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SESAR Solution 02-08 SPR-INTEROP/OSED for V3 - Part I

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Authoring & Approval

Authors of the document

Name/Beneficiary	Position/Title	Date
MENDOZA, Montserrat / SKYGUIDE	V3 OSED Task Leader	07.11.2019
ELLEJMI, Mohamed / EUROCONTROL	PJ02-08 Member	07.11.2019
KOPEC Jacek / UNIWARSAW-PANSA (B4)	PJ02-08 Member	07.11.2019
SOKOLOWSKI, Mateusz / PANSA	PJ02-08 Member	07.11.2019
WALL, Ake / LFV-COOPANS	PJ02-08 Member	07.11.2019

Reviewers internal to the project

Name/Beneficiary	Position/Title	Date
CHALON MORGAN, Catherine / EUROCONTROL	PJ02-08 Member	22.07.2019
CHOUVET, Didier / THALES AIR SYS	PJ02-08 Member	22.07.2019
COSTA CONDE, Sarai / INDRA	PJ02-08 Member	22.07.2019
FUENTES DE FRUTOS, Pablo / INDRA	PJ02-08 Member	22.07.2019
JOHNSEN, Svein G. / SINTEF	V3 TS Task Leader	22.07.2019
KJENSTAD, Dag / SINTEF	PJ02-08 Member	22.07.2019
KETTNER, Mattes / ZRH-SEAC2020	PJ02-08 Member	22.07.2019
MANGO, Gennaro / LEONARDO	PJ02-08 Member	22.07.2019
PERROTTA, Luigi / NAIS-ENAV	PJ02-08 Member	22.07.2019
ROOS, Jan-Olof / LFV-COOPANS	Solution Leader	22.07.2019
RYDELL, Sofia / LFV-COOPANS	V3 VALP & VALR Task Leader	22.07.2019
VELJANOVSKI, Nikola / LFV-COOPANS	PJ02-08 Member	22.07.2019

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	26.07.2019
COSTA CONDE, Sarai / INDRA	INDRA PJ02.08 POC	26.07.2019
ELLEJMI, Mohamed /	EUROCONTROL PJ02.08 POC	26.07.2019

EUROCONTROL		
KETTNER, Mattes / SEAC	SEAC PJ02.08 POC	26.07.2019
KJENSTAD, Dag / SINTEF	SINTEF PJ02.08 POC	26.07.2019
MANGO, Gennaro / LEONARDO	LEONARDO PJ02.08 POC	26.07.2019
MENDOZA NAVAS, Montserrat / SKYGUIDE	SKYGUIDE PJ02.08 POC	26.07.2019
PERROTTA, Luigi / NAIS-ENAV	ENAV PJ02.08 POC	26.07.2019
ROOS, Jan-Olof / LFV-COOPANS	LFV-COOPANS PJ02.08 POC	26.07.2019
NIEWINSKI, Jaroslaw / PANSA	PANSA PJ02.08 POC	26.07.2019
TREVE, Vincent / EUROCONTROL	EUROCONTROL PJ02 PROJECT MANAGER	26.07.2019

Rejected By - Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date

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Copyright Statement

EARTH

TRAFFIC OPTIMISATION ON SINGLE AND MULTIPLE RUNWAY AIRPORTS

This OSED 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 first part of the concept 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 APP Controllers, Tower Controllers and Supervisors in monitoring and optimising runway usage.

The other parts of the concept, which are provided in separate documents, are:

- Part II: Safety Assessment Report (SAR);
- Part III: Security Assessment Report (SeAR). *Note that this Part will not be produced but security requirements will be addressed in Part I;*
- Part IV: HP Assessment Report (HPAR);
- Part V: Performance Assessment Report (PAR).

The document contains the (V3) Operational Services and Environment Definition (OSED), the System Performance (SPR) and Interoperability (INTEROP) Requirements related to the different concepts that solution 02-08 encompasses:

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

- **Concept 2:** Optimised use of RWY capacity for multiple runway airports with the combined use of an Integrated Runway Sequence and RMAN (TS-0313)

- **Concept 3:** Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337).

- **Concept 4:** Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338).

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1 Executive Summary

This document contains the (V3) Operational Services and Environment Definition (OSED), the System **Performance (SPR) and Interoperability (INTEROP) Requirements related to the Traffic optimisation on** single and multiple runway airports concept.

It describes a solution concept that aims at improving single and multiple runway airport operations by:

- increasing the predictability and punctuality 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),
- Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337) and Increased Runway Throughput based AROT optimisation (AO-0338).

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 applies mainly to execution phase and addresses mainly TWR and TMA ATCOs.
- **Concept 2:** Optimised use of RWY capacity for multiple runway airports with the combined use of an Integrated Runway Sequence and RMAN (TS-0313).
- **Concept 3:** Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337).
- **Concept 4:** Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338).

This V3 document covers the following Operational Improvements and Enablers:

- TS-0301: Integrated Arrival Departure Management for full traffic optimisation
    - AERODROME-ATC-33: Coupled sequencing tool enhanced to better handle arrivals and departures.
    - AERODROME-ATC-58: Agile synchronisation of arrivals with departure information for the same airport.
    - APP-ATC-164: APP ATC System adapted to support integrated arrival/departure sequence functionalities in ATCO's HMI.
- TS-0313: Optimized use of runway capacity for multiple runway airports.

- APP-ATC-164: APP ATC System adapted to support integrated arrival/departure sequence functionalities in ATCO's HMI.
    - AERODROME-ATC-74: Airport Demand and Capacity system enhanced for multiple runway airport.
- AO-0337: Increased Runway Throughput based on local ROT characterization (ROCAT)
    - AERODROME-ATC-55: Airport ATC analyser tool for predicting ROT.
- AO-0338: Use of Enhanced Runway Occupancy Time (ROT) for medium airports
    - AERODROME-ATC-32: Runway condition awareness management system based on weather-based runway condition model.
    - AERODROME-ATC-55a: Airport ATC analyser tool for optimising AROT.

2 Introduction

2.1 Purpose of the document

This document provides the requirements specification, covering functional, non-functional and interface requirementsrelated to SESAR Solution 02-08.

The SESAR Solution Development Life Cycle aims to structure and perform the work at project level and progressively increase SESAR Solution maturity, with the final objective of delivering a SESAR Solution datapack for industrialisation and deployment. The SPR-INTEROP/OSED represents one of the key parts of this SESAR Solution datapack.

The SPR-INTEROP/OSED Template is composed of five different parts:

Part I (this document) provides the Safety and Performance Requirements (SPR) and Interoperability Requirements (INTEROP), related to a SESAR Solution, that have been validated during validation activities at a V3 level. They are presented in the context of the Operational Service and Environment Definition (OSED) which describes the environment, assumptions, etc. that are applicable to the SPR and INTEROP requirements.

These requirements will cover safety, performance, operational aspects as well as the interoperability aspects (related to a specific technology to support the SESAR Solution).

The document is completed by appendixes, including: The Benefit and cost Mechanisms, showing how the SESAR Solution elements contribute (positively or negatively) to the delivery of performance benefits and the costs.

Parts II to V provide the series of assessments performed at SESAR Solution level that justify the SPR and INTEROP requirements:

- Part II: The Safety Assessment Report describes the results of the safety assessment work for the SESAR Solution. Due to regulatory obligations, it should be expected that a Safety Assessment is required for any proposed change to the system, although the depth of such an assessment will depend on the nature of the change.
- Part III: The Security Assessment Report describes the results of the security assessment work for the SESAR Solution. Please note that for confidentiality reasons it has been decided not to produce or distribute the Security Assessment Report for V3 but security requirements are included in the TS.
- Part IV: The Human Performance Assessment Report describes the results of the Human Performance assessment work for the SESAR Solution.
- Part V: The Performance Assessment Report (PAR) that consolidates the performance results obtained in different validation activities at SESAR Solution level.

2.2 Scope

This is the SPR-INTEROP/OSED for Solution 02-08 for V3 phase, once verification activities and validation exercises have been performed and their validation results analysed and consolidated in the V3 Validation Report ([52]).

A main assumption for the V3 validation has been that an Integrated Runway Sequence (TS-0301) is expected to bring benefits in RWY capacity, predictability & punctuality, and fuel efficiency and that its combination with RMAN (TS-0313) can provide additional benefits in terms of predictability & punctuality and fuel efficiency. The Enhanced Prediction of Runway Occupancy Time (ROT) addressed by AO-0337 and AO-0338 is expected to bring benefits in RWY capacity.

The requirements contained in this document cover safety, performance, operational aspects as well as the interoperability aspects related to a specific technology to support the SESAR Solution 02-08 and the following Operational Improvements and Enablers:

OI Step Code	OI Step title	Enabler	Required / Optional	V3 coverage
TS-0301	Integrated Arrival Departure Management for Full Traffic Optimisation on the Runway	AERODROME-ATC-33	Required	YES
		AERODROME-ATC-58	Required	YES
		APP-ATC-164	Required	YES
		AERODROME-ATC-09c, AERODROME-ATC-27, AERODROME-ATC-34	Optional	NO
TS-0313	Optimized Use of Runway Capacity for Multiple Runway Airports	AERODROME-ATC-74	Required	YES
		APP-ATC-164	Required	YES
		AERODROME-ATC-29, METEO-03c, METEO-04c	Optional	NO
AO-0337	Increased Runway Throughput based on local ROT characterization (ROCAT)	AERODROME-ATC-55	Required	YES
		APP-ATC-169	Required	YES
AO-0338	Runway Throughput based on AROT optimisation	AERODROME-ATC-32	Optional	NO
		AERODROME-ATC-55a	Required	YES

Table 1: Solution #02-08 OIs and Enablers

The coverage of the remaining required OIs and EN will be analysed in the next maturity phase.

2.3 Intended readership

This document is intended for the following audience (but no external review has been performed) :

- SESAR 2020 Projects/Solutions:
  - PJ01-01 (Enhanced Arrivals and Departures): Extended arrival management with overlapping AMAN operations and interaction with DCB.
  - PJ01-02 (Enhanced Arrivals and Departures): Use of arrival and departure management information for traffic optimisation in the TMA.
  - PJ02-01, Optimised Runway Delivery on Final Approach, AO-328.
  - PJ02-03 develops the concept of Minimum Pair Separations Based on Required Surveillance Performance (RSP) in support of a reduction of the in-trail Minimum Radar Separation (MRS) from 2.5 NM to 2 NM on final approach.
  - PJ.03b-06 which develops runway condition continuous monitoring and prediction tools.
  - PJ04 (Total Airport Management): Improved prediction and quality of estimated take-off and landing time for Airport DCB.
  - PJ09 (Advanced DCB): Improved prediction and quality of estimated take-off and landing time for Network management.
  - PJ16 (Controller Working Position / Human Machine Interface): HMI integration aspects.
  - PJ18 (4D Trajectory Management): Improved prediction and quality of estimated take-off times for trajectory management processes.
  - PJ20 (Master Plan Maintenance).
  - PJ22 Validation and Demonstration Engineering.
  - PJ19: Content Integration
  - PJ02-01 (Wake Turbulence Separation Minima): Use of the prediction algorithm of ROT for the separation delivery tool. A combined V3 validation will be performed. Reduced separations used by WDS in arrivals and departures can modify the sequence provided by the Integrated Runway Sequence function,
- The validation exercises associated to this phase of the project.
- In general, the SESAR JU community.

2.4 Background

This document has been based on the work performed in SESAR 1. The concepts have been further developed in the frame of the PJ02-08 with a special focus on the topics that did not provide the expected results during SESAR 1. In addition, the results of V2 phase for Concept1 and Concept 2 have been integrated to refine the definition.

2.4.1 Concept 1 background

In SESAR1, two ways of coupling arrival and departure flows were submitted to validation in the frame of the project 06.08.04 (OFA 04.01.01), compared with a reference scenario that was the use of non-coupled standalone AMAN and standalone DMAN:

- Step 1 (solution #54): pattern-based coupling, with AMAN as a master of the sequence. This solution reached the V3 maturity level during SESAR 1;
- Step 2: dynamic coupling to achieve a trajectory based integrated runway sequence. This solution did not reach V3 maturity as the validations did not show the expected results in terms of predictability and capacity enhancement because of problems of sequence stability during validation.

As documented in 06.08.04 Step 2 final OSED (refer to [43]), the assumption of SESAR 1 was that Step1 was not a baseline scenario for Step 2. This assumption has been kept in SESAR 2020.

As a result, regarding the integration of arrival and departure traffic, the document reuses the work done by project 06.08.04 Step 2. This document also reuses the results of the V2 phase of PJ02-08 which was focused on reaching sequence stability and operational usability and making sure that the system fixes the sequence as soon as it is clear that no overtaking can take place. The V3 phase has focused on the demonstration of performance benefits of the Integrated Runway Sequence in all operational situations.

2.4.2 Concept 2 background

Regarding the optimisation of RWY capacity for multiple runway airports, the document takes into account the work done by the project 06.05.03 (OFA 05.01.01). The focus is on the interdependencies between Airport DCB management (RMAN) and Integrated Runway Sequence that were not fully validated during SESAR 1. It is assumed that the use of RMAN reached the V3 maturity during SESAR1 (refer to [45], [46] and [47]). Therefore, solution 02-08 is not re-assessing the use of RMAN, but the combined use of RMAN and an Integrated Runway Sequence.

This background information has been completed with the results from V3 validation exercises that have been performed in the frame of PJ02-08.

2.4.3 Concept 3 background

Several ways could be envisaged to manage the ROT spacing. As stated by 06.08.01 D-PWS-OSED [50], the ROT prediction information could be given in one of the following ways:

- Level 1: Static model defining ROT, eventually based on aircraft type/category
- Level 2: Dynamic model using additional variables (i.e. operator, runway condition, local weather conditions etc.). This model is locally calibrated and subsequently may evolve as data is collected
- Level 3: Uses downlinked ROT from the aircraft (Enhanced Braking System (EBS) concept)

The Level 3 concept, (AUO-0703 – Optimised enhanced braking information at a pre-selected runway exit coordinated with Ground ATC by Datalink), was studied within OFA 01.03.01 (Enhanced Runway Throughput). The study developed downlinked ROT from the aircraft via Enhanced Braking System (EBS) concept.

Concept 3 regards AO-0337, i.e. Increased Runway Throughput based on local ROT characterization (ROCAT), that is based on static models to improve prediction of the arrival runway occupancy time.

Other linked initiatives are considering or need precise Runway Occupancy Time characterization:

- PJ02-01, Optimised Runway Delivery on Final Approach, AO-328, considers ROT prediction, in order to compute a Target Distance indicator showing what is the ROT spacing needs. The Target distance indicator is showed to controllers when the ROT spacing prevails over wake separation and MRS.
- PJ02-03 develops the concept of Minimum Pair Separations Based on Required Surveillance Performance (RSP) in support of a reduction of the in-trail Minimum Radar Separation (MRS) from 2.5 NM to 2 NM on final approach. In this context, runway occupancy time (ROT) data analysis allows MRS reduction in final approach phase of flight.

2.4.4 Concept 4 background

AO-0338 addresses dynamic models to improve prediction of the arrival runway occupancy time.

Concept 4 addresses AO-0338 and the optimisation of runway capacity using machine learning enhanced ROT.

Other initiatives that lead to improvement of data for dynamic modelling:

- PJ.03b-06 which develops runway condition continuous monitoring and prediction tools. The results of calculations can be taken into account together with local weather data and other in order to feed the dynamic ROT model.

2.5 Structure of the document

The structure of this OSED is as follows:

- **Chapter 1** presents the document in summary;
- **Chapter 2** (the present section) provides general information on the document. It details the scope.
- **Chapter 3** contains the OSED essential information:
  - **Section 3.1:** provides a summarized description of the solution and the traceability to the relevant OIs and CONOPS High Level Requirements;
  - **Section 3.2:** defines the operational environment in which the future concept is presented. (main operational characteristics, actors and constraints);
  - **Section 3.3:** describes the current and the new operating methods and provides an analysis of the differences between those operating methods;
  - **Section 3.4**: details the Use Cases describing the concept;
- **Chapter 4** provides the Safety, Performance and Interoperability Requirements (SPR-INTEROP).
- **Chapter 5** lists the used references and applicable documents.
- **Appendix A** includes the Cost and Benefits Mechanisms.

Each section is split into sub-sections corresponding to the four concepts of the Solution. As Concept 1 and Concept 2 are strongly related (Concept 1 is a pre-requirement for Concept 2) and Concept 3 and Concept 4 are also related (both address AROT), some sections are split by pair of concepts and not by individual concept.

2.6 Glossary of terms

Term	Definition	Source of the definition
ALDT	Actual Landing Time is the actual date and time when the aircraft has landed (touch down).	[37]
AOBT	Actual Off-Block Time is the actual date and time the aircraft has vacated the parking position (pushed back or on its own power).	[37]
	the time interval between the aircraft crossing the threshold and its tail vacating the runway.	EUROCONTROL Enhancing Airside Capacity, the Complete Guide [39]
ASAT	Actual Start Up Approval Time is the time that an aircraft receives its start-up approval.	[37]
ATOT	Actual Take off Time is the time that an aircraft takes off from the runway (Equivalent to ATC ATD–Actual Time of Departure, ACARS = OFF).	[37]
COMPLEX TAXIWAY LAYOUT	Complex taxiway lay-outs are those where one or more of the following issues apply: • Ground movement traffic in opposing directions takes place on a regular basis • Crossing of active runways is required • Backtracking on the runway is required	[45]
CTOT	The Calculated Take Off Time (CTOT) is a time calculated and issued by the Central Flow Management unit, as a result of tactical slot allocation, at which a flight is expected to become airborne. (ICAO Doc 7030/4 – EUR, Table 7).	[37]
DBS	Refers to applying wake separations on final approach which are based on distances. This is how wake separations are applied in the majority of current operations.	OFA 01.03.01 Enhanced Runway Throughput Consolidated

		Final Step 1 OSED [48]
ELDT	Estimated Landing Time is the estimated time that an aircraft will touchdown on the runway. (Equivalent to ATC ETA – Estimated Time of Arrival = landing).	[37]
EOBT	The Estimated Off-Block Time (EOBT) is the estimated time at which the aircraft will start movement associated with departure (ICAO).	[37]
ETOT	Estimated Take-Off Time is the forecast of time when aircraft will become airborne taking into account the EOBT plus EXOT.	[37]
EXOT	The estimated taxi time between off-block and take off. This estimate includes any delay buffer time at the holding point or remote de-icing prior to take off.	[37]
In-trail aircraft pair	Refers to consecutive aircraft pairs that are landing on the same runway.	OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED [48]
Not-in-trail aircraft pair	Refers to consecutive aircraft pairs that are landing on different parallel runways.	OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED [48]
NOMINAL and ADVERSE WEATHER CONDITIONS	Characteristics for the nominal and adverse conditions which have a negative impact on operations at airports. They are provided in the following table:	ICAO Manual on A-SMGCS doc 9830

Weather constraint	Nominal conditions	Typical adverse Conditions	Comments
Visibility	More than 1,500 m	Less than 550 m	Visibility Condition 2
Cloud Base	> 1,500 ft	< 200 ft	
Wind Intensity and	Less than 15 kt	More	ICAO recommends

Direction		than: - 15 kt head - 30 kt head	a maximum tailwind of 5kts for runway.
Wind gusts	No gusting	Gusting	Cross wind gust characteristics impact on wake vortex restrictions
Freezing conditions	Above +3 deg C, no moisture	Below +3 deg C	
Precipitation	No precipitation, No standing water on runway	Heavy rain, standing water on runway	
Snow/slush	No snow or slush on runway	Snow or slush on runway	
Braking conditions	Good	Medium to poor	
Duration of weather events	Less than 15 minutes	15 minutes or more	
Thunderstorm / lightning	No occurrence	Within 5 km of airport or on arrival / departure paths	Within 5 km of airport may result in the temporary halt of aircraft handling (e.g. fuelling) at the aircraft stand. On arrival /

	departure path may result in runway changes or temporary halt of runway operations	
ORD	Refers to the Optimised Runway Delivery concept which intends to provide additional tool support to show the Controller the required spacing on the approach to take into account the effect of compression primarily caused by aircraft decelerating to land.	OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED [48]
Runway Occupancy Time	The amount of time that each aircraft occupies the runway.	[3]
Runway Throughput	The runway capacity (maximum throughput) can be defined as the hourly rate of aircraft operations that are expected to be accommodated by a single or combination of runways. It is generally dependent on the runway occupancy time, mix of aircraft using the runway, availability of taxiways, aircraft type/performance, spacing between parallel runways, intersecting point of runways, mode of operation (segregated or mixed), performance of the ATM systems, weather condition (visibility, wind strength and direction), and noise restriction	[38]
S-PWS	A wake separation concept where wake separations are optimised by defining them between aircraft type pairs rather than between wake categories.	OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED [48]
SOBT	Scheduled Off-Block Time is the time a flight is scheduled to depart from its parking position	[37]
TBS	Refers to the generic TBS concept that was developed in SESAR 1 Project P06.08.01 which included tool support to show the Controller the required separation.	OFA 01.03.01 Enhanced Runway Throughput

		Consolidated Final Step 1 OSED [48]
TLDT	The Target Landing Time is the targeted time from the Arrival management process at the threshold, taking runway sequence and constraints into account. It is not a constraint but a progressively refined planning time used to coordinate between arrival and departure management processes.	[37]
TOBT	The Target Off-Block Time is the time that an aircraft operator / handling agent estimates that an aircraft will be ready, all doors closed, boarding bridge removed, push back vehicle present, ready to start up / push back immediately upon reception of clearance from the TWR.	[37]
TSAT	The Target Start Up Approval Time is the time provided by ATC taking into account TOBT, CTOT and/or the traffic situation that an aircraft can expect to receive start-up / push back approval.	[37]
TTOT	The Target Take-Off Time is the time taking into account the Target Start Up Approval Time (TSAT) plus the Estimated Taxi-Out Time (EXOT).	[37]
VISIBILITY CONDITION 2	Visibility sufficient for the pilot to taxi and to avoid collision with other traffic on taxiways and at intersections by visual reference, but insufficient for personnel of control units to exercise control over all traffic on the basis of visual surveillance)	ICAO Manual on A-SMGCS doc 9830
WDS (arrivals)	There are two versions: WDS (total wind) and WDS (crosswind). WDS (total wind) aims to allow reduced Wake Turbulence (WT) separations based on the argument that WT is more rapidly decayed as the wind magnitude increases. WDS (crosswind) aims to allow the reduction of WT separations based on the argument that WT is transported out of the path of follower aircraft.	OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED [48]

Table 2: Glossary of terms

2.7 List of Acronyms

Acronym	Definition

A-CDM	Advanced Collaborative Decision Making
ALDT	Actual Landing Time
AMAN	Arrival Manager
AOP	Airport Operations Plan
AROT	Arrival Runway Occupancy Time
ASAT	Actual Start-up Approval Time
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATO	Actual Time Over
ATOT	Actual Take-Off Time
CBA	Cost Benefit Analysis
CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
CR	Change Request
CTA	Controlled Time of Arrival
CTOT	Calculated Take Off Time
CWP	Controller Working Position
DCB	Demand and Capacity Balancing
DMAN	Departure Manager
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
EFS	Electronic Flight Strip
ELDT	Estimated Landing Time
EOBT	Estimated Off-Block Time
ETO	Estimated Time Over
ETOT	Estimated Take-Off Time
EXOT	Estimated Taxi Time for departing aircraft
DPI	Departure Planning Information
FDP(S)	Flight Data Processing (System)
FLDT	Forecasted Landing Time

FOD	Foreign Object Debris
FTOT	Forecasted Take-Off Time
HMI	Human Machine Interface
HPAR	Human Performance Assessment Report
INTEROP	Interoperability Requirements
KPA	Key Performance Area
KPI	Key Performance Indicator
MF	Metering Fixes
OFA	Operational Focus Area
OI	Operational Improvement
OPAR	Operational Performance Assessment Report
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PIRM	Programme Information Reference Model
QoS	Quality of Service
RBT	Reference Business Trajectory
RMAN	Runway Manager
ROT	Runway Occupancy Time
RWY	Runway
SAC	Safety Criteria
SAR	Safety Assessment Report
SecAR	Security Assessment Report
SESAR	Single European Sky ATM Research Programme
SID	Standard Instrumental Departure
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
STAR	Standard Arrival
SWIM	System Wide Information Management
TBS	Time Based Separation
TLDT	Target Landing Time
TMA	Terminal Manoeuvring Area

TOBT	Target Off Block Time
TOD	Top Of Descend
TS	Technical Specification
TSAT	Target Start-up Approval Time
TTG	Time To Gain
TTL	Time To Lose
TTOT	Target Take-Off Time
TWR	Tower
VTT	Variable Taxi Time
WDS	Weather Dependent Separation

Table 3: List of acronyms

3 Operational Service and Environment Definition

3.1 SESAR Solution PJ02-08: a summary

The solution described in this document encompasses four different concepts (and OIs) that aim to optimize RWY operations by providing dynamic assistance to controllers and supervisors in TWR and TMA:

- **Concept 1:** Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence (TS-0301). This concept applies mainly to execution phase and addresses mainly TWR and TMA ATCOs.
- **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 applies mainly to planning phase, uses forecasted data of traffic demand, capacity constraints and target KPIs and addresses TWR Supervisor although considers inputs from execution phase.
- **Concept 3:** Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337).
- **Concept 4:** Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338).

The following tables provide the traceability of the solution to the relevant OIs and CONOPS High Level Requirements. Note that the Integrated Runway Sequence function is referred as to Advanced Coupled AMAN/DMAN in the high-level CONOPS requirement

OI Step code	OI Step title	OI Step coverage
TS-0301	Integrated Arrival Departure Management for Full Traffic Optimisation on the Runway	Fully
A full integration of arrival and departure management processes provides dynamic assistance to the Tower controllers to optimize runway throughput. Additionally to runway throughput optimization, making best use of variable taxi time, minimum separations and runway occupancy time could optimize arrival/departure spacing.		

OI Step code	OI Step title	OI Step coverage
TS-0313	Optimized Use of Runway Capacity for Multiple Runway Airports	Fully
The controller of a multiple runway airport is provided with decision support tools enhanced to allow runway capacity optimization from planning phase throughout the day of operations, improving predictability on airport operations.		

OI Step code	OI Step title	OI Step coverage
AO-0337	Increased Runway Throughput based on local ROT characterization (ROCAT)	Fully

The Minimum Radar Separation (MRS as defined in ICAO 4444 section 8.7.3) is reduced for low runway occupancy time medium aircraft. The analysis of historical ground radar data allows for characterization of ROT per aircraft type and per runway. Based on these results, the Medium aircraft can be grouped into 2 categories:

- one for aircraft with short ROT,

- one for aircraft with long ROT

A separation of either 2.0 NM (for aircraft presenting average ROT below 40s), 2.5 NM (for aircraft presenting average ROT below 50s) or 3.0 NM (for aircraft presenting average ROT above 50s) is associated to each ROT category.

Expected benefits is on capacity by increasing runway throughput (ranging between 5 and 10% increased throughput as a function of the proportion of Medium aircraft moved into the low-ROT categories allowing MRS reduction).

OI Step code	OI Step title	OI Step coverage
AO-0338	Increased Runway Throughput based on AROT optimisation	Fully

The tower runway controller of a medium single runway airport is provided with an additional information in CWP that consists of predicted ROT and recommended exit TWY allowing for optimisation in RWY use in peak hours.

Table 4: SESAR Solution PJ02-08 Scope and related OI steps

High Level CONOPS Requirement ID	High Level CONOPS Requirement	Reference to relevant CONOPS Sections e.g. Operational Scenario applicable to the SESAR Solution
S02-08-HLOR-01	The Advanced Coupled AMAN/DMAN shall: • Optimise runway throughput • increase predictability and improve strategic optimisation of runway arrival and departure demand • improve accuracy of TLDT, TTOT and TSAT by all or parts of: · providing improved landing and	B.3.3 Operational Scenario Execution Phase: Arrival: B.3.4 Operational Scenario Execution Phase: Surface in B.3.5 Operational Scenario Execution Phase: Surface out B. 3.6 Operational Scenario

	departure times integrated with routing functions · DCB tools for runways configuration in planning phase · improved ROT calculation capability · giving ATC more precise information about aircraft behaviour during first or last part of their flight · linking the capability to new Routing and Planning systems that compute a more dynamic taxi-out time through · pre-tactical use of the improved predictability · improved prediction of variable taxi times	Execution Phase: Departure B. 4.1 TMA Scenario 2: Strategic Medium Density/Complexity B.4.3 TMA Scenario 3a/3b: Pre-Tactical/Tactical High Density/Complexity

Table 5: Link to CONOPS

Note that the link with routing function and capabilities is not addressed by the Solution.

3.1.1 Concept 1: Optimised integration of arrival and departure flows with the use of a trajectory based Integrated Runway Sequence

The use of an Integrated Runway Sequence is expected to bring the following benefits, even if not necessarily all at the same time, each operational situation requiring a trade-off between different KPIs:

- Increase **RWY capacity**, by optimising the spacing between arrivals and departures in all situations in a dynamic way;
- Increase **predictability and punctuality** by making all ATS units follow a common plan based on an accurate integrated runway sequence;
- Increase **fuel efficiency** by reducing overall the flight duration (mostly reducing the need for holdings and the overall taxi-time as a result of following an accurate integrated runway sequence);

The figure 1 hereafter illustrates the processes and events linked to the management of the Integrated Runway Sequence. The time values are dependent on local environment, the presented values being provided as examples. There are a number of information layers Inserted into the image.

- **Arrival traffic information** is described above the timeline with Top of descent, Time to lose and Time to gain and finally the Target Landing Time.
- **Departure traffic information** is described below the timeline with push back (including start-up) and taxi out time to the runway (EXOT).

- **Business Trajectory** describing the progress of Scheduled and Reference Business Trajectory with final update by Airspace Users revised RBT.

One hour before estimated arrival/departure time, the Integrated Runway Sequence function provides an integrated runway sequence with setting of Target landing times and Target take-off times. In a certain stable time horizon before estimated arrival/departure time there will be a fine tuning of spacing values resulting in the update of Target landing times and Target take-off times. At this time, the sequence order is fixed in the integrated runway sequence.

Depending of retained options for deployment, these processes and events linked to the management of the Integrated Runway Sequence can be supported partly by AMAN and or DMAN. The integrated runway sequence is either built on its own or complements the arrival sequence built by AMAN and/or the departure sequence built by DMAN.

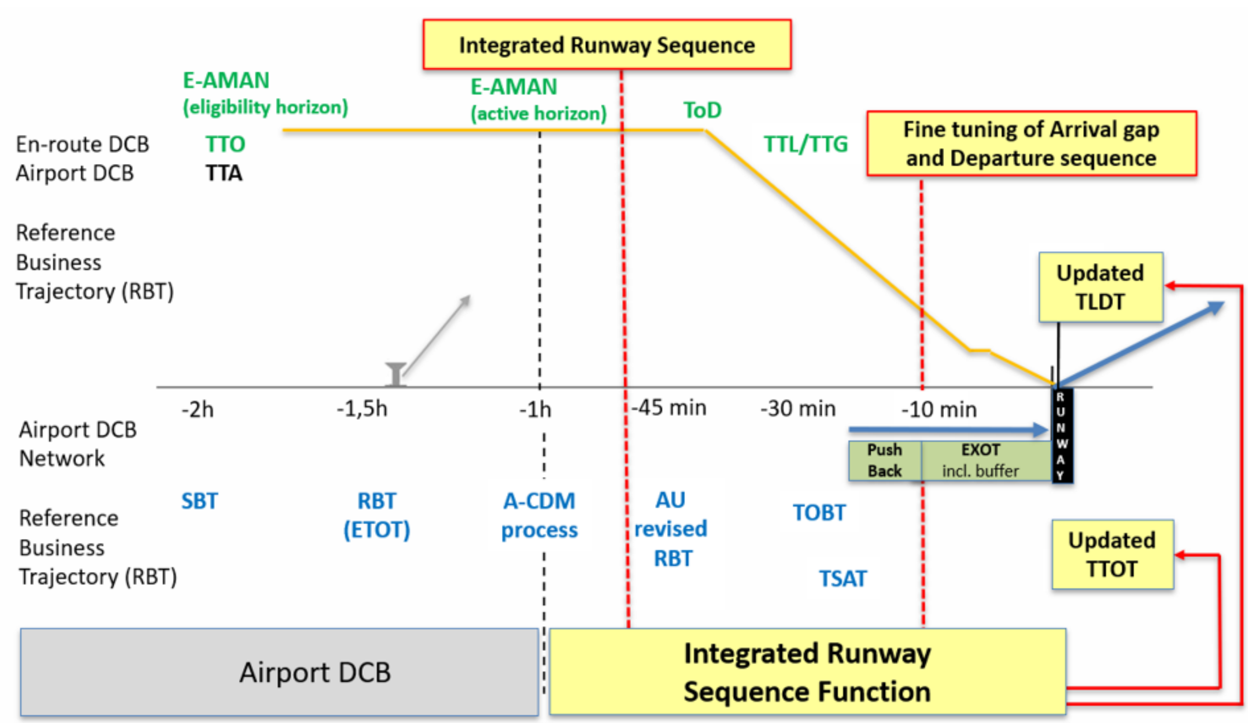


Figure 1: Integrated RWY Sequence

3.1.2 Concept 2: Optimised use of RWY capacity for multiple runway airports with the combined use of an Integrated Runway Sequence and RMAN

The combination of the integrated runway sequence with the use of an RMAN is expected to bring additional gains in **predictability and punctuality** and **fuel efficiency** compared to the use of Integrated Runway Sequence by suggesting an optimum runway configuration that feeds the building of an integrated sequence early in advance.

3.1.3 Relationship between Concept 1 and Concept 2

As Concept 2 is based on Concept 1, there is a need for consistency between the different elements of the two concepts. In terms of HMI, the display of the different output data and the integration of the different tools in the CWP should be consistent, usable and efficient to support team situation awareness.

The following table summarizes the link and differences between the different elements composing these two concepts:

Element	Time horizon	Input	Output	End User
Integrated Runway Sequence function	Execution phase (see Figures 2 and 3)	Arrivals and departures flight plan data (FDP). Pre-departure sequence and TOBT (A-CDM). Airborne trajectories ROT (static data) Separation minima criteria Airspace and airport layout data Optional inputs: -RMAN output (if available) - Taxi Time	Integrated runway sequence TSAT updates TTOT updates TLDT updates Spacing advisories	TWR and TMA ATCOs
RMAN	Planning phase (see Figures 2 and 3)	Demand: Arrivals and departures flight plan data (FDP) Weather information Statistical data (manual input) Runway and taxiway capacities (manual input) Separation minima criteria (manual input).	Demand-capacity imbalance warnings in terms of KPIs (delay, punctuality) Suggested Runway configuration and flight allocation to Runway	TWR Supervisor
RMAN	Execution phase (see Figures 2 and 3)	TLDT/TTOT from Integrated Runway Sequence for monitoring and adjustment of capacity for the following hours	Optimised runway configuration and flight allocation	TWR Supervisor

Table 6: Link and specificities of the Solution 02-08 Concept 1 and Concept 2

The figure 2 hereafter illustrates the different time horizons for the application of the Concept 1 and Concept 2 of the solution. The time values are dependent on local environment, the presented values being provided as examples.

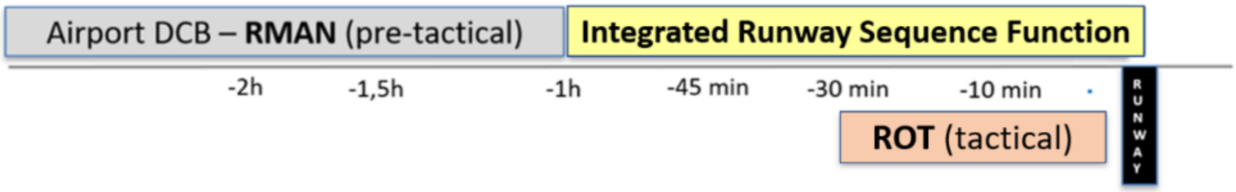


Figure 2: Time horizon application for the PJ02-08 solution Concept 1 and Concept 2

The figure 3 hereafter illustrates the relationship between Integrated RWY Sequence and RMAN. The time values are dependent on local environment, the presented values being provided as examples.

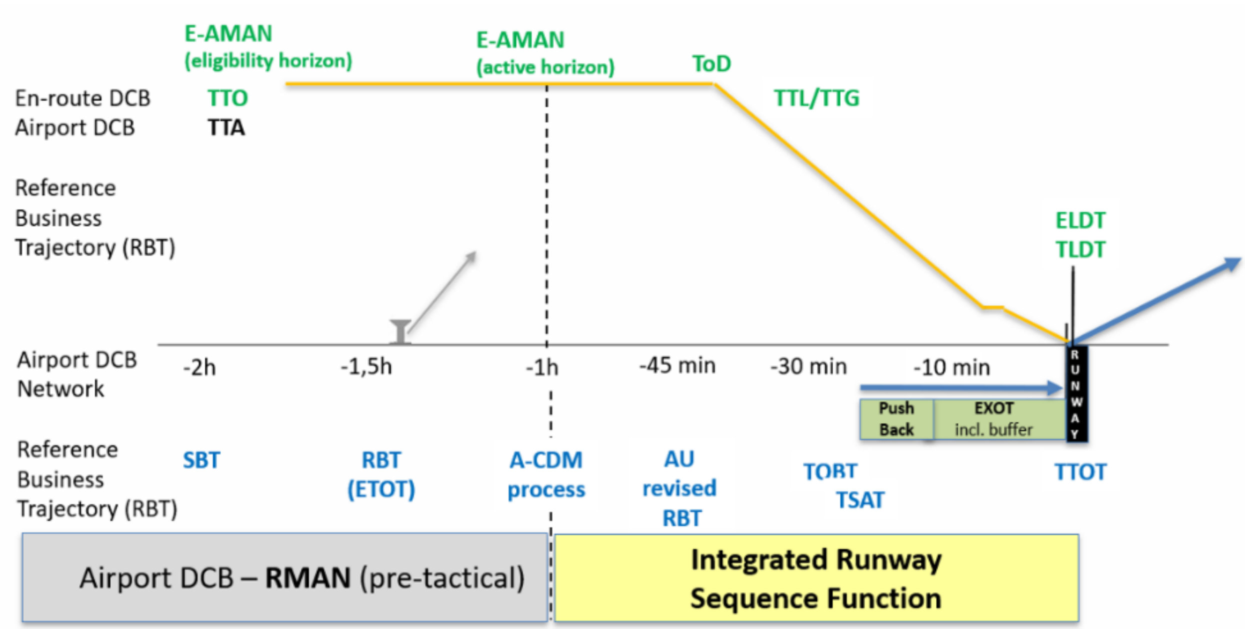


Figure 3: Integrated RWY Sequence and RMAN

3.1.4 Concept 3: Increased Runway Throughput based on local ROT characterization (ROCAT)

In this concept, enhanced Prediction of ROT aims to bring an improvement in terms of Runway Capacity. Runway Occupancy Time is one major factor limiting the runway capacity: currently the AROT constraint of the leader aircraft to be considered for the separation minimum of its follower is taken into consideration in the applicable MRS. Then, for aircraft pairs where the MRS is the highest separation constraint, runway occupancy is very likely to be the limiting factor for runway throughput. For those aircraft types, better characterisation of AROT may allow reducing the separation minima and thus the runway capacity.

Additionally, in the context of PJ02-01, developing an Optimised Separation delivery function, and concept to define wake separation minima based on Static aircraft characteristics (AO-306) and on weather (AO-310), better characterising the AROT would allow computing the minimum applicable separation per aircraft pair, considering the wind conditions accounting for wake constraint (if any), applicable MRS down to 2.0 NM and leader AROT. Better quantifying AROT to reduce separation on final approach

Two options could be used. Note that all of them could be combined with ICAO reduced runway separation rules describe in ICAO 4444 section 7.10.7, if applicable.

Option 1

According to ICAO, a reduced separation minimum of 2.5 NM may be applied provided the average runway occupancy time of landing aircraft is proven, by means such as data collection and statistical analysis and methods based on a theoretical model, not to exceed 50 seconds (See ICAO 4444 for other conditions to be provided).

