 18.3.2002
Air Traffic Management (ATM)	The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.	ICAO Doc 4444
Airport Operations Plan (AOP)	A single, common and collaboratively agreed rolling plan available to all airport stakeholders whose purpose is to provide common situational awareness and to form the basis upon which stakeholder decisions relating to process optimisation can be made. As well as timely and accurate information, the AOP also contains a robust performance monitoring capability that allows the airport processes to be efficiently managed in real-time. Through its 'rolling' nature, the AOP will ensure that mitigation actions taken by each stakeholder will be based on accurate information with the result of their actions being reflected directly back into the AOP.	SESAR Concept of Operations Step 2 Edition 2014 (Ed. 01.01.00)
AU Margins of Manoeuvre	AU Business Needs are expressed in the form of margins of manoeuvre in time. Points of the AU	PJ09

	trajectory are expressed with time tolerance [min, max] indicating the margins of manoeuvre acceptable or not acceptable for the AU cost.	
Complexity	In the ATM context, complexity refers to the number of simultaneous or near- simultaneous interactions of trajectories in a given volume of airspace.	SESAR Concept of Operations Step 2 Edition 2014 (Ed. 01.01.00)
Demand and Capacity Balancing (DCB)	A process to identify and manage imbalances between demand and capacity. It focuses on a period of 4 hours to 15 minutes prior to the entry of a flight in a congestion area. It includes capacity measures on sector configuration and demand measures on flights.	Enhanced DCB OSED for Step1. D303. Project Number 13.02.03. Edition 00.05.01. August 2016.
DCB Measure	It includes all Capacity measure and Demand measure to be taken during in several days to 4 hours prior to the congested area event.	PJ09 OSED DCB
Congestion Level Indicators	The Congestion Indicator (CI) represents the visualization of the consolidated Network Imbalance for a RBT/SBT (PFP or flight plan). It enables a view of all the imbalances that are affecting a SBT/RBT. This helps in understanding the trajectories that can be targeted for a DCB solution and also allows for efficient selection and implementation of measures.	PJ09 OSED DCB
Extended ATC Planner (EAP)	EAP is a role that intends to alleviate the LTM workload by working with him on flights. The EAP acts in its given EAP Area (Multi-sector area of responsibility), under close coordination with the LTM, as the LTM has a global view on the ATSU's area.	Step 1 V2 Final OSED (extended ATC Planner). D76. Edition 00.01.04. February 2016.
HotSpot	Local demand/capacity imbalance on the day of operations, which may result from a complex traffic situation or a short period of high demand. A hotspot is created to raise awareness of the situation and may act as a precursor to solving the imbalance (STAM or ATFM regulation).	STAM CONOPS
Integrated Network Management and Extended ATC Planning	Generic term encompassing all the processes related to the Conformance and workload assessment (e.g. Application of DCB at ACC level, extended ATC planning).	SESAR Concept of Operations Step 1 Edition 2013 (Ed. 01.02.00)

(INAP)		
Key Performance Area (KPA)	1. 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 SESAR, the 11 ICAO KPAs plus Human Performance (a proposed addition not yet formally adopted by ICAO) are considered as given. 2. KPAs are a way of categorizing performance subjects related to high-level ambitions and expectations.	1.SESAR Guidance on KPIs and Data Collection Version 1 (D85, Ed. 00.01.01, 2014) 2.ICAO (2009) doc. 9883, Manual on Global Performance of the Air Navigation System
Local Traffic Manager (LTM)	LTM is a role exercised at local level that contributes to the Network Management function. It is related to the INAP function, bringing the expertise of workload assessment and resolution with Network Management dimension awareness to facilitate a continuous and coherent activity with ATC planning process. This role acts as the coordinating link between the ANSP, sub-regional and regional flow and airspace management.	ATM Master Plan
NetRes	Network state and resilience tool that display the resilience of the network and its state at a given time	PJ09
Network Operational Plan (NOP)	1. The plan, including its supporting tools, developed by the Network Manager in coordination with the operational stakeholders to organise its operational activities in the short and medium term in accordance with the guiding principles of the Network Strategic Plan. For the European route network design- specific part of the Network Operations Plan, it includes the European Route Network Improvement Plan. 2. 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.	1. 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. 2. SESAR Concept of Operations Step 2 Edition 2014 (Ed. 01.01.00)
Network	Capacity of the network to return from non-	PJ09

