

SESAR Solution PJ.05-W2-35 SPR-INTEROP/OSED for V3 - Part II - Safety Assessment Report

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PJ.05-W2-DTT

MULTIPLE REMOTE TOWER AND REMOTE TOWER CENTRE

This SPR-INTEROP/OSED for V3 - Part II - Safety Assessment Report document is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874470 under European Union's Horizon 2020 research and innovation programme.



Abstract

This document collects the safety assurance activities that have been carried out by project PJ05-W2-35 – “Multiple Remote Tower and Remote Tower Centre”, in order to create necessary and sufficient Evidence for this Safety Assessment Report (SAR), the OSED/SPR/INTEROP and Validation activities.

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1 Executive Summary

This document contains the Specimen Safety Assessment for a typical application of the 35 – “Multiple Remote Tower and Remote Tower Centre” Solution in PJ05-W2 operations. The Safety Assessment Report (SAR) represents Part II of the SPR-INTEROP/OSED document and presents the assurance that the Safety Requirements for the V1-V3 phases are complete, correct and realistic, thereby providing all material to adequately inform the PJ05-W2-35 Solution SPR-INTEROP/OSED and TS/IRS.

This document is based on SESAR Solution PJ.05.02 SPR-INTEROP/OSED for V3 - Part II - Safety Assessment Report and SESAR Solution PJ.05.03 SPR-INTEROP/OSED for V2 - Part II - Safety Assessment Report.

Although approach operation was part of one of the validation exercises, it is out of scope of this Safety Assessment Report.

2 Introduction

The previous work done in SESAR 2020 Wave 1, has delivered results determining the solution PJ05-02-V3 as a reference for Solution 35 regarding Multiple Remote Tower Modules. Solution 35 will focus on Remote Tower Centre and highly flexible allocation of aerodromes to MRTMs, with validations at V3 maturity level.

The opinions expressed herein reflect the author's view only. Under no circumstances shall the SESAR3 Joint Undertaking be responsible for any use that may be made of the information contained herein.

2.1 Background

The objective of Solution 35 is to increase ATCO productivity (i.e. reduce the number of ATCOs required) by a better balance of workload between different MRTMs within a Remote Tower Centre. The balance is achieved through a flexible allocation of aerodromes to each MRTM. A flexible allocation of aerodromes in the MRTM implies that one aerodrome can take different positions within MRTMs (e.g. aerodrome A is at the left position of the MRTM (1) in the morning and after a transfer to another MRTM (2) is received back at the right position of the MRTM (1)). The expectation is that this will increase the complexity, as it will be more difficult to maintain situational awareness for the ATCO on the controlled aerodromes, with this flexibility (this compared to a fixed presentation of 2 or 3 aerodromes).

This document is based on the following documents from SESAR 2020 Wave 1:

- SESAR Solution PJ.05.02 SPR-INTEROP/OSED for V3 - Part II - Safety Assessment Report
- SESAR Solution PJ.05.03 SPR-INTEROP/OSED for V2 - Part II - Safety Assessment Report

2.2 General Approach to Safety Assessment

This safety assessment is conducted as per the SESAR Safety Reference Material (SRM) which itself is based on a twofold approach:

- a success approach which is concerned with the safety of the Solution operations in the absence of failure within the end-to-end Solution functional system, encompassing both Normal operation and Abnormal conditions,
- a conventional failure approach which is concerned with the safety of the Solution operations in the event of failures within the end-to-end Solution functional system.

These two approaches are applied to the derivation of safety properties at each of the successive lifecycle stages of the Solution development (Safety Requirements at service level and at design level).

Remote Towers in SESAR1 developed the baseline for the concept of Single Remote Towers. In SESAR2020 within the PJ05 Solution 35 we are looking at three different types of requirements:

- Those that are to be guaranteed for any Single Remote Tower before it can be added to a MRTM, also named as part of the **"Pack"** of Requirements from here on, are the SESAR 1 requirements also taken into account for PJ05 in SESAR 2020

- Those that are particular to the integration of two or more aerodromes into the same MRTM, also named as particular to the “**Multiple**” setting, are the SESAR 2020 W1 (PJ.05.02 and PJ.05.03) requirements also taken into account for PJ05 in SESAR 2020 W2
- Those that are particular to Highly Flexible Allocation of Aerodromes to Remote Tower Modules, also named as particular to the “**Multiple W2**” setting, are the new or modified Safety Requirements developed in SESAR 2020 W2

2.3 Scope of the Safety Assessment

This document describes the safety assessment of Remote Tower Centre with flexible allocation of aerodromes to a MRTM.

The solution addressed in this Safety Assessment Report is:

- **Solution PJ05-W2-35: Multiple Remote Tower and Remote Tower Centre**

The OI step addressed in this Safety Assessment Report is:

- **SDM-0210: Highly Flexible Allocation of Aerodromes to Remote Tower Modules**

The main assessment phase covered in the safety assessment report in relation to the maturity level targeted by the Solution (V3) at the end of Wave 2 is the safe refined design (a second iteration of the process conducted at the safe initial design level, mainly deriving Safety Requirements at refined design level – rSRD to be documented as appropriate in SPR-INTEROP/OSED and TS/IRS).

Although approach operation was part of one of the validation exercises, it is out of scope of this Safety Assessment Report.

2.4 Layout of the Document

Section 1 provides the executive summary of this safety assessment report.

Section 2 provides an overview of the safety assessment report.

Section 3 provides an overview of the PJ.05-W2-35.

Section 4 presents the safety specifications at ATS Service level.

Section 5 presents the Safe Design of the Solution functional system.

Section 6 presents the Safety Criteria achievability

Section 7 provides the list of acronyms and terminology.

Section 8 lists the documents referred to in this document.

3 Setting the Scene of the safety assessment

The purpose of this section is to provide the main information collected within SAF&HP Scoping and Change assessment and Safety Plan development process in order to set the scene for the safety assessment documented in the SAR.

3.1 Operational concept overview and scope of the change

The previous work done in SESAR 1 on Single Remote Tower, and in SESAR 2020 Wave1, has delivered results determining Single RTWR and the solution PJ05-02-V3. PJ.05.02-V3 is also the reference for Solution 35 regarding Multiple Remote Tower Modules. Solution 35 will focus on Remote Tower Centre and highly flexible allocation of aerodromes to MRTMs, and it will be validated at V3 maturity level.

The objective of solution 35 is to increase ATCO productivity (i.e. reduce the number of ATCOs required) through a better balance of workload between different MRTMs within a Remote Tower Centre. This will be achieved by a flexible allocation of grouped aerodromes to dedicated MRTMs, possibly supported by a Remote Tower Centre Supervisor role (RTC supervisor) and a Supervisor Planning Tool. An existing ATCO within the RTC can carry out this task, e.g. planning of the shift, need for added staff will be dependent on the size of the RTC.

Such a flexible allocation of aerodromes in the MRTM implies that one aerodrome can take different positions within MRTMs (e.g. aerodrome A is at the left position of the MRTM (1) in the morning and after a transfer to another MRTM (2) is received back at the right part of the MRTM (1)). It is expected that this will increase the complexity as it will be more difficult to maintain situation awareness on the controlled aerodromes compared to a fixed allocation with dedicated aerodromes to a specific MRTM.

Depending on the complexity of the flexible allocation, the task of the flexible allocation of grouped aerodromes to dedicated MRTMs can be allocated to a controller with a specific role – (e.g. the RTC supervisor). In order to enable an efficient allocation, it is assumed that a Supervisor Planning Tool that incorporates data like traffic volume/complexity and weather conditions at the different airports, as well as ATCO endorsements and availability will support the RTC Supervisor.

Automation planning support tools has a possibility to assist the Supervisor in an efficient allocation of aerodromes to MRTMs (strategic, pre-tactical, and also tactical). This can in the validations be made through usage of more aerodromes than those within each validation, meaning not the ones operated by the ATCOs. Validation activities might use virtual aerodromes not part of the main validation. This to support the supervisor role in an RTC with several connected airports with aim to find a more efficient allocation of aerodromes and ATCOs.

Research within SESAR LSD.02.05 has shown that equipment costs can be reduced further for AFIS. As PJ.05 is focusing on more complex environments and increased traffic, AFIS is not considered as an R&D objective even though all parts are applicable for such a service, but with different impact on savings.

3.2 Solution Operational Environment and Key Properties

The hypothesis of PJ.05 operational environment baseline is based on the SESAR2020 Wave 1 concept of multiple remote towers. More information can be found in OSED **Fehler! Verweisquelle konnte nicht gefunden werden.**

The operational safety assessment for Multiple Remote Towers will address a specimen operational environment where the main characteristics are recalled below.

Air traffic service roles

Tower Supervisor, Tower Clearance Delivery Controller, Tower Ground Controller, Tower Runway Controller, Apron Manager, Approach Controller (optional)

Types of Airspace – ICAO Classification

Class C and D

CTR - 10- 15 NM radius/rectangular, vertical extension up to about 3000 ft MSL

TMA (optional – dependent on regional regulations/procedures) – out of scope

Airspace Users

VFR and IFR

Mainly scheduled, charter and GA

Military traffic

All aircraft types

Note: RPAS were planned in the OSED/SPR/INTEROP but the SAR does not evaluate or validate if any differences would arise from the introduction of co-operative RPAS in the environment

Flight Rules

IFR and VFR

Procedures

Specific IFR routes & approach procedures

Established VFR procedures

Airport Layout

- One runway
- Typically 1 or 2 aprons (ordinary and GA/freight)
- Typically one major taxiway parallel with the runway, number of runway intersections/entries varying typically between 1 and 3. Also smaller aerodromes with APRON connected directly to runway by one to three shorter taxiways.

Traffic levels and complexity

Corresponding to the “small” airport operating environments (up to a maximum of 40.000 movements as described in the PJ.20 Operation environment description’) (Note: Results from this solution will also be valid for airports within category Other environment Airport)

The scenarios will have maximum 30 movements (aircrafts and vehicles) and up to 6 simultaneous movements (aircrafts and vehicles) per hour in total per MRTM.

Note: The number of simultaneous movements depends on the traffic complexity.

CNS/ATS capabilities

- Communication: ATC Voice Communications, VHF and UHF-transmitters/receivers, Ground Radio System, Autonomous VHF-radio, SAR radio.
- Voice Services: advanced Voice Services
- Navigation: monitoring and manoeuvring of navigation specifications including ILS, RNAV, NDB, and DME.
- Surveillance: air surveillance, ground surveillance (optional)
- Visual observation: visual information replacing the tower view with the Visual Presentation view (VP)
- Visual features: visual tracking / object bounding (optional), radar tracking (optional)
- Flight Plan Data Processing: electronic Flight Strips (Presentation and updating of flight plan and control data) or flight lists supporting silent coordination
- Planning tools: ATCO planning tools for planning purposes, RTC Supervisor planning tools for planning of an entire RTC and allocation of aerodromes to MRTM's
- Other Systems: The remote facility shall include all other technical functions and systems, currently found in an RTM and necessary to provide the services e.g.:
 - Monitoring and control of ground lighting, navigation aids, alarms, etc.;
 - Pan Tilt Zoom camera, PTZ;
 - MET presentation and information

Staffing

One ATCO per MRTM with 1, 2 or 3 aerodromes per MRTM

Spare ATCO in case there is a need of opening more MRTMs

One supervisor

Ratings: ADI, possibly APP, APS/RAD (ratings are optional dependent on service delivered from the RTC or MRTM)

Significant weather and other meteorological conditions

Any weather or visibility condition that is currently typical at a given airport (snow, rain, sun, temperature, etc.)

3.3 Stakeholders' expected benefits with potential Safety impact

This chapter provides an outline of the benefits that the Solution is intended to bring to the airspace users with a specific focus on the key requirement related to safety assessment.

Stakeholder	Involvement	Why it matters to stakeholder, potential safety impact
ANS providers	ANSPs will be able to implement the systems	ANSPs expect a reduction of cost for running local air traffic service at aerodromes
Staff union and organisations	ATCOs will be the end user of the system	Staff working in a MRTM and RTC will be affected when working with more than one aerodrome at a time (workload and situational awareness). Their expectations are that the technology will ensure that daily work can be performed safe and controlled.
ATM infrastructure and equipment suppliers	The technology set new demands on a reliable system for Multiple Remote Tower	Industries is affected by new requirements on multiple remote towers and the need for safe and stable systems
Airspace users	Airspace users fly to and from aerodromes with RTC and Multi Remote Tower	Traffic to and from airports expect to continue to traffic aerodromes without impact on scheduled traffic with a kept availability for each of the aerodromes controlled in Multiple mode. As pilots could hear the communication from more than one aerodrome, additional information might be necessary for them concerning the aerodromes within one MRTM.
Affected NSA	NSA will issue approval for any new ANS systems	NSA expect that any new technology is safe and stable for air traffic service and that methodology is properly adapted to the technology
Airport owners/providers	Airport owners are customers to ANS providers	Airports expect prices for ANS to be lowered with Multiple Remote Tower without a negative impact on their availability for flying customers.

Table 1: Stakeholder's expectations

3.4 Safety Criteria

The updated list of Safety criteria defined for the Multiple Remote Tower solutions in SESAR 2020 wave 1 (PJ.05.02 and PJ.05.03) are to be used in PJ.05.35 solutions. To also include TMA, some safety criteria have been slightly re-phrased. The term “area of responsibility” is used to cover both CTR and TMA.

Note that all of them are to be checked against the corresponding Safety Validation Targets provided by PJ.19-4.1.

In addition to the SACs listed below, the following regulation standards should also apply:

- EUROCAE ED-240, ED-240A - Minimum Aviation System Performance Standards (MASPS) for Remote Tower Optical Systems, November 2018
- Amendment of PANS ATM 4444 (State Letter AN 7/63 sent on March 2017) **Fehler! Verweisquelle konnte nicht gefunden werden..** The change is about allowing Remote tower (i.e. use of a device for seen OTW).
- ED Decision 2019/004/R, 19th February 2019
- EASA rulemaking task RMT.0624 (RMT.0624 Issue 2 work)

Safety Criteria related to Mid-Air Collision on Initial Departure

SAC#1 There shall be no increase of Imminent MRS infringement on initial departure in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower

SAC#2 There shall be no increase of Imminent Collision in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower

- a. as a function of Ineffective ATC Collision prevention

Safety Criteria related to Mid-Air Collision on Final Approach

SAC#3 There shall be no increase of Imminent infringement on final approach in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower

SAC#4 There shall be no increase of Imminent Collision in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower

- a. as a function of Ineffective ATC Collision prevention

Safety Criteria related to Mid-Air Collision in TMA (approach operation is out of scope)

SAC#5 There shall be no increase of Crew/Aircraft Induced conflict, Planning conflict and ATC Induced conflict in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower

SAC#6 There shall be no increase of Imminent Infringement in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower

- a. as a function of Ineffective ATC induced conflict management
- b. as a function of Ineffective Crew/AC induced conflict management
- c. as a function of Ineffective plan induced conflict management

- SAC#7** There shall be no increase of Imminent Collision in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower
- a. as a function of Ineffective ATC Collision prevention

Safety Criteria related to Controlled Flight into Terrain

- SAC#8** There shall be no increase of Flight Towards Terrain commanded by ATC in each area of responsibility for which ATS are remotely provided using Multiple Remote Tower
- SAC#9** There shall be no increase of Imminent Controlled Flight Into Terrain (CFIT) in each area of responsibility for which ATC are remotely provided using Multiple Remote Tower
- a. as a function of Ineffective ATCO warning

Safety Criterion related to Wake Vortex Induced Accidents on Initial Departure

- SAC#10** There shall be no increase of Wake Encounter on Initial Departure in each aerodrome for which ATS are remotely provided using Multiple Remote Tower

Safety Criterion related to Wake Vortex Induced Accidents on Final Approach

- SAC#11** There shall be no increase of Wake Encounter on Final Approach in each aerodrome for which ATS are remotely provided using Multiple Remote Tower

Safety Criteria related to Taxiway Collision

- SAC#12** There shall be no increase of Taxiway conflicts in each aerodrome for which ATS are remotely provided using Multiple Remote Tower
- a. as a function of ineffective Tactical taxiway planning
- SAC#13** There shall be no increase of Imminent Taxiway Infringement in each aerodrome for which ATC are remotely provided using Multiple Remote Tower
- a. as a function of Inadequate taxiway conflict management
- SAC#14** There shall be no increase of Imminent Taxiway Collision in each aerodrome for which ATC are remotely provided using Multiple Remote Tower
- a. as a function of Ineffective ATC taxiway collision avoidance
- SAC#15** There shall be no increase of pre-Tactical taxiway conflicts in each aerodrome for which ATC are remotely provided, using Multiple Remote Tower

Safety Criteria related to Runway Collision

- SAC#16** There shall be no increase of Induced Incursion in each aerodrome for which ATC are remotely provided using Multiple Remote Tower
- a. as a function of Inadequate Runway Incursion Monitoring

- b. as a function of ineffective Runway Crossing Management
- c. as a function of ineffective Line-up/Take-Off Management
- d. as a function of ineffective Landing Management

SAC#17 There shall be no increase of Runway Conflict in each aerodrome for which ATC are remotely provided using Multiple Remote Tower

SAC#18 There shall be no increase of Imminent Runway Collision in each aerodrome for which ATC are remotely provided using Multiple Remote Tower

- a. as a function of Inadequate ATC Runway Collision Avoidance

Safety Criteria related to “Landing accidents”

SAC#19 There shall be no increase of Runway Excursions in each aerodrome for which ATS are remotely provided using Multiple Remote Tower

- a. as a function of ineffective ATCO weather conditions monitoring affecting arriving aircraft (leading to runway excursion)
- b. as a function of ineffective check of the runway surface (with respect to snow, slush, RWY surface friction, FOD, ...) (leading to runway excursion)
- c. as a function of ineffective ATCO monitoring of AC trajectory on final approach (leading to runway excursion)

SAC#20 There shall be no increase of other Landing related Accidents in each aerodrome for which ATS are remotely provided, using Multiple Remote Tower

- a. as a function of ineffective ATCO weather conditions monitoring affecting arriving aircraft (leading to landing accident)
- b. as a function of ineffective check of the runway surface (with respect to snow, slush, RWY surface friction, FOD, ...) (leading to loss of control on the runway)
- c. as a function of ineffective ATCO monitoring of AC trajectory on final approach (leading to undershoot, AC landing in wrong/closed RWY, AC landing with undercarriage retracted)
- d. as a function of ineffective monitoring of potential intrusions inside the landing-aid protection area (affecting landing AC) as a function of inefficient management of landing-aid light

4 Safety specification at ATS service level

The purpose of this section is to derive the Safety Requirements at Service level for the ATS operational Solution. The Safety Requirements at ATS Service level (SRS) specify the desired safety behaviour of the change at its interface with the ATS operational context considering normal and abnormal conditions of the context (success approach) and the failures of the functional system (failure approach).

The interface of the change with the ATS operational context might be at the level of the ATS service provided by the Solution functional system to an aircraft or a group of aircraft (i.e. the WHAT of the ATS service specification) or at the level of the specification of the ATS service in terms of the ATCOs and Pilots action, mutual interaction and use of functionalities/information/other services (i.e. the HOW of the ATS service specification).

Safety requirements at ATS Service level (SRS) are placed on the services of the Solution functional system that are changed or affected by the change (through change in behaviour or through new interactions introduced). The derived SRSs are consistent with the set of operational requirements produced by the Solution team in charge of SPR-INTEROP/OSED Part I (Section 4) and completeness and correctness of the full set of SRSs with regards to the satisfaction of the Safety Criteria is to be shown. Any Assumption, Safety Issue or Limitation identified during the service specification process is recorded in Appendix I.

List of SRS identified in PJ05.02, and 03 (SESAR 2020 wave 1) provides the basis of SRS identification, but the original list is refined and completed based on outcomes from the safety assurance activities done in PJ05.35.

4.1 Overview of activities performed

This section addresses the following activities:

- Derivation of Safety Requirements at ATS Service level (SRS) in view of mitigating the relevant risks inherent to aviation in normal conditions of operation – section 4.2
- Assessment of the adequacy of the ATS operational services provided by the Solution under abnormal conditions of the Operational Environment & derivation of necessary SRSs – section 4.3
- Assessment of the adequacy of the ATS operational services provided by the Solution in the case of internal failures and mitigation of the Solution functional system-generated hazards through derivation of SRSs – section 4.4
- Verification of the operational safety specification process (mainly about obtaining Backing evidence from the properties of the processes by which Direct Evidence was gleaned) – section 4.5.

4.2 Mitigation of Risks Inherent to Aviation – Normal conditions

The purpose of this section is to present the Safety Requirements at ATS Service level (SRS) derived for Normal conditions of operation following Guidance F of Safety Reference Material and additional related SAF-GUI in STELLAR.

The set of Safety Requirements at the ATS Service level (SRS) in this section specifies the desired safety behaviour of the change at its interface with the operational context considering normal conditions.

The SRS are derived taking into account:

- All relevant Use Cases
- EATMA Models at operational specification level (NOV-5 diagrams).
- Impact on adjacent airspace or on neighbouring ATM Systems

A complete set of SRS is provided in order to ensure satisfaction of the Safety Criteria in Normal conditions of operation. For that, operational requirements produced by the Solution team in charge of SPR-INTEROP/OSED Part I (and documented in Section 4) are taken into consideration and to be completed as necessary.

The design characteristics/items of the Solution functional system are not considered at this level but at the design level (in section 5.2), when the derived SRSs will enable the derivation of the Safety Requirements at Design level (SRD).

4.2.1 Safety Requirements at ATS Service level (SRS) for Normal conditions of operation

In Table 2, the ATS operational services potentially impacted by the Change are identified based on the hazards inherent to aviation listed in Appendix A.1, and following Guidance E.3 of SESAR Safety Reference Material, to address and mitigate the hazards inherent to aviation.

ID	ATS Operational Service	Hazards inherent to aviation
ATS-01	Traffic Planning and synchronisation (coordination, arrival sequencing and metering, holding, handling request from AC - level and routing, manage trajectory)	Ha#01
ATS-02	Traffic monitoring, separation provision, conflict detection and resolution in the vicinity of the aerodrome	Ha#01, Ha#05, Ha#19
ATS-03	ATC short term conflict detection and resolution in the vicinity of the aerodrome	Ha#01, Ha#19
ATS-04	Start-up, Push-back, Stand/Parking management	Ha#02
ATS-05	Tactical TWY Planning, TWY Routing	Ha#02, Ha#13
ATS-06	Traffic Monitoring on the manoeuvring area and TWY Conflict resolution	Ha#02, Ha#13
ATS-07	ATC short term TWY conflict detection and resolution, ATC Taxiway Collision Avoidance	Ha#02

ID	ATS Operational Service	Hazards inherent to aviation
ATS-08	Runway Crossing management, Line-up/Take-off Management, Landing Management	Ha#03, Ha#04, Ha#14
ATS-09	Runway Incursion Monitoring	Ha#03, Ha#04, Ha#08
ATS-10	Traffic Monitoring on the RWY and RWY Conflict prevention	Ha#03, Ha#08, Ha#14, Ha#15
ATS-11	ATC short term RWY conflict detection and resolution, ATC Runway Collision Avoidance	Ha#03
ATS-12	Traffic monitoring, separation provision on final approach and initial departure	Ha#06
ATS-13	ATC short term conflict detection and resolution on final approach and initial departure	Ha#06
ATS-14	ATC trajectory management with respect to terrain	Ha#07
ATS-15	Route/Procedure design and publication	Ha#07
ATS-16	Managing RWY conditions with respect to weather	Ha#09, Ha#10
ATS-17	Managing RWY suitability	Ha#10, Ha#11, Ha#16
ATS-18	Managing unstable approaches	Ha#15
ATS-19	ATC prevention of / recovery from other events potentially leading to other landing related accidents	Ha#12, Ha#17
ATS-20	Ensure availability/continuity of the ATC service	Ha#18
ATS-21	Pre-tactical and tactical management of resources	All
ATS-22	Pre-tactical and tactical demand and capacity balancing	All

Table 2: ATS Operational services potentially impacted and Hazards inherent to aviation

Table 3 provides the consolidated list of the SRS for normal conditions of operation that have been derived in Appendix B.