Based on this principle, option 1 aims to quantify a target average ROT that allows to reduce the MRS value up to a certain value. This option is the one used in the EXE.02-08.V3.005 EUROCONTROL validation exercise.

This method could be applied to all traffic mix, to each Wake Turbulence Category of the Wake scheme in place (e.g. RECAT-EU or ICAO) or to aircraft category:

- ROT allowing MRS = 2.5 NM (ICAO, based on demonstration of average AROT not to exceed 50s)
- ROT allowing MRS = 2.0 NM (same principle of ICAO, instead based on demonstration of average AROT not to exceed 40s)
- ROT allowing aircraft-wise MRS specification: the applicable MRS is obtained per aircraft type based on its average ROT, measured locally in peak conditions, and multiplied by 180 kts capped down to 2.0 NM (See REF to TS or technical study for rationale and detailed methodology).

Option 2

A Second option is to define MRS based on comparison of ROT distribution characterization combined with time-to-fly distribution.

3.1.4.1.1 Notes and comments on AO-0337

The reduction of Minimum Radar Separation (MRS) is constrained by the following criteria: runway contamination, ATS surveillance system, visibility conditions and ROT. Provided that Meteo-related aspects and surveillance criteria are met, the reduction therefore can be based on ROT. In case not all aircraft types meet the criteria of 50s mean ROT, the reduction of separation minima could be only envisaged by splitting the Medium aircraft population in sub ROT categories.

The OI Step is particularly targeting airports where some Medium aircraft present average ROT above 50s, preventing the MRS separation to be reduced for the complete Medium category.

Besides, the OI step focuses on Medium aircraft only since:

- behind Heavy aircraft, the prevailing separation is based on wake standard,

- Light aircraft are, on one hand, rare on Large and Very large airports, and on the other hand, present high variability of ROT that prevents reliable ROT characterization.

Note that a third category (medium-ROT ; in addition to low-ROT and high-ROT) could be considered if the total number of categories including wake ones do not exceed 6 (considered as the maximum of categories manageable by ATCO without support tool). If the ATCO HMI allows for aircraft wise separation delivery, ROT/MRS separations can also be defined aircraft-wise.

3.1.4.1.2 Need for support tool

When it comes to ROT constraint, the need for a support function to deliver the spacing that considers the predicted ROT depends on how granular the ROT characterization is.

If the characterized ROT applies to all the traffic mix or applies to wake turbulence category, then no support function is required.

If the predicted ROT is characterized per aircraft type (so that the characterized ROT is different for aircrafts within the same (WTC), then a separation delivery support function, supporting Tower and Approach controllers in applying the appropriate ROT induced separation behind an arrival aircraft, is required.

The Separation delivery function support approach and tower runway controller by providing at least one static target distance indicator corresponding to the applicable MRS for the considered leader depending on its ROT. More advanced separation delivery function could be used (see section 3.2.3.2).

See section 3.2.3.2 for more details.

3.1.5 Concept 4: Optimised use of RWY capacity for medium airports with the enhanced prediction of Runway Occupancy Time (ROT)

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.

Enhanced Prediction of ROT is an interesting solution to increase runway capacity, especially in contexts where no additional runway or change of airport layout could be made for environmental, economic reasons etc.

Another characteristic of the automated runway occupancy time prediction is that it considers the runway layout for the calculations. This allows for optimizing of the runway exit suggestion for Tower Runway Controller. The suggestion when communicated to the Flight Crew together with the provision of the landing clearance serves to reduce the runway occupancy when properly executed.

This concept aims to increase capacity of medium airports in peak hours by allowing easier operations in reduced separation minima on final approach. Additional effect of the proposed working method may be the simplification of ATCO decision process when handling traffic in diverse conditions.

This concept addresses mostly medium aircraft although ROT prediction development, testing and validation include realistic mix of light traffic that is present on medium airports. However, it was found that light traffic ROT is very variable and usually significantly smaller than for medium traffic which causes ROT prediction for this class not to contribute significantly to optimization of RWY use. On the other hand, heavy traffic is mostly absent from medium airports and once heavy flight is present wake separation minima negate any impact of ROT-based solution.

3.1.5.1 AROT used in modified Tower Runway Controller CWP

In this scenario AROT is calculated individually for each flight considering present and predicted weather conditions as well as static aircraft characteristics. The Enhanced AROT Predictor also considers present ground situation as well as dynamic flight path characteristics to make Landing Information available for Tower Runway ATCO 5 min before expected touchdown for each flight. Landing Information consists of ROT calculation result accompanied by the exit taxiway suggestion which is displayed on a modified Tower Runway Controller CWP.

The exit taxiway suggestion is then communicated to the Flight Crew once close to handover from Approach and subsequently together with the landing clearance.

This kind of operations is expected to give benefit once the separation minima are low enough and the incoming traffic intensity is consistently high. This may only be expected during peak hours on medium airports. It is also possible to imagine using this concept on independent runways of larger airports. However, the concept has not been validated in this operational environment.

The concept is straightforward to implement. No additional regulation necessity is foreseen and only limited training need is expected. Also the modifications to the TWR CWP are limited and feasible using most presently available EFS tools.

3.1.6 Deviations with respect to the SESAR Solution(s) definition

All Change Requests issued had been endorsed in DS20 (refer to CR 03274 for the creation of AO-0337 and to CR 03275 for the creation of AO-0338, as a replacement of former AUO-0704)

OI Step Code	OI Step title	Deviation
AO-0337	Increased Runway Throughput based on local ROT characterization (ROCAT)	New OI Step. CR 03274 creates AO-0337 to replace AUO-0704
AO-0338	Increased Runway Throughput based on AROT optimisation	New OI Step. CR 03275 creates AO-0338 to complement former AUO-0704 New enabler to be created: AERODROME-ATC-55a
TS-0301	Integrated Arrival Departure Management for Full Traffic Optimisation on the Runway	N/A
TS-0313	Optimized Use of Runway Capacity for Multiple Runway Airports	N/A

Table 7: SESAR Solution PJ02-08 deviations

3.2 Detailed Operational Environment

3.2.1 Operational Characteristics

3.2.1.1 Operational Characteristics for Concept 1 and Concept 2

This section contains the detailed description of the Operational Environment addressed by Concept 1 and Concept 2 within this solution:

Operational interactions per context (NOV-2)	Operating Environment
[NOV-2] Integrated Arrival-Departure Sequence Management	Airport;

Comment
This section provides the main characteristics of the Operational Environment in terms of layout, complexity, traffic density and weather conditions to which the concept of Traffic Optimisation on single and multiple runway airports applies. The concept of Traffic Optimisation on single and multiple runway airports is applicable for all airport layouts that have dependencies between arrivals and departures. This includes runways operated in mixed mode as well as runway layouts with interdependencies between arrivals and departures. However the airport layout may bring constraints on the traffic flow management flexibility and then yield less coupling potential. The single runway in mixed mode is currently recognised to be the most constrained situation. Besides the number of runways and their geometry the connecting taxiway system determines the "basic" runway and ground movement operations. The Traffic Optimisation on single and multiple runway airports concept applies to complex as well as to non-complex taxiway layouts This new concept yields highest benefit in airports classified by SESAR1 06.02 as 'highly utilised with more than 90% utilisation during 3 or more peak periods a day', being most beneficial in phases when arrival and departure peaks overlap. Weather conditions will have an impact on the traffic optimisation. The concept described in this document is expected to provide benefits in all weather conditions.

Table 8: SESAR Solution PJ02-08 operational characteristics for Concept 1 and Concept 2

3.2.1.2 Operational Characteristics for Concept 3 and Concept 4

This section contains the detailed description of the Operational Environment addressed by Concept 3 and Concept 4 within this solution:

Operational interactions per context (NOV-2)	Operating Environment
[NOV-2] Advanced Runway Occupancy Time	Airport;

Comment
The Enhanced AROT Prediction is a concept aiming to optimise utilisation of runway via assisting ATCOs in choices regarding separation management and runway exits. This concept is most beneficial in case of airports characterised by presence of peak periods with more than 90% runway utilisation. There are two use variants considered for the concept: Medium Airports variant and Large+ Airports variant. The former is aimed at assisting Tower Controllers while the latter is the full toolset designed to assist Approach and Tower Controllers in maintaining optimal pairwise separation (especially important for environments with reduced MRS). In the current implementation the Medium Airport variant uses machine learning and evaluates each individual aircraft situation taking into account a range of factors including environment and other traffic. The Large+ Airports variant is a more comprehensive tool addressed to both Tower and Approach controllers. However, at this stage it uses static pairwise separation tables with some environmental factor modifications taken into consideration.

Table 9: SESAR Solution PJ02-08 operational characteristics for Concept 3 and Concept 4

3.2.2 Roles and Responsibilities

3.2.2.1 Roles and Responsibilities for Concept 1 and Concept 2

Node	Responsibilities
Aerodrome ATS	Performs all the aerodrome ATS operations. [RELATED ACTORS/ROLES] Runway controller, ground controller, etc.
Airspace User Ops Support	Performs all the necessary activities to support AU ops, including the strategic and tactical planning of AU operations, participation to related CDM processes and UDPP, update of AOP with AU information, ground handling. [RELATED ACTORS/ROLES] Flight Schedule Planner, Airline Operations and Control Centre (AOCC), Wing Operations Centre (WOC), etc.
En-Route/Approach ATS	Performs all the en-route and approach ATS operations. [RELATED ACTORS/ROLES] Executive controller, planning controller, etc.
Flight Deck	Performs all the on-board AU operations including flight execution/monitoring according to agreed trajectory, compliance with ATC clearances/instructions, etc. [RELATED ACTORS/ROLES] Flight Crew

Table 10: SESAR Solution PJ02-08 roles and responsibilities for Concept 1 and Concept 2

Operational interactions per context (NOV-2)		**Operating Environment**
[NOV-2] Integrated Arrival-Departure Sequence Management		Airport;
Node	Node instance	Node instance description
Airspace User Ops Support	Airspace User Ops Support	In the context of the solution 02-08, The Airspace User OPS Support provides Integrated RWY Sequence with an accurate target off-block time (TOBT) via its AOCC or via airport's CDM interface. Its responsibilities in this context are mainly related to departure traffic and might be also assumed by the Ground Handling Agent: · Agrees/updates target off-block time (TOBT); · Manages the turn-round in accordance with the TOBT · Provides turn-around progress information (milestones) through Airport CDM, · Optimizes the RBT (execution phase) to ensure the users'' business objectives for a flight are met.
En-Route/Approach ATS	Approach Executive Control	The Approach Executive Control is responsible for the safe and efficient air traffic management service for the aircraft approach to the runway. This control is also covering the departure traffic. Approach Executive Control responsibilities in the frame of the solution 02-08 are: · Sequence arrivals (clearances) according to the indications provided by the Integrated RWY Sequence function including TLDT, order and spacing indicators (time or distance based; · Ensure sufficient spacing between successive arrivals upon their turn onto final according to the spacing proposed by the Integrated RWY Sequence.
En-Route/Approach ATS	En-Route Executive Control	Depending on the Integrated Runway Sequence horizon, En-route Control has to follow the Target Metering Times and arrival sequence (order and time) provided by the Integrated RWY Sequence.
Flight Deck	Flight Deck	Flight Deck has no specific responsibilities regarding the solution 02-08, in addition to its usual role of the on board flight execution and monitoring.
Aerodrome ATS	Tower Clearance Delivery	Tower Clearance Delivery is responsible to provide the Start-Up approval according to the TSAT and integrated arrival/departure sequence provided by Integrated RWY Sequence.
Aerodrome ATS	Tower Ground Control	This node is covering both Ground control (taxiways) and Apron management. Ground control is responsible of aircraft taxi and has to comply

		as much as possible with the expected surface traffic flow from the off block to the departure holding point (TSAT and TTOT) to respect the runway sequence for departure flights according to the Integrated RWY Sequence function proposals. Ground Control does, however, have the ability to change the sequence if needed. Push-back and start engines approval responsibility sometimes rests with the Apron Management.
Aerodrome ATS	Tower Runway Control	Tower Runway Control has the following responsibilities: · Sequences departures as much as possible according to the TTOT and the integrated arrival/departure sequence provided by Integrated RWY Sequence, · Manages integration of departures in the arrival sequence in mixed-mode operations according to Integrated RWY Sequence proposals, · Ensures sufficient spacing between successive arrivals and departures to follow the integrated arrival/departure sequence, · Issues runway entry and take-off clearance to depart flights and use the arrival gaps as efficient as possible, · Use intersection Take-off to optimise runway throughput, · Issues landing and RWY exit clearances to arrival flights, · If possible, fine tunes sequence for throughput improvement, · If necessary, adjusts the sequence for safety.
Aerodrome ATS	Tower Supervision	Tower Supervision has the following responsibilities: · Decides on runway(s) for landing and take-off in co-operation with all concerned partners · Decides on nominal Departure Capacity in terms of separations, · Coordinates with APOC or with the Approach Supervisor regarding the measures related to Demand Capacity Balancing and traffic smoothing measures, · Coordinates with the Approach Supervisor on the runway configuration and associated capacity depending on the current and future weather situation (used in the Integrated RWY Sequence function), · Check the KPIs calculated for the different runway configurations available and applies the runway configuration provided by RMAN (if existing) that better fits the expected demand, · Plan, agree, set and adjust runway landing rates/changes/closures,

		· Monitors that the planned integrated arrival/departure sequence is applied.

Table 11: SESAR Solution PJ02-08 roles and responsibilities in the context of the Solution for Concept 1 and Concept 2

3.2.2.2 Roles and Responsibilities for Concept 3 and Concept 4

Node	Responsibilities
Aerodrome ATS	Performs all the aerodrome ATS operations. [RELATED ACTORS/ROLES] Runway controller, ground controller, etc.
Airspace User Ops Support	Performs all the necessary activities to support AU ops, including the strategic and tactical planning of AU operations, participation to related CDM processes and UDPP, update of AOP with AU information, ground handling. [RELATED ACTORS/ROLES] Flight Schedule Planner, Airline Operations and Control Centre (AOCC), Wing Operations Centre (WOC), etc.
En-Route/Approach ATS	Performs all the en-route and approach ATS operations. [RELATED ACTORS/ROLES] Executive controller, planning controller, etc.
Flight Deck	Performs all the on-board AU operations including flight execution/monitoring according to agreed trajectory, compliance with ATC clearances/instructions, etc. [RELATED ACTORS/ROLES] Flight Crew

Table 12: SESAR Solution PJ02-08 roles and responsibilities for Concept 3 and Concept 4

Operational interactions per context (NOV-2)		Operating Environment
[NOV-2] Advanced Runway Occupancy Time		Airport
Node	Node instance	Node instance description
En-Route/Approach ATS	Final Approach Control	Responsible for ensuring that the arrival aircraft information used by the Separation Delivery tool to calculate the TDIs is correct. This includes the arrival sequence order intent, and the flight specific aircraft information such as the aircraft type, the landing speed intent, and in the case of parallel active duty runways-in-use, the landing runway intent of each aircraft. Uses the Separation Delivery tool to ensure final approach

		separations are set up consistently and efficiently. Uses the Separation Delivery tool to monitor that separations remain consistent as aircraft descend on final approach, so as to enable timely intervention action to be taken when there is separation infringement. He is responsible on the separation when he transfer the aircraft to the tower controller
Flight Deck	Flight Crew Follower Aircraft	Flight Deck is receiving exit taxiway recommendation from Tower Runway Control and is expected to try to comply taking into account safety and performance factors. Except for this Flight Deck is performing the usual flight execution/monitoring duties
Flight Deck	Flight Crew Leader Aircraft	Flight Deck is receiving exit taxiway recommendation from Tower Runway Control and is expected to try to comply taking into account safety and performance factors. Except for this Flight Deck is performing the usual flight execution/monitoring duties
En-Route/Approach ATS	Initial Approach Control	Responsible for ensuring that the arrival aircraft are well spaced before transferring them the Final Approach Control, he ensures that the separations are set up consistently and efficiently before transferring the flight to the Final Approach control
Aerodrome ATS	Tower Runway Control	Tower Runway Control has the following responsibilities: · Manages integration of departures in the arrival sequence in mixed-mode operations, · Ensures appropriate separation between successive arrivals and departures to adhere to local minima and indications of the Enhanced AROT Prediction, · Issues runway entry and take-off clearance to departing flights and use the arrival gaps as efficient as possible, · Issues landing and RWY exit clearances to arrival flights, · Provides Landing Information to arriving flights according to Enhanced AROT Prediction indications, · Assesses the feasibility of Enhanced AROT Prediction advisory, · If necessary, adjusts the separations for safety reasons.

Table 13: SESAR Solution PJ02-08 roles and responsibilities in the context of the Solution for Concept 3 and Concept 4

3.2.3 Technical Characteristics

3.2.3.1 Technical Characteristics for Concept 1 and Concept 2

Technical constraint	description
Technical constraints of solution 02-08	No specific CNS technology identified for the development of the concept.

Table 14: SESAR Solution PJ02-08 technical constraints for Concept 1 and Concept 2

3.2.3.2 Technical Characteristics for Concept 3 and Concept 4

When it comes to ROT constraint, the need for a support function to deliver the spacing that considers the predicted ROT depends on how granular the ROT characterization is.

The Enhanced predicted ROT could be split into two categories:

- Category 1. Either the characterized ROT for reduced MRS is the same for all aircrafts part of the same Wake Turbulence Category of the DBS wake scheme in place (e.g. all RECA-EU upper medium aircrafts have been proven to have the same targeted average ROT).
- Category 2. Either the characterized ROT is different for aircrafts within the same Wake Turbulence Category of the scheme in application.

These categories are addressed in Concept 3. If the predicted ROT is characterized per aircraft type (so that the characterized ROT is different for aircrafts within the same (WTC), then a separation delivery support function, supporting Tower and Approach controllers in applying the appropriate ROT induced separation behind an arrival aircraft, is required.

Concept 4 addresses another approach where even more granular ROT can be used. In case of landing operations the runway condition along with some weather factors have critical impact on aircraft braking performance. This in turn determines which exit taxiways are feasible for use in given circumstances. Exit taxiway usage feasibility directly influences ROT performance. Therefore a third category of ROT prediction would be:

- Category 3. ROT is not only considered per aircraft type or its wake category but also is dependent on local weather and target runway condition.

The knowledge of this very granular ROT allows for simultaneous calculation of feasible exit taxiways.

3.2.3.2.1 ROT characterised per WTC (Concept 3)

The ROT criteria for reduced MRS being the same for all aircrafts part of the same Wake Turbulence Category of the DBS wake scheme in place (wake scheme in place being ICAO or RECAT-EU), the reduced MRS taking into account ROT could be added to the separation scheme table and applied by the controller without any additional functions.

Operationally, it could introduces different values of MRS according to Wake Turbulence Category.

3.2.3.2.2 Aircraft wise characterised ROT and more complex model (Concept 3)

The Separation delivery function support approach and tower runway controller by providing at least one static target distance indicator corresponding to the applicable MRS for the considered leader depending on its ROT. More advanced separation delivery function could be used.

In this case, a simple separation table could not be used anymore as the minimum separation to be applied vary according to aircraft, within the same wake turbulence category.

In that, case a separation delivery support function is required to assist the approach and the tower controller in delivering the correct minimum separation for any aircraft pair. Then two options are foreseen:

Option 1: DBS with simple tool

If the Enhanced Prediction of ROT model characterised a ROT defined per aircraft type, a simple separation delivery tool can also be used providing, for MRS pairs only, one static Target distance indicator corresponding to the applicable MRS for the considered leader depending on its ROT.

Option 2: TBS with ORD tool

In case the separations are delivered using a separation delivery support tool, the ROT constraint is defined per aircraft type (based on the ROT distribution). The minimum applicable separation is then computed per pair and considering the wind conditions accounting for wake constraint (if any), applicable MRS down to 2.0 NM and leader ROT.

Therefore, there is a dependency with the Optimised Runway Delivery tool support being developed and validated in SESAR Solution PJ02-01: the prediction algorithm of ROT will feed the Optimised Runway Delivery tool developed in PJ02-01 – Solution 1 AO-0328. When the ROT constraint will prevail over surveillance or wake constraint, it will be the parameter taken into account for tactical separation management (solution 1, 2 and 3).

3.2.3.2.3 Aircraft wise characterised ROT considering target runway and weather conditions (Concept 4)

Concept 4 uses ML based algorithm to determine the granular ROT and provide exit TWY recommendations. This algorithm relies on data already available in the Tower environment (surveillance, aerodrome MET, runway condition information) to produce results. With this level of granularity of ROT calculation the main factor in effective runway utilisation (and indirectly on optimal approach separation setting) is the optimal assignment of available exit taxiways.

With this in mind the ROT prediction model also calculates the recommended exit taxiway that can be assigned to a landing aircraft. This approach requires knowledge of current weather and target runway condition as well as surveillance information about the approach parameters. This implies the dependency on SESAR Solution PJ.03b-06 which develops and validates a suitable runway condition model.

In order to utilise the exit taxiway and ROT prediction the information is presented to the Tower Runway Controller using modified CWP that features EFS enriched by this information. The recommended exit taxiway is then communicated to the Flight Crew upon landing clearance provision.

3.2.4 Applicable standards and regulations

3.2.4.1 Applicable standards and regulations for Concept 1 and Concept 2

N/A

3.2.4.2 Applicable standards and regulations for Concept 3 and Concept 4

3.2.4.2.1 AROT Definition

AROT is defined as the time interval between the aircraft crossing the threshold and its tail vacating the runway (Source [39]).

3.2.4.2.2 Reduced Runway Separation minima (Concept 3)

Reduced runway separation minima between aircraft using the same runway defined in According to ICAO 4444 [40], section 7.11.7, is relevant to the present study.

It would allow in certain conditions described in ICAO 4444 [40], section 7.11 for a succeeding landing aircraft to cross the runway threshold when a preceding Category 3 aircraft:

i) has landed and has passed a point at least 2 400 m from the threshold of the runway, is in motion and will vacate the runway without backtracking; or

ii) is airborne and has passed a point at least 2 400 m from the threshold of the runway

3.2.4.2.3 Provision of exit taxiway recommendation (Concept 4)

N/A

3.3 Detailed Operating Method

3.3.1 Previous Operating Method

3.3.1.1 Previous Operating Method for Concept 1

For the Traffic Optimisation on single and multiple runway airports concept (Concept 1), the previous operating method considered is the current situation where AMAN and DMAN work separately.

The procedures used are the following:

- The **Tower Runway Controller** uses the arrival and departure sequences calculated by the AMAN and DMAN as support in order to maximise runway throughput. The integration of both sequences and the use of the runway occupancy time per flight is done in the ATCOs head and not shared via HMI with the other stakeholders.
- The **Tower Ground Controller** manages the traffic taking into account the arrival and departure sequences calculated by the AMAN and DMAN. The Tower Ground Controller mostly manages

the departure sequence calculated by the DMAN taking into account the arrival sequence calculated by the AMAN.

- The **Apron Controller** manages the traffic in order to permit the Tower Ground Controller to manage the departure sequence calculated by the DMAN.
- The **Executive TMA controller** manages the traffic taking into account the arrival and departure sequences calculated by the AMAN and DMAN. The Executive TMA controller mostly manages the arrival sequence calculated by the AMAN taking into account the departure sequence calculated by the DMAN.
- The **TWR Supervisor / Sequence Manager** manages the arrival sequence by planning, setting and adjusting runway landing rates according to changes, by monitoring the arrival sequence and by introducing on it the necessary manual changes when required.

In this situation, consistency between tools are only maintained by coordination between TWR Supervisor and TMA and TWR ATCOs.

3.3.1.2 Previous Operating Method for Concept 2

For the Optimised use of RWY capacity for multiple runway airports concept (Concept 2), the previous operating method is the new operating method of Concept 1: use of an Integrated Runway Sequence not fed by a Runway Manager tool. TWR Supervisor establishes RWY configuration based on experience. Changes in RWY conditions need to be reported from Tower Supervisor to the Tower Controllers in order to ensure consistency from the planning to the execution phase.

The procedures followed are:

- The **Tower Runway Controller**, **Tower Ground Controller**, **Apron Manager**, **Executive TMA controller** and **Sequence Manager** follow the common plan provided by the Integrated Runway Sequence function.
- The **Airport Tower Supervisor** decides a Runway Configuration based on experience and information about the planned demand without any decision support tool.

3.3.1.3 Previous Operating Method for Concept 3

Regarding arrivals, the operating method covers from the arrival aircraft crossing the Initial Approach Fix (IAF) until the aircraft lands.

The Air Traffic Control (ATC) procedures for an aircraft approaching an aerodrome will be specific to each airport. This section summarises the standard procedures used to transition an arriving aircraft through the TMA and approach to landing and vacating the runway.

3.3.1.3.1 Transition from TMA to Approach

Aircraft approaching one or more aerodrome(s) from surrounding sectors typically follow a number of Standard Arrival Routes (STARs) – each aircraft follows one STAR - providing the transition from the En-route structure, and are progressively merged into a single flow for each active landing runway.

The separation of arrivals and departures is facilitated by strategic segregation of flows through airspace structures. The separation of arrivals from other arrivals is often closely related to the building and maintenance of the sequence. These tasks are performed through the use of open loop vectoring, issuing a large number of headings, speeds and level instructions.

Holding patterns may be used for arrivals, subject to local practices, either when the TMA capacity is exceeded at peak times, or more systematically to maintain the pressure at the runway.

RNAV Procedures have been defined to replace open-loop vectors. In such procedures ideally the principle is to keep aircraft on their routes; the procedures are designed so that the trajectory can be stretched or shortened through pre-defined/fixed route modifications if this is needed for the merging of arrival flows; these procedures are generally fully applied only under low to medium traffic loads.

An "efficient landing sequence" refers both to an optimised sequence order (e.g. according to wake turbulence constraints), and to the achievement of appropriate spacing between flights, both aspects contributing to maintain the throughput as close as possible to the available runway capacity. This involves:

- Planning the sequence (i.e. allocate landing runway if needed, and define sequence order);
- Building the sequence (including order and appropriate spacing);
- Maintaining the sequence (including optimisation of inter-aircraft spacing).

The Controller is the authority for assuring safe operations in the TMA / Approach and issues information and instructions to aircraft under control in order to assist pilots to navigate safely and timely in the TMA / Approach.

Voice communication is the primary Air / Ground communication in the TMA / Approach.

The Ground / Ground connection is ensured through an overall network approach using common protocols such as Aeronautical Fixed Telecommunication Network (AFTN). It covers exchanges of surveillance, trajectory data and other flight planning information.

Navigation services using conventional terrestrial navigation aids (such as VOR/DME/NDB and ILS for the final approach phase) are the primary form of ground based navigation aid, however there is an increased usage of developing technologies such as GPS and GNSS. A large range of airborne navigation capability exists, usually based on multi-sensor navigation systems.

Surveillance Coverage is provided by the use of SSR (Secondary Surveillance Radar) in combination with PSR (Primary Surveillance Radar).

3.3.1.3.2 Separation Standards

Radar separation standards for arrivals and departures include MRS which prevents aircraft collision and WT separation which is intended to protect aircraft from adverse WTEs. In current day operations WT separations are defined between categories of aircraft which are grouped based on their MTOW. Examples of WT category schemes include ICAO, RECAT-EU 6 category and UK 6 category. When no WT separation is applicable then MRS is applied. This is typically 3Nm although can be 2.5Nm under certain conditions. Radar separations in current operations are defined in distance for arrival aircraft.

If the Flight Crew perform a visual approach, the separation mode changes, and the responsibility lies with the Flight Crew to determine the spacing.

Radar separation is applied by observing the headings, distances, and speeds, between consecutive aircraft. The Final Approach Controller knows the locally applied wake turbulence radar separation table (i.e. ICAO). From the respective aircraft wake turbulence categories from the flight strips, or from the target labels, the Controller establishes the wake turbulence radar separation required between the respective aircraft.

The separation distance limits are determined by the use of scales on the radar map and through the observation of catch-up from the separation distance progression observed between the follower aircraft and the lead aircraft. In case of possible infringement, the Controller will first use speed instructions, and then use vectoring, or order a go-around. Inside of 4Nm from the runway threshold no speed instructions are advised.

3.3.1.3.3 Runway Layout Configuration

Runway direction is chosen, based on many criteria, but the main one is the wind direction. Headwind conditions at the runway surface are the preferred wind for arrivals and departures, compared to crosswind conditions or tailwind conditions.

In a large airport, you can distinguish between two main runway operations. One is the segregated mode, where one duty runway-in-use is used for arrivals, and another duty runway-in-use is used for the departures. The other configuration is mixed mode, where the arrival and departure streams are interlaced on to a duty runway-in-use.

If operating in mixed mode, the penalty of having to apply distance based separation is less, since Controllers are typically able to reduce the 'Gap' size required to depart one aircraft between two arrivals, as the headwind increases, without becoming constrained by the wake turbulence separation minimum.

The two modes can also be combined, so that a few arrivals will land on the departure runway, or vice versa.

3.3.1.3.4 Arrival Management

In current operations, an Arrival Manager (AMAN) is often used for the TMA approach sector. The AMAN organises the arriving traffic, so that it can be merged and sequenced to one or more runways, as efficiently as possible. The AMAN can integrate wake turbulence categories (and distance needed) for each aircraft pair, and allocate them accordingly into the sequence. Aircraft speeds are taken into account, as well as wind speeds.

The arrival Controllers will, as far as is feasible, accommodate the AMAN proposed sequence order. Normally, the sequence order in AMAN is not updated after aircraft have passed the IAF. This means that the sequence order intent can be changed by the Approach Controllers without any update input into the associated system support. Through procedural coordination the Approach Controllers know the changed sequence order, which can also be deduced by looking at the relative display positions of the aircraft lined up on intermediate and final approach. As a consequence, there is currently no need for the Approach Controllers to update the associated system support.

For the Tower Runway Controller, the same logic applies, since there will in most cases be a slave radar display in the Tower. For other actors, it is not as clear what the real sequence actually is, or will be.

Different airports have developed different solutions, in order to provide the airport with correct landing estimates, and the correct landing runway for each aircraft.

When aircraft approach final approach, the Final Approach Controller will separate, sequence and merge all arrivals to a specific runway. This task is very precise, and requires skills in determining the correct headings and speeds to be applied, in order to be both efficient and remain safely separated.

3.3.1.3.5 Planning

In current operations at an airport, one important aspect of the short term planning, and reiterative planning done during the execution phase, is to select the most appropriate runway combination and configuration. This takes into account many criteria, such as weather forecast, infrastructure status, traffic demand and traffic mix.

For arrivals, the planning horizon is at least 20-30 minutes, in order to smoothly change the runway for landing, when in high traffic demand. Even so, a runway change will often lead to disruptions and delays.

3.3.1.4 Previous Operating Method for Concept 4

In current operations, the Tower Runway Controller is responsible for providing landing clearance to arriving aircraft. In order to do this, the arrival traffic is transferred to the Tower Runway Controller a few nautical miles from the threshold, and the Tower Runway Controller monitors that the runway occupancy of preceding aircraft is progressing as expected. The Tower Runway Controller monitors the speed and position of the next approaching arrival, in order to determine when to give a landing clearance, or to order a go-around, if the previous aircraft runway occupancy exceeds the applied separation. Both visual out of the window, and surveillance equipment, is used.

If in mixed mode, the Tower Runway Controller also has to deliver line-up and take-off clearances to departing aircraft, and time this so that the gap between the two associated arrivals can be used.

The accuracy of planning and execution of runway and surface movements is constrained by the degree of uncertainty of aircraft behaviour in the landing, roll-out and taxi phases. Tower Runway Controllers apply additional margins to take account of aircraft behaviour during these phases, in terms of predictability of performance. Margins to absorb the uncertainty over the AROT are factored into the final approach spacing applied.

Observations at congested airports indicate that depending on runway and taxiway layout and airline operating procedures, an excess of time can be spent on the runway by individual aircraft as the current aircraft auto-brake systems apply predetermined braking to the aircraft. If braking is left to the autobrake system, the aircraft will stop on the runway. However, in practise, the Flight Crew disconnect the autobrake on the roll out and use pedal braking to arrive at the runway exit at the correct speed.

Existing autobrake systems reduce pilot workload by providing deceleration at a set rate. The autobrake setting will guarantee that the aircraft stops at or before the pre-selected distance (adjacent to the selected exit).

With a limited number of autobrake settings available the deceleration is not necessarily customised to the specific runway exit. In theory this can lead to the AROT being extended.

As there are many factors that influence AROT it is not possible to predict an accurate AROT or guarantee the runway exit within the current operational setup. However, in some cases experienced Tower Runway Controllers are able to recommend an exit taxiway to the Flight Crew based on extensive knowledge of local conditions.

The situation is worsened in low visibility conditions when CAT II/III operations are in force and after landing, the auto-brake decelerates the aircraft according to the predetermined setting until the Flight Crew disconnect the autobrake system. Flight Crew have to cope with reduced visibility and must locate the runway exit in constrained visibility conditions and this may take considerably longer than would be the case in better visibility conditions (CAT I or better). As a result, this is one reason why reductions in runway capacity are declared during CAT II/III operations which can lead to significant delays.

3.3.2 New SESAR Operating Method

This section describes the new operating method to achieve the Traffic Optimisation on single and multiple runway airport. It first describes the main features and the operating method for the use of the Integrated RWY Sequence function (Concept 1), a description of the combinatory aspects of RMAN with an Integrated Runway Sequence and the proposed operating method for Concept 2, the new operating method for the use of local ROT characterization (ROCAT) to increase RWY Throughput (Concept 3) and the new operating method for the use of Enhanced Runway Occupancy Time (ROT) to optimise the use of RWY capacity in medium airports (Concept 4).

3.3.2.1 New SESAR Operating Method for Concept 1

The main goal for the Integrated RWY Sequence function is to establish an integrated arrival and departure sequence by providing accurate TTOTs and TLDTs, including **dynamic balancing of arrivals and departures** while optimising the runway throughput.

The trajectory based integrated sequence issued by the Integrated RWY Sequence function is calculated according to a look-ahead **Time Horizon** which value will range from firstly a time before arrival flights top of descent (e.g. 60 minutes before entry to runway) and updated in the tactical phase until a certain **Stable Sequence Time Horizon**. Then, TTOTs and TLDTs will be fine-tuned according to flight progress until a **Frozen Sequence Time Horizon**, from which TTOT/TLDT will be frozen.

The Figure 4 below gives a view of time horizons for arrivals from the right to middle (runway) and of departures from the left to middle (runway) including a highlight of the main working area for setting of the combined sequence. The look ahead Time Horizon is the time at which flights become eligible for the integrated sequence The **Stable Sequence Time Horizon** is the time horizon within which no automatic swapping of flights in the sequence will occur, but landing and departure time will still be updated. The **Frozen Sequence Time Horizon** is the time horizon within which no automatic swapping of flights in the sequence, and no update of landing /departure time will occur. The value of these time horizons is determined by the local implementation and they are not necessarily the same for arrivals and departures.

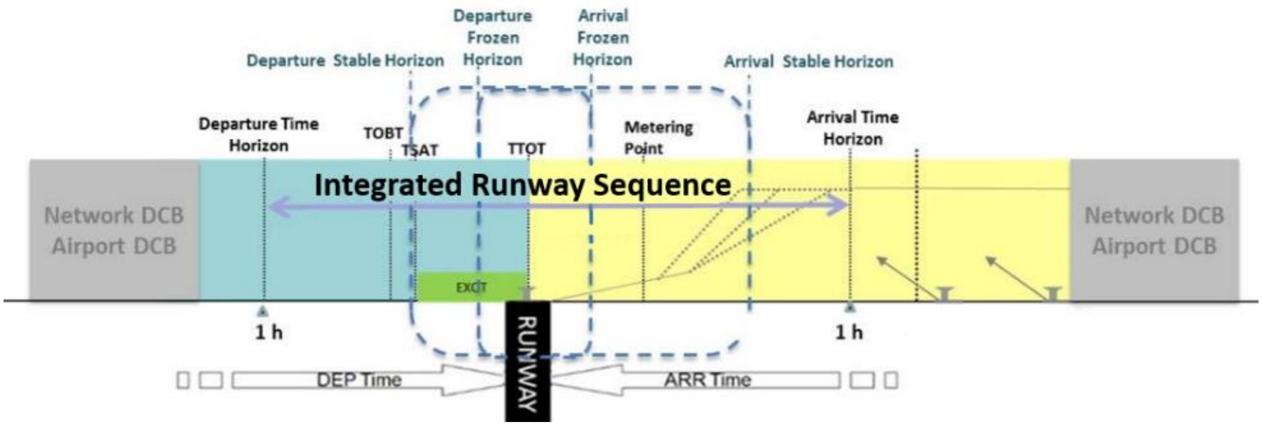


Figure 4: Time horizons for the Integrated Runway Sequence

The Integrated RWY Sequence function receives:

- The Flight data for arrivals including estimated and actual times involved in the arrival process
- The Flight data for departures including estimated and actual times involved in the departure process.
- Arrival/Departure ratio (option)
- The planned taxi time from each Stand to the Runway in Use.
- The Trajectory data including ETO, ATO for each point.

The Integrated RWY Sequence function perform the following tasks:

- Calculation of an integrated arrival/departure sequence based on a dynamic balancing of arrival and departures, by using the estimated times at the runway;
- Assign TLDTs and TTOTs to arrivals and departures based on the best runway sequence which optimise the runway throughput;
- Update applicable parts of the sequence based on new information on arrival and departure flight progress.
- Provide a buffer of departing flights (predefined number) at the Runway hold to consider variability and delays depending on specific situation.
- Balancing of KPIs via parameters:
  - Runway Throughput
  - Fuel Efficiency
  - Predictability
  - Punctuality

The integrated sequence optimisation of TTOT and TLDT is firstly calculated by the Integrated RWY Sequence function in a the look ahead Time Horizon balancing arrivals and departures according to demand, needs and configured parameters in order to achieve the best trade-off between efficiency, predictability and optimised throughput.

Target landing times (TLDT) will be set by the Integrated RWY Sequence function to calculate constrains at Metering Fixes (MF). If TTL/TTG or CTA procedures are in place to implement the arrival sequence, the

TLDTs from the Integrated RWY Sequence are converted to Time to Lose (TTL), Time to Gain (TTG) or Controlled Time of Arrival *(CTA)* and made available for ATCO and Flight Crew.

The TTOTs calculated from the Integrated RWY Sequence are converted to Target Start-Up Approval Times (TSAT) by the A-CDM platform and made available for ATCO, Flight Crew and relevant actors. TTOTs are also converted to DPIs according to the A-CDM concept and distributed to the network manager. The integrated sequence is built including departure aircraft that are not yet off-block (initial runway sequence) and an adjustment of the sequence (expected mainly for departures) will be made when the stability of flight progress is increased (update of runway sequence).

Within an off-line configurable look ahead time before landing/take-off (e.g. 1 hour), the **Integrated RWY Sequence** function calculates an **initial integrated runway sequence** as follows:

- Integrated RWY Sequence function adjusts the number of arrivals and departures (dynamic ratio) to be in line with the planned runway capacity provided by A-DCB (optional).
- Integrated RWY Sequence function distributes flights in the most optimal way taking into account a number of parameters e.g. wake vortex separations, SIDs etc. The integrated sequence includes time separation between pairs of aircraft, giving the minimum required spacing values for different wake vortex categories, wind conditions and weather.
- TLDTs and TTOTs are provided from the Integrated RWY Sequence function. Since departure times are more volatile than arrivals, the goal to be achieved with the optimization is to assign a combined runway sequence where TLDTs match the most likely TTOTs (sequences of departures to occur).

The **Integrated RWY Sequence** is then updated as follows**:**

- The Integrated RWY Sequence function receives updated information on arrivals and departures including update of flight progress and checks
  - arrivals ability to meet TLDT;
  - departures ability to meet TTOT (adopt to late changes close to TSAT);
- Integrated RWY Sequence function updates the runway sequence, at a latest time which is locally configurable based on progress information on arrivals and departures. As a result, it updates TLDTs and TTOTs

To support ATC with an overview of the integrated runway sequence an appropriate HMI presenting the integrated runway sequence order for both arrivals and departures will be provided. This HMI will provide to each ATC role the relevant information on the integrated runway sequence. This HMI may include support functions to enhance awareness and increase controller ability to comply with a predefined integrated runway sequence.

