SESAR Solution 02-08 SPR/INTEROP-OSED for V3 - Part V - Performance Assessment Report (PAR)

D6.1.20	PU
Project Acronym	EARTH
Grant:	731781
Call:	H2020-SESAR-2015-2
Topic:	Traffic Optimisation on Single and Multiple Runways
Consortium coordinator:	EUROCONTROL
Edition date:	8 November 2019
Edition:	00.03.00

Authoring & Approval

Authors of the document

Name/Beneficiary	Position/Title	Date
MENDOZA, Montserrat / SKYGUIDE	V3 OSED Task Leader	07.11.2019
TREVE, Vincent / EUROCONTROL	PJ02-08 Member	05.08.2019
FUENTES DE FRUTOS Pablo / INDRA	PJ02-08 Member	05.08.2019
PERROTTA, Luigi / NAIS-ENAV	PJ02-08 Member	05.08.2019
WALL, Ake / LFV-COOPANS	PJ02-08 Member	05.08.2019
SUŁEK, Radosław / UNIWARSAW /PANSA	PJ02-08 Member	05.08.2019
KOPEĆ, Jacek / UNIWARSAW / PANSA	PJ02-08 Member	09.08.2019

Reviewers internal to the project

Name/Beneficiary	Position/Title	Date
CHOUVET, Didier / THALES AIR SYS	PJ02-08 Member	02.09.2019
COSTA CONDE, Sarai / INDRA	PJ02-08 Member	02.09.2019
KETTNER, Mattes / ZRH-SEAC2020	PJ02-08 Member	02.09.2019
KJENSTAD, Dag / SINTEF	TS Task Leader	02.09.2019
KOPEC, Jacek / PANSA	PJ02-08 Member	02.09.2019
MANGO, Gennaro / LEONARDO	PJ02-08 Member	02.09.2019
ROOS, Jan-Olof / LFV-COOPANS	PJ02-08 Solution Leader	02.09.2019
RYDELL, Sofia / LVF-COOPANS	VALR Task Leader	02.09.2019
SOKOLOWSKI, Mateusz / PANSA	PJ02-08 Member	02.09.2019
STAROSZCZYK, Jacek / PANSA	CBA Task Leader	02.09.2019

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

Name/Beneficiary	Position/Title	Date
CHOUVET, Didier / THALES AIR SYS	THALES AIR SYS PJ02.08 POC	11.09.2019
COSTA CONDE, Sarai / INDRA	INDRA PJ02.08 POC	11.09.2019
ELLEJMI, Mohamed / EUROCONTROL	EUROCONTROL PJ02.08 POC	11.09.2019
KETTNER, Mattes / SEAC	SEAC PJ02.08 POC	11.09.2019

KJENSTAD, Dag / SINTEF	SINTEF PJ02.08 POC	11.09.2019
MANGO, Gennaro / LEONARDO	LEONARDO PJ02.08 POC	11.09.2019
MENDOZA NAVAS, Montserrat / SKYGUIDE	SKYGUIDE PJ02.08 POC	11.09.2019
PERROTTA, Luigi / NAIS-ENAV	ENAV PJ02.08 POC	11.09.2019
ROOS, Jan-Olof / LFV-COOPANS	LFV-COOPANS PJ02.08 POC	11.09.2019
NIEWINSKI, Jaroslaw / PANSA	PANSA PJ02.08 POC	11.09.2019
TREVE, Vincent / EUROCONTROL	EUROCONTROL PJ02 PROJECT MANAGER	11.09.2019

Rejected By - Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date

Document History

Edition	Date	Status	Author	Justification
00.00.01	07.05.2019	Draft	M. Mendoza	Document creation
00.00.02	17.06.2019	Draft	M. Mendoza L. Perrotta A. Wall P. Fuentes De Frutos	Contribution from ENAV, LFV and INDRA
00.00.03	12.07.2019	Draft	M. Mendoza L. Perrotta A. Wall P. Fuentes De Frutos	PANSA review, ENAV and INDRA corrections and contribution from EUROCONTROL. Final draft for internal review.
00.00.04	23.07.2019	Final Draft	M. Mendoza V. Treve C. Chalon-Morgan	Contribution from EUROCONTROL. Final version for internal approval
00.01.00	26.07.2019	Final Draft	M. Mendoza	Final version for SJU quality check concept 1, 2 and 3
00.01.01	05.08.2019	Draft	M. Mendoza R. Sułek	Document creation with integration of Concept 4 PAR
00.01.02	09.08.2019	Draft Final	J. Kopeć	Finalise Concept 4 contribution.
00.01.03	02.09.2019	Draft Final	M. Mendoza	Final version for internal approval concept 4

00.02.00	11.09.2019	Issue for SJU Quality check Concept 4	Jan Olof Roos	Approved version including Concept 4
00.02.01	24.09.2019	Draft	M. Mendoza	Update integrating PJ19 remarks on Security section.
00.02.02	18.10.2019	Final draft	M. Mendoza	Update integrating PJ19 updates
00.02.03	07.11.2019	Final draft	M. Mendoza	Update integrating SJU quality check remarks
00.03.00	08.11.2019	Final Issue	Jan Olof Roos	Final issue ready for Data Pack delivery

EARTH

TRAFFIC OPTIMISATION ON SINGLE AND MULTIPLE RUNWAY AIRPORTS

This PAR V3 is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 731781 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document is the fifth part of the OSED SPR INTEROP document for the Solution 8 of the Project PJ02 EARTH that addresses traffic optimisation on single and multiple runway airports by integrating multiple concepts operating in both Execution and Planning Phases and supporting both Tower Controllers and Supervisors in monitoring and optimising runway usage.

The document contains the (V3) Performance Assessment Report related to the concept. The contents are based on the results of the V3 validation exercises performed at the Solution.

This document addresses the Performance assessment report for four of the Concepts included in the Solution 02-08: Concept 1, Concept 2, Concept 3 and Concept 4.

Founding Members

EUROPEAN UNION EUROCONTROL

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1 Executive Summary

This document provides the Performance Assessment Report (PAR) for 02-08 Traffic Optimisation on single and multiple runway airports.

The PAR is consolidating Solution performance validation results addressing KPIs/PIs and metrics from the SESAR2020 Performance Framework [3].

Description:

The solution integrates four different concepts operating in Execution and Planning Phases to support APP Controllers, Tower Controllers and Supervisors in monitoring and optimising runway system usage. This document addresses three of these concepts:

- **Concept 1:** Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence (TS-0301). This concept addresses mainly TWR and TMA ATCOs and is expected to increase runway capacity and predictability & punctuality and bring environmental benefits without impairing Safety or Human Performance.
- **Concept 2:** Optimised use of RWY capacity for multiple runway airports with the combined use of an Integrated Runway Sequence and RMAN (TS-0313). This concept is expected to increase runway capacity and predictability & punctuality.
- **Concept 3:** Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337). This concept is expected to increase runway capacity without impairing Safety or Human Performance.
- **Concept 4:** Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338). This concept is expected to increase runway Capacity without impairing Safety or Human Performance.

Taking into account the different nature of the concepts and as requested by the SJU, no aggregation will be done between the different concepts and each section of this document will be divided into 4 sub-sections:

- One sub-section that addresses Concept 1;
- One sub-section that addresses Concept 2;
- One sub-section that addresses Concept 3 and
- One sub-section that addresses Concept 4.

More Information can be found in Chapter 2!

Assessment Results Summary:

The following tables summarise the assessment outcomes per KPI (Table 1) and mandatory PI (Table 2) puts them side-by side against Validation Targets in case of KPI from PJ19 [18]. The impact of a

Solution on the performances are described in Benefit Impact Mechanism. All the KPI and mandatory PI from the Benefit Mechanism were the Solution potentially impact have to be assessed via validation results, expert judgment etc.

There are three cases:

1. An assessment result of 0 with confidence level other level High, Medium or Low indicates that the Solution is expected to impact in a marginal way the KPI or mandatory PI.

2. An assessment result (positive or negative) different than 0 with confidence level High, Medium or Low indicates that the Solution is expected to impact the KPI or mandatory PI.

3. An assessment result of N/A (Not Applicable) with confidence level N/A indicates that the Solution is not expected to impact at all the KPI or mandatory PI consistently with the Benefit Mechanism.

Two tables containing the summary of KPI and mandatory PI results are provided for each Concept of the solution (in total 8 tables). The validation target presented in all the tables are the ones apportioned to the Solution (refer to [18]) whereas the performance benefits expectations are provided for each Concept.

Concept 1

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[1]	Confidence in Results[2]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	3.87 kg/flight	High
CAP1: TMA Airspace Capacity – TMA throughput, in challenging airspace, per unit time.	3.599%	0	N/A

[1] Negative impacts are indicated in red.

[2] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

CAP2: En-Route Airspace Capacity – En-route throughput, in challenging airspace, per unit time	0.000%	0	N/A
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	5.1% and 90 flights/hour (*LFV-COOPANS RTS with Stockholm-Arlanda Airport operating on independent parallel runways*)	Medium
		0.2% (*ENAV FTS with Rome Fiumicino Airport operating on dependent runways*)	High
PRD1: Predictability – Variance of Difference in actual & Flight Plan or RBT durations	5.034%	3.139%	High
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	1.81%	Medium
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	0.000%	0	N/A
CEF3: Technology Cost – Cost per flight	0	0	N/A
SAF1: Safety - Total number of fatal accidents and incidents with ATM Contribution per year	-0.45%	0%	High (Safety maintained)

Table 1: KPI Assessment Results Summary for Solution 02-08 Concept 1

Mandatory PI	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[3]	Confidence in Results[4]
SAF1.X: Mid-air collision – En-Route	0	N/A
SAF2.X: Mid-air collision – TMA	0	N/A
SAF3.X: RWY-collision accident	0	N/A
SAF4.X: RWY-excursion accident	0	N/A
SAF5.X: TWY-collision accident	0	N/A
SAF6.X: CFIT accident	0	N/A
SAF7.X: Wake related accident	0	N/A
SEC1: A security risk assessment has been carried out	0	N/A
SEC2: Risk Treatment has been carried out	0	N/A
SEC3: Residual risk after treatment meets security objective.	0	N/A
SEC7: Personnel (safety) risk after mitigation	0	N/A
SEC8: Capacity risk after mitigation	0	N/A
SEC9: Economic risk after mitigation	0	N/A
FEFF2: CO2 Emissions.	12.19 kg/flight	High
FEFF3: Reduction in average flight duration.	0.44 min/flight	High
NOI1: Relative noise scale	0	N/A
NOI2: Size and location of noise contours	0	N/A

[3] Negative impacts are indicated in red.

[4] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

NOI4: Number of people exposed to noise levels exceeding a given threshold	0	N/A
LAQ1: Geographic distribution of pollutant concentrations	0	N/A
CAP3.1: Peak Departure throughput per hour (Segregated mode)	Not measured	Not measured
CAP3.2: Peak Arrival throughput per hour (segregated mode)	Not measured	Not measured
CAP4: Un-accommodated traffic reduction	0	N/A
RES1: Loss of Airport Capacity Avoided	0	N/A
RES1.1: Airport time to recover from non-nominal to nominal condition	0	N/A
RES2: Loss of Airspace Capacity Avoided.	0	N/A
RES2.1: Airspace time to recover from non-nominal to nominal condition.	0	N/A
RES4: Minutes of delays.	Not measured	Not measured
RE5: Number of cancellations.	0	N/A
CEF1: Direct ANS Gate-to-gate cost per flight	0	N/A
AUC3: Direct operating costs for an airspace user	0	N/A
AUC4: Indirect operating costs for an airspace user	0	N/A
AUC5: Overhead costs for an airspace user	0	N/A
CMC1.1: Available/Required training Duration within ARES	0	N/A
CMC1.2: Allocated/ Optimum ARES dimension	0	N/A
CMC1.3: Transit Time to/from airbase to ARES	0	N/A
CMC2.1: Fuel and Distance saved (for GAT operations)	0	N/A
CMC2.2: GAT planning efficiency of Available ARES	0	N/A
HP1: Consistency of human role with respect to	Refer to section 4.16.1	High

human capabilities and limitations		
HP2: Suitability of technical system in supporting the tasks of human actors	Refer to section 4.16.1	High
HP3: Adequacy of team structure and team communication in supporting the human actors	Refer to section 4.16.1	High
HP4: Feasibility with regard to HP-related transition factors	Refer to section 4.16.1	High
FLX1: Average delay for scheduled civil/military flights with change request and non-scheduled or late flight plan request	0	N/A

Table 2 Mandatory PIs Assessment Summary for Solution 02-08 Concept 1

Concept 2

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[5]	Confidence in Results[6]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	1.04kg/flight	High
CAP1: TMA Airspace Capacity – TMA throughput, in challenging airspace, per unit time.	3.599%	0	N/A
CAP2: En-Route Airspace Capacity – En-route throughput,	0.000%	0	N/A

[5] Negative impacts are indicated in red.

[6] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

in challenging airspace, per unit time			
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	0	High
PRD1: Predictability – Variance of Difference in actual & Flight Plan or RBT durations	5.034%	0.60%	High
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	0.86%	High
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	0.000%	0	N/A
CEF3: Technology Cost – Cost per flight	0	0	N/A
SAF1: Safety - Total number of fatal accidents and incidents with ATM Contribution per year	-0.45%	0	N/A

Table 3: KPI Assessment Results Summary for Solution 02-08 Concept 2

Mandatory PI	Performance Benefits Expectations at Network	Confidence in Results[8]

	Level (ECAC Wide or Local depending on the KPI)[7]	
SAF1.X: Mid-air collision – En-Route	0	N/A
SAF2.X: Mid-air collision – TMA	0	N/A
SAF3.X: RWY-collision accident	0	N/A
SAF4.X: RWY-excursion accident	0	N/A
SAF5.X: TWY-collision accident	0	N/A
SAF6.X: CFIT accident	0	N/A
SAF7.X: Wake related accident	0	N/A
SEC1: A security risk assessment has been carried out	0	N/A
SEC2: Risk Treatment has been carried out	0	N/A
SEC3: Residual risk after treatment meets security objective.	0	N/A
SEC7: Personnel (safety) risk after mitigation	0	N/A
SEC8: Capacity risk after mitigation	0	N/A
SEC9: Economic risk after mitigation	0	N/A
FEFF2: CO2 Emissions.	3.30 kg/flight	High
FEFF3: Reduction in average flight duration.	0.4 min/flight	High
NOI1: Relative noise scale	0	N/A
NOI2: Size and location of noise contours	0	N/A
NOI4: Number of people exposed to noise levels exceeding a given threshold	0	N/A

[8] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

[7] Negative impacts are indicated in red.

LAQ1: Geographic distribution of pollutant concentrations	0	N/A
CAP3.1: Peak Departure throughput per hour (Segregated mode)	Not measured	Not measured
CAP3.2: Peak Arrival throughput per hour (segregated mode)	Not measured	Not measured
CAP4: Un-accommodated traffic reduction	0	N/A
RES1: Loss of Airport Capacity Avoided	0	N/A
RES1.1: Airport time to recover from non-nominal to nominal condition	0	N/A
RES2: Loss of Airspace Capacity Avoided.	0	N/A
RES2.1: Airspace time to recover from non-nominal to nominal condition.	0	N/A
RES4: Minutes of delays.	Not measured	Not measured
RE5: Number of cancellations.	0	N/A
CEF1: Direct ANS Gate-to-gate cost per flight	0	N/A
AUC3: Direct operating costs for an airspace user	0	N/A
AUC4: Indirect operating costs for an airspace user	0	N/A
AUC5: Overhead costs for an airspace user	0	N/A
CMC1.1: Available/Required training Duration within ARES	0	N/A
CMC1.2: Allocated/ Optimum ARES dimension	0	N/A
CMC1.3: Transit Time to/from airbase to ARES	0	N/A
CMC2.1: Fuel and Distance saved (for GAT operations)	0	N/A
CMC2.2: GAT planning efficiency of Available ARES	0	N/A
HP1: Consistency of human role with respect to human capabilities and limitations	0	N/A
HP2: Suitability of technical system in supporting	0	N/A

the tasks of human actors		
HP3: Adequacy of team structure and team communication in supporting the human actors	0	N/A
HP4: Feasibility with regard to HP-related transition factors	0	N/A
FLX1: Average delay for scheduled civil/military flights with change request and non-scheduled or late flight plan request	0	N/A

Table 4 Mandatory PIs Assessment Summary for Solution 02-08 Concept 2

Concept 3

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[9]	Confidence in Results[10]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	0	N/A
CAP1: TMA Airspace Capacity – TMA throughput, in challenging airspace, per unit time.	3.599%	0	N/A
CAP2: En-Route Airspace Capacity – En-route throughput, in challenging airspace, per unit time	0.000%	0	N/A

[9] Negative impacts are indicated in red.

[10] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	0	N/A (Concept 3 validation exercise has not explored benefits in mixed mode)
PRD1: Predictability – Variance of Difference in actual & Flight Plan or RBT durations	5.034%	0	N/A
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	0	N/A
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	0.000%	0	N/A
CEF3: Technology Cost – Cost per flight	0	0	N/A
SAF1: Safety - Total number of fatal accidents and incidents with ATM Contribution per year	-0.45%	0%	High (Safety maintained)

Table 5: KPI Assessment Results Summary for Solution 02-08 Concept 3

Mandatory PI	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[11]	Confidence in Results[12]

[11] Negative impacts are indicated in red.