SRS ID	SRS for Normal conditions of operation	Related SAC
SRS-001	MRTM shall enable coordination and transfer procedures with adjacent ATS unit concerning inbound/outbound traffic (including as necessary aircraft identification) for all aerodromes allocated to the same MRTM	SAC#1, SAC#3, SAC#5

SRS ID	SRS for Normal conditions of operation	Related SAC
SRS-002	MRTM shall enable to manage inbound traffic (including as necessary management of the approach, visual acquisition, entry into traffic circuit and landing sequence) for all aerodromes allocated to the same MRTM	SAC#1, SAC#3, SAC#5
SRS-003	MRTM shall enable to manage outbound traffic (including as necessary aircraft identification and departure sequence on the runway) for all aerodromes allocated to the same MRTM	SAC#1, SAC#3, SAC#5
SRS-004	MRTM shall enable to separate traffic, with respect to other traffic, applying the corresponding separation minima to the airspace under control responsibility (in the vicinity of the aerodrome) or allowing reduction in separation minima in the vicinity of the aerodrome for all aerodromes allocated to the same MRTM	SAC#1, SAC#3, SAC#6
SRS-005	MRTM shall enable to separate traffic with respect to restricted areas on the airspace under control responsibility for all aerodromes allocated to the same MRTM	SAC#1, SAC#3, SAC#6
SRS-006	MRTM shall enable to manage missed approaches situations (including detection of need for go-around, monitoring of involved aircraft and proposal for resolution) for all aerodromes allocated to the same MRTM	SAC#1, SAC#3, SAC#6
SRS-007	MRTM shall enable the detection of conflicts or potential collisions between aircraft (within departing, within arriving and between both traffic) on the airspace under control responsibility for all aerodromes allocated to the same MRTM	SAC#2, SAC#4, SAC#7
SRS-008	MRTM shall enable the detection of restricted areas infringements by aircraft in the airspace under control responsibility for all aerodromes allocated to the same MRTM	SAC#2, SAC#4, SAC#7
SRS-009	MRTM shall enable the provision of ATC instructions to resolve conflicts/avoid collisions on the airspace under control responsibility for all aerodromes allocated to the same MRTM	SAC#2, SAC#4, SAC#7
SRS-010	MRTM shall enable the provision of ATC instructions to resolve airspace infringements for all aerodromes allocated to the same MRTM	SAC#2, SAC#4, SAC#7
SRS-011	MRTM shall enable to identify departing AC on the stand for providing ATC service for all aerodromes allocated to the same MRTM	SAC#13, SAC#14

SRS ID	SRS for Normal conditions of operation	Related SAC
SRS-012	MRTM shall enable start-up procedures for departing aircraft (including as appropriate the provision of necessary aerodrome information - operational and meteorological) for all aerodromes allocated to the same MRTM	SAC#13, SAC#14
SRS-013	MRTM shall enable push-back and towing procedures for all aerodromes allocated to the same MRTM	SAC#13, SAC#14
SRS-014	MRTM shall enable the provision of conflict-free routing and taxi instructions to aircraft in the manoeuvring area for all aerodromes allocated to the same MRTM	SAC#12
SRS-015	MRTM shall enable the provision of taxi instructions to vehicles in the manoeuvring area for all aerodromes allocated to the same MRTM	SAC#12
SRS-016	MRTM shall enable to support AC and vehicle movements in the manoeuvring area (through visual aids on the airport surface) for all aerodromes allocated to the same MRTM	SAC#12
SRS-017	MRTM shall enable the detection of conflicting situations in the manoeuvring area (involving aircraft, vehicles, and obstacles) for all aerodromes allocated to the same MRTM	SAC#13
SRS-018	MRTM shall enable the provision of taxi instructions (to aircraft and vehicles) to resolve conflicts and avoid potential collisions in the manoeuvring area for all aerodromes allocated to the same MRTM	SAC#14
SRS-019	MRTM shall enable to manage runway entry for departing aircraft (this includes RWY status, occupancy, and correctness check before issuing line-up clearance) for all aerodromes allocated to the same MRTM	SAC#16
SRS-020	MRTM shall enable to manage runway exit for arriving aircraft (this includes exit TWY status/occupancy check) for all aerodromes allocated to the same MRTM	SAC#16
SRS-021	MRT shall enable to manage aircraft/vehicles runway crossing (this includes RWY status/occupancy/correctness check before issuing runway crossing clearance) for all aerodromes allocated to the same MRTM	SAC#16
SRS-022	MRTM shall enable to support aircraft for take-off and landing operations (though visual-aids on the airport surface) for all aerodromes allocated to the same MRTM	SAC#16

SRS ID	SRS for Normal conditions of operation	Related SAC
SRS-023	MRTM shall enable to carry out vehicle related tasks on the runway (inspections, etc.) for all aerodromes allocated to the same MRTM	SAC#16
SRS-024	MRT shall enable to manage aircraft take-off (this includes RWY status, occupancy, and correctness check before issuing take-off clearance) for all aerodromes allocated to the same MRTM	SAC#16
SRS-025	MRTM shall enable to manage aircraft landing (this includes RWY status, occupancy, and correctness check before issuing landing clearance) for all aerodromes allocated to the same MRTM	SAC#16
SRS-026	MRTM shall enable ATC detection and resolution of imminent runway incursions (AC, vehicle, animal, person incursions) for all aerodromes allocated to the same MRTM	SAC#16
SRS-027	MRTM shall enable ATC detection and resolution of runway incursions (AC, vehicle, animal, person incursions) for all aerodromes allocated to the same MRTM	SAC#17
SRS-028	MRTM shall enable ATC detection and instructions provision to prevent or resolve runway collisions for all aerodromes allocated to the same MRTM	SAC#18
SRS-029	MRTM shall enable to establish/maintain sufficient wake turbulence spacing between arriving and/or departing aircraft for all aerodromes allocated to the same MRTM)	SAC#10, SAC#11
SRS-030	MRTM shall enable ATC detection and instructions provision to prevent or resolve imminent wake encounters between arriving and/or departing aircraft for all aerodromes allocated to the same MRTM)	SAC#10, SAC#11
SRS-031	MRTM shall enable the detection of flight towards terrain situations for all aerodromes allocated to the same MRTM	SAC#8, SAC#9
SRS-032	MRTM shall enable to warn/support pilot on Controlled Flight Towards Terrain situations for all aerodromes allocated to the same MRTM	SAC#8, SAC#9
SRS-033	MRTM shall enable to support taking off and landing operations taking account of weather conditions affecting arriving/departing aircraft (applying corresponding procedures and informing pilots as necessary) for all aerodromes allocated to the same MRTM	SAC#19, SAC#20

SRS ID	SRS for Normal conditions of operation	Related SAC
SRS-034	MRTM shall enable to support landing and taking off aircraft taking account of runway surface conditions and potential foreign objects debris - FOD (applying corresponding procedures and informing pilots as necessary) for all aerodromes allocated to the same MRTM	SAC#19, SAC#20
SRS-035	MRTM shall enable to support arriving aircraft on final approach (providing relevant information and instructions as necessary) for all aerodromes allocated to the same MRTM	SAC#19, SAC#20
SRS-036	MRTM shall enable to provide “navigation” support to aircraft during landing operations (using available non-visual navigation aids as necessary) for all aerodromes allocated to the same MRTM	SAC#19, SAC#20
SRS-037	MRTM shall enable the detection of potential intrusions inside landing-aid protection area for all aerodromes allocated to the same MRTM	SAC#19, SAC#20
SRS-038	MRTM shall enable to assess the operational environmental conditions on each corresponding aerodrome in order to provide appropriate remote ATC service (for example “visualisation” related conditions: daylight, dawn, darkness, dusk, CAVOK and low visual conditions)	All SACs
SRS-039	MRTM shall enable the provision of appropriate and seamless ATC services in the several operational environmental conditions on each corresponding aerodrome (e.g. daylight, dawn, darkness, dusk, CAVOK and low visual conditions)	All SACs
SRS-040	Prior to remotely providing ATC services, MRTM capabilities shall be assessed/verified for all aerodromes allocated to the same MRTM	All SACs
SRS-041	Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware / notified when the remote provision of ATC service is initiated in each aerodrome (as per planned schedules)	All SACs
SRS-042	Remote provision of ATC service shall appropriately (safely) be stopped for planned terminations for one or more aerodromes while continuing the service provision in the other/s if needed	All SACs
SRS-043	Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware / notified when the remote provision of ATC service is terminated in one or more aerodromes (as per planned schedules)	All SACs

SRS ID	SRS for Normal conditions of operation	Related SAC
SRS-044	MRTM shall enable to prioritize tasks based on a short-term planning tool	All SACs
SRS-045	MRTM shall enable to safely split aerodromes in charge (transferring it/them to another MRTM in the same MRTC)	All SACs
SRS-046	MRTM shall enable to safely merge an aerodrome to the MRTM (transferring from another MRTM in the same MRTC)	All SACs
SRS-047	MRTM shall enable to coordinate with other MRTMs within the same MRTC	All SACs
SRS-048	MRTM shall enable to the receiving ATCO to approve the transfer of an aerodrome	All SACs
SRS-049	The MRTM cluster of aerodromes is planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes	All SACs
SRS-050	RTC SUP position shall enable tactical management of ATC resources (ATCO) ensuring safe service to all aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events.	All SACs
SRS-051	RTC SUP position shall enable to continuously check that which aerodromes are linked to the MRTMs within the MRTC	All SACs
SRS-052	RTC SUP position shall enable to continuously check traffic situation and traffic demand for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	All SACs
SRS-053	RTC SUP position shall enable to continuously check weather forecast for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	All SACs
SRS-054	RTC SUP position shall enable to continuously check any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	All SACs
SRS-055	RTC SUP position shall access contingency plan and ERP information for all MRTMs within the MRTC	All SACs
SRS-056	RTC SUP position shall enable to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another	All SACs
SRS 057	RTC SUP position shall be able to coordinate with the Technical SUP position	All SACs

SRS ID	SRS for Normal conditions of operation	Related SAC
SRS 058	RTC SUP position shall be able to coordinate with all relevant external parties	All SACs
SRS 086	MRTM shall enable to safely execute flexible allocation of aerodromes (HUD and HDD) within the same MRTM	All SACs

Table 3: List of SRS (functionality and performance) for normal conditions of operation

4.2.2 Additional SRS related to adjacent airspace or neighbouring ATM Systems

Additional SRS (functionality and performance) required for compatibility (e.g. Service Level Agreement SLA) related to changes in the Operational Environment to host the Solution operations or to impact on behaviour via the interactions with neighbouring ATM functional systems was not defined, these aspects are already covered by existing SRS.

4.3 Mitigation of Risks Inherent to Aviation - Abnormal conditions

The purpose of this section is to present the Safety Requirements at ATS Service level (SRS) derived for Abnormal conditions of operation.

The SRS in this section refer to the ability of the Solution to work through (robustness), or at least recover from (resilience) any abnormal conditions, external to the Solution functional system, that might be encountered relatively infrequently.

4.3.1 Identification of Abnormal Conditions

The following abnormal conditions have been identified. This list includes the typical abnormal conditions identified already in SESAR 1 and SESAR 2020 Wave 1.

- Unexpected/unplanned flight in airspace
- Aircraft with emergency
- Crash on an airport's vicinity
- Fire on one or more aerodromes
- Unplanned closure or opening of an airport
- Closing ATC service in one or more aerodromes
- (Unplanned) ATCO overload in one or more MRTM of the RTC
- Unexpected occurrences in the RTC (e.g. ATCO becomes ill)

Note: during the safety workshop of PJ.05.02 and 03, some controllers considered “unexpected/unplanned flights” as a nominal condition they are used to deal with; this depends on the type of airspace, traffic, complexity, etc. that they face every day. Hence definition of abnormal conditions might be different depending on the operational environment of a certain aerodrome.

4.3.2 Safety Requirements at ATS Service level (SRS) for Abnormal conditions of operation

Table 4 provides the consolidated view of the SRS for abnormal conditions of operation derived in Appendix C.

SRS ID	Description	Related SAC
SRS 059	MRTM shall enable, as in current operations, the detection of unexpected flights in the area of responsibility where ATC services are being provided for all aerodromes allocated to the same MRTM	SAC#1, SAC#2, SAC#3, SAC#4, SAC#5, SAC#6, SAC#7
SRS 060	MRTM shall enable to detect emergency situations on an aircraft (gear problems, fire on gears or aircraft, tail strike, etc.) for all aerodromes allocated to the same MRTM	SAC#19, SAC#20
SRS 061	MRTM shall enable to initiate emergency procedures and follow emergency situations affecting aircraft for all aerodromes allocated to the same MRTM	SAC#19, SAC#20
SRS 062	OPS SUP position shall enable to provide appropriate support in case of an emergency situation (gear problems, fire on gears or aircraft, tail strike, etc.) or crash situation for all MRTMs within the MRTC	SAC#19, SAC#20
SRS 063	Staffing level of the MRTC shall be adequate to take over one or more aerodromes from the concerned MRTM in case of an emergency or crash situation	All SACs
SRS 064	Number of MRTMs within the MRTC shall be adequate to take over one or more aerodromes from the concerned MRTM in case of an emergency or crash situation	All SACs
SRS 065	MRTM shall enable to detect and manage a crash situation on the aerodrome/s allocated to the same MRTM or in their vicinity	SAC#8, SAC#9, SAC#19, SAC#20
SRS 066	MRTM shall enable to have awareness of potential abnormal situations (abnormal weather, fire on terminal or aerodrome building, overload on the apron, etc.) in the aerodrome/s allocated to the same MRTM that could affect or even force the termination (unplanned terminations) of the provision of ATC services	All SACs
SRS 068	Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware/notified when the remote provision of ATC service is terminated in an unplanned manner in one or more aerodromes	All SACs
SRS 069	Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware/notified when the ATC service provision is stopped or	All SACs

	transferred to another MRTM (technical system failure, merging of aerodromes, etc.).	
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Table 4: List of additional SRS for Abnormal conditions of operation

4.4 Mitigation of System-generated Risks (failure conditions)

The purpose of this section is to present the Safety Requirements at ATS Service level (SRS) associated to the operational hazards.

The SRS provided in this section complete the safety specification of the Solution at operational service level, providing the adequate mitigation against the possible adverse effects that failures internal to the Solution functional system might have upon the provision of the relevant ATS operational services. Two types of SRS are to be included here:

- Additional SRS (functionality and performance) to mitigate against operational hazard effects (protective mitigation)
- SRS addressing integrity/reliability in order to limit the frequency with which the Solution functional system-generated operational hazards could be allowed to occur.

The SRS here are associated to either new operational hazards introduced by the Solution or to operational hazards defined in PJ.05-02 and PJ.05-03 (SESAR 2020 Wave 1).

4.4.1 Operational Hazards Identification and Analysis

Operational hazards defined in PJ.05-02 and PJ.05-03 (SESAR 2020 Wave 1) were slightly revised and used in this section, while additional ones were identified based on the results of the HAZID workshop (the workshop was the part of the Safety and HP workshop, held at ENAV premises in Naples, on the 8th and 9th of June, 2022). All operational hazards are listed in Table 5, and the consolidated results from the hazard identification, analysis and HAZID workshop (detailed working tables, results and HAZID workshop participation) can be found in Appendix D.

Note that the Severity Classification Schemes (SCS), as per the safety assessment practices in the ATM community are still in use for Wave 2 although their use is no more aligned with the new regulation 2017/373 and will be changed in the next version of the Safety Reference Material to be developed for use in SESAR 3.

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 01	MRTM fails to enable coordination and transfer procedures with adjacent ATS unit concerning inbound/outbound traffic (including as necessary aircraft identification) for one or several aerodromes allocated to the same MRTM		Planned conflict (MAC-TMA MF5.1)	n/a	MAC-SC4b

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 02	MRTM fails to manage inbound traffic (including as necessary management of the approach, visual acquisition, entry into traffic circuit and landing sequence) for one or several aerodromes allocated to the same MRTM		Imminent infringement (MAC-FAP MF5) Imminent Infringement (MF5-9)	n/a	MAC-FA-SC3 MAC-SC3
OH 03	MRTM fails to manage outbound traffic (including as necessary aircraft identification and departure sequence on the runway) for one or several aerodromes allocated to the same MRTM		Imminent MRS infringement on initial departure (MAC-ID ME7F) Imminent Infringement (MF5-8)	n/a	MAC-FA-SC3 MAC-SC3
OH 04	MRTM fails to separate traffic, with respect to other traffic, applying the corresponding separation minima to the airspace under control responsibility (in the vicinity of the aerodrome) or allowing reduction in separation minima in the vicinity of the aerodrome for one or several aerodromes allocated to the same MRTM		Imminent MRS infringement on initial departure (MAC-ID ME7F) Imminent infringement (MAC-FAP MF5, MAC-TMA MF5-9)	n/a	MAC-FA-SC3 MAC-SC3
OH 05	MRTM fails to separate traffic with respect to restricted areas on the airspace under control responsibility for one or several aerodromes allocated to the same MRTM		Imminent MRS infringement on initial departure (MAC-ID ME7F) Imminent infringement (MAC-FAP MF5, MAC-TMA MF5-9)	n/a	MAC-FA-SC3 MAC-SC3

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 06	MRTM fails to manage missed approaches situations (including detection of need for go-around, monitoring of involved aircraft and proposal for resolution) for one or several aerodromes allocated to the same MRTM		Imminent MRS infringement on initial departure (MAC-ID ME7F) Imminent infringement (MAC-FAP MF5, MAC-TMA MF5-9)	n/a	MAC-FA-SC3 MAC-SC3
OH 07	MRTM fails to detect conflicts or potential collisions between aircraft (within departing, within arriving and between both traffic) on the airspace under control responsibility for one or several aerodromes allocated to the same MRTM		Imminent Collision (MAC-ID MF4, MAC-FAP MF4, MAC-TMA MF4)	n/a	MAC-FA-SC2b MAC-SC2b
OH 08	MRTM fails to detect restricted areas infringements by aircraft in the airspace under control responsibility for one or several aerodromes allocated to the same MRTM		Imminent Collision (MAC-ID MF4, MAC-FAP MF4, MAC-TMA MF4)	n/a	MAC-FA-SC2b MAC-SC2b
OH 09	MRTM fails to provide ATC instructions to resolve conflicts/avoid collisions on the airspace under control responsibility for one or several aerodromes allocated to the same MRTM		Imminent Collision (MAC-ID MF4, MAC-FAP MF4, MAC-TMA MF4)	n/a	MAC-FA-SC2b MAC-SC2b
OH 10	MRTM fails to provide ATC instructions to resolve airspace infringements for one or several aerodromes allocated to the same MRTM		Imminent Collision (MAC-ID MF4, MAC-FAP MF4, MAC-TMA MF4)	n/a	MAC-FA-SC2b MAC-SC2b
OH 11	MRTM fails to identify departing AC on the stand for providing ATC service for one or several aerodromes allocated to the same MRTM		Taxiway Conflict (TWY-COL TP3)	n/a	TWY-SC5

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 12	MRTM fails to correctly apply start-up procedures for departing aircraft (including as appropriate the provision of necessary aerodrome information - operational and meteorological) for one or several aerodromes allocated to the same MRTM		Taxiway Conflict (TWY-COL TP3)	n/a	TWY-SC5
OH 13	MRTM fails to correctly apply push-back and towing procedures for one or several aerodromes allocated to the same MRTM		Imminent Taxiway Infringement (TP2)	n/a	TWY-SC4
OH 14	MRTM fails to provide conflict-free routing and taxi instructions to aircraft in the manoeuvring area for one or several aerodromes allocated to the same MRTM		Imminent Taxiway Infringement (TP2)	n/a	TWY-SC4
OH 15	MRTM fails to provide taxi instructions to vehicles in the manoeuvring area for one or several aerodromes allocated to the same MRTM		Imminent Taxiway Infringement (TP2)	n/a	TWY-SC4
OH 16	MRTM fails to support AC and vehicle movements in the manoeuvring area (through visual aids on the airport surface) for one or several aerodromes allocated to the same MRTM		Imminent Taxiway Collision (TWY-COL TP1) Induced Incursion (RWY-COL RP3)	n/a	TWY-SC4 RWY-SC5
OH 17	MRTM fails to detect conflicting situations in the manoeuvring area (involving aircraft, vehicles, and obstacles) for one or several aerodromes allocated to the same MRTM		Imminent Taxiway Collision (TWY-COL TP1)	n/a	TWY-SC3

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 18	MRTM fails to provide taxi instructions (to aircraft and vehicles) resolve conflicts and avoid potential collisions in the manoeuvring area for one or several aerodromes allocated to the same MRTM		Imminent Taxiway Collision (TWY-COL TP1)	n/a	TWY-SC3
OH 19	MRTM fails to manage runway entry for departing aircraft (this includes RWY status, occupancy, and correctness check before issuing line-up clearance) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RP2)	n/a	RWY-SC3
OH 20	MRTM fails to manage runway exit for arriving aircraft (this includes exit TWY status/occupancy check) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RP2)	n/a	RWY-SC3
OH 21	MRT fails to manage aircraft/vehicles runway crossing (this includes RWY status/occupancy/correctness check before issuing runway crossing clearance) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RP2)	n/a	RWY-SC3
OH 22	MRTM fails to support aircraft for take-off and landing operations (though visual-aids on the airport surface) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RP2)	n/a	RWY-SC3
OH 23	MRTM fails to carry out vehicle related tasks on the runway (inspections, etc.) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RP2)	n/a	RWY-SC3

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 24	MRT fails to manage aircraft take-off (this includes RWY status, occupancy, and correctness check before issuing take-off clearance) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RP2)	n/a	RWY-SC3
OH 25	MRTM fails to manage aircraft landing (this includes RWY status, occupancy, and correctness check before issuing landing clearance) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RP2)	n/a	RWY-SC3
OH 26	MRTM fails to enable ATC detection and resolution of imminent runway incursions (AC, vehicle, animal, person incursions) for one or several aerodromes allocated to the same MRTM		Induced Incursion (RWY-COL RP3)	n/a	RWY-SC4
OH 27	MRTM fails to enable ATC detection and resolution of runway incursions (AC, vehicle, animal, person incursions) for one or several aerodromes allocated to the same MRTM		Runway Conflict (RWY-COL RP2)	n/a	RWY-SC3
OH 28	MRTM fails to enable ATC detection and instructions provision to prevent or resolve runway collisions for one or several aerodromes allocated to the same MRTM		Imminent Runway Collision (RWY-COL RP1)	n/a	RWY-SC2b

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 29	MRTM fails to establish/maintain sufficient wake turbulence spacing between arriving and/or departing aircraft for one or several aerodromes allocated to the same MRTM)		Unmanaged underseparation in adequate separation mode- second a/c not yet airborne (WAKE-ID WE7F.1a) Imminent infringement (WAKE-FAP WE8)	n/a	Wake-SC3a WK-FA-SC3b
OH 30	MRTM fails to enable ATC detection and instructions provision to prevent or resolve imminent wake encounters between arriving and/or departing aircraft for one or several aerodromes allocated to the same MRTM)		Wake encounter (WAKE-ID WE5, WAKE-FAP WE5)	n/a	Wake-SC2 WK-FA-SC2
OH 31	MRTM fails to detect of flight towards terrain situations for one or several aerodromes allocated to the same MRTM		Imminent CFIT (CFIT CF3)	n/a	CFIT- SC2
OH 32	MRTM fails to warn/support pilot on Controlled Flight Towards Terrain situations for one or several aerodromes allocated to the same MRTM		Imminent CFIT (CFIT CF3)	n/a	CFIT- SC2
OH 33	MRTM fails to support taking off and landing operations taking account of weather conditions affecting arriving/departing aircraft (applying corresponding procedures and informing pilots as necessary) for one or several aerodromes allocated to the same MRTM		Landing to a weather affected RWY Imminent Runway Excursion	n/a	RWY-EXC SC2b

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 34	MRTM fails to support landing and taking off aircraft taking account of runway surface conditions and potential foreign objects debris - FOD (applying corresponding procedures and informing pilots as necessary) for one or several aerodromes allocated to the same MRTM		Imminent Runway Excursion	n/a	RWY-EXC SC2b
OH 35	MRTM fails to support arriving aircraft on final approach (providing relevant information and instructions as necessary) for one or several aerodromes allocated to the same MRTM		Unstable Approach / Imminent Runway Excursion	n/a	RWY-EXC SC2b/SC3a
OH 36	MRTM fails to provide "navigation" support to aircraft during landing operations (using available non-visual navigation aids as necessary) for one or several aerodromes allocated to the same MRTM		Unstable Approach	n/a	RWY-EXC SC3a
OH 37	MRTM fails to detect potential intrusions inside landing-aid protection area for one or several aerodromes allocated to the same MRTM		Imminent Runway excursion	n/a	RWY-EXC SC2b
OH 38	MRTM fails to assess the operational environmental conditions on each corresponding aerodrome in order to provide appropriate remote ATC service (for example "visualisation" related conditions: daylight, dawn, darkness, dusk, CAVOK and low visual conditions)		n/a – this hazard is already covered by the previous list of hazards as it might be a cause leading to several of them.		

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 39	MRTM fails to provide appropriate and seamless ATC services in the several operational environmental conditions on each corresponding aerodrome (e.g. daylight, dawn, darkness, dusk, CAVOK and low visual conditions)		n/a – this hazard is already covered by the previous list of hazards as it might be a cause leading to several of them		
OH 40	Prior to remotely providing ATC services, MRTM capabilities are not assessed/verified for one or several aerodromes allocated to the same MRTM		n/a – this hazard is already covered by the previous list of hazards as it might be a cause leading to several of them.		
OH 41	Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units are not aware / notified when the remote provision of ATC service is initiated in one or several aerodrome (as per planned schedules)		As airspace users and respective airport services were not involved in the project, potential effect of this operational hazard is not presented here. Further assessment should be made in this topic, as the lack of information concerning multiple operation might cause confusion on airspace user's/vehicle driver's side.		
OH 42	Remote provision of ATC service fails to appropriately (safely) be stopped for planned terminations for one or more aerodromes while continuing the service provision in the other/s if needed		Same consequences as in Single Remote Tower		
OH 43	Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units are not aware / notified when the remote provision of ATC service is terminated in one or more aerodromes (as per planned schedules)		Same consequences as in Single Remote Tower		

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 44	MRTM fails to prioritize tasks based on a short-term planning tool		n/a – this hazard is already covered by the previous list of hazards as it might be a cause leading to several of them.		
OH 45	MRTM fails to execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC)		<p>Induced Incursion (RWY-COL RP3)</p> <p>Taxiway Conflict (TWY-COL TP3)</p> <p>Tactical Conflict (MAC-FAP MF6-MF12)</p>	n/a	<p>RWY-SC4</p> <p>TWY-SC5</p> <p>MAC-FA-SC4</p>
OH 46	MRTM fails to adequately execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC)		<p>Imminent Runway Collision (RWY-COL RP1)</p> <p>Imminent Taxiway Collision (TWY-COL TP1)</p> <p>Imminent MRS infringement on initial departure (MAC-ID ME7F)</p>	n/a	<p>RWY-SC2</p> <p>TWY-SC3</p> <p>MAC-FA-SC3</p>
OH 47	MRTM fails to enable coordination with other MRTMs within the same MRTC		<p>Induced Incursion (RWY-COL RP3)</p> <p>Taxiway Conflict (TWY-COL TP3)</p> <p>Tactical Conflict (MAC-FAP MF6-MF12)</p>	n/a	<p>RWY-SC4</p> <p>TWY-SC5</p> <p>MAC-FA-SC4</p>

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 48	MRTM fails to enable to the transferring and/or the receiving ATCO to approve the transfer of an aerodrome		Runway Conflict (RWY-COL RP2) Imminent Taxiway Collision (TWY-COL TP1) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC3 TWY-SC4 MAC-FA-SC3
OH 49	MRTM fails to enable to the receiving ATCO to present all relevant information of an aerodrome in look only mode before approve the transfer		Induced Incursion (RWY-COL RP3) Taxiway Conflict (TWY-COL TP3) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC4 TWY-SC5 MAC-FA-SC4
OH 50	The MRTM cluster of aerodromes is not planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes		Induced Incursion (RWY-COL RP3) Taxiway Conflict (TWY-COL TP3) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC4 TWY-SC5 MAC-FA-SC4
OH 51	RTC SUP position fails to enable tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events		Induced Incursion (RWY-COL RP3) Taxiway Conflict (TWY-COL TP3) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC4 TWY-SC5 MAC-FA-SC4

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 52	RTC SUP position provides corrupted information to support tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events		Induced Incursion (RWY-COL RP3) Taxiway Conflict (TWY-COL TP3) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC4 TWY-SC5 MAC-FA-SC4
OH 53	RTC SUP position fails to continuously check that which aerodromes are linked to the MRTMs within the MRTC		n/a		
OH 54	RTC SUP position fails to continuously check traffic situation and traffic demand for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC		n/a		
OH 55	RTC SUP position fails to continuously check weather forecast for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC		n/a		
OH 56	RTC SUP position fails to continuously check any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC		n/a		

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 57	RTC SUP position fails to access contingency plan and ERP information for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC		Induced Incursion (RWY-COL RP3) Taxiway Conflict (TWY-COL TP3) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC4 TWY-SC5 MAC-FA-SC4
OH 58	RTC SUP position fails to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another		Induced Incursion (RWY-COL RP3) Taxiway Conflict (TWY-COL TP3) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC4 TWY-SC5 MAC-FA-SC4
OH 59	RTC SUP position fails to coordinate with the Technical SUP position		n/a		
OH 60	RTC SUP position fails to coordinate with all relevant external parties		n/a		
OH 61	RTC SUP position fails to access visual surveillance, air surveillance, EFS data, or communication of any of the MRTMs within the ATC		n/a		
OH 62	MRTM fails to provide flexible allocation of aerodromes within the same MRTM		Induced Incursion (RWY-COL RP3) Taxiway Conflict (TWY-COL TP3) Tactical Conflict (MAC-FAP MF6-MF12)	n/a	RWY-SC4 TWY-SC5 MAC-FA-SC4

ID	Operational Description	Hazard	Operational Effects	Mitigation of effects propagation	Severity (most probable effect)
OH 63	MRTM fails to adequately execute flexible allocation of aerodromes within the same MRTM		Runway Conflict (RP2) Imminent Taxiway Collision (TWY-COL TP1) Imminent MRS infringement on initial departure (MAC-ID ME7F)	n/a	RWY-SC2 TWY-SC3 MAC-FA-SC3
OH 64	MRTM fails to provide remote ATC service to one/some/all aerodromes allocated to the same MRTM		Same consequences as in Single Remote Tower		
OH 65	MRTM fails to provide communication to a/c and/or vehicles in one/some/all aerodromes allocated to the same MRTM		Same consequences as in Single Remote Tower		
OH 66	MRTM presents a failure on the screens which prevents ATCO from visually assessing traffic in one/some/all aerodromes allocated to the same MRTM		Same consequences as in Single Remote Tower		
OH 67	Partial failures in the MRTM (e.g. some screens failing, communication in only one aerodrome is interrupted, etc.)		n/a – this hazard is already covered by the previous list of hazards as it might be a cause leading to several of them.		

Table 5: Operational Hazards and Analysis

4.4.2 Safety Requirements at ATS Service level (SRS) associated to failure conditions

The consolidated list of additional SRS (functionality and performance) associated to failure conditions and therefore mitigating against operational hazard effects (protective mitigation), derived during the operational hazard assessment is provided in Table 6.