Example of ATC support functions are the provision of:

- Arrival sequence number;
- Departure sequence number;
- Speed instructions for arrivals;
- Integrated Runway sequence list;

- Spacing indicators for arrivals on final approach (distance based or time based);
- Spacing advisories and planned gap size between arrivals to accommodate planned departing flights.

These support functions can be used according to local ATC preferences.

In this operating method, the required time inserted between arrivals to allow departures is determined by the Integrated RWY Sequence and is no longer determined in advance by the Tower Runway Controller. The procedure for TWR is to respect and follow the departure sequence and TTOTs as closely as practical. The procedure for Approach is to respect the arrival sequence and follow advisories for gap size between arrivals to accommodate departing flights.

The following procedures are used:

- **Approach controllers**
  will have to respect the arrival sequence and follow spacing advisories between arrivals to accommodate departing flights.

- **Clearance Delivery Controller**
  will provide start-up approval based on TSAT (considering that TSAT is a predefined window of e.g. - 2/+3 minutes TBD) provided by the Integrated RWY Sequence. TSAT calculation will be based on TOBT and estimated taxi times.

- **Ground Controller (including Apron Manager)**
  will provide push-back approval in line with TSAT window (- 2/+3 minutes TBD). Taxi-out clearance is arranged to meet the proposed departure sequence, updated in line with TTOTs as closely as practical. Handle deviations and possible updates based on remaining taxi-out time with update of departure sequence. Propose the use of runway intersections according to local procedures.

- **Tower Runway Controller**
  will verify that the runway is clear and that the aircraft will meet arrival/departure separation requirements. He/she has to respect and follow the departure sequence and TTOTs as closely as practical. In coordination with Flight Crew use runway intersections according to local procedures to maintain runway throughput.

- **TWR Supervisor / Sequence Manager**
  will manage the integrated arrival/departure runway sequence by planning, setting and adjusting runway landing and departure rates according to changes, by monitoring the runway integrated sequence and by introducing on it the necessary manual changes when required.

3.3.2.2 New SESAR Operating Method for Concept 2

The Runway Manager (RMAN) is a support tool for the Tower Supervisor to determine the optimal runway configuration and distribution of demand according to capacity and local constraints.

The time horizon supported by the Runway Manager is the Medium/Short term Planning Phase up to the Execution Phase.

During the Medium/Short Term Planning Phase, the Runway Management Tool checks the intentional demand versus the available capacity and it is capable of forecasting imbalances, raising alarms and alerts based on the indicators provided.

In the Execution Phase, the Runway Management tool monitors departure, arrival and overall delay and punctuality, in addition to the capacity shortage proposing changes if necessary.

Since the demand is continuously evolving along time, the RMAN continuously computes the optimal runway configuration and the associated Forecasted Landing (FLDT) and Take Off (FTOT) Times of arrival and departures flights that maximises the runway throughput.

As described before, in the same phase, the Integrated Runway Sequence function calculates Target Landing and Take-Off Times based on the flight plan information and considering the active runways.

The combination of the Runway Manager and the Integrated Runway Sequence (TS-0313) has the aim of improving the predictability and punctuality of flights. The Forecasted Times calculated by the RMAN are provided to the Integrated Runway Sequence using them to calculate the final Target Times.

As a conclusion TLDT and TTOT calculated by the Integrated Sequence follows the Runway DCB Plan allowing the feedback to the RMAN to monitor the status of the Runway and to detect possible imbalances.

The following figure gives an overview on RMAN Input and Output for DCB Management. The output from the RMAN is the input for the Integrated RWY Sequence function.

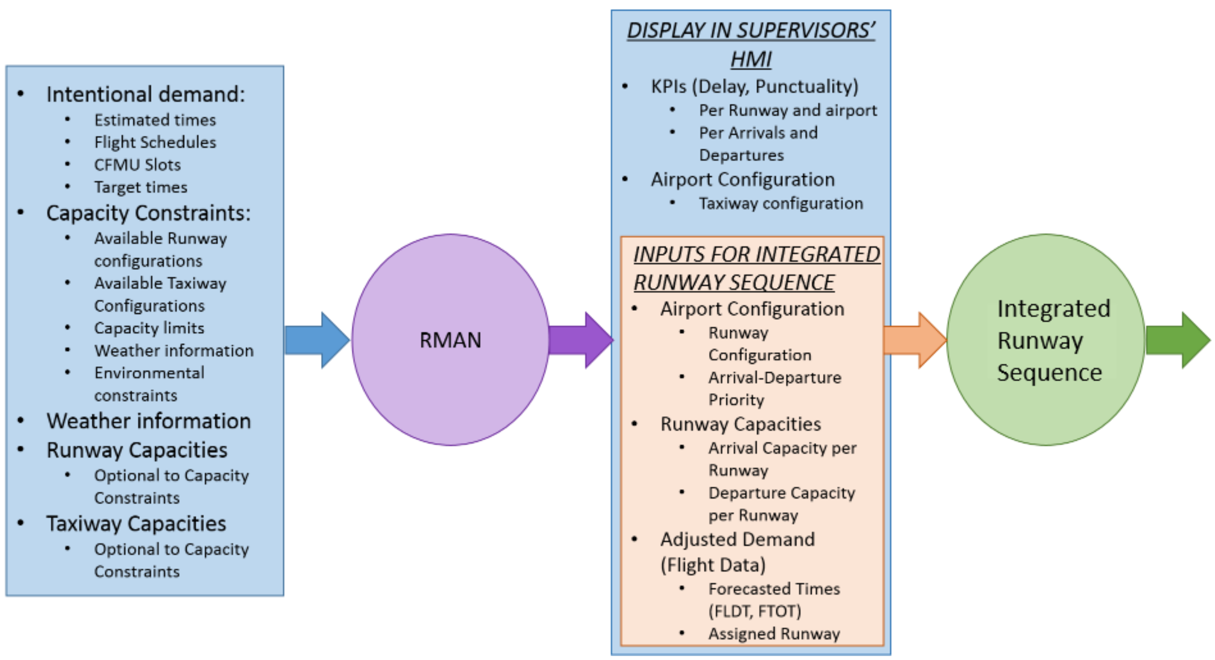


Figure 5: Inputs and Outputs RMAN

The following procedures are used:

- **Tower and Approach controllers**

  will apply the procedures for the use of an Integrated Runway Sequence.

- **Approach and Tower Supervisor**
  will determine the runway configuration and distribution of demand following the information provided by the RMAN, which will take into account all the constraints entered in the system and will determine the runway configuration achieving.

3.3.2.3 New SESAR Operating Method for Concept 3

In order to influence performance the Enhanced AROT Prediction concept requires further integration into the dedicated ATC systems.

The hypothesis taken by Concept 3 for new operating methods description are based on the hypothesis of an Enhance Predicted ROT model that require a separation delivery tool, i.e. when the ROT provided is aircraft type dependent when the Enhanced Predicted ROT model output vary for aircraft types within the same Wake Categories (see section 3.2.3.2).

When a separation delivery tool is not required, the operating method are deemed identical to Previous Operating method described in previous section.

The present section summarizes most important element of the Separation Delivery tool that supports the Controller in delivering the required separation or spacing, including the ROT spacing constraint.

The Separation Delivery function aims to compute the minimum applicable separation per pair, considering a wake separation scheme, applicable MRS down to 2.0 NM and leader ROT.

The separation delivery function could be distance based or times based. In the latter case, it considers the wind conditions accounting for wake constraint (if any).

The Separation Delivery tool calculates and displays Target Distance Indicators (TDIs) on the Approach and Tower CWPs. The TDIs include an FTD indicator which displays the required separation/spacing to be delivered to the required delivery point and an Initial Target Distance (ITD) indicator which displays the required spacing to deliver at the DF to support the Controller in delivering the required separation / spacing.

The key steps regarding the calculation and display of these TDIs are as follows:

- Determine the Approach Arrival Sequence;
- Identify all applicable separations / spacing's per arrival pair (includes in-trail and not-in-trail pairs);
- Compute the equivalent distance for any time separations or spacing's;
- Select the maximum applicable separation or spacing which is known as the FTD
- Compute the ITD by taking into account the effect of compression;
- Determine if the TDI should be displayed;

- Display the TDI on all applicable CWPs.

The time when an aircraft needs to be given clearance to land will depend on the local operation, but this should be considered when defining the ROT spacing constraint which the Separation Delivery tool will use.

See [54], PJ02-01 SPR-INTEROP/OSED for V3 for full description of the Separation Delivery tool.

3.3.2.3.1 Final Target Distance

The FTD is the separation or spacing that the Controller needs to deliver on final approach. This is the largest separation or spacing constraint among

- Wake separation scheme
- Applicable MRS
- Enhanced prediction of ROT
- Applicable buffer
- Eventually other applicable constraints

The method applied to compare all constraints is described in PJ02-01 OSED [54].

3.3.2.3.2 Initial Target Distance

The ITD is the spacing to be applied before compression to support the Controller in delivering the required separation or spacing (the FTD) at the delivery point. This is the FTD plus the predicted compression distance plus any additional buffer (if needed, as safety mitigation to uncertainty in the aircraft speed or wind forecast).

See PJ02-01 OSED [54] for full description.

Note: as explained in section 3.2.3.2, the minimum support function to exploit the Enhance prediction of ROT is the FTD.

3.3.2.3.3 Indicator Support and Turn-On Support

The FTD and ITD are displayed on the extended runway centreline of the Intermediate Approach, Final Approach and Tower Runway Controller CWPs. The display criteria for initial display of TDIs will depend on the operational needs of a local implementation.

As the TDI could represent safety related separation constraint, i.e. wake separation, and MRS, and non-safety related constraint, e.g. ROT spacing, approach and tower runway controller need to be aware of the constraint considered for each aircraft pair.

As illustrated on Figure 6, a solution is to differentiate the representation of TDIs on the HMI with various shapes.

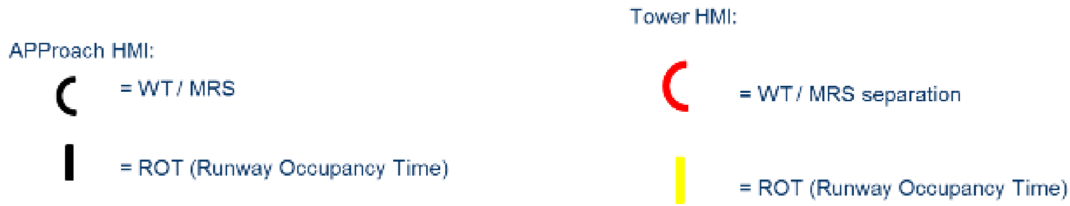


Figure 6: Example of HMI design for TDIs

To avoid cluttering and support display clarity, only one FTD (and ITD if implemented) related to the most constraining separation or spacing is displayed.

In case the ROT spacing is the most constraining spacing required between an aircraft pair, on the ROT related FTD (and eventually ITD) is displayed. However, in case of infringement of the ROT FTD, Approach controller and tower controller need to be able to identify the second less constraining separation (MRS or wake separation) in order to be able to assess and make appropriate decision/action.

Infringement of ROT constraint

- Automatic FTD popup - If there is no catch-up alert, the ORD tool shows only one FTD and one ITD as described in [54]. As shown on Figure 7, if ITD related to a given constraint is infringed, the Approach controller sees the FTD associated to the same infringed constraint. Note that even if there are not displayed, all constraints –i.e. MRS; wake separation; ROT and GAP- associated ITD and FTD are computed. If the ITD associated to the second largest constraint is infringed, the FTD associated to this second largest constraint is also displayed to the approach controller; and so on.

Figure 7: Automatic FTD popup

The tower controller sees only the FTD if an ITD associated to MRS or wake separation constraint is infringed.

In this implementation of the Separation Delivery tool the FTD is not displayed if ITD associated to ROT or gap constraint is infringed, as they are not safety related). In addition to the FTD, the tower controller gets information about the distance between FTD and aircraft position displayed next to the FTD as shown by Figure 8.

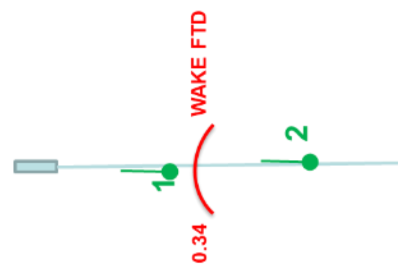


Figure 8: Infringement alert display for the Tower controller

3.3.2.4 New SESAR Operating Method for Concept 4

In order to more significantly influence performance the Enhanced AROT Prediction concept requires further integration into the dedicated ATC systems. The proposed Concept 4 is the simplest integration scenario where Enhanced AROT Predictor is used directly in Tower Runway Controller CWP via modification of the information available via EFS.

In Concept 4 it is assumed that Enhanced AROT Prediction is available at a certain time interval before the estimated time of touchdown for each arriving flight. The prediction algorithm not only takes into account the aircraft type and Wake Category but also other parameters that are related to current approach performance and designated runway condition. In this setting each time an aircraft is on final approach there is an AROT estimate available for this flight at some point in time. Currently based on operational and technical constrains the lead time of AROT prediction is set to be 5 min. before planned touchdown.

Except for AROT the system also estimates the approximate braking distance. As a result it is able to provide an advisory on the exit taxiway applicable to each flight. In giving this recommendation the Enhanced AROT Predictor considers the approach trajectory and performance, ground situation and runway condition including airport MET situation.

Given AROT and exit TWY information the Tower Runway Controller is then able to optimise two activities:

- recommend an exit that is both attainable and optimal for the oncoming flight considering the current and predicted weather situation,
- Manage following aircraft velocity on the final approach so that the separation is preserved and, if possible, avoid chance for go around in advance.

As a result the arriving traffic is more predictable and final approach management is simplified. Not only very experienced controllers have the ability to assess the braking of various aircraft as the knowledge is stored and updated in the ML system that takes into account a wide set of arriving aircraft parameters (both dynamic and static).

The increased stability and predictability of arriving traffic in the mixed mode (which is the dominant runway utilisation mode on medium airports) allows better accommodation of departing flights. This effect is especially pronounced in the peak hours when arriving traffic is using near to minimum allowed separation.

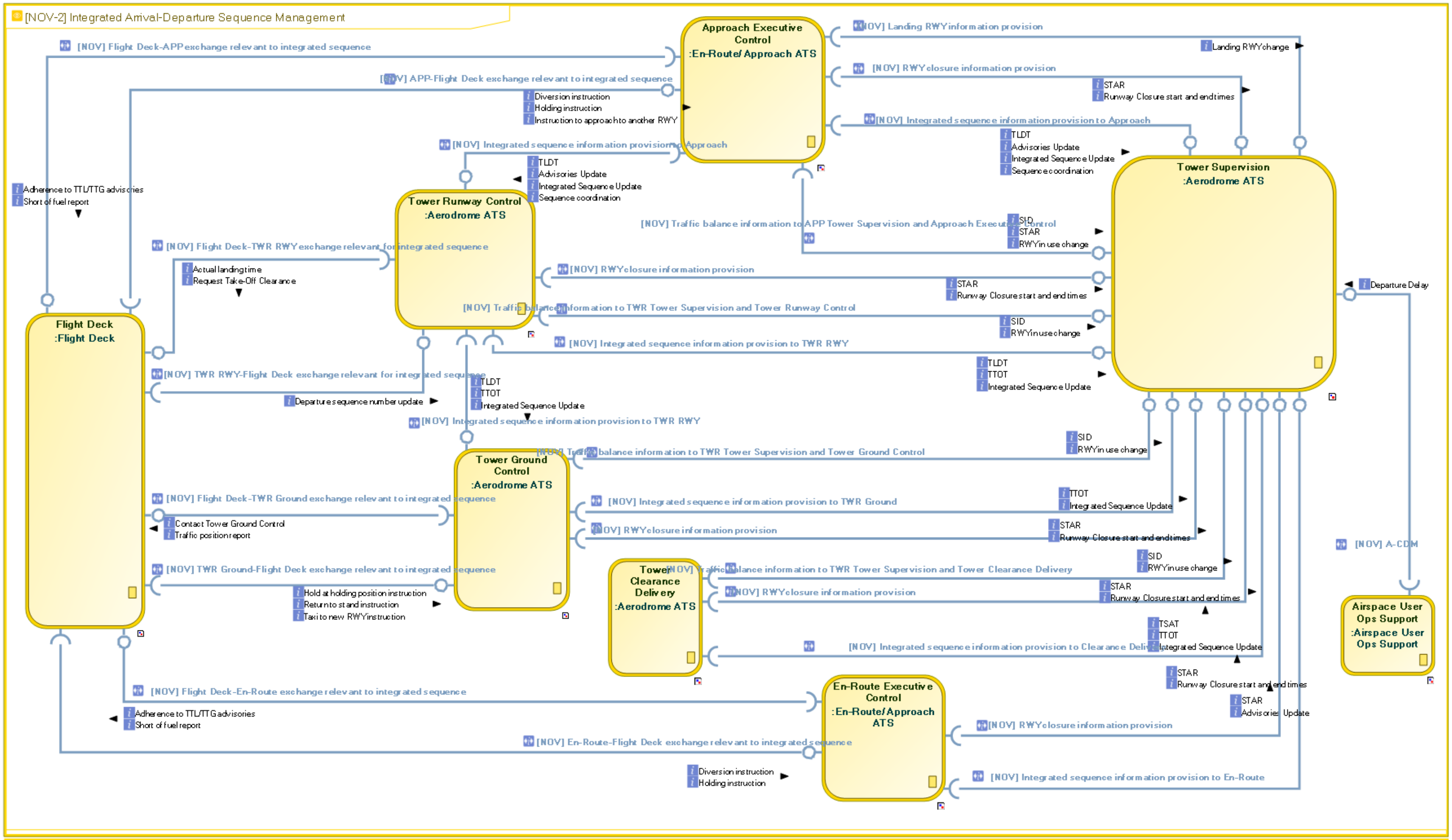
3.4 Use Cases associated to New SESAR Operating Method

3.4.1 Use Cases associated to New SESAR Operating Method for Concept 1 and Concept 2

The following Node View summarizes the information exchange described in the following Use Cases:

Use case	Use case title
Use case	[NOV-5][RWY-SEQ-01] Manage departure flight (using an integrated arrival/departure sequence)
Use case	[NOV-5][RWY-SEQ -02] Manage arrival flight (using an integrated arrival/departure sequence)
Use case	[NOV-5][RWY-SEQ -03] Manage integrated arrival/departure sequence changes prior to TSAT
Use case	[NOV-5][RWY-SEQ -04] Manage integrated arrival/departure sequence changes prior to TTOT
Use case	[NOV-5][RWY-SEQ -05] Manage integrated arrival/departure sequence changes impacting sequence order
Use case	[NOV-5][RWY-SEQ -06] Manage planned runway closure (using arrival/departure integrated sequence)
Use case	[NOV-5][RWY-SEQ -07] Manage unplanned Runway Closure (using arrival/departure integrated sequence)
Use case	[NOV-5][RWY-SEQ -08] Manage integrated arrival/departure sequence in case of Go-Around
Use case	[NOV-5][RWY-SEQ -09] Use an integrated arrival/departure sequence and decision support tool to manage RWY configuration
Use case	[NOV-5][RWY-SEQ -10] Manage integrated arrival/departure sequences during balancing of the number of arrival/departure flights between the two runways

Table 15: SESAR Solution PJ02-08 use cases for Concept 1 and Concept 2



[NOV-5][RWY-SEQ-10] Manage an integrated arrival/departure sequence during balancing of the number of arrival/departure flights between two runways [Approach Executive Controller, Sequence Manager, Tower Clearance Delivery, Tower Ground Control, Tower Runway Control, Tower Supervision]
[NOV-5][RWY-SEQ-05] Manage integrated arrival/departure sequence changes impacting sequence order [Approach Executive Control, Flight Deck, Tower Ground Control, Tower Runway Control]
[NOV-5][RWY-SEQ-07] Manage unplanned Runway Closure (using arrival/departure integrated sequence) [Approach Executive Control, En-Route Executive Control, Flight Deck of impacted arrival in contact with Approach Control, Flight Deck of impacted arrival in contact with En-Route Control, Flight Deck of Impacted Departures, Tower Clearance Delivery, Tower Ground Control, Tower Runway Control, Tower Supervision]
[NOV-5][RWY-SEQ-06] Manage planned runway closure (using arrival/departure integrated sequence) [Airspace User Ops Support, Approach Executive Control, En-Route Executive Control, Flight Deck (Impacted arrival), Tower Clearance Delivery, Tower Ground Control, Tower Runway Control, Tower Supervision]
[NOV-5][RWY-SEQ-01] Manage departure flight (using an integrated arrival/departure sequence) [Flight Deck, Tower Clearance Delivery, Tower Ground Control, Tower Runway Control]
[NOV-5][RWY-SEQ-02] Manage arrival flight (using an integrated arrival/departure sequence) [Approach Executive Control, En-Route Executive Control, Flight Deck, Tower Runway Control]
[NOV-5][RWY-SEQ-03] Manage integrated arrival/departure sequence changes prior to TSAT [Airspace User Ops Support, Tower Clearance Delivery, Tower Ground Control, Tower Runway Control, Tower Supervision]
[NOV-5][RWY-SEQ-04] Manage integrated arrival/departure sequence changes prior to TTOT [Flight Deck, Tower Ground Control, Tower Runway Control]
[NOV-5][RWY-SEQ-08] Manage integrated arrival/departure sequence in case of Go-Around [Approach Executive Control, Flight Deck, Tower Runway Control]
[NOV-5][RWY-SEQ-09] Use an integrated arrival/departure sequence and decision support tool to manage RWY configuration [Tower Clearance Delivery, Tower Ground Control, Tower Runway Control, Tower Supervision]

Figure 9: SESAR Solution PJ02-08 Node view (NOV-2 diagram) for Concept 1 and Concept 2

3.4.1.1 Use Cases for [NOV-2] Integrated Arrival-Departure Sequence Management

This section provides the use cases that describe the new operating method for Concept 1 and Concept 2.

3.4.1.1.1 [NOV-5][RWY-SEQ-01] Manage departure flight (using an integrated arrival/departure sequence)

General Conditions (Scope and Summary)

This Use Case describes the management of a sequenced departure in nominal mode following the integrated sequence provided by the Integrated RWY Sequence function.

Pre-Conditions

- Airport CDM process is in place and there is an agreed business trajectory
- Advanced HMI
- An integrated sequence is provided by the Integrated RWY Sequence function
- The pilot calls within the TSAT window

Assumptions

- The Sequence Manager has verified that the Integrated RWY Sequence function is configured according to the operational needs.
- If TSAT is respected, TTOT is achieved (i.e. the taxi times are as expected);

Trigger

The pilot calls for start-up.

Main Flow

[1] TWR Clearance Delivery Controller checks that pilot calls within the TSAT window as provided in the integrated sequence.

[2] TWR Clearance Delivery Controller provides start-up clearance to pilot.

[3] Flight performs start-up and when applicable requests for push-back.

[4] If push-back is required, Apron Manager provides the push-back clearance according to the TSAT window provided by the Integrated RWY Sequence function.

[5] TWR Ground Controller monitors the progress of taxiing against TTOT provided by the Integrated RWY Sequence function.

[6] Flight arrives to the holding position.

[7] TWR RWY Controller provides line-up and take-off clearance according to TTOT.

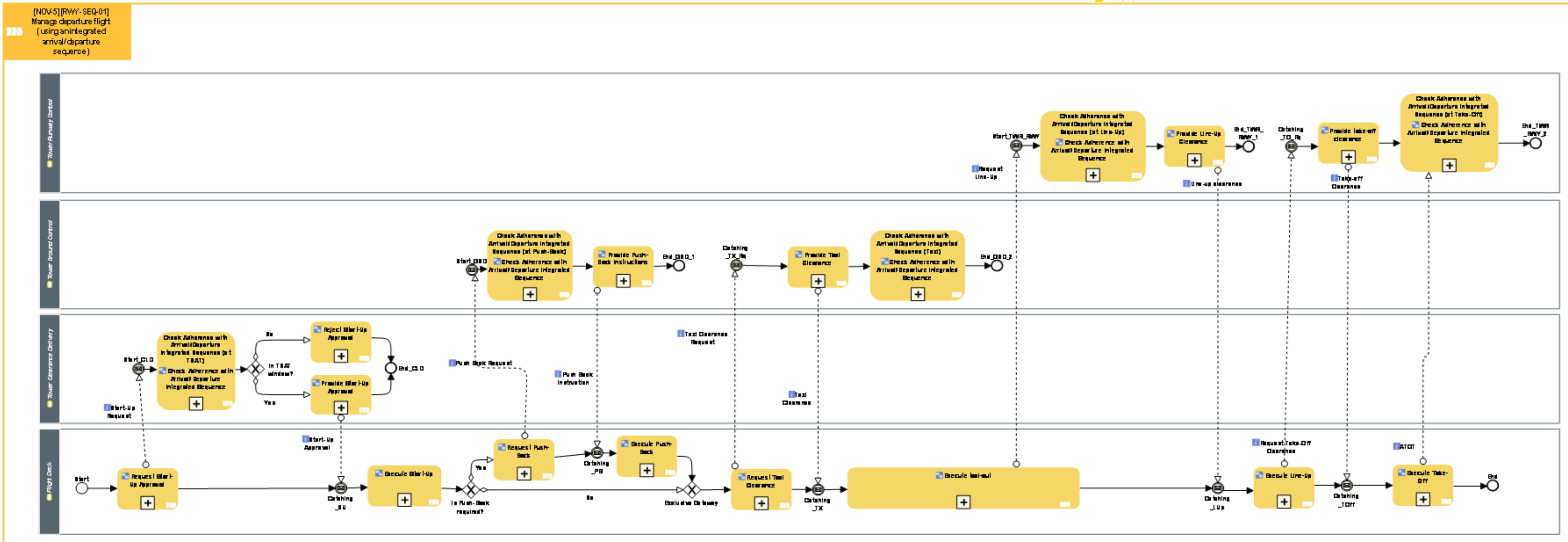


Figure 10: [NOV-5][RWY-SEQ-01] Manage departure flight (using an integrated arrival/departure sequence) Use Case diagram (NOV-5 diagram)

Diagram Id: 56595B205A955A57

Activity	Description
Check Adherence with Arrival/Departure Integrated Sequence (at Line-Up)	Checking adherence of TTOT (against the integrated arrival departure sequence) at Line-Up. In case of non adherence, the TWR Runway Controller will manually update the integrated sequence (see appropriate UC), e.g. by swapping order with another departure, which results in a TTOT update.
Check Adherence with Arrival/Departure Integrated Sequence (at Push-Back)	Checking adherence of TTOT (against the integrated arrival departure sequence) at Push-Back. In case of non adherence, the controller will manually change TTOT (see appropriate UC)
Check Adherence with Arrival/Departure Integrated Sequence (at Take-Off)	Checking adherence of TTOT (against the integrated arrival departure sequence) at Take-Off. In case of non adherence (e.g. aborted take-off, a/c not following the take-off clearance), the TWR Runway Controller will manually update the integrated sequence (see appropriate UC), e.g. by re-sequencing the flight to a later time, which results in a TTOT update.
Check Adherence with Arrival/Departure Integrated Sequence (at TSAT)	The Clearance Delivery retrieves the TSAT information (value + window) as provided by the integrated arrival/departure sequence. Checking adherence of TSAT (against the integrated arrival departure sequence) at TSAT request.
Check Adherence with Arrival/Departure Integrated Sequence (Taxi)	Checking adherence of TTOT (against the integrated arrival departure sequence) during the whole taxiing process. In case of non adherence, the controller will manually change TTOT (see appropriate UC)
Execute Line-Up	The Flight Deck performs line-up following clearance from Tower Runway Controller.
Execute Push-Back	The Flight Deck executes the push-back following the Apron Manager push-back instructions.
Execute Start-Up	After receiving the start-up approval, the Flight Deck executes the start-up.
Execute Take-Off	The Flight Deck performs take-of following the clearance from Tower Runway Controller.
Execute taxi-out	The Flight Deck executes the taxi to the holding point following the taxi clearance from Ground Control.
Provide Line-Up Clearance	The Tower Runway Controller clears the Flight Deck to line-up.
Provide Push-Back Instructions	If push-back is required, Apron Manager will provide push-back instructions to the Flight Deck.
Provide Start-Up Approval	Clearance Delivery provides start-up approval to Flight Deck.
Provide take-off clearance	The Tower Runway Controller clears the Flight Deck for take-off.
Provide Taxi Clearance	Ground Control provides taxi clearance to Flight Deck (including taxi route).

Reject Start-Up Approval	-reject start-up approval, requesting the AU to update the TOBT (which will in turn trigger an integrated sequence update).
Request Push-Back	If push-back is required, the Flight Deck will request for push-back instructions.
Request Start-Up Approval	When ready, the Flight Deck contacts the Tower Clearance Delivery to request Start-Up Approval
Request Taxi Clearance	The Flight Deck requests Ground Control for taxi clearance.

Table 16: [NOV-5][RWY-SEQ -01] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Flight Deck	Execute Take-Off o--> Check Adherence with Arrival/Departure Integrated Sequence (at Take-Off)	Tower Runway Control	ATOT	ActualTakeOffTime
Tower Runway Control	Provide take-off clearance o--> Catching_TOff	Flight Deck	Take-off Clearance	TakeOffClearance
Flight Deck	Execute Line-Up o--> Catching_TO_Rq	Tower Runway Control	Request Take-Off Clearance	PilotRequest
Flight Deck	Request Push-Back o--> Start_GND	Tower Ground Control	Push Back Request	PushBackInstructionRequest
Flight Deck	Request Taxi Clearance o--> Catching_TX_Rq	Tower Ground Control	Taxi Clearance Request	PilotRequest
Tower Ground Control	Provide Taxi Clearance o--> Catching_TX	Flight Deck	Taxi Clearance	TaxiClearance
Tower Ground Control	Provide Taxi Clearance o--> Catching_TX	Flight Deck	Taxi Clearance	TaxiInClearance
Tower Ground Control	Provide Taxi Clearance o--> Catching_TX	Flight Deck	Taxi Clearance	TaxiOutClearance
Tower Clearance Delivery	Provide Start-Up Approval o--> Catching_SU	Flight Deck	Start-Up Approval	StartUpClearance
Flight Deck	Execute taxi-out o--> Start_TWR_RWY	Tower Runway Control	Request Line-Up	

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Provide Line-Up Clearance o--> Catching_LUp	Flight Deck	Line-up clearance	
Tower Ground Control	Provide Push-Back Instructions o--> Catching_PB	Flight Deck	Push Back Instruction	PushBackInstruction
Flight Deck	Request Start-Up Approval o--> Start_CLD	Tower Clearance Delivery	Start-Up Request	StartUpApprovalRequest

Table 17: [NOV-5][RWY-SEQ-01] Use Case information and information exchanges

3.4.1.1.2 [NOV-5][RWY-SEQ-02] Manage arrival flight (using an integrated arrival/departure sequence)

General Conditions (Scope and Summary)

This Use Case describes the management of a sequenced arrival in nominal mode following the integrated sequence provided by the Integrated Runway Sequence function.

Pre-Conditions

- Airport CDM process is in place and there is an agreed business trajectory
- Advanced HMI
- An integrated sequence is provided by the Integrated Runway Sequence function
- Flight is within the AMAN horizon

Assumptions

- The Sequence Manager has verified that the Integrated Runway Sequence function is configured according to the operational needs.
- TLDT and linked TTL/TTG are provided by the Integrated Runway Sequence function;
- TTL can be absorbed within the unit
- Most of the TTL should be absorbed within ACC, as far as practicable.

Trigger

The flight is entering the Integrated Runway Sequence function eligibility time horizon.

Main Flow

[1] The ATC Sector Planner Controller verifies TTL/TTG of the flight as provided by Integrated Runway Sequence function;

[2] The pilot contacts the ATC Sector Executive Controller (ACC).

[3] The ATC Sector Executive Controller (ACC) provides clearances to pilot in order to follow TTL/TTG advisories.

[4] The ATC Sector Executive Controller (ACC) transfers the flight to the ATC Sector Executive Controller (APP).

[5] The pilot contacts the ATC Sector Executive Controller (APP).

[6] The ATC Sector Executive Controller (APP) provides clearances to pilot in order to respect the planned sequence number of the flight calculated by the Integrated Runway Sequence function.

[7] ATC Sector Executive Controller (APP) provides clearances to pilot in order to respect the spacing (gap size) and the TTL/TTG advisories.

[8] ATC Sector Executive Controller (APP) transfers control to TWR RWY Controller.

[9] Pilot contacts TWR RWY Controller.

[10]TWR RWY Controller provides landing clearance according to TLDT.

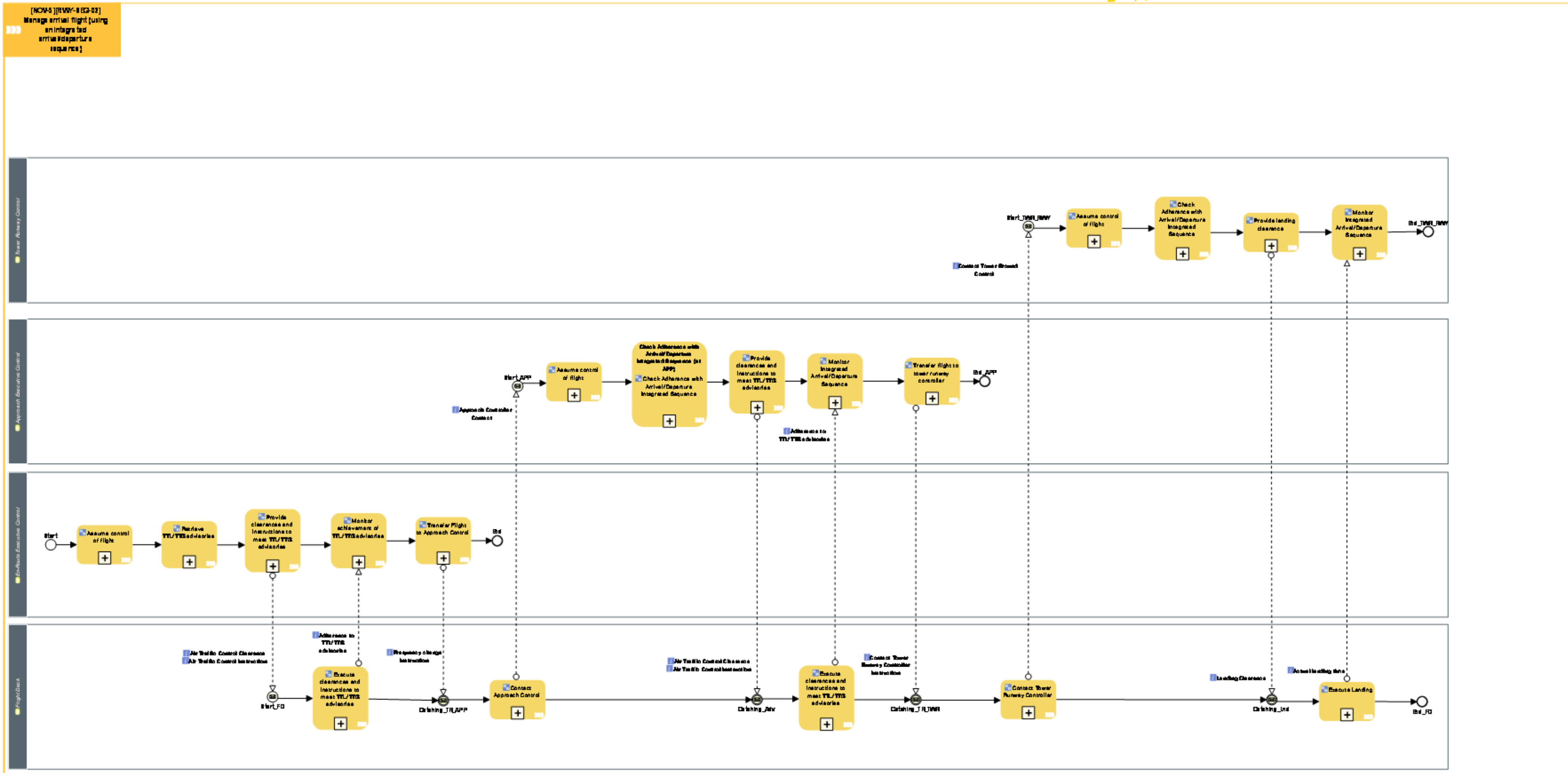


Figure 11: [NOV-5][RWY-SEQ-02] Manage arrival flight (using an integrated arrival/departure sequence) Use Case diagram (NOV-5 diagram)

Diagram Id: 7B9E8F7B5A9665F4

Activity	Description
Assume control of flight	Assume the control of the flight
Assume control of flight	The Tower Runway Controller assumes the control of the flight on Flight Deck contact.
Assume control of flight	Assume control of the flight after Flight Deck call.
Check Adherence with Arrival/Departure Integrated Sequence	The Tower Runway Controller checks adherence of the arrival flight (against the integrated arrival departure sequence). The controller will follow the sequence by providing the necessary instructions but, if the sequence cannot be met, he/she will make the necessary manual updates on the sequence (see appropriate UC)
Check Adherence with Arrival/Departure Integrated Sequence (at APP)	The Executive Approach Controller checks adherence of the arrival flight (against the integrated arrival departure sequence). The controller will follow the sequence by providing the necessary instructions but, if the sequence cannot be met, he/she will make the necessary manual updates on the sequence (see appropriate UC)
Contact Approach Control	Flight Deck contacts Approach Control.
Contact Tower Runway Controller	The Flight Deck contacts Tower Runway Control.
Execute clearances and instructions to meet TTL/TTG advisories	The Flight Deck executes the clearances and instructions provided by the executive controller in order to meet the TTL/TT advisories.
Execute clearances and instructions to meet TTL/TTG advisories	The Flight Deck executes the clearances and instructions provided by the executive controller in order to meet the TTL/TT advisories.
Execute Landing	The Flight Deck executes the landing at the TLDT calculated by the Integrated Runway Sequence function, following the clearance from the Tower Runway Controller.
Monitor achievement of TTL/TTG advisories	ACC Executive Controller monitors the achievement of the TTL/TTG advisories provided by the Integrated Runway Sequence function by monitoring the adherence to the clearances and instructions provided to the Flight Deck in order to meet TTL/TT advisories.
Monitor Integrated Arrival/Departure Sequence	The Tower Runway Controller monitors the landing of the arriving flight against the integrated arrival/departure sequence calculated by the Integrated Runway Sequence function and, if required, makes the necessary manual adjustments.
Monitor Integrated Arrival/Departure Sequence	Monitoring of the integrated arrival/departure sequence calculated by the Integrated Runway Sequence function. If the integrated sequence cannot be followed, manual updates will be required (see corresponding UC).
Provide clearances and instructions to meet TTL/TTG advisories	En-Route/Approach ATS provides clearances and instructions to Flight Deck in order to meet TTL/TTG (time to lose/time to gain) advisories for arriving flights.
Provide clearances and	En-Route/Approach ATS provides clearances and instructions to

instructions to meet TTL/TTG advisories	Flight Deck in order to meet TTL/TTG (time to lose/time to gain) advisories for arriving flights.
Provide landing clearance	The Tower Runway Controller provides the Flight Deck of the arriving flight with the Landing Clearance according to the TLDT calculated by the Integrated Runway Sequence function.
Retrieve TTL/TTG advisories	Obtain the TTL/TTG (time to lose/time to gain) advisories on arrival flights generated by the Integrated Runway Sequence function.
Transfer Flight to Approach Control	Transfer from En-Route Control to Approach Control.
Transfer flight to tower runway controller	The approach controller transfers the aircraft to the control tower frequency.