SAF1.X: Mid-air collision – En-Route	0	N/A
SAF2.X: Mid-air collision – TMA	0	N/A
SAF3.X: RWY-collision accident	0	N/A
SAF4.X: RWY-excursion accident	0	N/A
SAF5.X: TWY-collision accident	0	N/A
SAF6.X: CFIT accident	0	N/A
SAF7.X: Wake related accident	0	N/A
SEC1: A security risk assessment has been carried out	0	N/A
SEC2: Risk Treatment has been carried out	0	N/A
SEC3: Residual risk after treatment meets security objective.	0	N/A
SEC7: Personnel (safety) risk after mitigation	0	N/A
SEC8: Capacity risk after mitigation	0	N/A
SEC9: Economic risk after mitigation	0	N/A
FEFF2: CO2 Emissions.	0	N/A
FEFF3: Reduction in average flight duration.	0	N/A
NOI1: Relative noise scale	0	N/A
NOI2: Size and location of noise contours	0	N/A
NOI4: Number of people exposed to noise levels exceeding a given threshold	0	N/A
LAQ1: Geographic distribution of pollutant concentrations	0	N/A
CAP3.1: Peak Departure throughput per hour	0	N/A

[12] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

(Segregated mode)		
CAP3.2: Peak Arrival throughput per hour (segregated mode)	7.5%	Medium
CAP4: Un-accommodated traffic reduction	0	N/A
RES1: Loss of Airport Capacity Avoided	0	N/A
RES1.1: Airport time to recover from non-nominal to nominal condition	0	N/A
RES2: Loss of Airspace Capacity Avoided.	0	N/A
RES2.1: Airspace time to recover from non-nominal to nominal condition.	0	N/A
RES4: Minutes of delays.	0	N/A
RE5: Number of cancellations.	0	N/A
CEF1: Direct ANS Gate-to-gate cost per flight	0	N/A
AUC3: Direct operating costs for an airspace user	0	N/A
AUC4: Indirect operating costs for an airspace user	0	N/A
AUC5: Overhead costs for an airspace user	0	N/A
CMC1.1: Available/Required training Duration within ARES	0	N/A
CMC1.2: Allocated/ Optimum ARES dimension	0	N/A
CMC1.3: Transit Time to/from airbase to ARES	0	N/A
CMC2.1: Fuel and Distance saved (for GAT operations)	0	N/A
CMC2.2: GAT planning efficiency of Available ARES	0	N/A
HP1: Consistency of human role with respect to human capabilities and limitations	Refer to section 4.16.3	High
HP2: Suitability of technical system in supporting the tasks of human actors	Refer to section 4.16.3	High
HP3: Adequacy of team structure and team communication in supporting the human actors	Refer to section 4.16.3	High

HP4: Feasibility with regard to HP-related transition factors	Refer to section 4.16.3	High
FLX1: Average delay for scheduled civil/military flights with change request and non-scheduled or late flight plan request	0	N/A

Table 6 Mandatory PIs Assessment Summary for Solution 02-08 Concept 3

Concept 4

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[13]	Confidence in Results[14]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	0	N/A
CAP1: TMA Airspace Capacity – TMA throughput, in challenging airspace, per unit time.	3.599%	0	N/A
CAP2: En-Route Airspace Capacity – En-route throughput, in challenging airspace, per unit time	0.000%	0	N/A
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	1.86%	Medium
PRD1: Predictability –	5.034%	0	N/A

[13] Negative impacts are indicated in red.

[14] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

Variance of Difference in actual & Flight Plan or RBT durations			
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	0	N/A
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	0.000%	0	N/A
CEF3: Technology Cost – Cost per flight	0	0	N/A
SAF1: Safety - Total number of fatal accidents and incidents with ATM Contribution per year	-0.45%	0%	High (Safety maintained)

Table 7: KPI Assessment Results Summary for Solution 02-08 Concept 4

Mandatory PI	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[15]	Confidence in Results[16]

[15] Negative impacts are indicated in red.

[16] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

Founding Members

SAF1.X: Mid-air collision – En-Route	0	N/A
SAF2.X: Mid-air collision – TMA	0	N/A
SAF3.X: RWY-collision accident	0	N/A
SAF4.X: RWY-excursion accident	0	N/A
SAF5.X: TWY-collision accident	0	N/A
SAF6.X: CFIT accident	0	N/A
SAF7.X: Wake related accident	0	N/A
SEC1: A security risk assessment has been carried out	0	N/A
SEC2: Risk Treatment has been carried out	0	N/A
SEC3: Residual risk after treatment meets security objective.	0	N/A
SEC7: Personnel (safety) risk after mitigation	0	N/A
SEC8: Capacity risk after mitigation	0	N/A
SEC9: Economic risk after mitigation	0	N/A
FEFF2: CO2 Emissions.	0	N/A
FEFF3: Reduction in average flight duration.	0	N/A
NOI1: Relative noise scale	0	N/A
NOI2: Size and location of noise contours	0	N/A
NOI4: Number of people exposed to noise levels exceeding a given threshold	0	N/A
LAQ1: Geographic distribution of pollutant concentrations	0	N/A
CAP3.1: Peak Departure throughput per hour (Segregated mode)	0	N/A
CAP3.2: Peak Arrival throughput per hour (segregated mode)	0	N/A
CAP4: Un-accommodated traffic reduction	0	N/A
RES1: Loss of Airport Capacity Avoided	0	N/A

RES1.1: Airport time to recover from non-nominal to nominal condition	0	N/A
RES2: Loss of Airspace Capacity Avoided.	0	N/A
RES2.1: Airspace time to recover from non-nominal to nominal condition.	0	N/A
RES4: Minutes of delays.	0	N/A
RE5: Number of cancellations.	0	N/A
CEF1: Direct ANS Gate-to-gate cost per flight	0	N/A
AUC3: Direct operating costs for an airspace user	0	N/A
AUC4: Indirect operating costs for an airspace user	0	N/A
AUC5: Overhead costs for an airspace user	0	N/A
CMC1.1: Available/Required training Duration within ARES	0	N/A
CMC1.2: Allocated/ Optimum ARES dimension	0	N/A
CMC1.3: Transit Time to/from airbase to ARES	0	N/A
CMC2.1: Fuel and Distance saved (for GAT operations)	0	N/A
CMC2.2: GAT planning efficiency of Available ARES	0	N/A
HP1: Consistency of human role with respect to human capabilities and limitations	Refer to section 4.16.4	High
HP2: Suitability of technical system in supporting the tasks of human actors	Refer to section 4.16.4	High
HP3: Adequacy of team structure and team communication in supporting the human actors	Refer to section 4.16.4	High
HP4: Feasibility with regard to HP-related transition factors	Refer to section 4.16.4	High
FLX1: Average delay for scheduled civil/military flights with change request and non-scheduled or late flight plan request	0	N/A

Table 8 Mandatory PIs Assessment Summary for Solution 02-08 Concept 4

Additional Comments and Notes:

Due to the different nature of the Concepts addressed in the Solution, no aggregation of results can be done between them. This issue was already raised by the Solution at the beginning of the V3 phase and it was agreed with SJU that the Solution PAR would contain sub-PARs per concept and that the Solution CBA would contain sub-CBAs per concept.

For CAP1, there is a validation target of 3.599% according to [18], but this validation target is not consistent to the Grant Agreement 731781. Therefore, this KPI is not considered for PJ02-08. PJ02-08 is not expected to bring any benefits in terms of TMA Airspace capacity. There is an error in document [18] that needs to be corrected in next version. This issue has already been raised by the Solution in V2 phase.

For PUN1, there is no validation target according to [18] but PJ02-08 is expected to bring a benefit in terms of punctuality, which has been confirmed by the results of the V3 validation exercises.

For Safety and HP, no quantitative figures can be provided. The results of the validation exercises show that Safety should not be impacted by the Solution except an indirect improvement linked to HP benefits (situation awareness enhancement, workload and stress reduction) that are difficult to quantify.

2 Introduction

2.1 Purpose of the document

The following text is not supposed to be changed!

The Performance Assessment covers the Key Performance Areas (KPAs) defined in the SESAR2020 Performance Framework [3]. Assessed are at least the Key Performance Indicators (KPIs) and the mandatory Performance Indicators (PIs), but also additional PIs as needed to capture the performance impacts of the Solution. It considers the guidance document on KPIs/PIs [3] for practical considerations, for example on metrics.

The purpose of this document is to present the performance assessment results from the validation exercises at SESAR Solution level. The KPA performance results are used for the performance assessment at strategy level and provide inputs to the SESAR Joint Undertaking (SJU) for decisions on the SESAR2020 Programme.

In addition to the results, this document presents the assumptions and mechanisms (how the validation exercises results have been consolidated) used to achieve this performance assessment result.

One Performance Assessment Report shall be produced or iterated per Solution.

2.2 Intended readership

In general, this document provides the ATM stakeholders (e.g. airspace users, ANSPs, airports, airspace industry) and SJU performance data for the Solution addressed.

Produced by the Solution project, the main recipient in the SESAR performance management process is PJ19, which will aggregate all the performance assessment results from the SESAR2020 solution projects PJ1-18, and provide the data to PJ20 for considering the performance data for the European ATM Master Plan. The aggregation will be done at higher levels suitable for use at Master Planning Level, such as deployment scenarios. Additionally, the consolidation process will be carried out annually, based on the SESAR Solution's available inputs.

2.3 Inputs from other projects

The document includes information from the following SESAR 1 projects:

- B.05 D72 [5]: SESAR 1 Final Performance Assessment, where are described the principles used in SESAR1 for producing the performance assessment report.

PJ19 will manage and provide:

- PJ19.04.01 D4.1 [3]: Performance Framework (2018), guidance on KPIs and Data collection supports.

- PJ19.04.03 D4.0.1: S2020 Common assumptions, used to aggregate results obtained during validation exercises (and captured into validation reports) into KPIs at the ECAC level, which will in turn be captured in Performance Assessment Reports and used as inputs to the CBAs produced by the Solution projects. Where are also included performance aggregation assumptions, with traffic data items.
- For guidance and support PJ19 have put in place the Community of Practice (CoP)[17] within STELLAR, gathering experts and providing best practices.

2.4 Glossary of terms

See the AIRM Glossary [1] for a comprehensive glossary of terms.

2.5 Acronyms and Terminology

Term	Definition
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
BAD	Benefits Assessment Date
BAER	Benefit Assessment Equipment Rate
CBA	Cost Benefit Analysis
DOD	Detailed Operational Description
E-ATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
DB	Deployment Baseline

17 https://stellar.sesarju.eu/?link=true&domainName=saas&redirectUrl=%2Fjsp%2Fproject%2Fproject.jsp%3FobjId%3Dxrn%3Aview%3Axrn%3Adatabase%3Aondb%2Ftable%2F59_anonymous%402333834.13%403834139.13

KPA	Key Performance Area
KPI	Key Performance Indicator
N/A	Not Applicable
OI	Operational Improvement
PAR	Performance Assessment Report
PI	Performance Indicator
PRU	Performance Review Unit
QoS	Quality of Service
RBT	Reference Business / Mission Trajectory
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SESAR2020 Programme	The programme which defines the Research and Development activities and Projects for the SJU.

Table 9: Acronyms and terminology

3 Solution Scope

3.1 Detailed Description of the Solution

The solution 02-08 integrates different concepts operating in both Execution and Planning Phases (Short and Medium term) and supports both Tower Controllers and Supervisors in monitoring and optimising runway system usage by:

- increasing the predictability and punctuality and runway throughput as well as fuel efficiency through the management of an Integrated Runway Sequence (TS-0301), or with a combination of optimised runway configuration management and Integrated Runway Sequence in case of multiple runways (TS-0313),
- Optimising runway configuration by means of an enhanced prediction of Runway Occupancy Time at medium/high density airport (AO-0337).

The solution aims to provide these improvements without impairing Safety or Human Performance, which are overall expected to be maintained even if the sharing of an Integrated Runway Sequence between the different actors should enhance situation awareness and therefore safety.

The solution integrates different concepts operating in both Execution and Planning Phases (Short and Medium term) to support both APP Controllers, Tower Controllers and Supervisors in monitoring and optimising runway system usage:

- **Concept 1:** Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence (TS-0301). This concept addresses mainly TWR and TMA ATCOs and is expected to increase runway capacity and predictability & punctuality and bring environmental benefits without impairing Safety or Human Performance. This concept is demonstrated by 3 different validation exercises:
  - EXE.02-08.V3.002 LFV-COOPANS RTS;
  - EXE.02-08.V3.003 SKYGUIDE RTS and
  - EXE.02-08.V3.007 ENAV FTS
- **Concept 2:** Optimised use of RWY capacity for multiple runway airports with the combined use of an Integrated Runway Sequence and RMAN (TS-0313). This concept is expected to increase runway capacity and predictability & punctuality. This concept is demonstrated by EXE.02-08.V3.006 INDRA RTS validation exercise.
- **Concept 3:** Optimised use of RWY capacity for medium/high density airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0337). This concept is expected to increase runway capacity without impairing Safety or Human Performance. This concept is demonstrated by the EXE.02-08.V3.005 EUROCONTROL RTS validation exercise.
- **Concept 4:** Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338). This concept is expected to increase runway Capacity without impairing Safety or Human Performance. This concept is demonstrated by the 2 different validation exercises:

- EXE.02-08.V3.004 PANSA RTS and
- EXE.02-08.V3.008 PANSA FTS.

3.2 Detailed Description of relationship with other Solutions

Concept 1 is a pre-requisite for Concept 2.

Concept 3 is independent from Concept 1 and Concept 2.

Concept 4 is independent from Concept 1, Concept 2 and Concept 3.

3.2.1 Detailed Description of relationship of Concept 1 with other Solutions

N/A

3.2.2 Detailed Description of relationship of Concept 2 with other Solutions

N/A

3.2.3 Detailed Description of relationship of Concept 3 with other Solutions

The concept 3 consisting in defining separation as a function of each aircraft type. This practically means that each landing aircraft will have an in-trail separation behind him specific to his type and defined by 0.1Nm increment. This accuracy and variability cannot be managed by an ATCO without a support tool indicating the separation to apply for each aircraft pair. That tool (AO-0328) was developed into Solution 1. That solution also allows to customised wake separation pair-wise. This why the Concept 3 has to be implemented with, at minima, the AO-0328 operation improvement. Once the tool in place, it is however logical to also beneficiate from the wakes separation reductions from Solution 1 AO-0306.

The Solution 1 and 3 are therefore compatible but also dependant from each other. Concept 3 can only be deployed together with AO-0328 from Solution 1. Note that the opposite is not true: The solution 1 including the separation delivery tool (AO-0328), the pair wise wake separation (AO-0306) for example can be deployed without the Concept 3.

The AO-0328 Solution 1 is therefore a pre-requisite to the Concept 3.

The deployment of the 2 solutions, result in the sum of the benefits of the two Solutions. This is explained by the fact that the benefit of Solution 1 result from the reduction on separation between “wake-pair” (pair where separation applied result from the application of wake separation) while the benefit of the Concept 3 results from the reduction of “non-wake-pair” (pair where separation applied result from the application Runway Occupancy Time separation).

Solution Number	Solution Title	Relationship	Rational for the relationship
PJ02-08 Concept	Safety support tools for runway excursions	AO-0328 Solution 1 is a pre-requisite to the	The separation delivery tool (AO-0328) from Solution 1 is needed

3 with PJ02-01		Concept 3	for deploying Concept 3. The resulting benefit will be the sum of the Solution 1 and Concept 3 benefit since each are reducing separation between different pairs (Wake Pairs for Solution 1 and Non-wake pairs for Concept 3) The respective effect of each solution vary significantly as a function of the traffic mix. The Concept 3 capacity benefit range between 4% and 10% for traffic mix with 50% to 0% of heavy aircraft. The solution 1 capacity benefit range between 10% and 0% for traffic mix with 50% to 0% of heavy aircraft. However, once combined to Solution 1 and Concept 3 deliver a capacity benefit relatively stable between 10 and 14%.

Table 10: Relationships of Solution 02-08 Concept 3 with other Solutions

3.2.4 Detailed Description of relationship of Concept 4 with other Solutions

N/A

4 Solution Performance Assessment

4.1 Assessment Sources and Summary of Validation Exercise Performance Results

4.1.1 Assessment Sources and Summary of Validation Exercise Performance Results (Concept 1)

Previous Validation Exercises (pre-SESAR2020, etc.) relevant for this assessment are listed below.

Organisation	Document Title	Publishing Date
DFS	EXE-06.08.04-vp-358 Validation Report – Step 2 (Coupled AMAN-DMAN-Routing)	20.05.2015
ENAIRE	Performance Assessment Report (PAR) for OFA 04.01.01 Integrated Arrival/Departure Management at Airports	11.10.2016
PJ02-08 members	PJ02-08 V2 validation exercises (refer to PJ02-08 V2 PAR [41])	12.10.2018

Table 11: Pre-SESAR2020 Exercises for Solution 02-08 Concept 1

SESAR Validation Exercises of this Solution (completed ones and planned ones) are listed below.

Exercise ID	Exercise Title	Release	Maturity	Status
EXE.02-08.V2.001	Traffic optimisation on Roma Fiumicino airport and TMA (ENAV FTS)	R7	V2	Cancelled
EXE.02-08.V2.002	Traffic optimisation on Roma Fiumicino airport and TMA (ENAV RTS)	R7	V2	Completed
EXE.02-08.V2.003	Integrated Runway Sequence function to integrate arrivals and departures on mixed mode parallel runways at Stockholm-Arlanda airport and TMA environment (COOPANS RTS)	R7	V2	Completed
EXE.02-08.V2.004	Runway Throughput optimisation through the use of an Integrated Runway Sequence function (SKYGUIDE RTS)	R7	V2	Completed
EXE.02-08.V3.001	Traffic optimisation on Roma Fiumicino airport and TMA (ENAV RTS)	R8	V3	Cancelled

EXE.02-08.V3.002	Integrated Runway Sequence function to integrate arrivals and departures on mixed mode parallel runways at Stockholm-Arlanda airport and TMA environment (COOPANS RTS)	R8	V3	Completed
EXE.02-08.V3.003	Use of an Integrated Runway Sequence function in single runway mixed mode operations of Geneva Airport and TMA (SKYGUIDE RTS)	R8	V3	Completed
EXE.02-08.V3.007	Traffic optimisation on Roma Fiumicino airport and TMA (ENAV FTS)	R8	V3	Completed

Table 12: SESAR2020 Validation Exercises for Solution 02-08 Concept 1

The following table provides a summary of information collected from available performance outcomes

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EXE.02-08.V3.002	TS-0301	Real Time Simulation of Stockholm-Arlanda Airport and TMA environment with focus on Tower and Approach. The objective is to assess the impact when using an Integrated Runway Sequence function for traffic optimisation on parallel independent runways.	FEFF3 positive CAP3 increased PRD1 increased PUN1 increased SAF1 maintained HP1, HP4 maintained, HP2, HP3 improved	FEFF1 and FEFF2 not measured
EXE.02-08.V3.003	TS-0301	Real Time Simulation in Geneva Airport on RWY throughput optimisation through the operational use of an Integrated Runway Sequence function The objective is to assess the impact on RWY throughput in an Airport with single RWY in mixed mode operations in nominal conditions.	FEFF3 slightly positive PRD1 slightly increased PUN1 slightly increased SAF1 maintained HP1, HP2, HP3, HP4 improved	FEFF1, FEFF2 and CAP3 not measured
EXE.02-	TS-0301	Fast time simulation to validate the application of the use of an	FEFF1 increased	SAF1, PUN1, HP1, HP2,

08.V3.007		Integrated Runway Sequence to optimize traffic flow to Roma Fiumicino airport and TMA.	FEFF2 increased FEFF3 positive CAP3 increased PRD1 increased	HP3 and HP4 not measured
V2 exercises	TS-0301	Refer to [41]	Refer to [41]	Refer to [41]

Table 13: Summary of Validation Results for Solution 02-08 Concept 1

4.1.2 Assessment Sources and Summary of Validation Exercise Performance Results (Concept 2)

Previous Validation Exercises (pre-SESAR2020, etc.) relevant for this assessment are listed below.

Organisation	Document Title	Publishing Date
PJ02-08 members	PJ02-08 V2 validation exercises (refer to PJ02-08 V2 PAR [41])	12.10.2018

Table 14: Pre-SESAR2020 Exercises for Solution 02-08 Concept 2

SESAR Validation Exercises of this Solution (completed ones and planned ones) are listed below.