SRS ID	Additional Safety Requirements at ATS Service level (functionality & performance)	Mitigated Operational Hazard
SRS 070	Contingency procedures are to be in place in case the MRTM fails to provide remote ATC service to one/some/all aerodromes allocated to the same MRTM	Wave-1
SRS 071	Contingency procedures are to be in place in case the MRTM fails to communicate with a/c and/or vehicles in one/some/all aerodromes allocated to the same MRTM	Wave-1
SRS 072	Contingency procedures are to be in place in case the MRTM presents a failure on the screens which prevents ATCO from visually assessing traffic in one/some/all aerodromes allocated to the same MRTM	Wave-1
SRS 074	An operational procedure shall be available for the split & merge process, listing the critical systems which shall be available for the receiving MRTM to take over control from the transferring MRTM	OH-46
SRS 075	A spare MRTM should be available in the RTC	OH-45, OH-46, OH51-63
SRS 076	An assistant (ATCO, OPS SUP) should be available to support the work of the ATCO in the MRTM if split of one or more aerodromes is not possible (if feasible in VCS level)	OH-45, OH-46
SRS 077	Split and merge indication on the HMI should be intuitive enough to avoid unintentional or incidental split and merge initiation	OH-46, OH-48
SRS 078	An operational procedure shall be available for the OPS SUP, listing all relevant factors shall be evaluated when the MRTM cluster of aerodromes is planned	OH-49
SRS 080	Backup coordination system should be available for MRTM-MRTM coordination	OH-47

Table 6: Additional SRS (functionality and performance) to mitigate operational hazards

The list of SRS addressing integrity/reliability in order to limit the frequency with which the operational hazards (listed in section 4.4.1) could be allowed to occur is provided in Table 7. *The following safety requirements on service level are expressed in terms of maximum tolerable occurrence frequency of the effect from hazards. The tolerable probability of system failure should be calculated based on this and according to local characteristics.*

SRS ID	Safety Requirements at ATS Service level (integrity/reliability)	Related Operational Hazard	Severity & IM
SRS 101	The likelihood that MRTM fails to enable coordination and transfer procedures with adjacent ATS unit concerning inbound/outbound traffic (including as necessary aircraft identification) for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-04 per flight hour	OH 01	MAC-SC4b
SRS 102	The likelihood that MRTM fails to manage inbound traffic (including as necessary management of the approach, visual acquisition, entry into traffic circuit and landing sequence) for one or several aerodromes allocated to the same MRTM shall be no more than 4.00E-06 per flight hour	OH 02	MAC-FA-SC3 MAC-SC3
SRS 103	The likelihood that MRTM fails to manage outbound traffic (including as necessary aircraft identification and departure sequence on the runway) for one or several aerodromes allocated to the same MRTM shall be no more than 4.00E-06 per flight hour	OH 03	MAC-FA-SC3 MAC-SC3
SRS 104	The likelihood that MRTM fails to separate traffic, with respect to other traffic, applying the corresponding separation minima to the airspace under control responsibility (in the vicinity of the aerodrome) or allowing reduction in separation minima in the vicinity of the aerodrome for one or several aerodromes allocated to the same MRTM shall be no more than 4.00E-06 per flight hour	OH 04	MAC-FA-SC3 MAC-SC3
SRS 105	The likelihood that MRTM fails to separate traffic with respect to restricted areas on the airspace under control responsibility for one or several aerodromes allocated to the same MRTM shall be no more than 4.00E-06 per flight hour	OH 05	MAC-FA-SC3 MAC-SC3
SRS 106	The likelihood that MRTM fails to manage missed approaches situations (including detection of need for go-around, monitoring of involved aircraft and proposal for resolution) for one or several aerodromes allocated to the same MRTM shall be no more than 4.00E-06 per flight hour	OH 06	MAC-FA-SC3 MAC-SC3
SRS 107	The likelihood that MRTM fails to detect conflicts or potential collisions between aircraft (within departing, within arriving and between both traffic) on the airspace under control responsibility for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-06 per flight hour	OH 07	MAC-FA-SC2b MAC-SC2b

SRS ID	Safety Requirements at ATS Service level (integrity/reliability)	Related Operational Hazard	Severity & IM
SRS 108	The likelihood that MRTM fails to detect restricted areas infringements by aircraft in the airspace under control responsibility for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-06 per flight hour	OH 08	MAC-FA-SC2b MAC-SC2b
SRS 109	The likelihood that MRTM fails to provide ATC instructions to resolve conflicts/avoid collisions on the airspace under control responsibility for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-06 per flight hour	OH 09	MAC-FA-SC2b MAC-SC2b
SRS 110	The likelihood that MRTM fails to provide ATC instructions to resolve airspace infringements for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-06 per flight hour	OH 10	MAC-FA-SC2b MAC-SC2b
SRS 111	The likelihood that MRTM fails to identify departing aircraft on the stand for providing ATC service shall be no more than 0.01 per movement	OH 11	TWY-SC5
SRS 112	The likelihood that MRTM fails to provide appropriate information to departing aircraft for the start-up shall be no more than 0.01 per movement	OH 12	TWY-SC5
SRS 113	The likelihood that MRTM fails to correctly apply push-back and towing procedures for one or several aerodromes allocated to the same MRTM shall be no more than 3.33E-03 per flight hour	OH 13	TWY-SC4
SRS 114	The likelihood that MRTM fails to provide conflict-free routing and taxi instructions to aircraft in the manoeuvring area for one or several aerodromes allocated to the same MRTM shall be no more than 3.33E-03 per movement	OH 14	TWY-SC4
SRS 115	The likelihood that MRTM fails to provide taxi instructions to vehicles in the manoeuvring area for one or several aerodromes allocated to the same MRTM shall be no more than 3.33E-03 per movement	OH 15	TWY-SC4
SRS 116	The likelihood that MRTM fails to support AC and vehicle movements in the manoeuvring area (through visual aids on the airport surface) for one or several aerodromes allocated to the same MRTM shall be no more than 3.33E-06 per movement	OH 16	TWY-SC4 RWY-SC5
SRS 117	The likelihood that MRTM fails to detect conflicting situations in the manoeuvring area (involving aircraft, vehicles, and obstacles) for one or several aerodromes allocated to the same MRTM shall be no more than 5.00E-04 per flight hour	OH 17	TWY-SC3

SRS ID	Safety Requirements at ATS Service level (integrity/reliability)	Related Operational Hazard	Severity & IM
SRS 118	The likelihood that MRTM fails to provide taxi instructions (to aircraft and vehicles) resolve conflicts and avoid potential collisions in the manoeuvring area for one or several aerodromes allocated to the same MRTM shall be no more than 5.00E-04 per flight hour	OH 18	TWY-SC3
SRS 119	The likelihood that MRTM fails to manage runway entry for departing aircraft (this includes RWY status, occupancy, and correctness check before issuing line-up clearance) for one or several aerodromes allocated to the same MRTM shall be no more than 5E-07 per flight hour	OH 19	RWY-SC3
SRS 120	The likelihood that MRTM fails to manage runway exit for arriving aircraft (this includes exit TWY status/occupancy check) for one or several aerodromes allocated to the same MRTM shall be no more than 5E-07 per flight hour	OH 20	RWY-SC3
SRS 121	The likelihood that MRT fails to manage aircraft/vehicles runway crossing (this includes RWY status/occupancy/correctness check before issuing runway crossing clearance) for one or several aerodromes allocated to the same MRTM shall be no more than 5E-07 per flight hour	OH 21	RWY-SC3
SRS 122	The likelihood that MRTM fails to support aircraft for take-off and landing operations (though visual-aids on the airport surface) for one or several aerodromes allocated to the same MRTM shall be no more than 5E-07 per flight hour	OH 22	RWY-SC3
SRS 123	The likelihood that MRTM fails to carry out vehicle related tasks on the runway (inspections, etc.) for one or several aerodromes allocated to the same MRTM shall be no more than 5E-07 per flight hour	OH 23	RWY-SC3
SRS 124	The likelihood that MRT fails to manage aircraft take-off (this includes RWY status, occupancy, and correctness check before issuing take-off clearance) for one or several aerodromes allocated to the same MRTM shall be no more than 5E-07 per flight hour	OH 24	RWY-SC3
SRS 125	The likelihood that MRTM fails to manage aircraft landing (this includes RWY status, occupancy, and correctness check before issuing landing clearance) for one or several aerodromes allocated to the same MRTM shall be no more than 5E-07 per flight hour	OH 25	RWY-SC3

SRS ID	Safety Requirements at ATS Service level (integrity/reliability)	Related Operational Hazard	Severity & IM
SRS 126	The likelihood that MRTM fails to enable ATC detection and resolution of imminent runway incursions (AC, vehicle, animal, person incursions) for one or several aerodromes allocated to the same MRTM shall be no more than 3.33E-06 per flight hour	OH 26	RWY-SC4
SRS 127	The likelihood that MRTM fails to enable ATC detection and resolution of runway incursions (AC, vehicle, animal, person incursions) for one or several aerodromes allocated to the same MRTM shall be no more than 5.00E-07 per flight hour	OH 27	RWY-SC3
SRS 128	The likelihood that MRTM fails to enable ATC detection and instructions provision to prevent or resolve runway collisions for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-07 per flight hour	OH 28	RWY-SC2b
SRS 129	The likelihood that MRTM fails to establish/maintain sufficient wake turbulence spacing between arriving and/or departing aircraft for one or several aerodromes allocated to the same MRTM) shall be no more than 4.00E-05 per flight hour	OH 29	Wake-SC3a WK-FA-SC3b
SRS 130	The likelihood that MRTM fails to enable ATC detection and instructions provision to prevent or resolve imminent wake encounters between arriving and/or departing aircraft for one or several aerodromes allocated to the same MRTM) shall be no more than 2.00E-06 per flight hour	OH 30	Wake-SC2 WK-FA-SC2
SRS 131	The likelihood that MRTM fails to detect of flight towards terrain situations for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-07 per flight hour	OH 31	CFIT- SC2
SRS 132	The likelihood that MRTM fails to warn/support pilot on Controlled Flight Towards Terrain situations for one or several aerodromes allocated to the same MRTM shall be no more than 1.00E-07 per flight hour	OH 32	CFIT- SC2
SRS 145	The likelihood that MRTM fails to execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) shall be no more than 3.33E-06 per flight hour	OH 45	RWY-SC4 TWY-SC5 MAC-FA-SC4
SRS 146	The likelihood that MRTM fails to adequately execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) shall be no more than 1.00E-07 per flight hour	OH 46	RWY-SC2b TWY-SC3 MAC-FA-SC3

SRS ID	Safety Requirements at ATS Service level (integrity/reliability)	Related Operational Hazard	Severity & IM
SRS 147	The likelihood that MRTM fails to enable coordination with other MRTMs within the same MRTC shall be no more than 3.33E-06 per flight hour	OH 47	RWY-SC4 TWY-SC5 MAC-FA-SC
SRS 148	The likelihood that MRTM fails to enable to the transferring and/or the receiving ATCO to approve the transfer of an aerodrome shall be no more than 5.00E-07 per flight hour	OH 48	RWY-SC3 TWY-SC4 MAC-FA-SC3
SRS 149	The likelihood that MRTM fails to enable to the receiving ATCO to present all relevant information of an aerodrome in look only mode before approve the transfer shall be no more than 3.33E-06 per flight hour	OH 49	RWY-SC4 TWY-SC5 MAC-FA-SC4
SRS 150	The likelihood that The MRTM cluster of aerodromes is not planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes shall be no more than 3.33E-06 per flight hour	OH 50	RWY-SC4 TWY-SC5 MAC-FA-SC4
SRS 151	The likelihood that RTC SUP position fails to enable tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events shall be no more than 3.33E-06 per flight hour	OH 51	RWY-SC4 TWY-SC5 MAC-FA-SC4
SRS 152	The likelihood that RTC SUP position provides corrupted information to support tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events shall be no more than 3.33E-06 per flight hour	OH 52	RWY-SC4 TWY-SC5 MAC-FA-SC4
SRS 157	The likelihood that RTC SUP position fails to access contingency plan and ERP information for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC shall be no more than 3.33E-06 per flight hour	OH 57	RWY-SC4 TWY-SC5 MAC-FA-SC4
SRS 158	The likelihood that RTC SUP position fails to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another shall be no more than 3.33E-06 per flight hour	OH 58	RWY-SC4 TWY-SC5 MAC-FA-SC4

SRS ID	Safety Requirements at ATS Service level (integrity/reliability)	Related Operational Hazard	Severity & IM
SRS 162	The likelihood that MRTM fails to provide flexible allocation of aerodromes within the same MRTM shall be no more than 3.33E-06 per flight hour	OH 62	RWY-SC4 TWY-SC5 MAC-FA-SC4
SRS 163	The likelihood that MRTM fails to adequately execute flexible allocation of aerodromes within the same MRTM shall be no more than 1.00E-07 per flight hour	OH 63	RWY-SC2b TWY-SC3 MAC-FA-SC3

Table 7: Safety Requirements at Service level - integrity/reliability

4.5 Process assurance of the Safety Specification at ATS Service level

All SAC and SRS were defined in accordance with the relevant parts of the SRM, the list was reviewed and agreed by all partners within the solution. A Safety and HP workshop was held (for details and results, see 4.4.1 and Appendix D). Detailed results of the validation exercises are available in SESAR Solution PJ05_35 VALR-V3, while the relevant results from safety point of view are available in Appendix H.

5 Safe Design of the Solution functional system

The purpose of this section is to document the Safety Requirements at Design level (SRD) for the corresponding ATS operational Solution.

The Safety Requirements at Design level (SRD) are design characteristics/items of the Solution functional system to ensure that the system operates as specified and is able to achieve the SAC (because based on the verification/demonstration of these characteristics/items, it could be concluded that the SAC are met).

The set of Safety Requirements at Service level (SRS) enables the derivation of a correct and complete set of Safety Requirements at Design level (SRD) for ensuring the achievability of the Safety Criteria.

In SESAR2020 within the PJ05 Solution 35 we are looking at one type of requirements:

- Those that are particular to Highly Flexible Allocation of Aerodromes to Remote Tower Modules, also named as particular to the “Multiple W2” setting, are the new or modified Safety Requirements developed in SESAR 2020 W2

Any Assumption, Safety Issue or Operational Limitation identified during the design process was recorded in Appendix I.

5.1 Overview of activities performed

This section addresses the following activities:

- introduction of the design model (initial or refined) of the Solution functional system – section 5.2
- derivation of Safety Requirements (functionality & performance) at Design level (SRD) in normal conditions of operation from the SRS (functionality & performance) of section 4.2 and supported by the analysis of the initial or refined design model above - section 5.3
- derivation of Safety Requirements (functionality & performance) at Design level (SRD) in abnormal conditions of operation from the SRS (functionality and performance) of section 4.3 and supported by the analysis of the operation of the initial or refined design under abnormal conditions of operation - section 5.4
- assessment of the adequacy of the design (initial or refined) in the case of internal failures and mitigation of the Solution operational hazards (identified at section 4.4) through derivation from SRS (integrity/ reliability) of Safety Requirements (functionality & performance) and Safety Requirements (integrity&reliability) at Design level (SRD)- section 5.5
- realism of the refined safe design (i.e. achievability and “testability” of the SRD) - section 5.6
- safety process assurance at the initial or refined design level - section 5.7

5.2 Design model of the Solution functional system

The design model represents the architecture combining the elements composing the Solution functional system in terms of procedures, human resources and equipment. Safety requirements at design level (SRD) are to be placed on those elements afterwards. EATMA diagrams developed by the Solution, and a model for the purpose of the safety assessment (coming from PJ05.03 of SESAR 2020 wave 1) were used.

5.2.1 Description of the Design Model

A logical model of the solution, and respective model elements can be found in chapter 4.2.1 of the SESAR Solution PJ.05.03 SPR-INTEROP/OSED for V2 - Part II - Safety Assessment Report. To be in line with the former projects, an updated form of this model was used.

As the original model does not contains supervisor-related functions, the following additional elements were added:

- RTC supervisor
- RTC supervisor tool
- MRTM – referring to functions which can affect more other elements within the MRTM, and/or the location of those within the functional system might vary in case of different exercises and implementations (e.g. the function which is responsible for the flexible allocation, or the split & merge of aerodromes)

Relevant EATMA diagrams are available in Appendix B.

5.2.2 Task Analysis

A task analysis has not been developed in the framework of the HP assessment in SESAR2020. This task was however performed in SESAR1 and provided the detail of the tasks done by the ATCO for the provision of the ATC services described in section **Fehler! Verweisquelle konnte nicht gefunden werden..**

5.3 Deriving Safety Requirements at Design level for Normal conditions of operation

The purpose of this section is to present the Safety Requirements at Design level (SRD) derived for Normal conditions of operation following related SAF-GUI in STELLAR.

The derivation of the SRD for Normal conditions of operation is mainly driven by the SRS (functionality and performance) for Normal conditions of operation from section 4.2.

Any assumption, safety issue or operational limitation stated during the derivation of the SRDs for Normal conditions of operation are captured in Appendix I.

5.3.1 Safety Requirements at Design level (SRD) – Normal conditions of operation

Table 8 provides the consolidated list of Safety Requirements at Design level (functionality and performance) for Normal conditions of operations derived by mapping the SRS for Normal conditions of operations (documented in section 4.2) onto the related elements of the Design Model. For each SRD, the associated SRS and the type of the requirement (“Pack”, “Multiple”, or “Multiple W2”) are indicated.

The detail of the derivation process is to be included in Appendix E.

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-74	The ATCO should be supported in prioritising tasks (e.g. providing landing clearance or taxi clearance) from a support tool in the tactical short term.	Multiple (W2)	SRS-44
SRD-75	ATCO should continuously be monitoring the upcoming and present traffic flow for all active aerodromes dedicated to the MRTM to avoid overload.	Multiple (W2)	SRS-44
SRD-76	ATCO shall be able to communicate with ATCOs in other MRTMs within the RTC in order to coordinate transfer procedure at each aerodrome allocated to the MRTM.	Multiple (W2)	SRS-47
SRD-77	The ATCO shall be able to transfer one of the controlled aerodromes to another MRTM.	Multiple (W2)	SRS-45
SRD-78	The ATCO shall be able to take over an aerodrome to one MRTM	Multiple (W2)	SRS-46, SRS-48
SRD-79	During Transfer of an aerodrome both ATCOs shall be presented with the same information on the aerodrome being transferred with all available technical systems as replicas until the transfer process is finished, readiness by overtaking ATCO is confirmed and the fully control over the new aerodrome is being reported established.	Multiple (W2)	SRS-45, SRS-46
SRD-80	Transfer procedures (for the transfer of an aerodrome between MRTMs) shall be locally defined with a clear description of the associated roles and responsibilities and corresponding coordination procedures.	Multiple (W2)	SRS-39, SRS-45, SRS-46, SRS-48, SRS-50, SRS-62, SRS-74
SRD-81	All available technical systems of an aerodrome shall be available for input in only one MRTM at a time, in line with the control responsibility of the given aerodrome.	Multiple (W2)	SRS-45, SRS-46

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-82	The RTC Supervisor role should be provided with a display presenting an overview of the RTC, including e.g. MRTM status, aerodromes allocated to MRTMs, traffic load, etc. to be able to transfer an airport	Multiple (W2)	SRS-51, SRS-52, SRS-54
SRD-83	The RTC Supervisor role should be provided with a technical overview of all systems e.g. the MRTM, camera functionality etc. in the RTC and of the aerodrome systems e.g. navigational aids, lights, emergency alerting functions, for all involved aerodromes part of the RTC	Multiple (W2)	SRS-54
SRD-84	The RTC Supervisor should be provided with the forecasted demand for all involved aerodromes part of the RTC.	Multiple (W2)	SRS-52
SRD-85	The RTC Supervisor role shall be provided with an overview of ATCO availability and their valid endorsements	Multiple (W2)	SRS-54
SRD-86	The RTC Supervisor shall be provided with up-to date information to facilitate decisions regarding how to combine aerodromes in the MRTM.	Multiple (W2)	SRS-49, SRS-78
SRD-87	The RTC Supervisor shall be provided with Contingency Plan information for all involved aerodromes part of the RTC.	Multiple (W2)	SRS-55
SRD-88	The RTC Supervisor role shall be provided with Emergency Response Plan information for all involved aerodromes part of the RTC.	Multiple (W2)	SRS-55, SRS-62
SRD-89	RTC Supervisor role shall be able to communicate with ATCOs in all MRTMs within the RTC in order to coordinate transfer procedures at each aerodrome allocated to the MRTM	Multiple (W2)	SRS-56, SRS-62
SRD-90	The RTC Supervisor role shall access functions for communicating the status of RTC and aerodromes and coordinating maintenance (to be carried out by a qualified engineer/technician).	Multiple (W2)	SRS-57
SRD-91	RTC Supervisor shall be able to coordinate with all relevant external parties	Multiple (W2)	SRS-58
SRD-96	The receiving MRTM should not take over control from the transferring MRTM if any critical system or information is not available	Multiple (W2)	SRS-45, SRS-46, SRS-149

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-106	The border of each displayed aerodrome should be marked in the visual presentation and head-down displays with possible colour coding for the different positions or aerodromes.	Multiple (W2)	SRS-86
SRD-107	In case of colour coding, consistent indication shall be used for the different aerodromes on visual presentation and head down displays.	Multiple (W2)	SRS-86
SRD-108	Flexible positioning of aerodromes within the same MRTM shall be performed by the ATCO.	Multiple (W2)	SRS-86
SRD-109	The function enabling flexible positioning of aerodromes within the same MRTM should be intuitive enough to avoid unintentional or incidental changes	Multiple (W2)	SRS-86
SRD-114	The ATCO may be supported in monitoring conformance to clearances on ground.	Multiple (W2)	SRS-017
SRD-115	The ATCO may be supported in monitoring conformance to clearances for airborne movements	Multiple (W2)	SRS-004
SRD-116	The ATCO may be supported by the system, indicating situations when contradictory (incompatible) clearances are delivered.	Multiple (W2)	SRS-004, SRS-017
SRD-117	The ATCO may be supported by the system indicating when clearances can be given.	Multiple (W2)	SRS-004, SRS-017

Table 8. Safety Requirements at design level (functionality and performance) satisfying SRS for Normal conditions of operation

An indication of the correspondence with the requirement from SPR-INTERP/OSED Part I is also provided.

OSD Req. ID	OSD req.	Covered by SRD ID
REQ-05.00-SPRINTEROP-MP01.0001	<p>In case of high workload situations, such as an emergency situation, at one of the airports - significantly increasing the ATCO/AFISO workload and affecting her/his capability to continue to provide ATS to all airports under responsibility - the ATCO may perform one of the following actions in order to be able to manage the high workload situation:</p> <ul style="list-style-type: none"> Temporarily stopping/delaying traffic at the other/all airport(s); Transferring the provisioning of ATS for the airport(s) not affected by the unexpected event to another MRTM; Requesting the support of another ATCO to be able to continue the service provision for all aerodromes from the existing RTM. <p>Note: The RTC Supervisor may support the controller to apply these procedures.</p>	SRD 017
REQ-05.00-SPRINTEROP-CO01.0005	The RTC should host a locally determined number of MRTMs to be able to split aerodromes.	SRD 094
REQ-05.03-SPRINTEROP-AP01.0002	The ATCO should be supported in prioritising tasks (e.g. providing landing clearance or taxi clearance) from a support tool in the tactical short term.	SRD 074
REQ-05.00-SPRINTEROP-AF01.0001	The ATCO should be provided with a clear indication of which aerodrome an incoming radio transmission is related to.	SRD 006
REQ-05.03-SPRINTEROP-AF01.0002	The ATCO may be supported in monitoring conformance to clearances on ground.	SRD-114
REQ-05.03-SPRINTEROP-AF01.0003	The ATCO may be supported in monitoring conformance to clearances for airborne movements	SRD-115
REQ-05.03-SPRINTEROP-AF01.0004	The ATCO may be supported by the system, indicating situations when contradictory (incompatible) clearances are delivered.	SRD-116
REQ-05.35-SPRINTEROP-AF01.0005	The ATCO may be supported by the system indicating when clearances can be given.	SRD-117
REQ-05.00-SPRINTEROP-TM02.0001	The ATCO shall be provided with a system enabling to transfer one of the controlled aerodromes to another MRTM	SRD 077
REQ-05.00-SPRINTEROP-TM02.0002	The ATCO shall be able to take over an aerodrome to one MRTM	SRD 078

OSD Req. ID	OSD req.	Covered by SRD ID
REQ-05.00-SPRINTEROP-TM02.0004	During Transfer of an aerodrome both ATCOs shall be presented with the same information on the aerodrome being transferred with all available technical systems as replicas until the transfer process is finished, readiness by overtaking ATCO is confirmed and the fully control over the new aerodrome is being reported established.	SRD 079
REQ-05.00-SPRINTEROP-TM02.0005	Transfer procedures (for the transfer of an aerodrome between MRTMs) shall be locally defined with a clear description of the associated roles and responsibilities and corresponding coordination procedures.	SRD 080
REQ-05.03-SPRINTEROP-TM03.0002	The RTC Supervisor role should be provided with a display presenting an overview of the RTC, including e.g. MRTM status, aerodromes allocated to MRTMs, traffic load, etc. to be able to transfer an airport	SRD 082
REQ-05.03-SPRINTEROP-SP02.0003	The RTC Supervisor role shall be able to access functions for the monitoring of weather conditions for all aerodromes.	SRD 029
REQ-05.03-SPRINTEROP-SP02.0004	The RTC Supervisor role should be provided with a technical overview of all systems e.g. the MRTM, camera functionality etc. in the RTC and of the aerodrome systems e.g. navigational aids, lights, emergency alerting functions, for all involved aerodromes part of the RTC	SRD 083
REQ-05.03-SPRINTEROP-SP03.0002	The RTC Supervisor should be provided with the forecasted demand for all involved aerodromes part of the RTC.	SRD 084
REQ-05.03-SPRINTEROP-SP03.0004	The RTC Supervisor role shall be provided with an overview of ATCO availability and their valid endorsements	SRD 085
REQ-05.03-SPRINTEROP-TM03.0003	The RTC Supervisor shall be provided with information to facilitate decisions regarding how to combine aerodromes in the MRTM	SRD 086

5.3.2 Static analysis of the functional system behaviour – Normal conditions of operation

No new Safety Objectives or Requirements were identified from a static analysis of the functional system behaviour.

5.3.3 Dynamic Analysis of the functional system behaviour – Normal conditions of operation

No new Safety Objectives or Requirements were identified from Real Time Simulations. For more information see Validation Report [11].

5.3.4 Effects on Safety Nets – Normal conditions of operation

No new Safety Objectives or Requirements were identified impacting Safety Nets. For more information see Validation Report [11].

5.4 Deriving Safety Requirements at Design level for Abnormal conditions of operation

The purpose of this section is to present the Safety Requirements at Design level (SRD) for Abnormal conditions of operation.

The Safety requirements at design level - SRD (functionality and performance) are derived from the SRS (functionality and performance) which have been identified when mitigating risks inherent to aviation in abnormal conditions of operations (section 4.3).

Contingency procedures associated to the degraded modes of operation in which the functional system might enter as a result of certain abnormal conditions of operation were captured as SRD.

Additional SRD identified from the analysis of the system behaviour in abnormal operational conditions conducted to show completeness/correctness of the Safety Requirements (Functionality and Performance) are also documented here.

Any assumption, safety issue or limitation stated during the derivation of the SRDs for Abnormal conditions of operation are captured in Appendix I.

5.4.1 Safety Requirements at Design level (SRD) for Abnormal conditions of operation

Table 9 provides the consolidated list of Safety Requirements at Design level (functionality and performance) for Abnormal conditions of operations derived from the Service Requirements at Service level (SRS) documented in section 4.3. For each SRD indicate the element of the design model on which the SRD is placed, as well as the associated SRS.

The details of the derivation process are included in Appendix F.