Table 18: [NOV-5][RWY-SEQ-02] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Flight Deck	Execute Landing o–> Monitor Integrated Arrival/Departure Sequence	Tower Runway Control	Actual landing time	ActualLandingTime
Flight Deck	Execute clearances and instructions to meet TTL/TTG advisories o--> Monitor achievement of TTL/TTG advisories	En-Route Executive Control	Adherence to TTL/TTG advisories	ArrivalManagementAdvisory
En-Route Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o--> Start_FD	Flight Deck	Air Traffic Control Instruction	ATCInstruction
En-Route Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o--> Start_FD	Flight Deck	Air Traffic Control Clearance	ATCClearance
En-Route Executive Control	Transfer Flight to Approach Control o--> Catching_TR_APP	Flight Deck	Frequency change instruction	FrequencyChangeInstruction
Flight Deck	Contact Approach Control o--> Start_APP	Approach Executive Control	Approach Controller Contact	AIRM_OutOfScope

Issuer	Info Flow	Addressee	Info Element	Info Entity
Flight Deck	Contact Tower Runway Controller o--> Start_TWR_RWY	Tower Runway Control	Contact Tower Ground Control	FrequencyChangeInstruction
Approach Executive Control	Transfer flight to tower runway controller o--> Catching_TR_TWR	Flight Deck	Contact Tower Runway Controller instruction	FrequencyChangeInstruction
Tower Runway Control	Provide landing clearance o--> Catching_Lnd	Flight Deck	Landing Clearance	LandingClearance
Flight Deck	Execute clearances and instructions to meet TTL/TTG advisories o--> Monitor Integrated Arrival/Departure Sequence	Approach Executive Control	Adherence to TTL/TTG advisories	ArrivalManagementAdvisory
Approach Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o--> Catching_Adv	Flight Deck	Air Traffic Control Instruction	ATCInstruction
Approach Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o--> Catching_Adv	Flight Deck	Air Traffic Control Clearance	ATCClearance

Table 19: [NOV-5][RWY-SEQ-02] Use Case information and information exchanges

3.4.1.1.3 [NOV-5][RWY-SEQ-03] Manage integrated arrival/departure sequence changes prior to TSAT

General Conditions (Scope and Summary)

This Use Case describes the management of the integrated arrival/departure sequence when a departure flight cannot meet its TSAT.

Pre-Conditions

- Airport CDM process is in place and there is an agreed business trajectory
- An integrated sequence is provided by the Integrated Runway Sequence function

Assumptions

- Close monitoring of the handling process must assure that in case of late boarding / loading the impact on TOBT is recognized in an early stage and when necessary an updated TOBT determined, the AOP updated and a new TSAT provided. In case of a new TSAT an updated pre-departure sequence and TTOT are determined, taking into account local constraints at the airport (on apron, taxiways and/or runways);
- Arrival sequence is not impacted;
- TWR Supervisor performs the tasks of Sequence Manager;

This use case applies to different operational situations:

- **A departure flight is not ready for push-back at the TSAT**: If for whatever reason (e.g. technical problem) the aircraft is foreseen not ready at TSAT, a new TOBT has to be announced and a new TSAT determined (based on available TTOT) ;
- **Aircraft is not foreseen ready at TOBT**: when for whatever reason (e.g. de-icing on stand takes longer, missing passengers, late boarding of passengers and/or late loading of baggage and cargo) the aircraft is not ready at TOBT, a new TOBT and TSAT has to be determined;

Main Flow

[1] The Airspace User OPS Support updates the TOBT according to the A-CDM procedures;

[2] The Integrated Runway Sequence function processes the new TOBT ad re-sequences the flight by moving it into the sequence at the next appropriate departure slot and updates its TTOT and TSAT accordingly;

[3] The TWR Runway Controller, TWR Ground Controller, TWR Clearance Delivery and TWR Supervisor receive the relevant information on the up-to-date integrated sequence (TSAT, TTOT, TLDT, sequence numbers);

[4] The TWR Clearance Delivery follows the TSAT re-calculated by the Integrated Runway Sequence function based on the new TOBT;

[5] The TWR Supervisor assesses the change in the sequence and makes manual adjustments if required (e.g. if spacing of arrivals need to be fit with the runway occupancy time of the departing flight).

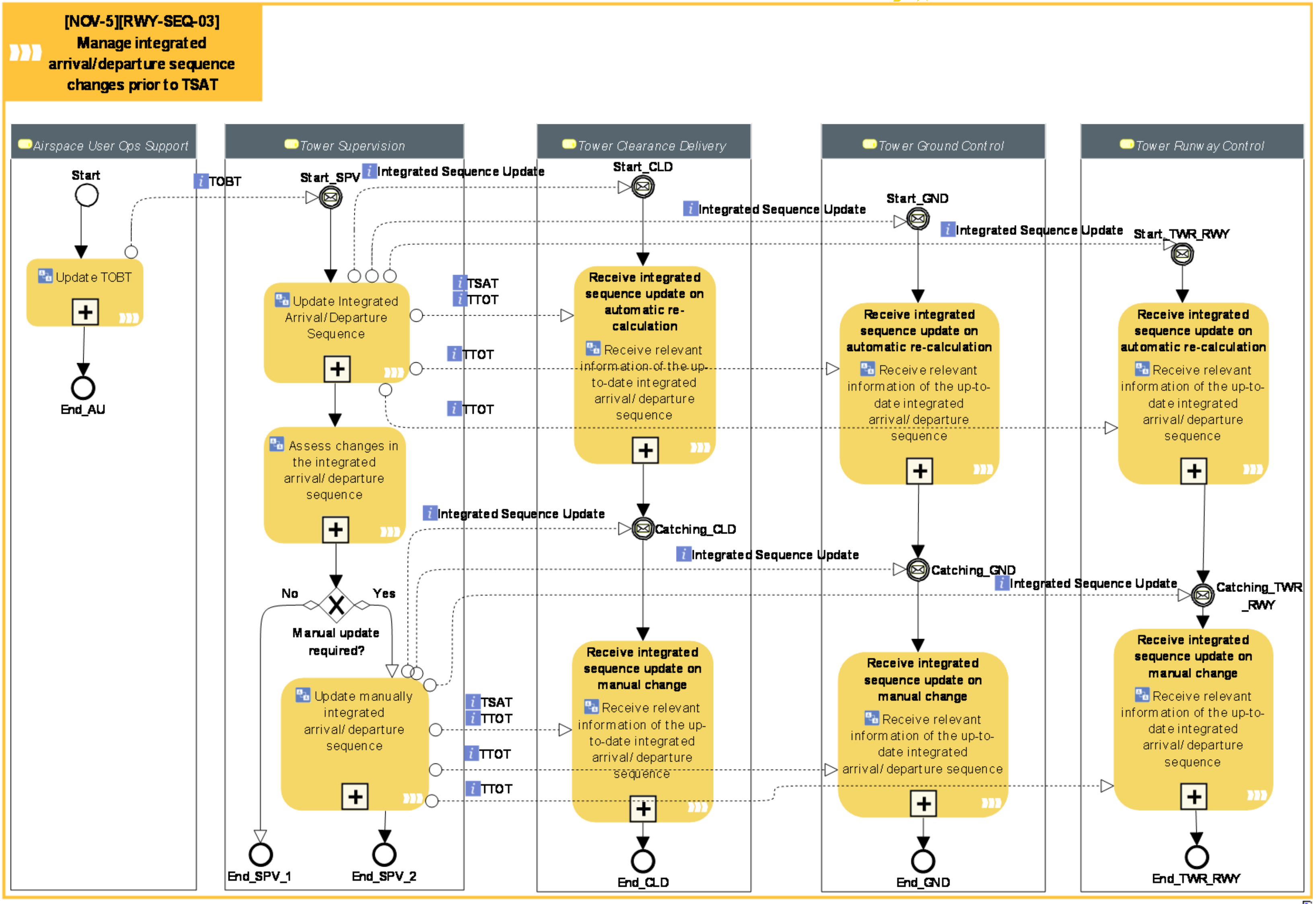


Figure 12: [NOV-5][RWY-SEQ-03] Manage integrated arrival/departure sequence changes prior to TSAT Use Case diagram (NOV-5 diagram)

Diagram Id: 305E66465AE87FCD

Activity	Description
Update TOBT	The Airspace User OPS Support updates the TOBT in case of changes in departure time.
Assess changes in the integrated arrival/departure sequence	Changes in the traffic might impact the integrated arrival/departure sequence. ATCOs assess this impact in order to take the appropriate actions (e.g. update plan or provide instructions to ensure that the plan is applied).
Receive relevant information of the up-to-date integrated arrival/departure sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is shared between En-Route, APP and TWR controllers. Any change into the sequence (manual or automatic update) triggers an update of the relevant information provided to the different ATCO.
Update Integrated Arrival/Departure Sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is updated automatically further to certain events (e.g. TOBT update, trajectory re-calculations) and also further to certain ATCO actions (e.g. RWY closure, Go-around input), depending on local implementation.
Update manually integrated arrival/departure sequence	ATCOs can manually change the integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function, depending on local implementation (e.g. move manually a flight in the sequence, swap flights, modify spacing).

Table 20: [NOV-5][RWY-SEQ-03] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Start_CLD	Tower Clearance Delivery	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Start_CLD	Tower Clearance Delivery	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Start_GND	Tower Ground Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Start_GND	Tower Ground Control	Integrated Sequence Update	DepartureSequence
Airspace User Ops Support	Update TOBT o--> Start_SPV	Tower Supervision	TOBT	TargetOffBlockTime

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update manually integrated arrival/departure sequence o--> Catching_CLD	Tower Clearance Delivery	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update manually integrated arrival/departure sequence o--> Catching_CLD	Tower Clearance Delivery	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Start_TWR_RWY	Tower Runway Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Start_TWR_RWY	Tower Runway Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update manually integrated arrival/departure sequence o--> Catching_GND	Tower Ground Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update manually integrated arrival/departure sequence o--> Catching_GND	Tower Ground Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Tower Clearance Delivery	TTOT	TargetTakeOffTime
Tower Supervision	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Tower Clearance Delivery	TSAT	TargetStartUpApprovalTime
Airspace User Ops Support	Update TOBT o-->	Tower Clearance Delivery	TOBT	TargetOffBlockTime

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive integrated sequence update on automatic re-calculation	Tower Runway Control	TTOT	TargetTakeOffTime
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive integrated sequence update on automatic re-calculation	Tower Ground Control	TTOT	TargetTakeOffTime
Tower Supervision	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Tower Runway Control	TTOT	TargetTakeOffTime
Tower Supervision	Update manually integrated arrival/departure sequence o--> Catching_TWR_RWY	Tower Runway Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update manually integrated arrival/departure sequence o--> Catching_TWR_RWY	Tower Runway Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive integrated sequence update on automatic re-calculation	Tower Clearance Delivery	TTOT	TargetTakeOffTime

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive integrated sequence update on automatic re-calculation	Tower Clearance Delivery	TSAT	TargetStartUpApprovalTime
Tower Supervision	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Tower Ground Control	TTOT	TargetTakeOffTime

Table 21: [NOV-5][RWY-SEQ-03] Use Case information and information exchanges

3.4.1.1.4 [NOV-5][RWY-SEQ-04] Manage integrated arrival/departure sequence changes prior to TTOT

General Conditions (Scope and Summary)

This use case describes the management of the changes occurring in the integrated arrival/departure sequence prior to TTOT. The departure flight deviating from the integrated sequence plan cannot meet its TTOT either because of own reasons (e.g. slow taxi, call late in the TSAT window) or because of the context (e.g. taxi blocked by other traffic).

Pre-Conditions

- Airport CDM process is in place and there is an agreed business trajectory
- Advanced HMI
- An integrated sequence is provided by the Integrated Runway Sequence function
- The sequence manager has verified that the Integrated Runway Sequence function is configured according to the operational needs;
- -Start-up has been performed within calculated TSAT.

Assumptions

- Impacted flights are in contact with TWR Ground Control;
- All manual actions (if any) are performed by TWR Ground Control;
- Changes impact only TWR.

This generic use case covers the following operational situations:

1. **Sequence Changes due to TSAT window**: departure flight AC-1 initially planned ahead of departure flight AC-2 calls within the TSAT window but too late with a potential impact on the sequence. Several strategies can apply in this case:

   The **possibility for Recovering the Plan** is given if:

   - AC-2 can be overtaken by AC-1,
     - e.g. manual sequence change at taxiway intersection
     - different taxi speeds
     - using different runway intersections for take-off

   The **possibility for Updating the Plan** is given if:

     - AC-1 and AC-2 are the same vortex category and same SID (if SID is relevant for separation)
     - No runway waiting time is expected (few departure demand)

   The **need for Updating the Plan** is given if:

     - The plan can be improved (capacity prioritised over predictability)
     - The plan is not feasible any more
       - The actual time plus remaining taxi time is bigger than TTOT

- Sequence is changed compared to plan and there is no possibility for overtaking (ac on same taxiway and same intersection)

2. Integrated Runway Sequence **with aircraft not ready at TTOT:** The departing flight was ready at TSAT but is not ready at TTOT due to taxi delay.

Main Flow

Alternative 1: Automatic re-calculation of the sequence

[1] Tower Ground Controller monitors taxi and receives automatic update of TTOT based on the remaining taxi time and on local constraints at the airport (on apron, taxiways and/or runways).

[2] Tower Ground Controller provides new TTOT to the Flight Crew.

[3] Tower Ground Controller or Tower Runway Controller re-sequences the other departures if required based on the updated sequence.

Alternative 2: Manual update of the TTOT

[1] Tower Ground Controller manually re-sequences the flight and provides the Flight Crew with the new TTOT.

[2] Tower Runway Controller or Tower Runway Controller manually adjusts the sequence if required and provides new TTOT and sequence number to the Flight Crew of the impacted flights.

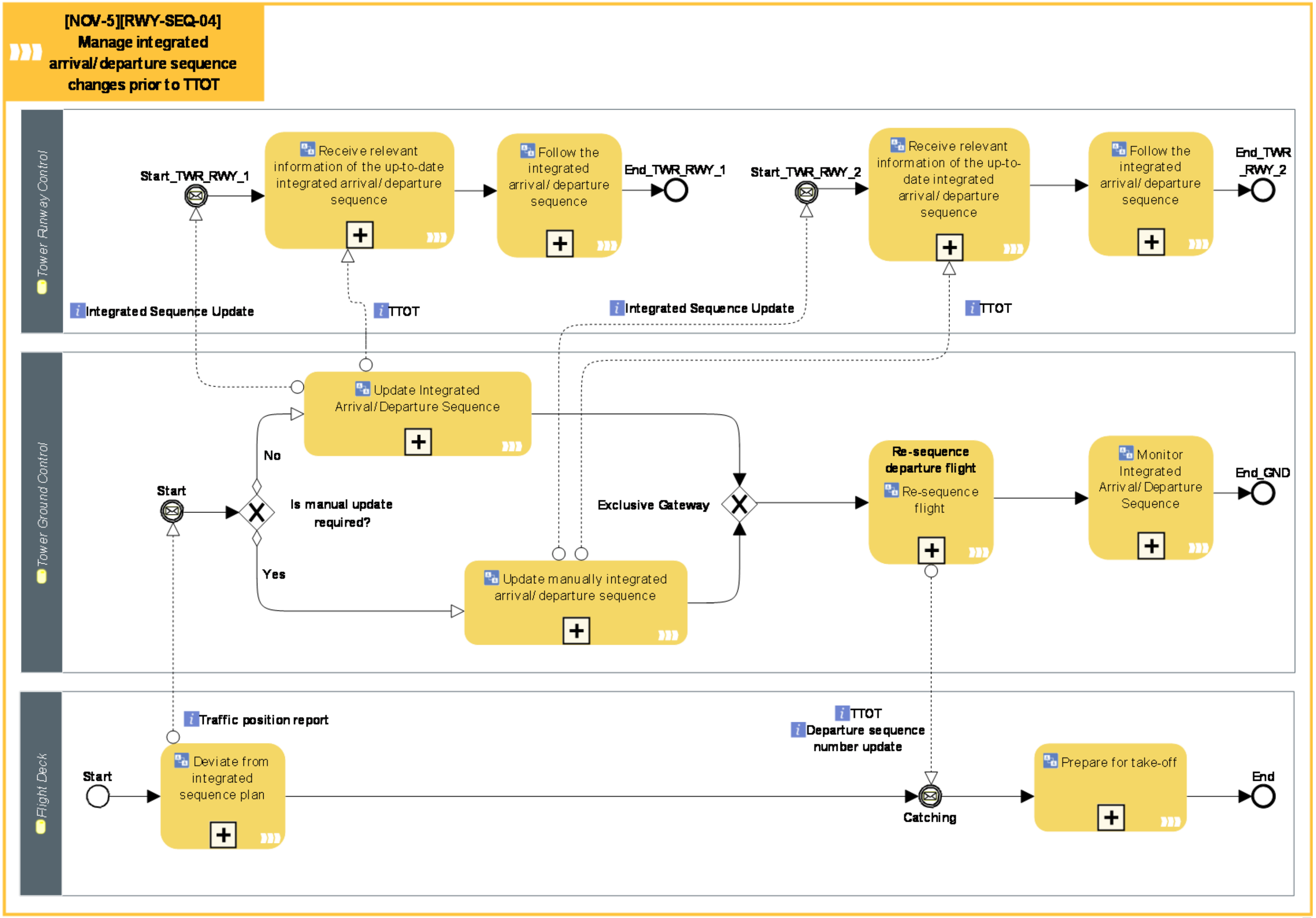


Figure 13: [NOV-5][RWY-SEQ-04] Manage integrated arrival/departure sequence changes prior to TTOT Use Case diagram (NOV-5 diagram)

Diagram Id: 3F20665A5AF18588

Activity	Description
Deviate from integrated sequence plan	Flight does not meet target times calculated by the Integrated Runway Sequence function in the integrated arrival/departure sequence and therefore deviates from the proposed plan.
Follow the integrated arrival/departure sequence	ATCOs follow the plan proposed by means of the integrated arrival/departure sequence, i.e. they provide all necessary clearances and instructions to meet the target times of the integrated arrival/departure sequence calculated by the Integrated Runway Sequence function.
Monitor Integrated Arrival/Departure Sequence	The ATCOs monitor the integrated arrival/departure sequence computed by the Integrated Runway Sequence function and that constitutes the plan they have to follow.
Prepare for take-off	Flight deck prepares for take-off at the planned TTOT.
Re-sequence flight	ATCOs can modify the position of a flight in the integrated arrival/departure sequence (modification of the sequence order). This is normally done via a manual action.
Receive relevant information of the up-to-date integrated arrival/departure sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is shared between En-Route, APP and TWR controllers. Any change into the sequence (manual or automatic update) triggers an update of the relevant information provided to the different ATCO.
Update Integrated Arrival/Departure Sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is updated automatically further to certain events (e.g. TOBT update, trajectory re-calculations) and also further to certain ATCO actions (e.g. RWY closure, Go-around input), depending on local implementation.
Update manually integrated arrival/departure sequence	ATCOs can manually change the integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function, depending on local implementation (e.g. move manually a flight in the sequence, swap flights, modify spacing).

Table 22: [NOV-5][RWY-SEQ-04] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Ground Control	Update manually integrated arrival/departure sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	TTOT	TargetTakeOffTime

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Ground Control	Re-sequence departure flight o--> Catching	Flight Deck	Departure sequence number update	DepartureOperations
Tower Ground Control	Re-sequence departure flight o--> Catching	Flight Deck	Departure sequence number update	DepartureSequence
Tower Ground Control	Re-sequence departure flight o--> Catching	Flight Deck	TTOT	TargetTakeOffTime
Tower Ground Control	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	TTOT	TargetTakeOffTime
Tower Ground Control	Update manually integrated arrival/departure sequence o--> Start_TWR_RWY_2	Tower Runway Control	Integrated Sequence Update	ApproachSequence
Tower Ground Control	Update manually integrated arrival/departure sequence o--> Start_TWR_RWY_2	Tower Runway Control	Integrated Sequence Update	DepartureSequence
Flight Deck	Deviate from integrated sequence plan o--> Start	Tower Ground Control	Traffic position report	PositioningInformation
Tower Ground Control	Update Integrated Arrival/Departure Sequence o--> Start_TWR_RWY_1	Tower Runway Control	Integrated Sequence Update	ApproachSequence
Tower Ground Control	Update Integrated Arrival/Departure Sequence o--> Start_TWR_RWY_1	Tower Runway Control	Integrated Sequence Update	DepartureSequence

Table 23: [NOV-5][RWY-SEQ-04] Use Case information and information exchanges

3.4.1.1.5 [NOV-5][RWY-SEQ-05] Manage integrated arrival/departure sequence changes impacting sequence order

General Conditions (Scope and Summary)

This Use Case describes how to manage the situation when the integrated arrival/departure sequence order cannot be followed due to last time events. For this use case, 2 options are possible: either the Integrated Runway Sequence function re-calculates automatically the integrated sequence based on current traffic situation and local rules or the controller updates the sequence manually to fit to the new plan.

Pre-Conditions

- Airport CDM process is in place and there is an agreed business trajectory
- An integrated sequence is provided by the Integrated Runway Sequence function

Assumptions

- Flight deviating from plan is in contact with TWR Runway Control;
- Manual updates of the sequence are done by TWR Runway Controller;
- Changes in the sequence impact only TWR (impacted flights are normally in contact with Tower Runway Control, but can also be in contact with Tower Ground Control) and Approach.
- The spacing problem is limited to a couple of arrivals approaching and can be managed in a tactical way. If the spacing problem is systematic for the whole sequence, refer to use case of manual change of Integrated Runway Sequence function configuration.

Post-Conditions

All impacted flights follow their life cycle:

- In Alternative 1, another departure able to take the gap between arrivals takes-off and the originally planned departure will take off at a later time.
- In Alternative 2, the gap between arrivals is wasted and all departures take-off at a later time.

Main Flow

Alternative 1: An aircraft that requires less departure time (runway occupancy time) is available to safely use the actual arrival gap.

[1] The Tower Runway Controller manually places the waiting aircraft (available to safety use the gap between arrivals) at the head of the departure sequence (normally by making a manual swap of sequence order with the originally planned departure).

[2] The Tower Runway Controller, using the Integrated Runway Sequence function, re-sequences the departure that can't take the gap moving it to the earliest place in the sequence and updates the rest of the sequence, adjusting the spacing to succeeding aircraft if necessary.

[3] The Tower Runway Controller clears the waiting aircraft (available to safely use the actual gap) for take-off.

Alternative 2: The actual arrival gap cannot be used by any awaiting departure.

[1] The Tower Runway Controller checks to see if the departing aircraft can comply with its TTOT once it has been held to allow the second arrival to land. If there is enough margin between the TTOT and the updated new planned take-off time and that the runway approach area is clear prior to providing by R/T the line-up instruction to the aircraft, the flow continues as planned.

[2] The Tower Runway Controller monitors progress and after flight is airborne (ATOT set) the runway sequence will be updated.

Alternative option is for the Tower Runway Controller to update the TTOT prior take-off and the Integrated Runway Sequence function will update the sequence and TTOTs as necessary.

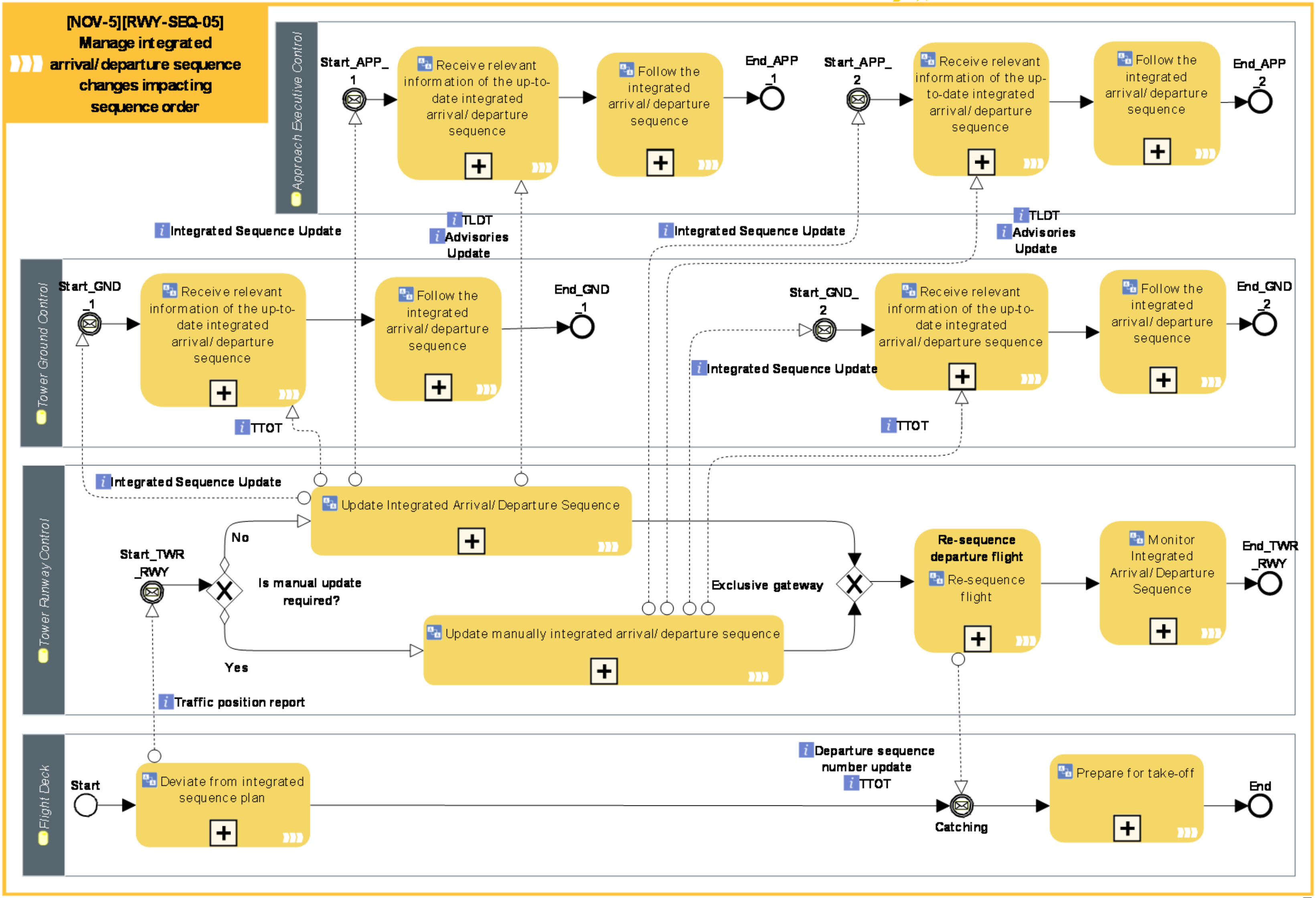


Figure 14: [NOV-5][RWY-SEQ-05] Manage integrated arrival/departure sequence changes impacting sequence order Use Case diagram (NOV-5 diagram)

Diagram Id: F7867BDF5AF07790

Activity	Description
Deviate from integrated sequence plan	The flight does not match the integrated sequence plan for various reasons that might depend on its own behavior (e.g. slow taxi, not ready at TTOT) or on the context (e.g. spacing between arrivals not sufficient)
Follow the integrated arrival/departure sequence	ATCOs follow the plan proposed by means of the integrated arrival/departure sequence, i.e. they provide all necessary clearances and instructions to meet the target times of the integrated arrival/departure sequence calculated by the Integrated Runway Sequence function.
Monitor Integrated Arrival/Departure Sequence	The ATCOs monitor the integrated arrival/departure sequence computed by the Integrated Runway Sequence function and that constitutes the plan they have to follow.
Prepare for take-off	Flight deck prepares for take-off at the planned TTOT.
Re-sequence flight	ATCOs can modify the position of a flight in the integrated arrival/departure sequence (modification of the sequence order). This is normally done via a manual action.
Receive relevant information of the up-to-date integrated arrival/departure sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is shared between En-Route, APP and TWR controllers. Any change into the sequence (manual or automatic update) triggers an update of the relevant information provided to the different ATCO.
Update Integrated Arrival/Departure Sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is updated automatically further to certain events (e.g. TOBT update, trajectory re-calculations) and also further to certain ATCO actions (e.g. RWY closure, Go-around input), depending on local implementation.
Update manually integrated arrival/departure sequence	ATCOs can manually change the integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function, depending on local implementation (e.g. move manually a flight in the sequence, swap flights, modify spacing).

Table 24: [NOV-5][RWY-SEQ-05] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Advisories Update	ArrivalManagementAdvisory

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	TLDT	TargetLandingTime
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Start_APP_2	Approach Executive Control	Integrated Sequence Update	ApproachSequence
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Start_APP_2	Approach Executive Control	Integrated Sequence Update	DepartureSequence
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Start_GND_2	Tower Ground Control	Integrated Sequence Update	ApproachSequence
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Start_GND_2	Tower Ground Control	Integrated Sequence Update	DepartureSequence
Flight Deck	Deviate from integrated sequence plan o--> Start_TWR_RWY	Tower Runway Control	Traffic position report	PositioningInformation
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Start_APP_1	Approach Executive Control	Integrated Sequence Update	ApproachSequence
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Start_APP_1	Approach Executive Control	Integrated Sequence Update	DepartureSequence

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Start_GND_1	Tower Ground Control	Integrated Sequence Update	ApproachSequence
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Start_GND_1	Tower Ground Control	Integrated Sequence Update	DepartureSequence
Tower Runway Control	Re-sequence departure flight o--> Catching	Flight Deck	Departure sequence number update	DepartureOperations
Tower Runway Control	Re-sequence departure flight o--> Catching	Flight Deck	Departure sequence number update	DepartureSequence
Tower Runway Control	Re-sequence departure flight o--> Catching	Flight Deck	TTOT	TargetTakeOffTime
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	TTOT	TargetTakeOffTime
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	TTOT	TargetTakeOffTime

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Advisories Update	ArrivalManagementAdvisory
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	TLDT	TargetLandingTime

Table 25: [NOV-5][RWY-SEQ-05] Use Case information and information exchanges

3.4.1.1.6 [NOV-5][RWY-SEQ-06] Manage planned runway closure (using arrival/departure integrated sequence)

General Conditions (Scope and Summary)

This Use Case describes the management of the situation when it is necessary to temporary close the runway (planned closure 60 min in advance –e.g. maintenance, runway inspection).

Pre-Conditions

- Airport CDM process is in place and there is an agreed business trajectory
- Advanced HMI exists for TWR Supervisor to input runway closure
- An integrated sequence is provided by the Integrated Runway Sequence function
- The Integrated Runway Sequence function takes into account runway closure and holding clearance inputs to update the integrated sequence

Assumptions

Planned RWY closure is announced early in advance so that the closure will not affect arrival aircraft already in the TMA (landing before the closure period) or departure aircraft already taxiing. This is done after coordination between APP and TWR.

Main Flow

[1] The Tower Supervisor assesses the impact of the runway closure on the integrated sequence (e.g. using what-if assistance) and decides on the planned closure and re-opening time of the runway.

[2] The TWR Supervisor inputs runway closure period with start and end times into the HMI.

[3] ATC Sector Executive Controllers (ACC and APP) receive the relevant information on the up-to-date integrated sequence (TLDT, TTL/TTG and sequence numbers).

[4] TWR Runway Controller and TWR Ground Controller receive the relevant information on the up-to-date integrated sequence (TLDT, TTOT and sequence numbers).

[5] TWR Clearance Delivery and Apron Manager receive the relevant information on the up-to-date integrated sequence (TTOT, TSAT).

[6] Airspace User OPS Support of re-scheduled departures receive the relevant information on the delay, updates TOBT as required

[7] Airspace User OPS inform Flight Crew (pilots) of the delay.

[8] ATC Sector Executive Controllers (ACC) provide speed reduction and vectoring instructions to Flight Crew of re-scheduled arrivals in order to absorb the additional delay (runway closure period) unless the flights can be directed to another active runway.

[9] Flight Crew (pilots) of re-scheduled departure flights contact TWR Clearance Delivery within the new TSAT window.

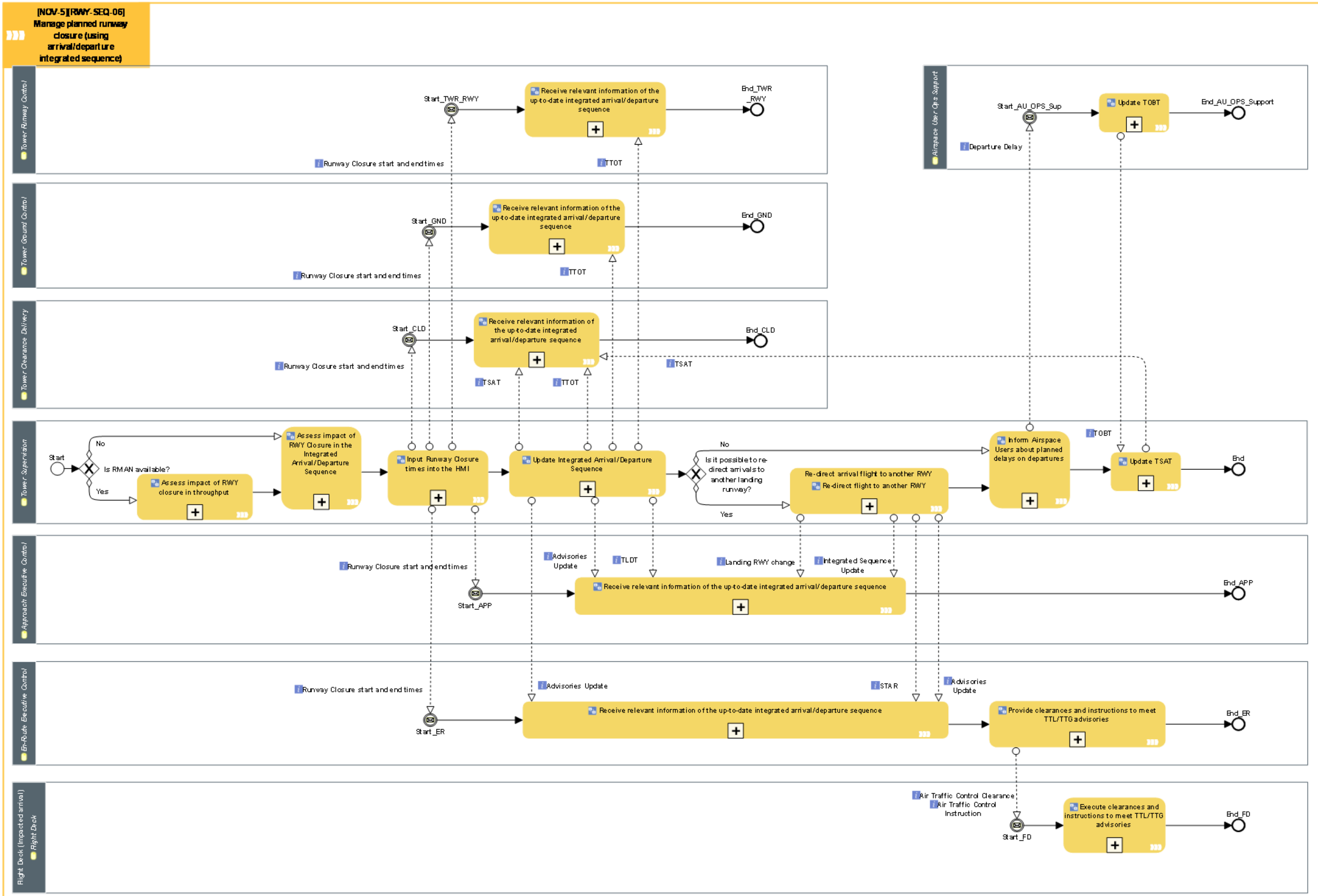


Figure 15: [NOV-5][RWY-SEQ-06] Manage planned runway closure (using arrival/departure integrated sequence) Use Case diagram (NOV-5 diagram)

Diagram Id: FB9E02F55ABA67AE

Activity	Description
Assess impact of RWY Closure in the Integrated Arrival/Departure Sequence	TWR Supervisor assesses the impact of a RWY closure in the integrated arrival/departure sequence calculated by Integrated Runway Sequence function (mainly impact in delays). When RMAN is available, this assessment can be done with what-if functionality of RMAN. Otherwise, TWR Supervisor will use what-if functions linked to Integrated Runway Sequence function.
Assess impact of RWY closure in throughput	When RMAN is available, TWR Supervisor uses it to assess the impact of a runway closure in the throughput. Based on the options proposed by the RMAN (e.g. a new configuration that reduces the expected delays and assigns forecasted times and runway allocation per flight), the TWR Supervisor decides on the planned closure period.
Execute clearances and instructions to meet TTL/TTG advisories	The Flight Deck executes the clearances and instructions provided by the executive controller in order to meet the TTL/TT advisories.
Inform Airspace Users about planned delays on departures	The TWR Supervisor will inform the Airspace Users OPS Support about the possible delays on departures according to the A-CDM process.
Input Runway Closure times into the HMI	TWR Supervisor inputs the RWY closure start and end times into the HMI of the CWP. This information is distributed to all concerned actors (En-Route/Approach Executive Control, TWR Clearance Delivery, TWR Ground Control and TWR RWY Control)
Provide clearances and instructions to meet TTL/TTG advisories	En-Route/Approach ATS provides clearances and instructions to Flight Deck in order to meet TTL/TTG (time to lose/time to gain) advisories for arriving flights.
Re-direct arrival flight to another RWY	When possible and suitable according to assessment done prior to RWY Closure, if a RWY devoted to arrivals is closed, TWR Supervisor will re-direct the traffic to another RWY and either make the necessary manual updates in the integrated arrival/departure sequence or trigger an automatic re-calculation or the integrated arrival/departure sequence.
Receive relevant information of the up-to-date integrated arrival/departure sequence	TWR Ground Controller receives the relevant information further to the integrated arrival/departure sequence update performed by Integrated Runway Sequence function: up-to-date integrated sequence (sequence number and spacing) and up-to-date TTOT.
Receive relevant information of the up-to-date integrated arrival/departure sequence	TW Clearance Deliver Controller receives the relevant information further to the integrated arrival/departure sequence update performed by Integrated Runway Sequence function: up-to-date TSAT and TTOT.
Receive relevant information of the up-to-date integrated arrival/departure sequence	En-Route executive controller receive the relevant information further to the integrated arrival/departure sequence update performed by Integrated Runway Sequence function: up-to-date TTL/TTG advisories.

Receive relevant information of the up-to-date integrated arrival/departure sequence	En-Route Approach Controller receives the relevant information further to the integrated arrival/departure sequence update performed by Integrated Runway Sequence function: up-to-date integrated sequence (sequence number of all flights and spacing), up-to-date TLDT and TTOT and up-to-date TTL/TTG advisories.
Receive relevant information of the up-to-date integrated arrival/departure sequence	TWR Runway Controller receives the relevant information further to the integrated arrival/departure sequence update performed by Integrated Runway Sequence function: up-to-date integrated sequence (sequence number and spacing) and up-to-date TTOT.
Update Integrated Arrival/Departure Sequence	The Integrated Runway Sequence function updates the integrated arrival/departure sequence based on the RWY Closure input made by the TWR Supervisor.
Update TOBT	When delays for departures are announced by ATC, Airspace Users OPS Support updates TOBT accordingly.
Update TSAT	The Integrated Runway Sequence function adjusts TSAT according to the new TOBT information provided by the Airspace Users OPS Support.