Exercise ID	Exercise Title	Release	Maturity	Status
EXE.02-08.V2.005	Runway optimisation by using a runway planning tool integrated into the arrival and departure management (INDRA RTS)	R7	V2	Completed
EXE.02-08.V3.006	Runway optimisation by using a runway planning tool integrated into the arrival and departure management (INDRA RTS)	R8	V3	Completed

Table 15: SESAR2020 Validation Exercises for Solution 02-08 Concept 2

The following table provides a summary of information collected from available performance outcomes.

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EXE.02-08.V3.006	TS-0313	Real Time Simulation of Barcelona – El Prat Airport and TMA environment with focus on Tower and Approach.	PRD1 decreased PUN1 increased FEFF1 slightly	

		The objective is to assess the impact when using a runway management tool (RMAN) providing information to the Integrated Runway Sequence function for traffic optimisation on parallel independent runways.	increased FEFF2 slightly increased FEFF3 slightly increased	
V2 exercises	TS-0313	Refer to [41]	Refer to [41]	Refer to [41]

Table 16: Summary of Validation Results for Solution 02-08 Concept 2

4.1.3 Assessment Sources and Summary of Validation Exercise Performance Results (Concept 3)

Previous Validation Exercises (pre-SESAR2020, etc.) relevant for this assessment are listed below.

Organisation	Document Title	Publishing Date
None	None	None

Table 17: Pre-SESAR2020 Exercises for Solution 02-08 Concept 3

SESAR Validation Exercises of this Solution (completed ones and planned ones) are listed below.

Exercise ID	Exercise Title	Release	Maturity	Status
EXE.02-08.V3.005	EUROCONTROL RTS	R8	V3	Completed

Table 18: SESAR2020 Validation Exercises for Solution 02-08 Concept 3

The following table provides a summary of information collected from available performance outcomes.

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EXE.02-08.V3.005	AO-0337	Real time Zurich Real Time Simulation of Zurich Airport and TMA environment with focus on Approach with application of the ROCAT concept	CAP3.2: ROCAT increases of the runway throughput SAF1: ROCAT does not increase the number of separation infringements and even reduces them mostly because of the	

			use of the ORD tool (AO-0328-Solution 1) HP1: ROCAT has no negatively impact on the end users (air and ground) roles, tasks and human performance HP2: System changes relating to ROCAT has no negatively impact on human performance HP3: System changes relating to ROCAT has no negatively impact on teams and communication HP4: Transition Factors relating to the ROCAT are identified and mitigation proposed	

Table 19: Summary of Validation Results for Solution 02-08 Concept 3.

4.1.4 Assessment Sources and Summary of Validation Exercise Performance Results (Concept 4)

Previous Validation Exercises (pre-SESAR2020, etc.) relevant for this assessment are listed below.

Organisation	Document Title	Publishing Date
None	None	None

Table 20: Pre-SESAR2020 Exercises for Solution 02-08 Concept 4

SESAR Validation Exercises of this Solution (completed ones and planned ones) are listed below.

Exercise ID	Exercise Title	Release	Maturity	Status

EXE.02-08.V3.004	PANSA RTS	R8	V3	Completed
EXE.02-08.V3.008	PANSA FTS	R8	V3	Completed

Table 21: SESAR2020 Validation Exercises for Solution 02-08 Concept 4

The following table provides a summary of information collected from available performance outcomes.

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EXE.02-08.V3.004	AO-0338	Real time simulation to validate operational aspects and capacity/safety influence of the ROT prediction integrated into TWR controller CWP. This exercise uses data recorded on Gdańsk Airport as well as its layout and airspace structure. Expected achievement was to verify qualitatively the results of EXE.02-08.V3.008 and confirm the expected benefit mechanisms in the integrated system with human in the loop. Address some safety aspects.	CAP inconclusive SAF maintained (low confidence) HP maintained or improved	Due to unexpected simulation errors the resulting capacity measurement error was much greater than expected benefit. Independent Concept 4 safety analysis indicated strong connection between the system performance and safety. However, RTS results indicated were twofold: 1. There is a very strong link between safety and system performance 2. The safety impact is neutral

				compared to reference scenario despite intentionally degraded system performance. As a result confidence on safety result is assigned as low.
EXE.02-08.V3.008	AO-0338	Fast time simulation to validate quality of Enhanced Prediction ROT using significant sample of real recorded arrivals from Gdańsk Airport. The exercise quantised the error levels and some safety impacts. The results of the exercise also served to refine scenarios prepared for EXE.02-08.V3.004.	CAP increased	

Table 22: Summary of Validation Results for Solution 02-08 Concept 4.

4.2 Conditions / Assumptions for Applicability

4.2.1 Conditions / Assumptions for Applicability (Concept 1)

The PJ02-08 Solution Concept 1 is expected to be applied in Medium to Very Large Airports with runways operated in mixed mode or having other dependencies between arrivals and departures between the runways. The PJ02-08 Solution Concept 1 is expected to provide benefits in all conditions but especially when runways are used in mixed mode operations.

No particular conditions are considered to be of negative benefits.

OI Step	OI Step Title	Operating Environment	Constraints for deployment
TS-0301	Integrated Arrival Departure management for full traffic optimisation on the RWY	APT Very Large APT Large APT Medium	AMAN/DMAN implemented

As the main goal of the Concept 1 is the integration of AMAN and DMAN), prerequisite for the its deployment is AMAN's previous successful implementation. The basic AMAN will be implemented, regarding the European ATM Master Plan, at 24 PCP + 8 Non-PCP Airports in ECAC area by 12/2019. In further development, Extended AMAN in a SESAR Solution which has been selected by the European Commission to be part of the Pilot Common Project (PCP) 1 and shall be operated at 25 European Airports as from 1st January 2024 (REGULATION (EU) No 716/2014).

The following table summarises the applicable operating environments in accordance with latest 2019 SESAR 2020 airports classification provided by PJ20 sWP2.2 WG.

OE	Applicable sub-OE	Special characteristics
Airport	Very Large	**Multiple runways:** EDDF Flughafen Frankfurt/Main EDDM Munich Airport EGKK Gatwick Airport EGLL Heathrow Airport EHAM Amsterdam Airport EKCH Copenhagen Airport LEBL Aeropuerto de Barcelona-El Prat LEMD Aeropuerto de Adolfo Suárez Madrid-Barajas LFPG Aéroport de Paris-Charles de Gaulle LIRF Aeroporto di Roma-Fiumicino LSZH Flughafen Zürich ENGM Oslo-Garnemoen Airport LOWW Vienna International Airport LTBA Atatürk International Airport
	Large	**Single runway:** EGSS Stansted Airport LSGG Genève Aéroport

		Multiple runways: LFPO Aéroport de Paris-Orly ESSA Stockholm-Arlanda Airport EBBR Brussels Airport EDDL Düsseldorf International Airport EIDW Dublin Airport LEPA Aeropuerto de Palma de Mallorca EGCC Manchester Airport LIMC Milano MalpensaLisbon Airport LPPT Lisbon Airport EFHK Helsinki-Vantaa Airport EPWA Warsaw Frederic Chopin Airport LKPR Prague Airport
	Medium	**Single runway:** EVRA Riga International Airport **Multiple runways:** LFMN Aéroport Nice Côte d'Azur EDDB Schoenefeld Airport LROP Henri Coanda International Airport UKBB Boryspil State International Airport

Table 23: Applicable Operating Environments for Solution 02-08 Concept 1.

The following table summarises the essential deployment details.

BAD	Specific geographical and/or stakeholder deployment
31-08-2030	Deployment in Medium to Very Large Airports with runways operated in mixed mode or having other dependencies between arrivals and departures between the runways

Table 24: Deployment details for Solution 02-08 Concept 1.

Equipage details and how equipage influences benefits in the ramp-up phase are not applicable for this Solution Concept.

Min flight equipage rate	Opt flight equipage rate	BAER	AUs that need to equip	Start of flight equipage	End of flight equipage
N/A	N/A	N/A	N/A	N/A	N/A

Table 25: Influence of Equipage on benefits for Solution 02-08 Concept 1.

4.2.2 Conditions / Assumptions for Applicability (Concept 2)

The PJ02-08 Solution Concept 2 is expected to be applied in Medium to Very Large Airports which will have implemented Integrated Runway Sequence and with multiple runways operated in mixed mode or having other dependencies between arrivals and departures between the runways. The

PJ02-08 Solution Concept 2 is expected to provide benefits in all conditions but especially when runways are used in mixed mode operations.

No particular conditions are considered to be of negative benefits.

The following table summarises the applicable operating environments.

OE	Applicable sub-OE	Special characteristics
Airport	Very Large	**Multiple runways:** EDDF Flughafen Frankfurt/Main EDDM Munich Airport EGKK Gatwick Airport EGLL Heathrow Airport EHAM Amsterdam Airport EKCH Copenhagen Airport LEBL Aeropuerto de Barcelona-El Prat LEMD Aeropuerto de Adolfo Suárez Madrid-Barajas LFPG Aéroport de Paris-Charles de Gaulle LIRF Aeroporto di Roma-Fiumicino LSZH Flughafen Zürich ENGM Oslo-Garnemoen Airport LOWW Vienna International Airport LTBA Atatürk International Airport
	Large	**Multiple runways:** LFPO Aéroport de Paris-Orly ESSA Stockholm-Arlanda Airport EBBR Brussels Airport EDDL Düsseldorf International Airport EIDW Dublin Airport LEPA Aeropuerto de Palma de Mallorca EGCC Manchester Airport LIMC Milano Malpensa LPPT Lisbon Airport EFHK Helsinki-Vantaa Airport EPWA Warsaw Frederic Chopin Airport LKPR Prague Airport
	Medium	**Multiple runways:** LFMN Aéroport Nice Côte d'Azur EDDB Schoenefeld Airport LROP Henri Coanda International Airport UKBB Boryspil State International Airport

Table 26: Applicable Operating Environments for Solution 02-08 Concept 2.

The following table summarises the essential deployment details.

BAD	Specific geographical and/or stakeholder deployment
31-08-2030	Deployment in Medium to Very Large Airports with runways operated in mixed mode or having other dependencies between arrivals and departures between the runways

Table 27: Deployment details for Solution 02-08 Concept 2.

Equipage details and how equipage influences benefits in the ramp-up phase are not applicable for this Solution Concept.

Min flight equipage rate	Opt flight equipage rate	BAER	AUs that need to equip	Start of flight equipage	End of flight equipage
N/A	N/A	N/A	N/A	N/A	N/A

Table 28: Influence of Equipage on benefits for Solution 02-08 Concept 2.

4.2.3 Conditions / Assumptions for Applicability (Concept 3)

The following table summarises the applicable operating environments.

OE	Applicable sub-OE	Special characteristics	
Airport	Very Large / Large	EBBR	Brussels / Brussels – National
		EDDF	Frankfurt - Main
		EGLL	London Heathrow
		EHAM	Amsterdam - Schipol
		EKCH	Kobenhavn - Kastrup
		ESSA	Stockholm – Arlanda
		LEBL	Barcelona
		LEMD	Madrid
		LEPA	Palma de Mallorca
		LFPG	Paris Charles de Gaulle
		LGAV	Athens
		LOWW	Vienna
		LSZH	Zürich
		LTBA	Istanbul – Ataturk

Table 29: Applicable Operating Environments for Solution 02-08 Concept 3.

The following Table 30 summarises the essential deployment details.

BAD	Specific geographical and/or stakeholder deployment
31-08-2030	Deployment in Medium to Very Large Airports with runways operated in segregated mode or mix-mode with series of consecutive arrivals and operating at or close to maximum runway capacity during peak hours.

Table 30: Deployment details for Solution 02-08 Concept 3.

Equipage details and how equipage influences benefits in the ramp-up phase are not applicable for this Solution Concept.

Min flight equipage rate	Opt flight equipage rate	BAER	AUs that need to equip	Start of flight equipage	End of flight equipage
N/A	N/A	N/A	N/A	N/A	N/A

Table 31: Influence of Equipage on benefits for Solution 02-08 Concept 3.

4.2.4 Conditions / Assumptions for Applicability (Concept 4)

The following table summarises the applicable operating environments.

OE	Applicable sub-OE	Special characteristics	
Airport	Medium	LEMG EGGW GCLP LIML EGBB	Malaga/Costa Del Sol London Luton Gran Canaria Milano/Linate Birmingham

Table 32: Applicable Operating Environments for Solution 02-08 Concept 4.

The following table summarises the essential deployment details.

BAD	Specific geographical and/or stakeholder deployment
31-08-2030	Deployment in Small to Medium Airports with runways operated in segregated mode or mix-mode with series of consecutive arrivals and operating at or close to maximum runway capacity during peak hours.

Table 33: Deployment details for Solution 02-08 Concept 4.

Equipage details and how equipage influences benefits in the ramp-up phase are not applicable for this Solution Concept.

Min flight equipage rate	Opt flight equipage rate	BAER	AUs that need to equip	Start of flight equipage	End of flight equipage
N/A	N/A	N/A	N/A	N/A	N/A

Table 34: Influence of Equipage on benefits for Solution 02-08 Concept 4.

4.3 Safety

4.3.1 Safety (Concept 1)

The information requested in this section is in-line with the SESAR Safety Reference Material (SRM [30] and Guidance [31]) methodology to be applied for performing the safety assessment of each Solution.

4.3.1.1 Safety Criteria and Performance Mechanism

Safety impact of Integrated Arrival Departure management for full traffic optimisation on the runway with the introduction of the Integrated Runway Sequence Function (TS-0301).

- The use of an Integrated Runway Sequence function is validated to provide maintained safety levels.

The following figure provide an overview of safety impact with an Integrated Arrival and Departure Management.

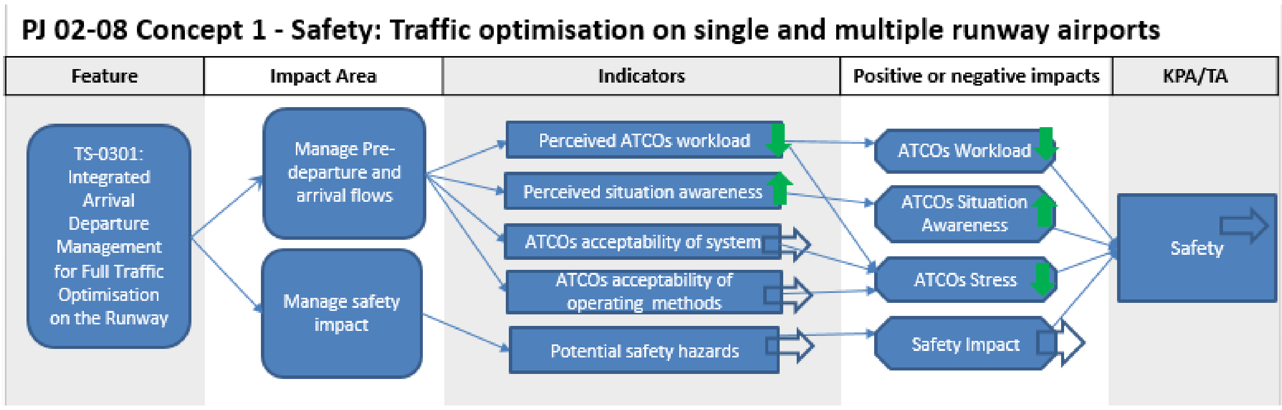

Figure 1: Concept 1 Safety impact

4.3.1.2 Data collection and Assessment

Impact on Capacity (increase of runway throughput) has been found positive in both V3 RTS and V3 FTS validations were the Integrated Runway Sequence is set before arrival flights top of descent.

Safety has been validated when using of Integrated Arrival Departure management for full traffic optimisation on the runway with the introduction of Integrated Runway Sequence Function (TS-0301) and were analysed using validation in two Real Time Simulations, with results from EXE.02-08 V3.002 and EXE.02-08 V3.003.

Both validations provided an initial Safety Assessment, i.e. identifying potential Safety Hazards with the introduction of the operational improvement.

Impact on Safety has been found to be maintained in the two V3 RTS validations when using operational procedures and functionality with the Integrated Runway Sequence Function linked to AMAN and DMAN.

The following table provides an information on PJ02-08 V3 performance results addressing safety for Concept 1.

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EXE.02-08 V3.002 LFV-COOPANS	TS-0301	Real Time Simulation of Stockholm-Arlanda Airport and TMA environment, operations on independent parallel runways and main focus on Tower and Approach. The objective is to assess the impact when using Coupled AMAN/DMAN for traffic optimisation on parallel independent runways.	Safety levels were found to be maintained.	The ATCOs situation awareness was increased.
EXE.02-08 V3.003 Skyguide	TS-0301	Real Time Simulation of Geneva Airport and TMA environment, operations on single runway with focus on Tower and Approach. The objective is to assess the impact when using Coupled AMAN/DMAN for traffic optimisation on single runway.	No direct impact in the safety indicators (potential number of loss of separation, potential number of runway incursions).	Increased team and individual situation awareness and reduced ATCOs mental workload and stress.

Table 35: Concept 1 Safety performance results

Concept 1 Safety results

Objective title: Safety acceptability and feasibility (TS-0301)

Objective description: To assess the impact of the operational improvement on safety.

Success Criteria: The objective is fulfilled by making an initial Safety Assessment, i.e. identifying potential Safety Hazards with the introduction of the operational improvement.

Exercises that cover this Objective;

- **LFV-COOPANS Real Time Simulation**
  The Integrated Runway Sequence Function provided TWR and Approach with a shared situation awareness (similar views) with balancing of arrival and departure flights.
  - ATCOs found safety maintained while coordination workload was reduced;

- ATCOs confirmed the ability to safely work with separation management and manual coordination in the tested failure mode.

The capability for ATC to take control and perform sequencing by reference techniques in case of cancellation of the functionality of the Integrated Runway Sequence Function.

- Controllers confirmed ability to handle situations with reduced functionality during degraded mode.

- **Skyguide Real Time Simulation**
  The coupled AMAN/DMAN remains a planning tool that does not impact safety as directly as tactical control tools.
  - The coupled AMAN/DMAN contributes to indirectly improve safety as it increases team and individual situation awareness and reduces ATCOs mental workload and stress especially at Approach;
  - The use of coupled AMAN/DMAN is considered not to have any direct impact in the safety indicators (potential number of loss of separation, potential number of runway incursions).

The following table address the gap between capacity expectations and the results obtained, providing explanation and remarks based on the V3 validation exercises experience:

KPA	KPI / PI	Validation Target	Results	Remarks
SAFETY	**SAF1** Total number of fatal accidents and incidents **SAF3 RWY-COLLISION ACCIDENT** **SAF4 RWY-EXCURSION ACCIDENT** **SAF5 TWY-COLLISION ACCIDENT** **SAF 6 CFIT ACCIDENT** **SAF7 WAKE related ACCIDENT**	-0,41%	0,0%	Maintained safety levels when assessing impact of the operational improvement.