Safety Req. ID	Safety Requirement (functionality & performance) for abnormal operation	Type	Derived from SRS (ID)
SRD-93	The spare ATCOs shall have endorsement for all aerodromes within the RTC.	Multiple (W2)	SRS-63, SRS-76
SRD-94	A spare MRTM, which is not used in day to day operational service, should be available	Multiple (W2)	SRS-64, SRS-75

Table 9. Safety Requirements at design level (functionality and performance) satisfying SRS for Abnormal conditions

Ref	Abnormal Conditions	Operational Effect	Mitigation of Effects / [SRD xxx]
ABN 1	Unexpected/unplanned flight in airspace	This may induce conflict with other traffic within the same area, as it overloads ATCOs and/or unexpectedly changes their way of managing traffic	SRD-16, SRD-17, SRD-18, SRD-32, SRD-33, SRD-42
ABN 2	Aircraft with emergency (gear problem, brakes overheating - fire on the tires, tail strike, bird strike, etc.).	All these emergencies may induce landing or take-off accidents	SRD-03, SRD-04, SRD-05, SRD-06, SRD-07, SRD-08, SRD-14, SRD-15, SRD-16, SRD-17, SRD-18, SRD-22, SRD-29, SRD-30, SRD-31, SRD-32, SRD-33, SRD-35, SRD-36, SRD-37, SRD-41, SRD-42, SRD-48, SRD-49, SRD-50, SRD-51, SRD-76, SRD-77, SRD-78, SRD-79, SRD-80, SRD-81, SRD-82, SRD-83, SRD-84, SRD-85, SRD-87, SRD-88, SRD-89, SRD-90, SRD-93, SRD-94, SRD-96
ABN 3	Crash on an airport's vicinity	In this case the objective is to trigger the corresponding services for rescue as quick as possible	SRD-03, SRD-04, SRD-05, SRD-06, SRD-07, SRD-08, SRD-14, SRD-15, SRD-16, SRD-17, SRD-18, SRD-22, SRD-29, SRD-30, SRD-31, SRD-32, SRD-33, SRD-35, SRD-36, SRD-37, SRD-41, SRD-42, SRD-48, SRD-49, SRD-50, SRD-51, SRD-76, SRD-77, SRD-78, SRD-79, SRD-80, SRD-81, SRD-82, SRD-83, SRD-84, SRD-85, SRD-87, SRD-88, SRD-89, SRD-90, SRD-93, SRD-94, SRD-96,
ABN 4	Fire on one or more aerodromes	Operations on the aerodrome/s may need to be stopped as conditions may not be safe for aircraft, passengers and airport personnel.	SRD-05, SRD-06, SRD-07, SRD-08, SRD-12, SRD-14, SRD-15, SRD-22, SRD-24, SRD-30, SRD-76, SRD-77, SRD-78, SRD-79, SRD-80, SRD-81, SRD-82, SRD-83, SRD-85, SRD-89, SRD-93, SRD-94, SRD-96
ABN 5	Unplanned closure of an airport, closing ATC service in one or more aerodromes	Operations on the aerodrome shall be stopped as conditions are not safe for aircraft, passengers and airport personnel. (In case there is a situation significantly affecting the safety of the operations in a corresponding aerodrome, the airport operations manager may decide to close the aerodrome hence stopping ATC services.)	SRD-05, SRD-06, SRD-07, SRD-08, SRD-12, SRD-14, SRD-15, SRD-22, SRD-24, SRD-30, SRD-82, SRD-83, SRD-85, SRD-89

Ref	Abnormal Conditions	Operational Effect	Mitigation of Effects / [SRD xxx]
ABN 6	Unplanned request for opening of an airport	An unplanned opening might cause ATCO overload in the affected MRTM. Opening might be delayed to reduce this effect.	SRD-05, SRD-06, SRD-07, SRD-08, SRD-14, SRD-15, SRD-22, SRD-82, SRD-83, SRD-85, SRD-89, SRD-93, SRD-94
ABN 7	(Unplanned) ATCO overload in one or more MRTM of the RTC, ATCO becomes incapable	Overload might decrease ATCO's ability to provide safe and efficient ATC service in one or more aerodromes	SRD-76, SRD-77, SRD-78, SRD-79, SRD-80, SRD-81, SRD-82, SRD-83, SRD-84, SRD-85, SRD-89, SRD-93, SRD-94, SRD-96

Table 10. Safety Requirements at design level (functionality and performance) for each Abnormal condition

5.4.2 Analysis of the functional system behaviour – Abnormal conditions of operation

No new Safety Objectives or Requirements were identified from Real Time Simulations. For more information see Validation Report [11].

5.5 Safety Requirements at Design level addressing Internal Functional System Failures

The purpose of this section is to present the Safety Requirements at Design level (SRD) associated to internal failures of the Solution functional system.

Safety requirements at design level - SRD are derived from the SRS (functionality and performance) and SRS (integrity and reliability) which have been identified when mitigating system generated risks (section 4.4).

The following Safety requirements at design level (SRD) are to be included (derived from a top down causal analysis of the operational hazards identified at §4.4.1, from a bottom up failure modes and effects analysis encompassing the analysis of common causes and, if applicable, from the SRS (functionality&performance) derived during the operational hazard assessment at §4.4.1):

- SRD (functionality and performance) derived to provide adequate mitigations to reduce the likelihood that specific failures would propagate up to the operational hazard
- SRD (integrity/ reliability) to limit the frequency with which failure of modified/new equipment elements in the Solution Functional system could be allowed to occur
- SRD (functionality and performance) derived to provide mitigation against operational hazard effects (protective mitigation, from the SRS (functionality&performance) derived during the operational hazard assessment at §4.4.1).

Any assumption, safety issue or limitation stated during the derivation of the SRDs associated to internal system failures is captured in Appendix I.

5.5.1 Design analysis addressing internal functional system failures

Casual analyses of SRS 101-SRS 132 are available in Appendix D of SESAR Solution PJ.05.03 SPR-INTEROP/OSED for V2 - Part II - Safety Assessment Report [19], while for new integrity&reliability SRS, the details are included in Appendix G.

5.5.2 Safety Requirements at Design level associated to internal functional system failures

Table 11 provides the consolidated list of Safety Requirements at Design level (functionality and performance) associated to internal system failures. Include the following:

- the SRD (functionality and performance) derived from the SRS (integrity/reliability) from section 4.4.2 to provide adequate mitigations to reduce the likelihood that specific failures would propagate up to the operational hazard, with due consideration for mitigating the common cause failures,
- the SRD (functionality and performance) derived to provide mitigation against operational hazard effects (protective mitigation, from the SRS (functionality&performance) derived during the operational hazard assessment at §4.4.1), with due consideration for mitigating the common cause failures.

The details of the derivation process are included in Appendix G.

Safety Req. ID	Safety Requirement at Design level (SRD) (functionality & performance)	Type	Derived from SRS (ID) or Common cause failure
SRD-93	The spare ATCOs shall have endorsement for all aerodromes within the RTC.	Multiple (W2)	SRS-63, SRS-76
SRD-94	A spare MRTM, which is not used in day to day operational service, should be available	Multiple (W2)	SRS-64, SRS-75
SRD-98	The system enabling to transfer one of the controlled aerodromes to another MRTM should be intuitive enough to avoid unintentional or incidental transfer initiation	Multiple (W2)	SRS-77
SRD-99	The RTC should host a locally determined number of MRTMs to be able to split aerodromes.	Multiple (W2)	SRS-78
SRD-102	A backup system should be available for the situation when coordination is not possible within the RTC	Multiple (W2)	SRS-80
SRD-110	An alert shall be provided to the controller in case of failure of the transfer function.	Multiple (W2)	SRS 145

Safety Req. ID	Safety Requirement at Design level (SRD) (functionality & performance)	Type	Derived from SRS (ID) or Common cause failure
SRD-111	An alert shall be provided to the supervisor in case of the Supervisor Planning Tool receives corrupted data from any critical systems	Multiple (W2)	SRS 150, SRS 152

Table 11. SRD (functionality & performance) to mitigate the operational hazards

Provide in Table 12 provides the consolidated list of Safety Requirements at Design level (integrity/reliability) associated to internal system failures derived from the Service Requirements at Service level (integrity/reliability) documented in section 4.4.2, with due consideration of any potential common cause failure. For each SRD (integrity/reliability) indicate the element of the design model on which the SRD is placed, as well as the originating SRS.

The details of the derivation process are included in Appendix G.

Safety Req. ID	Safety Requirement at Design level (SRD) (integrity /reliability)	Type	Derived from SRS integrity & reliability (ID)
SRD 212	The likelihood of loss of transfer functionality between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same RTC) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 145, SRS 148
SRD 213	The likelihood of an inadequately executed transfer between aerodromes in charge (one or more critical functions of an aerodrome is not available from the receiving position) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 146
SRD 214	The likelihood of an inadequately executed transfer between aerodromes in charge (one or more critical functions of an aerodrome is available from more than one MRTM) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 146
SRD 215	The likelihood of an inadequately executed transfer between aerodromes in charge (one or more critical functions of an aerodrome is not available from any MRTM) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 146
SRD 216	For a local implementation, corresponding assurance level for the software development process of the relevant components of the transfer function and its availability shall be defined based on applicable regulation.	Multiple (W2)	SRS 146
SRD 217	The likelihood of loss of coordination between MRTMs, and/or OPS SUP role and MRTMs within the same RTC shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 147, SRS 158

Safety Req. ID	Safety Requirement at Design level (SRD) (integrity /reliability)	Type	Derived from SRS integrity & reliability (ID)
SRD 218	The likelihood that any critical information is not available for the receiving ATCO shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 149
SRD 219	The likelihood of loss of the Supervisor Planning Tool shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 150, SRS 151, SRS 157
SRD 220	The likelihood of partial loss of the Supervisor Planning Tool functionality due to missing data from any critical systems shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 150, SRS 151, SRS 157
SRD 221	The likelihood of partial loss of the Supervisor Planning Tool functionality shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 150, SRS 151, SRS 157
SRD 222	The likelihood that the Supervisor Planning Tool receives corrupted data from any critical systems shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 150, SRS 152
SRD 223	The likelihood that the information provided by the Supervisor Planning Tool becomes corrupted in the processing phase shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 150, SRS 152
SRD 224	For a local implementation, corresponding assurance level for the software development process of the relevant components of the Supervisor Planning Tool and its availability shall be defined based on applicable regulation.	Multiple (W2)	SRS 150, SRS 151, SRS 152
SRD 225	The likelihood of loss of the flexible positioning function within one MRTM shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 162
SRD 226	The likelihood of partial loss of the flexible positioning function within one MRTM shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 162
SRD 227	The likelihood of an inadequately executed flexible positioning function within one MRTM shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	SRS 163

Safety Req. ID	Safety Requirement at Design level (SRD) (integrity /reliability)	Type	Derived from SRS integrity & reliability (ID)
SRD 228	For a local implementation, corresponding assurance level for the software development process of the relevant components of the flexible positioning function within one MRTM and its availability shall be defined based on applicable regulation.	Multiple (W2)	SRS 162, SRS 163

Table 12. SRD (integrity/reliability) to mitigate the operational hazards

5.6 Realism of the safe design

To prove that the Safety Requirements in Solution PJ05.35 are achievable and implementable, a complete table of all Safety Requirements is included in Appendix H. This table contains the evidence that they are achievable – that is, the trial, workshop discussion or expert judgement that validate the concept.

5.7 Process assurance for a Safe Design

All SRD were defined in accordance with the relevant parts of the SRM, the list was reviewed and agreed by all partners within the solution. A Safety and HP workshop was held (for details and results, see 4.4.1 and Appendix D). Detailed results of the validation exercises are available in SESAR Solution PJ05_35 VALR-V3, while the relevant results from safety point of view are available in Appendix H.

6 Safety Criteria achievability

As for Single Remote Tower, no quantitative evidence on the achievability of the Safety Criteria through the specification of the Safety Objectives has been collected for Multiple Remote Tower.

From the Safety Criteria listed in section 3.4, and following the SRM process, the SRS and Operational Hazards have been developed and identified. Therefore the Safety Criteria are implicitly achieved through the demonstration of the aforementioned.

The Validation Report [11] captured the Safety Validation Objectives, among others. These Safety Validation Objectives were covered by the Validation exercises and/or the HP and Safety workshop (see Appendix H of this document, and chapters 4. and 5. of the Validation Report [11]).

Appendix H also presents the traceability table that links the SRS covering all Safety Validation Objectives for ATCO and RTC supervisor as well.

All **nominal** Safety Validation Objectives have been covered by either the Validation exercises or the Safety and HP workshop. Particularities on how to implement different aspects are to be developed in local implementation and therefore considered covered in V3.

The Safety Validation Objectives for **abnormal conditions** were validated in some cases during Validation Exercises. Discussions show that the Multiple Remote Tower setting would not impede ATCOs to deal with abnormal situations, although further assessment needs to be conducted locally for implementation, including the mitigations (additional ATCO, silent communication, etc.).

Some of the Safety Validation Objectives related to **degraded modes** of operations have been also covered during the validations, and those have been further discussed during the HP and Safety workshop.

Evidences collected for abnormal and failure conditions are partially subjective feedback from operational people involved in the project and in the validation exercises, together with some scenarios that were simulated but that do not cover all cases. This feedback has been collected by questionnaires and group discussions in a Safety and Human Performance workshop with ATCOs in Naples, 07-08 June 2022.

The working table(s) for the demonstration of the Safety Criteria achievability is provided in Appendix H.

7 Acronyms and Terminology

Acronym	Definition
ACC	Area Control Centre
ADI	Aerodrome Control Instrument (Rating)
AFIS	Aerodrome Flight Information Service
AFISO	Aerodrome Flight Information Service Officer
AIM	Aeronautical Information Management
AIP	Aeronautical Information Publication
ALRS	Alerting Service
APP	Approach Control
APS	Approach Control Surveillance (Rating)
ATCC	Air Traffic Control Centre
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATS	Air Traffic Service
AVF	Advance Visual Features
CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
CR	Change Request
CTR	Control Zone
CWP	Controller Working Position
DME	Distance Measuring Equipment
EASA	European Aviation Safety Agency
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
FATO	Final approach and take-off area
HPAR	Human Performance Assessment Report
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INTEROP	Interoperability Requirements
KPA	Key Performance Area

LVO	Low Visibility Operations
LVP	Low Visibility Procedures
MET	Meteorology, meteorological
MRTM	Multiple Remote Tower Module
NDB	Non Directional Beacon
NSA	National Supervisory Authority
OFZ	Obstacle Free Zone
OI	Operational Improvement
OSED	Operational Service and Environment Definition
OTW	Out-The-Window
PAR	Performance Assessment Report
PTZ	Pan-Tilt-Zoom
QoS	Quality of Service
RNAV	Area Navigation (Random Navigation)
RPAS	Remotely Piloted Aircraft Systems
RTC	Remote Tower Centre
RTM	Remote Tower Module
RTO	Remote Tower Operations
RVR	Runway Visual Range
RWS	RTC supervisor
SAC	Safety Criteria
SAR	Safety Assessment Report
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
STK	Stakeholder
SWIM	System Wide Information Model
TGL	Touch-and-Go Landing
U/S	Unserviceable
VCS	Voice Communications System
VFR	Visual Flight Rules
VP	Visual Presentation; previously called “OTW” as out-the-window view

Table 13: Acronyms and terminology

8 References

Safety

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- [5] SESAR, Guidance to Apply the Safety Reference Material, Edition 4.01, December 2018
- [6] SESAR 2020 PJ.05-W2-35 Validation Plan – Part I, 2021
- [7] SESAR 2020 PJ.05-W2-35 Validation Plan – Part II Safety Plan, 2021
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- [12] SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015
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- [16] AIM – Accident Incident Model
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- [18] SESAR Solution PJ.05.02 SPR-INTEROP/OSED for V3 - Part II - Safety Assessment Report, 2018
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- [22] EASA ED Decision 2019/004/R “Guidance Material on remote aerodrome air traffic services”, 2019

[23]SESAR 1 for Single Remote Tower

[24] SESAR 1 for Multiple Remote Tower

Appendix A Preliminary safety impact assessment

This appendix presents the outcomes of the preliminary safety impact assessment and Safety Criteria determination, conducted within the “SAF&HP Scoping and Change Assessment” and documented in Section 4.2 of the Safety Plan, performed in accordance with the relevant SAF-GUI in STELLAR.

A.1 Relevant Hazards Inherent to Aviation

Hazards inherent to aviation	ATM-related accident type & AIM model
Ha 01. Situation in which A/C trajectories can lead to mid-air collision	Mid Air Collision - MAC-TMA
Ha 02. Situation leading to collision with an obstacle, ground vehicle, another aircraft on apron or taxiway	Taxiway Collision - TWY-Col
Ha 03. Situation leading to collision with an obstacle, ground vehicle, another aircraft on the runway	Runway Collision - RWY-Col
Ha 04. Another aircraft or vehicle inside the Obstacle Free Zone – OFZ	Runway Collision - RWY-Col
Ha 05. Missed approach	Mid Air Collision - MAC-TMA
Ha 06. Situation leading to Wake vortex encounter in final approach	Wake Turbulence Accident - WV-FAP
Ha 07. Situation leading to Controlled Flight Into Terrain	Controlled Flight Into Terrain - CFIT
Ha 08. Bird close to/in path of aircraft or animal on the runway	Bird-strike Animal-strike - RWY-Col
Ha 09. Adverse weather conditions like violent winds or severe crosswind	Hard landing, runway excursion, Landing accident - RWY-EXC
Ha 010. Snow/slush on the runway	Loss of control on the runway, Landing accident - RWY-EXC
Ha 011. Low runway surface friction	Runway excursion (veer-off, overrun) Landing accident - RWY-EXC
Ha 012. Runway undershoot	Off-runway touchdown, Landing accident - None
Ha 013. Aircraft using a closed taxiway	Taxiway Collision - TWY-Col
Ha 014. Aircraft landing in/taking off from a wrong/closed runway	Runway Collision (wrong/closed RWY in which an AC, vehicle, obstacle is present), Landing accident (closed runway because of maintenance: RWY surface not operational) - RWY-Col

Hazards inherent to aviation	ATM-related accident type & AIM model
Ha 015. Another aircraft or vehicle inside landing-aid protection area during CATII/III instrument approach	Landing accident - RWY-EXC
Ha 016. Foreign Object Debris within the Runway protected area	(Loss of control on the runway) Landing accident - RWY-EXC
Ha 017. Aircraft attempt to land with undercarriage retracted	(Gears-up landing) Landing accident - RWY-EXC
Ha 018. Loss/interruption of ATC services (to one or more aerodromes)	All types of accidents - None
Ha 019. Aircraft entering a restricted area (airspace)	Airspace infringement - MAC-TMA

Table 14. Hazards inherent to aviation relevant for the Solution

A.2 Functional system-generated hazards (preliminary)

Functional system-generated hazards (preliminary)	Impacted (new/modified) & justification
Hs 01: Transfer of aerodromes in charge and safely transfer one/several aerodromes to another MRTM in the same MRTC fails	Unsuccessful split and merge process affects ATCO workload and situational awareness, and eliminate the possibility to solve a difficult situation (potential overload, abnormal or degraded situation) with transfer of one or more aerodromes
Hs 02: Split and merge of aerodromes in charge and safely transfer one/several aerodromes to another MRTM in the same MRTC is executed incorrectly – communication is not available	Receiving ATCO is not able to approve transfer, unsuccessful split and merge process affects ATCO workload and situational awareness, and eliminate the possibility to solve a difficult situation (potential overload, abnormal or degraded situation) with transfer of one or more aerodromes. If transfer is executed, ATC service is highly degraded, or impossible due to the loss of communication in one aerodrome.
Hs 03: Split and merge of aerodromes in charge and safely transfer one/several aerodromes to another MRTM in the same MRTC is executed incorrectly – visualization is not available	Receiving ATCO is not able to approve transfer, unsuccessful split and merge process affects ATCO workload and situational awareness, and eliminate the possibility to solve a difficult situation (potential overload, abnormal or degraded situation) with transfer of one or more aerodromes. If transfer is executed, ATC service provision is highly degraded due to the loss of visualization in one aerodrome.
Hs 04: Split and merge of aerodromes in charge and safely transfer one/several aerodromes to another MRTM in the same MRTC is executed	Receiving ATCO is not able to approve transfer, unsuccessful split and merge process affects ATCO workload and situational awareness, and eliminate the possibility to solve a difficult situation (potential overload, abnormal or degraded situation) with transfer of one or more aerodromes. If transfer is executed,

Functional system-generated hazards (preliminary)	Impacted (new/modified) & justification
incorrectly – ATM system is not available	ATC service provision is highly degraded due to the loss of ATM system in one aerodrome.
Hs 05: Split and merge of aerodromes in charge and safely transfer one/several aerodromes to another MRTM in the same MRTC is executed incorrectly – wrong aerodrome is selected for the handover and assigned to the other MRTM	Incorrect split and merge process cause confusion on transferring and receiving sides, and affects ATCO workload and situational awareness. Responsibility of ATC service provision in one or more aerodromes might be unclear.
Hs 06: Merge a new aerodrome transferred to the MRTM with all capabilities to provide ATC services fails	Receiving ATCO is not able to approve transfer
Hs 07: Merge a new aerodrome transferred to the MRTM with all capabilities to provide ATC services is executed incorrectly	Receiving ATCO is not able to approve transfer, if transfer is executed, ATC service provision might be highly degraded, or impossible.
Hs 08: RTC SUP planning tool provide false or insufficient information to indicate split and merge procedure on time	RTC SUP is not able to indicate split and merge process on time, which might cause ATCO overload in one or more MRTMs, or RTC SUP indicates an unnecessary split and merge process.
Hs 09: Flexible allocation of aerodromes within the same MRTM fails	Slightly increased ATCO workload due to an unpreferable setup.
Hs 10: Flexible allocation of aerodromes within the same MRTM is executed incorrectly	An incorrectly executed flexible allocation can cause major confusion on ATCO side, situational awareness might be decreased.

Table 15. Functional system-generated hazards applicable to the Solution (preliminary list)

Appendix B Derivation of SRS (Functionality & Performance) for Normal conditions of operation

This appendix presents the derivation of the SRS (functionality and performance) in order to mitigate the hazards inherent to aviation under normal conditions of operation, i.e. those conditions that are expected to occur on a day-to-day basis.

B.1 EATMA Process models or alternative description

A copy (image) of the EATMA Process model for each Use Case is included here.