Table 26: [NOV-5][RWY-SEQ-06] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Input Runway Closure times into the HMI o--> Start_ER	En-Route Executive Control	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Inform Airspace Users about planned delays on departures o--> Start_AU_OPS_Sup	Airspace User Ops Support	Departure Delay	GroundDelayProgramme
Tower Supervision	Input Runway Closure times into the HMI o--> Start_APP	Approach Executive Control	Runway Closure start and end times	RunwayConfiguration
En-Route Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o--> Start_FD	Flight Deck (Impacted arrival)	Air Traffic Control Instruction	ATCInstruction
En-Route Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o--> Start_FD	Flight Deck (Impacted arrival)	Air Traffic Control Clearance	ATCClearance

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Input Runway Closure times into the HMI o--> Start_GND	Tower Ground Control	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Input Runway Closure times into the HMI o--> Start_TWR_RWY	Tower Runway Control	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Input Runway Closure times into the HMI o--> Start_CLD	Tower Clearance Delivery	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Input Runway Closure times into the HMI o-->	Tower Clearance Delivery	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	En-Route Executive Control	Advisories Update	ArrivalManagementAdvisory
Tower Supervision	Input Runway Closure times into the HMI o-->	En-Route Executive Control	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Input Runway Closure times into the HMI o-->	En-Route Executive Control	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Input Runway Closure times into the HMI o-->	En-Route Executive Control	Runway Closure start and end times	RunwayConfiguration
En-Route Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o-->	En-Route Executive Control	Air Traffic Control Clearance	ATCClearance

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Re-direct arrival flight to another RWY o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	En-Route Executive Control	STAR	StandardInstrumentArrival
Tower Supervision	Re-direct arrival flight to another RWY o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	En-Route Executive Control	Advisories Update	ArrivalManagementAdvisory
En-Route Executive Control	Provide clearances and instructions to meet TTL/TTG advisories o-->	En-Route Executive Control	Air Traffic Control Instruction	ATCInstruction
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Advisories Update	ArrivalManagementAdvisory
Tower Supervision	Re-direct arrival flight to another RWY o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Landing RWY change	RunwayConfiguration
Tower Supervision	Input Runway Closure times into the HMI o-->	Approach Executive Control	Runway Closure start and end times	RunwayConfiguration

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	TLDT	TargetLandingTime
Tower Supervision	Re-direct arrival flight to another RWY o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Re-direct arrival flight to another RWY o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	TTOT	TargetTakeOffTime
Tower Supervision	Inform Airspace Users about planned delays on departures o-->	Tower Runway Control	Departure Delay	GroundDelayProgramme

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	TSAT	TargetStartUpApprovalTime
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	TTOT	TargetTakeOffTime
Airspace User Ops Support	Update TOBT o--> Update TSAT	Tower Supervision	TOBT	TargetOffBlockTime
Tower Supervision	Update TSAT o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	TSAT	TargetStartUpApprovalTime
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	TTOT	TargetTakeOffTime

Table 27: [NOV-5][RWY-SEQ-06] Use Case information and information exchanges

3.4.1.1.7 [NOV-5][RWY-SEQ-07] Manage unplanned Runway Closure (using arrival/departure integrated sequence)

General Conditions (Scope and Summary)

This Use Case describes the management of the situation when it is necessary to instantly close the active runway (unplanned closure of runway, a shorter period of time, for inspection after bird strike or FOD). The use case focuses on the specificity of an unplanned runway closure compared to a planned runway closure, i.e. the management of departures already taxiing and the management of arrivals already in the TMA.

Pre-Conditions

- Advanced HMI exists for TWR Supervisor to input runway closure
- Advanced HMI exists for APP and ACC controllers to input holding clearances
- An integrated sequence is provided by the Integrated Runway Sequence function
- The Integrated Runway Sequence function takes into account runway closure and holding clearance inputs to update the integrated sequence

Assumptions

Unplanned RWY closure will immediately affect arrival aircraft already in the TMA and departure aircraft already taxiing. Go arounds might be required if there are flights in short final. Arriving flights not yet in the TMA might be also impacted. The absorption of the supplementary unplanned delay will require holding.

It is assumed that the impacted departures having started taxi are in contact with the TWR Ground Controller and that the impacted arrivals are in contact with Approach and En-Route Control. The impact on TWR Clearance Delivery and TWR Runway Control in the frame of the concept is the same as for a planned runway closure (refer to [NOV-5][RWY-SEQ-06] Manage Planned Runway Closure), therefore it is not described in this use case.

Main Flow

[1] The Tower Supervisor estimates how long the runway will need to be closed for

[2] The Tower Supervisor inputs the closure and the planned re-opening time into the HMI and informs Approach.

[3] ATC Sector Executive Controllers (ACC and APP) receive the relevant information on the up-to-date integrated sequence (TLDT, TTL/TTG and sequence numbers).

[4] TWR Runway Controller and TWR Ground Controller receive the relevant information on the up-to-date integrated sequence (TLDT, TTOT and sequence numbers).

[5] TWR Clearance Delivery and Apron Manager receive the relevant information on the up-to-date integrated sequence (TTOT, TSAT).

[6] TWR Ground Controller provides information about the delay to the Flight Crew of departing aircraft already taxiing or re-routes the flight to other runways if available. If the delay is likely to last for an extended period it may happen that the TWR Ground Controller instructs the Flight Crew to hold at the holding point or to return back to stand.

[7] Flight Crew of impacted departures follow TWR Ground Controller instructions and hold at the holding point or modify taxi route to proceed to another runway or to return back to stand. In case of holding for an extended period, they might shut down engines.

[8] If flight is in short final, TWR Runway Controller instructs the Flight Crew to perform a go-around.

[9] The Flight Crew of flight in short final performs the go-around (refer to use case [NOV-5][RWY-SEQ-08).

[10] ATC Sector Executive Controllers (APP) instruct the Flight Crew of the impacted arriving aircraft to break off their approach and to hold until the runway is reopened and make the necessary holding clearance inputs in the HMI.

[11] Flight Crew of impacted arriving aircraft perform holding as instructed.

[12] If arriving aircraft don't have sufficient fuel, ATC Sector Executive Controller (APP) instructs the Flight Crew to divert to another airport.

[13] Flight Crew performs diversion to another airport as instructed.

[14] At airports with more than one runway in use for arrivals, the ATC Sector Executive Controller (APP) manually moves the impacted flights to the sequence of the available (open) runway and instructs the Flight Crew to approach to the other runway

[15] Flight Crew performs approach to the other runway as instructed.

[16] ATC Sector Executive Controllers (ACC) instruct the Flight Crew of the impacted arriving aircraft to hold and make the necessary holding clearance inputs in the HMI.

[17] Flight Crew of impacted arriving aircraft perform holding as instructed.

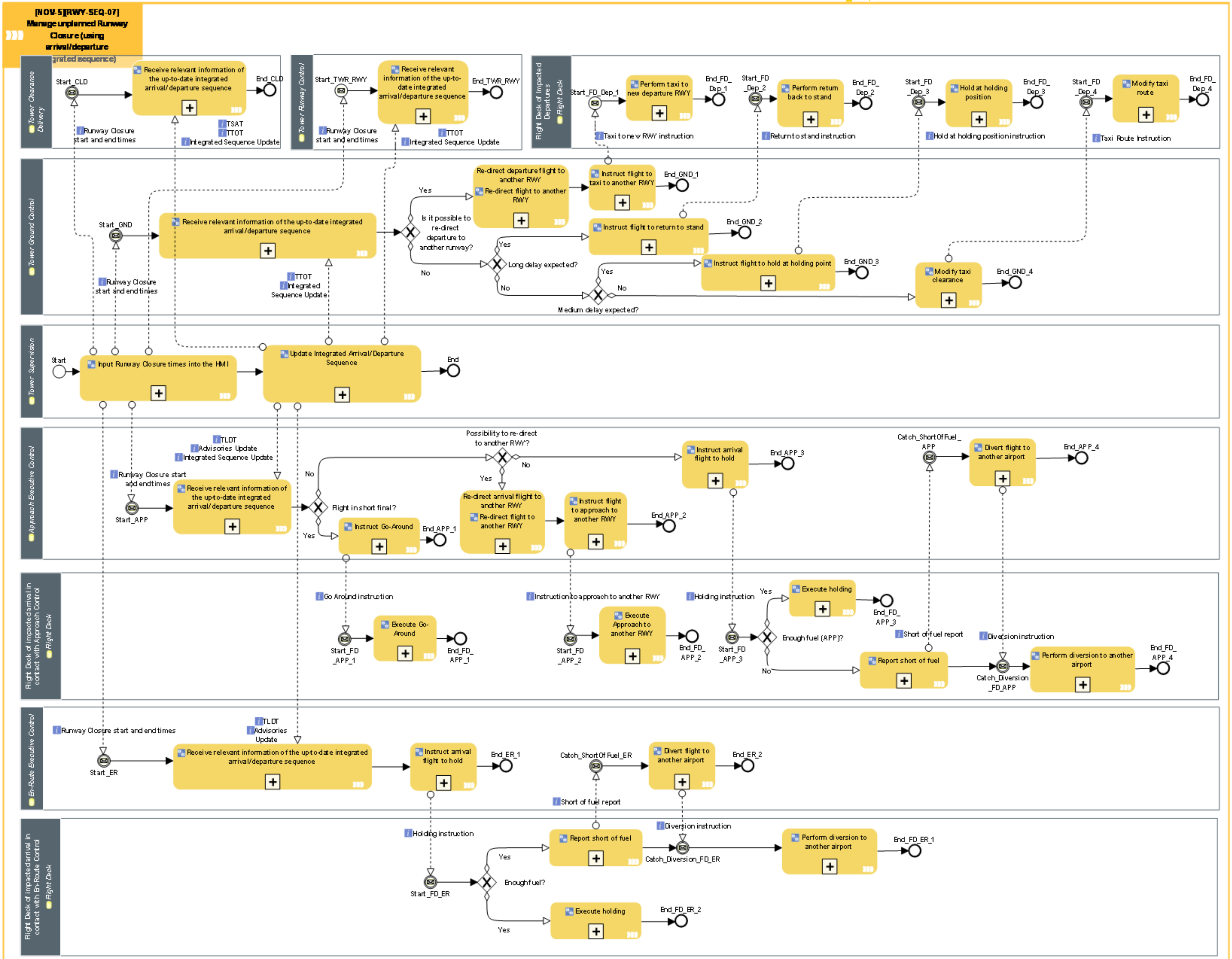


Figure 16: [NOV-5][RWY-SEQ-07] Manage unplanned runway closure (using arrival/departure integrated sequence) Use Case diagram (NOV-5 diagram)

Diagram Id: 056E06715ABD6EF5

Activity	Description
Divert flight to another airport	ATCO might make a diversion of a flight to an alternate airport if required in certain circumstances (e.g. pilot reports short of fuel and unable to land at the TLDT).
Execute Approach to another RWY	On ATCOs instruction, when a flight is re-directed to another runway, the pilot executes an approach to the new landing runway.
Execute Go-Around	The pilot executes a go-around in case it is unable to land on the runway, for whatever reasons. The go-around can be executed on pilot's decision or further to a go-around instruction from ATC.
Execute holding	On ATCOs instruction, pilot executes holding in order to absorb TTL.
Hold at holding position	On ATCOs instruction, the pilot holds at the runway holding position.
Input Runway Closure times into the HMI	The TWR Supervisor inputs RWY closure start and end times into the appropriate HMI. This information will be distributed to the concerned ATCOs.
Instruct arrival flight to hold	The ATCO instructs the flight to hold in order to absorb TTL.
Instruct flight to approach to another RWY	The ATCO re-directs the flight to another landing runway (if available) and issues the appropriate instructions to the pilot. This action might require a manual action to swap the flight from one runway sequence to another.
Instruct flight to hold at holding point	The ATCO instructs the pilot of a departure flight to hold at its holding position.
Instruct flight to return to stand	If the delay for a departure flight already taxiing is too long, the ATCO instructs the pilot to return to stand.
Instruct flight to taxi to another RWY	If a departure flight is re-directed to another runway, the Tower Ground Controller instructs the pilot to change its taxi route and taxi to the new runway.
Instruct Go-Around	ATCO instructs the pilot of an arrival flight to perform a go-around.
Modify taxi clearance	Tower Ground Controller modifies the taxi clearance of a departure flight already taxiing if the taxi route needs to be modified.
Modify taxi route	For different reasons, the taxi route may need to be modified. It may be re-calculated by the Route Generation Algorithm in automatic mode taking into account the new constraints or modified in semi-automatic or manual mode by the Tower Ground Controller. The ATC system re-calculates the corresponding estimated taxi time, and if necessary updates the EIBT.
Perform diversion to another airport	The pilot performs diversion to an alternate airport.
Perform return back to stand	On Ground Controller's instruction, the pilot of a departure flight already taxiing returns back to stand.
Perform taxi to new departure RWY	On Ground Controller's instruction, the pilot of a departure flight that has been re-directed to a new departure runway taxies to that runway.
Re-direct flight to another	ATCO re-directs a flight to another runway (if available).

RWY	
Receive relevant information of the up-to-date integrated arrival/departure sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is shared between En-Route, APP and TWR controllers. Any change into the sequence (manual or automatic update) triggers an update of the relevant information provided to the different ATCO.
Report short of fuel	The pilot reports short of fuel to ATC.
Update Integrated Arrival/Departure Sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is updated automatically further to certain events (e.g. TOBT update, trajectory re-calculations) and also further to certain ATCO actions (e.g. RWY closure, Go-around input), depending on local implementation.

Table 28: [NOV-5][RWY-SEQ-07] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
En-Route Executive Control	Divert flight to another airport o-->	Flight Deck of impacted arrival in contact with En-Route Control	Diversion instruction	ATCInstruction
Flight Deck of impacted arrival in contact with En-Route Control	Report short of fuel o-->	Flight Deck of impacted arrival in contact with En-Route Control	Short of fuel report	AIRM_OutOfScope
En-Route Executive Control	Instruct arrival flight to hold o-->	Flight Deck of impacted arrival in contact with En-Route Control	Holding instruction	ATCInstruction
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	En-Route Executive Control	Advisories Update	ArrivalManagementAdvisory
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	En-Route Executive Control	TLDT	TargetLandingTime

Issuer	Info Flow	Addressee	Info Element	Info Entity
Approach Executive Control	Instruct Go-Around o--> Start_FD_APP_1	Flight Deck of impacted arrival in contact with Approach Control	Go Around instruction	ATCInstruction
En-Route Executive Control	Divert flight to another airport o--> Catch_Diversion_FD_ER	Flight Deck of impacted arrival in contact with En-Route Control	Diversion instruction	ATCInstruction
Approach Executive Control	Instruct arrival flight to hold o--> Start_FD_APP_3	Flight Deck of impacted arrival in contact with Approach Control	Holding instruction	ATCInstruction
Approach Executive Control	Divert flight to another airport o--> Catch_Diversion_FD_APP	Flight Deck of impacted arrival in contact with Approach Control	Diversion instruction	ATCInstruction
Approach Executive Control	Instruct flight to approach to another RWY o--> Start_FD_APP_2	Flight Deck of impacted arrival in contact with Approach Control	Instruction to approach to another RWY	ATCInstruction
En-Route Executive Control	Instruct arrival flight to hold o--> Start_FD_ER	Flight Deck of impacted arrival in contact with En-Route Control	Holding instruction	ATCInstruction
Tower Supervision	Input Runway Closure times into the HMI o--> Start_ER	En-Route Executive Control	Runway Closure start and end times	RunwayConfiguration
Flight Deck of impacted arrival in contact with En-Route Control	Report short of fuel o--> Catch_ShortOfFuel_ER	En-Route Executive Control	Short of fuel report	AIRM_OutOfScope
Tower Supervision	Input Runway Closure times into the HMI o--> Start_TWR_RWY	Tower Runway Control	Runway Closure start and end times	RunwayConfiguration

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	TTOT	TargetTakeOffTime
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	TSAT	TargetStartUpApprovalTime
Tower Supervision	Input Runway Closure times into the HMI o-->	Tower Clearance Delivery	Runway Closure start and end times	RunwayConfiguration

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Input Runway Closure times into the HMI o-->	Tower Ground Control	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	Integrated Sequence Update	DepartureSequence

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	TTOT	TargetTakeOffTime
Tower Supervision	Input Runway Closure times into the HMI o-->	Tower Ground Control	Runway Closure start and end times	RunwayConfiguration
Tower Supervision	Input Runway Closure times into the HMI o-->	Tower Ground Control	Runway Closure start and end times	RunwayConfiguration
Flight Deck of impacted arrival in contact with Approach Control	Report short of fuel o-->	Tower Ground Control	Short of fuel report	AIRM_OutOfScope
Approach Executive Control	Instruct arrival flight to hold o-->	Tower Ground Control	Holding instruction	ATCInstruction
Tower Ground Control	Instruct flight to hold at holding point o-->	Tower Ground Control	Hold at holding position instruction	ATCInstruction
Tower Ground Control	Instruct flight to hold at holding point o-->	Tower Ground Control	Hold at holding position instruction	DepartureOperations
Approach Executive Control	Divert flight to another airport o-->	Tower Ground Control	Diversion instruction	ATCInstruction
Tower Ground Control	Modify taxi clearance o-->	Tower Ground Control	Taxi Route Instruction	TaxiRouteInstruction
Approach Executive Control	Instruct flight to approach to another RWY o-->	Tower Ground Control	Instruction to approach to another RWY	ATCInstruction

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Advisories Update	ArrivalManagementAdvisory
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Control	TLDT	TargetLandingTime
Approach Executive Control	Instruct Go-Around o-->	Approach Executive Control	Go Around instruction	ATCInstruction
Tower Supervision	Input Runway Closure times into the HMI o--> Start_APP	Approach Executive Control	Runway Closure start and end times	RunwayConfiguration

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Input Runway Closure times into the HMI o--> Start_CLD	Tower Clearance Delivery	Runway Closure start and end times	RunwayConfiguration
Flight Deck of impacted arrival in contact with Approach Control	Report short of fuel o--> Catch_ShortOfFuel _APP	Approach Executive Control	Short of fuel report	AIRM_OutOfScope
Tower Ground Control	Instruct flight to return to stand o–> Start_FD_Dep_2	Flight Deck of Impacted Departures	Return to stand instruction	ATCInstruction
Tower Ground Control	Modify taxi clearance o--> Start_FD_Dep_4	Flight Deck of Impacted Departures	Taxi Route Instruction	TaxiRouteInstruction
Tower Ground Control	Instruct flight to hold at holding point o--> Start_FD_Dep_3	Flight Deck of Impacted Departures	Hold at holding position instruction	ATCInstruction
Tower Ground Control	Instruct flight to hold at holding point o--> Start_FD_Dep_3	Flight Deck of Impacted Departures	Hold at holding position instruction	DepartureOperations
Tower Supervision	Input Runway Closure times into the HMI o--> Start_GND	Tower Ground Control	Runway Closure start and end times	RunwayConfiguration
Tower Ground Control	Instruct flight to taxi to another RWY o--> Start_FD_Dep_1	Flight Deck of Impacted Departures	Taxi to new RWY instruction	TaxiRouteInstruction
Tower Ground Control	o--> Start_FD_Dep_2	Flight Deck of Impacted Departures	Return to stand instruction	ATCInstruction
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	Integrated Sequence Update	ApproachSequence

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	TTOT	TargetTakeOffTime

Table 29: [NOV-5][RWY-SEQ-07] Use Case information and information exchanges

3.4.1.1.8 [NOV-5][RWY-SEQ-08] Manage integrated arrival/departure sequence in case of Go-Around

General Conditions (Scope and Summary)

This use case describes the management of the integrated arrival/departure sequence when a go-around needs to be initiated due to special occurrences (e.g. missed approach, aircraft on runway, technical failure etc.). In this case the aircraft conducting a go-around as well as the aircraft retained from take-off need to be re-sequenced.

Pre-Conditions

- An integrated sequence is provided by the Integrated Runway Sequence function
- Flight performing a go around is within the stable or frozen Integrated Runway Sequence function time horizon

Assumptions

- The flight is in contact with Tower Runway Controller.

Main Flow

Alternative 1: Flight performing go-around is manually re-sequenced

[1] The TWR controller coordinates with Approach controller and manually re-sequences the flight. At airports with two runways in use for arrivals there is an option to after a Go-Around, manually move the arrival flight to the other parallel runway in use, to reduce overall delay.

[2] The APP controller, after dialogue with TWR controller, follows the updated sequence.

[3] Airport Tower Supervisor monitors the updated sequence.

[4] TWR controller manually re-sequences impacted departures if needed.

Alternative 2: Flight performing go-around is automatically re-sequenced (go-around input from Tower Runway Controller required)

[1] The Tower Runway Controller makes a go-around input and the flight is automatically re-sequenced at the first available and reachable place in the sequence, depending on local parameterisation. At airports with two runways in use for arrivals there is an option to after a Go-Around, automatically move the arrival flight to the other parallel runway in use, to reduce overall delay.

[2] The APP controller follows the updated sequence.

[3] Airport Tower Supervisor monitors the updated sequence.

[4] TWR controller manually adjusts the sequence if required.

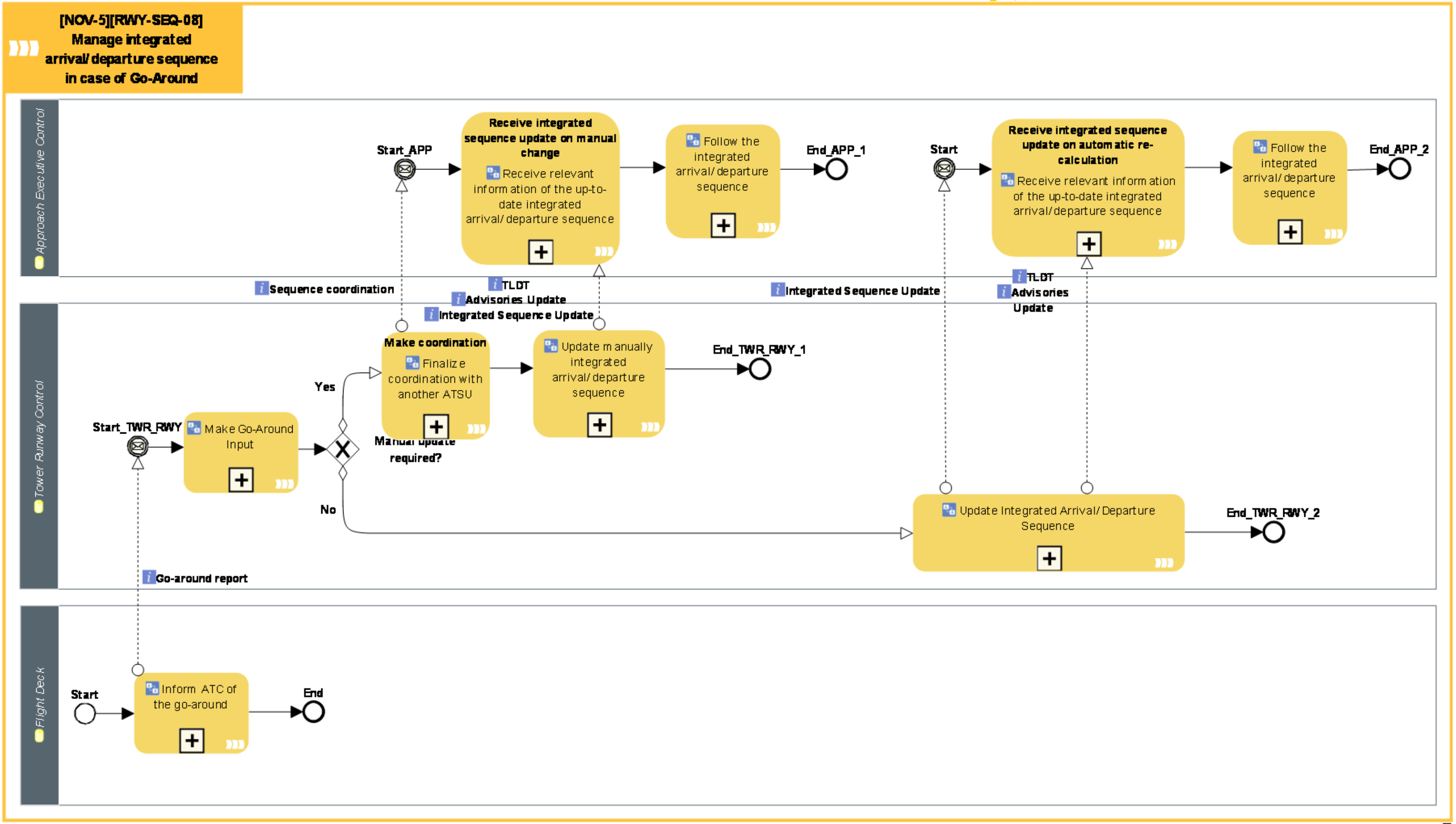


Figure 17: [NOV-5][RWY-SEQ-08] Manage integrated arrival/departure sequence in case of Go-Around Use Case diagram (NOV-5 diagram)

Diagram Id: F7862BF55AF03648

Activity	Description
Update Integrated Arrival/Departure Sequence	Flight is automatically re-sequenced at the first available and feasible place in the sequence, depending on local parameterization. At airports with two runways in use for arrivals, the flight can be moved to another runway in use to reduce overall delay.
Update manually integrated arrival/departure sequence	Flight is manually re-sequenced at the first available and feasible place in the sequence, according to previous coordination with Approach. At airports with two runways in use for arrivals, the flight can be manually moved to another runway in use to reduce overall delay.
Follow the integrated arrival/departure sequence	ATCOs follow the plan proposed by means of the integrated arrival/departure sequence, i.e. they provide all necessary clearances and instructions to meet the target times of the integrated arrival/departure sequence calculated by the Integrated Runway Sequence function.
Inform ATC of the go-around	The pilot informs the controller of the go-around.
Make coordination	When the flight reaches a predetermined time/distance (as set by LOA) from the common ATSU boundary, the Transferring ATSU system automatically updates the Flight Object with a coordination with the Accepting ATSU. ALTERNATIVE: The Transferring ATSU planner controller manually initiates the standard coordination activity via the HMI. The Flight Object is updated with a coordination with the Accepting ATSU (if the flight is not already coordinated). The coordination is in compliance with the conditions of the LOA which were present in the flight intent available in the Flight Object.
Make Go-Around Input	On Go-Around instruction, ATCO makes the corresponding go-around input in the HMI. This input might be distributed to the concerned ATCOs and to the Integrated Runway Sequence function for integrated sequence re-calculation.
Receive relevant information of the up-to-date integrated arrival/departure sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is shared between En-Route, APP and TWR controllers. Any change into the sequence (manual or automatic update) triggers an update of the relevant information provided to the different ATCO.

Table 30: [NOV-5][RWY-SEQ-08] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Flight Deck	Inform ATC of the go-around o--> Start_TWR_RWY	Tower Runway Control	Go-around report	AIRM_Change_Request

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Start	Approach Executive Control	Integrated Sequence Update	ApproachSequence
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Start	Approach Executive Control	Integrated Sequence Update	DepartureSequence
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Receive integrated sequence update on automatic re-calculation	Approach Executive Control	Advisories Update	ArrivalManagementAdvisory
Tower Runway Control	Update Integrated Arrival/Departure Sequence o--> Receive integrated sequence update on automatic re-calculation	Approach Executive Control	TLDT	TargetLandingTime
Tower Runway Control	Make coordination o--> Start_APP	Approach Executive Control	Sequence coordination	CoordinationAndTransfer
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Approach Executive Control	Advisories Update	ArrivalManagementAdvisory
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Approach Executive Control	Integrated Sequence Update	ApproachSequence
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Approach Executive Control	Integrated Sequence Update	DepartureSequence

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Update manually integrated arrival/departure sequence o--> Receive integrated sequence update on manual change	Approach Executive Control	TLDT	TargetLandingTime

Table 31: [NOV-5][RWY-SEQ-08] Use Case information and information exchanges

3.4.1.1.9 [NOV-5][RWY-SEQ-09] Use an integrated arrival/departure sequence and decision support tool to manage RWY configuration

General Conditions (Scope and Summary)

This Use Case describes how the Airport Tower Supervisor uses the available decision tools (i.e. **RMAN**) to manage the Runway Configuration and the Runway Capacities in a consistent way.

Pre-Conditions

- Advanced HMI
- Flight Data information is available (demand)
- Accurate meteorological information

Assumptions

- Airport CDM process applies
- The Airport Operation Center (APOC) could be in place
- RMAN retrieves the information required for calculation (capacity constraints, demand, runway capacities, taxiway capacities, weather information)
- RMAN computes, based on the inputs, both optimal runway configuration and the forecasted times per flight
- The Integrated Runway Sequence function receives the runway in use, mode of operation and forecasted times from RMAN;
- The Integrated Runway Sequence function respects the RMAN configuration and distribution of demand

Main Flow

[1] Tower Supervisor monitors the optimal runway configuration proposed by the RMAN and the associated KPIs. In case of imbalance a new RWY configuration is proposed to the Supervisor and he/she assesses if there is a need to change the RWY configuration.

[2] In case APOC is in operation, Tower Supervisor agrees the Runway Configuration with the APOC.

[3] The Tower Supervisor applies the Optimal Configuration in the RMAN and the system distributes it to all TWR positions (Ground, Runway and Clearance ATCOs) which receive the updated information on RWY configuration.

[4] The Apron Manager, Tower Clearance Delivery Controller, Tower Ground Controller and Tower Runway Controller receive the updated information of the integrated sequence as calculated by the Integrated Runway Sequence function based on the new configuration.

[5] The Apron Manager, Tower Clearance Delivery Controller, Tower Ground Controller and Tower Runway Controller follow the planning from the RMAN for the time horizon in which they are active and the integrated sequence proposed by the Integrated Runway Sequence function.

Failure Flow

[1] The Airport Tower Supervisor notifies to the Tower Clearance Delivery, Tower Ground Controller, Tower Runway Controller, Apron Manager and APOC that the RMAN is not providing the forecasted times and/or configuration.

[2] Airport Tower Supervisor decides on runway(s) for landing and take-off.

[3] Airport Tower Supervisor inserts manually the required values for the Integrated Runway Sequence function.

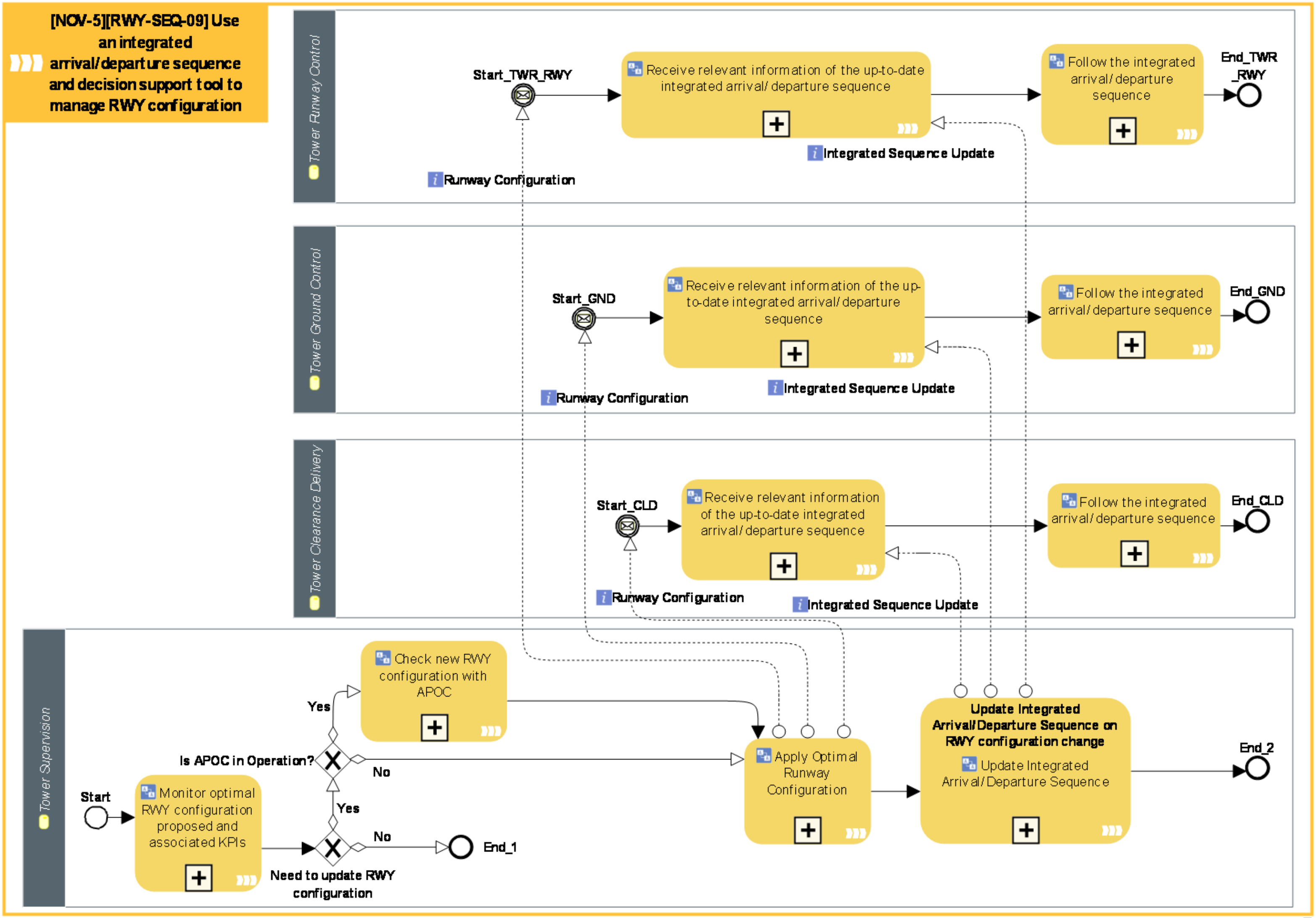


Figure 18: [NOV-5][RWY-SEQ-09] Use an integrated arrival/departure sequence and decision support tool to manage RWY configuration Use Case diagram (NOV-5 diagram)

Diagram Id: F7865FC15AF05EFF

Activity	Description
Apply Optimal Runway Configuration	The Tower Supervisor applies the optimal runway configuration based on the KPI assessment performed. If a RMAN is available, he inputs the optimal configuration in the RMAN, which distributes it to all TWR positions. Otherwise, he provides the information to all roles.
Monitor optimal RWY configuration proposed and associated KPIs	The Tower Supervisor monitors the optimal runway configuration proposed by the RMAN and the associated KPIs. In case of imbalance a new runway configuration is proposed to the Supervisor and he/she assesses if there is a need to change the runway configuration.
Check new RWY configuration with APOC	The TWR Supervisor agrees the runway configuration with the APOC.
Follow the integrated arrival/departure sequence	ATCOs follow the plan proposed by means of the integrated arrival/departure sequence, i.e. they provide all necessary clearances and instructions to meet the target times of the integrated arrival/departure sequence calculated by the Integrated Runway Sequence function.
Receive relevant information of the up-to-date integrated arrival/departure sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is shared between En-Route, APP and TWR controllers. Any change into the sequence (manual or automatic update) triggers an update of the relevant information provided to the different ATCO.
Update Integrated Arrival/Departure Sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated Runway Sequence function is updated automatically further to certain events (e.g. TOBT update, trajectory re-calculations) and also further to certain ATCO actions (e.g. RWY closure, Go-around input), depending on local implementation.

Table 32: [NOV-5][RWY-SEQ-09] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Apply Optimal Runway Configuration o--> Start_TWR_RWY	Tower Runway Control	Runway Configuration	ActiveRunwayConfiguration
Tower Supervision	Apply Optimal Runway Configuration o--> Start_CLD	Tower Clearance Delivery	Runway Configuration	ActiveRunwayConfiguration

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence on RWY configuration change o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence on RWY configuration change o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Runway Control	Integrated Sequence Update	DepartureSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence on RWY configuration change o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence on RWY configuration change o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Ground Control	Integrated Sequence Update	DepartureSequence

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Supervision	Update Integrated Arrival/Departure Sequence on RWY configuration change o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update Integrated Arrival/Departure Sequence on RWY configuration change o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	Integrated Sequence Update	DepartureSequence
Tower Supervision	Apply Optimal Runway Configuration o--> Start_GND	Tower Ground Control	Runway Configuration	ActiveRunwayConfiguration

Table 33: [NOV-5][RWY-SEQ-09] Use Case information and information exchanges

3.4.1.1.10 [NOV-5][RWY-SEQ-10] Manage an integrated arrival/departure sequence during balancing of the number of arrival/departure flights between two runways

General Conditions (Scope and Summary)

This Use Case describes how to manage the integrated arrival/departure sequences while balancing the number of flights between two runways, applicable for airports with two runways in use. This Use Case also describes how to support balancing of flights between the two runways to enhance overall runway throughput. The balancing for a single flight will imply a change of runway in use (and SID/STAR) and an update of integrated arrival/departure sequences for both runways.

Pre-Conditions

- Airport CDM process is in place and here is an agreed business trajectory
- Two runways are in use at the airport
- An integrated sequence for each runway is provided by the Integrated Runway Sequence Function
- Rules to define the criteria for traffic balancing between runways are pre-defined

Assumptions

- Automatic update of runway in use for an arrival or a departure flight is performed by the Integrated Runway Sequence function according to local rules (e.g. depending on runway configuration, flights planning to follow a certain SID / STAR can be eligible for balancing from one runway to another)
- Update of runway in use for a specific flight is performed in a timeframe according to local rules (e.g. normally before arrival TOD and/or a locally defined time before departure EOBT)
- The integrated sequence will be updated for both runways

Post-Conditions

Balanced arrival or departure flights follow their lifecycle to a new runway and other flights are re-planned.

- Integrated Runway Sequence Function performs automatic balancing arrival and departure flights
- Planned number of flights for each runway are balanced with positive impact on overall runway throughput.
- All flights are re-planned according to updated runway sequences on both runways.

Main Flow

[1] Airport Tower Supervisor activates the option for automatic balancing at the Integrated Runway Sequence Function.

[2] The Integrated Runway Sequence Function identifies the need for traffic balancing between runways (e.g. one runway is at maximum capacity) and automatically moves arrival or departure flights from one runway sequence to another, according to pre-defined eligibility criteria (e.g. SID, STAR, runway configuration).

[3] Airport Tower Supervisor, Approach Sequence Manager and Approach and Tower Controllers receive the information on the updated runway sequences for the two runways.

[4] Airport Tower Supervisor monitors the updated runway sequences for the two runways.

[5] Approach Sequence Manager monitors the updated runway sequences for the two runways.

[6] The Tower Runway Controller follows the updated sequence, including management of flights re-planned for a new runway.

[7] The APP controller follows the updated sequence, including management of flights re-planned for a new runway.

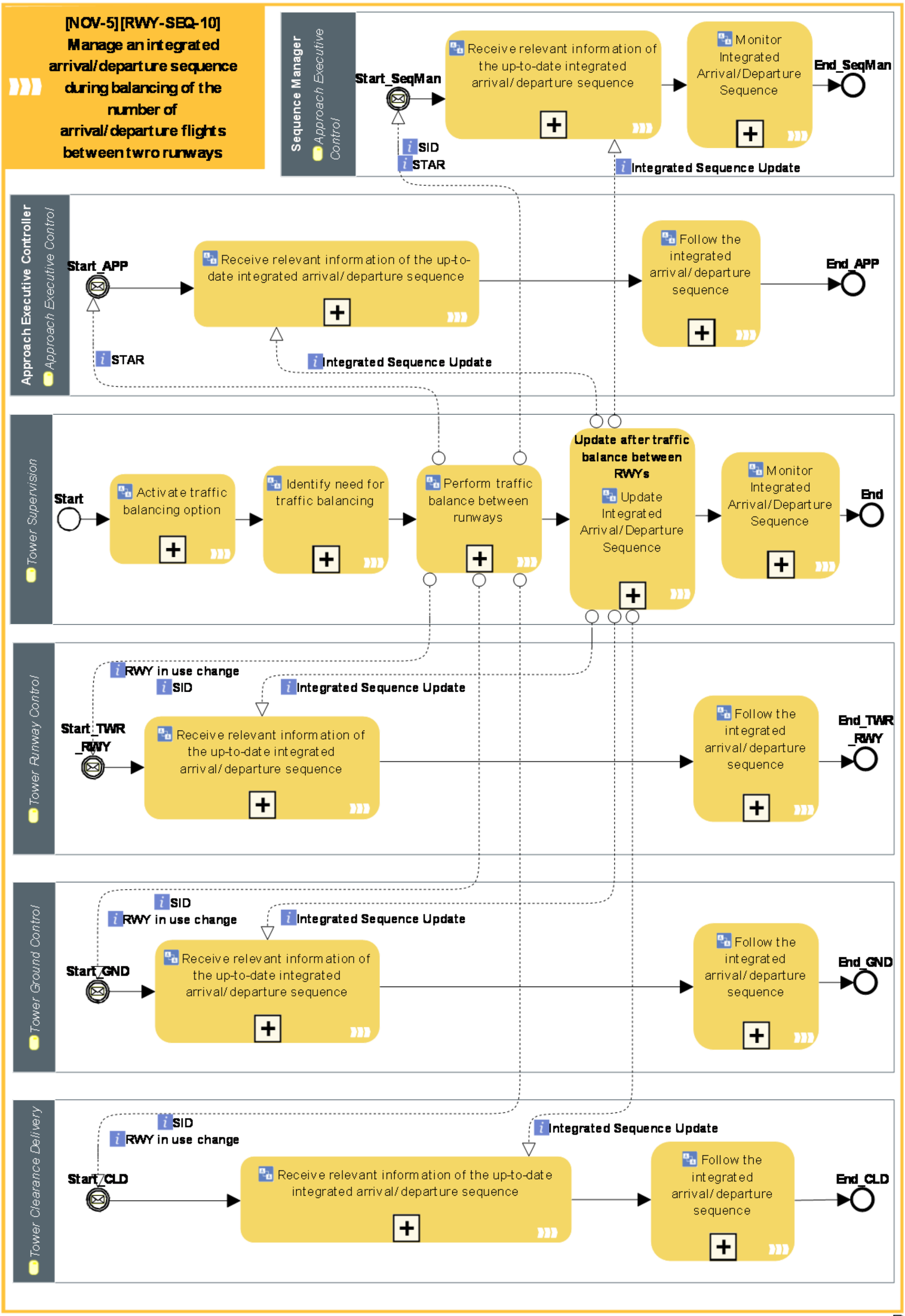


Figure 19: [NOV-5][RWY-SEQ-10] Manage an integrated arrival/departure sequence during balancing of the number of arrival/departure flights between two runways Use Case diagram (NOV-5 diagram)

Diagram Id: AAE9BF575C66384A

Activity	Description
Activate traffic balancing option	The TWR Supervisor can activate the option that allows the Integrated Runway Sequence function (Coupled AMAN/DMAN) to automatically balance traffic between the integrated sequences of two runways depending on off-line pre-defined criteria in order to achieve objectives in terms of KPIs (e.g. reduce delays).
Follow the integrated arrival/departure sequence	ATCOs follow the plan proposed by means of the integrated arrival/departure sequence, i.e. they provide all necessary clearances and instructions to meet the target times of the integrated arrival/departure sequence calculated by the Integrated RWY Sequence function.
Identify need for traffic balancing	The Integrated Runway Sequence function (Coupled AMAN/DMAN) identifies the need for traffic balancing between runways when certain criteria are met (e.g. one runway is at maximum capacity).
Monitor Integrated Arrival/Departure Sequence	The ATCOs monitor the integrated arrival/departure sequence computed by the Integrated RWY Sequence function and that constitutes the plan they have to follow.
Perform traffic balance between runways	The Integrated Runway Sequence function (Coupled AMAN/DMAN) automatically moves arrival or departure flights from one runway integrated sequence to another, according to pre-defined eligibility criteria (e.g. SID, STAR, runway configuration).
Receive relevant information of the up-to-date integrated arrival/departure sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated RWY Sequence function is shared between En-Route, APP and TWR controllers. Any change into the sequence (manual or automatic update) triggers an update of the relevant information provided to the different ATCO.
Update Integrated Arrival/Departure Sequence	The integrated arrival/departure sequence calculated and maintained by the Integrated RWY Sequence function is updated automatically further to certain events (e.g. TOBT update, trajectory re-calculations) and also further to certain ATCO actions (e.g. RWY closure, Go-around input), depending on local implementation.