Table 36: Concept 1 Safety KPA results

4.3.1.3 Extrapolation to ECAC wide

With results providing maintained safety levels, there will be no ECAC wide extrapolation of airport data for Concept 1.

4.3.1.4 Discussion of Assessment Result

Results on safety are coming from two Real Time Simulations providing results that the introduction of the operational improvement with Integrated Runway Sequence Function ensure a maintained level of safety.

Safety Assessment Report at V3 level is developed for Concept 1 in the V3 OSED Part II SAR and provide detailed assessment of safety, including measured Safety KPI´s.

4.3.1.5 Additional Comments and Notes

N/A

4.3.2 Safety (Concept 2)

N/A

4.3.3 Safety (Concept 3)

The information requested in this section is in-line with the SESAR Safety Reference Material (SRM [30] and Guidance [31]) methodology to be applied for performing the safety assessment of each Solution.

4.3.3.1 Safety Criteria and Performance Mechanism

Safety impact of Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337).

- The use of Runway Throughput based on local ROT characterization (ROCAT) is validated to provide maintained safety levels.

Safety Criteria 1: There is evidence that the level of operational safety is maintained and not negatively impacted when ROCAT is applied compared to the current operations.

The evidence for this validation safety objective was based on controller feedback (through questionnaires and debriefings) and observations combined with expert judgement

Safe standard practices were observed during the runs with the ROCAT with the FTD and RECAT-EU as well as with the OITD/LRD tool and PWS. Additionally, no specific comments related to potential impact on operational safety were reported by the controllers.

Success Criteria 2: There is evidence that ROCAT does not increase the number of separation infringements.

For the Reference runs, up to 7 % of the pairs are seen to be delivered with an under-spacing larger than 0.25 whereas the others are delivered with less than 0.25 NM under-spacings.

For the ROCAT with FTD and RECAT-EU runs, for the only run with under-spacing, the under-spaced pairs show an infringement of the FTD by less than 0.25 NM. This further confirms the safety benefit related to the FTD tool as the obtained under-spacing rates are lower as well as the under-spacing values.

For the ROCAT with ITD/LORD tool and PWS no under-spacing occurred. The positive impact of the use of the ITD/LORD tool with both the ITD and FTD on the separation conformance is thus clearly visible.

Success Criteria 3: There is evidence that ROCAT does not increase the likelihood of go around compared to the current operations.

Overall in the runs with ROCAT with FTD (AO-0328), no go-arounds occurred compared to 4 occurrences in the reference runs indicating a positive impact of the FTD tool on ATCO performance.

Two go-arounds occurred in the ROCAT with ITD/LORD (AO-0328) tool runs compared to 4 go-arounds in Reference, thus a positive impact of the solution scenario on ATCO performance could again be concluded.

The safety validation of the use of Solution 1 AO-328 was confirmed by the Concept 3 RTS5.

4.3.3.2 Data collection and Assessment

<u>ROCAT with the FTD tool and RECAT EU separation scheme</u>

The findings from the simulation showed that the ROCAT with the FTD tool and RECAT EU was found to be operationally feasible and acceptable when implemented into the Zurich approach environment in segregated mode runway operations as tested in the simulation.

In fact, both performance data, as well as the subjective feedback provide the evidence about the positive impact of the ROCAT concept and the FTD tool on runway throughput capacity and controller performance in all three sectors.

- The runway throughput with the ROCAT with the FTD tool and RECAT EU runs increased 45.6 up to 48.6 ac/h (+7% up to +16% compared to Reference runs.

- Safe standard practices were observed during the runs with ROCAT with the FTD tool and RECAT EU. Furthermore, a lower number of under spacings occurred with ROCAT with the FTD tool and RECAT EU runs than in the Reference runs. Considering the separation conformance before the alignment on the final approach, less conflicts were observed in ROCAT with the FTD tool and RECAT EU runs than in Reference runs without the tool. Additionally, no go-arounds occurred compared to 4 go around occurrences in the reference runs indicating positive impact of the FTD tool on ATCO performance.

- Controller performance was found to be more consistent with the ROCAT with the FTD tool and RECAT EU runs. The median buffer applied with the FTD tool was seen to increase compared to the median buffer applied in the Reference runs. The controller workload was at comparable or lower level for APPE and APPW position. A slight increase of workload was recorded for the FIN position. However, the number of aircraft handled per hour increased. Although the throughput increased, no negative impact on RT occupancy was found.

- All the controllers reported that the workload level was acceptable with the ROCAT with the FTD tool and RECAT EU.

- No specific risk of increase of human error with relation to ROCAT with the FTD tool and RECAT EU was observed or reported during the simulation. Although ATCOs would have to be fully trained on contingency procedures for degraded modes e.g. loss of separation indicators prior to implementation.

- Situational awareness level ratings were slightly higher in the ROCAT with the FTD tool and RECAT EU runs than in the reference scenario for all ATCO positions, indicating a positive impact of the FTD tool on situational awareness levels.
- Finally, high level of trust and system acceptance was given to ROCAT with the FTD tool and RECAT EU concept in the Zurich environment.
- The controllers in post simulation debriefing reported that the ROCAT with the FTD tool and RECAT EU is acceptable and usable in Zurich environment in segregated runway mode operations.

ROCAT with the ITD/LORD tool (ITD/FTD) (AO-0328) and PWS separation scheme (AO-0306)

The simulation findings show that the Zurich Solution scenario with the ITD/LORD tool and PWS is operationally feasible and acceptable when implemented in Zurich approach environment in segregated mode runway operation as tested in the simulation.

As with the FTD tool and RECAT EU separation scheme, the performance data, as well as the subjective feedback provide evidence regarding the positive impact of the ROCAT concept with the ITD/LORD tool on runway throughput capacity and controller performance in all three approach sectors evaluated.

- The runway throughput with the ITD/LORD tool and PWS runs increased from 46.3 up to 48.7 ac/h (+10% up to +14%) compared to Reference runs.
- Safe standard practices were observed during the runs with the ITD/LORD tool and PWS. Furthermore, no under spacing occurred in the runs with the ITD/LORD tool and PWS. Additionally no occurrences of under separation before alignment on the final approach were observed showing positive impact of the tool.
- Two go-arounds occurred in the ROCAT with ITD/LORD tool and PWS runs compared to four go-arounds in the Reference runs, thus a positive impact on the ATCO performance could also be concluded.
- The workload level was at comparable for APPE position, decreased for APPW position and slightly increased for FIN position. However, more aircraft were handled per hour in the exercise runs with the ITD/LORD tool and PWS. Furthermore, the controllers provided the feedback that workload level should improve with the ITD/LORD tool due to fact that less monitoring is required on final approach and therefore some spare capacity is gained to monitor the separation before the base leg. Additionally, the controllers reported that the workload level was acceptable with the PWS-A with the ITD/LORD tool.
- No specific risk of increase of human error with relation to ROCAT with the ITD/LORD tool and PWS was observed or reported during the simulation.
- The situational awareness ratings for runs with ROCAT and the ITD/LORD tool and PWS showed the increase of situational awareness level for APPE and FIN positions. A small decrease of situational awareness level was observed for APPW position.
- Additionally high levels of trust and system acceptance was given to the ROCAT with the ITD/LORD tool and PWS although some recommendations concerning the improvement of the LORD tool e.g. in terms of the applied buffer, were required.

- Overall, the findings of the simulation showed that ROCAT with the ITD/LORD tool with PWS is operationally feasible in the Zurich approach environment. The evidence coming from both performance data, and the subjective feedback demonstrate the positive impact of the concept with the ITD/LORD tool on controller performance in all three sectors.
- Additionally, the controllers reported the preference for the full Zurich solution, thus ROCAT with the ITD/LORD tool and PWS implemented together rather than ROCAT with the FTD alone and RECAT-EU separation scheme.

The following table provides an information on PJ02-08 V3 performance results addressing safety for Concept 3.

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EXE.02-08 V3.005 EUROCONTROL	AO-0337	Real time Zurich Real Time Simulation of Zurich Airport and TMA environment with focus on Approach with application of the ROCAT concept	There is evidence that ROCAT is acceptably safe	Safe standard practices were observed during the runs with ROCAT with the FTD tool and RECAT-EU separation scheme and with ROCAT with the ITD/LORD tool and PWS. No specific risk of increase of human error with ROCAT with the FTD tool and RECAT-EU separation scheme or with ROCAT with the LORD tool and PWS was observed or identified by the ATCOs during the simulation.
EXE.02-08 V3.005 EUROCONTROL	AO-0337	Real time Zurich Real Time Simulation of Zurich Airport and TMA environment with focus on Approach with application of the ROCAT concept	There is evidence that ROCAT does not increase the number of separation infringements	A lower number of under spacings occurred with intermediate solution of ROCAT with FTD and RECAT - EU runs than in the Reference runs. Less separation non-conformances before the alignment on the final approach were observed in intermediate solution runs with ROCAT with the

				FTD tool and RECAT-EU compared to the Reference runs. In the ROCAT scenarios with the ITD/LORD tool and PWS there were further benefits in terms of under separation were observed: No under spacing occurred with the PWS with the ITD/LORD tool runs. No occurrences of under separation before alignment were observed showing positive impact of the tool
EXE.02-08 V3.005 EUROCONTROL	AO-0337	Real time Zurich Real Time Simulation of Zurich Airport and TMA environment with focus on Approach with application of the ROCAT concept	There is evidence that ROCAT does not increase the likelihood of go around compared to the current operations.	No go-arounds occurred in the exercise runs with ROCAT with the FTD and RECAT-EU DBS compared to 4 go around occurrences in the reference runs. This indicates a positive impact of ROCAT with the FTD on ATCO performance. In the ROCAT scenarios with the ITD/LORD tool and PWS there were 2 go-arounds compared to 4 go around occurrences in the reference runs. Therefore the number of go-arounds did not increase with the ROCAT solutions and was even found to decrease.

Table 37: Concept 3 Safety performance results

4.3.3.3 Extrapolation to ECAC wide

With results providing maintained safety levels, there will be no ECAC wide extrapolation of airport data for Concept 3.

4.3.3.4 Discussion of Assessment Result

Results on safety are coming from one Real Time Simulations providing results that the introduction of the operational improvement ROCAT ensure a maintained level of safety.

Safety Assessment Report at V3 level is developed for Concept 3 in the V3 OSED Part II SAR and provide detailed assessment of safety, including measured Safety KPI´s.

4.3.3.5 Additional Comments and Notes

N/A

4.3.4 Safety (Concept 4)

The information requested in this section is in-line with the SESAR Safety Reference Material (SRM [30] and Guidance [31]) methodology to be applied for performing the safety assessment of each Solution.

4.3.4.1 Safety Criteria and Performance Mechanism

Safety in case of Concept 4 is expected to be maintained at the current level. This corresponds to a definition of two safety criteria. All safety evaluation activities in case of Concept 4 are

SAC-4-1 The level of operational safety is not degraded while using Enhanced ROT Prediction integrated into TWR ATCO CWP.

The evidence here was based on debriefings and questionnaires originating from EXE.02-08.V3.004.

SAC-4-2 The rate of occurrence of go-arounds is not increased while using Enhanced ROT Prediction integrated into TWR ATCO CWP.

This was an objectively measured quantity per each exercise run during EXE.02-08.V3.004.

4.3.4.2 Data collection and Assessment

Exercise EXE.02-08.V3.004 provided initial safety assessment during debriefing and also during pre-exercise consultations with operational experts. Hazards introduced with the new system were identified and discussed. Impact on operations was evaluated.

It has been established that the main potential negative impact of the solution is related to the increase of the rate of go-arounds due to insufficient system performance. During the RTS exercise reference runs the number of go-arounds was 3 while during the nominal scenario runs it was 2. Similar results were observed for intentionally separation braking traffic runs where this number was 4 both for solution and scenario. Interestingly for non-nominal solution scenarios with system performance degraded the number of go-arounds was once again 3. However, in case of non-nominal solution scenarios the distribution of go-arounds is clearly influenced by degraded system advisory. Therefore, we may conclude that SAC-4-2 is fulfilled but the non-nominal runs indicate that system performance is a strong safety influencing factor.

The operational safety impact evaluated during the debriefings and via CARS questionnaires has been estimated to be minimal. However, the HMI configuration used during validation (separate monitor as opposed to EFS integration intended initially) is not acceptable and is not safe. Evaluators agreed that initially intended EFS integration would mitigate this negative impact and operational safety would be maintained.

4.3.4.3 Extrapolation to ECAC wide

With results providing maintained safety levels, there will be no ECAC wide extrapolation of airport data for Concept 4.

4.3.4.4 Discussion of Assessment Result

As a result of safety assessment, we conclude that Concept 4 does not have impact on safety (safety is maintained) provided that HMI is indeed in line with OSED requirements. However, the result of RTS indicates that the number of go-arounds is maintained but their distribution correlates with erroneous system indications in case Concept 4 is used. This performance-safety link needs to be further investigated and validated. As a result, the confidence level assigned to safety result is low.

Safety Assessment Report at V3 level is developed for Concept 4 in the V3 OSED Part II SAR and provide detailed assessment of safety, including measured Safety KPI´s.

4.3.4.5 Additional Comments and Notes

N/A

4.4 Environment / Fuel Efficiency

4.4.1 Environment / Fuel Efficiency (Concept 1)

Often fuel efficiency is improved through a reduction of flight or taxi time. This time benefit is also assessed, in this section, as it is additional input for the business case.

4.4.1.1 Performance Mechanism

Fuel Efficiency benefits due to the application of operational concepts addressed by PJ02.08 have been indirectly identified taking into account:

- arrival and departures delay;
- taxi-time reduction;
- average flight duration;

The measure of above listed aspects allowed to estimate the fuel burn per flight through the application of common assumptions for performance aggregation.

4.4.1.2 Assessment Data (Exercises and Expectations)

Fuel Efficiency benefits of Integrated Arrival Departure management for full traffic optimisation on the RWY with the introduction of Integrated Runway Sequence Function (TS-0301) were analysed using validation results from exercise EXE.02-08 V3.007 confirmed by the other V3 exercises covering the same operational improvement in the solution.

Net benefit was identified in terms of Fuel Efficiency and related CO_2/Flight Time Efficiency

4.4.1.2.1 Validation Results

Data coming from Fast Time Simulation showed that the integrated runway sequence function ensure a total fuel consumption lower that the amount obtained from the same number of flights in the reference scenario.

- Average departure taxi time reduction = 0.07 min
- Average arrival flight duration reduction = 0.89 min

4.4.1.2.2 Assumptions

- Fuel burn rate Departure/Taxi (see [Ref – Assumptions for Performance Aggregation – CPA 2018]) = 900 kg/h = 15 kg/min
- Fuel burn rate Arrival (see [Ref – Assumptions for Performance Aggregation – CPA 2018]) = 500 kg/h = 8.3 kg/min
- CO2/Fuel ratio = 3.15
- Average fuel burn per flight = 4800 kg

- Share of ECAC traffic to which the Integrated Runway Sequence function (TS-0301) applies: 45.3%.

4.4.1.3 Extrapolation to ECAC wide

The table below is showing the impact on flight phases (provided when it is possible).

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
FEFF1 Actual Average fuel burn per flight	1.10 Kg			7.44 Kg	
FEFF2 Actual Average CO_2 Emission per flight	3.45 Kg			23.45 Kg	
FEFF3 Reduction in average flight duration	0.07 min			0.89 min	

Table 38: Fuel burn reduction per flight phase for Solution 02-08 Concept 1.

Impact of Integrated Arrival Departure management for full traffic optimisation on the RWY with the introduction of Integrated Runway Sequence Function were identified in the FTS simulation basing on a busy traffic peak during the 2017 summer period (July) that was gradually increased at 2020 traffic forecast till to consider +30% of traffic demand in high-density airports with dependent runways. To obtain an assessment on fuel efficiency per day, KPIs were apportioned among a day. The same benefits have been confirmed by the other exercises EXE.02-08 V3.002 and EXE.02-08 V3.003 addressing the same operational improvement though Real Time Simulation techniques.

Results for TS-0301 flights:

1) Flight time reduction on arrival = 0.89 min
2) Flight time reduction on departure = 0.07 min
3) Absolute flight time reduction = 0.89 min (Flight time reduction on arrival) + [-0.07 min (Flight time reduction on departure)] = 0.97 min
4) **Flight time reduction (FEFF3) at ECAC level = 45.3% (share of ECAC traffic) x -0.97 min (Absolute flight time reduction) = 0.44 min/flight**
5) Fuel consumption reduction on arrival = -0.89 min (Flight time reduction on arrival) x 8.33 kg/min (Fuel burn rate Arrival) = -7.44 kg
6) Fuel consumption reduction on departure = -0.07 min (Flight time reduction on departure) x 15 kg/min (Fuel burn rate Arrival) = -1.10 kg
7) Absolute fuel consumption reduction = -7.44 kg (Fuel consumption reduction on arrival) + [-1.10 kg (Fuel consumption reduction on departure)] =-8.54 kg/flight

8) Relative fuel consumption reduction = 8.54 kg/flight (Absolute fuel consumption reduction) / 4800 kg (Average fuel burn per flight) = 0.18%

9) **Fuel consumption reduction (FEFF1) at ECAC level = 45.3% (share of ECAC traffic) x -0.18% (Relative fuel consumption reduction) = -0.08% = -3.87 kg/flight**

10) CO2 emission reduction on arrival = 7.44 kg (Fuel consumption reduction on arrival) x 3.15 (CO2/Fuel ratio) = 23.45 kg

11) CO2 emission reduction on departure = 1.10 kg (Fuel consumption reduction on arrival) x 3.15 (CO2/Fuel ratio) = 3.45 kg

12) Absolute CO2 emission reduction = 8.54 kg/flight (Absolute fuel consumption reduction) x 3.15 (CO2/Fuel ratio) = 26.90 kg

13) Relative CO2 emission reduction = 26.90 kg (Absolute CO2 emission reduction) / 4800 kg (Average fuel burn per flight) / 3.15 (CO2/Fuel ratio) = 0.18%

14) **CO2 emission reduction (FEFF2) at ECAC level = 45.3% (share of ECAC traffic) x 0.18% (Relative fuel consumption reduction) = 0.08% = -12.19 kg/flight**

4.4.1.4 Discussion of Assessment Result

The assessment of fuel efficiency is based on V3 Fast Time Simulation results obtained considering a busy traffic peak during the 2017 summer period (July) that was gradually increased at 2020 traffic forecast till to consider +30% of traffic demand in high-density airports with dependent runways.

The fast time simulation technique represents the best way to measure benefits (in terms of environmental assessment) brought by new operational concept focussed on the application on the Integrated Runway Sequence Function. Furthermore, the same results have be confirmed by the other validation exercises performed in the solution and addressing the same operational improvement via Real Time Simulation technique. Consequently, the confidence level for the benefit result is judged to be "high"

In the exercise EXE.02-08 V3.007, the Solution Scenarios for both simulated runway configurations (considering both the actual traffic demand on the airport and the future ones increased in line with SESAR forecast) report a Total Fuel consumption that is lower than the amount obtained from the same flights in the Reference Scenario corresponding to the current situation with the AMAN and DMAN working independently.