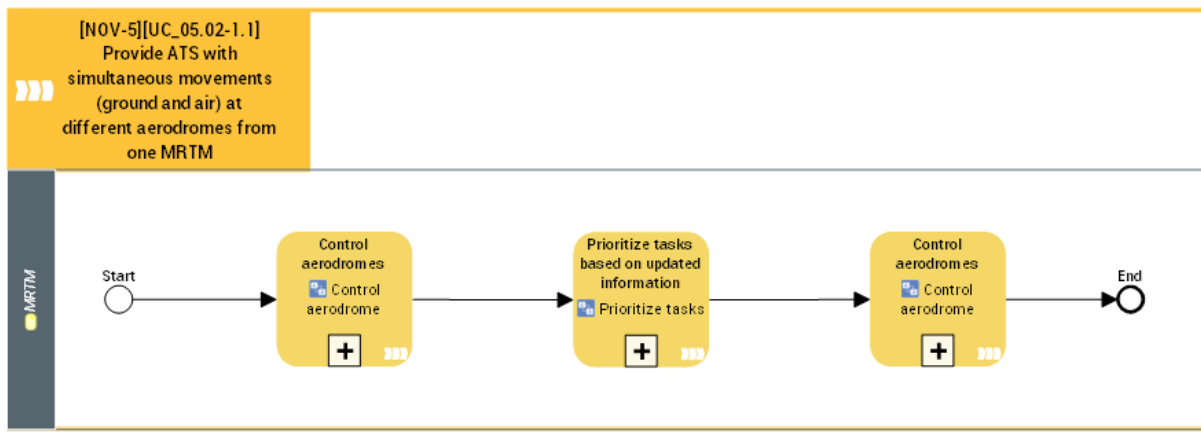


Figure 1 Use Case 1:1

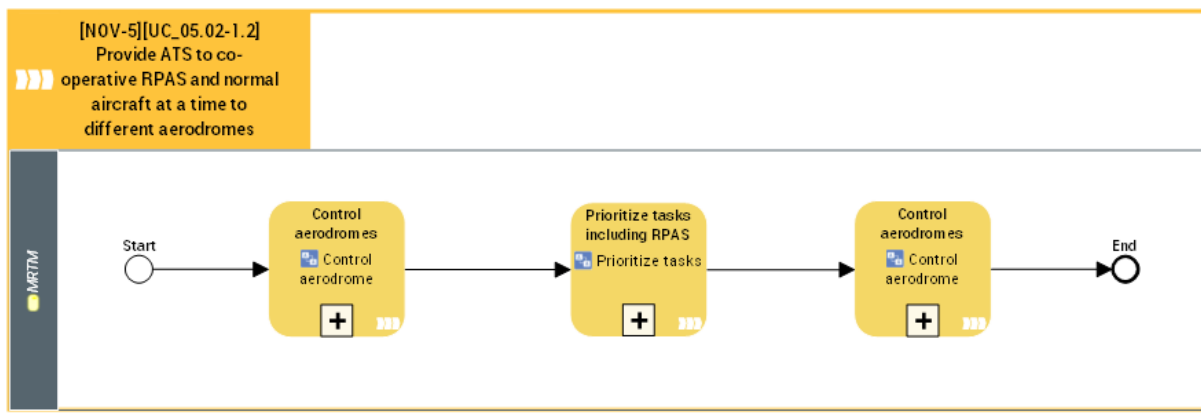


Figure 2 Use Case 1:2

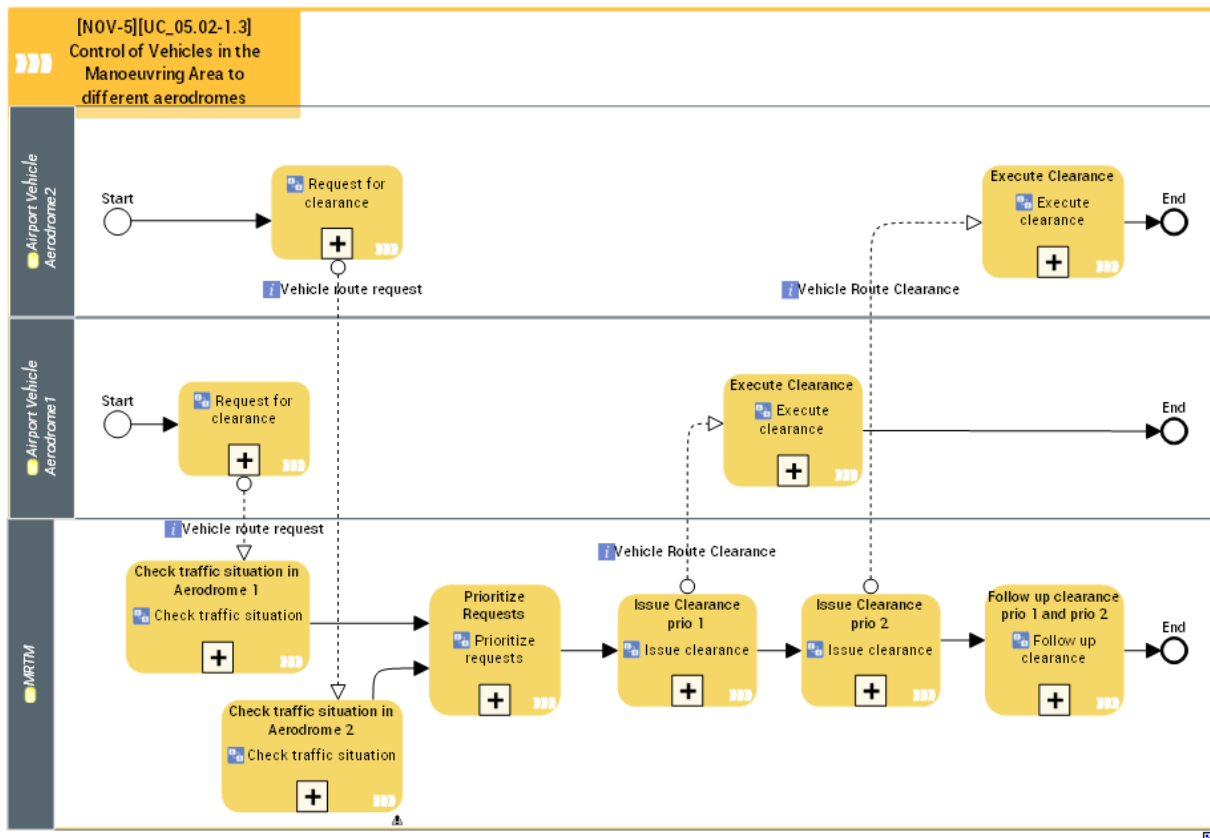


Figure 3 Use Case 1:3

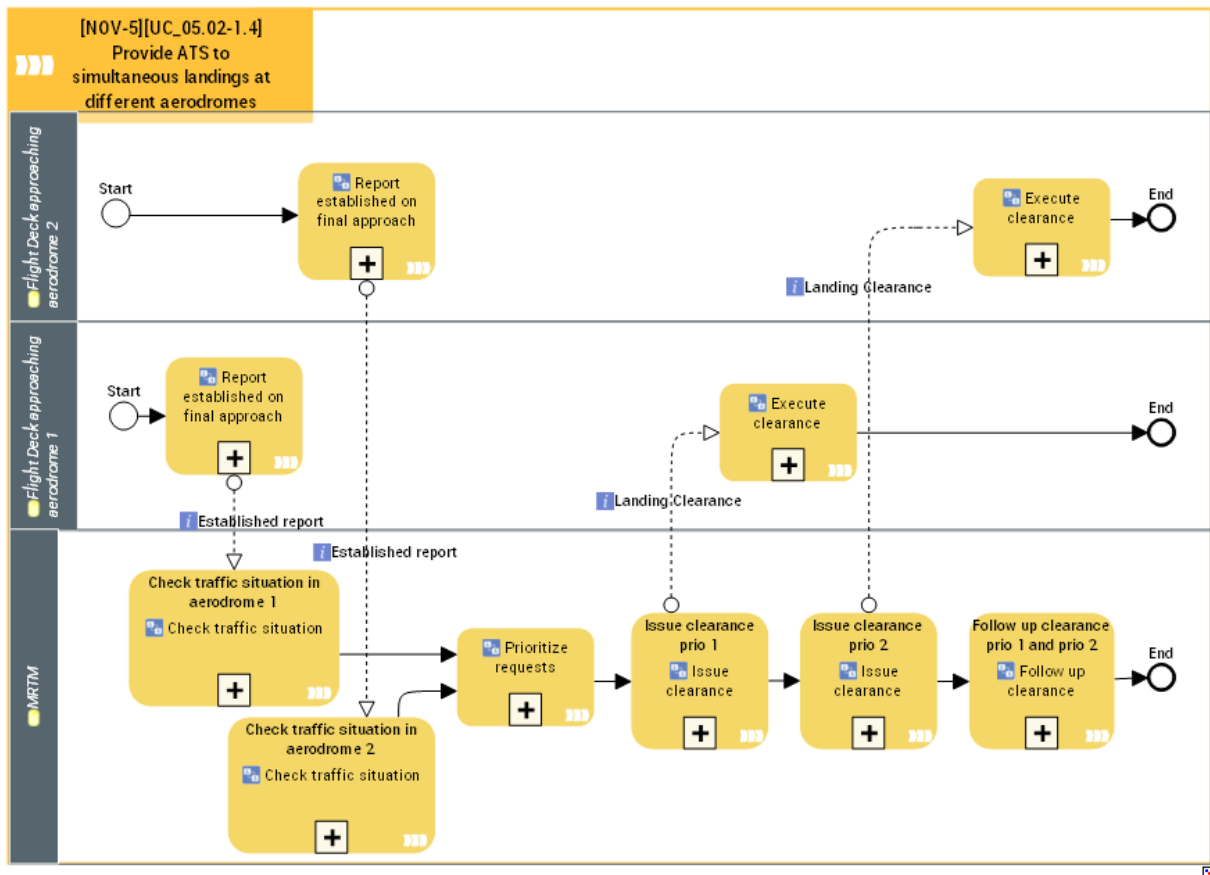


Figure 4 Use Case 1:4

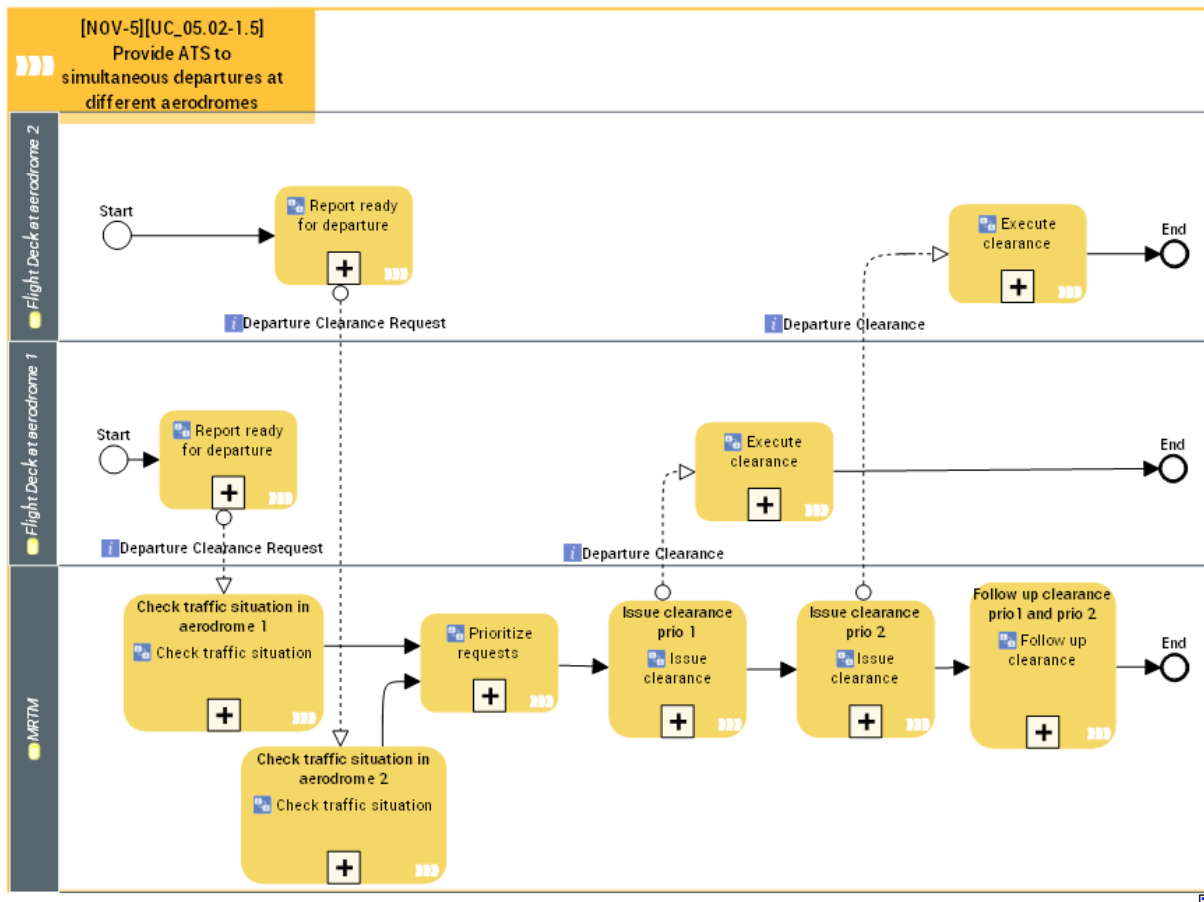


Figure 5 Use Case 1:5

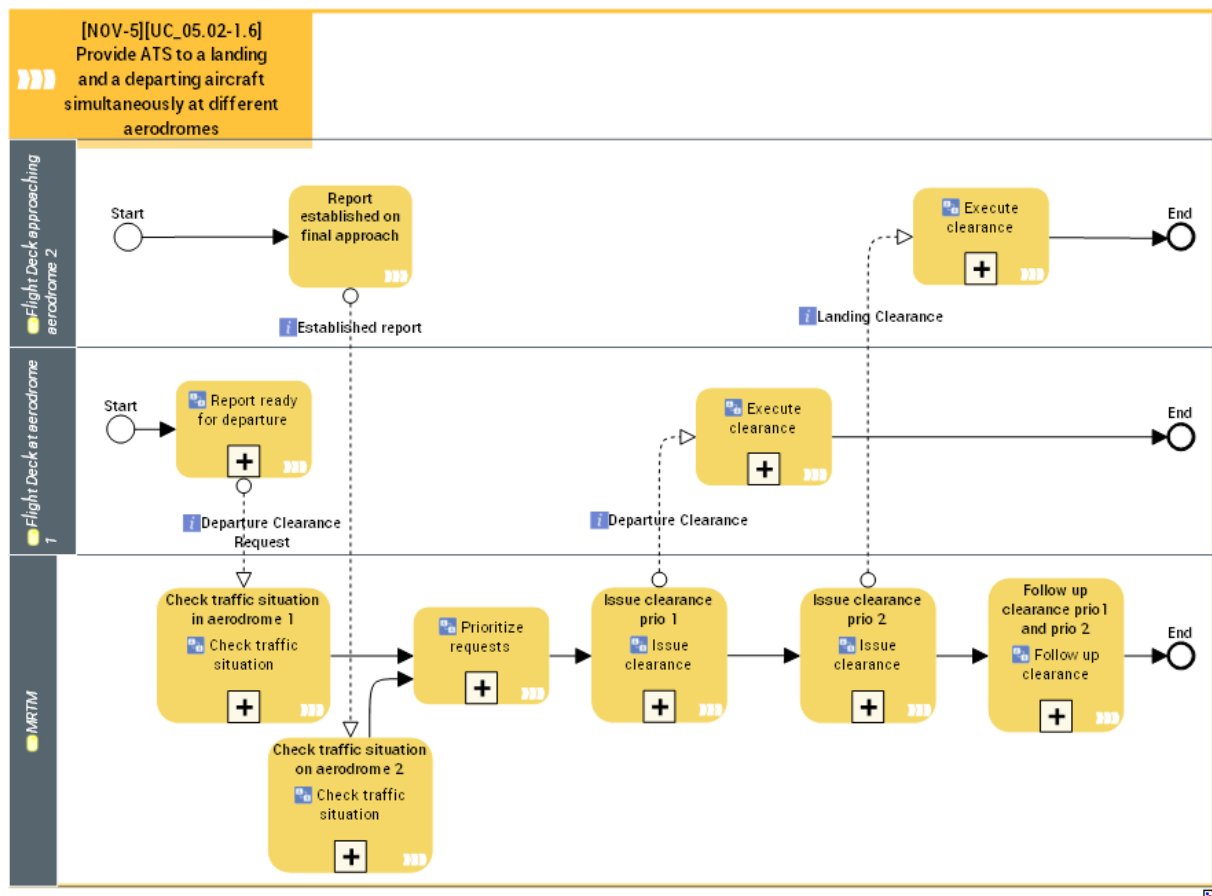


Figure 6 Use Case 1:6

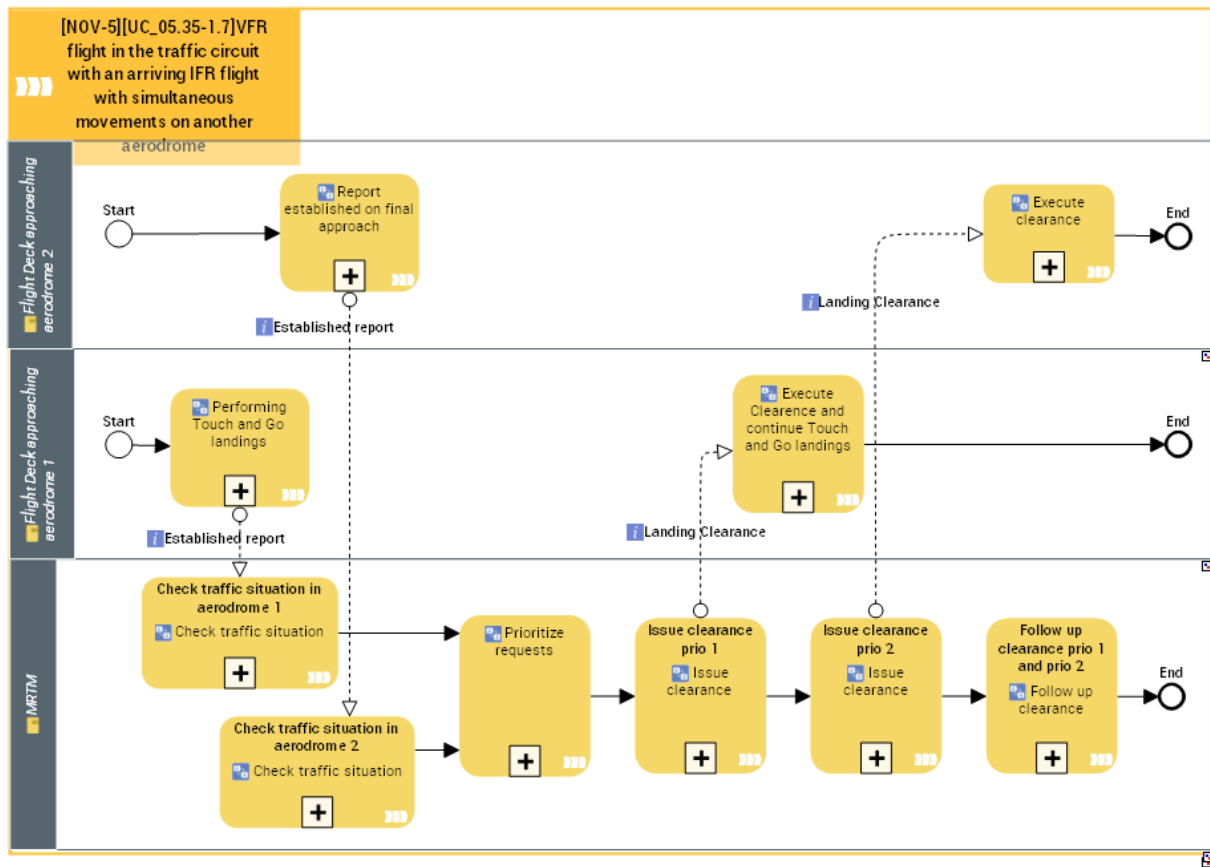


Figure 7 Use Case 1:7

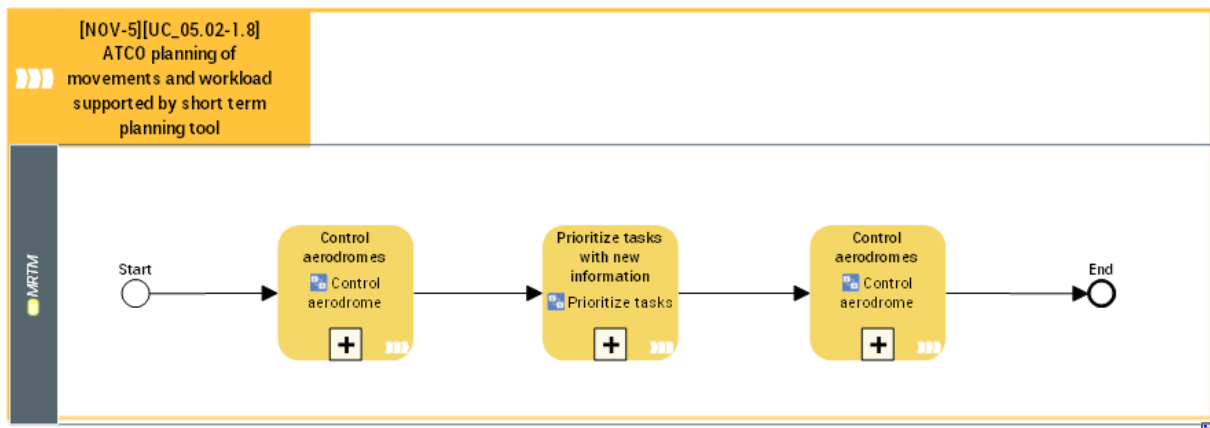


Figure 8 Use Case 1:8

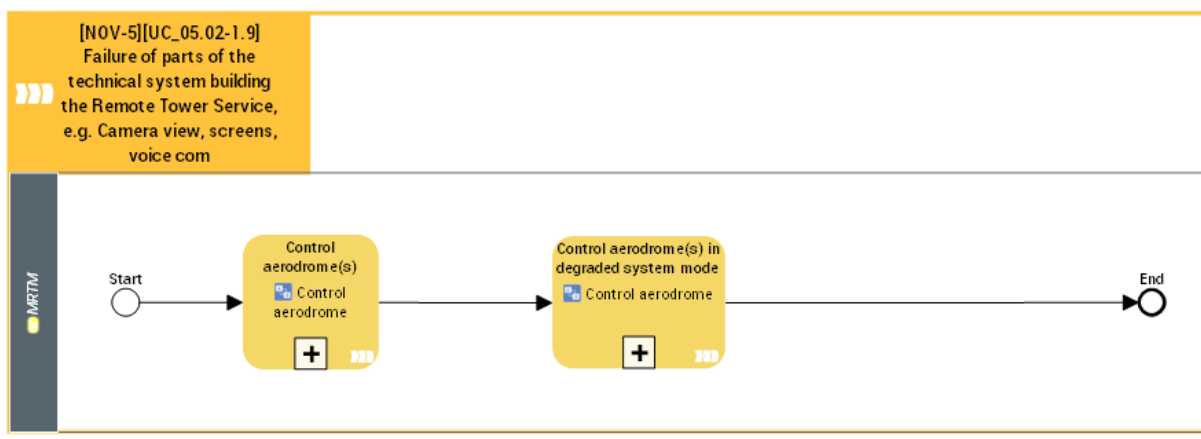


Figure 9 Use Case 1:9

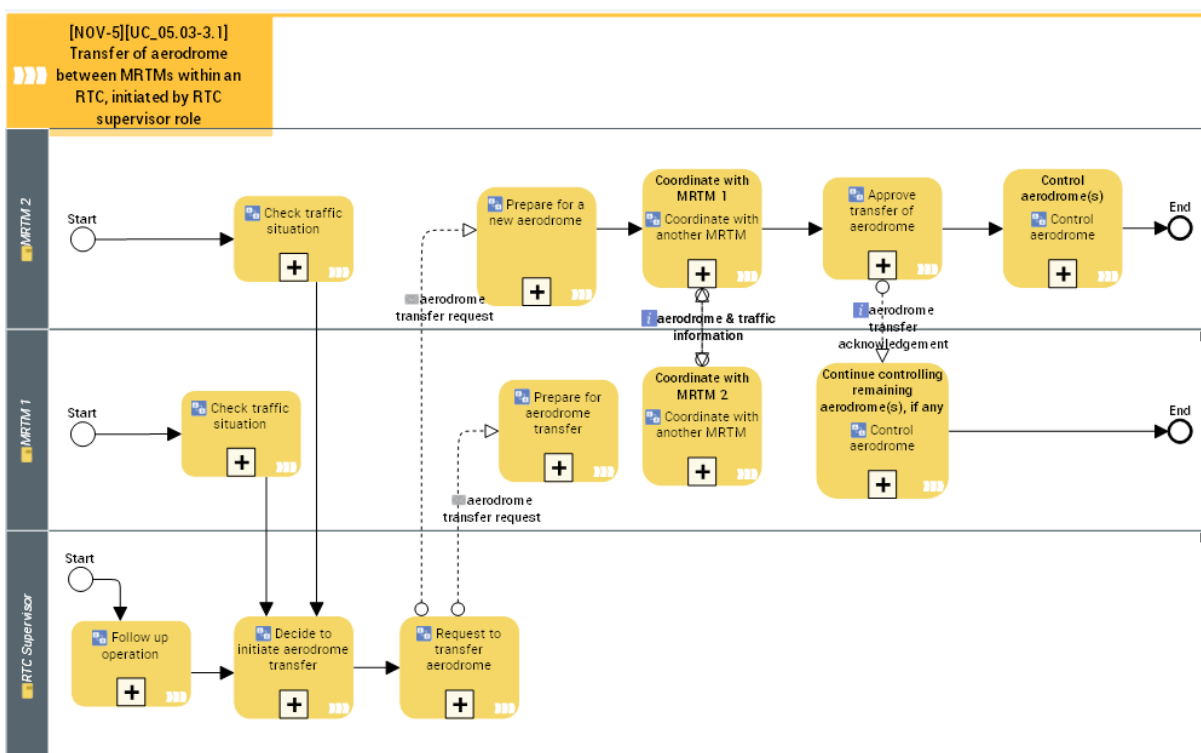


Figure 10 Use Case 3:1

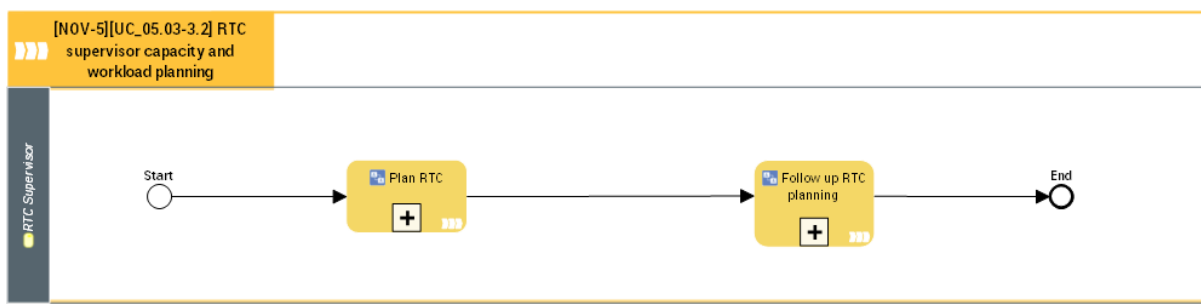


Figure 11 Use Case 3:2

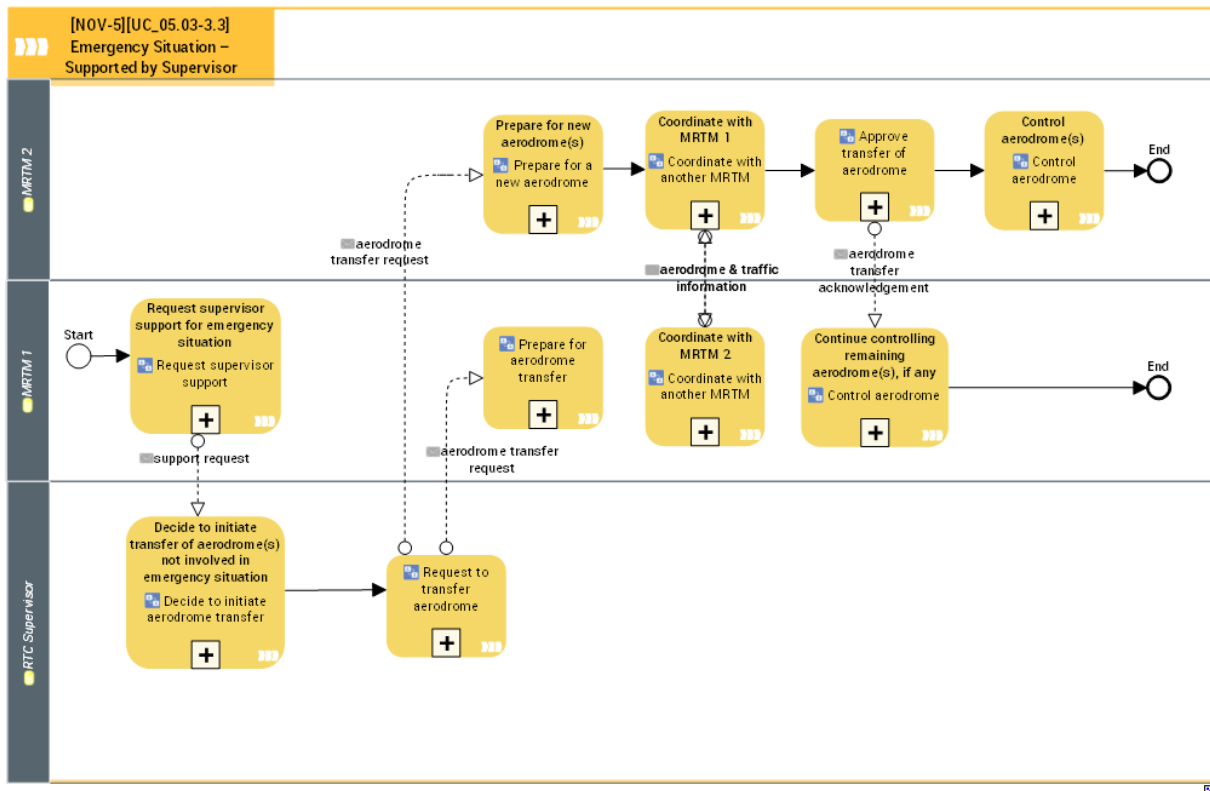


Figure 12 Use Case 3:3

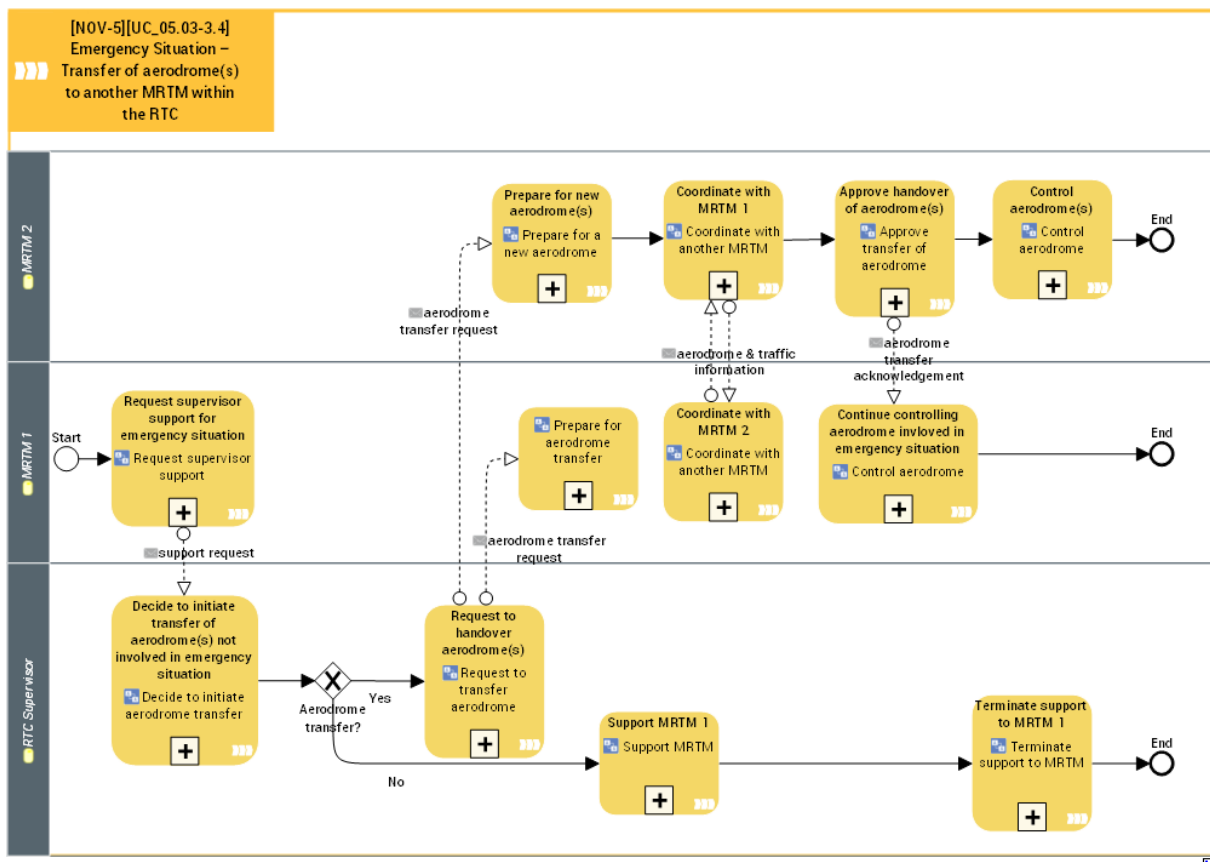


Figure 13 Use Case 3:4

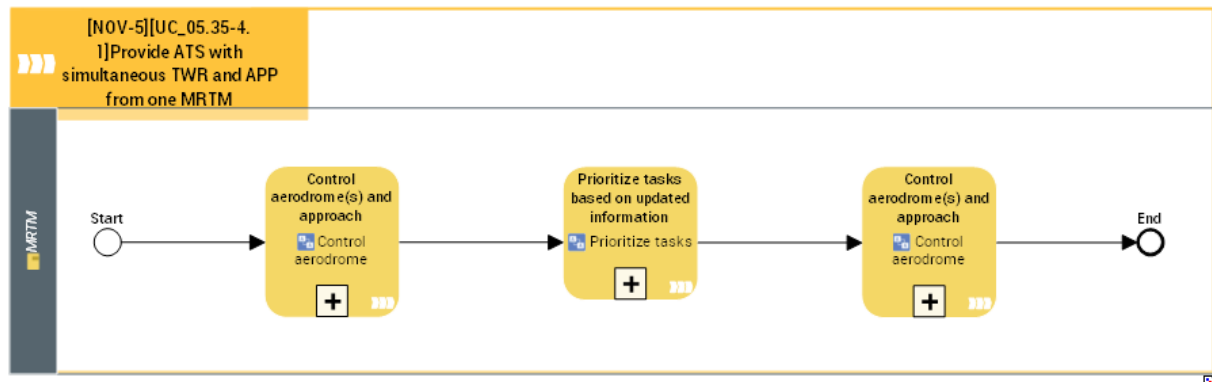


Figure 14 Use Case 4:1

B.2 Derivation of SRS for Normal Operations

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
<i>UC 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7, 1:8, 3:1, 3:2</i>			
Traffic Planning and synchronisation (coordination, arrival sequencing and metering, holding, handling request from AC - level and routing, manage trajectory)	<p>UC 1:1 Prioritize tasks based on updated information</p> <p>UC 1:2 Prioritize tasks including RPAS</p> <p>UC 1:8 Prioritize tasks with new information</p> <p>UC 4:1 <i>Prioritize tasks based on updated information</i></p> <p>Climb/Descend</p>	<p>SRS 001: MRTM shall enable coordination and transfer procedures with adjacent ATS unit concerning inbound/outbound traffic (including as necessary aircraft identification) for all aerodromes allocated to the same MRTM</p> <p>SRS 002: MRTM shall enable to manage inbound traffic (including as necessary management of the approach, visual acquisition, entry into traffic circuit and landing sequence) for all aerodromes allocated to the same MRTM</p> <p>SRS 003: MRTM shall enable to manage outbound traffic (including as necessary aircraft identification and departure sequence on the runway) for all aerodromes allocated to the same MRTM</p>	<p>SAC#1 (MAC ID B4)</p> <p>SAC#3 (MAC FAP B7)</p> <p>SAC#5 (MAC TMA B10)</p>
Traffic monitoring, separation provision, conflict	<p>UC 1:1, 1:2</p> <p>Control aerodrome(s)</p> <p>UC 1:4, 1:5, 1:6, 1:7</p>	<p>SRS 004: MRTM shall enable to separate traffic, with respect to other traffic, applying the corresponding separation minima to the airspace under control</p>	<p>SAC#1 (MAC ID B4, B4a)</p> <p>SAC#3 (MAC FAP B4, B4a, B5, B5a, B7, B8, B9, B9a, B10)</p>