Table 34: [NOV-5][RWY-SEQ-10] Use Case activities

Tower Supervision	Update after traffic balance between RWYs o-->Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Controller	Integrated Sequence Update	ApproachSequence

Tower Supervision	Update after traffic balance between RWYs o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Approach Executive Controller	Integrated Sequence Update	DepartureSequence
Tower Supervision	Perform traffic balance between runways o--> Start_TWR_RWY	Tower Runway Control	SID	StandardInstrumentDeparture
Tower Supervision	Perform traffic balance between runways o--> Start_TWR_RWY	Tower Runway Control	RWY in use change	RunwayConfiguration
Tower Supervision	Perform traffic balance between runways o--> Start_CLD	Tower Clearance Delivery	SID	StandardInstrumentDeparture
Tower Supervision	Perform traffic balance between runways o--> Start_CLD	Tower Clearance Delivery	RWY in use change	RunwayConfiguration
Tower Supervision	Update after traffic balance between RWYs o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update after traffic balance between RWYs o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Tower Clearance Delivery	Integrated Sequence Update	DepartureSequence

Tower Supervision	Update after traffic balance between RWYs o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Sequence Manager	Integrated Sequence Update	ApproachSequence
Tower Supervision	Update after traffic balance between RWYs o--> Receive relevant information of the up-to-date integrated arrival/departure sequence	Sequence Manager	Integrated Sequence Update	DepartureSequence

Table 35: [NOV-5][RWY-SEQ-10] Use Case information and information exchanges

3.4.2 Use Cases associated to New SESAR Operating Method for Concept 3 and Concept 4

The following Node View summarizes the information exchange described in the following Use Cases:

Use case	Use case title
Use case	[NOV-5][AROT-01] Increased RWY Throughput based on local ROT characterization (ROCAT) (Concept 3)
Use case	[NOV-5][AROT-02] AROT used in Tower Controller HMI (Concept 4)

Table 36: SESAR Solution PJ02-08 use cases for Concept 3 and Concept 4

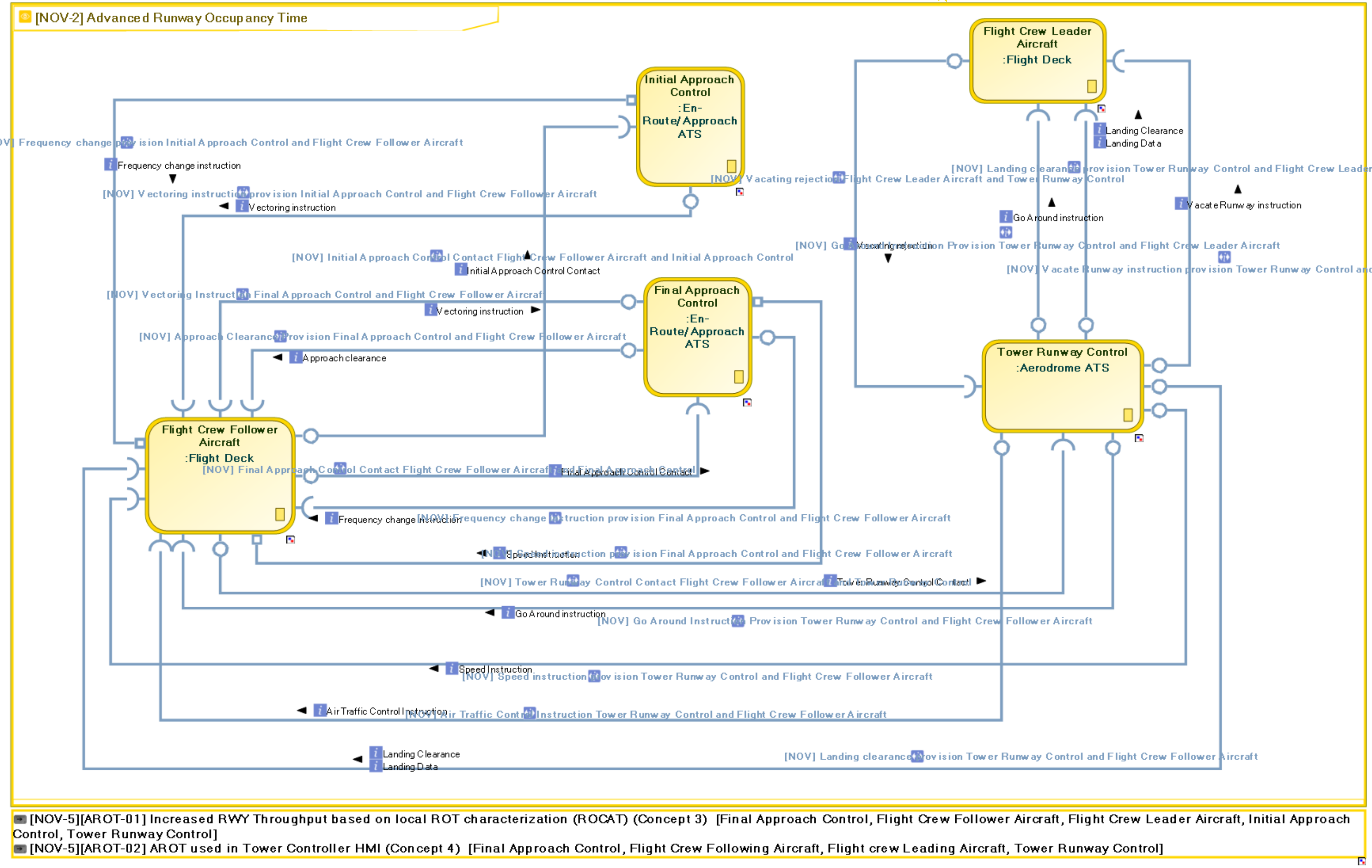


Figure 20: SESAR Solution PJ02-08 Node view (NOV-2 diagram) for Concept 3 and Concept 4

3.4.2.1 Use Cases for [NOV-2] Advanced Runway Occupancy Time

This section provides the use cases that describe the new operating method for Concept 3 and Concept 4.

3.4.2.1.1 [NOV-5][AROT-01] Increased RWY Throughput based on local ROT characterization (ROCAT) (Concept 3)

General Conditions (Scope and Summary)

This Use Case describes the exploitation of the Increased Runway Throughput based on local ROT characterization (ROCAT)

This Use Case takes place during the phase of flight where the arrival aircraft is being metered through the TMA and towards the IAF. This Use Case end upon arrival and the aircraft vacates the runway.

Pre Conditions

The Minimum Radar Separation (MRS as defined in ICAO 4444 section 8.7.3) is reduced for low runway occupancy time medium aircraft. The analysis of historical ground radar data allows for characterization of ROT per aircraft type and per runway. Based on these results, the Medium aircraft can be grouped into 2 categories:

- one for aircraft with short ROT,

- one for aircraft with long ROT

A separation of either 2.0 NM (for aircraft presenting average ROT below 40s), 2.5 NM (for aircraft presenting average ROT below 50s) or 3.0 NM (for aircraft presenting average ROT above 50s) is associated to each ROT category.

Post Conditions

The arrival aircraft have landed and vacated the runway.

Actors

Approach Supervisor, Tower Supervisor, Initial Approach Control, Final Approach Control, Tower Runway Control, Flight Crew.

Trigger

Coordination of an arrival aircraft into the assigned IAF between the TMA Sector Controller and the Intermediate Approach Controller.

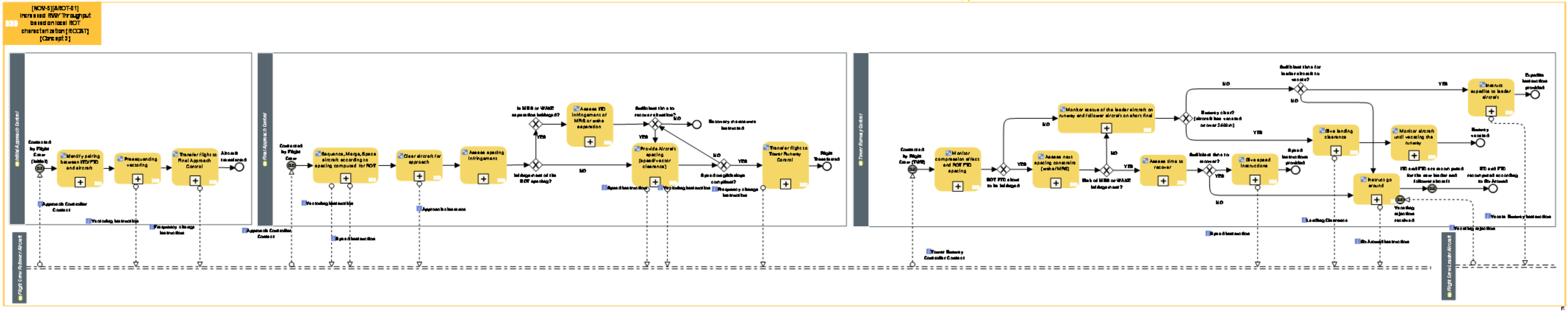


Figure 21: [NOV-5][AROT-01] Increased RWY Throughput based on local ROT characterization (ROCAT) (Concept 3) Use Case diagram (NOV-5 diagram)

Diagram Id: A8DEB20C5C627340

Activity	Description
Assess ITD infringement of MRS or wake separation	When the ROT ITD is infringed by the aircraft, the minimum separation (WT or MRS) is displayed to give the controllers an awareness of the safety minima. Then, the Final Approach Controller assesses if there is sufficient time to amend the situation. If there is, the controller will provide corresponding aircraft spacing instructions (speed change instructions new headings and manoeuvres) to the follower aircraft. Otherwise, a manoeuvre will be required.
Assess next spacing constraint (wake/MRS)	When the ROT FTD is infringed by the aircraft, then the Tower Runway Controller will check is there is a safety issue regarding the WT or MRS minimum separation. To support that task, When the ROT FTD is infringed by the aircraft, the minimum separation (WT or MRS) is displayed to give the controllers an awareness of the safety minima
Assess spacing infringement	Nominal workflow The Final Approach Controller shall assess the resulting separation from the aircraft ahead and judge any required refinement action. In particular, the controller will decide when to reduce, maintain or even cancel any speed instructions. This may happen before or after the aircraft has intercepted the localiser.
Assess time to recover	When the ROT FTD is infringed by the aircraft, the minimum separation (WT or MRS) is displayed to give the controllers an awareness of the safety minima Then, the Tower Runway Controller assesses if there is sufficient time to amend the situation. If there is, the Tower Runway Controller will provide corresponding aircraft spacing instructions to the follower aircraft. Otherwise a go-around will be required.
Change RT frequency to Final Approach Control	The Flight Crew change RT frequency to the Final Approach Controller.
Change RT frequency to Initial Approach Control	The Flight Crew change RT frequency to the Approach Controller
Change RT frequency to Tower Runway Control	The Flight Crew change RT frequency to the Tower Runway Controller frequency and confirm identity
Clear aircraft for approach	Final Approach Controller issues, at the appropriate time, approach clearance to the aircraft.
Execute and vacate	The leader aircraft vacates runway following Tower Runway controller's instruction and ability to comply with the instructed exit taxiway.
Execute Go around	1. The Flight Crew execute the standard missed approach procedure/Go-Around and await further instructions from the Tower Runway Controller. 2. The missed approach aircraft is automatically removed from the Approach Arrivals Sequence Display. The TDIs associated with the missed approach aircraft are automatically removed and a TDI for the resulting new lead aircraft and follower aircraft from ahead and behind the missed approach aircraft is displayed. 3. The Tower Runway Controller ensures appropriate separation

	from other traffic and instructs the aircraft to turn on to a heading away from the final approach centre-line or simply follow the missed approach procedure. 4. The Tower Runway Controller instructs the Flight Crew to transfer to the responsible Departure Controller. 5. The Flight Crew transfer to the Initial Approach Controller. 6. The Initial Approach Controller determines where the missed approach aircraft is to be accommodated in the arrival sequence order and amends the arrival sequence order position in the Approach Arrival Sequence and ensures that this is reflected into the Approach Arrival Sequence Display and the impacted TDIs or system turn on support are correctly amended. 7. The Initial Approach Controller instructs the aircraft to merge back into the intermediate approach stream at the required position.
Execute landing and vacate runway	After instruction from tower runway control, the flight decks touches down, rolls out and proceeds to the assigned / appropriate exit taxiway and vacates the runway
Fly aircraft according to instructions: intercept Localiser and Glideslope	The Flight Crew intercept and establish on the final approach course and when are fully established i.e. localiser and glide-slope are intercepted, report to the Final Approach Controller.
Fly aircraft according to vectoring instructions	The Flight Deck flies the aircraft according to heading and altitude instructions or to the appropriate Point Merge RNAV point provided corresponding instructions or clearance by the initial approach controller whilst maintaining the applicable separation with other aircraft.
Give landing clearance	The Tower Runway Controller provides landing clearance to the aircraft as per local procedures with some assurance that the lead aircraft will vacate the runway in time, or when it has been confirmed that the lead aircraft has vacated the runway. Or if the aircraft ahead is a departure then clearance to land will be provided after the departure is airborne or there is some assurance the aircraft will be airborne on time.
Give speed instructions	If there is sufficient time to recover the FTD infringement, the Tower Runway Controller gives speed instructions.
Identify pairing between ITD/FTD and aircraft	Nominal Workflow Once the aircraft enters the TDI (target distance indicator) area, the corresponding ITD (Initial Target Distance) indicator and FTD (Final Target Distance) indicators are computed in HMI for Initial Approach Controller use according to ROT constraint. At that moment, the Initial Approach Controller matches the entering aircraft with its corresponding ITD to follow the progression of the trajectory until the transfer to Final Approach. The TDI represents the FTD and ITD. TDIs for the aircraft may be displayed on the extended runway centreline at this time depending on the horizon of the approach arrival sequence service. If not, then another form of system support will be available to provide information about the expected separation to be applied on final

	approach. Alternatives flow Aircraft type / wake category incorrect on FPS 1. The Initial Approach Controller ensures that the aircraft type / wake category is corrected in the system flight plan data. 2. The Initial Approach Controller checks that the corrected aircraft type / wake category is propagated through to the Approach Arrival Sequence Display. 3. The Use Case resumes at step 2. Change in sequence order 1. If an automatic sequence detection solution is implemented no action is needed as a change of sequence will be correctly reflected in the TDIs. 2. The Use Case resumes at the step it was invoked
Instruct expedite to leader aircraft	If the runway is not occupied and the Tower Runway Controller is about to instruct follower aircraft to land but yet again there is enough time for the leader aircraft to vacate the runway via a specific exit taxiway, the Tower Runway Controller may instruct the leader aircraft to expedite and exit via the taxiway.
Instruct go around	If there is not enough time to recover the risk of spacing infringement in the short final approach or not sufficient time for the leader to vacate the runway on time, the Tower Runway Controller instructs the aircraft to go around. Tower Runway Controller assures appropriate separation from other traffic and instructs the aircraft to turn on to a heading away from the final approach centre-line or simply to follow the missed approach procedure.
Monitor aircraft until vacating the runway	Monitor the aircraft touching down, rolling out, proceeding to the assigned/appropriate exit taxiway and vacating the runway The FTD will remain displayed until the lead aircraft lands.
Monitor compression effect and ROT FTD spacing	Tower Runway Controller will need to consider the effect of compression when determining the required separation to be applied on final approach.
Monitor status of the leader aircraft on runway and follower aircraft on short final	If there is no risk of ROT FTD infringement, the Tower Runway Controller monitors the positions of the leader and follower aircraft on short final, assessing whether the runway is clear and safe for the follower to land and for the leader to expedite.
Presequencing vectoring	Nominal Workflow The Initial Approach Controller issues necessary heading and altitude instructions to vector the aircraft or provides a clearance to the appropriate Point Merge RNAV waypoint while maintaining the applicable separation with other aircraft. The pre-sequencing is further managed to develop the appropriate stream of arrival aircraft for the Final Approach Controller. Alternative flow Change in sequence order 1. If an automatic sequence detection solution is implemented no action is needed as a change of sequence will be correctly reflected in the TDIs.

	2. The Use Case resumes at the step it was invoked
Provide Aircraft spacing (speed/vector clearance)	If needed and if sufficient time allows, the controller provides corresponding aircraft spacing instructions (speed change instructions new headings and manoeuvres)
Reject instruction to vacate	If for whatever reason the Flight Crew of the leader aircraft is unable to comply with the vacating instruction by the Tower Runway Controller, the Flight Crew rejects vacating instructions and aims for another exit taxiway.
Sequence, Merge, Space aircraft according to spacing computed for ROT	Nominal Workflow The Final Approach Controller shall use the turn onto base leg and intercept as well as use appropriate procedural airspeeds (possibly airport specific) to set up the required spacing on final approach based on the information supplied via the TDIs or other turn on support. Alternative Flows Change in sequence order 1. If an automatic sequence detection solution is implemented no action is needed as a change of sequence will be correctly reflected in the TDIs. 2. The Use Case resumes at the step it was invoked Wrong aircraft turned onto TDI 1. In case the wrong aircraft are turned onto the TDI, an alert is triggered informing the Final Approach Controller via the HMI which aircraft is out of sequence and hence being put behind the incorrect TDI. 2. The Final Approach Controller checks whether it is safe to proceed with merging the impacted aircraft on final approach and if not, breaks the aircraft off from merging on to final approach. 3. The Final Approach Controller checks whether it is safe to proceed with merging the impacted aircraft on to final approach and if not breaks the aircraft off from merging on to final approach. 4. If it is safe to proceed, the Final Approach Controller amends the sequence order in the Approach Arrival Sequence Display and checks the update is correctly reflected in the Approach Arrival Sequence Display. The Final Approach Controller checks the TDIs are correctly updated. 5. If it is not safe to proceed the Final Approach Controller decides on the path stretching action to take to separate the aircraft from other traffic and to set up the aircraft such that it can be merged back on to final approach. 6. If there is an impact to the sequence order on final approach the Final Approach Controller amends the arrival order in the Approach Arrival Sequence Display and checks the update is correctly reflected in the Approach Arrival Sequence Display. The Final Approach Controller checks the TDIs are correctly updated. 7. The Use Case resumes at step 9 if the aircraft continues the approach.

	6. The Use Case resumes at the appropriate step between 7 and 9 if the aircraft discontinues the approach.
Transfer flight to Final Approach Control	At appropriate time and operational conditions (around Final Approach Fix), the Initial Approach Controller · hands over and transfers the control of the flight to the Final Approach Control · instructs the Flight Crew to contact Final Approach Controller
Transfer flight to Tower Runway Control	When satisfied that an appropriate stable separation has been obtained the Final Approach Controller instructs the Flight Crew to transfer to the Tower Runway Controller.

Table 37: [NOV-5][AROT-01] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	Instruct expedite to leader aircraft o--> Flight Crew Leader Aircraft	Flight Crew Leader Aircraft	Vacate Runway instruction	ATCInstruction
Flight Crew Leader Aircraft	Flight Crew Leader Aircraft o--> Vacating rejection received	Tower Runway Control	Vacating rejection	AIRM_OutOfScope
Final Approach Control	Provide Aircraft spacing (speed/vector clearance) o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Vectoring instruction	OpenLoopInstruction
Tower Runway Control	Give landing clearance o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Landing Clearance	LandingClearance
Flight Crew Follower Aircraft	Flight Crew Follower Aircraft o--> Contacted by Flight Crew (TWR)	Tower Runway Control	Tower Runway Controller Contact	ATCInstruction
Final Approach Control	Sequence, Merge, Space aircraft according to spacing computed for ROT o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Vectoring instruction	OpenLoopInstruction
Final Approach Control	Clear aircraft for approach o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Approach clearance	ApproachClearance

Issuer	Info Flow	Addressee	Info Element	Info Entity
Flight Crew Follower Aircraft	Flight Crew Follower Aircraft o--> Contacted by Flight Crew	Final Approach Control	Approach Controller Contact	AIRM_OutOfScope
Final Approach Control	Provide Aircraft spacing (speed/vector clearance) o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	IncreaseSpeedToSpeed
Final Approach Control	Provide Aircraft spacing (speed/vector clearance) o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	ReduceSpeedToSpeed
Final Approach Control	Provide Aircraft spacing (speed/vector clearance) o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	SpeedConstraint
Final Approach Control	Transfer flight to Tower Runway Control o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Frequency change instruction	FrequencyChangeInstru ction
Tower Runway Control	Instruct go around o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Go Around instruction	ATCInstruction
Initial Approach Control	Transfer flight to Final Approach Control o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Frequency change instruction	FrequencyChangeInstru ction
Final Approach Control	Sequence, Merge, Space aircraft according to spacing computed for ROT o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	IncreaseSpeedToSpeed

Issuer	Info Flow	Addressee	Info Element	Info Entity
Final Approach Control	Sequence, Merge, Space aircraft according to spacing computed for ROT o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	ReduceSpeedToSpeed
Final Approach Control	Sequence, Merge, Space aircraft according to spacing computed for ROT o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	SpeedConstraint
Initial Approach Control	Presequencing vectoring o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Vectoring instruction	OpenLoopInstruction
Flight Crew Follower Aircraft	Flight Crew Follower Aircraft o--> Contacted by Flight Crew (initial)	Initial Approach Control	Approach Controller Contact	AIRM_OutOfScope
Tower Runway Control	Give speed instructions o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	IncreaseSpeedToSpeed
Tower Runway Control	Give speed instructions o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	ReduceSpeedToSpeed
Tower Runway Control	Give speed instructions o--> Flight Crew Follower Aircraft	Flight Crew Follower Aircraft	Speed Instruction	SpeedConstraint

Table 38: [NOV-5][AROT-01] Use Case information and information exchanges

3.4.2.1.2 [NOV-5][AROT-02] AROT used in Tower Controller HMI (Concept 4)

General Conditions (Scope and Summary)

This Use Case describes the exploitation of Enhanced AROT Prediction via the Tower Controller HMI only. This method of AROT information exploitation is intended for medium and smaller airports where implementation of full Approach – Tower toolset might not be viable. This use case is intended for both mixed and segregated modes on a single or multiple runways.

Pre-Conditions

- A pre-defined mixed mode or segregated mode sequence is in place for the runway(s)

Assumptions

- Enhanced AROT Prediction is on line for arriving aircraft
- Leader Aircraft is an arrival
- Flight Crews try to follow Tower Controller exit designations

Post-Conditions

- Leader aircraft vacated the runway
- Follower aircraft is cleared for landing or departure

Main Flow

Main flow is presented for segregated mode or a pair of arrivals:

[1] Leader Aircraft is detected by the Enhanced AROT Prediction and AROT estimate with exit estimate is placed in the EFS system for Tower Controller to use.

[2] Leader Aircraft is handed over to Tower

[3] Tower Controller assesses feasibility of recommended Exit for Leader Aircraft and impact of ROT on the Follower Aircraft

[4] Tower Controller provides landing information to the Leader Aircraft Flight Crew. The information includes recommended exit taxiway designation.

[5] Follower Aircraft is detected by the Enhanced AROT Prediction and AROT estimate with exit estimate is placed in the EFS system for Tower Controller to use.

[6] Follower Aircraft is handed over to Tower

[7] If there is an impact on feasibility of Follower Aircraft operation the Tower Controller issues appropriate instructions to account for predicted Leader Aircraft AROT impact.

[8] Tower Controller assesses feasibility of recommended Exit for Follower Aircraft

[9] Tower Controller provides landing information to the Follower Aircraft Flight Crew. The information includes recommended exit taxiway designation.

[10] If the runway is clear for landing Tower Controller issues landing clearance including repeating of the landing information (with exit taxiway designation). Otherwise Leader aircraft is instructed to go around.

[11] The Leader Aircraft is performing landing and landing roll.

[12] In case the exit is missed the Tower Controller is monitoring the Follower Aircraft trajectory

[13] If the runway is clear Tower Controller issues landing clearance, otherwise Tower Controller issues go around instruction.

Alternate Flow

This alternate flow is used in case the follower aircraft is a departure.

[1] Leader Aircraft is detected by the Enhanced AROT Prediction and AROT estimate with exit estimate is placed in the EFS system for Tower Controller to use.

[2] Leader Aircraft is handed over to Tower

[3] Tower Controller assesses feasibility of recommended Exit for Leader Aircraft and impact of ROT on the Follower Aircraft

[4] Tower Controller provides landing information to the Leader Aircraft Flight Crew. The information includes recommended exit taxiway designation.

[5] If the runway is clear for landing Tower Controller issues landing clearance including repeating of the landing information (with exit taxiway designation). Otherwise Leader aircraft is instructed to go around.

[6] The Leader Aircraft is performing landing and landing roll.

[7] If there is an impact on feasibility of Follower Aircraft operation the Tower Controller does not issue line up instruction. Otherwise line up and take of clearances are issued consecutively.

[8] Follower aircraft departs

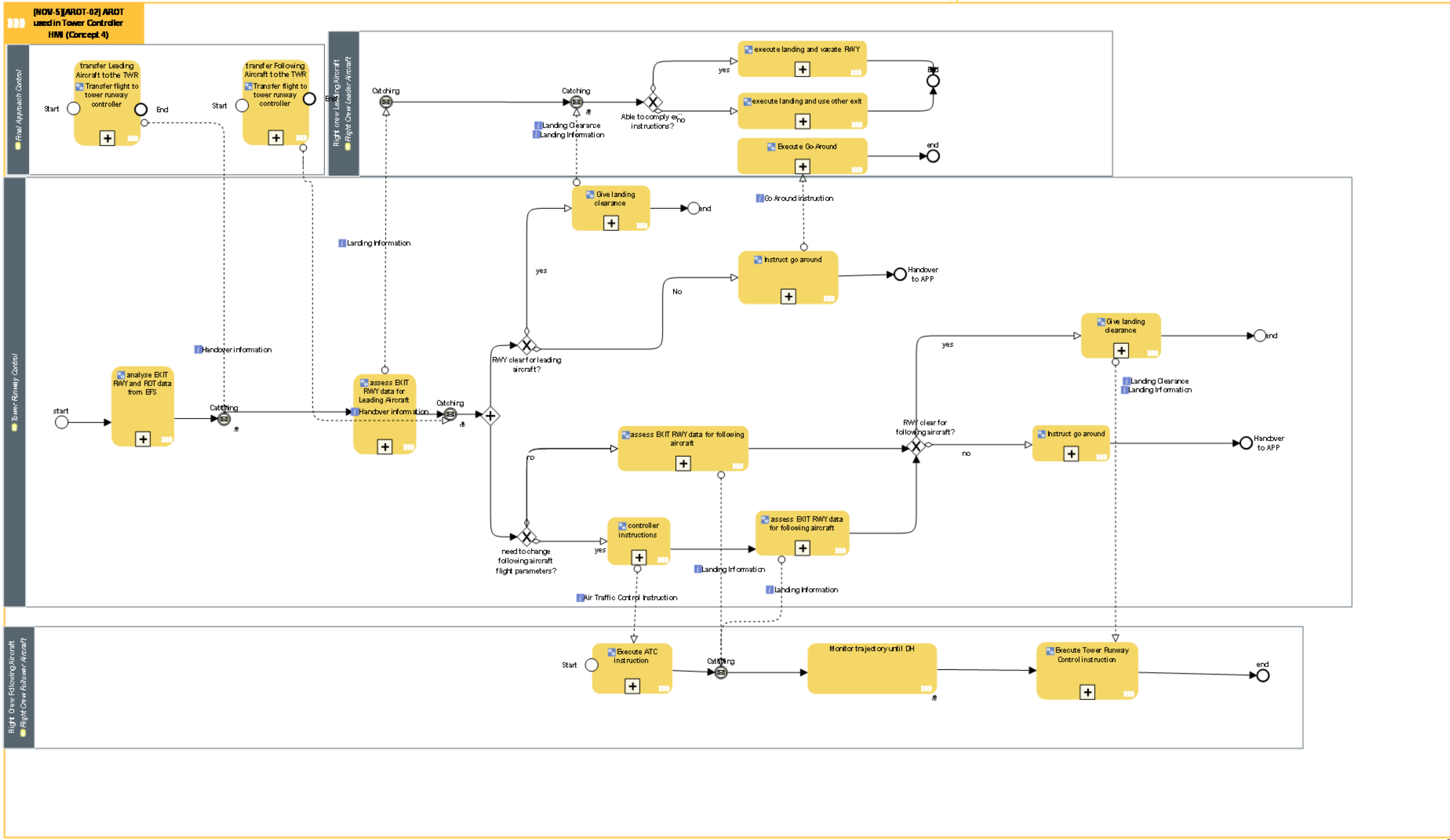


Figure 22: [NOV-5][AROT-02] ROT used in Tower Controller HMI (Concept 4) Use Case diagram (NOV-5 diagram)

Diagram Id: B541B9C85C77173B

Activity	Description
Instruct go around	In case the aircraft is on short final and runway is not available for landing the controller instructs go around. Aircraft is subsequently handed over to Approach for further instructions
Monitor trajectory until DH	Until the landing clearance is received, the Flight Crew monitors the approach, adjusting the trajectory until reaching the DA/H. If distance and altitude information is provided on the chart the "Distance to Go" (to threshold) information can be used to perform distance/altitude checks. The purpose is to check whether the aircraft flies the correct vertical approach path.
analyse EXIT RWY and ROT data from EFS	Tower Controller initially assesses the feasibility of recommended Exit for Leader Aircraft and any impact of AROT on the Follower Aircraft
assess EXIT RWY data for following aircraft	Tower Controller assesses the feasibility of recommended Exit for Follower Aircraft
assess EXIT RWY data for Leading Aircraft	Tower Controller assesses the feasibility of recommended Exit for Leader Aircraft and any impact of AROT on the Follower Aircraft
controller instructions	An instruction issued by Tower Controller to minimise impact of Leader Aircraft AROT on the feasibility of Follower Aircraft operation. Usually a speed instruction.
Execute ATC instruction	The pilot applies the instructions provided by ATC (such as radar vectoring instructions, speed instruction, TPO, 2D route).
Execute Go-Around	The pilot executes and follows the missed approach as defined in the approach chart. For the helicopters, the final point of the IFR procedure that corresponds to the missed approach is the PinS. After the PinS, the flight crew has the options to perform the approach visually or VFR if clearly stated in the charts.
execute landing and use other exit	Flight Crew executes landing, landing roll and vacated the runway via exit other than recommended.
execute landing and vacate RWY	Flight Crew executes landing, landing roll and vacated the runway via recommended exit.
Execute Tower Runway Control instruction	The Flight Crew executes Tower Runway Controller instructions as issued.
Give landing clearance	The Tower Runway Controller provides landing clearance to the aircraft as per local procedures with some assurance that the lead aircraft will vacate the runway in time, or when it has been confirmed that the lead aircraft has vacated the runway. Or if the aircraft ahead is a departure then clearance to land will be provided after the departure is airborne or there is some assurance the aircraft will be airborne on time. Optionally together with landing clearance controller provides “landing information” containing of suggested exit TWY.
Transfer flight to tower runway controller	The approach controller transfers the aircraft to the control tower frequency.

Table 39: [NOV-5][AROT-02] Use Case activities

Issuer	Info Flow	Addressee	Info Element	Info Entity

Issuer	Info Flow	Addressee	Info Element	Info Entity
Tower Runway Control	controller instructions o--> Execute ATC instruction	Flight Crew Following Aircraft	Air Traffic Control Instruction	ATCInstruction
Tower Runway Control	Give landing clearance o--> Catching	Flight crew Leading Aircraft	Landing Clearance	LandingClearance
Tower Runway Control	Give landing clearance o--> Catching	Flight crew Leading Aircraft	Landing Information	ATISMessage
Tower Runway Control	Give landing clearance o--> Execute Tower Runway Control instruction	Flight Crew Following Aircraft	Landing Clearance	LandingClearance
Tower Runway Control	Give landing clearance o--> Execute Tower Runway Control instruction	Flight Crew Following Aircraft	Landing Information	ATISMessage
Tower Runway Control	assess EXIT RWY data for following aircraft o--> Catching	Flight Crew Following Aircraft	Landing Information	ATISMessage
Tower Runway Control	assess EXIT RWY data for following aircraft o--> Catching	Flight Crew Following Aircraft	Landing Information	ATISMessage
Final Approach Control	transfer Leading Aircraft to the TWR o--> Catching	Tower Runway Control	Handover information	CoordinationAndTransfer
Final Approach Control	transfer Following Aircraft to the TWR o--> Catching	Tower Runway Control	Handover information	CoordinationAndTransfer
Tower Runway Control	assess EXIT RWY data for Leading Aircraft o--> Catching	Flight crew Leading Aircraft	Landing Information	ATISMessage
Tower Runway Control	Instruct go around o--> Execute Go-Around	Flight crew Leading Aircraft	Go Around instruction	ATCInstruction

Table 40: [NOV-5][AROT-02] Use Case information and information exchanges

3.4.3 Differences between new and previous Operating Methods

3.4.3.1 Differences between new and previous Operating Methods for Concept 1

OI Step code – title (OI Step CR)		
TS-0301 - Integrated Arrival Departure Management for Full Traffic Optimisation on the Runway (CR 01092 Update TS-0301 (PJ.02-08))		
Activity	Impact	Change
Activate traffic balancing option	Introduce	This activity is introduced by the solution together with the concept of integrated arrival/departure sequence that is calculated automatically by the coupled AMAN/DMAN and distributed to all concerned actors. In the case of multiple runways, the management of the integrated arrival/departure sequence can include an option to allow an automatic balancing of traffic between different runways when the maximum capacity of one of them is reached. This option is manually activated by the TWR Supervisor, who decides whether this automatic balancing is performed by the system or not.
Assess changes in the integrated arrival/departure sequence	Introduce	This activity is introduced by the solution because of the introduction of the integrated arrival/departure sequence, which is no longer the result of the ATCO's mental merging of arrival and departure sequences but a plan computed by the Integrated Runway Sequence function and provided to the ATCO. The integrated sequence becomes a centralized plan and ATCOs assess the changes to this plan in order to take the necessary actions.
Check Adherence with Arrival/Departure Integrated Sequence	Introduce	This activity is introduced by the solution because of the introduction of the integrated arrival/departure sequence, which is no longer the result of the ATCO's mental merging of arrival and departure sequences but a plan computed by the Integrated Runway Sequence function and provided to the ATCO. ATCOs will monitor the adherence to this plan.
Determine TSAT	Update	This activity is updated by the solution because TSAT is no longer determined by a DMAN to build a departure sequence but it is determined by a Integrated Runway Sequence function to build a runway arrival/departure integrated sequence.
Deviate from integrated sequence plan	Introduce	This activity is introduced by the solution because of the introduction of the integrated arrival/departure sequence, which is no longer the result of the ATCO's mental merging of arrival and departure sequences but a plan computed by the Integrated Runway Sequence function and provided to the ATCO. Flights might deviate to this plan, which will trigger changes the integrated arrival/departure sequence.
Follow the integrated arrival/departure sequence	Introduce	This activity is introduced by the solution because of the introduction of the integrated arrival/departure sequence, which is no longer the result of the ATCO's mental merging of arrival and departure sequences but a plan computed by the Integrated Runway Sequence function and provided to the ATCO. ATCOs follow this plan (new working method).

Identify need for traffic balancing	Update	This activity is updated by the solution as currently the TWR Supervisor identifies the need for traffic balancing between runways based on experience and the assistance of different monitoring tools not necessarily linked to the management of the sequence. With the introduction of the integrated arrival/departure runway sequence, the need for traffic balancing between runways is automated and performed by the integrated runway sequence function, provided that this automatic balancing option has been activated by the TWR Supervisor. Based on off-line configured parameters, the system identifies that the maximum capacity of one runway is reached and that some traffic can be balanced to the integrated sequence of another runway.
Monitor achievement of TTL/TTG advisories	Update	This activity is updated by the solution because the reference against which the monitoring is done is no longer the TTL/TTG advisories provided by an AMAN to meet an arrival sequence, but the TL/TTG advisories to meet an integrated arrival/departure sequence computed by the Integrated Runway Sequence function and provided to the ATCO.
Monitor Integrated Arrival/Departure Sequence	Introduce	This activity is introduced by the solution because of the introduction of the integrated arrival/departure sequence, which is no longer the result of the ATCO's mental merging of arrival and departure sequences but a plan computed by the Integrated Runway Sequence function and provided to the ATCO. ATCOs will monitor this plan and follow it.
Perform traffic balance between runways	Update	This activity is updated by the solution as currently the TWR Supervisor performs traffic balancing between runways that might or not impact the calculation of the different traffic sequences (departure, arrival). With the introduction of the integrated arrival/departure runway sequence, the traffic balancing between runways is automated and performed by the integrated runway sequence function, provided that this automatic balancing option has been activated by the TWR Supervisor. Based on off-line configured parameters, the system moves automatically some traffic meeting certain conditions (specific SID/STAR, runway in use, etc.) from the integrated runway sequence of a runway to the integrated runway sequence of another runway. This is done if certain conditions off-line defined are met, e.g. maximum capacity of one runway reached.
Provide clearances and instructions to meet TTL/TTG advisories	Update	This activity is updated by the solution because the reference for the clearances and instructions are no longer the TTL/TTG advisories provided by an AMAN to meet an arrival sequence, but the TTL/TTG advisories to meet an integrated arrival/departure sequence computed by the Integrated Runway Sequence function and provided to the ATCO.
Provide landing clearance	Update	This activity is updated by the solution because the landing clearance will be provided to meet the TLDT calculated by the Integrated Runway Sequence function to build an integrated

		arrival/departure sequence.
Provide Line-Up Clearance	Update	This activity is updated by the solution because the line-up clearance will be provided to meet the TTOT calculated by the Integrated Runway Sequence function to build an integrated arrival/departure sequence.
Provide Push-Back Instructions	Update	This activity is updated by the solution because the push-back instructions will be provided to meet the TTOT calculated by the Integrated Runway Sequence function to build an integrated arrival/departure sequence.
Provide Start-Up Approval	Update	This activity is updated by the solution because the reference for the start-up approval is the TSAT calculated by the Integrated Runway Sequence function to build an integrated arrival/departure sequence.
Provide take-off clearance	Update	This activity is updated by the solution because the take-off clearance will be provided to meet the TTOT calculated by the Integrated Runway Sequence function to build an integrated arrival/departure sequence.
Provide Taxi Clearance	Update	This activity is updated by the solution because taxi clearance will aim to achieve the TTOT calculated by the Integrated Runway Sequence function to build an integrated arrival/departure sequence.
Re-direct flight to another RWY	Update	This activity is updated by the solution because the re-direction of a flight to another runway implies the update of the arrival/departure integrated sequence calculated by the Integrated Runway Sequence function.
Re-sequence flight	Update	This activity is updated by the solution because the change of departure sequence number impacts an integrated arrival/departure sequence, and not only a departure sequence.
Receive relevant information of the up-to-date integrated arrival/departure sequence	Introduce	This activity is introduced by the solution together with the concept of integrated arrival/departure sequence that is calculated automatically by the Integrated Runway Sequence function and distributed to all concerned actors. Each ATCO receives the relevant information on the integrated arrival/departure sequence according to their roles and responsibilities.
Reject Start-Up Approval	Update	This activity is updated by the solution because the reference for the start-up rejection is the TSAT calculated by the Integrated Runway Sequence function to build an integrated arrival/departure sequence.
Update Integrated Arrival/Departure Sequence	Introduce	This activity is introduced by the solution together with the concept of integrated arrival/departure sequence that is calculated automatically by the Integrated Runway Sequence function and distributed to all concerned actors. The integrated sequence is maintained by the Integrated Runway Sequence function and shared by all actors. Changes on the traffic might trigger automatic updates of the integrated arrival/departure sequence.