4.4.1.5 Additional Comments and Notes

No additional comments.

4.4.2 Environment / Fuel Efficiency (Concept 2)

Often fuel efficiency is improved through a reduction of flight or taxi time. This benefit in time is also assessed, in this section, as it is additional input for the business case.

4.4.2.1 Performance Mechanism

Fuel Efficiency benefits due to the application of TS-0313 Operational Improvement (Optimized Use of Runway Capacity for Multiple Runway Airports) have been identified taking into account:

- Average flight duration
- Arrivals and departures delay

The measure of above listed aspects allowed estimating the fuel burn per flight through the application of common assumptions for performance aggregation.

Reduction in taxi times would also report benefits in Fuel Efficiency. However, for the validation exercise Taxi Times were fixed, so no impact in these times was reported.

4.4.2.2 Assessment Data (Exercises and Expectations)

Fuel Efficiency benefits of using a runway management decision support tool for the planning phase (RMAN) linked to an Integrated Runway Sequence function for multiple runway airports and the Optimized Use of Runway Capacity for Multiple runway Aiports (TS-0313) were analysed using validation results from exercise EXE.02-08.V3.006.

- Flight duration reduction in arrivals and departures were taken into account to assess the overall fuel-kg/flight saved
- Arrival and departures delay were taken into account to assess the overall fuel-kg/flight saved

4.4.2.2.1 Validation Results

Validation results of using a runway management decision tool for the planning phase (RMAN) that provides more refined arrival and departure times, linked to an Optimized Use of Runway Capacity for Multiple runway Airports (TS-0313) showed a minor increase in Fuel Efficiency in solution runs of EXE.02-08.V3.006. A bigger increase of this KPA values and more optimistic results are expected when applied to a more suitable scenario (non-CDM airport) and with a more extensive environment (upstream controllers available).

- Average arrival flight duration reduction = 0.4 min
- Average departure flight duration reduction = N/A; no significant impact due to Barcelona being a CDM airport (EOBT are already refined in Reference scenario) and Taxi Times being fixed

It can be concluded that flight duration was potentially reduced with the integration of RMAN because delays were mainly absorbed in the planning phase. Consequently, fuel savings in arrivals were confirmed since flights could arrive earlier as well as avoid holdings in some cases.

On the other hand, departures flight time was not affected by the introduction of RMAN since the Reference scenario already used an Integrated Runway Sequence function and Barcelona – El Prat is a CDM, so EOBT are updated in accordance to TTOT to avoid waits in the holding point.

4.4.2.2.2 Assumptions

- Fuel burn rate Departure/Taxi (see [Ref – Assumptions for Performance Aggregation – CPA 2018]) = 900 kg/h = 15 kg/min
- Fuel burn rate Arrival (see [Ref – Assumptions for Performance Aggregation – CPA 2018]) = 500 kg/h = 8.3 kg/min
- CO_2/Fuel ratio = 3.15
- Average ECAC flight time = 1.5 hours
- Average fuel burn per flight = 4800 kg
- Share of ECAC traffic to which the Integrated Runway Sequence function integrated with RMAN (TS-0313) applies = 31.2%. This is calculated by multiplying the nominal traffic applicable for TS-0313 (43.83%) by the peak hour traffic share (71%).

4.4.2.3 Extrapolation to ECAC wide

The table below is showing the impact on flight phases (provided when it is possible).

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
FEFF1 Actual Average fuel burn per flight				-3.33	
FEFF2 Actual Average CO_2 Emission per flight				-10.49	
FEFF3 Reduction in average flight duration				-0.4	

Table 39: Fuel burn reduction per flight phase for Solution 02-08 Concept 2.

Improvements of integrating RMAN and Integrated Runway Sequence function were only identified during peak hours in high-density airports with dependent runways. To obtain an assessment on fuel efficiency per day, KPIs were apportioned among a day.

Results for TS-0313 flights:

1) Flight time reduction on arrival = 0.40 min
2) Flight time reduction on departure = 0.00 min
3) Absolute flight time reduction = 0.40 min

4) **Flight time reduction (FEFF3) at ECAC level = 31.2% (Share of ECAC traffic) x 0.40 min (Absolute flight time reduction) = 0.125 min/flight**

5) Fuel consumption reduction on arrival = 0.40 min (Flight time reduction on arrival) x 8.33 kg/min (fuel burn rate for arrival) = 3.33 kg

6) Fuel consumption reduction on departure = 0.0 min (Flight time reduction on departure) x 15 kg/min (fuel burn rate for departure/taxi) = 0.00 kg

7) Absolute fuel consumption reduction = 3.33 kg (Fuel consumption reduction on arrival) + 0.00 kg (Fuel consumption reduction on departure) = 3.33 kg/flight

8) Relative fuel consumption reduction = 3.33 kg/flight (Absolute fuel consumption reduction) / 4800 kg (Average fuel burn per flight) = 0.07%

9) **Fuel consumption reduction (FEFF1) at ECAC level = 31.2% (share of ECAC traffic) x 0.07% (Relative fuel consumption reduction) = 0.0218% = 1.04 kg/flight**

10) CO_2 emission reduction on arrival = 3.33 kg (Fuel consumption reduction on arrival) x 3.15 (CO_2/Fuel ratio) = 10.49 kg

11) CO_2 emission reduction on departure = 0.00 kg (Fuel consumption reduction on departure) x 3.15 (CO_2/Fuel ratio) = 0.00 kg

12) Absolute CO_2 emission reduction = 10.49 kg/flight (Absolute fuel consumption reduction) x 0.00 (CO_2/Fuel ratio) = 10.49 kg

13) Relative CO2 emission reduction = 10.49 kg (Absolute CO2 emission reduction) / 4800 kg (Average fuel burn per flight) / 3.15 (CO2/Fuel ratio) = 0.07%

14) **CO2 emission reduction (FEFF2) at ECAC level = 31.2% (share of ECAC traffic) x 0.07% (Relative fuel consumption reduction) = 0.0218% = 3.30 kg/flight**

4.4.2.4 Discussion of Assessment Result

It has been concluded that the integration of RMAN with Integrated Runway Sequence function causes a reduction in fuel consumption and contributes to the overall optimisation of Fuel Efficiency. Overall behaviour has been positive in relation to this KPA.

A more suitable scenario that includes upstream sectors to absorb delays in earlier stages would report bigger increases of Fuel Efficiency, which would occur too if Reference scenario for the measures were not a CDM airport where EOBT are updated in accordance to new TTOT.

Fuel efficiency related values reduction due to the application of TS-0313 build upon TS-0310, as the latter is considered as the Reference scenario. Thus, the improvements are not as significant as it would be when considering independent AMAN and DMAN or not having them deployed at all.

All in all, there is a slight reduction in flight time duration, CO2 emissions and fuel consumed. Results are conclusive with a medium level of significance.

4.4.2.5 Additional Comments and Notes

No additional comments

4.4.3 Environment / Fuel Efficiency (Concept 3)

N/A

4.4.4 Environment / Fuel Efficiency (Concept 4)

N/A

4.5 Environment / Noise and Local Air Quality

N/A

4.6 Airspace Capacity (Throughput / Airspace Volume & Time)

N/A

4.7 Airport Capacity (Runway Throughput Flights/Hour)

4.7.1 Airport Capacity (Concept 1)

4.7.1.1 Performance Mechanism

The use of an Integrated Runway Sequence function is expected to bring benefits by an increase of runway capacity, by optimising the spacing between arrivals and departures in a dynamic way, for an increase of runway throughput.

When using an Integrated Runway Sequence function additional efficiency will be achieved by an early planning of arrival sequence also including departure flights. In this way there will be a significant increase in accuracy of target arrival times with positive impact on stability of both sequence and target landing times. There will be an ability to maintain high capacity levels with the dynamic balancing were the overall delay will take both departure and arrival flights into account. For an airport it´s essential to manage minimum delays for both departing and arrival flights.

The following figure provide an overview of capacity impact with an Integrated Arrival and Departure Management.

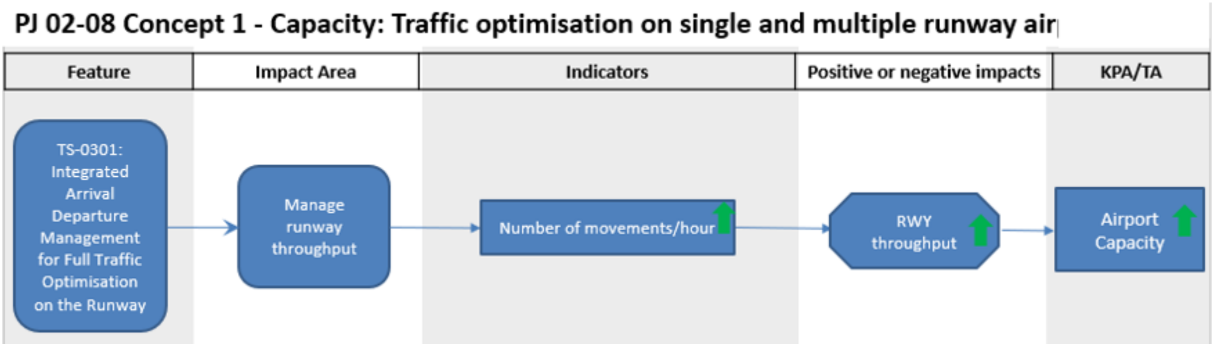

Figure 2: Concept 1 Capacity impact

4.7.1.2 Assessment Data (Exercises and Expectations)

Impact on Capacity (increase of runway throughput) has been found positive in both V3 RTS and V3 FTS validations were the Integrated Runway Sequence is set before arrival flights top of decent. Results from the validations show the use of an Integrated Runway Sequence bring benefits to a number of KPA´s, even if not necessarily all at the same time, with a trade-off between different KPA´s depending on airport priorities and the operational situation.

From a capacity point of view the main benefits are coming from the step from a situation with no sequencing tools, into an airport with a more advanced setup with both AMAN and DMAN. The additional capacity levels when introducing an Integrated Runway Sequence Function are depending on the airport complexity, runway layout and linked operating procedures at each airport.

Concept 1 address optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence (TS-0301). This concept applies namely to execution phase and addresses mainly TWR and TMA ATCOs.

Results from the validations show the use of an Integrated Runway Sequence bring benefits to a number of KPA´s, even if not necessarily all at the same time, each operational situation requiring a trade-off between different KPA´s.

Concept 1 Capacity results

Objective Description: To assess the impact on capacity of the operational improvement.

Success criteria: Slight benefit identified in terms of runway throughput with the introduction of the operational improvement.

Exercises that cover this Objective;

- **LFV-COOPANS Real Time Simulation**

  The results of the Real Time Simulation when operating on two parallel runways in mixed mode (both arrivals and departures) show a consistently higher runway throughput in solution runs compared to baseline runs. This result is also valid during runs with planned runway closure and also during runs with un-planned runway closure and go-around.

  - The results from the Real Time Simulation show the Solution Scenario in this operating environment have an average Capacity increase of 5.1%.

- **ENAV Fast Time Simulation**

  The results of the Fast Time Simulation when operating on dependent runways to balance arrivals and departures show a slight benefit in terms of runways throughput.

  - The results from the Fast Time Simulation show the Solution Scenario in this operating environment have an average Capacity increase of 0,2%.

The following table address the gap between capacity expectations and the results obtained, providing explanation and remarks based on the V3 validation exercises experience:

KPA	KPI / PI	Validation Target	Results	Remarks
Capacity	CAP1: TMA Airspace Capacity – Throughput / airspace volume & time	2.737%	Not measured	Concept 1 is not expected to bring benefits in TMA capacity. Validation Target to be updated.
	CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode) % and Flight per hour	1.351%	5,1% and 90 flights per hour	LFV-COOPANS RTS with Stockholm-Arlanda Airport operating on independent parallel runways.
			0,2%	ENAV FTS with Rome Fiumicino Airport operating on dependent runways.

Table 40: Concept 1 Capacity KPA results

4.7.1.3 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.7.1.4 Discussion of Assessment Result

The increase of capacity when introducing an Integrated Runway Sequence Function are depending on the airport complexity, runway layout and linked operating procedures at each airport. Airport priorities for balancing of different KPA´s will also have an impact.

The results are derived from both one V3 Real Time Simulation and one V3 Fast Time Simulation and together providing quantitative results.

4.7.1.5 Additional Comments and Notes

No additional comments.

4.7.2 Airport Capacity (Concept 2)

N/A

4.7.3 Airport Capacity (Concept 3)

4.7.3.1 Performance Mechanism

The prediction per aircraft type of the runway occupancy type allows applying reduced separations compared to today operations. Considering there is a linear relation between the average separation applied and the runway capacity, each separation reduction leads to increase runway throughput.

On tactical aspect, there is a need to provide the result of the ROT prediction via a support tool to approach and tower runway controllers. This support tool displays the predicted ROT as a Target Distance Indicator (TDI). A support tool is needed because the prediction of ROT spacing to be applied is varying as a function of the leader aircraft type by 0.1Nm increment. The improve conformance to separation allowed by this tool also contribute to increased capacity.

4.7.3.2 Assessment Data (Exercises and Expectations)

Using as metric the throughput at runway threshold observed in the various runs of the RTS5, the impact of ROCAT and reducing MRS to 2.5NM when using the FTD compared to current operations is clearly visible when comparing the ROCAT solution and scenarios to the Reference scenario.

When comparing the runs with the ROCAT concept with the ITD/LORD tool and PWS to the Reference runs, the benefits are also seen to be less dependent on the ATCO team compared to the RECAT-EU with FTD runs, i.e. ATCo performance becomes more standardised with the ITD/LORD tool..

Overall, systematic increase of the throughput was observed for the ROCAT with FTD and RECAT-EU and the ROCAT with ITD/LORD and PWS compared to the reference runs.

The following ranges of values were obtained:

- For the Reference runs: throughput from 41.8 up to 43.1 ac/h
- For the ROCAT with FTD with RECAT-EU runs: throughput from 45.6 up to 48.6 ac/h (+7 up to +16% compared to Reference with same ATCO configuration)
- For ROCAT with ITD/LORD and PWS runs: throughput from 46.3 up to 48.7 ac/h (+10 up to +14% compared to Reference with same ATCO configuration)

Using this metric, the impact of ROCAT and reducing MRS to 2.5NM when using the FTD compared to current operations is clearly visible when comparing the ROCAT solution and scenarios to the Reference scenario. When comparing the runs with the ROCAT concept with the ITD/LORD tool and PWS to the Reference runs, the benefits are also seen to be less dependent on the ATCO team compared to the RECAT-EU with FTD runs, i.e. ATCo performance becomes more standardised with the ITD/LORD tool..

Overall, systematic increase of the throughput was observed for the ROCAT with FTD and RECAT-EU and the ROCAT with ITD/LORD and PWS compared to the reference runs.

KPIs / PIs	Unit	Calculation	Mandatory	Benefit in SESAR1 (if applicable)	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
CAP3.2 Peak Arrival throughput per hour (Segregated mode)	% and Flight per hour	% and also total number of arrivals per one runway per one hour for specific traffic mix and density (in segregated mode of operations). The percentage change is measured against the maximum observed throughput during peak demand hours in the segregated-mode RWY operations airports group.	YES	N/A	Increase throughput by 1 to 4 landings Average 3	Increase throughput by 4% to 10%. Average 7.5%

4.7.3.3 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.7.3.4 Discussion of Assessment Result

The runway throughput increase will depend on the traffic mix. In airport with significant part of the traffic being Heavy aircraft, the separation will be mostly driven by wake constraints and the reduction based on ROT prediction will not be frequently applied. However, if Concept 3 is combined with Solution 1, a more systematic benefit will be observed between 10% and 14% increase throughput whatever the traffic mix.

4.7.3.5 Additional Comments and Notes

No additional comments.

4.7.4 Airport Capacity (Concept 4)

4.7.4.1 Performance Mechanism

Enhanced Prediction of ROT aims to bring an improvement in terms of Runway Capacity in regional aerodromes: the reduction of separation and/or designation of optimal exit taxiway has a direct impact on runway throughput (and also in the efficiency of runway usage) and therefore runway capacity.

Prediction of arrival ROT for each arriving aircraft, based on performance per aircraft type and weather conditions, including wind speed and direction, is passed to Tower Runway ATCO 5 min before expected touchdown for each flight. The prediction includes suggested runway exit for each arriving aircraft. Suggested runway exit is communicated also to the flight crew together with landing clearance.

The use of optimised arrival ROT increases the number of movements per hour on the runway in peak hours, when incoming traffic is persistently high. Increased number of movements per hour, thanks to optimized planning of landing clearances, runway occupancy and use of optimized exit taxiways is translated in an increase of Runway throughput, leading to a positive impact on Runway Capacity and hence Airport Capacity.

4.7.4.2 Assessment Data (Exercises and Expectations)

Following Table 41 present the validation KPI for both V3 FTS and V3 RTS

KPA	KPI / PI	Validation Target	Results	Remarks
Capacity	CAP3 Peak Runway Throughput (% and also total number of movements per one runway per one hour for specific traffic mix and density)	1.341%	1.86%	This result is based solely on FTS. RTS failed to meet objective of estimating the realism of this number. In the present document we only take into account results of FTS for mixed mode.

Table 41 V3 FTS and V3 RTS Validation KPI

4.7.4.3 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.7.4.4 Discussion of Assessment Result

The following Figure 3 presents V3 FTS capacity gains for EPGD airport depending on the applied separation. The expected capacity gain for the separation of 4Nm is up to 1 operation per hour. This capacity gain is below the error of measurement in V3 RTS.