resilience	nominal to nominal state	
NMF	NMF is an integrated ATM activity with the aim of ensuring optimised Network Operations and ATM service provision meeting the Network performance targets, which encapsulates: • Collaborative layered planning and execution processes, including the facilitation of business/mission trajectories. • Airspace organisation and management processes. • Demand and Capacity Balancing processes through all planning and execution phases to ensure the most efficient use of airspace resources, to anticipate and solve workload/complexity issues and to minimise the effects of ATM constraints. • The enabling of UDPP process. • The provision and maintenance of Operation Plans covering the range of activity, i.e. Network to Local. • The provision of relevant complexity resolution advice to ATC operations. Based on CDM, the Network Management Function is executed at all levels (Regional, Sub-regional, and Local), throughout all planning and execution phases, involving, as appropriate, the adequate actors. Network Manager function represents the actors (NM, INAP: LTM & EAP) involved in the management of the Network.	SESAR 1 WP7.2 DOD
Nominal state	State where the network is stable	PJ09
Non-nominal state	State of the network after an expected or unexpected disruptive event that caused a drop in the performance	PJ09
Performance Indicator	Performance Indicator is a measurable value that supports the achievement of business objectives	PJ09
Reactionary Delay	Reactionary delays: Delays incurred by delays affecting previous flights and using the same aircraft.	OSED P13.02.03 SESAR1
Reference Time Window	Occurrence time of a hotspot	OSED PJ09

Short Term ATFCM Measure (STAM)	An approach to smooth sector workloads by reducing traffic peaks through short-term application of minor ground delays, appropriate flight level capping and exiguous rerouting to a limited number of flights	SESAR Operational Service and Environment Definition (OSED) P.7.6.5, Ed.00.01.00, 2013
Stakeholder	A stakeholder is an entity that cares for any project in some ways. A stakeholder represents a group of actors. (i.e. Airport, AU, FMP)	VALR PJ09.01
UDPP	User Driven Prioritisation Process used by Airspace users to prioritise their flights	PJ07
Validation Targets	1. The overall contribution to the high level (ECAC) network performance targets set in the ATM Master Plan. 2. Targets that focus the development of enhanced capabilities by the SJU Projects. They aim to get from the R&D the required performance capability to contribute to the achievement of a strategic target and, thus, to the SES high-level goals.	1.SESAR European ATM Architecture (EATMA) Guidance Material v4 (D66, Ed. 00.04.00, 2014) 2.SESAR Guidance on KPIs and Data Collection Version 1 (D85, Ed. 00.01.01, 2014)

Table 3: Glossary

A.2 Acronyms and Terminology

Term	Definition
AIMA	Airport IMpact Assessment
APOC	Airport Operations Center
APT	Airport
ATC	Air Traffic Control
ATM	Air Traffic Management
ATSU	Air Traffic Service Unit
ATT	Achievable Target Time
AU	Airspace User
CI	Congestion Indicator
CFSP	Computerised Flight Plan Service Providers

CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
COP	Coordination Point
CORSE	Complexity Reduction SErvice
CR	Change Request
CTOT	Calculated Take Off Time
CWP	Controller Working Position
DCB	Demand and Capacity Balancing
DCB	Dynamic Demand and Capacity Balancing
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
EC	Executive Controller
eFPL	Electronic Flight Plan
FBT	Forecast Business Trajectory
FOC	Flight Operation Center
HPAR	Human Performance Assessment Report
ICI	Imbalance Confidence Index
INAP	Integrated Network Management and (Extended) ATC Planning
iNWP	Innovative Network Working Position
INTEROP	Interoperability Requirements
KPA	Key Performance Area
LTM	Local Traffic Manager
MIP	Most Important Problem
MPC	Most Penalizing Constraint
MSP	Multi-Sector Planner/ Multi-Sector Planning (Controller)
NMf	Network Management Functions
OI	Operational Improvement
OPAR	Operational Performance Assessment Report
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PC	Planning Controller
PFP	Preliminary Flight Plan