Update manually integrated arrival/departure sequence	Introduce	This activity is introduced by the solution together with the concept of integrated arrival/departure sequence that is calculated automatically by the Integrated Runway Sequence function and distributed to all concerned actors. The integrated sequence is maintained by the Integrated Runway Sequence function and shared by all actors. ATCOs might perform manual changes in the integrated sequence (e.g. swap fights, manual move flights in the sequence) in case the plan cannot be followed or if a better plan can be proposed by the ATCO.
Update TSAT	Update	This activity is updated by the solution because the TSAT update impacts an integrated arrival/departure sequence, and not only a departure sequence.

Table 41: Differences between new and previous Operating Methods for Solution 02-08 Concept 1

3.4.3.2 Differences between new and previous Operating Methods for Concept 2

OI Step code – title (OI Step CR)		
TS-0313 - Optimized Use of Runway Capacity for Multiple Runway Airports (CR 01093 Update TS-0313 (PJ.02-08))		
Activity	Impact	Change
Apply Optimal Runway Configuration	Update	This activity is updated by the solution because the runway configuration change impacts the integrated arrival/departure sequence, which is no longer the result of the ATCO's mental merging of arrival and departure sequences but a plan computed by the Integrated Runway Sequence function and provided to the ATCO.
Assess impact of RWY Closure in the Integrated Arrival/Departure Sequence	Introduce	This activity is introduced by the solution because of the introduction of the integrated arrival/departure sequence, which is no longer the result of the ATCO's mental merging of arrival and departure sequences but a plan computed by the Integrated Runway Sequence function and provided to the ATCO. The integrated sequence becomes a centralized plan and Tower Supervisor assesses the changes to this plan triggered by RWY closure in order to decide on the closure time.
Monitor optimal RWY configuration proposed and associated KPIs	Update	This activity is updated by the solution as the check of KPIs can be assisted by what-if tools to support decision making.

Table 42: Differences between new and previous Operating Methods for Solution 02-08 Concept 2

3.4.3.3 Differences between new and previous Operating Methods for Concept 3

OI Step code – title
AO-0337 – Increased Runway Throughput based on local ROT characterization (ROCAT)

(CR 03274 Create AO-0337 to replace AUO-0704 (PJ02-08))		
Activity	Impact	Change
Assess ITD infringement of MRS or wake separation	Update	Assessment of the infringement is now based on TDIs (ITD and FTD), which is a new concept. In nominal case, the ITD shown to the Final Approach Controller is the most containing one, the ROT in this use case. In case of infringement, the second most constraining ITD (either coming from MRS or wake turbulence separation) is displayed to the controllers.
Assess next spacing constraint (wake/MRS)	Introduce	Assessment of the infringement is now based on TDIs (ITD and FTD), which is a new concept. In nominal case, the ITD shown to the Final Approach Controller is the most containing one, the ROT in this use case. In case of infringement, the second most constraining ITD (either coming from MRS or wake turbulence separation) is displayed to the controllers.
Assess spacing infringement	Update	Assessment of the infringement is now based on TDIs. Concept of Target Distance Indicator is new compared to current ATS. Moreover, the Target Distance Indicator considers the value of ROT, value for the MRS and value of Wake Turbulence separation.
Identify pairing between ITD/FTD and aircraft	Introduce	Initial approach controller's support tool, the ORD, introduces the ITD and FTD to be used in the spacing of aircraft.
Monitor compression effect and ROT FTD spacing	Update	The Tower Runway Control must now consider a precise value of ROT in the spacing including after deceleration.
Sequence, Merge, Space aircraft according to spacing computed for ROT	Update	The Final Approach Control must now consider a precise value of the spacing resulting from an ROT constraint. The value is provided to the final approach controller via the TDI.

Table 43: Differences between new and previous Operating Methods for Solution 02-08 Concept 3

3.4.3.4 Differences between new and previous Operating Methods for Concept 4

OI Step code – title
AO-0338 – Increased Runway Throughput based on AROT optimisation (CR 03275 Create AO-0338 to complement former AUO-0704 (PJ02-08))

AO-0338 – Use of Enhanced Prediction of Arrival Runway Occupancy Time (ROT) for medium airports		
Activity	Impact	Change
analyse EXIT RWY and ROT data from EFS	Introduce	Tower Controller initially assesses the feasibility of recommended Exit for Leader Aircraft and any impact of AROT on the Follower Aircraft
assess EXIT RWY data for Leading Aircraft	Introduce	Tower Controller assesses the feasibility of recommended Exit for Follower Aircraft
assess EXIT RWY data for following aircraft	Introduce	Tower Controller assesses the feasibility of recommended Exit for Leader Aircraft and any impact of AROT on the Follower Aircraft
Give landing clearance	Update	Tower Runway controller now considers the exit TWY and ROT in managing the traffic. This information is also passed to the flight crew with landing clearance as a reminder (landing information is communicated once upon transfer to TWR and then with landing clearance).

Table 44: Differences between new and previous Operating Methods for Solution 02-08 Concept 4

4 Safety, Performance and Interoperability Requirements (SPR-INTEROP)

The following section compiles Operational Service and Environment Requirements defined in Solution 02-08 for V3 maturity:

The requirements REQ-XXb.YY-SPRINTEROP-UU01.0123 are built in compliance with the following criteria as described in the document [4] :

- **Identifier field:** Unambiguous identifier including <Object type>-<Solution code>-<Document code>-<Reference code>.<Reference number> where
    - <Object type> is REQ - Requirement
    - <Solution code> XXb.YY for the project code and then the last two digits for the solution identifier (i.e. 02.08)
    - <Document code> is SPRINTEROP - Safety, Performance, Interoperability and operational requirements
    - <Reference code> is a combination of four alphanumeric characters (i.e. MET1, HMI1…)
        - Operational requirements (numbered as):
            - For Concept 1 (numbered as FUN1);
            - For Concept 2 (numbered as FUN2)
            - For Concept 3 (numbered as FUN3)
            - For Concept 4 (numbered as FUN4)
        - HMI requirements (numbered as HMI)
            - For Concept 1 (numbered as HMI1);
            - For Concept 2 (numbered as HMI2)
            - For Concept 3 (numbered as HMI3)
            - For Concept 4 (numbered as HMI4)
        - Safety requirements (numbered as SAF)
            - For Concept 1 (numbered as SAF1);
            - For Concept 2 (numbered as SAF2)
            - For Concept 3 (numbered as SAF3)
            - For Concept 4 (numbered as SAF4)
        - Performance requirements (numbered as PRF):
            - For Concept 1 (numbered as PRF1);
            - For Concept 2 (numbered as PRF2)
            - For Concept 3 (numbered as PRF3)
            - For Concept 4 (numbered as PRF4)
        - Interoperability requirements (numbered as INT):
            - For Concept 1 (numbered as INT1);
            - For Concept 2 (numbered as INT2)
            - For Concept 3 (numbered as INT3)
            - For Concept 4 (numbered as INT4)

- Security requirements (numbered as SEC):
  - For Concept 1 (numbered as SEC1);
  - For Concept 2 (numbered as SEC2)
  - For Concept 3 (numbered as SEC3)
  - For Concept 4 (numbered as SEC4)

- <Reference number> is a sequence of four digits.

- **Title field**: Free text providing general description.
- **Requirement**: Description of the requirement developed from the relevant needs where the format has been applied: *The <Issuer> shall exchange the <Information Element> with the <Addressee>, and where relevant added with "in combination with <Additional Information Elements X, Y etc>. <Issuer>, <Information Element> and <Addressee> taken from the relevant IER.*
- **Status field**: Requirement lifecycle status that may be:
  - <In Progress> if the requirement is not confirmed as validated;
  - <Deleted> is used to indicate that the requirement is not considered valid anymore
  - <Validated> if the validation of the requirement is completed in the frame of the SESAR R&D activities (until V3) and the requirement is mature enough to be directly transferred to Industrialisation (V4). .
- **Rational Field**: Free text describing (if applicable) the changes with respect to previous versions. The explanation may include references to other studies.
- **Category field**: Requirement category may be:
  - <Operational>
  - <Safety>
  - <Security>
  - <HMI>
  - <Human Performance>
  - <IER>
  - <Interoperability>

Note that for some requirements listed in this section there is no link to an EATMA element (Information Exchange or Activity). The reasons for this might be different and are explained for each case:

- Requirement is too technical and should be moved to TS in V3 or
- Non-functional requirement, therefore no possibility of link with EATMA elements which model functional views

The link between Requirements and Service, Function and Functional Blocks are set as N/A as not required in EATMA.

4.1 Operational Requirements

4.1.1 Operational Requirements (Concept 1)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0001
Title	Integrated Runway Sequence inputs
Requirement	In order to achieve an optimal integration of arrival and departure flows, ATCOs shall receive an automatically calculated integrated arrival and departure sequence (the Integrated Runway Sequence) based on the following inputs if available: • Flight progress reports • Input clearances from the controller • Arrival and Departure traffic volumes from the airport • Estimated Take-off and Landing times • Airport priorities and constraints • Updated manual sequences from the controller • Arrival and departure required spacing • SID Constraints • Planned runway configuration • The variable taxi-out times Actual landing and actual off-block and take-off times • Weather conditions • Runway Occupancy Times static values • Wake vortex separations
Status	<Validated>
Rationale	The information is used by Integrated Runway Sequence function to calculate the integrated sequence that is used by the ATCOs
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0001
<SESAR Solution>	PJ.02-08
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to En-Route
<Information Flow>	N/A
<Activity>	Receive relevant information of the up-to-date integrated arrival/departure sequence
<Functional Block><	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0002
Title	Integrated Runway Sequence KPA Balancing
Requirement	The Sequence Manager shall be able to manually adjust the criteria for the calculation of the integrated sequence by setting the priority on proposed KPAs (e.g. capacity, efficiency) off-line configurable based on local implementation needs.
Status	< Validated >
Rationale	As the operational priorities of the airport change throughout the day (arrival/departure throughput, environmental impact, etc.), the KPAs in the Integrated Runway Sequence function need to be able to be adjusted to follow these priorities. Different approaches can be taken on how to handle the traffic on the runway (e.g. maximising runway capacity vs minimizing environmental impact). The Integrated Runway Sequence function will use the priorities and constraints defined at the local implementation level.

Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Monitor optimal RWY configuration proposed and associated KPIs
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0003
Title	Integrated Runway Sequence departure queue number
Requirement	The ATCO with the authorised role (e.g. Sequence Manager) shall be able to manually adjust the number of flights in the departure queue (buffer) at runway hold.
Status	< Validated >
Rationale	To balance the taxi efficiency with runway pressure, the controller shall have the ability to set the number of aircraft that should be holding at the runway before take-off.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0003
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update manually integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0004
Title	Integrated Runway Sequence what if
Requirement	The ATCO with the authorised role (e.g. Sequence Manager) shall be able to probe changes on the integrated sequence and to assess the effects of the proposed sequence changes, without disrupting the active integrated sequence (what-if capability).
Status	< Validated >
Rationale	The controller needs to be able to weight the options that the Integrated Runway Sequence function makes before implementation.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0004
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Assess impact of RWY Closure in the Integrated Arrival/Departure Sequence
<Activity>	Assess changes in the integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0005
Title	Optimisation of the Integrated Runway Sequence in the pre-tactical phase.
Requirement	In the pre-tactical phase, ATCOs shall receive an optimised Integrated runway Sequence with the TLDT, TTOT and TSAT adjusted by the Integrated Runway Sequence function.
Status	< Validated >
Rationale	The Integrated Runway Sequence function can make significant changes on the SBT in the planning phase
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0005
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update Integrated Arrival/Departure Sequence
<Activity>	Update TSAT
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0006
Title	Optimisation of the Integrated Runway Sequence in the tactical phase
Requirement	In the tactical phase, ATCOs shall receive an optimised Integrated Runway Sequence with TLDT and TTOT fine-tuned by the Integrated Runway Sequence function.
Status	< Validated >
Rationale	The Integrated Runway Sequence function can make minor changes on the RBT in the execution phase.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0006
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update Integrated Arrival/Departure Sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0007
Title	Integrated Runway Sequence optimisation goals
Requirement	ATCOs shall receive an optimised Integrated Runway Sequence according to the airport priorities and constraints (off-line configurable operational indicators based on local implementation needs).
Status	< Validated >
Rationale	The Integrated Runway Sequence function takes into account the most important airport priorities and constraints (e.g. nature and type of the traffic, specific priority rules, physical or environmental constraints) to optimise the integrated sequence accordingly. These priorities are different at each airport.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0007
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0008
Title	Freeze a flight in the Integrated Runway Sequence.
Requirement	The ATCO shall be able to manually freeze/un-freeze a flight in the Integrated Runway Sequence.
Status	< Validated >
Rationale	The ability to freeze (and un-freeze) a flight in the Integrated Runway Sequence is necessary in certain situations (e.g. when departure flight is asked to perform push-back before TSAT to hold at a remote position or when an arrival flight needs to maintain its order in the sequence for operational reasons.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0008
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update manually integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0009
Title	Suspend a flight from the Integrated Runway Sequence.
Requirement	The ATCO shall be able to manually suspend/insert a flight from/to the Integrated Runway Sequence.
Status	< Validated >
Rationale	In certain situations (e.g. when flight crew announce a temporary unplanned delay during the taxi out phase or in case of unplanned diversion) the ability to suspend a flight into the runway sequence is necessary and eventually also the ability to later insert the flight).
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0009
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update manually integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0010
Title	Integrated Runway Sequence Stabilisation
Requirement	When an aircraft estimated landing time/take-off time is within an off-line defined stability time horizon, its position in the Integrated Runway Sequence provided to ATCOs shall remain unchanged and stable, avoiding any automatic sequence order change unless specific rules apply to cope with local exceptions.
Status	< Validated >
Rationale	To avoid continuous update of the sequence, Integrated Runway Sequence function shall freeze aircraft position in the sequence once they are below a defined time horizon. Examples of local exceptions are joining/leaving flights, flights from departure aerodromes too close to the destination aerodrome.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0010
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0011
Title	Runway closure lock
Requirement	The TWR Supervisor or the Sequence Manager shall be able to manually input a runway closure to a “specific time” or “after selected aircraft in the Integrated Runway Sequence”.
Status	< Validated >
Rationale	The inclusion of a runway closure at a certain place in the sequence is necessary for optimized planning of operations.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0011
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Input Runway Closure times into the HMI
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0012
Title	Traffic re-planning after runway closure
Requirement	When TWR Supervisor or ATCO inputs manually a runway closure, ATCOs shall automatically receive a recalculated Integrated Runway Sequence that takes into account the runway closure input.
Status	< Validated >
Rationale	The Integrated Runway Sequence depends on the availability of the runway and therefore it has to be re-calculated automatically in case of runway closure.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0012
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update Integrated Arrival/Departure Sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0013
Title	Traffic re-planning after go-around
Requirement	ATCOs shall receive a recalculated Integrated Runway Sequence after a go-around (either automatically or after manual input from the controller)
Status	< Validated >
Rationale	The go-around introduces a modification in the Integrated Runway Sequence. Therefore, the Integrated Runway Sequence needs to be re-calculated after go-around.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0013
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update Integrated Arrival/Departure Sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0014
Title	Manual Integrated Runway Sequence changes
Requirement	The ATCO shall be able to manually change the Integrated Runway Sequence.
Status	< Validated >
Rationale	ATCO shall have the possibility to manually change the sequence, e.g. in the case where he thinks there is room to improve the proposed sequence, or if he realizes that the sequence is not applicable.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0014
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update manually integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0015
Title	Integrated Runway Sequence re-computation on manual inputs
Requirement	When an ATCO makes manual updates in the Integrated Runway Sequence, all ATCOs shall receive a re-computed Integrated Runway Sequence based on the manual update
Status	< Validated >
Rationale	When ATCO forces a manual update of the sequence, Integrated Runway Sequence function shall calculate a new Integrated Runway Sequence considering ATCO intervention as a constraint.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0015
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive integrated sequence update on manual change
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0016
Title	Integrated Runway Sequence compliance with CTOT
Requirement	ATCOs shall receive an Integrated Runway Sequence where TTOT is compliant with CTOT.
Status	< Validated >
Rationale	The Integrated Runway Sequence shall be aligned with CTOT, so that scheduled departures in the proposed sequence have their CTOT unchanged.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0016
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0017
Title	Integrated Runway Sequence update at the runway hold
Requirement	ATCOs shall receive an Integrated Runway Sequence update at the runway holding point based on one of the following options: • The Tower Runway controller manually updates the sequence OR, • The system updates the sequence accurately reflecting actual situation.
Status	< Validated >
Rationale	Controller situational awareness can be compromised if Integrated Runway Sequence function proceeds to automatically update the sequence at the runway hold without prioritising feasibility and the actual position of aircraft at the runway hold.
Category	<Operational><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0017
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Update manually integrated arrival/departure sequence
<Activity>	Update Integrated Arrival/Departure Sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0018
Title	Integrated Runway Sequence balancing of arrival/departure flights between two runways.
Requirement	ATCOs shall receive an update of the Integrated Runway Sequences in case the Integrated Runway Sequence function balances arrival/departure flights between two runways by changing the runway in use for the concerned flights, taking into account offline defined timeframe and eligibility rules (e.g. runway configuration, predefined STAR for arrivals, predefined SID for departures).
Status	< Validated >
Rationale	For airports with two runways in use planned allocation of arrival and departure runway is geographically defined, based on TMA entry/exit (or other locally defined constraints). During periods there can be an overload of flights planned for one of the runways. With early balancing of flights between the runways the overall throughput can be increased, with maintained ability to plan for arrival continuous descent. Update of runway in use for a specific flight is performed in a timeframe according to local rules (e.g. normally before arrival TOD and/or a locally defined time before departure EOBT)

Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0018
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Identify need for traffic balancing
<Activity>	Perform traffic balance between runways
<Activity>	Update Integrated Arrival/Departure Sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-FUN1.0019
Title	Activation of Integrated Runway Sequence balancing of arrival/departure flights between two runways.
Requirement	The Tower Supervisor shall be able to activate or de-activate the automatic balancing of arrival/departure flights between two runways.
Status	< Validated >
Rationale	For airports with two runways in use balancing of flights between the runways can be selected or deselected by the Tower Supervisor based on the local situation (e.g. traffic, weather etc.).
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-FUN1.0019
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Activate traffic balancing option
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 45: Functional Requirements capture for Solution 02-08 Concept 1

4.1.2 Operational Requirements (Concept 2)

N/A (Concept 2 is rather a technical solution that brings an interface between coupled AMAN/DMAN and RMAN). The validation of RMAN is not in the scope of PJ02-08 but just the validation of the technical interface. Operational requirements for RMAN were already identified in SESAR 1 in the frame of project 12.02.01 Runway Management Tools and are considered as still valid and unchanged. Therefore, no specific operational requirements are identified for Concept 2.

4.1.3 Operational Requirements (Concept 3)

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP-FUN3.0001
Title	Indication of MRS considering the ROT constraint.
Requirement	In case the Predicted ROT is identical ROT for all aircraft types of a Wake Turbulence Category (WTC), Tower and approach controllers should be provided with separation minima that consider the reduced MRS allowed for that WTC.
Status	< Validated >
Rationale	For the controller to be apply the adequate minimum separation, taking into account the ROT constraint of the leader aircraft.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN3.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN3.0002
Title	Enhanced Prediction of ROT to provide predicted ROT to Separation Delivery function
Requirement	In case a separation delivery tool is used, ATCOs shall receive from the Enhanced Prediction of ROT the ROT characterized for the leader aircraft, according to its characteristics: • aircraft type • airline • runway exit • runway conditions • expected aircraft speed or time-to-fly profile model on the final approach glide-slope
Status	< Validated >
Rationale	For the separation delivery function to consider the adequate characterized ROT in the computation of the spacing.
Category	<Operational>, <Interoperability>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN3.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN3.0003
Title	Approach and tower runway controller needs for the maximum of all applicable separation minima.
Requirement	The approach and tower runway controller shall be provided with the maximum of all applicable separation or spacing minima, including the ROT spacing as given by the Enhanced Prediction of ROT function.
Status	< Validated >
Rationale	Mixing several separation minima, the tower and approach controller needs to know the most constraining minima to be applied, including the ROT induced spacing.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN3.0003
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A

<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN3.0004
Title	ATCO to be aware of the reason for separation/spacing applied
Requirement	ATCOs (approach and tower controllers) shall be able to identify the reason behind the separation minima for an aircraft pair onto final approach segment given by the Separation Delivery: MRS, Wake separation Minima or ROT.
Status	< Validated >
Rationale	Differentiation of safety related separation such wake and MRS, from non-safety related such as ROT might lead to different action upon operational situations.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN3.0004
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN3.0005
Title	Tower and approach controller needs to know the margin compared to the safety related separation minima.
Requirement	Assuming the ROT is the most constraining spacing; in case the ROT spacing constraint and the wake (respectively MRS) optimum separation minima (ITD) are infringed, the Approach and Tower controller shall be able to see the separation minima (FTD) linked to wake (respectively MRS).
Status	< Validated >
Rationale	For the approach and tower controller to be able to detect safety related issue, assess situation and make appropriate recovery action.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN3.0005
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN3.0006
Title	Enhanced Prediction of ROT to provide predicted ROT to Separation Delivery function
Requirement	The approach and tower runway controller shall be provided with the maximum of all applicable separation or spacing minima, including the ROT

	spacing as given by the Enhanced Prediction of ROT function.
Status	< Validated >
Rationale	For the separation delivery tool to take into consideration the ROT constraint in the separation minima.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN3.0006
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 46: Functional Requirements capture for Solution 02-08 Concept 3

4.1.4 Operational Requirements (Concept 4)

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN4.0001
Title	Tower controller to be aware of the runway exit considered by the Enhanced Prediction of the ROT
Requirement	The Tower Controller shall be able to know the exit for each approaching flight, considered optimal by the Enhanced AROT Prediction.
Status	< Validated >
Rationale	For the tower controller to be able to detect anomalies as well as give optimal exit recommendation in clearances.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN4.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Analyse EXIT RWY and ROT data from EFS
<Activity>	Assess EXIT RWY data for following aircraft
<Activity>	Assess EXIT RWY data for Leading aircraft
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN4.0002
Title	Enhanced Prediction of ROT to provide predicted ROT to Tower Runway Controller
Requirement	The Tower Runway controller shall be able to know ROT forecast corresponding to the optimal runway exit selected by the Enhanced AROT prediction.
Status	< Validated >
Rationale	In order to maintain awareness and ability to detect anomalies in oncoming sequence. In Small Airport sub-environment the airport layout is simpler allowing for more detailed dynamic prediction.
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN4.0002
<SESAR Solution>	PJ.02-08

<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Analyse EXIT RWY and ROT data from EFS
<Activity>	Assess EXIT RWY data for following aircraft
<Activity>	Assess EXIT RWY data for Leading aircraft
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- FUN4.0007
Title	Tower controller ROT and exit estimation timing
Requirement	In case ROT and exit estimations are passed directly to TWR Runway Controller CWP they shall be available with lead time of at least 3 min.
Status	<Validated>
Rationale	Tower runway controller must have appropriate time to take decisions based on exit and ROT prediction. Moreover any speed regulations can be more effective if applied with larger lead time. Requirement validated during EXE.02-08.V3.004
Category	<Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-FUN4.0007
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	Analyse EXIT RWY and ROT data from EFS
<Activity>	Assess EXIT RWY data for following aircraft
<Activity>	Assess EXIT RWY data for Leading aircraft
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 47: Functional Requirements capture for Solution 02-08 Concept 4

4.2 HMI Requirements

4.2.1 HMI Requirements (Concept 1)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-HMI1.0001
Title	Configure Integrated Runway Sequence display.
Requirement	Based on off-line configuration by role, each ATCO shall receive from the Integrated Runway Sequence function the appropriate information on the HMI, among the following: - Time horizon of the time line; - Calculated target times (TSAT, TTOT, TLDT); - Sequence number; - Advisories (time to loose/gain, tactical); - Airport priorities.
Status	<Validated>
Rationale	The information provided by Integrated Runway Sequence function must the appropriate for each stakeholder in order to support his/her job and to avoid display overload. For instance, an En-Route Controller might not be interested in having the TSAT information but rather the advisories on arrival flights, whereas the opposite applies for Tower Controllers. The time horizon of interest might also vary between roles.
Category	<HMI>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-HMI1.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to En-Route
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-to-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-HMI1.0002
Title	Minimum required Integrated Runway Sequence information for Approach Controller
Requirement	The Approach Controller shall receive from the Integrated Runway Sequence function at least the TLDT on the HMI.
Status	<Validated>
Rationale	Controller should follow TLDT as closely as practicable.
Category	<HMI>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-HMI1.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to Approach
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-do-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-HMI1.0003
Title	Minimum required Integrated Runway Sequence information for Tower Runway Controller
Requirement	The Tower Runway Controller shall receive from the Integrated Runway Sequence function at least the TTOT and TLDT on the HMI.
Status	<Validated>
Rationale	Controller should follow target times as closely as possible.
Category	<HMI>
Validation Method	<Real Time Simulation>
Verification Method	<Test>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-HMI1.0003
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-do-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-HMI1.0004
Title	Minimum required Integrated Runway Sequence information for Tower Clearance Delivery Controller and Apron Manager.
Requirement	The Tower Clearance Delivery Controller and the Apron Manager (where applicable) shall receive from the Integrated Runway Sequence function the TSAT and TTOT values on the HMI.
Status	<Validated>
Rationale	Controller should follow target times as closely as possible.
Category	<HMI>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-HMI1.0004
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-do-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-HMI1.0005
Title	Minimum required Integrated Runway Sequence information for En-Route Controller.
Requirement	The En–Route Controllers shall receive from the Integrated Runway Sequence function advisories on time to lose or gain for arrival traffic on the HMI.
Status	< Validated >
Rationale	Controller should follow Integrated Runway Sequence as closely as possible.
Category	<HMI>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-HMI1.0005
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to En-Route
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-do-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08- SPRINTEROP-HMI1.0006
Title	Minimum required Integrated Runway Sequence information for Tower Ground Controller
Requirement	The Tower Ground Controller shall receive from the Integrated Runway Sequence function at least the TTOT values on the HMI.
Status	< Validated >
Rationale	Controller should follow Integrated Runway Sequence as closely as possible.
Category	<HMI>

[REQ Trace]

Linked Element Type	REQ-02.08- SPRINTEROP-HMI1.0006
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-do-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-HMI1.0008
Title	Runway closure displayed on HMI
Requirement	The ATCOs shall be able to see indications of any runway closure included in Integrated Runway Sequence display.
Status	< Validated >
Rationale	The Integrated Runway Sequence function has to provide the capability to display critical safety information under abnormal conditions, such as a runway closure.
Category	<HMI>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-HMI1.0008
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to En-Route
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-to-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-HMI1.0010
Title	Provide TLDT/TTOT and TSAT to Sequence Manager
Requirement	The Sequence Manager shall receive from the Integrated Runway Sequence function the TTOT, TSAT and TLDT on the HMI.
Status	< Validated >
Rationale	Sequence Manager will need to know the relevant Integrated Runway Sequence information to manage it accordingly.
Category	<HMI>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-HMI1.0010
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-to-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 48: HMI Requirements capture for Solution 02-08 Concept 1

4.2.2 HMI Requirements (Concept 2)

N/A (Concept 2 is rather a technical solution that brings an interface between coupled AMAN/DMAN and RMAN). The validation of RMAN is not in the scope of PJ02-08 but just the validation of the technical interface. HMI requirements for RMAN were already identified in SESAR 1 in the frame of project 12.02.01 Runway Management Tools and are considered as still valid and unchanged. Therefore, no specific HMI requirements are identified for Concept 2.

4.2.3 HMI Requirements (Concept 3)

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP-HMI3-0001
Title	Approach controller needs for Target distance indicator considering ROT
Requirement	In case the Enhanced ROT prediction quantifies an aircraft wise ROT (ROT is different for aircraft part of the same WTC) the Approach Controller shall be supported by a Separation Delivery and Monitoring function at least providing a static indication about applicable separation minima between arrival aircraft pairs onto final approach segment and taking into account the Enhanced Prediction of ROT of the leader aircraft.
Status	< Validated >
Rationale	For approach controllers to be able to apply pair wise computed AROT spacing (and Wake separation) according to aircraft pair. In that case controller cannot use anymore a 2 entry separation table, as the separation could vary according to ROT within the same wake turbulence category.
Category	<HMI> <Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-HMI3.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Provide Aircraft spacing (speed/vector clearance)
<Information Flow>	N/A
<Function>	N/A
<Activity>	Assess ITD infringement spacing infringement
<Activity>	Assess spacing infringement
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- HMI3-0002
Title	Tower Runway Controller needs for Target distance indicator considering ROT
Requirement	In case the Enhanced ROT prediction quantifies an aircraft wise ROT (ROT is different for aircraft part of the same WTC) the Approach Controller shall be supported by a Separation Delivery and Monitoring function at least providing a static indication about applicable separation minima between arrival aircraft pairs onto final approach segment and taking into account the Enhanced Prediction of ROT of the leader aircraft.
Status	< Validated >
Rationale	Tower Runway Controller to be able to apply pair wise computed AROT spacing (and Wake separation) according to aircraft pair. In that case controller cannot use anymore a 2 entry separation table, as the separation could vary according to ROT within the same wake turbulence category.
Category	<HMI> <Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-HMI3.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Give speed instructions
<Information Flow>	N/A
<Function>	N/A
<Activity>	Give speed instructions
<Activity>	Assess time to recover
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 49: HMI Requirements capture for Solution 02-08 Concept 3

4.2.4 HMI Requirements (Concept 4)

[REQ]

Identifier	REQ-PJ02.08-SPRINTEROP- HMI4-0001
Title	Tower Runway Controller HMI shows ROT and considered exit TWY
Requirement	Tower runway controller shall be informed of ROT and exit TWY via appropriate HMI.
Status	< In progress >
Rationale	Tower Runway Controller to be able to ingest ROT and exit TWY information. Due to necessity to use contingency platform in EXE.02-08.V3.004 this requirement was not successfully validated at V3 level. Replacement of HMI was used which was found unsatisfactory.
Category	<HMI> <Operational>

[REQ Trace]

Linked Element Type	REQ-PJ02.08-SPRINTEROP-HMI4.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	analyse EXIT RWY and ROT data from EFS
<Activity>	assess EXIT RWY data for following aircraft
<Activity>	assess EXIT RWY data for Leading Aircraft
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 50: HMI Requirements capture for Solution 02-08 Concept 4

4.3 Safety and Performance Requirements (SPR)

4.3.1 Safety Requirements

The objective of this section is to provide the basis to ensure and demonstrate that the implemented systems can meet the relevant safety and performance requirements for the services described in the OSED. To this aim the section analyzes the KPAs impacted by the described concepts and the specific KPIs involved for each KPA. The performance results are also reported as observed in the validation exercises carried on in the frame of the solution 08-02.

This section collects all the safety and performance requirements derived from the assessment illustrated in the Part II of the OSED (Safety Assessment Report) as well as the ones identified in SESAR1 and still relevant for the solution.

4.3.1.1 Safety Requirements (Concept 1)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF1.0001
Title	Display of the Planned Integrated Sequence
Requirement	The Integrated Runway Sequence function shall support shared situation awareness between TWR and Approach by providing the relevant information (based on local implementation needs) of the up-to-date integrated arrival/departure sequence.
Status	< Validated >
Rationale	Awareness of the Integrated Runway Sequence by both parties is essential in aiding coordination between them.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF1.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-to-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF1.0003
Title	Information on Integrated Runway Sequence function failure
Requirement	An alert on the HMI shall warn the Controller and Supervisor in case of a failure (partial or total loss) of the Integrated Runway Sequence function.
Status	< Validated >
Rationale	The alert will be useful to notify the failure of the Integrated Runway Sequence function to the controller/supervisor who has to apply the foreseen backup procedures.
Category	<Safety>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF1.0003
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF1.0004
Title	Training on Integrated Runway Sequence function
Requirement	The responsible units shall ensure that Controllers are properly trained in the back up procedures for failures (partial or total loss) of Integrated Runway Sequence function
Status	< Validated >
Rationale	As for any function that includes automation, when the ATCOs gets used to it, their unavailability might have an impact in human performance and a proper training in backup procedures can mitigate this impact and prevents that it leads to an unsafe situation.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF1.0004
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF1.0008
Title	Higher priority of manual updates versus automatic updates
Requirement	The Integrated Runway Sequence function shall never override a manual update of the Integrated Runway Sequence with an automatic update.
Status	< Validated >
Rationale	In order to avoid errors and loss of situation awareness and to ensure the trust of the controller in the system, the manual changes made in the sequence by the controller should be maintained. Otherwise, the controller might be out of the loop.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF1.0008
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 51: Safety Requirements capture for Solution 02-08 Concept 1

4.3.1.2 Safety Requirements (Concept 2)

N/A (Concept 2 is rather a technical solution that brings an interface between coupled AMAN/DMAN and RMAN). The validation of RMAN is not in the scope of PJ02-08 but just the validation of the technical interface. Safety requirements for RMAN were already identified in SESAR 1 in the frame of project 12.02.01 Runway Management Tools and are considered as still valid and unchanged . Therefore, no specific Safety requirements are identified for Concept 2.