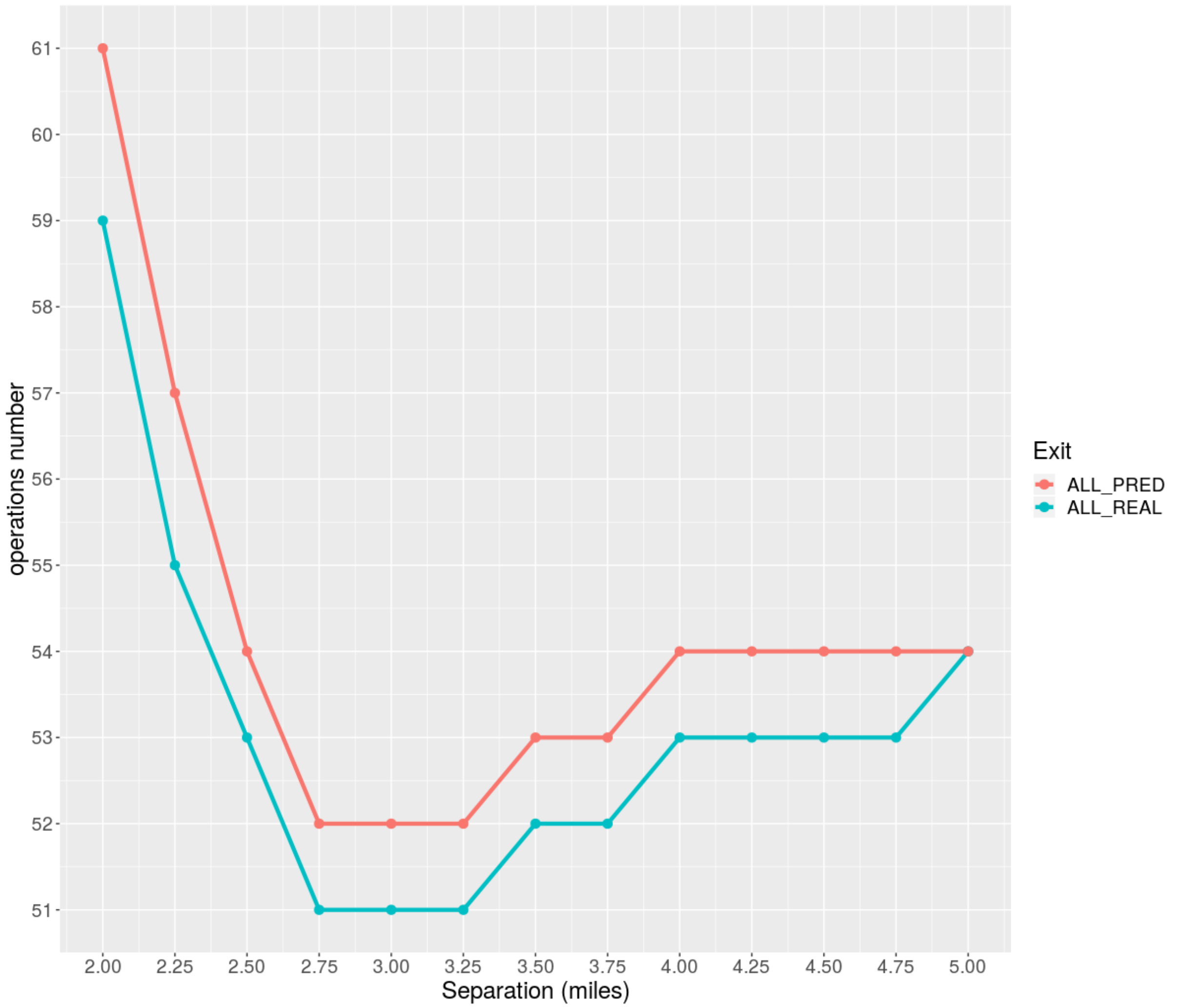

Figure 3 V3 FTS Number of operations per hour in mixed mode for different separation levels for EPGD airport

EPGD procedures assume minimum separation of 4Nm behind a light aircraft and 6Nm behind heavy aircraft. The traffic composition in the V3 RTS in segregated mode scenarios and malfunctions in validation platform, e.g. 2 aircrafts set for departure not leaving the taxiway, affecting significantly the calculated increase of runway throughput, were not suitable to confirm capacity gains.

Considering sample size and lost capacity result due to cancelled departures, the V3 FTS results are more meaningful in terms of possible capacity gains in peak traffic.

The V3 RTS proved, that capacity in solution scenario is not smaller than in the reference scenario, which along with the V3 FTS results satisfies the validation objective OBJ-PJ02.08-V3-

VALP-CA3

The following Figure 4 presents the general capacity gain (number of additional operations per hour obtained by using recommendations divided by number of operations per hour without using recommendations) on number of operations for different separation modes based on V3 FTS results. Capacity gain is not present in mixed mode for separation above 4.75 Nm.

Comparison between reference solution scenarios and solution scenarios shows improvement in the actual arrival ROT . The mean improvement in ROT is calculated at across all scenarios. This improvement in AROT allows for increased number of movement, resulting in increased runway throughput. The performance mechanism is however limited to peak hours .

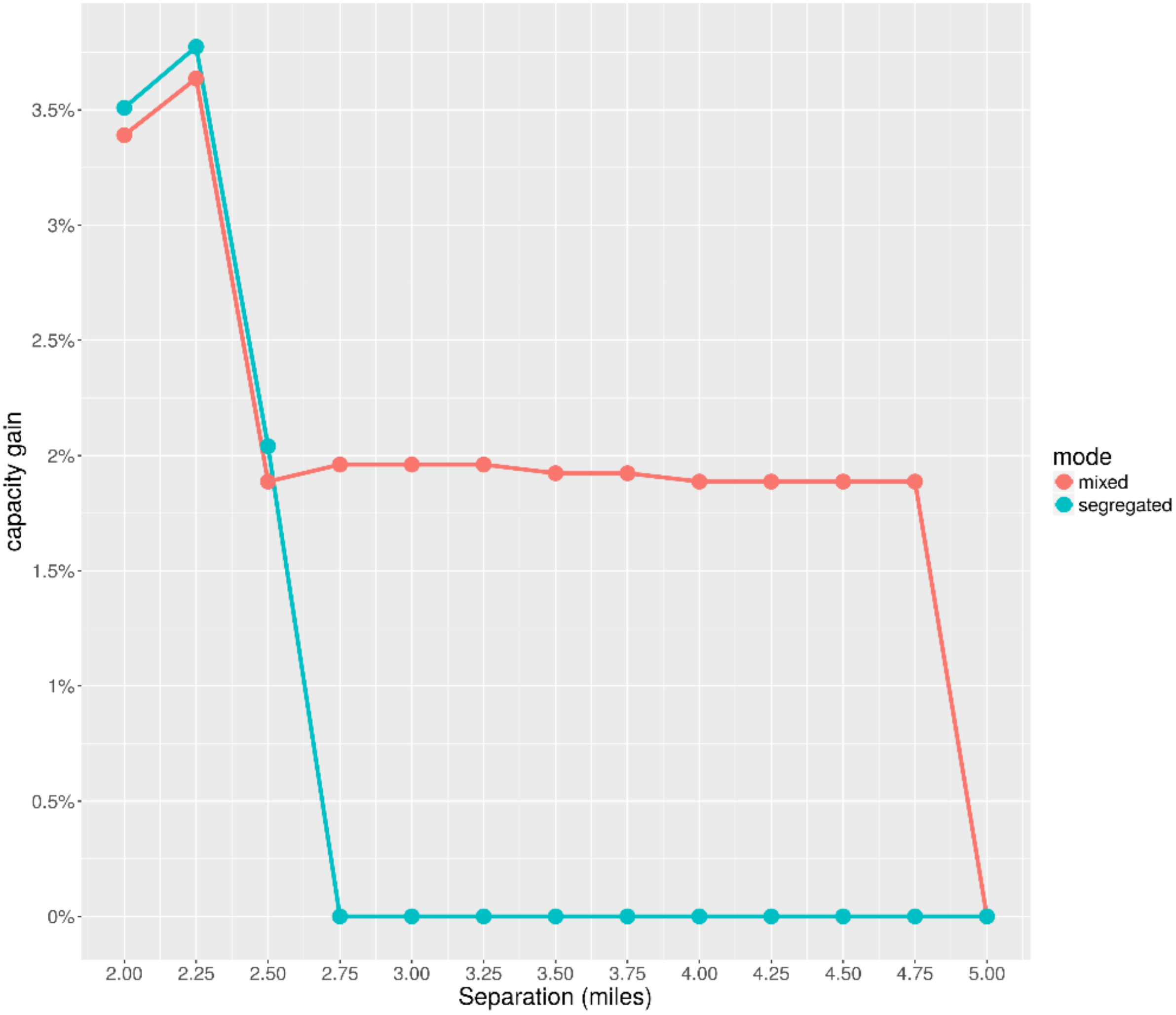

Figure 4 General capacity gain based on number of operations for different separation levels.

4.7.4.5 Additional Comments and Notes

No additional comments.

4.8 Resilience (% Loss of Airport & Airspace Capacity Avoided)

N/A

4.9 Predictability (Flight Duration Variability, against RBT)

4.9.1 Predictability (Concept 1)

4.9.1.1 Performance Mechanism

Predictability benefits due to the application of operational concepts addressed by PJ02.08 have been indirectly measured considering:

- Reduction in variance of difference in actual and Flight Plan durations
- Reduction of Arrival delay.
- Reduction of Departure delay

The measure of above listed aspects allowed to estimate the predictability through the application of common assumptions for performance aggregation.

4.9.1.2 Assessment Data (Exercises and Expectations)

Predictability benefits of Integrated Arrival Departure management for full traffic optimisation on the RWY with the introduction of Integrated Runway Sequence Function (TS-0301) were analysed using validation results from exercise EXE.02-08 V3.007 confirmed by the other V3 exercises covering the same operational improvement in the solution.

4.9.1.2.1 Validation Results

Data coming from Fast Time Simulation showed that the integrated runway sequence function ensure an increase in terms of Predictability with respect to the same number of flights in the reference scenario.

- TMA arrival variability = -0.005 min^2
- Taxi out variability = 0.004 min^2

4.9.1.2.2 Assumptions

- TMA arrival variability contribution = 43%
- Taxi out variability = 40%
- Share of ECAC traffic to which the Integrated Runway Sequence function (TS-0301) applies: 45.3%.

4.9.1.3 Extrapolation to ECAC wide

Impact of Integrated Arrival Departure management for full traffic optimisation on the RWY with the introduction of Integrated Runway Sequence Function were identified in the FTS simulation basing on a busy traffic peak during the 2017 summer period (July) that was gradually increased at 2020 traffic forecast till to consider +30% of traffic demand in high-density airports with dependent runways. To obtain an assessment on predictability, the main influencing factors were considered (Taxi-Out variability and the TMA in Arrival variability). The same benefits have been confirmed by the other exercises EXE.02-08 V3.002 and EXE.02-08 V3.003 addressing the same operational improvement though Real Time Simulation techniques.

Results for TS-0301 flights:

1) TMA arrival variability = -0.0005 min^2 = -1.429%
2) Taxi out variability = -0.004 min^2 = 8.163%
3) Absolute reduction in variance of difference in actual and Flight Plan durations = -0.0005 min^2 (TMA arrival variability) + [0.004 min^2 (Taxi out variability)] = 0.0035 min^2 =-6.929%
4) **<u>Variance of difference in actual and Flight Plan durations (PRD1) at ECAC level</u> = 45.3% (share of ECAC traffic) x 0.003 min^2 (Absolute reduction in variance of difference in actual and Flight Plan or RBT durations) = 0.0016 min^2 = 3.139%**

The table below is showing the impact on flight phases (provided when it is possible).

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
PRD1 Variance[18] of Difference in actual & Flight Plan or RBT durations	0.004 min^2			-0.0005 min^2	

Table 42: Predictability benefit per flight phase, standard deviation improvement for Solution 02-08 Concept1

4.9.1.4 Discussion of Assessment Result

The assessment of predictability is based on V3 Fast Time Simulation results obtained considering a busy traffic peak during the 2017 summer period (July) that was gradually increased at 2020 traffic forecast till to consider +30% of traffic demand in high-density airports with dependent runways.

The fast time simulation technique represents the best way to measure benefits brought by new operational concept focussed on the application on the Integrated Runway Sequence Function. Furthermore, the same results have been confirmed by the other validation exercises performed in the solution and addressing the same operational improvement via Real Time Simulation technique. Consequently, the confidence level for the benefit result is judged to be "high"

4.9.1.5 Additional Comments and Notes

No additional comments.

[18] Standard Deviation is also accepted.

4.9.2 Predictability (Concept 2)

4.9.2.1 Performance Mechanism

Predictability benefits due to the application of TS-0313 Operational Improvement (Optimized Use of Runway Capacity for Multiple Runway Airports) have been indirectly identified taking into account:

- Reduction in variance of difference in actual and Flight Plan or RBT durations
- Arrival delay reduction
- Departure delay reduction

A decrease of Predictability has been identified after the introduction of runway management planning tool (RMAN). Variance values grew in the Solution scenario, what could produce a less predictable situation.

The use of slots proposed by RMAN achieved a reduction in the average departure delay, and flights departed earlier than in the Reference scenario. However, this fact affected negatively to the Predictability, as it produced a less predictable situation where times were more scattered.

This problem could be solved or at least attenuated by constraining the maximum time a flight can depart earlier, which would produce a situation where flights are not so scattered.

4.9.2.2 Assessment Data (Exercises and Expectations)

Predictability benefits of using a runway management decision support tool (RMAN) linked to DCB in the planning phase for multiple runway airports (TS-0313) was measured using the results of EXE.02-08.V2.006, based on:

- Reduction in variance of difference in actual and Flight Plan or RBT durations

4.9.2.2.1 Validation results

Validation results of using a runway management decision support tool for the planning phase (RMAN) linked to Integrated Runway Sequence function for multiple runway airports (TS-0313). An increase in the variance was identified, hence there was a decrease in the Predictability in Solution runs of EXE.02-08.V3.006. The data has an acceptable level of significance.

- +0.146 min^2 increase of variance in arrivals
- +1.79 min^2 increase of variance in departures

4.9.2.2.2 Assumptions

The following assumptions are considered taking into account the applicable traffic share of the solution and the peak hour traffic share (where the concept brings benefits).

- TMA arrival contribution to variability = 43%
- Taxi out contribution to variability = 40%

- Share of ECAC traffic to which the Integrated Runway Sequence function integrated with RMAN (TS-0313) applies = 31.2%. This is calculated by multiplying the nominal traffic applicable for TS-0313 (43.83%) by the peak our traffic share (71%).

4.9.2.3 Extrapolation to ECAC wide

Results for TS-0313 flights:

1) Arrivals variability = +0.146 min^2
2) Departures variability = +1.79 min^2
3) Absolute variance reduction = -0.146 min^2 (variance on arrivals) + (-1.79 min^2) (variance on departures) = -1.936 min^2
4) **Variance reduction (PRD1) at ECAC level = 31.2% (Share of ECAC traffic) x (-1.936) min^2 (Absolute variance reduction) = -0.60 min^2/flight= -43.992%**

The table below is showing the impact on flight phases (provided when it is possible).

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
PRD1 Variance[19] of Difference in actual & Flight Plan or RBT durations	1.79			0.146	

Table 43: Predictability benefit per flight phase, standard deviation improvement for Solution 02-08 Concept2

4.9.2.4 Discussion of Assessment Result

Negative results on variance reduction means an increase in variance figures, hence Predictability is decreased. Therefore, an increase of variance of difference in actual and Flight Plan or RBT durations for Arrivals was identified when RMAN tool was introduced and new updated TTOT and TLDT (in the form of forecasted times) were used.

Overall, average delays were reduced for Arrivals and Departures. However, this caused ALDT and ATOT to be more scattered, which increased variance and decreased Predictability subsequently. This behaviour is opposite to Punctuality, which grew when RMAN was integrated with Integrated Runway Sequence function.

A better behaviour regarding Predictability could be achieved by fixing the maximum and minimum time that arrivals and departures times can be deviated by RMAN from their estimated time.

[19] Standard Deviation is also accepted.

4.9.2.5 Additional Comments and Notes

No additional comments.**Predictability (Concept 3)**

N/A

4.9.4 Predictability (Concept 4)

N/A

4.10 Punctuality (% Departures < +/- 3 mins vs. schedule due to ATM causes)

4.10.1 Punctuality (Concept 1)

4.10.1.1 Performance Mechanism

Punctuality benefit of Integrated Arrival Departure management for full traffic optimisation on the RWY with the introduction of the Integrated Runway Sequence Function (TS-0301).

Punctuality net benefit identified in terms of:

- Percentage of departures that had |AOBT - EOBT| < 3 minutes

4.10.1.2 Assessment Data (Exercises and Expectations)

Punctuality benefits of Integrated Arrival Departure management for full traffic optimisation on the RWY with the introduction of Integrated Runway Sequence Function (TS-0301) were analysed using validation results coming from Real Time validation exercises EXE.02-08 V3.002 and EXE.02-08 V3.003.

4.10.1.2.1 Validation Results

Data coming from both real time simulations showed that the integrated runway sequence function ensure an increase in terms of Punctuality with respect to the same number of flights in the reference scenario.

- Average percentage of departures that had |AOBT - EOBT| < 3 minutes = 8%

4.10.1.2.2 Assumptions

- Share of ECAC traffic to which the Integrated Runway Sequence function (TS-0301) applies: 45.3%.
- As for PUN1 only departures are considered, the ECAC traffic affected should be divided by 2 to only consider the targeted flights

4.10.1.3 Extrapolation to ECAC wide

TS-0301 results:

1) Percentage of Flights departing within +/- 3 minutes of scheduled departure time = 8%
2) **Percentage of Flights departing within +/- 3 minutes of scheduled departure time (PUN1) at ECAC level = $\frac{45.3\%}{2}$ (share of ECAC traffic) x 8% (Percentage of Flights departing within +/- 3 minutes of scheduled departure time) = 1.81%**

The table below is showing the impact on flight phases (provided when it is possible).

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
PUN1 % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather-related delay causes	8%				

Table 44: Punctuality benefit per flight phase for Solution 02-08 Concept 1.

4.10.1.4 Discussion of Assessment Result

The validation result provided in the previous section represents the average benefit value obtained considering the comparative value towards the reference.

The assessment of punctuality is based on V3 Real Time Simulation results that don't represent the best technique to measure benefits brought by new operational concept focussed on the application on the Integrated Runway Sequence Function. Consequently, the confidence level for the benefit result is judged to be "medium-low"

4.10.1.5 Additional Comments and Notes

No additional comments.

4.10.2 Punctuality (Concept 2)

4.10.2.1 Performance Mechanism

Flow based Integration of Arrival and Departure Management aims at increasing throughput at an airport by improved co-ordination between Approach and Tower controllers. Arrival and Departure flows to the same runway or dependent runways should reduce the overall airport delay (arrivals and departures).

Punctuality performance mechanism has been developed from Airport, TMA ANSP and AU points of view for solution PJ.02-08. They cover Integrated Runway Sequence function (TS-0301) and Integrated Runway Sequence function and RMAN integration (TS-0313).

Punctuality Performance Mechanism in relation to TS-0313 is depicted below.