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
detection and resolution in the vicinity of the aerodrome	<p>Check traffic situation in aerodrome n</p> <p>Prioritize requests</p> <p>Issue clearance priority n</p> <p>Follow up clearance priority n</p> <p>UC 4:1</p> <p><i>Control aerodrome(s) and approach</i></p> <p>Climb/Descend</p>	<p>responsibility (in the vicinity of the aerodrome) or allowing reduction in separation minima in the vicinity of the aerodrome for all aerodromes allocated to the same MRTM</p> <p>SRS 005: MRTM shall enable to separate traffic with respect to restricted areas on the airspace under control responsibility for all aerodromes allocated to the same MRTM</p> <p>SRS 006: MRTM shall enable to manage missed approaches situations (including detection of need for go-around, monitoring of involved aircraft and proposal for resolution) for all aerodromes allocated to the same MRTM</p>	SAC#6 (MAC TMA B6, B7, B8, B9)
ATC short term conflict detection and resolution in the vicinity of the aerodrome	<p>UC 1:1, 1:2</p> <p>Control aerodrome(s)</p> <p>UC 1:4, 1:5, 1:6, 1:7</p> <p>Check traffic situation in aerodrome n</p> <p>Prioritize requests</p> <p>Issue clearance priority n</p> <p>Follow up clearance priority n</p> <p>UC 4:1</p> <p><i>Control aerodrome(s) and approach</i></p> <p>Climb/Descend</p>	<p>SRS 007: MRTM shall enable the detection of conflicts or potential collisions between aircraft (within departing, within arriving and between both traffic) on the airspace under control responsibility for all aerodromes allocated to the same MRTM</p> <p>SRS 008: MRTM shall enable the detection of restricted areas infringements by aircraft in the airspace under control responsibility for all aerodromes allocated to the same MRTM</p> <p>SRS 009: MRTM shall enable the provision of ATC instructions to resolve conflicts/avoid collisions on the airspace under control responsibility for all aerodromes allocated to the same MRTM</p> <p>SRS 010: MRTM shall enable the provision of ATC instructions to resolve airspace infringements for all aerodromes allocated to the same MRTM</p>	<p>SAC#2 (MAC ID B3)</p> <p>SAC#4 (MAC FAP B3)</p> <p>SAC#7 (MAC TMA B4)</p>

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
Start-up, Push-back, Stand/Parking management	UC 1:1, 1:2 Control aerodrome(s) UC 1:3 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Surface-in, Surface-out, (Apron/Taxi-in/Taxi-out)	SRS 011: MRTM shall enable to identify departing AC on the stand for providing ATC service for all aerodromes allocated to the same MRTM SRS 012: MRTM shall enable start-up procedures for departing aircraft (including as appropriate the provision of necessary aerodrome information - operational and meteorological) for all aerodromes allocated to the same MRTM SRS 013: MRTM shall enable push-back and towing procedures for all aerodromes allocated to the same MRTM	SAC#13 (TWY-COL B3) SAC#14 (TWY-COL B2)
Tactical TWY Planning, TWY Routing	UC 1:1, 1:2 Control aerodrome(s) UC 1:3 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Surface-in, Surface-out, (Apron/Taxi-in/Taxi-out)	SRS 014: MRTM shall enable the provision of conflict-free routing and taxi instructions to aircraft in the manoeuvring area for all aerodromes allocated to the same MRTM SRS 015: MRTM shall enable the provision of taxi instructions to vehicles in the manoeuvring area for all aerodromes allocated to the same MRTM SRS 016: MRTM shall enable to support AC and vehicle movements in the manoeuvring area (through visual aids on the airport surface) for all aerodromes allocated to the same MRTM	SAC#12 (TWY-COL B4)
Traffic Monitoring on the manoeuvring area and TWY Conflict resolution	UC 1:1, 1:2 Control aerodrome(s) UC 1:3 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n	SRS 017: MRTM shall enable the detection of conflicting situations in the manoeuvring area (involving aircraft, vehicles, and obstacles) for all aerodromes allocated to the same MRTM SRS 018: MRTM shall enable the provision of taxi instructions (to aircraft and vehicles) to resolve conflicts and avoid potential	SAC#13 (TWY-COL B3)

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
	Surface-in, Surface-out, (Apron/Taxi-in/Taxi-out)	collisions in the manoeuvring area for all aerodromes allocated to the same MRTM	
ATC short term TWY conflict detection and resolution, ATC Taxiway Collision Avoidance	UC 1:1, 1:2 Control aerodrome(s) UC 1:3 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Surface-in, Surface-out, (Apron/Taxi-in/Taxi-out)	SRS 017: MRTM shall enable the detection of conflicting situations in the manoeuvring area (involving aircraft, vehicles, and obstacles) for all aerodromes allocated to the same MRTM SRS 018: MRTM shall enable the provision of taxi instructions (to aircraft and vehicles) to resolve conflicts and avoid potential collisions in the manoeuvring area for all aerodromes allocated to the same MRTM	SAC#14 (TWY-COL B2)
Runway Crossing management, Line-up/Take-off Management, Landing Management	UC 1:1, 1:2 Control aerodrome(s) UC 1:3, 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Surface-in, Surface-out, (Runway)	SRS 019: MRTM shall enable to manage runway entry for departing aircraft (this includes RWY status, occupancy, and correctness check before issuing line-up clearance) for all aerodromes allocated to the same MRTM SRS 020: MRTM shall enable to manage runway exit for arriving aircraft (this includes exit TWY status/occupancy check) for all aerodromes allocated to the same MRTM SRS 021: MRT shall enable to manage aircraft/vehicles runway crossing (this includes RWY status/occupancy/correctness check before issuing runway crossing clearance) for all aerodromes allocated to the same MRTM SRS 022: MRTM shall enable to support aircraft for take-off and landing operations (though visual-aids on the airport surface) for all aerodromes allocated to the same MRTM	SAC#16 (RWY-COL B5, B6, B7)

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
		<p>SRS 023: MRTM shall enable to carry out vehicle related tasks on the runway (inspections, etc.) for all aerodromes allocated to the same MRTM</p> <p>SRS 024: MRT shall enable to manage aircraft take-off (this includes RWY status, occupancy, and correctness check before issuing take-off clearance) for all aerodromes allocated to the same MRTM</p> <p>SRS 025: MRTM shall enable to manage aircraft landing (this includes RWY status, occupancy, and correctness check before issuing landing clearance) for all aerodromes allocated to the same MRTM</p>	
Runway Incursion Monitoring	<p>UC 1:1, 1:2 Control aerodrome(s)</p> <p>UC 1:3, 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n</p> <p>Surface-in, Surface-out, (Runway)</p>	<p>SRS 026: MRTM shall enable ATC detection and resolution of imminent runway incursions (AC, vehicle, animal, person incursions) for all aerodromes allocated to the same MRTM</p>	SAC#16 (RWY-COL B4A, B4B, B4C, B4D, B4E)
Traffic Monitoring on the RWY and RWY Conflict prevention	<p>UC 1:1, 1:2 Control aerodrome(s)</p> <p>UC 1:3, 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n</p> <p>Surface-in, Surface-out, (Runway)</p>	<p>SRS 027: MRTM shall enable ATC detection and resolution of runway incursions (AC, vehicle, animal, person incursions) for all aerodromes allocated to the same MRTM</p>	SAC#17 (RWY-COL B3A, B3B, B3C)

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
ATC short term RWY conflict detection and resolution, ATC Runway Collision Avoidance	UC 1:1, 1:2 Control aerodrome(s) UC 1:3, 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Surface-in, Surface-out, (Runway)	SRS 028: MRTM shall enable ATC detection and instructions provision to prevent or resolve runway collisions for all aerodromes allocated to the same MRTM	SAC#18 (RWY-COL B2)
Traffic monitoring, separation provision on final approach and initial departure	UC 1:1, 1:2 Control aerodrome(s) UC 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n UC 4:1 <i>Control aerodrome(s) and approach</i> Climb/Descend	SRS 029: MRTM shall enable to establish/maintain sufficient wake turbulence spacing between arriving and/or departing aircraft for all aerodromes allocated to the same MRTM)	SAC#10 (WAKE-ID B4) SAC#11 (WAKE-FAP B4, B5, B6, B7)
ATC short term conflict detection and resolution on final approach and initial departure	UC 1:1, 1:2 Control aerodrome(s) UC 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n UC 4:1 <i>Control aerodrome(s) and approach</i> Climb/Descend	SRS 030: MRTM shall enable ATC detection and instructions provision to prevent or resolve imminent wake encounters between arriving and/or departing aircraft for all aerodromes allocated to the same MRTM)	SAC#10 (WAKE-ID B2, B3) SAC#11 (WAKE-FAP B2, B3)

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
ATC trajectory management with respect to terrain	UC 1:1, 1:2 Control aerodrome(s) UC 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n UC 4:1 <i>Control aerodrome(s) and approach</i> Climb/Descend	SRS 031: MRTM shall enable the detection of flight towards terrain situations for all aerodromes allocated to the same MRTM SRS 032: MRTM shall enable to warn/support pilot on Controlled Flight Towards Terrain situations for all aerodromes allocated to the same MRTM	SAC#8, SAC#9 (CFIT B3, B7)
Route/Procedure design and publication	Climb/Descend	n/a	SAC#8, SAC#9 (CFIT B8)
Managing RWY conditions with respect to weather	UC 1:1, 1:2 Control aerodrome(s) UC 1:3, 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Climb/Descend	SRS 033: MRTM shall enable to support taking off and landing operations taking account of weather conditions affecting arriving/departing aircraft (applying corresponding procedures and informing pilots as necessary) for all aerodromes allocated to the same MRTM SRS 034: MRTM shall enable to support landing and taking off aircraft taking account of runway surface conditions and potential foreign objects debris - FOD (applying corresponding procedures and informing pilots as necessary) for all aerodromes allocated to the same MRTM	SAC#19, SAC#20 (RWY EXC – Managing RWY conditions with respect to weather; Managing RWY suitability)
Managing RWY suitability	UC 1:1, 1:2 Control aerodrome(s) UC 1:3, 1:4, 1:5, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n	SRS 034: MRTM shall enable to support landing and taking off aircraft taking account of runway surface conditions and potential foreign objects debris - FOD (applying corresponding procedures and informing pilots	SAC#19, SAC#20 (RWY EXC – Managing RWY suitability)

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
	Follow up clearance priority n Climb/Descend	as necessary) for all aerodromes allocated to the same MRTM	
Managing unstable approaches	UC 1:1, 1:2 Control aerodrome(s) UC 1:4, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Descend / Landing	SRS 035: MRTM shall enable to support arriving aircraft on final approach (providing relevant information and instructions as necessary) for all aerodromes allocated to the same MRTM	SAC#19, SAC#20 (RWY EXC – Managing stabilisation in final approach)
ATC prevention of / recovery from other events potentially leading to other landing related accidents	UC 1:1, 1:2 Control aerodrome(s) UC 1:4, 1:6, 1:7 Check traffic situation in aerodrome n Prioritize requests Issue clearance priority n Follow up clearance priority n Descend / Landing	SRS 036: MRTM shall enable to provide “navigation” support to aircraft during landing operations (using available non-visual navigation aids as necessary) for all aerodromes allocated to the same MRTM SRS 037: MRTM shall enable the detection of potential intrusions inside landing-aid protection area for all aerodromes allocated to the same MRTM	SAC#19, SAC#20 (there are no specific AIM barriers)
Ensure availability/continuity of the ATC service	UC 1:1, 1:2 Control aerodrome(s)	SRS 038: MRTM shall enable to assess the operational environmental conditions on each corresponding aerodrome in order to provide appropriate remote ATC service (for example “visualisation” related conditions: daylight, dawn, darkness, dusk, CAVOK and low visual conditions) SRS 039: MRTM shall enable the provision of appropriate and seamless ATC services in the several operational environmental conditions on each corresponding aerodrome (e.g.	All SACs and relevant models are affected

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
		<p>daylight, dawn, darkness, dusk, CAVOK and low visual conditions)</p> <p>SRS 040: Prior to remotely providing ATC services, MRTM capabilities shall be assessed/verified for all aerodromes allocated to the same MRTM</p> <p>SRS 041: Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware / notified when the remote provision of ATC service is initiated in each aerodrome (as per planned schedules)</p> <p>SRS 042: Remote provision of ATC service shall appropriately (safely) be stopped for planned terminations for one or more aerodromes while continuing the service provision in the other/s if needed</p> <p>SRS 043: Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware / notified when the remote provision of ATC service is terminated in one or more aerodromes (as per planned schedules)</p>	
ATCO pre-tactical and tactical demand and capacity balancing	<p>UC 1:8 Prioritize tasks with new information</p> <p>UC3:1 MRTM1 – Prepare for aerodrome transfer MRTM2 – Prepare for a new aerodrome Coordination with another MRTM MRTM2 – Approve transfer of aerodrome</p>	<p>SRS 044: MRTM shall enable to prioritize tasks based on a short term planning tool</p> <p>SRS 045: MRTM shall enable to safely split aerodromes in charge (transferring it/them to another MRTM in the same MRTC)</p> <p>SRS 046: MRTM shall enable to safely merge an aerodrome to the MRTM (transferring from another MRTM in the same MRTC)</p>	All SACs and relevant models are affected

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
		<p>SRS 047: MRTM shall enable to coordinate with other MRTMs within the same MRTC</p> <p>SRS 048: MRTM shall enable to the receiving ATCO to approve the transfer of an aerodrome</p> <p>SRS 086: MRTM shall enable to safely execute flexible allocation of aerodromes (HUD and HDD) within the same MRTM</p>	
RTC SUP pre-tactical and tactical management of resources	<p>UC3:2 Plan RTC Follow up RTC planning</p>	<p>SRS 049: The MRTM cluster of aerodromes is planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes</p> <p>SRS 050: RTC SUP position shall enable tactical management of ATC resources (ATCO) ensuring safe service to all aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events.</p>	All SACs and relevant models are affected
RTC SUP pre-tactical and tactical demand and capacity balancing	<p>UC3:1 Check traffic situation Decide to initiate aerodrome transfer Request to transfer aerodrome UC3:2 Plan RTC Follow up RTC planning</p>	<p>SRS 051: RTC SUP position shall enable to continuously check that which aerodromes are linked to the MRTMs within the MRTC</p> <p>SRS 052: RTC SUP position shall enable to continuously check traffic situation and traffic demand for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC</p> <p>SRS 053: RTC SUP position shall enable to continuously check weather forecast for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC</p> <p>SRS 054: RTC SUP position shall enable to continuously check any</p>	All SACs and relevant models are affected

ATS Operational Service	EATMA Use Case- Activity or Flow and/or Phase of Flight	Derived SRS	Related SAC# (AIM Barrier or Precursor)
		<p>other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC</p> <p>SRS 055: RTC SUP position shall access contingency plan and ERP information for all MRTMs within the MRTC</p> <p>SRS 056: RTC SUP position shall enable to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another</p> <p>SRS 057: RTC SUP position fails to coordinate with the Technical SUP position</p> <p>SRS 058: RTC SUP position fails to coordinate with all relevant external parties</p>	

Table 16: Derivation of SRS for Normal Operations driven by EATMA Process models

Appendix C Risk analysis of Abnormal conditions and derivation of SRS (functionality&performance)

Ref	Abnormal Conditions	Operational Effect	Mitigation of Effects / [SRS xxx]
ABN 1	Unexpected/unplanned flight in airspace	This may induce conflict with other traffic within the same area, as it overloads ATCOs and/or unexpectedly changes their way of managing traffic	MRTM shall enable, as in current operations, the detection of unexpected flights in the area of responsibility where ATC services are being provided for all aerodromes allocated to the same MRTM [SRS-059]
ABN 2	Aircraft with emergency (gear problem, brakes overheating - fire on the tires, tail strike, bird strike, etc.).	All these emergencies may induce landing or take-off accidents	<p>ATCO must be able to potentially detect those situations [SRS-057] and provide appropriate support for solving them [SRS-061]</p> <p>ATCO must be able to execute split/merge process in case of an abnormal situation [SRS-045, SRS-046, SRS-047, SRS-048]</p> <p>OPS SUP must be able to get sufficient information about those situations [SRS-054] and provide appropriate support for solving them [SRS-050, SRS-051, SRS-052, SRS-053, SRS-054, SRS-055, SRS-056, SRS-062]</p> <p>Staffing level of the MRTM and the number of available MRTMs shall be adequate to take over one or more aerodromes from the concerned MRTM [SRS-063, SRS-064]</p>

Ref	Abnormal Conditions	Operational Effect	Mitigation of Effects / [SRS xxx]
ABN 3	Crash on an airport's vicinity	In this case the objective is to trigger the corresponding services for rescue as quick as possible	<p>ATCO must be able to detect the loss of an aircraft on the vicinity of the aerodrome/s. Then they must be able to trigger appropriate rescue procedure, contacting relevant personnel and units and providing available information [SRS-065]</p> <p>ATCO must be able to execute split/merge process in case of an abnormal situation [SRS-045, SRS-046, SRS-047, SRS-048]</p> <p>OPS SUP must be able to get sufficient information about the loss of an aircraft on the vicinity of the aerodrome/s. Then they must be able to provide appropriate support to the MRTM [SRS-050, SRS-051, SRS-052, SRS-053, SRS-054, SRS-055, SRS-056, SRS-062]</p> <p>Staffing level of the MRTC and the number of available MRTMs shall be adequate to take over one or more aerodromes from the concerned MRTM [SRS-063, SRS-064]</p>
ABN 4	Fire on one or more aerodromes	Operations on the aerodrome/s may need to be stopped as conditions may not be safe for aircraft, passengers and airport personnel.	<p>ATCO must be informed about the situation and if necessary interrupt arrival and departure operations, or they may even terminate provision of ATC service in the area [SRS-066]</p> <p>ATCO must be able to execute split/merge process in case of an abnormal situation [SRS-045, SRS-046, SRS-047, SRS-048]</p> <p>OPS SUP must be informed about the situation [SRS-054] and provide appropriate support for solving them [SRS-056]</p> <p>Staffing level of the MRTC and the number of available MRTMs shall be adequate to take over one or more aerodromes from the concerned MRTM [SRS-063, SRS-064]</p> <p>Airspace users are also to be informed [SRS-068, SRS-069]</p>

Ref	Abnormal Conditions	Operational Effect	Mitigation of Effects / [SRS xxx]
ABN 5	Unplanned closure of an airport, closing ATC service in one or more aerodromes	<p>Operations on the aerodrome shall be stopped as conditions are not safe for aircraft, passengers and airport personnel.</p> <p>(In case there is a situation significantly affecting the safety of the operations in a corresponding aerodrome, the airport operations manager may decide to close the aerodrome hence stopping ATC services.)</p>	<p>ATCO must be informed about the situation in the aerodrome/s in order to apply appropriate termination procedure [SRS-066]</p> <p>OPS SUP must be informed about the situation [SRS-054] and provide appropriate support for solving them [SRS-056]</p> <p>Airspace users are also to be informed [SRS-068, SRS-069]</p>
ABN 6	Unplanned request for opening of an airport	An unplanned opening might cause ATCO overload in the affected MRTM. Opening might be delayed to reduce this effect.	<p>OPS SUP must be informed about the situation [SRS-054] and provide appropriate support for solving them [SRS-056]</p> <p>Airspace users are also to be informed [SRS-068, SRS-069]</p> <p>Staffing level of the MRTC and the number of available MRTMs shall be adequate to take over one or more aerodromes [SRS-063, SRS-064]</p>
ABN 7	(Unplanned) ATCO overload in one or more MRTM of the RTC, ATCO becomes incapable	<p>Overload might decrease ATCO's ability to provide safe and efficient ATC service in one or more aerodromes</p> <p>In an extreme case, ATCO might become incapable to provide ATC service in all aerodromes of his/her MRTM</p>	<p>OPS SUP must be informed about the traffic situation [SRS-052, SRS-054] and provide appropriate support for solving them [SRS-056]</p> <p>ATCO must be informed about the situation in the aerodrome/s in order to apply appropriate transfer or termination procedure [SRS-045, SRS-046, SRS-047, SRS-048, SRS-066]</p> <p>Staffing level of the MRTC and the number of available MRTMs shall be adequate to take over one or more aerodromes from the concerned MRTM [SRS-063, SRS-064]</p>

Table 17: Risk analysis for Abnormal conditions of operation

Appendix D Risk analysis addressing internal functional system failures and derivation of SRS

This appendix presents the risk analysis done at the level of the ATS service specification, including operational hazards identification and analysis in view of deriving additional SRS.

D.1 HAZID workshop

The outcomes from the preliminary safety impact assessment included in Appendix A were used as input for the HAZID workshop. The HAZID workshop was prepared and hazards were identified and analysed as per Guidance G of the Safety Reference Material and the relevant SAF-GUI available in STELLAR.

The HAZID workshop took place within the constraints of the HP and Safety workshop on the 8th and 9th of June, in ENAV premises, Naples. Consolidated results of the workshop are listed in Table 18, while the list of participants can be found in Table 19.

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
The split & merge process between two MRTMs fails - transferring aerodrome(s) to another MRTM in the same MRTC in not possible	Failure of the MRTM-MRTM interface Software component error	Potential ATCO overload	SRD_candidate_01 An assistant (ATCO, OPS SUP) should be available to support the work of the ATCO in the MRTM (if feasible in Voice Communication System level) SRD_candidate_02 Contingency plan shall be in place - if takeover is critical, capacity reduction should be applied SRD_candidate_03 A spare MRTM should be available SRD_candidate_04 The ATCO shall be alerted if split is not possible due to technical reasons (if it is an already known issue)	OH 45: MRTM fails to execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4
The split & merge process between two MRTMs fails - transferring aerodrome(s) to another MRTM in the same MRTC is executed inadequately	Failure of the MRTM-MRTM interface Software component error	The receiving MRTM does not have all necessary systems/information to provide ATC service at the transferred aerodrome (lack of visual surveillance information, A/G communication, G/G communication, air/ground surveillance, EFS system, AGL control, MET information). ATC service is degraded, or not even possible, seriously decreased ATCO situational awareness.	SRD_candidate_05 The receiving MRTM should not take over control from the transferring MRTM if any critical system is not available SRD_candidate_06 Contingency plan shall be in place - ATC service should be restricted/ceased SRD_candidate_03 A spare MRTM should be available	OH 46: MRTM fails to adequately execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) Severity: RWY-SC3, TWY-SC4, MAC-FA-SC3

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
The split & merge process between two MRTMs fails - transferring aerodrome(s) to another MRTM is executed inadequately, control of one or more critical system is not available neither from the transferring, nor from the receiving MRTMs	Failure of the MRTM-MRTM interface Software component error	In theory, if the transfer of control is executed incorrectly, some systems might not be used neither from the transferring, nor from the receiving MRTM, which decreases the capacity to provide safe ATC service, and can seriously decrease the situational awareness of the concerned ATCOs.	SRD_candidate_05 The receiving MRTM should not take over control from the transferring MRTM if any critical system is not available SRD_candidate_06 Contingency plan shall be in place - ATC service should be restricted/ceased SRD_candidate_03 A spare MRTM should be available	OH 46: MRTM fails to adequately execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) Severity: RWY-SC2, TWY-SC3, MAC-FA-SC3
The split & merge process between two MRTMs fails - transferring aerodrome(s) to another MRTM is executed inadequately, control of one or more critical system is available from both of the transferring and receiving MRTMs	Failure of the MRTM-MRTM interface Software component error	In theory, if the transfer of control is executed incorrectly, some systems might be used from both of the transferring and receiving MRTMs, which decreases the capacity to provide safe ATC service, and can seriously decrease the situational awareness of the concerned ATCOs.	SRD_candidate_07 The systems of each aerodrome should be accessible for input only from one MRTM at a time. SRD_candidate_06 Contingency plan shall be in place - ATC service should be restricted/ceased SRD_candidate_03 A spare MRTM should be available	OH 46: MRTM fails to adequately execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) Severity: RWY-SC3, TWY-SC4, MAC-FA-SC3

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
Unintended split & merge process - transfer of aerodrome(s) to another MRTM is executed without the acceptance of the transferring and/or receiving ATCO	Failure of the MRTM-MRTM interface Software component error	The receiving MRTM is not prepared to take over control of the aerodrome(s), which can seriously decrease the situational awareness of the concerned ATCOs.	SRD_candidate_08 The system shall not execute split and merge process without the receiving ATCO's indication SRD_candidate_09 Split and merge indication on the HMI should be intuitive enough to avoid unintentional or incidental split and merge indication	OH 46: MRTM fails to adequately execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) OH 48: MRTM fails to enable to the transferring and/or the receiving ATCO to approve the transfer of an aerodrome Severity: RWY-SC3, TWY-SC4, MAC-FA-SC3
MRTM fails to enable coordination with other MRTMs within the same MRTC to support safe transition of an aerodrome	Failure of the A/G communication system (internal coordination)	Alternative ways of coordination should be used, which can cause increased workload for the ATCOs	SRD_candidate_10 Backup coordination system should be available, or verbal coordination should be used (if possible) SRD_candidate_11 OPS SUP should assist in great MRTCs, if other means of coordination are not available	OH 47: MRTM fails to enable coordination with other MRTMs within the same MRTC Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4
MRTM fails to enable to the receiving ATCO to present all relevant information of an aerodrome in look only mode before approve the transfer	Failure of the MRTM-MRTM interface Software component error	The preparation of the ATCO at the receiving MRTM is more complex (or not fully possible), which can increase workload, and decrease situational awareness	SRD_candidate_05 The receiving MRTM should not take over control from the transferring MRTM if any critical system is not available	OH 49: MRTM fails to enable to the receiving ATCO to present all relevant information of an aerodrome in look only mode before approve the transfer Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
The MRTM cluster of aerodromes is not planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes	Failure of the OPS SUP tool Inadequate OPS SUP working procedures Human error	Potential ATCO overload	SRD_candidate_12 All relevant factors shall be evaluated by the OPS SUP when the MRTM cluster of aerodromes is planned SRD_candidate_13 All relevant information shall be available for the OPS SUP when the MRTM cluster of aerodromes is planned	OH 50: The MRTM cluster of aerodromes is not planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4
RTC SUP position fails to enable tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Alternative sources of information should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 51: RTC SUP position fails to enable tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
RTC SUP position provides corrupted information to support tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Situational awareness of the OPS SUPs might decrease Inadequate planning might cause ATCO overload	SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 52: RTC SUP position provides corrupted information to support tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4
RTC SUP position fails to continuously check that which aerodromes are linked to the MRTMs within the MRTC	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Alternative sources of information should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 53: RTC SUP position fails to continuously check that which aerodromes are linked to the MRTMs within the MRTC No immediate safety effect