4.3.1.3 Safety Requirements (Concept 3)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF3.0001
Title	Enhanced ROT Prediction disabled warning
Requirement	System shall warn operators of loss of Enhanced Prediction of ROT function
Status	< Validated >
Rationale	Upon loss of capability to perform its function system should inform the operator of such circumstances by an appropriate warning.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF3.0002
Title	Enhanced ROT Prediction display disabled
Requirement	System shall automatically disable system display overlay (Target distance indicators, ROT forecast) in case of loss of Enhanced Prediction of ROT function
Status	< Validated >
Rationale	Upon loss of capability to perform its function system should not misinform its operators.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF3.0003
Title	Enhanced ROT Prediction display synchronised between Approach and Tower controllers
Requirement	System shall maintain shared situational awareness between Tower runway controller and Approach controller by providing the same Target distance indicators updated simultaneously
Status	< Validated >
Rationale	Both Tower and Approach Controllers need shared situational awareness to perform their responsibilities optimally.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0003
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF3.0004
Title	Enhanced ROT Prediction ROT based separation infringement warning
Requirement	System shall warn ATCOs in case the arrival spacing is less than ROT + safety margin
Status	< Validated >
Rationale	Any separation infringement potential needs to be immediately brought to the attention of responsible controller.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0004
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF3.0005
Title	Enhanced ROT Prediction training prior to deployment
Requirement	Approach and Tower Controllers shall be fully trained to apply the procedures for the new separation modes e.g. Enhanced ROT prediction/ ROCAT and to use of the Separation Delivery Tool and supporting systems (e.g. alerts) with indicators prior to deployment. Training shall cover procedures for normal, abnormal and degraded modes of operations with Enhanced ROT prediction/ ROCAT and the ORD tool
Status	<Validated>
Rationale	To ensure Controllers are sufficiently competent to apply the applicable concept. Controllers and Supervisors must feel at ease working with the Separation Delivery Tool and the associated procedures before deployment. They need to have high trust in the tool - which is associated with a high understanding of the procedures and the mechanisms of the tool. This must cover procedures for normal, abnormal and degraded modes of operations with Enhanced ROT prediction/ ROCAT and the ORD tool
Category	<Safety> <Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0005
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports
<Sub-Operating Environment>	TMA

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF3.0006
Title	Enhanced ROT Prediction training
Requirement	Supervisors and Controllers shall be trained on the Enhanced ROT prediction/ROCAT and / or ORD concept of operations prior to implementation to ensure they have a good mental model of the tool and they understand the algorithm behind the ORD tool with ROCAT procedures.
Status	<Validated>
Rationale	The Supervisors and Controllers need a good understanding of the concept of operations to be able to apply them correctly in the operational environment and understand the constraints and limitation of the concept.
Category	<Safety> <Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0006
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airport
<Sub-Operating Environment>	TMA

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF3.0007
Title	Enhanced ROT Prediction with no controller support tool under DBS
Requirement	Approach and Tower Controllers shall be provided with look-up tables for distance based separation minima to support distance based separation operations with no target distance indicators when necessary.
Status	<Validated>
Rationale	There will be times when the Controllers need to revert to DBS with no TDIs hence may need a reminder of the DBS wake separations.
Category	<Safety> <Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0007
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports
<Sub-Operating Environment>	TMA

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF3.0008
Title	Roles, tasks and responsibilities under Enhanced ROT Prediction operations
Requirement	Roles and responsibilities shall be locally defined for all actors identified-under all modes of operations under Enhanced ROT Prediction/ROCAT operations.
Status	<Validated>
Rationale	To ensure all actors are aware of their roles, tasks and responsibilities under all mode of operations and hence prevent confusion.
Category	<Safety> <Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0008
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports
<Sub-Operating Environment>	TMA

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF3.0009
Title	ORD tool design for the Enhanced ROT Prediction solution
Requirement	Indicators of ORD i.e. WT, MRS, ROT and Gap shall be distinguishable in the FINAL APP / TWR
Status	<Validated>
Rationale	The final approach / TWR ATCOs need to be able to distinguish between the different spacing/separation constraints as their actions towards and infringement may differ.
Category	< Safety> <Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0009
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports
<Sub-Operating Environment>	TMA

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF3.0010
Title	Guidelines / procedures for enhanced ROT prediction / ROCAT and associated tools
Requirement	A set of working methods / guidelines to cover the proposed time based or distance based procedures for enhanced ROT prediction / ROCAT and associated tools (i.e. Separation Delivery Tool or ORD) shall be locally defined.
Status	<Validated>
Rationale	To provide a reference and ensure that the procedures for working with enhanced ROT prediction / ROCAT and the associated tools are documented and hence to ensure that all controllers have the same understanding of how to work with enhanced ROT prediction / ROCAT and associated tools.
Category	< Safety> <Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF3.0010
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports
<Sub-Operating Environment>	TMA

Table 52: Safety Requirements capture for Solution 02-08 Concept 3

4.3.1.4 Safety Requirements (Concept 4)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-SAF4.0001
Title	Enhanced ROT Prediction disabled warning
Requirement	Tower Runway Controller shall be warned of a loss of Enhanced Prediction of ROT function
Status	< Validated >
Rationale	Upon loss of capability to perform its function system should inform the operator of such circumstances by an appropriate warning. System is displaying adequate error messages per flight. Requirement validated during EXE.02-08.V3.004 with the result that messages shall be displayed also globally (if a failure is affecting all flights).
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF4.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	analyse EXIT RWY and ROT data from EFS
<Activity>	assess EXIT RWY data for following aircraft
<Activity>	assess EXIT RWY data for Leading Aircraft
<Functional Block>>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF4.0002
Title	Enhanced ROT Prediction display disabled
Requirement	Tower Runway Controller HMI shall be automatically disabled (ROT forecast, considered exit TWY) in case of loss of Enhanced Prediction of ROT function
Status	<Validated>
Rationale	Upon loss of capability to perform its function system should not misinform its operators. The display is replaced with error warnings whenever at least one data source is failing. Requirement validated during EXE.02-08.V3.004
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF4.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	analyse EXIT RWY and ROT data from EFS
<Activity>	assess EXIT RWY data for following aircraft
<Activity>	assess EXIT RWY data for Leading Aircraft
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF4.0003
Title	Assess exit and ROT for arriving aircraft
Requirement	Tower Runway Controller shall judge the achievability of predicted exit taxiway and ROT upon reception of the estimate from Enhanced AROT Predictor.
Status	<Validated>
Rationale	Only if the AROT information is reliable it can be used operationally. Therefore, TWR RWY Controller needs to assess the achievability of the AROT proposal before using it.
Category	<Safety>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF4.0003
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF4.0004
Title	Give Landing information
Requirement	Flight Crew shall check for achievability and inform ATCO immediately if proposed exit is not achievable.
Status	<Validated>
Rationale	Only if the AROT information is reliable it can be used operationally. Therefore, flight crew needs to assess the achievability of the AROT proposal before following it.
Category	<Safety>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF4.0004
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF4.0005
Title	Give Controller Instructions
Requirement	Tower Runway Controller shall judge achievability of estimated exit taxiway and ROT prior to giving any controller instructions based on those estimates.
Status	<Validated>
Rationale	Only if the AROT information is reliable it can be used operationally. Therefore, TWR RWY Controller needs to assess the achievability of the AROT proposal before using it.
Category	<Safety>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF4.0005
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

REQ]

Identifier	REQ-02.08-SPRINTEROP- SAF4.0006
Title	Provide Landing Clearance
Requirement	Tower Runway Controller shall judge achievability of estimated exit taxiway and ROT before providing landing clearance.
Status	<Validated>
Rationale	Only if the AROT information is reliable it can be used operationally. Therefore, TWR RWY Controller needs to assess the achievability of the AROT proposal before using it.
Category	<Safety><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-SAF4.0006
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 53: Safety Requirements capture for Solution 02-08 Concept 4

4.3.2 Performance Requirements

4.3.2.1 Performance Requirements (Concept 1)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0001
Title	Time look ahead
Requirement	The Integrated Runway Sequence look ahead time horizon shall be off-line configurable according to local preferences
Status	< Validated >
Rationale	The information is used by the Integrated Runway Sequence function to derive a first stable integrated sequence. An example of this value can be 60 minutes.
Category	<Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0002
Title	Stability time horizon
Requirement	The Integrated Runway Sequence stability time horizon shall be off-line configurable according to local preferences

Status	< Validated >
Rationale	The information is used by the Integrated Runway Sequence function to stabilize the sequence and avoid swaps and sequence order changes. An example of this value can be 40 minutes.
Category	<Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0003
Title	Frozen time horizon
Requirement	The Integrated Runway Sequence frozen time horizon shall be off-line configurable according to local preferences
Status	< Validated >
Rationale	The information is used by the Integrated Runway Sequence function to freeze the TLDT/TTOT updates. An example of this value can be 10 minutes.
Category	<Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0003
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0004
Title	Live input monitoring
Requirement	The Integrated Runway Sequence shall be updated as soon as new arrival or departure information becomes available.
Status	< Validated >
Rationale	The information is used by the Integrated Runway Sequence function to optimize the stability and predictability of the integrated sequence.
Category	<Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0004
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to En-Route
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0005
Title	Integrated Runway Sequence optimization
Requirement	The Integrated Runway Sequence shall maximize runway throughput.
Status	< Validated >
Rationale	The main goal of the Integrated Runway Sequence function is to deliver the most stable integrated sequence which optimizes throughput and provides accurate TTOT, TSAT and TLDT. The expected optimization is measured in the validation exercises but no specific figure can be provided at requirement level, as this is subject to specific implementation. The apportioned validation target on RWY capacity increase for the solution is 1.351%.
Category	<Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0005
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0006
Title	Demand and capacity balance
Requirement	The planned number of arrivals and departures shall not exceed the available capacity.
Status	< Validated >
Rationale	Integrated Runway Sequence function cannot plan for and sequence more combined arrivals and departures than the runway can support given its capacity, therefore putting an upper limit to sequencing. This is dependent on local environment.
Category	<Performance> <Safety>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0006
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0007
Title	Sequence update freeze
Requirement	ATCOs shall not receive updates from the Integrated Runway Sequence function in the Arrival part of the Integrated Runway Sequence that are no longer feasible.
Status	< Validated >
Rationale	Controller situational awareness can be compromised if the Integrated Runway Sequence function makes changes to the arrival sequence at a time when such updates are no longer feasible. Hence, the Integrated Runway Sequence function shall fix the arrival sequence at the point where further changes cannot be complied with, and then keep updating the departure sequence in a realistic way.
Category	<Performance><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0007
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-to-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF1.0008
Title	Integrated Runway Sequence stability
Requirement	ATCOs shall receive an Integrated Runway Sequence with an adequate level of stability.
Status	< Validated >
Rationale	Controller situational awareness can be compromised if the Integrated Runway Sequence function continuously updates the integrated sequence in an unrealistic manner, proposing sequence swaps that cannot be complied with due to the limitations of the airport layout or other procedural and safety concerns. The level of stability of the Integrated Runway Sequence is measured in validation exercises through the number of automatic updates. However, it is not possible to provide precise target figures for this requirements, as the assessment of the stability is very dependent on subjective appreciation. An example can be to accept 0 automatic updates after stability horizon, but other values might be set.
Category	<Performance><Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF1.0008
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	Integrated sequence information provision to En-Route
<Information Exchange>	Integrated sequence information provision to Approach
<Information Exchange>	Integrated sequence information provision to TWR RWY
<Information Exchange>	Integrated sequence information provision to TWR Ground
<Information Exchange>	Integrated sequence information provision to Clearance Delivery
<Information Exchange>	Integrated sequence information provision to En-Route
<Information Flow>	N/A
<Function>	N/A
<Activity>	Receive relevant information of the up-to-date integrated arrival/departure sequence
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 54: Performance Requirements capture for Solution 02-08 Concept 1

4.3.2.1 Performance Requirements (Concept 2)

N/A (Concept 2 is rather a technical solution that brings an interface between coupled AMAN/DMAN and RMAN). The validation of RMAN is not in the scope of PJ02-08 but just the validation of the technical interface. Performance requirements for RMAN were already identified in SESAR 1 in the frame of project 12.02.01 Runway Management Tools and are considered as still valid and unchanged. Therefore, no specific Performance requirements are identified for Concept 2.

4.3.2.2 Performance Requirements (Concept 3)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF3.0001
Title	Enhanced ROT Prediction configurable dynamic forecast horizon
Requirement	In case dynamic Enhanced ROT Predictor is used forecast horizon(s) shall be off line configurable according to local preferences (including possible multiple estimations at varying lead times).
Status	< Validated >
Rationale	In order to achieve the optimal performance gain the information availability must be adjustable to local needs.
Category	<Performance><Human Performance> <Safety>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF3.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF3.0002
Title	ORD parameters for the Enhanced ROT Prediction solution
Requirement	The parameters in the ORD tool shall be fine-tuned for the local environment prior to implementation e.g. buffers to account for variability in a/c performance and reliability of wind measurements to ensure safe operations, speed profile on final approach

Status	<Validated>
Rationale	To ensure that operations are optimised for the local environment in which the solution will be implemented with ORD
Category	<Performance> <Human Performance>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF3.0002
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 55: Performance Requirements capture for Solution 02-08 Concept 3

4.3.2.1 Performance Requirements (Concept 4)

[REQ]

Identifier	REQ-02.08-SPRINTEROP-PRF4.0001
Title	Enhanced ROT Prediction configurable dynamic forecast horizon
Requirement	In case dynamic Enhanced ROT Predictor is used forecast horizon(s) shall be off line configurable according to local preferences.
Status	<Deleted>
Rationale	In order to achieve the optimal performance gain the information availability must be adjustable to local needs. It has been found that forecast lead time is critically influencing system output quality. In order to maintain consistent and reliable system performance and fulfil other requirements the system has been developed using 5 min static lead time.
Category	<Performance><Human Performance> <Safety>

[REQ Trace]

Linked Element Type	REQ-02.08-SPRINTEROP-PRF4.0001
<SESAR Solution>	PJ.02-08
<Service>	N/A
<Information Exchange>	N/A (Non functional requirement)
<Information Flow>	N/A
<Function>	N/A
<Activity>	N/A (Non functional requirement)
<Functional Block>	N/A
<Role>	N/A
<Sub-Operating Environment>	Airports

Table 56: Performance Requirements capture for Solution 02-08 Concept 4

4.4 Interoperability Requirements (INTEROP)

This section is conceived as a technology independent definition of interoperability requirements commensurate with predominant focus on operational needs imposed by the context on information exchange. This edition of the INTEROP relies on and derives from the Operational Requirements captured in the preceding paragraphs.

Taking into account the nature of the Solution, there are no specific INTEROP requirements at operational level. All Interoperability requirements for the Solution are technical and can be found in the Technical Specifications.

4.5 Security requirements

This section is conceived to provide the list of high-level security requirements derived from the Security Assessment Report (Part III of OSED).

Taking into account the nature of the Solution, there are no specific Security requirements at operational level. All Security requirements for this Solution are technical and can be found in the Technical Specifications.

5 References and Applicable Documents

5.1 Applicable Documents

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

Content Integration

[1] SESAR PJ19 D5.11 EATMA Guidance Material and Report (2019), Edition 01.00.01, October 2019

[2] EATMA Community pages, eATM Portal; https://www.eatmportal.eu

[3] SESAR ATM Lexicon, September 2016; https://ext.eurocontrol.int/lexicon/index.php/Main_Page

Content Development

[4] Transition ConOps SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects (1_0), Edition 01.00, June 2016

System and Service Development

[5] SESAR 08.01.01 D52: SWIM Foundation v2 , Edition 02.01, May 2016

[6] SESAR 08.01.01 D49: SWIM Compliance Framework Criteria, Edition 01.01, March 2016

[7] SESAR 08.01.03 D47: ATN Information Reference Model, Edition 04.01.00, March 2016

[8] SESAR 08.03.10 D45: ISRM Foundation Rulebook, Edition 00.08.00, May 2016

[9] SESAR B.04.03 D102: Service Method update 2015-Report, Edition 01.02, May 2016

[10]SESAR B.04.03 D128: ADD SESAR1 Edition 01.00, July 2016

[11]SESAR B.04.05 D15: Service Processing Method Report, Edition 02.01, September 2016

Performance Management

[12]SESAR B.04.01 D108: Performance Framework for SESAR2020 Transition, Edition 05.00, August 2016

[13]SESAR B.05.02 D109: Transition Validation Strategy for SESAR2020, Edition 01.00.01, October 2016

[14]SESAR B.05 D86: Guidance on KPIs and Data Collection Support to SESAR 2020 transition, Edition 01.00, May 2016

[15]SESAR 16.06.06 D68: New CBA Models and Methods 2015-Part 2 of 2, Edition 01.01, June 2016

[16]SESAR 16.06.06-D51-SESAR_1 Business Case Consolidated Deliverable with contributions from 16_06_01-16_06_02-16_06_03-16_06_05, Edition 01.01, July 2016

[17]Method to assess cost of European ATM improvements and technologies, EUROCONTROL, July 2014

[18]ATM Cost Breakdown Structure EUROCONTROL, Edition 02,2014

[19]Standard Inputs for EUROCONTROL Cost Benefit Analyses, Edition 8.0, January 2018

[20]SESAR 16.06.06_D26-08 ATM CBA Quality Checklist, Edition 02.00.01, June 2016

[21]SESAR16.06.06_D26_04_Guidelines_for_Producing_Benefit_and_Impact_Mechanisms, Edition 03.00.01, June 2016

Validation

[22]SESAR 03.00 D16 WP3 System Engineering for the VVP VVI and Demonstration Platform development, Edition 02.00.00, June 2016

[23]SESAR D2_6 - PJ19 - VALS (2019), Edition 01.00, October 2019

[24]European Operational Concept Validation Methodology (E-OCVM), Edition 3.0, February 2010

System Engineering

[25]SESAR 2020 Requirements and V&V guidelines, Edition 01.01, November 2017

Safety

[26]SESAR 2020 Safety Reference Material, Edition 04.01, December 2018

[27]SESAR 2020 Guidance to Apply the Safety Reference Material, Edition 03.01, December 2018

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

[29]SESAR, Resilience Engineering Guidance Final Deliverable, Edition 00.00.12 May 2016

Human Performance

[30]SESAR 16.06.05 D 27 Human Performance Assessment Process V1 to V3 – including VLDs, Edition 01.00, February 2016

[31]SESAR 16.04.02 D04 e-HP Repository - Release note, Edition 01.00, December 2013

Environment Assessment

[32]SESAR 16.06.03, D27, SESAR ENV Assessment Process 4 (ERM methodology update), Edition 03.00.00, May 2016.

[33]ICAO CAEP – "Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes" document, Doc 10031, 2014.

Security

[34]SESAR 16.06.02 D103 SESAR Security Ref Material – Level 2, Edition 02.01, June 2016

[35]SESAR 16.06.02 D137 Minimum Set of Security Controls, Edition 01.00, May 2016.

[36]SESAR 16.06.02 D131 Security Database Application, Edition 01.00, June 2016

5.2 Reference Documents

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

[37]ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[1] , December 2000

[38]EUROCONTROL Airport CDM Implementation Manual, Edition 5.0, March 2017

[39]EUROCONTROL (2003) Enhancing Airside Capacity, the Complete Guide, Edition 2.0, 2003

[40]ICAO Doc 4444, Air Traffic Management, Sixteenth Edition, 2016.

[41]A Review of Airport Runway Optimization, Potts& Mesgarpour, October 2009

[42]SESAR Solution 02-08 D6.1.14 - Cost Benefit Analysis (CBA) for V2, Edition 01.02, October 2018

[43]SESAR1 06.08.04 D29 Step 2 V3 Final OSED, Edition 01.01, July 2016

[44]SESAR 1 06.08.04 D28 Step 2 V3 Validation Report Advanced AMAN-DMAN-Routing, Edition 01.01, July 2016

[45]SESAR 1 06.03.01.D145 - OFA 05.01.01 Final OSED, Edition 04.02, November 2016

[46]SESAR 1 06.03.01.D146 - OFA 05.01.01 Final INTEROP, Edition 03.02, November 2016

[47]SESAR 1 06.03.01.D147 - OFA 05.01.01 Final Safety and Performance Requirements, Edition 03.02, November 2016

[48]SESAR 1 P06 08 01 D30, OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED, Edition 01.00, May 2016

[49]SESAR 1 P06.08.01 D32, OFA 01.03.01 Enhanced Runway Throughput Consolidated SPR, Edition 00.00.01, May 2016

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[50]SESAR 1 P06.08.01 D34, OFA 01.03.01 Enhanced Runway Throughput Consolidate Final Step 1 Interop, Edition 00.01.01, May 2016

[51]SESAR Solution 02-08 D6.1.10 – V2 SPR-INTEROP/OSED for V2 – Part I, Edition 01.01, October 2018

[52]SESAR Solution 02-08 D6.1.233 Validation Report (VALR) for V3, Edition 01.01, September 2019

[53]SESAR Solution 02-08 D6.1.24 CBA for V3 , Edition 02.01, November 2019

[54]SESAR Solution PJ02-01, Wake Turbulence Separation Optimisation, SPR-INTEROP/OSED for V3 - Part I, 2019

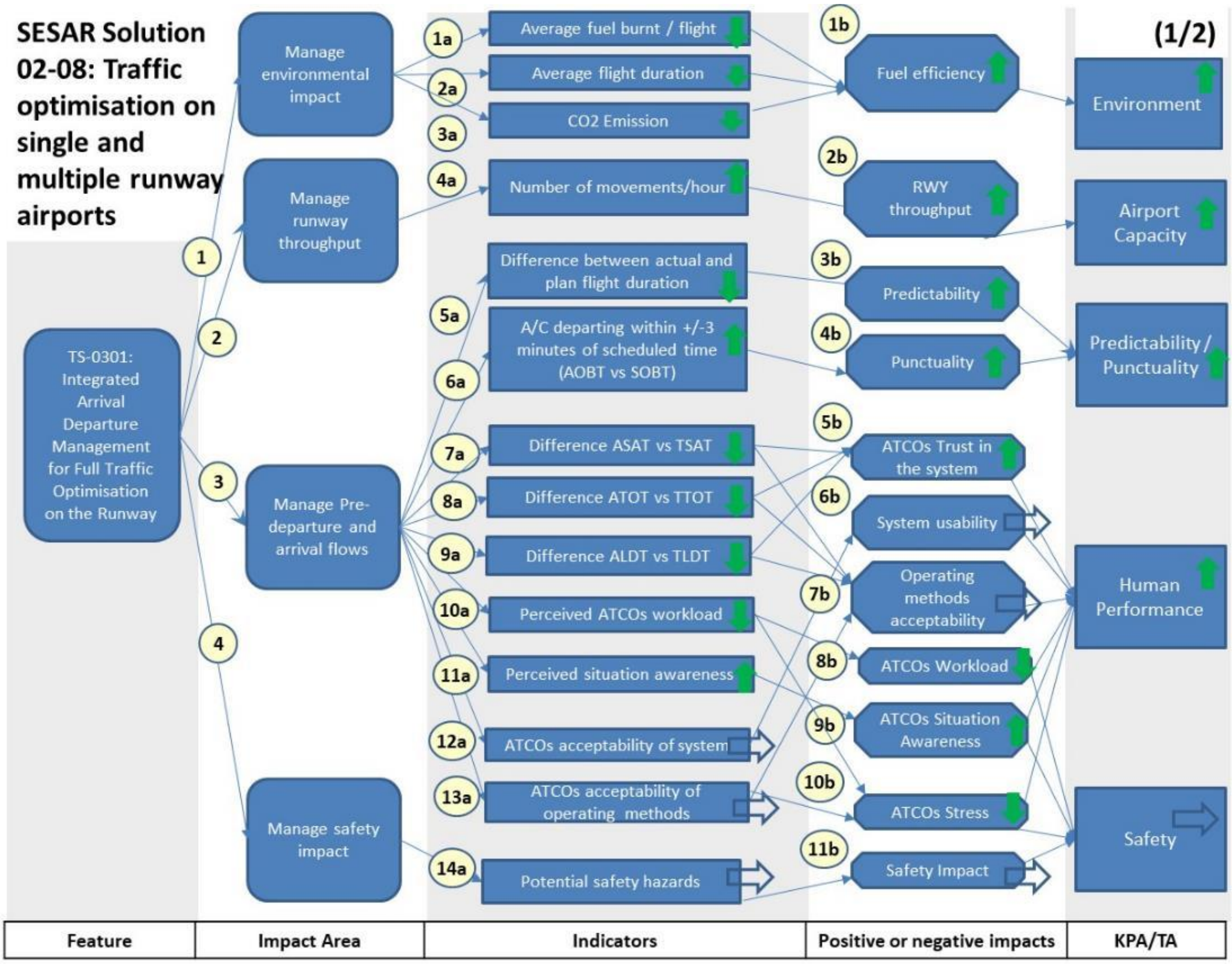
Appendix A Cost and Benefit Mechanisms for Concept 1 and Concept 2

A.1 Stakeholders identification and Expectations

Stakeholder	Involvement	Why it matters to stakeholder
ANSP	Project contributors	To provide evidence on safety, capacity and environmental impact.
ATCO	End User	To show that the new tool and procedures: • improve efficiency; • are acceptable (related to workload and functionality of tools).
Ground Industry	Project contributors	To assess technical feasibility and to obtain validated requirements.
Airport operators	Project contributors	To provide evidence that the concept: • maintains safety levels; • allows improved capacity, predictability and fuel efficiency
Airspace Users (airlines and pilots)	End User	To provide evidence that the concept: • maintains safety levels; • allows improved capacity, predictability and fuel efficiency

Table 57: Stakeholder's expectations for Concept 1 and Concept 2

A.2 Benefits mechanisms for Concept 1 and Concept 2



(1a)The use of Integrated RWY sequence reduces the average fuel burnt per flight.

(2a)The use of Integrated RWY sequence reduces the average flight duration.

(3a)The use of Integrated RWY sequence reduces the CO2 emission.

(1b)The reduction of average flight duration and consequently average fuel burnt per flight and the reduction of CO2 emissions contribute to an increase of fuel efficiency, leading to a positive impact on Environment.

(4a)The use of Integrated RWY sequence increases the number of movements per hour on the RWY.

(2b)The increase of the number of movements per hour on the RWY triggered by the use of the Integrated Runway Sequence is the indicator of an increase of RWY Throughput, meaning to a positive impact on Airport Capacity.

(5a)The use of Integrated RWY sequence reduces the difference between actual and planned flight duration.

(3b)The reduction of difference between actual and planned flight duration is an indicator of an increase of Predictability, leading to a positive impact on Predictability & Punctuality.

(6a)The use of Integrated RWY sequence increases the number of a/c departing within +/ - 3 minutes of scheduled time.

(4b)The increase of number of a/c departing within +/ - 3 minutes of scheduled time is the indicator of an increase of Punctuality, meaning a positive impact on Predictability & Punctuality.

(7a)The use of Integrated RWY sequence reduces the difference between actual and target start-up times.

(8a)The use of Integrated RWY sequence reduces the difference between actual and target take-off times.

(9a)The use of Integrated RWY sequence reduces the difference between actual and target landing times.

(5b)The reduction of the difference between actual and target times are indicators of sequence accuracy and reliability improvement, which contributes to increase ATCOs trust in the system, leading to a positive impact in Human Performance.

(13a)The operating methods linked to the use of Integrated RWY sequence are accepted by ATCOs in the same way as the current operating methods.

(7b)The sequence accuracy and reliability (indicated by reduction of different between actual and target times) together with a good acceptance by ATCO of the new operating methods contribute to maintain ATCOs acceptance on operating methods, leading to a neutral impact on Human Performance.

(12a)The Integrated RWY sequence function is accepted by ATCOs in the same way as standalone AMAN and standalone DMAN.

(6b)The good acceptance by ATCOs of the Integrated RWY sequence function is an indicator of the fact that system usability is maintained, leading to a neutral impact on Human Performance.

(10a)The use of Integrated RWY sequence reduces the perceived ATCOs workload.

(8b)The perceived ATCOs workload reduction is an indicator that ATCOs workload is reduced, leading to a positive impact in Human Performance and Safety.

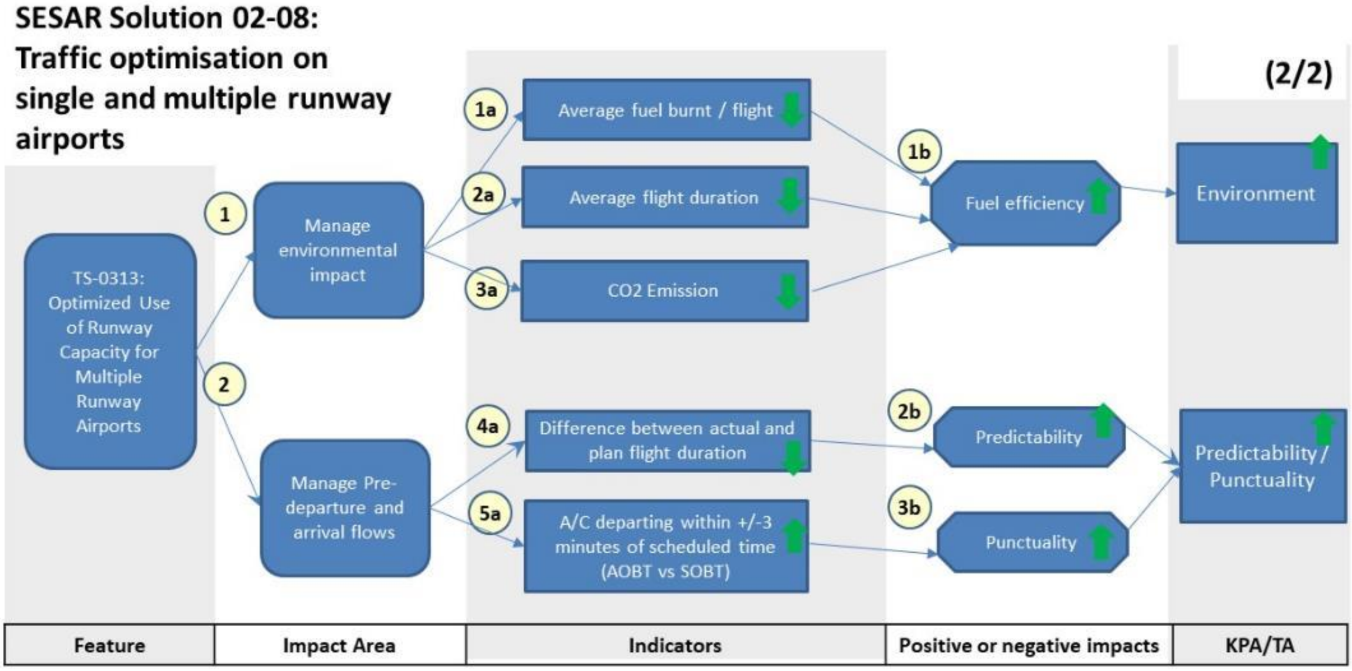
(10b)The perceived ATCOs workload reduction and the ATCOs acceptability of the new operating methods contribute to ATCOs stress reduction, leading to a positive impact in Human Performance and Safety.

(11a)The use of Integrated RWY sequence improves the perceived ATCOs Situation Awareness.

(9b)The perceived ATCOs Situation Awareness improvement is an indicator that ATCOs Situation Awareness (individual and team) is improved, leading to a positive impact in Human Performance and Safety.

(14a)The number of potential safety hazards is not impacted by the use of Integrated RWY sequence function.

(11b)The unchanged number of potential hazards is an indicator that Safety Level is maintained, meaning a neutral impact on Safety.



(1a)The combined use of Integrated RWY sequence and RMAN reduces the average fuel burnt per flight.

(2a)The combined use of Integrated RWY sequence and RMAN reduces the average flight duration.

(3a)The combined use of Integrated RWY sequence and RMAN reduces the CO2 emission.

(1b)The reduction of average flight duration and consequently average fuel burnt per flight and the reduction of CO2 emissions contribute to an increase of fuel efficiency, leading to a positive impact on Environment.

(4a)The combined use of Integrated RWY sequence and RMAN is expected to decrease the difference between actual and planned flight duration. However, the results in the validation exercises did not confirm this expectation due to the inter-related effect between ATOT and TTOT in the RMAN horizon, far before the Integrated RWY sequence stable horizon. For more information, refer to the PJ02-08 V3 VALR ([52]).

(2b)The decrease of difference between actual and planned flight duration is an indicator of increase of Predictability, leading to a positive impact on Predictability & Punctuality.

(5a)The combined use of Integrated RWY sequence and RMAN increases the number of a/c departing within the -/+ 3 minutes of scheduled time.

(3b)The increase of the number of a/c departing within the -/+ 3 minutes of scheduled time indicates an increase of Punctuality, leading to a positive impact on Predictability & Punctuality.

As Concept 2 is expected to have a positive impact in Punctuality and also in Predictability, it is considered that the overall impact in Predictability&Punctuality is positive.

A.3 Costs mechanisms for Concept 1 and Concept 2

The list below only presents the types of costs to consider in order to deploy the Solution:

- Implementation costs
  - One-off Costs (Initial training for ATCOs, Supervisors, airport staff and ATSEPs, project management, administrative costs, installation and commissioning, validation and certification)
  - Capital costs (Equipment and system, integration costs)
- Operating costs
  - Maintenance and repair

ANSPs bear the cost of the solution deployment. Different cost strategies are possible depending on local strategies, even if the PJ02-08 CBA (refer to **[53]**) applies the following assumptions:

- ANSP manage 100% of the cost.
- Operating costs represents 10% of implementation costs per OI;
- Costs are the same, whatever the implementation option selected (implement a coupling function between existing AMAN and DMAN or replace existing AMAN and DMAN by a new system providing integrated sequence). Only the split between types of cost change (in the first implementation option the costs of integration will be higher but the costs of development lower, whereas in the second option the costs of development will be higher but the costs of integration lower).

For more details, refer to PJ02-08 CBA ([53]).

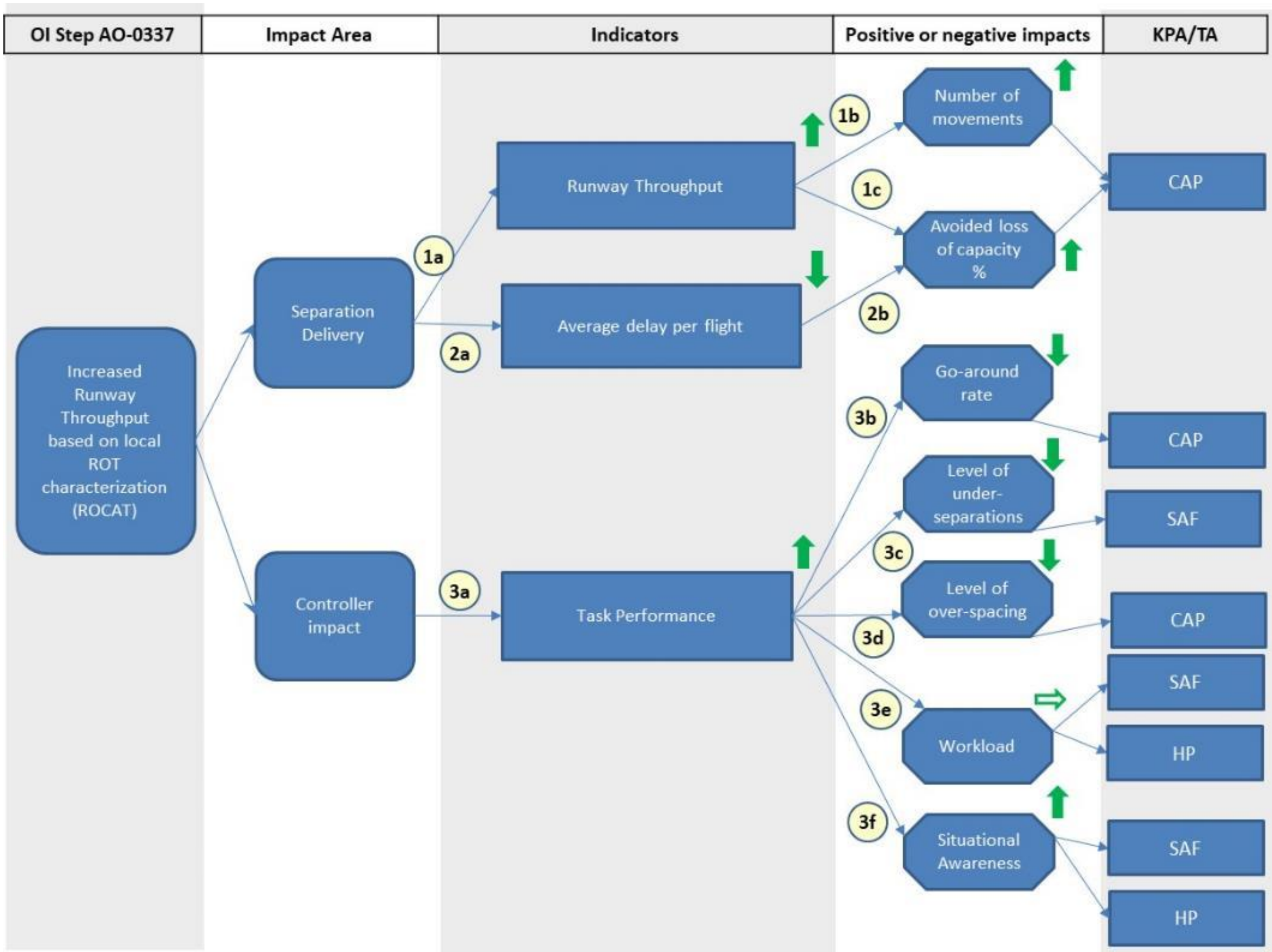
Appendix B Cost and Benefit Mechanisms for Concept 3

B.1 Stakeholders identification and Expectations for Concept 3

Stakeholder	Involvement	Why it matters to stakeholder
ANSP	Project contributors	To provide evidence on safety, capacity and environmental impact.
ATCO	End User	To show that the new tool and procedures: • improve efficiency; • are acceptable (related to workload and functionality of tools).
Ground Industry	Project contributors	To assess technical feasibility and to obtain validated requirements.

Table 58: Stakeholder's expectations for Solution 02-08 Concept 3

B.2 Benefits mechanisms for Concept 3



(1a) ROCAT reduces current separation which increases the runway throughput.

(1b) A reduced spacing between aircraft has positive impact on the runway throughput. The higher the throughput, the higher the number of movements, leading to a positive impact on Capacity.

(1c) Reduction of separations thanks to ROCAT will avoid loss of capacity.

(2a) Reduction of separations will reduce the average delay per flight.

(2b) As airborne delay (e.g. in case of holding), a reduction in this delay will help to avoid a loss of capacity.

(3a) With the use of the ORD tool, controller performance improves and the accuracy of the spacing delivery between aircraft is improved compared to what is achieved today (e.g. distance between pair of aircraft closer to separation minima)

the ORD tool improves accuracy of separation delivery by the controllers and hence :

(3b) allows significant benefits in terms of reduction of go-arounds, which has a positive impact on Capacity.

(3c) reduces the number of aircraft that are under-separated which help to improve Safety.

(3d) reduces the number of aircraft with over-spacing, which has a positive impact on Capacity.

(3e) With ROCAT ATCO can handles more aircraft per hour; however as the ORD tool provides the required separation per aircraft pair on the final approach, and hence reduces the controller mental workload, result in keeping the overall workload at the current level, this is ensures there is no negative impact on Safety and Human performance.

(3f) the ORD Tool make it easier for controllers to identify separation infringement on final approach so the situation awareness is increased compared to the current way of work, this is has a positive impacts on safety and Human performance.

B.3 Costs mechanisms for Concept 3

The list below only presents the types of costs to consider in order to deploy the Solution:

- Implementation costs
  - One-off Costs (Initial training for ATCOs, Supervisors, airport staff and ATSEPs, project management, administrative costs, installation and commissioning, validation and certification)
  - Capital costs (Equipment and system, integration costs)
- Operating costs
  - Maintenance and repair

ANSPs have been identified as the only stakeholder who will bear the cost of the solution deployment, however depending on local ANSP-Airport strategies and relationship different cost sharing/split strategies are possible, particularly for Concept 1. The PJ02-08 CBA (refer to [53]) applies the following assumptions:

- 100% of deployment costs attributed to ANSPs;
- Operating costs represents 10% of implementation costs per OI;
- Low/High scenario -/+ 50%

For more details, refer to PJ02-08 CBA ([53]).

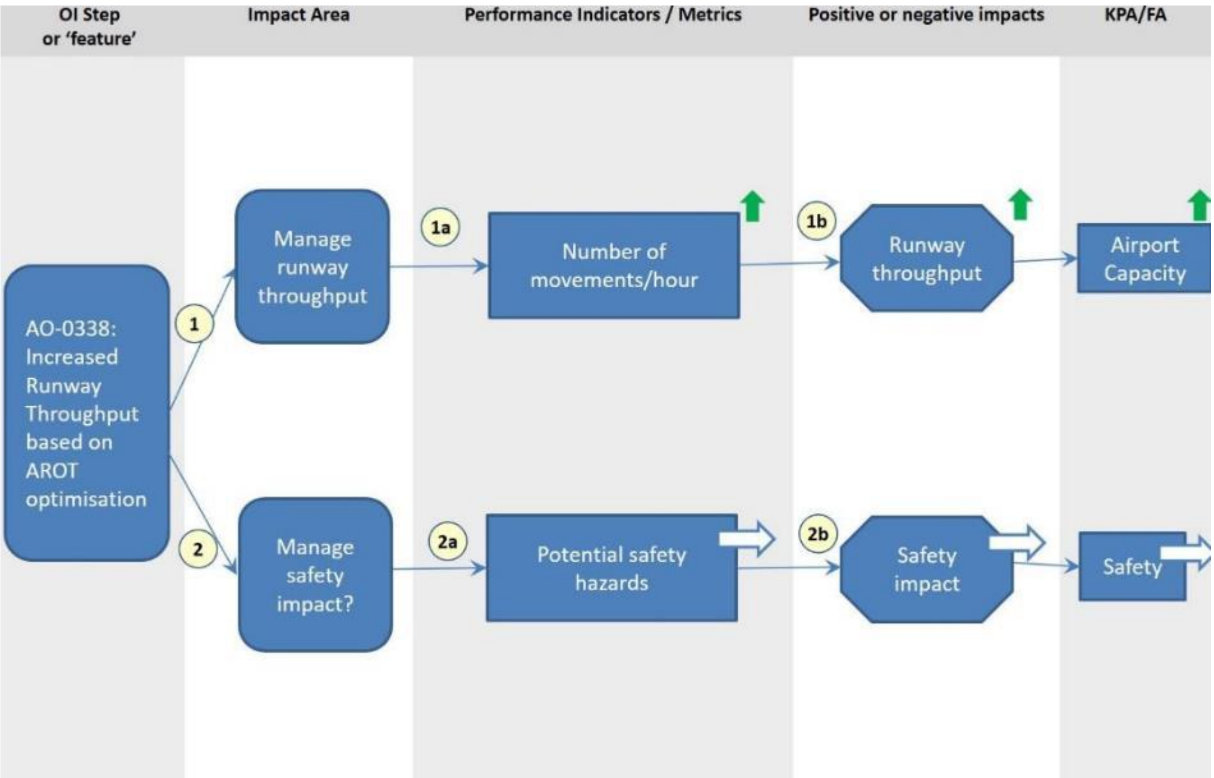
Appendix C Cost and Benefit Mechanisms for Concept 4

C.1 Stakeholders identification and Expectations for Concept 4

Stakeholder	Involvement	Why it matters to stakeholder
ANSP	Project contributors	To provide evidence on capacity and safety
ATCO	End user	• Enchasing situational awareness by better estimation of aircraft deceleration and runway occupancy during different weather conditions
Airport Operator	Indirect beneficiary	To provide evidence that the concept: • allows improved capacity • maintains safety levels

Table 59: Stakeholder's expectations for Solution 02-08 Concept 4

C.2 Benefits mechanisms for Concept 4



(1a)The use of optimised AROT increases the number of movements per hour on the runway in peak hours.

(1b) A reduced number of movements per hour in peak hours is translated in an increase of Runway throughput, leading to a positive impact on Airport Capacity.

(2a)The number of potential safety hazards is not impacted by Concept 4.

(2b)The unchanged number of potential hazards is an indicator that Safety Level is maintained, meaning a neutral impact on Safety.

C.3 Costs mechanisms for Concept 4

The list below only presents the types of costs to consider in order to deploy the Solution:

- Implementation costs
  - One-off Costs (Initial ATCO Training, Project Management, Administrative costs, Validation & Certification)
  - Capital costs (Equipment & System costs, Integration costs)
- Operating costs
  - Hardware & Software maintenance and repair / update, Other services (External contract fees to maintain the system)

Airport and ANSPs bear the cost of the solution deployment. Different cost sharing/split strategies are possible depending on local ANSP-Airport strategies and relationship, even if the PJ02-08 CBA (refer to **[53])** applies the following assumptions:

- 100% of deployment costs attributed to ANSPs;
- Operating costs represents circa 5% of implementation costs

For more details, refer to PJ02-08 CBA ([53]).