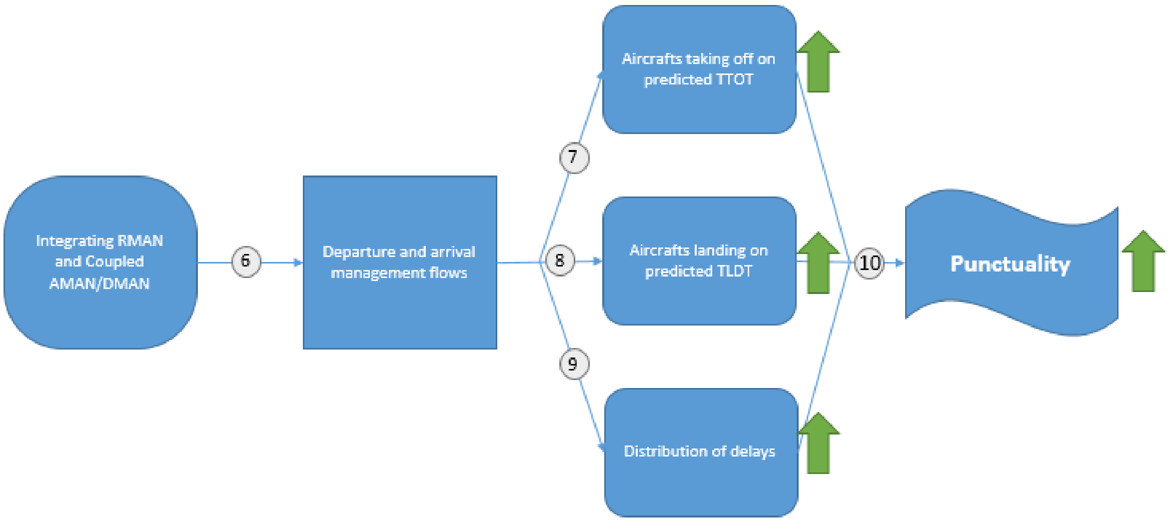

Figure 5: Punctuality Performance Mechanism TS-0313

4.10.2.2 Assessment Data (Exercises and Expectations)

Punctuality benefits of using a runway management decision support tool for the planning phase (RMAN) linked to Integrated Runway Sequence function for multiple runway airports (TS-0313)

Punctuality net benefit identified in terms of:

- Percentage of departures that had |AOBT - SOBT| < 3 minutes

4.10.2.2.1 Validation Results

Validation results of using a runway management decision support tool for the planning phase (RMAN) linked to Integrated Runway Sequence function for multiple runway airports (TS-0313). Increase in punctuality identified in Solution runs of EXE.02-08.V3.006. The data has an acceptable level of significance.

- 5.5% increase of on-time departures

4.10.2.2.2 Assumptions

The following assumptions are considered taking into account the applicable traffic share of the solution and the peak hour traffic share (where the concept brings benefits).

- Share of ECAC traffic to which the Integrated Runway Sequence function integrated with RMAN (TS-0313) applies = 31.2%. This is calculated by multiplying the nominal traffic applicable for TS-0313 (43.83%) by the peak hour traffic share (71%).
- As for PUN1 only departures are considered, the ECAC traffic affected should be divided by 2 in order to only consider the targeted flights.

4.10.2.3 Extrapolation to ECAC wide

Results for TS-0313 flights:

1) Additional percentage of on-time flights identified: 5.5%
2) **Punctuality improvement (PUN1) at ECAC level**:

$$Additional\ percentage\ of\ ontime\ flights\ identified\ x\ Traffic\ share\ in\ ECAC\ = 5.5\%\ x\frac{31.2\%}{2} = +\mathbf{0,86\%}$$

The table below is showing the impact on flight phases (provided when it is possible).

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
PUN1 % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	+5.5%	N/A	N/A	N/A	N/A

Table 45: Punctuality benefit per flight phase for Solution 02-08 Concept 2.

4.10.2.4 Discussion of Assessment Result

Although no benefits were expected regarding Punctuality in the Validation Targets, an increase in this KPA was observed.

On-time flights percentage increased when applying the Solution scenario, due to the integration of RMAN with Integrated Runway Sequence function and a more efficient use of slots and resources.

Some delays that occurred in the Reference scenario were absorbed in the Solution one, thus departure flights that would fall after the +3 minute window were then within the acceptable time interval.

The results obtained for Punctuality in this exercise could not be considered as very reliable. Traffic samples could not be as wide as required for consistent values. Due to this, a FTS could be considered as a more reliable source of data.

4.10.2.5 Additional Comments and Notes

No additional comments.

4.10.3 Punctuality (Concept 3)

N/A

4.10.4 Punctuality (Concept 4)

N/A

4.11 Civil-Military Cooperation and Coordination (Distance and Fuel)

N/A

4.12 Flexibility

N/A

4.13 Cost Efficiency

N/A

4.14 Airspace User Cost Efficiency

N/A

4.15 Security

The Solution is not expected to impair Security. A Security assessment has been performed and related security requirements identified and recorded in the TS (see ref [46]) sections 4.1.2.2 for Concepts 1 and 2), section 4.2.3 for Concept 3 and section 4.3.3 for Concept 4.

4.15.1 Security (Concepts 1 and 2)

Concepts 1 and 2 are not expected to impair Security. A Security assessment has been performed in V2 (refer to [45]) and related security requirements identified and recorded in the TS (see ref [46]) section 4.1.2.2).

4.15.1.1 The SecRAM 2.0 methodology and the Security Performance Mechanism

4.15.1.2 Security Assessment Data Collection

PIs	Unit	Calculation	Mandatory	Current value

PIs	Unit	Calculation	Mandatory	Current value
SEC1 A security risk assessment has been carried out	Y	A security risk assessment has been carried out applying SecRAM 2.0, and the following steps have each been carried out : The identification of Primary Assets, Supporting Assets, Threat Scenarios and Vulnerabilities; The evaluation of Impacts, Likelihoods and Risks.	YES (different steps are mandatory for different prioritization and maturity levels)	*Y (Refer to [45])*
SEC2 Risk Treatment has been carried out	Y	Following SecRAM 2.0, Security controls have been identified by Security Experts and implemented in the Solution.	YES (implementation just at higher maturity levels – V4)	*Y (Refer to [45])*
SEC3 Residual risk after treatment meets security objective.	Y	After Security Controls have been implemented, the Risk Level achieved per Supporting Asset decreases (H → M, M→L, H→L). It is important to notice that according to SecRAM the Risk Level achieved should be "Low" otherwise justifications must be provided.	YES	*Y (Refer to [45])*
SEC7 Personnel (safety) risk after mitigation	Risk 3 levels are possible: high, medium or low	Qualitative assessments are derived from application of the SESAR2020 Security Risk Assessment Methodology (SecRAM 2.0). The PI is the maximum risk evaluated for the SESAR Solution after application of the recommended controls and considering the Personnel Impact Area only.	According to the SESAR Solution prioritization list and to the maturity level of the solutions	*Refer to [45]*
SEC8 Capacity risk after mitigation	Risk – 3 levels are possible: high, medium or low	Qualitative assessments are derived from application of SecRAM 2.0. The PI is the maximum risk evaluated for the SESAR Solution after application of the recommended controls and considering the Capacity Impact Area only.	According to the SESAR Solution prioritization list and to the maturity level of the solutions	*Refer to [45]*
SEC9 Economic risk after mitigation	Risk – 3 levels are possible: high, medium or low	Qualitative assessments are derived from application of SecRAM 2.The PI is the maximum risk evaluated for the SESAR Solution after application of the recommended controls and considering the Economic Impact Area only.	According to the SESAR Solution prioritization list and to the maturity level of the solutions.	*Refer to [45]*

4.15.1.3 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.15.1.4 Discussion of Assessment Result

Refer to security requirements defined in the TS (see ref [46]) section 4.1.2.2).

4.15.1.5 Additional Comments and Notes

No additional comments.

4.15.2 Security (Concept 3)

N/A

4.15.3 Security (Concept 4)

N/A

4.16 Human Performance

4.16.1 Human Performance (Concept 1)

4.16.1.1 HP arguments, activities and metrics

PIs	Activities & Metrics	Second level indicators	Covered
HP1 Consistency of human role with respect to human capabilities and limitations	**ATCOs feedback on operating methods** during workshops and RTS de-briefing sessions **ATCOs workload** measures through questionnaires, RTS de-briefing sessions and objective data (comparative measure of number of manipulations required between solution and baseline)	**HP1.1** Clarity and completeness of role and responsibilities of human actors	N/A
		HP1.2 Adequacy of operating methods (procedures) in supporting human performance	CLOSED
		HP1.3 Capability of human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level	CLOSED
HP2 Suitability of technical system in supporting the tasks of human actors	**ATCOs trust in the system** measured through questionnaires, RTS de-briefing sessions and objective data (comparative measures on sequence reliability: ALDT vs TLDT, ASAT vs TSAT, ATOT vs TTOT, number of manual sequence updates required) **ATCOs feedback on usability** of sequence and HMI measured through questionnaires	**HP2.1** Adequacy of allocation of tasks between the human and the machine (i.e. level of automation).	CLOSED
		HP2.2 Adequacy of technical systems in supporting Human Performance with respect to timeliness of system responses and accuracy of information provided	CLOSED
		HP2.3 Adequacy of the human machine interface in supporting the human in carrying out their tasks.	CLOSED

Founding Members

PIs	Activities & Metrics	Second level indicators	Covered
	and RTS de-briefing sessions **ATCOs individual and team situation awareness** measured through questionnaires and RTS de-briefing sessions.		
HP3 Adequacy of team structure and team communication in supporting the human actors	**ATCOs communication load** measured through questionnaires, RTS de-briefing sessions, observations and objective data (number of coordination actions)	**HP3.1** Adequacy of team composition in terms of identified roles	N/A
		HP3.2 Adequacy of task allocation among human actors	N/A
		HP3.3 Adequacy of team communication with regard to information type, technical enablers and impact on situation awareness/workload	CLOSED
HP4 Feasibility with regard to HP-related transition factors	**ATCOs feedback on job satisfaction** measured through questionnaires, RTS de-briefing sessions **ATCOs stress** measured through questionnaires, RTS de-briefing sessions	**HP4.1** User acceptability of the proposed solution	CLOSED
		HP4.2 Feasibility in relation to changes in competence requirements	CLOSED
		HP4.3 Feasibility in relation to changes in staffing levels, shift organization and workforce relocation.	N/A
		HP4.4 Feasibility in relation to changes in recruitment and selection requirements .	N/A
		HP4.5 Feasibility in terms of changes in training needs with regard to its contents, duration and modality.	CLOSED

4.16.1.2 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.16.1.3 Open HP issues/ recommendations and requirements

The table hereafter lists the number of HP open issues and benefits as well as the recommendations and requirements. In general, there are no remaining open issues (except regarding the integration of the Integrated Runway Sequence in the CWP that is only partially achieved).

Note that there are no specific HP requirements but rather recommendations.

For more details, refer to the Solution 02-08 HPAR for V3 ([44]).

PIs	Number of open issues/ benefits	Nr. of recommendations	Number of requirements
HP1 Consistency of human role with respect to human capabilities and limitations	No open issues All benefits demonstrated	3	N/A
HP2 Suitability of technical system in supporting the tasks of human actors	No open issues except ISS-02-08-HP.0007 which remains partially open All benefits demonstrated	8	N/A
HP3 Adequacy of team structure and team communication in supporting the human actors	No open issues	N/A	N/A
HP4 Feasibility with regard to HP-related transition factors	No open issues	1	N/A

4.16.1.4 Concept interaction

N/A

4.16.1.5 Most important HP issues

The table hereafter lists all important issues and benefits that might have a major impact on the performance of the solution. Note that almost all these issues are considered closed and the benefits demonstrated based on the results of the V3 validation exercises. However, in view of any further operational deployment, they should be taken into consideration. For more details, refer to the V3 HPAR (ref [44]).

PIs	Most important issues and benefits of the solution
HP1 Consistency of human role with respect to human capabilities and limitations	**ISS-02-08-HP.0001:** The new operating methods linked to the use of the Integrated Runway Sequence might not be applicable by controllers (because they are perceived as less efficient or less safe), potentially leading to one of the following situations: - Controllers follow the prescribed operating methods but with a negative impact on HP (additional workload and stress, lack of trust in the system, increased potential for errors); - Controllers don't follow the prescribed operating methods, drifting from standard

PIs	Most important issues and benefits of the solution
	procedures in a variable way, with a negative impact on HP (loss of shared situation awareness, increased potential for errors)
	ISS-02-08-HP.0002: The Integrated Runway Sequence function may increase ATCO workload with the request to follow the Integrated Runway Sequence propositions, and may be with the need for more coordination between all the concerned actors. In turn this would have a negative impact on safety
	BEN-02-08-HP.0001: The Integrated Runway Sequence function is expected to improve ATCO's situation awareness on traffic (individual and team) with the provision of shared information on the departure and arrival sequences. In turn this will bring a benefit for safety.
HP2 Suitability of technical system in supporting the tasks of human actors	**ISS-02-08-HP.0003**: The sequence and advisories proposed by the Integrated Runway Sequence function might not match to the controller's logic, leading to a loss of trust in the system
	ISS-02-08-HP.0005: The Integrated Runway Sequence information provided to the tower controllers might not be usable. This in turn would have a negative impact on efficiency
	ISS-02-08-HP.0007: The new display presenting Integrated Runway Sequence information may not be well integrated and presented in the Approach, Runway and Ground controller working positions and might not be usable. This in turn would have a negative impact on efficiency.
	BEN-02-08-HP.0004: The display of the Integrated Runway Sequence is expected to improve situation awareness on the traffic situation for ACC, APP and TWR controllers
	BEN-02-08-HP.0003: The display of the Integrated Runway Sequence is expected to improve shared situation awareness between ACC, APP and TWR controllers
HP3 Adequacy of team structure and team communication in supporting the human actors	**ISS-02-08-HP.0011**: The communication load of team members may increase due to the need for coordination to apply the Integrated Runway Sequence as requested, including in case of rescheduling or modification of the sequence. In turn this would have a negative impact on safety
HP4 Feasibility with regard to HP-related transition factors	**ISS-02-08-HP.0012:** A lack of flexibility, reduced in favour of predictability, may negatively impact job satisfaction
	ISS-02-08-HP.0013: The automation of the integration of arrival and departure sequences might lead to a loss of skills in the long term, potentially impacting performance in case of unavailability of tools

4.16.1.6 Additional Comments and Notes

No additional comments.

4.16.2 Human Performance (Concept 2)

N/A

4.16.3 Human Performance (Concept 3)

4.16.3.1 HP arguments, activities and metrics

PIs	Activities & Metrics	Second level indicators	Covered
HP1 Consistency of human role with respect to human capabilities and limitations	**Activity: Real time simulation PJ02-08 RTS5:** **Measurements:** **Acceptability of roles and tasks procedures, workload, situation awareness, task performance, human error situation awareness.** **Techniques: ATCo feedback, observations, questionnaires for, (NASA-TLX, ISA, Bedford scale, CARS, SASHA, China Lakes) plus system performance data (e.g. a/c handled per hour, number of separation infringements, go-arounds, accuracy of separation delivery)**	**HP1.1** Clarity and completeness of role and responsibilities of human actors	Closed
		HP1.2 Adequacy of operating methods (procedures) in supporting human performance	Closed
		HP1.3 Capability of human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level	Closed
HP2 Suitability of technical system in supporting the tasks of human actors	**Activity: Real time simulation PJ02-08 RTS5:** **Measurements:** **Acceptability of roles and tasks procedures, workload, situation awareness, task performance,**	**HP2.1** Adequacy of allocation of tasks between the human and the machine (i.e. level of automation).	Closed
		HP2.2 Adequacy of technical systems in supporting Human Performance with respect to timeliness of system responses and accuracy of information provided	Closed
		HP2.3 Adequacy of the human machine interface in supporting the human in carrying out their tasks.	Closed

PIs	Activities & Metrics	Second level indicators	Covered
	human error situation awareness. Techniques: ATCo feedback, observations, questionnaires for, (NASA-TLX, ISA, Bedford scale, CARS, SASHA, China Lakes SATI) plus system performance data (e.g. a/c handled per hour, number of separation infringements,go-arounds, accuracy of separation delivery)		
HP3 Adequacy of team structure and team communication in supporting the human actors	Activity: Real time simulation PJ02-08 RTS5: Measurements: Acceptability of team roles and tasks procedures, workload, situation awareness, task performance, human error situation awareness. Techniques: ATCo feedback, observations, questionnaires for, (NASA-TLX, ISA, Bedford scale, CARS, SASHA, China Lakes SATI) plus system performance data (e.g. a/c handled per hour, RT	**HP3.1** Adequacy of team composition in terms of identified roles	N/A
		HP3.2 Adequacy of task allocation among human actors	N/A
		HP3.3 Adequacy of team communication with regard to information type, technical enablers and impact on situation awareness/workload	Closed

PIs	Activities & Metrics	Second level indicators	Covered
	occupancy)		
HP4 Feasibility with regard to HP-related transition factors	**Activity: Real time simulation PJ02-08 RTS5:** **Measurements: Acceptability of solution, competence requirements, training needs.** **Techniques: ATCo feedback,**	**HP4.1** User acceptability of the proposed solution	Closed
		HP4.2 Feasibility in relation to changes in competence requirements	N/A
		HP4.3 Feasibility in relation to changes in staffing levels, shift organization and workforce relocation.	N/A
		HP4.4 Feasibility in relation to changes in recruitment and selection requirements.	N/A
		HP4.5 Feasibility in terms of changes in training needs with regard to its contents, duration and modality.	Closed

4.16.3.2 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.16.3.3 Open HP issues/ recommendations and requirements

The table hereafter lists the number of HP open issues and benefits as well as the recommendations and requirements. In general, there are no remaining open issues (except regarding the integration of the Integrated Runway Sequence in the CWP that is only partially achieved).

Note that there are no specific HP requirements but rather recommendations.

For more details, refer to the Solution 02-08 HPAR for V3 ([44]).

PIs	Number of open issues/ benefits	Nr. of recommendations	Number of requirements
HP1 Consistency of human role with respect to human capabilities and limitations	No open issues All benefits demonstrated	0	4

HP2 Suitability of technical system in supporting the tasks of human actors	**No open issues** **All benefits demonstrated**	**0**	**2**
HP3 Adequacy of team structure and team communication in supporting the human actors	**No open issues** **All benefits demonstrated**	**1**	**0**
HP4 Feasibility with regard to HP-related transition factors	**No open issues** **All benefits demonstrated**	**0**	**3**

4.16.3.4 Concept interaction

If the ROCAT concept is to be applied by the ground actors (final approach ATCO and Tower runway controllers) then a controller support tool is required. Therefore, in this context the application of the ROCAT concept is dependent on the use of a controller support tool. It is proposed that the ORD tool (AO-0306) developed in PJ02-01 to support the application of TBS, PWS, and WDS, as well as reduction of MRS on the final approach in Pj02-03, is used to support the application of ROCAT based on the static definition of ROT per aircraft type.

4.16.3.5 Most important HP issues

Note the HP issues relating to ROCAT relate to the changes introduced by the tool support required to apply ROCAT.