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
RTC SUP position fails to continuously check traffic situation and traffic demand for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Alternative sources of information should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 54: RTC SUP position fails to continuously check traffic situation and traffic demand for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC No immediate safety effect
RTC SUP position fails to continuously check weather forecast for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Alternative sources of information should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 55: RTC SUP position fails to continuously check weather forecast for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC No immediate safety effect

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
RTC SUP position fails to continuously check any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Alternative sources of information should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 56: RTC SUP position fails to continuously check any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC No immediate safety effect
RTC SUP position fails to access contingency plan and Emergency Response Plan information for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Alternative sources of information should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_16 Alternative source of contingency plans and ERPs should be available in OPS SUP CWP SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs	OH 57: RTC SUP position fails to access contingency plan and ERP information for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
RTC SUP position fails to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another	Failure of the A/G communication system (internal coordination)	Alternative ways of coordination should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_16 OPS SUP shall be able to coordinate with the ATCOs in an alternative way (verbal coordination, backup system) SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 58: RTC SUP position fails to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4
RTC SUP position fails to coordinate with the Technical SUP position	Failure of the A/G communication system (internal coordination)	Alternative ways of coordination should be used, which can cause increased workload for the OPS SUPs	SRD_candidate_17 OPS SUP shall be able to coordinate with the TECH SUP in an alternative way (verbal coordination, backup system) SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 59: RTC SUP position fails to coordinate with the Technical SUP position No immediate safety effect
RTC SUP position fails to coordinate with all relevant external parties	Failure of the A/G communication system (external coordination)	Alternative ways of coordination should be used, which can cause increased workload for the OPS SUPs	SRD_candidate_17 OPS SUP shall be able to coordinate with all relevant external parties in an alternative way (backup system) SRD_candidate_15 Contingency plan shall be in place SRD_candidate_03 A spare MRTM should be available	OH 60: RTC SUP position fails to coordinate with all relevant external parties No immediate safety effect

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
RTC SUP position fails to access visual surveillance, air surveillance, EFS data, or communication of any of the MRTMs within the ATC	Failure of the OPS SUP tool Failure of the OPS SUP CWP interface	Alternative sources of information should be used, which can cause increased workload for the OPS SUPs Inadequate planning might cause ATCO overload	SRD_candidate_14 OPS SUP shall directly gather information from the ATCOs SRD_candidate_03 A spare MRTM should be available	OH 61: RTC SUP position fails to access visual surveillance, air surveillance, EFS data, or communication of any of the MRTMs within the ATC No immediate safety effect
MRTM fails to support the ATCO in flexible allocation of aerodromes (HUD and HDD) within the same MRTM (not available)	Failure of the MRTM interface Software component error	Decreased ATCO situational awareness	SRD_candidate_06 Contingency plan shall be in place - ATC service should be restricted/ceased SRD_candidate_03 A spare MRTM should be available SRD_candidate_01 An assistant (ATCO, OPS SUP) should be available to support the work of the ATCO in the MRTM (if feasible in VCS level)	OH 62: MRTM fails to provide flexible allocation of aerodromes within the same MRTM Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4
MRTM fails to support the ATCO in flexible allocation of aerodromes (HUD and HDD) within the same MRTM (partially available - with some restrictions)	Failure of the MRTM interface Software component error	Decreased ATCO situational awareness	SRD_candidate_06 Contingency plan shall be in place - ATC service should be restricted/ceased SRD_candidate_03 A spare MRTM should be available SRD_candidate_01 An assistant (ATCO, OPS SUP) should be available to support the work of the ATCO in the MRTM (if feasible in VCS level)	OH 62: MRTM fails to provide flexible allocation of aerodromes within the same MRTM Severity: RWY-SC4, TWY-SC5, MAC-FA-SC4

Use Case / Operational failure mode	Example of causes & preventive mitigations	Operational effect	Mitigations protecting against propagation of effects	Operational hazard & Severity
MRTM fails to support the ATCO in flexible allocation of aerodromes (HUD and HDD) within the same MRTM (HUD and HDD layouts are not changed consistently)	Failure of the MRTM interface Software component error	Seriously decreased ATCO situational awareness	<p>SRD_candidate_18 Different indication/colour coding shall be applied for the different aerodromes on HUD and HDD to clearly indicate inconsistency</p> <p>SRD_candidate_19 Contingency plan shall be in place - LVC rules should be applied (with turning off the screens)</p> <p>SRD_candidate_03 A spare MRTM should be available</p>	<p>OH 63: MRTM fails to adequately execute flexible allocation of aerodromes within the same MRTM</p> <p>Severity: RWY-SC2, TWY-SC3, MAC-FA-SC3</p>

Table 18. Full HAZID working table

D.2 HAZID participation list

Name	Surname	Company
Karina	Salmila	AVINOR
Lars Audun	Ragnvaldjord	AVINOR
Tristan	Blanc-Brude	AVINOR
Aurora Giovanna	Simonetti	DEEP BLUE
Michela	Terenzi	DEEP BLUE
Laura Louise	Moens	DEEP BLUE
Rainer	Kaufhold	DFS
Holger	van de Sand	DFS
Manuel	Hedermann	DFS

Name	Surname	Company
Leo	Materne	DLR
Giuseppe	De Falco	ENAV
Giuseppe	Perricone	ENAV
Pasquale	Amato	ENAV
Fabrizio	Buzzi	ENAV
Alberto	Lorenzoni	ENAV
Fanni	Kling	HungaroControl
Gábor	Draschitz	HungaroControl
Máté	Lakatos	HungaroControl
Zoltán László	Molnár	HungaroControl
Györgyi	Balogh	INDRA
Martin	Hasselknippe	INDRA
Lindsey	Martenez Hermosilla	LFV
Susanne	Widell	LFV
Niko	Vujina	LFV
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Table 19. HAZID participants

Appendix E Designing the Solution functional system for normal conditions

E.1 Deriving SRD from the SRS

Table 20 shows how the Safety Requirements at ATS Service level (SRS) for normal conditions of operation derived in section 4.2 map onto the related elements of the Design Model (functional system components or interactions/data flows) and derive Safety Requirements at Design level (SRD) (functionality and performance) for normal conditions of operation.

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 001: MRTM shall enable coordination and transfer procedures with adjacent ATS unit concerning inbound/outbound traffic (including as necessary aircraft identification) for all aerodromes allocated to the same MRTM	SRD-01 SRD-02 SRD-03 SRD-04 SRD-16 SRD-17 SRD-18 SRD-31	Flight Plan system Flight Plan system G-G Comm G-G Comm ATCO ATCO ATCO Surveillance data
SRS 002: MRTM shall enable to manage inbound traffic (including as necessary management of the approach, visual acquisition, entry into traffic circuit and landing sequence) for all aerodromes allocated to the same MRTM	SRD-01 SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42 SRD-45 SRD-47	Flight Plan system A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system Local MET system AI data system

¹ iSRD for the initial design or rSRD for the refined design

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 003: MRTM shall enable to manage outbound traffic (including as necessary aircraft identification and departure sequence on the runway) for all aerodromes allocated to the same MRTM	SRD-01 SRD-16 SRD-17 SRD-18 SRD-05 SRD-06 SRD-07 SRD-08 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42 SRD-45 SRD-47	Flight Plan system ATCO ATCO ATCO A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system Local MET system AI data system
SRS 004: MRTM shall enable to separate traffic, with respect to other traffic, applying the corresponding separation minima to the airspace under control responsibility (in the vicinity of the aerodrome) or allowing reduction in separation minima in the vicinity of the aerodrome for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-05 SRD-06 SRD-07 SRD-08 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42 SRD-115 SRD-116 SRD-117	ATCO ATCO ATCO A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system MRTM MRTM MRTM
SRS 005: MRTM shall enable to separate traffic with respect to restricted areas on the airspace under control responsibility for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-05 SRD-06 SRD-07 SRD-08 SRD-31 SRD-32 SRD-33 SRD-47	ATCO ATCO ATCO A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surveillance data Visualisation system Visualisation system Visualisation system AI data system

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 006: MRTM shall enable to manage missed approaches situations (including detection of need for go-around, monitoring of involved aircraft and proposal for resolution) for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42	ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system
SRS 007: MRTM shall enable the detection of conflicts or potential collisions between aircraft (within departing, within arriving and between both traffic) on the airspace under control responsibility for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42	ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system
SRS 008: MRTM shall enable the detection of restricted areas infringements by aircraft in the airspace under control responsibility for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42 SRD-47	ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system AI data system
SRS 009: MRTM shall enable the provision of ATC instructions to resolve conflicts/avoid collisions on the airspace under control responsibility for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 010: MRTM shall enable the provision of ATC instructions to resolve airspace infringements for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system
SRS 011: RTM shall enable to identify departing AC on the stand for providing ATC service for all aerodromes allocated to the same MRTM	SRD-01 SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-35	Flight Plan system A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system
SRS 012: MRTM shall enable start-up procedures for departing aircraft (including as appropriate the provision of necessary aerodrome information - operational and meteorological) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-12 SRD-16 SRD-17 SRD-18 SRD-35 SRD-45	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Airport Personnel) ATCO ATCO ATCO Visualisation system Local MET system
SRS 013: MRTM shall enable push-back and towing procedures for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-12 SRD-16 SRD-17 SRD-18 SRD-35	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Airport Personnel) ATCO ATCO ATCO Visualisation system

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 014: MRTM shall enable the provision of conflict-free routing and taxi instructions to aircraft in the manoeuvring area for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-35 SRD-36 SRD-37	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system Visualisation system Visualisation system
SRS 015: MRTM shall enable the provision of taxi instructions to vehicles in the manoeuvring area for all aerodromes allocated to the same MRTM	SRD-09 SRD-10 SRD-11 SRD-16 SRD-17 SRD-18 SRD-35 SRD-36 SRD-37	Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system Visualisation system Visualisation system
SRS 016: MRTM shall enable to support AC and vehicle movements in the manoeuvring area (through visual aids on the airport surface) for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-43	ATCO ATCO ATCO Visual Navigation Aids system
SRS 017: MRTM shall enable the detection of conflicting situations in the manoeuvring area (involving aircraft, vehicles, and obstacles) for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-35 SRD-36 SRD-37 SRD-114 SRD-116 SRD-117	ATCO ATCO ATCO Visualisation system Visualisation system Visualisation system MRTM MRTM MRTM

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 018: MRTM shall enable the provision of taxi instructions (to aircraft and vehicles) to resolve conflicts and avoid potential collisions in the manoeuvring area for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-09 SRD-10 SRD-11 SRD-16 SRD-17 SRD-18 SRD-35 SRD-36 SRD-37	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system Visualisation system Visualisation system
SRS 019: MRTM shall enable to manage runway entry for departing aircraft (this includes RWY status, occupancy, and correctness check before issuing line-up clearance) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-35	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system
SRS 020: MRTM shall enable to manage runway exit for arriving aircraft (this includes exit TWY status/occupancy check) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-35	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system
SRS 021: MRT shall enable to manage aircraft/vehicles runway crossing (this includes RWY status/occupancy/correctness check before issuing runway crossing clearance) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-09 SRD-10 SRD-11 SRD-16 SRD-17 SRD-18 SRD-35	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 022: MRTM shall enable to support aircraft for take-off and landing operations (though visual-aids on the airport surface) for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-43	ATCO ATCO ATCO Visual Navigation Aids system
SRS 023: MRTM shall enable to carry out vehicle related tasks on the runway (inspections, etc.) for all aerodromes allocated to the same MRTM	SRD-09 SRD-10 SRD-11 SRD-16 SRD-17 SRD-18	Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) ATCO ATCO ATCO
SRS 024: MRT shall enable to manage aircraft take-off (this includes RWY status, occupancy, and correctness check before issuing take-off clearance) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-35	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system
SRS 025: MRTM shall enable to manage aircraft landing (this includes RWY status, occupancy, and correctness check before issuing landing clearance) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-35	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system
SRS 026: MRTM shall enable ATC detection and resolution of imminent runway incursions (AC, vehicle, animal, person incursions) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-09 SRD-10 SRD-11 SRD-16 SRD-17 SRD-18 SRD-31 SRD-37 SRD-38	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) ATCO ATCO ATCO Ground surveillance Visualisation system Visualisation system

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 027: MRTM shall enable ATC detection and resolution of runway incursions (AC, vehicle, animal, person incursions) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-09 SRD-10 SRD-11 SRD-16 SRD-17 SRD-18 SRD-31 SRD-37 SRD-38	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) ATCO ATCO ATCO Ground surveillance Visualisation system Visualisation system
SRS 028: MRTM shall enable ATC detection and instructions provision to prevent or resolve runway collisions for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-09 SRD-10 SRD-11 SRD-16 SRD-17 SRD-18 SRD-35	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) ATCO ATCO ATCO Visualisation system
SRS 029: MRTM shall enable to establish/maintain sufficient wake turbulence spacing between arriving and/or departing aircraft for all aerodromes allocated to the same MRTM)	SRD-01 SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42	Flight Plan system A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Air surveillance Visualisation system Visualisation system Visualisation system Visualisation system

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 030: MRTM shall enable ATC detection and instructions provision to prevent or resolve imminent wake encounters between arriving and/or departing aircraft for all aerodromes allocated to the same MRTM)	SRD-01 SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42	Flight Plan system A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Air surveillance Visualisation system Visualisation system Visualisation system Visualisation system
SRS 031: MRTM shall enable the detection of flight towards terrain situations for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-34 SRD-41 SRD-42	ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system
SRS 032: MRTM shall enable to warn/support pilot on Controlled Flight Towards Terrain situations for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-41 SRD-42	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system
SRS 033: MRTM shall enable to support taking off and landing operations taking account of weather conditions affecting arriving/departing aircraft (applying corresponding procedures and informing pilots as necessary) for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-38 SRD-45 SRD-16 SRD-17 SRD-18	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Visualisation system Local MET system ATCO ATCO ATCO

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 034: MRTM shall enable to support landing and taking off aircraft taking account of runway surface conditions and potential foreign objects debris - FOD (applying corresponding procedures and informing pilots as necessary) for all aerodromes allocated to the same MRTM	SRD-13 SRD-35 SRD-39 SRD-16 SRD-17 SRD-18	Surf-G COMM (Airport Personnel) Visualisation system Visualisation system ATCO ATCO ATCO
SRS 035: MRTM shall enable to support arriving aircraft on final approach (providing relevant information and instructions as necessary) for all aerodromes allocated to the same MRTM	SRD-35 SRD-16 SRD-17 SRD-18	Visualisation system ATCO ATCO ATCO
SRS 036: MRTM shall enable to provide “navigation” support to aircraft during landing operations (using available non-visual navigation aids as necessary) for all aerodromes allocated to the same MRTM	SRD-44 SRD-16 SRD-17 SRD-18	Non-Visual Navigation Aids system ATCO ATCO ATCO
SRS 037: MRTM shall enable the detection of potential intrusions inside landing-aid protection area for all aerodromes allocated to the same MRTM	SRD-05 SRD-06 SRD-07 SRD-08 SRD-09 SRD-10 SRD-11 SRD-35 SRD-16 SRD-17 SRD-18	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Surf-G COMM (Vehicles) Visualisation system ATCO ATCO ATCO
SRS 038: MRTM shall enable to assess the operational environmental conditions on each corresponding aerodrome in order to provide appropriate remote ATC service (for example “visualisation” related conditions: daylight, dawn, darkness, dusk, CAVOK and low visual conditions)	SRD-38 SRD-45 SRD-16 SRD-17 SRD-18	Visualisation system Local MET system ATCO ATCO ATCO

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 039: MRTM shall enable the provision of appropriate and seamless ATC services in the several operational environmental conditions on each corresponding aerodrome (e.g. daylight, dawn, darkness, dusk, CAVOK and low visual conditions)	SRD-16 SRD-17 SRD-18 SRD-40 SRD-19 SRD-20 SRD-80	ATCO ATCO ATCO Visualisation system ATCO ATCO ATCO, RTC supervisor
SRS 040: Prior to remotely providing ATC services, MRTM capabilities shall be assessed/verified for all aerodromes allocated to the same MRTM	SRD-27 SRD-28 SRD-29 SRD-46	Supervisor Supervisor Supervisor Local NET/DCB Tools
SRS 041: Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware / notified when the remote provision of ATC service is initiated in each aerodrome (as per planned schedules)	SRD-21	ATCO
SRS 042: Remote provision of ATC service shall appropriately (safely) be stopped for planned terminations for one or more aerodromes while continuing the service provision in the other/s if needed	SRD-14 SRD-15 SRD-22 SRD-48	Surf-G COMM (Airport Personnel) Surf-G COMM (Airport Personnel) ATCO AI data system
SRS 043: Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware / notified when the remote provision of ATC service is terminated in one or more aerodromes (as per planned schedules)	SRD-23	ATCO
SRS 044: MRTM shall enable to prioritize tasks based on a short-term planning tool	SRD-74 SRD-75	Short term traffic forecast tool ATCO

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 045: MRTM shall enable to safely split aerodromes in charge (transferring it/them to another MRTM in the same MRTC)	SRD-20 SRD-14 SRD-15 SRD-22 SRD-23 SRD-24 SRD-48 SRD-77 SRD-79 SRD-80 SRD-81 SRD-96	ATCO Surf-G COMM (Airport Personnel) Surf-G COMM (Airport Personnel) ATCO ATCO Surf-G COMM (Airspace Users) AI data system RTC unit RTC unit ATCO RTC unit RTC unit
SRS 046: MRTM shall enable to safely merge an aerodrome to the MRTM (transferring from another MRTM in the same MRTC)	SRD-20 SRD-78 SRD-79 SRD-80 SRD-81 SRD-96	ATCO RTC unit RTC unit ATCO RTC unit RTC unit
SRS 047: MRTM shall enable to coordinate with other MRTMs within the same MRTC	SRD-76	Surf-G COMM (MRTMs)
SRS 048: MRTM shall enable to the receiving ATCO to approve the transfer of an aerodrome	SRD-78 SRD-80	RTC unit ATCO
SRS 049: The MRTM cluster of aerodromes is planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes	SRD-14 SRD-15 SRD-26 SRD-86	Surf-G COMM (Airport Personnel) Surf-G COMM (Airport Personnel) RTC unit RTC supervisor tool
SRS 050: RTC SUP position shall enable tactical management of ATC resources (ATCO) ensuring safe service to all aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events.	SRD-14 SRD-15 SRD-22 SRD-27 SRD-28 SRD-48 SRD-80	Surf-G COMM (Airport Personnel) Surf-G COMM (Airport Personnel) ATCO Supervisor Supervisor AI data system ATCO, RTC Supervisor

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 051: RTC SUP position shall enable to continuously check that which aerodromes are linked to the MRTMs within the MRTC	SRD-82	OPS supervisor tool
SRS 052: RTC SUP position shall enable to continuously check traffic situation and traffic demand for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	SRD-82 SRD-84	OPS supervisor tool OPS supervisor tool
SRS 053: RTC SUP position shall enable to continuously check weather forecast for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	SRD-29	OPS supervisor tool
SRS 054: RTC SUP position shall enable to continuously check any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes for all aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC	SRD-82 SRD-83 SRD-85	OPS supervisor tool OPS supervisor tool OPS supervisor tool
SRS 055: RTC SUP position shall access contingency plan and ERP information for all MRTMs within the MRTC	SRD-87 SRD-88	OPS supervisor tool OPS supervisor tool
SRS 056: RTC SUP position shall enable to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another	SRD-89	Surf-G COMM (MRTMs)
SRS 057: RTC SUP position shall be able to coordinate with the Technical SUP position	SRD-90	Surf-G COMM (TECH Supervisor)
SRS 058: RTC SUP position shall be able to coordinate with all relevant external parties	SRD-91	Surf-G COMM (External parties)

SRS for Normal Operation (ID & content)	Safety Requirement at Design level ¹ (SRD) or Assumption	Maps onto
SRS 086: MRTM shall enable to safely execute flexible allocation of aerodromes (HUD and HDD) within the same MRTM	SRD-106	MRTM
	SRD-107	MRTM
	SRD-108	MRTM
	SRD-109	MRTM

Table 20: SRD derived by mapping SRS for normal conditions of operation to Design Model Elements

E.2 Static analysis of the solution functional system behaviour

Not applicable.

E.3 Dynamic analysis of the Solution functional system behaviour

Not applicable.

Appendix F Designing the Solution Functional system for Abnormal conditions of operation

F.1 Deriving SRD from SRS

Table 21 shows how the Safety Requirements at ATS Service level (SRS) for abnormal conditions of operation derived in section 4.3 map onto the related elements of the Design Model (functional system components or interactions/data flows) and derive Safety Requirements at Design level (SRD) (functionality and performance) for abnormal conditions of operation.

SRS for Abnormal Operation (ID & content)	Safety Requirement at Design level ² (SRD) or Assumption	Maps onto
SRS 059: MRTM shall enable, as in current operations, the detection of unexpected flights in the area of responsibility where ATC services are being provided for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-32 SRD-33 SRD-42	ATCO ATCO ATCO Visualisation system Visualisation system Visualisation system
SRS 060: MRTM shall enable to detect emergency situations on an aircraft (gear problems, fire on gears or aircraft, tail strike, etc.) for all aerodromes allocated to the same MRTM	SRD-16 SRD-17 SRD-18 SRD-32 SRD-33 SRD-35 SRD-36 SRD-37 SRD-41 SRD-42	ATCO ATCO ATCO Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system

² iSRD for the initial design or rSRD for the refined design

SRS for Abnormal Operation (ID & content)	Safety Requirement at Design level ² (SRD) or Assumption	Maps onto
SRS 061: MRTM shall enable to initiate emergency procedures and follow emergency situations affecting aircraft for all aerodromes allocated to the same MRTM	SRD-03 SRD-04 SRD-05 SRD-06 SRD-07 SRD-08 SRD-16 SRD-17 SRD-18 SRD-30 SRD-31 SRD-32 SRD-33 SRD-35 SRD-36 SRD-37 SRD-41 SRD-42 SRD-49 SRD-50 SRD-51	G-G Comm G-G Comm A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) ATCO ATCO ATCO Airport Personnel Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Signalling Lamps System Accident, incident and distress alarms Accident, incident and distress alarms
SRS 062: OPS SUP position shall enable to provide appropriate support in case of an emergency situation (gear problems, fire on gears or aircraft, tail strike, etc.) or crash situation for all MRTMs within the MRTC	SRD-80 SRD-88 SRD-89 SRD-92	ATCO, RTC Supervisor RTC supervisor tool Surf-G COMM (MRTMs) RTC supervisor unit
SRS 063: Staffing level of the MRTC shall be adequate to take over one or more aerodromes from the concerned MRTM in case of an emergency or crash situation	SRD-93	ATCO
SRS 064: Number of MRTMs within the MRTC shall be adequate to take over one or more aerodromes from the concerned MRTM in case of an emergency or crash situation	SRD-94	ATCO

SRS for Abnormal Operation (ID & content)	Safety Requirement at Design level ² (SRD) or Assumption	Maps onto
SRS 065: MRTM shall enable to detect and manage a crash situation on the aerodrome/s allocated to the same MRTM or in their vicinity	SRD-03 SRD-04 SRD-12 SRD-16 SRD-17 SRD-18 SRD-31 SRD-32 SRD-33 SRD-35 SRD-36 SRD-37 SRD-41 SRD-42 SRD-50 SRD-51	G-G Comm G-G Comm Surf-G COMM (Airport Personnel) ATCO ATCO ATCO Surveillance data Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Visualisation system Accident, incident and distress alarms Accident, incident and distress alarms
SRS 066: MRTM shall enable to have awareness of potential abnormal situations (abnormal weather, fire on terminal or aerodrome building, overload on the apron, etc.) in the aerodrome/s allocated to the same MRTM that could affect or even force the termination (unplanned terminations) of the provision of ATC services	SRD-12 SRD-30	Surf-G COMM (Airport Personnel) Airport Personnel
SRS 068: Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware/notified when the remote provision of ATC service is terminated in an unplanned manner in one or more aerodromes	SRD-05 SRD-06 SRD-07 SRD-08 SRD-15	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Airport Personnel)
SRS 069: Airspace users, relevant ATS units (e.g. those in charge of adjacent sectors) and respective airport services units shall be aware/notified when the ATC service provision is stopped or transferred to another MRTM (technical system failure, merging of aerodromes, etc.).	SRD-05 SRD-06 SRD-07 SRD-08 SRD-14 SRD-22	A-G Comm A-G Comm A-G Comm A-G Comm, Surf-G COMM (Vehicles) Surf-G COMM (Airport Personnel) ATCO

Table 21: SRD derived by mapping SRS for Abnormal conditions of operation onto Design Model elements

F.2 Static and dynamic analysis of the Solution functional system behaviour for abnormal conditions of operation

Not applicable.

Appendix G Designing the Solution functional system addressing internal functional system failures

This appendix presents the detailed risk evaluation and mitigation of the operational hazards identified at §4.4, performed at the level of the design of the Solution functional system.

G.1 Deriving SRD from the SRS (integrity/reliability)

Casual analyses of SRS 101-SRS 132 are available in Appendix D of SESAR Solution PJ.05.03 SPR-INTEROP/OSED for V2 - Part II - Safety Assessment Report [19], while for other integrity&reliability SRS, Table 22 lists the results. Although likelihood is defined on SRS-level, following the method used by former PJ.05 projects, exact likelihoods are not defined on SRD level, these should be derived from local assessments.