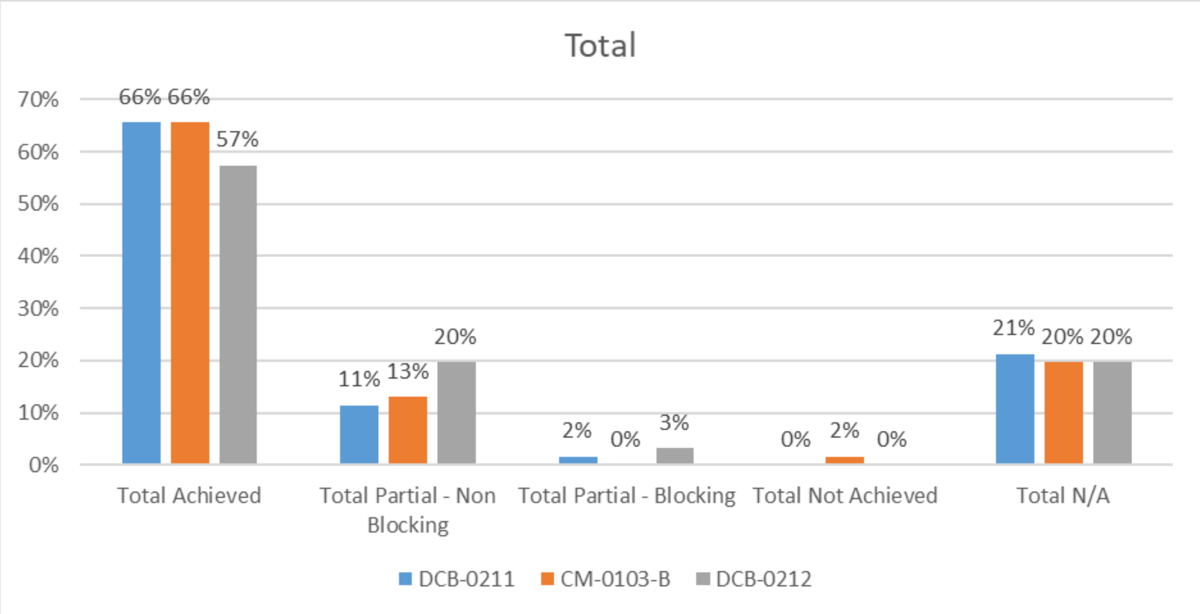
PIRM	Programme Information Reference Model
RBT	Reference Business Trajectory
QoS	Quality of Service
SAC	Safety Criteria
SAR	Safety Assessment Report
SBT	Shared Business Trajectory
SecAR	Security Assessment Report
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
SWIM	System Wide Information Model
TAM	Total Airport Management
TDI	Trajectory Deviation Indicator
TC	Tactical Controller (also called Executive Controller)
TS	Technical Specification
TTA	Target Time of Arrival for measure initiated in the SBT Elaboration phase
TTO	Target Time Over for measure initiated in the SBT Elaboration phase
tTTA	Tactical Target Time of Arrival for measure initiated in the RBT Revision phase
tTTO	Tactical Target Time Over for measure initiated in the RBT Revision phase
UDPP	User Driven Priorization Process