PIs	Most important issue of the solution	Most important issues due to solution interdependencies
HP1 Consistency of human role with respect to human capabilities and limitations		ROCAT leads to new abnormal events or degraded modes of operations that do not currently exist in the current system e.g. ORD tool failure. This may impact safety
		ATCOs do not trust the new working practices and the ROCAT related tools. This may lead to them adding extra buffer or not using the target distance indicators appropriately. This will impact the gains that can be achieved in terms of runway throughput capacity.
		Changes to working practices and tasks under ROCAT with the ORD tool increase APP (INT, FIN) and TWR ATCO workload. The increase in frequency of aircraft may impact the APP ATCOs workload with respect to setting up and monitoring the appropriate spacing on final approach, as well as the TWR ATCOs workload with respect to the increase in

PIs	Most important issue of the solution	Most important issues due to solution interdependencies
		monitoring the appropriate spacing on final approach. This may impact safety.
HP2 Suitability of technical system in supporting the tasks of human actors		The controller support tool required to apply ROCAT e.g. ORD indications, reduce ATCOs overall situational awareness, as ATCOs may just use the indicators as a target and focus all their attention on getting a/c to target so their focus of attention may become narrower and their general SA reduced overall. This may impact safety
		ATCOs do not trust the ROCAT controller support tool (ORD indications), or trust it too much. This may impact safety.
HP3 Adequacy of team structure and team communication in supporting the human actors		Communication load of ATCOs increases to unacceptable levels due to increased co-ordination with ROCAT/ ORD tool between ATCOs and also between ATCOs and pilots.
HP4 Feasibility with regard to HP-related transition factors		Introduction of ROCAT with ORD reduces ATCO job satisfaction due to ATCos work being more automated.
		Training requirements are not specified for working with ROCAT and ROT.
		Pilots do not conform to the final approach ATCO instructions in an accurate or timely manner. This may lead to separation infringements and impact safety.

4.16.3.6 Additional Comments and Notes

No additional comments.

4.16.4 Human Performance (Concept 4)

4.16.4.1 HP arguments, activities and metrics

PIs	Activities & Metrics	Second level indicators	Covered
HP1 Consistency of human role with respect to	**ATCOs feedback on operating methods** during	**HP1.1** Clarity and completeness of role and responsibilities of human actors	**N/A**

PIs	Activities & Metrics	Second level indicators	Covered
human capabilities and limitations	workshops and RTS de-briefing sessions	**HP1.2** Adequacy of operating methods (procedures) in supporting human performance	CLOSED
	ATCOs workload measures through questionnaires, SATI score, China Lakes situational awareness scale and SASHA, RTS de-briefing sessions and objective data – ISA workload	**HP1.3** Capability of human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level	OPEN
HP2 Suitability of technical system in supporting the tasks of human actors	**ATCOs trust in the system** measured through questionnaires, Bedford Workload Scale and CARS, RTS de-briefing sessions **ATCOs feedback on usability** of sequence and HMI measured through questionnaires and RTS de-briefing sessions	**HP2.1** Adequacy of allocation of tasks between the human and the machine (i.e. level of automation).	OPEN
		HP2.2 Adequacy of technical systems in supporting Human Performance with respect to timeliness of system responses and accuracy of information provided	OPEN
		HP2.3 Adequacy of the human machine interface in supporting the human in carrying out their tasks.	OPEN
HP3 Adequacy of team structure and team communication in supporting the human actors	**ATCOs communication load** measured through questionnaires, RTS de-briefing sessions, observations and objective data – ISA real time workload scale	**HP3.1** Adequacy of team composition in terms of identified roles	N/A
		HP3.2 Adequacy of task allocation among human actors	N/A
		HP3.3 Adequacy of team communication with regard to information type, technical enablers and impact on situation awareness/workload	N/A
	ATCOs feedback on job satisfaction measured through questionnaires,	**HP4.1** User acceptability of the proposed solution	N/A
		HP4.2 Feasibility in relation to changes in competence requirements	OPEN

Founding Members

PIs	Activities & Metrics	Second level indicators	Covered
HP4 Feasibility with regard to HP-related transition factors	RTS de-briefing sessions **ATCOs stress** measured through questionnaires, RTS de-briefing sessions	**HP4.3** Feasibility in relation to changes in staffing levels, shift organization and workforce relocation.	N/A
		HP4.4 Feasibility in relation to changes in recruitment and selection requirements .	N/A
		HP4.5 Feasibility in terms of changes in training needs with regard to its contents, duration and modality.	OPEN

4.16.4.2 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.16.4.3 Open HP issues/ recommendations and requirements

PIs	Number of open issues/ benefits	Nr. of recommendations	Number of requirements
HP1 Consistency of human role with respect to human capabilities and limitations	1	2	3
HP2 Suitability of technical system in supporting the tasks of human actors	2 Benefit demonstrated	2	N/A
HP3 Adequacy of team structure and team communication in supporting the human actors	N/A	N/A	N/A
HP4 Feasibility with regard to HP-related transition factors	2	2	N/A

4.16.4.4 Concept interaction

N/A

4.16.4.5 Most important HP issues

The table hereafter lists all important issues and benefits that might have a major impact on the performance of the solution. However, in view of any further operational deployment, they should be taken into consideration. For more details, refer to the V3 HPAR (ref [44]).

PIs	Most important issues and benefits of the solution
HP1 Consistency of human role with respect to human capabilities and limitations	**ISS-02-08-HP.4001:** The new HMI might provide information which is not consistent with the controllers judgment based on his/her experience. As a result the controller will be hesitant to follow HMI indications which in turn will create increased mental load and limit the trust in the system.
	ISS-02-08-HP.4002: ATCO workload might increase . It is not clear that the automation of ROT and exit estimation task will balance the assessment of tool output and possibly workload increase when communicating with Flight Crews.
	ISS-02-08-HP.4003: ATCOs might trust the tool too much and follow it's indications even in the case they are clearly not feasible for the arriving A/C.
	ISS-02-08-HP.4004: ATCOs situational awareness affected by the introduction of the system prediction: ATCO needs to critically assimilate additional HMI information, the mental process regarding final approach separation planning might be affected.
HP2 Suitability of technical system in supporting the tasks of human actors	**BEN-02-08-HP.4005**: ATCOs responsibility of continuous estimation of the expected ROT and expected exit of arriving a/c to provide clearances is enhanced with system provided informati on on expected ROT and expected exit as it is automated to some extent.
	ISS-02-08-HP.4006: In specific weather conditions the system provided information might be contradictory to ATCO own assessment.
	ISS-02-08-HP.4007: Concept 4 provides static information. ATCOs perception of this estimate of expected ROT and expected exit as out of date near the threshold might effectively negating HP benefits and make the tool unacceptable
HP3 Adequacy of team structure and team communication in supporting the human actors	**N/A**
HP4 Feasibility with regard to HP-related transition factors	**ISS-02-08-HP.4009:** ATCOs mental capability of estimation of the ROT and RWY exit based on combination of training, experience and a/c behaviour and weather conditions might be impaired with long exposure to the information provided by the tool
	ISS-02-08-HP.4010: Relying on automated ROT and exit assessment might reduce job satisfaction and decrease performance in long term..
	ISS-02-08-HP.4011: ATCOs need additional training on system output limitations in order to adequately categorize and utilize the information provided

4.16.4.6 Additional Comments and Notes

No additional comments.

4.17 Other PIs

N/A

4.18 Gap Analysis

4.18.1 Gap Analysis (Concept 1)

The results of the validation exercises differ from the expected Validation Targets as defined in [18].

The following table summarizes the gap between the expectations and the results obtained, providing explanation and remarks based on the V3 validation exercises experience:

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[20]	Rationale[21]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	3.87	Expected benefit is not high as the validation target. This is due to the fact that the validation target figure is related to the overall contribution of Solution in terms of FEFF1 while the results provided in the previous column is only related to the contribution of TS-0301
CAP1: TMA Airspace Capacity – TMA	3.599%	Not measured	KPI not measured. Solution is not

[20] Negative impacts are indicated in red.

[21] Discuss the outcome if, and only if, the gap indicates a different understanding of the contribution of the Solution (for example, the Solution is enabling other Solutions and therefore is not contributing a direct benefit).

throughput, in challenging airspace, per unit time.			expected to bring benefits in TMA capacity. Validation Target to be corrected.
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	5.1% and 90 flights/hour (*LFV-COOPANS RTS with Stockholm-Arlanda Airport operating on independent parallel runways*) 0.2% (*ENAV FTS with Rome Fiumicino Airport operating on dependent runways*)	Results derived from LFV-COOPANS RTS show an improvement higher than the validation target whereas results derived from ENAV FTS show an improvement slightly lower than the validation target. The influence of the specific environment needs to be taken into account. Overall, the Solution provides a higher improvement than the validation target.
PRD1: Predictability – Variance of Difference in actual & Flight Plan or RBT durations	5.034%	3.139%	Expected benefit is not as high as the validation target. This is due to the fact that the validation target figure is related to the overall contribution of Solution in terms of PRED1 while the results provided in the previous column is only related to the contribution of TS-0301
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	1.81%	Although, no benefits are expected in terms of punctuality, the solution demonstrated that the implementation of Concept 1 brings benefit in punctuality

			too
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	0.000%	Not measured	KPI not measured. Solution is not expected to bring benefits in Cost Efficiency. Validation Target to be corrected.

Table 46: Gap analysis Summary for Solution 02-08 Concept 1

4.18.2 Gap Analysis (Concept 2)

The results of the validation exercises differ from the expected Validation Targets as defined in [18].

The following table summarizes the gap between the expectations and the results obtained, providing explanation and remarks based on the V3 validation exercises experience:

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[22]	Rationale[23]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	1.04	Expected benefit is not as high as the validation target. This is due to the fact that the validation target figure is related to the overall contribution of Solution in terms of FEFF1 while the results provided in the previous column is only related to the contribution of TS-

[22] Negative impacts are indicated in red.

[23] Discuss the outcome if, and only if, the gap indicates a different understanding of the contribution of the Solution (for example, the Solution is enabling other Solutions and therefore is not contributing a direct benefit).

Founding Members

			0301
CAP1: TMA Airspace Capacity – TMA throughput, in challenging airspace, per unit time.	3.599%	Not measured	KPI not measured. Solution is not expected to bring benefits in TMA capacity. Validation Target to be corrected.
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	Not measured	KPI not measured. Concept 2 is not expected to bring benefits in Airport capacity.
PRD1: Predictability – Variance of Difference in actual & Flight Plan or RBT durations	5.034%	-0.43%	Expectations demonstrated in the validation exercise is opposite to the validation target: the predictability decreases. Refer to section 4.9.2 for explanation.
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	0.86%	Although, no benefits are expected in terms of punctuality, the solution demonstrated that the implementation of Concept 2 brings benefit in punctuality too
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	0.000%	Not measured	KPI not measured. Solution is not expected to bring benefits in Cost Efficiency. Validation Target to be corrected.

Table 47: Gap analysis Summary for Solution 02-08 Concept 2

4.18.3 Gap Analysis (Concept 3)

The results of the validation exercises differ from the expected Validation Targets as defined in [18].

The following table summarizes the gap between the expectations and the results obtained, providing explanation and remarks based on the V3 validation exercises experience:

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[24]	Rationale[25]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	Not measured	Concept 3 does not impact Fuel Efficiency
CAP1: TMA Airspace Capacity – TMA throughput, in challenging airspace, per unit time.	3.599%	Not measured	KPI not measured. Solution is not expected to bring benefits in TMA capacity. Validation Target to be corrected.
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	Not measured	The average Peak Runway Throughput (Segregated mode) is on average of **7.5%** on airport where the concept can be applied (meaning where separation are not constrained by other factors than ROT or where the separations are not already at the minima allowed by ROT). This is the case for : Brussels/Brussels-National Frankfurt-Main

[24] Negative impacts are indicated in red.

[25] Discuss the outcome if, and only if, the gap indicates a different understanding of the contribution of the Solution (for example, the Solution is enabling other Solutions and therefore is not contributing a direct benefit).

			London Heathrow Amsterdam-Schiphol Kobenhavn-Kastrup Stockholm-Arlanda Barcelona Madrid Palma de Mallorca Paris Charles de Gaulle Athens Vienna Zurich Istanbul-Ataturk
PRD1: Predictability – Variance of Difference in actual & Flight Plan or RBT durations	5.034%	Not measured	Concept 3 does not impact Predictability
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	Not measured	Concept 3 does not impact Punctuality
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	0.000%	Not measured	KPI not measured. Solution is not expected to bring benefits in Cost Efficiency. Validation Target to be corrected.

Table 48: Gap analysis Summary for Solution 02-08 Concept 3

4.18.4 Gap Analysis (Concept 4)

The results of the validation exercises differ from the expected Validation Targets as defined in [18].

The following table summarizes the gap between the expectations and the results obtained, providing explanation and remarks based on the V3 validation exercises experience:

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[26]	Rationale[27]
FEFF1: Fuel Efficiency – Fuel burn per flight	8.5	Not measured	Concept 4 does not impact Fuel Efficiency
CAP1: TMA Airspace Capacity – TMA throughput, in challenging airspace, per unit time.	3.599%	Not measured	KPI not measured. Solution is not expected to bring benefits in TMA capacity. Validation Target to be corrected.
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	1.341%	1,86%	For approach separations less than 5 NM. KPI achieved locally for V3 FTS, for V3 RTS the error of measurement exceeds the KPI.
PRD1: Predictability – Variance of Difference in actual & Flight Plan or RBT durations	5.034%	Not measured	Concept 4 does not impact Predictability
PUN1: Punctuality – % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	0.000%	Not measured	Concept 4 does not impact Punctuality
CEF2: ATCO Productivity – Flights	0.000%	Not measured	KPI not measured.

[26] Negative impacts are indicated in red.

[27] Discuss the outcome if, and only if, the gap indicates a different understanding of the contribution of the Solution (for example, the Solution is enabling other Solutions and therefore is not contributing a direct benefit).

per ATCO -Hour on duty			Solution is not expected to bring benefits in Cost Efficiency. Validation Target to be corrected.

Table 49: Gap analysis Summary for Solution 02-08 Concept 4

5 References

This PAR complies with the requirements set out in the following documents:

[1] 08.01.03 D47: AIRM v4.1.0

[2] B05 Performance Assessment Methodology for Step 1

[3] PJ19.04 D4.4 Performance Framework (2018), Edition 01.00.00, August 2018

[4] B.05 Guidance for Performance Assessment Cycle 2013

[5] B.05 D72, Updated Performance Assessment in 2016

https://stellar.sesarju.eu/servlet/dl/ShowDocumentContent?doc_id=1669873.13&att=attachment&statEvent=Download

[6] B05 Data Collection and Repository Cycle 2015

[7] Methodology for the Performance Planning and Master Plan Maintenance (edition 0.13)

https://stellar.sesarju.eu/servlet/dl/ShowDocumentContent?doc_id=4731333.13&att=attachment&statEvent=Download

Content Integration

[8] B.04.01 D138 EATMA Guidance Material

[9] EATMA Community pages

[10]SESAR ATM Lexicon

Content Development

[11]PJ19.02.02 D2.1 SESAR 2020 Concept of Operations Edition 2017, Edition 01.00.00, November 2017

System and Service Development

[12]08.01.01 D52: SWIM Foundation v2

[13]08.01.01 D49: SWIM Compliance Criteria

[14]08.03.10 D45: ISRM Foundation v00.08.00

[15]B.04.03 D102 SESAR Working Method on Services

[16]B.04.03 D128 ADD SESAR1

[17]B.04.05 Common Service Foundation Method

Performance Management

[18]PJ19.04.01 D4.5 Validation Targets (2019), Edition 00.01.00, February 2019

https://stellar.sesarju.eu/servlet/dl/ShowDocumentContent?doc_id=12041622.13&att=attachment&statEvent=Download16.06.06-D68 Part 1 –SESAR Cost Benefit Analysis – Integrated Model

[19]16.06.06-D51-SESAR_1 Business Case Consolidated_Deliverable-00.01.00 and CBA

[20]Method to assess cost of European ATM improvements and technologies, EUROCONTROL (2014)

[21]ATM Cost Breakdown Structure_ed02_2014

[22]Standard Inputs for EUROCONTROL Cost Benefit Analyses

[23]16.06.06_D26-08 ATM CBA Quality Checklist

[24]16.06.06_D26_04_Guidelines_for_Producing_Benefit_and_Impact_Mechanisms

Validation

[25]03.00 D16 WP3 Engineering methodology

[26]Transition VALS SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects

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

System Engineering

[28]SESAR Requirements and V&V guidelines

Safety

[29]SESAR, Safety Reference Material, Edition 4.0, April 2016

https://stellar.sesarju.eu/jsp/project/qproject.jsp?objId=1795089.13&resetHistory=true&statInfo=Ogp&domainName=saas

[30]SESAR, Guidance to Apply the Safety Reference Material, Edition 3.0, April 2016

https://stellar.sesarju.eu/jsp/project/qproject.jsp?objId=1795102.13&resetHistory=true&statInfo=Ogp&domainName=saas

[31]SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015

[32]Accident Incident Models – AIM, release 2017

https://stellar.sesarju.eu/servlet/dl/ShowDocumentContent?doc_id=3658775.13&att=attachment&statEvent=Download

Human Performance

[33]16.06.05 D 27 HP Reference Material D27

[34]16.04.02 D04 e-HP Repository - Release note

Environment Assessment

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

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

Security

[37]16.06.02 D103 SESAR Security Ref Material Level

[38]16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[39]16.06.02 D131 Security Database Application (CTRL_S)

5.1 Reference Documents

The following documents were used to provide input / guidance / further information / other:

[40]ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[28]

[41]SESAR 2020 – Solution 02-08 OSED SPR INTEROP for V2 Part V Performance Assessment Report, D6.1.10, edition 00.01.01, 12 October 2018

[42]SESAR Solution 02-08 Validation Plan (VALP) for V3, D6.1.22, 4 March 2019

[43]SESAR 2020 – Solution 02-08 OSED SPR INTEROP for V3 Part I, D1.202

[44]SESAR 2020 – Solution 02-08 OSED SPR INTEROP for V3 Part IV Human Performance Assessment Report (HPAR), D1.202

[45]SESAR 2020 Solution 02-08 OSED SPR INTEROP for V2 Part III Security Assessment Report (SeAR), D6.1.103

[46]SESAR 2020 TS IRS – PJ02-08 for V3/TRL6, D6.1.214

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Appendix A Detailed Description and Issues of the OI Steps

OI Step ID	Title	Consistency with latest Dataset
TS-0301	Integrated Arrival Departure Management for Full Traffic Optimisation on the Runway	DS20
TS-0313	Optimized Use of Runway Capacity for Multiple Runway Airports	DS20
AO-0337	Increased Runway Throughput based on local ROT characterization (ROCAT)	DS20
AO-0338	Runway Throughput based on AROT optimisation	DS20

Table 50: OI Steps allocated to the Solution and addressed by this document

Please note that AUO-0704 from Dataset DS18a has been split into 2 different OI Steps in DS20:

- AO-0337 (linked to enabler AERODROME-ATC-55: Airport ATC analyser tool for predicting ROT)
- AO-0338 (linked to enabler AERODROME-ATC-55a Airport ATC analyser tool for predicting ROT and AERODROME-ATC-32: Runway condition awareness management system based on weather-based runway condition model)