Table 4: Acronyms and technology

Additional Material

A.3 Final Project maturity self-assessment

Solution 1 Maturity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0% 2% 0%
21% 20% 20%
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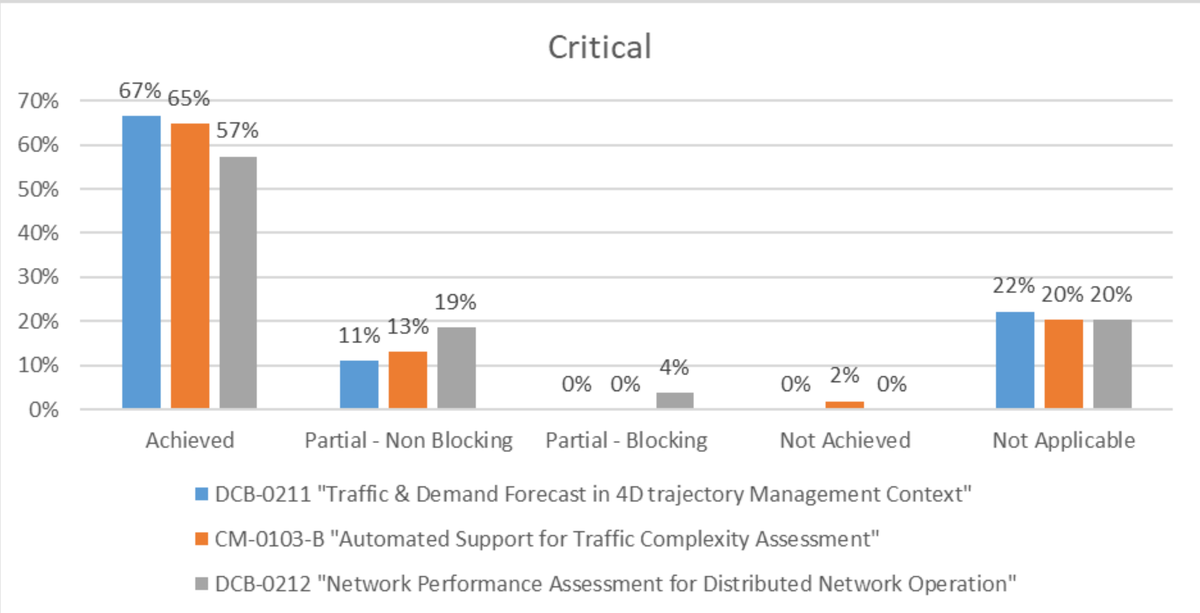
Total Partial - Non Blocking
Total Partial - Blocking
Total Not Achieved
Total N/A
DCB-0211
CM-0103-B
DCB-0212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11% 13%
19%
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4%
0% 2% 0%
22% 20% 20%
Achieved
Partial - Non Blocking
Partial - Blocking
Not Achieved
Not Applicable
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CM-0103-B "Automated Support for Traffic Complexity Assessment"
DCB-0212 "Network Performance Assessment for Distributed Network Operation"

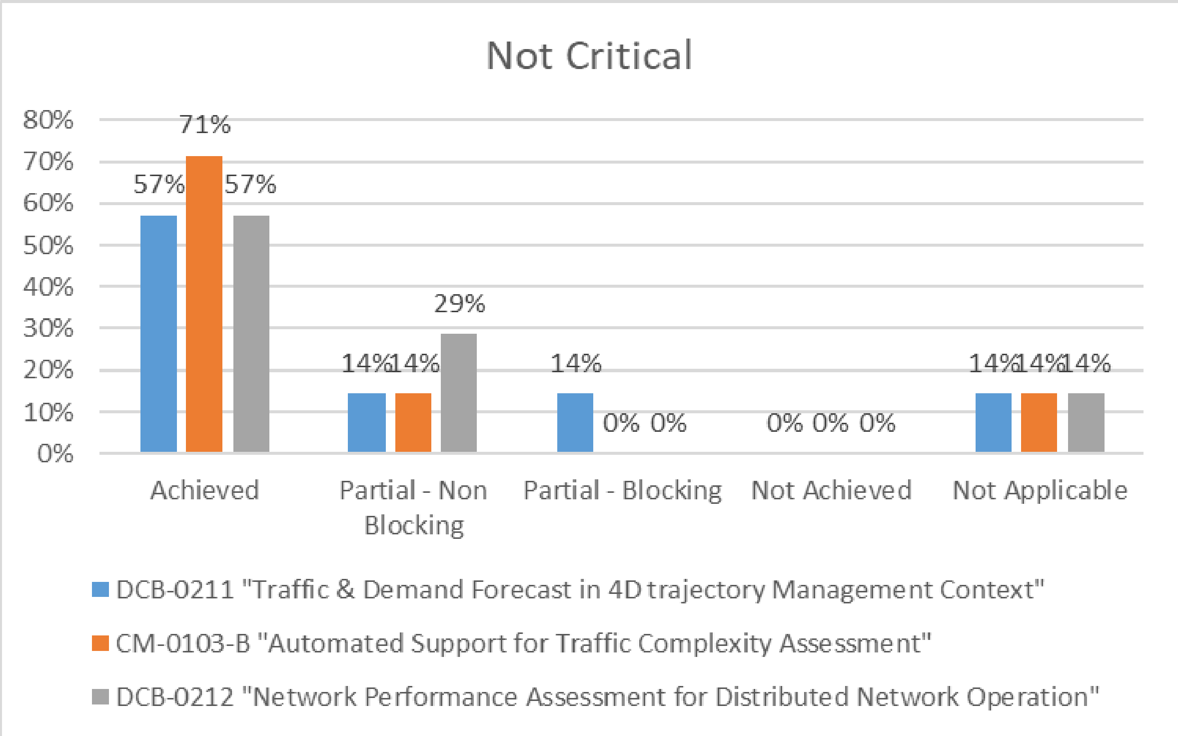
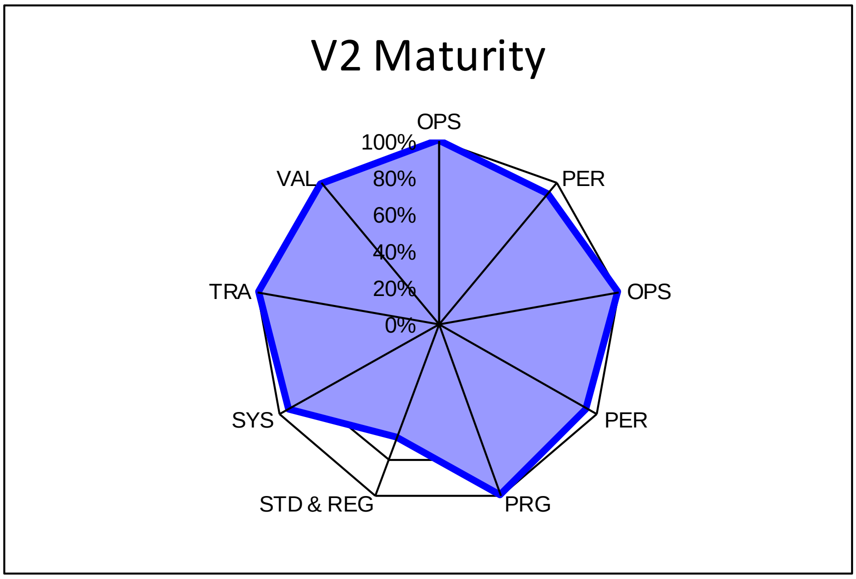
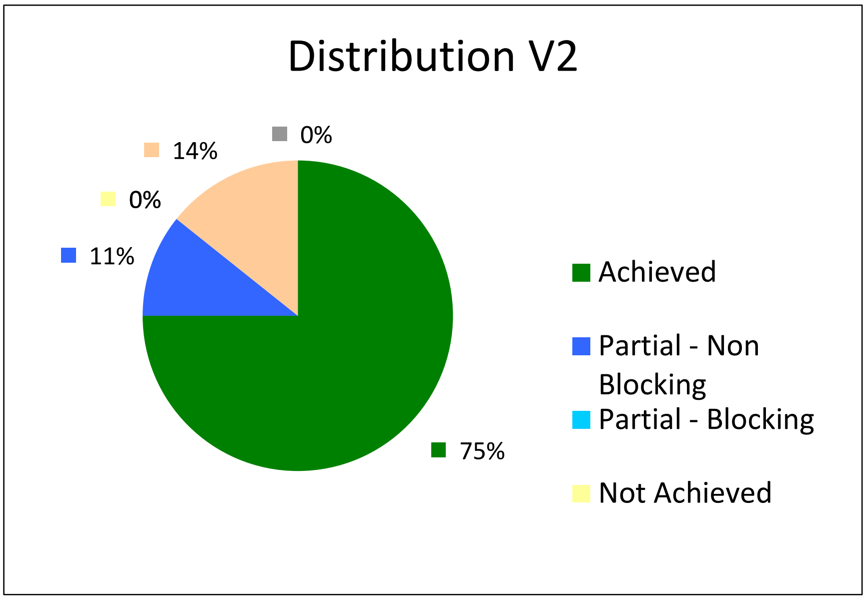


Figure 3: **Solution 1 Maturity Assessment**

Conclusion: Majority of V2 criteria achieved. No blocking points, **V2 maturity is reached**

Solution 2 Maturity

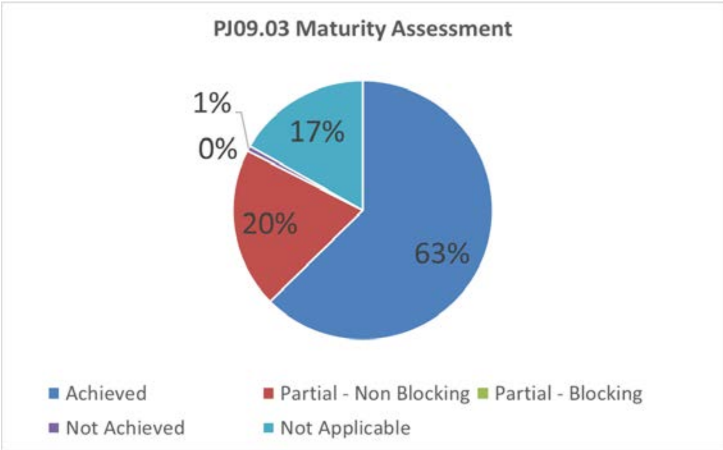




Figur

Conclusion: Majority of V2 criteria achieved. No blocking points, **V2 maturity is reached**

Solution 3 Maturity



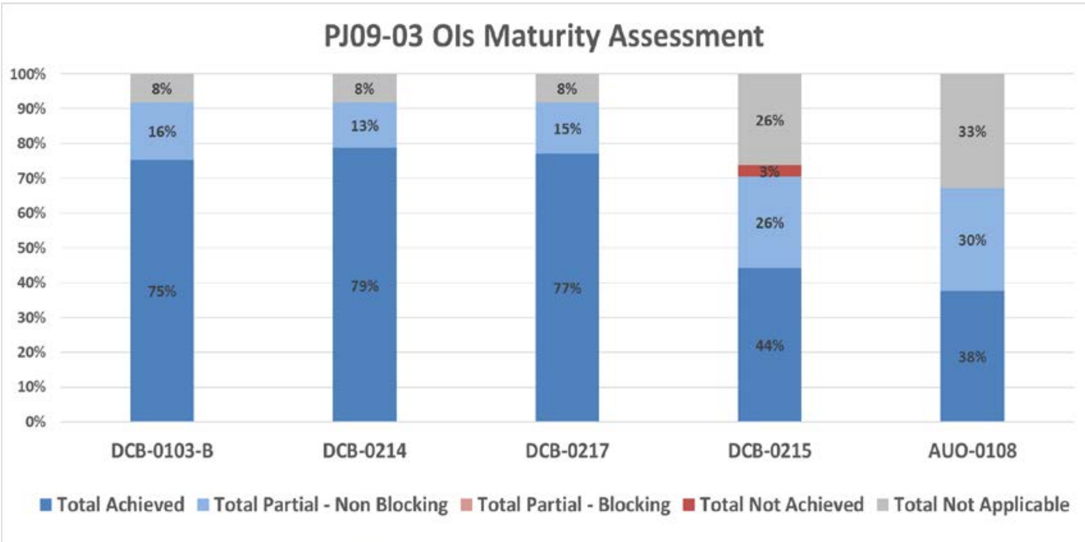


Figure 5: Solution 3 Maturity Assessment

Conclusion: Majority of V2 criteria achieved. No blocking points, **V2 maturity is reached**