SRS	Cause & description	Mitigation/Safety Requirement
SRS 145 The likelihood that MRTM fails to execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) shall be no more than 3.33E-06 per flight hour	Transferring one or more aerodromes to another MRTM in the same MRTC due to the failure of split & merge functionality	SRD 212
SRS 146 The likelihood that MRTM fails to adequately execute split & merge process between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same MRTC) shall be no more than 1.00E-07 per flight hour	<p>One or more critical functions of an aerodrome is not available from the receiving position due to the failure of the split & merge functionality, or one/more critical system interface(s)</p> <p>One or more critical functions of an aerodrome is available from more than one MRTM due to the failure of the split & merge functionality, or one/more critical system interface(s)</p> <p>One or more critical functions of an aerodrome is not available from any MRTM due to the failure of the split & merge functionality, or one/more critical system interface(s)</p> <p>Note: critical system shall be defined on local level, e.g. A/G communication, visual surveillance, air/ground surveillance, EFS/ATM system</p>	<p>SRD 213</p> <p>SRD 214</p> <p>SRD 215</p> <p>SRD 216</p>
SRS 147 The likelihood that MRTM fails to enable coordination with other MRTMs within the same MRTC shall be no more than 3.33E-06 per flight hour	Total loss of coordination between MRTMs due to the failure of the G/G communication system	SRD 217

SRS	Cause & description	Mitigation/Safety Requirement
SRS 148 The likelihood that MRTM fails to enable to the transferring and/or the receiving ATCO to approve the transfer of an aerodrome shall be no more than 5.00E-07 per flight hour	Transferring one or more aerodromes to another MRTM in the same MRTC due to the failure of split & merge functionality	SRD 212
SRS 149 The likelihood that MRTM fails to enable to the receiving ATCO to present all relevant information of an aerodrome in look only mode before approve the transfer shall be no more than 3.33E-06 per flight hour	Critical information is not available for the receiving ATCO due to the failure of the split & merge functionality, or one/more critical system interface(s) Note: critical system shall be defined on local level, e.g. A/G communication, visual surveillance, air/ground surveillance, EFS/ATM system	SRD 218
SRS 150 The likelihood that The MRTM cluster of aerodromes is not planned considering weather forecast, traffic demand and any other factors impacting the capacity of the MRTM to provide relevant ATC services to concerned aerodromes shall be no more than 3.33E-06 per flight hour	Total/partial loss of the Supervisor Planning Tool due to system failure Partial loss of the Supervisor Planning Tool functionality due to missing data from any critical systems Supervisor Planning Tool receives corrupted data from any critical systems The information provided by the Supervisor Planning Tool becomes corrupted in the processing phase	SRD 219 SRD 220 SRD 221 SRD 222 SRD 223 SRD 224
SRS 151 The likelihood that RTC SUP position fails to enable tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events shall be no more than 3.33E-06 per flight hour	Total/partial loss of the Supervisor Planning Tool due to system failure Partial loss of the Supervisor Planning Tool functionality due to missing data from any critical systems	SRD 219 SRD 220 SRD 221 SRD 224
SRS 152 The likelihood that RTC SUP position provides corrupted information to support tactical management of ATC resources (ATCO) ensuring safe service to one or several aerodromes in charge with respect to weather conditions, traffic overloads/peaks and unexpected events shall be no more than 3.33E-06 per flight hour	Supervisor Planning Tool receives corrupted data from any critical systems The information provided by the Supervisor Planning Tool becomes corrupted in the processing phase	SRD 222 SRD 223 SRD 224

SRS	Cause & description	Mitigation/Safety Requirement
SRS 157 The likelihood that RTC SUP position fails to access contingency plan and ERP information for one or several aerodromes allocated to the same MRTM, in case of all MRTMs within the MRTC shall be no more than 3.33E-06 per flight hour	Total/partial loss of the Supervisor Planning Tool due to system failure Partial loss of the Supervisor Planning Tool functionality due to missing data from any critical systems	SRD 219 SRD 220 SRD 221 SRD 224
SRS 158 The likelihood that RTC SUP position fails to coordinate with all MRTMs within the same MRTC, and request the transfer of an aerodrome from one MRTM to another shall be no more than 3.33E-06 per flight hour	Total loss of coordination between the RTC SUP position and MRTMs due to the failure of the G/G communication system	SRD 217
SRS 162 The likelihood that MRTM fails to provide flexible allocation of aerodromes within the same MRTM shall be no more than 3.33E-06 per flight hour	Total loss of the flexible allocation function due to system failure Partial loss of the flexible allocation function due to system failure	SRD 225 SRD 226 SRD 228
SRS 163 The likelihood that MRTM fails to adequately execute flexible allocation of aerodromes within the same MRTM shall be no more than 1.00E-07 per flight hour	Critical system elements are not changing consistently on ATCO HMI	SRD 227 SRD 228

Table 22. Casual analysis

G.2 Deriving SRD from the SRS (functionality&performance) for protective mitigation

The purpose is to derive SRD (functionality&performance) from the SRS (functionality&performance) that have been derived in §4.4.2 to provide mitigation against operational hazard effects (protective mitigation), with due consideration of the potential common cause failures that might affect the operational hazard causes and its protective mitigation.

Table 23 shows how the Safety Requirements at ATS Service level (SRS) functionality&performance derived in section 4.4.2 for protective mitigation map onto the related elements of the Design Model (functional system components or interactions/data flows) and derive additional Safety Requirements at Design level (SRD) (functionality and performance) for internal failure conditions of operation.

SRS (functionality & performance) for protective mitigation (ID & content)	Safety Requirement at Design level ³ (SRD) or Assumption	Maps onto
SRS 070: Contingency procedures are to be in place in case the MRTM fails to provide remote ATC service to one/some/all aerodromes allocated to the same MRTM	<p>SRD 017: ATCO shall be able to prevent overload and manage workload by</p> <ul style="list-style-type: none"> giving the responsibility of one or several ADs to an additional ATCO (or assistant) in the same MRTM or reducing capacity by slowing traffic down terminating ATC service for one or several aerodromes if no other option is possible. transferring it/them to another MRTM 	ATCO
SRS 071: Contingency procedures are to be in place in case the MRTM fails to communicate with a/c and/or vehicles in one/some/all aerodromes allocated to the same MRTM	<p>SRD 017: ATCO shall be able to prevent overload and manage workload by</p> <ul style="list-style-type: none"> giving the responsibility of one or several ADs to an additional ATCO (or assistant) in the same MRTM or reducing capacity by slowing traffic down terminating ATC service for one or several aerodromes if no other option is possible. <p>transferring it/them to another MRTM</p>	ATCO
	SRD 069: In case of failure or degradation of ground-ground communication with personnel operating on the apron or vehicles/personnel operating on the manoeuvring area relevant fallback procedures shall be applied (e.g. use of flash gun lights).	Surf-G Comm
	SRD 072: In case of failure or degradation or air-ground communication with traffic in a MRTM position, relevant procedures from PANS ATM [12] shall be applied (e.g. issuing clearances through the relevant APP controller).	A-G Comm

³ iSRD for the initial design or rSRD for the refined design

SRS (functionality & performance) for protective mitigation (ID & content)	Safety Requirement at Design level ³ (SRD) or Assumption	Maps onto
SRS 072: Contingency procedures are to be in place in case the MRTM presents a failure on the screens which prevents ATCO from visually assessing traffic in one/some/all aerodromes allocated to the same MRTM	SRD 017: ATCO shall be able to prevent overload and manage workload by <ul style="list-style-type: none"> giving the responsibility of one or several ADs to an additional ATCO (or assistant) in the same MRTM or reducing capacity by slowing traffic down terminating ATC service for one or several aerodromes if no other option is possible. transferring it/them to another MRTM	ATCO
	SRD 071: In case of loss of information or detected inappropriate information on a critical view of the visualisation (due to technical failure), a specific procedure shall be applied taking into account the timeframe of the failure mode (e.g. provision of ATC services limiting the simultaneous operations in the area of responsibility, using PTZ camera to get the corresponding lost image, stopping the provision of the service, etc.).	Visualisation System
SRS 074: An operational procedure shall be available for the split & merge process, listing the critical system which shall be available for the receiving MRTM to take over control from the transferring MRTM	SRD 080: Transfer procedures (for the transfer of an aerodrome between MRTMs) shall be locally defined with a clear description of the associated roles and responsibilities, corresponding coordination procedures and critical systems.	ATCO, Supervisor RTC
SRS 075: A spare MRTM should be available in the RTC	SRD 094: A spare MRTM, which is not used in day to day operational service, should be available	ATCO, Supervisor RTC
SRS 076: An assistant (ATCO, OPS SUP) should be available to support the work of the ATCO in the MRTM if split of one or more aerodromes is not possible (if feasible in VCS level)	SRD 093: A spare ATCO/spare ATCOs with licences for all active aerodromes within the MRTM should be available to take over one or more aerodromes from any MRTM in case of an unexpected event	ATCO, Supervisor RTC

SRS (functionality & performance) for protective mitigation (ID & content)	Safety Requirement at Design level ³ (SRD) or Assumption	Maps onto
SRS 077: Split and merge indication on the HMI should be intuitive enough to avoid unintentional or incidental split and merge initiation	SRD 098: The system enabling to transfer one of the controlled aerodromes to another MRTM should be intuitive enough to avoid unintentional or incidental split and merge initiation	RTC unit
SRS 078: An operational procedure shall be available for the OPS SUP, listing all relevant factors shall be evaluated when the MRTM cluster of aerodromes is planned	SRD 086: The RTC Supervisor shall be provided with information and an operational procedure to facilitate decisions regarding how to combine aerodromes in the MRTM	RTC supervisor tool
	SRD 099: The RTC should host a locally determined number of MRTMs to be able to split aerodromes.	RTC unit
SRS 080: Backup coordination system should be available for MRTM-MRTM coordination	SRD 102: A backup system should be available for the situation when coordination is not possible within the RTC	Surf-G COMM (RTC)

Table 23: SRD derived by mapping SRS (functionality&performance) for protective mitigation on to Design Model Elements

Appendix H Demonstration of Safety Criteria achievability

The achievability of the Safety Criteria has been demonstrated through the satisfaction of the success criteria of the safety validation objectives defined in relation to the Solution planned validation exercises and other specific validation means (Safety and HP workshop).

The safety-related outcomes of the validation exercises (traced back to the safety validation objectives) bring an essential contribution to the demonstration of the Safety Criteria achievability by the Solution design. Decision for deriving (or not) additional Safety Requirements might be taken from these results (SRD to be included at §5.3.3 or §5.4.2). Indeed, a SRS functionality&performance addressing human factors or procedures might be covered by a validation exercise but the validation outcome might be that it can be satisfied only partially or even not satisfied, in which case the design should ensure adequate risk mitigation.

The safety-relevant results of the validation exercises and of any other specific validation means (Safety and HP workshop) are summarized in Table 24, whilst indicating for each safety validation objective / success criteria the extent to which the relevant SRS have been covered. SRD status is detailed in Table 25.

Exercise Safety Validation Objective & related SAC(s)	Success criterion	Coverage (SRS and/or SRD)	Validation results
OBJ-PJ05-W2-35-V3-VALP-S04 Assess ATCO capability to provide ATC services in a safe manner when working in a RTC with a flexible allocation of aerodromes between MRTMs under all normal conditions	CRT-PJ05-W2-35-V3-VALP-S04.010 ATCO is able to identify and solve potential conflicts in a timely manner: <ul style="list-style-type: none"> In the vicinity of the aerodrome In the runway area On the manoeuvring area 	SRS 001-SRS 030, SRS 033-SRS 035, SRS 086	OK – The majority of the ATCOs confirm that they were able to identify and solve potential conflicts in a timely manner Nevertheless, ATCO training is required to avoid potential conflicts as far as possible in high traffic levels and/or complex situations (e.g. by using conservative separations and limiting traffic numbers when needed)
	CRT-PJ05-W2-35-V3-VALP-S04.020 ATCO is able to identify and solve potential hazardous situations in a timely manner (e.g.): <ul style="list-style-type: none"> Unstable approaches Bird strikes Aircraft not vacating RWY as expected 	SRS 001-SRS 035, SRS 045, SRS 046	POK – ATCOs partially agreed that they were able to identify and solve potential hazardous situations in a timely manner. The criterion was validated with a limited number of hazardous situations only

Exercise Safety Validation Objective & related SAC(s)	Success criterion	Coverage (SRS and/or SRD)	Validation results
	CRT-PJ05-W2-35-V3-VALP-S04.030 ATCO is able to distinguish with which aircraft, vehicle at which aerodrome the ATCO is communicating with	SRS 001-SRS 030, SRS 033-SRS 035, SRS 086	OK – ATCOs were generally able to distinguish with which aircraft or vehicle at which aerodrome they were communicating with. ATCOs appreciated the indication of an incoming call on the visual panorama
	CRT-PJ05-W2-35-V3-VALP-S04.050 ATCO is not inducing more conflicting situations than in the reference scenario	SRS 001-SRS 030, SRS 033-SRS 049, SRS 059-SRS 061, SRS 065, SRS 066, SRS 086	OK – The majority of ATCOs find that they were not inducing more conflicting situations than in the reference scenario
OBJ-PJ05-W2-35-V3-VALP-S05 Assess ATCO capability to perform specific procedures related to MRTM capabilities in a safe manner when working in a RTC with a flexible allocation of aerodromes between MRTMs	CRT-PJ05-W2-35-V3-VALP-S05.010 ATCO is able to foresee traffic at his/her MRTM at short term in order to avoid overloads	SRS 044	POK – The ATCOs were in general able to foresee traffic at his/her MRTM at short term in order to avoid overloads. It should be mentioned that unforeseen traffic (e.g. vehicles or police and rescue helicopters) can occur at any time. The ATCO planning tools did not always fully support foreseeing traffic (compare CRT-PJ05-W2-35-V3-VALP-H11.060).
OBJ-PJ05-W2-35-V3-VALP-S06 Assess ATCO capability to cope with / manage abnormal situation in a safe manner when working in a RTC with a flexible allocation of aerodromes between MRTMs	CRT-PJ05-W2-35-V3-VALP-S06.010 ATCO is able to identify and manage abnormal situations (e.g.): <ul style="list-style-type: none"> • Aircraft emergency • Crash on an airport or its vicinity • Fire on an airport • Unplanned closure of an airport 	SRS 059-SRS 061, SRS 063-SRS 069	OK – The majority of ATCOs find that they are able to identify and manage abnormal situations (aircraft emergency)

Exercise Safety Validation Objective & related SAC(s)	Success criterion	Coverage (SRS and/or SRD)	Validation results
OBJ-PJ05-W2-35-V3-VALP-S07 Assess ATCO capability to cope with / manage degraded modes and recover from them in a safe manner when working in a RTC with a flexible allocation of aerodromes between MRTMs	CRT-PJ05-W2-35-V3-VALP-S07.010 ATCO is able to detect and recover from a technical failure occurring at one of the airports affecting (e.g): <ul style="list-style-type: none"> • Communication • Visualisation system • Other airport systems / infrastructure 	SRS, 045, SRS 046, SRS 070-SRS 077, SRS 080	OK – The majority of the ATCOs confirm that they were able to detect and recover from a technical failure occurring at one of the aerodromes
	CRT-PJ05-W2-35-V3-VALP-S07.030 ATCO is able to detect and recover from a technical failure in the MRTM affecting the operation at one or more aerodromes (e.g): <ul style="list-style-type: none"> • Communication • Visualisation system 	SRS, 045, SRS 046, SRS 070-SRS 072	OK – The majority of the ATCOs confirm that they were able to detect and recover from a technical failure in the MRTM affecting the operation at one or more aerodromes
OBJ-PJ05-W2-35-V3-VALP-S08 Assess Supervisor capability to support the ATCO in abnormal conditions when working in a RTC with a flexible allocation of aerodromes between MRTMs	CRT-PJ05-W2-35-V3-VALP-S08.010 Supervisor is able to support an ATCO in abnormal situations (e.g): <ul style="list-style-type: none"> • Crash on an airport or its vicinity • Fire on an airport • Unplanned closure of an airport • ATCO overload in one or more MRTM of the RTC 	SRS 050, SRS 054, SRS 055, SRS 062	OK – Supervisors were able to support the ATCO in case of an emergency at one aerodrome by supervising the handover of aerodromes to another ATCO and offloading the ATCO from the coordination tasks.
OBJ-PJ05-W2-35-V3-VALP-S09 Assess Supervisor capability to cope with degraded situations and recover from it when working in a RTC with a flexible allocation of aerodromes between MRTMs	CRT-PJ05-W2-35-V3-VALP-S09.010 Supervisor is able to detect and manage technical failures occurring in one module of the RTC related to e.g: <ul style="list-style-type: none"> • Communication • Visualisation system • Other systems in the MRTM 	SRS 050, SRS 054-SRS 058	OK – Supervisors could manage the technical failure occurring in one MRTM by supporting the ATCO in the transfer of an aerodrome to a another MRTM

Exercise Safety Validation Objective & related SAC(s)	Success criterion	Coverage (SRS and/or SRD)	Validation results
OBJ-PJ05-W2-35-V3-VALP-S10 Assess Supervisor capability to support the ATCO under all normal conditions when working in a RTC with a flexible allocation of aerodromes between MRTMs	CRT-PJ05-W2-35-V3-VALP-S10.010 SUP is able to foresee traffic with supervisor planning tool to safely manage RTC operations	SRS 050-SRS 058, SRS 062	POK – Supervisors assessed that they did not always have all required information available. In some cases this was due to the way the information was presented rather than the availability of the information. (compare CRT-PJ05-W2-35-V3-VALP-H12.010)

Table 24: Solution Safety Validation results

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-01	Flight plan information shall be provided to ATCO for each aerodrome allocated to the MRTM	Pack	Validated in previous phases
SRD-02	ATCO shall be able to distinguish between aerodromes in the MRTM from which flight plan information is provided	Multiple	Validated in previous phases
SRD-03	ATCO shall be able to communicate with adjacent ATS units for each aerodrome allocated to the MRTM	Pack	Validated in previous phases
SRD-04	ATCO shall be able to distinguish between ATSUs (APP units) from different aerodromes in the MRTM that communication is established with	Multiple	Validated in previous phases
SRD-05	ATCO shall be able to communicate with A/C in all aerodromes to which ATC is being provided	Pack	Validated in previous phases
SRD-06	ATCO shall be able to distinguish between aerodromes in the MRTM that communication with A/C is established with	Multiple	Validated in previous phases
SRD-07	A-G Comm in the MRTM shall allow to receive communication from all traffic in all aerodromes allocated to the MRTM and to communicate with A/C	Multiple	Validated in previous phases
SRD-08	MRTM shall allow to communicate with A/C and Vehicles – coupling A/C frequencies from all aerodromes allocated to the same MRTM and keeping vehicles in separate frequencies for each aerodrome	Multiple	Validated in previous phases
SRD-09	ATCO shall be able to communicate with and give control instructions to Vehicles in manoeuvring areas at each aerodrome under control responsibility in the MRTM	Pack	Validated in previous phases

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-10	ATCO shall be able to distinguish between aerodromes in the MRTM that communication with Vehicles is established with	Multiple	Validated in previous phases
SRD-11	Communication function in the MRTM shall allow to transmit communication to Vehicles independently (not combined with A/C) for each aerodrome allocated to the MRTM	Multiple	Validated in previous phases
SRD-12	ATCO shall be able to communicate with Airport Personnel at each aerodrome under control responsibility (start-up, push-back, other services)	Pack	Validated in previous phases
SRD-13	ATCO shall be able to communicate with Airport Personnel in order to coordinate runway inspections to determine runway conditions and detect potential FODs/animals at each aerodrome allocated to the MRTM	Pack	Validated in previous phases
SRD-14	ATCO shall be able to communicate with Airport Personnel (in the different services present there) at each aerodrome under control responsibility (service initiation, termination)	Pack	Validated in previous phases
SRD-15	ATCO shall be able to distinguish between aerodromes in the MRTM that communication with Airport Personnel is established with	Multiple	Validated in previous phases
SRD-16	ATCO shall perform all tasks (procedures) to provide ATC Tower service to all aerodromes allocated to the MRTM	Pack	Validated in previous phases
SRD-17	ATCO shall be able to prevent overload and manage workload by: <ul style="list-style-type: none"> giving the responsibility of one or several ADs to an additional ATCO (or assistant) in the same MRTM reducing capacity by slowing traffic down terminating ATC service for one or several aerodromes if no other option is possible. transferring it/them to another MRTM 	Multiple	Validated in previous phases
SRD-18	In case a spare controller takes responsibility of one or several aerodromes from the same MRTM, handover/coordination procedures between both controllers shall be applied	Multiple	Validated in previous phases
SRD-21	ATCO allocated to an MRTM position shall apply the relevant MRT start-up procedure for each aerodrome before providing ATC service from that MRTM position (this start-up procedure includes check of the MRT capability)	Pack	Validated in previous phases

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-22	ATCO shall inform Airport Personnel at each aerodrome allocated to the MRTM about the remote provision of ATC service (initiation, termination)	Pack	Validated in previous phases
SRD-23	ATCO shall ensure that ATC services can be appropriately (safely) stopped at each aerodrome allocated to the MRTM in case the service has to be terminated	Pack	Validated in previous phases
SRD-24	ATCO shall inform Airspace Users at each aerodrome allocated to the MRTM about the unplanned termination of the ATC service provision.	Pack	Validated in previous phases
SRD-26	Clusters of aerodromes allocated to an MRTM shall be defined at local level in order to ensure that traffic levels and complexity do not exceed limitations so the ATCO can safely provide ATS services in nominal, abnormal and degraded conditions	Multiple	Validated in previous phases
SRD-27	RTC Supervisor shall be able to access functions for planning, coordination (staffing, RTC, etc.) and monitoring of the upcoming and present traffic flow	Multiple	Validated in previous phases
SRD-28	RTC Supervisor shall be able to provide relevant support to controllers in a the RTC in order to ensure safe ATC service (staffing, allocation of aerodromes)	Multiple	Validated in previous phases
SRD-29	RTC Supervisor shall be able to access functions for the monitoring of weather for all the aerodromes in the RTC	Multiple	Validated in previous phases
SRD-30	Airport Personnel shall inform RTC about emergency or abnormal situation in the aerodrome premises that may affect the safe provision of ATC service	Pack	Validated in previous phases
SRD-31	Surveillance data shall be provided to ATCO to support tasks for all aerodromes. Air surveillance data is mandatory while ground surveillance is optional	Pack	Validated in previous phases
SRD-32	Visual information on the vicinity of each aerodrome and the traffic in those areas shall be provided to ATCO to support tasks as in single remote tower operations	Pack	Validated in previous phases
SRD-33	Visual indication supporting A/C identification in the vicinity of each aerodrome allocated to the MRTM should be provided to the ATCO	Pack	Validated in previous phases
SRD-35	Visual information on the apron of each aerodrome allocated to the MRTM and traffic in those areas may be provided to ATCO to support tasks as in single remote tower operations	Pack	Validated in previous phases

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-36	Visual indication supporting A/C and Vehicle detection (i.e. object bounding) in the manoeuvring area of each aerodrome allocated to the MRTM should be provided to the ATCO	Pack	Validated in previous phases
SRD-37	Visual indication supporting detection of A/C, Vehicle, Personnel and Obstacle entering/being close to a runway of each aerodrome allocated to the MRTM should be provided to the ATCO	Pack	Validated in previous phases
SRD-38	Visual presentation (VP) on the relevant parts of the manoeuvring area and the vicinity of each aerodrome shall be provided to ATCO to support tasks as in single remote tower operations	Pack	Validated in previous phases
SRD-39	Visual presentation (VP) of the runway area for each aerodrome shall be provided to ATCO to support tasks as in single remote tower operations	Pack	Validated in previous phases
SRD-40	Visual information available in the Visualisation System shall be provided in the several visibility conditions (CAVOK, darkness,...) for all aerodromes allocated to the MRTM	Pack	Validated in previous phases
SRD-41	The PTZ shall be available for each aerodrome allocated to the MRTM in order to support ATC tasks as for Single Remote Tower	Pack	Validated in previous phases
SRD-42	Time, compass rose and aerodromes names should be provided on the visual presentation for each aerodrome allocated to the same MRTM	Pack	Validated in previous phases
SRD-43	Managing visual navigation aids shall be provided to ATCO to support tasks for each aerodrome allocated to the MRTM	Pack	Validated in previous phases
SRD-44	ATCO shall be able to manoeuvre non-visual navigation aids in order to support AC on landing operations for each aerodrome allocated to the MRTM	Pack	Validated in previous phases
SRD-45	Local MET information shall be provided to ATCO to support tasks for all aerodromes	Pack	Validated in previous phases
SRD-46	Information on present and incoming traffic (as well as real time airport capacity if applicable) and weather forecast shall be provided to the ATCO in order to be able to plan and manage ATCO resources adequately for a specific MRTM position.	Multiple	Validated in previous phases

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-47	Published AIP information for each aerodrome allocated to the same MRTM shall be provided to ATCO	Pack	Validated in previous phases
SRD-48	Airspace users shall be informed about the (planned) provision of remote ATC services through AIP	Pack	Validated in previous phases
SRD-49	ATCO shall be able to remotely use signalling lamps to communicate with concerned traffic in each aerodrome allocated to the same MRTM	Pack	Validated in previous phases
SRD-50	ATCO shall be able to activate accident/incident/distress alarms in order to alert relevant services in the correspondent aerodrome of the MRTM and to launch corresponding emergency procedures for that aerodrome	Pack	Validated in previous phases
SRD-51	ATCO shall be able to activate accident/incident/distress alarms from one or more aerodromes allocated to the MRTM with relevant information	Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD-52	ATCO shall be able to recognise alarms in order to prioritise and solve the possible situations	Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD-55	An alert should be provided to the controller in case of failure of the ground-ground communication service.	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-57	An alert should be provided to the controller in case of failure of the communication with personnel operating on the apron or vehicles/personnel operating on the manoeuvring area.	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-61	An alert shall be provided to the controller in case of failure or inappropriate information (delayed, corrupted, frozen, etc.) is provided on the visualisation system.	Pack	Validated (RTS)
SRD-62	Data recorder system shall not negatively impact (corrupting data or inducing malfunction) the system from which data is recorded, including the data from the Visualisation system.	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-64	An alert should be provided to the controller in case of failure of the air-ground communication system.	Pack	Mitigation mean identified from the hazard assessment of previous phases

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-68	In case of loss or degradation of ground-ground communication with adjacent ATSU units in a MRTM position relevant fallback procedures shall be applied.	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-69	In case of failure or degradation of ground-ground communication with personnel operating on the apron or vehicles/personnel operating on the manoeuvring area relevant fallback procedures shall be applied (e.g. use of flash gun lights).	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-70	In case surveillance function is available in the MRTM position, but the function is lost or the information provided is inappropriate and detected, relevant fallback procedures shall be applied	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-71	In case of loss of information or detected inappropriate information on a critical view of the visualisation (due to technical failure), a specific procedure shall be applied taking into account the timeframe of the failure mode (e.g. provision of ATC services limiting the simultaneous operations in the area of responsibility, using PTZ camera to get the corresponding lost image, stopping the provision of the service, etc.).	Pack	Validated (RTS)
SRD-72	In case of failure or degradation or air-ground communication with traffic in a MRTM position, relevant procedures from PANS ATM [12] shall be applied (e.g. issuing clearances through the relevant APP controller).	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-73	In case of incorrect MET/Weather information is provided in a MRTM position, or no information at all is provided, controller shall contact relevant airport personnel in the airport in order to obtain this information and any relevant update, if not possible to obtain such information from any other source (e.g. pilots, visual inputs from the visual presentation, MET-office, www/internet).	Pack	Mitigation mean identified from the hazard assessment of previous phases
SRD-74	The ATCO should be supported in prioritising tasks (e.g. providing landing clearance or taxi clearance) from a support tool in the tactical short term.	Multiple (W2)	Validated (RTS)
SRD-75	ATCO should continuously be monitoring the upcoming and present traffic flow for all active aerodromes dedicated to the MRTM to avoid overload.	Multiple (W2)	Validated (RTS)

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-76	ATCO shall be able to communicate with ATCOs in other MRTMs within the RTC in order to coordinate transfer procedure at each aerodrome allocated to the MRTM.	Multiple (W2)	Validated (RTS & workshop)
SRD-77	The ATCO shall be able to transfer one of the controlled aerodromes to another MRTM.	Multiple (W2)	Validated (RTS & workshop)
SRD-78	The ATCO shall be able to take over an aerodrome to one MRTM	Multiple (W2)	Validated (RTS & workshop)
SRD-79	During Transfer of an aerodrome both ATCOs shall be presented with the same information on the aerodrome being transferred with all available technical systems as replicas until the transfer process is finished, readiness by overtaking ATCO is confirmed and the fully control over the new aerodrome is being reported established.	Multiple (W2)	Validated (RTS & workshop)
SRD-80	Transfer procedures (for the transfer of an aerodrome between MRTMs) shall be locally defined with a clear description of the associated roles and responsibilities and corresponding coordination procedures.	Multiple (W2)	Validated (RTS & workshop)
SRD-81	All available technical systems of an aerodrome shall be available for input in only one MRTM at a time, in line with the control responsibility of the given aerodrome.	Multiple (W2)	Validated (RTS & workshop)
SRD-82	The RTC Supervisor role should be provided with a display presenting an overview of the RTC, including e.g. MRTM status, aerodromes allocated to MRTMs, traffic load, etc. to be able to transfer an airport	Multiple (W2)	Validated (workshop)
SRD-83	The RTC Supervisor role should be provided with a technical overview of all systems e.g. the MRTM, camera functionality etc. in the RTC and of the aerodrome systems e.g. navigational aids, lights, emergency alerting functions, for all involved aerodromes part of the RTC	Multiple (W2)	Validated (workshop)
SRD-84	The RTC Supervisor should be provided with the forecasted demand for all involved aerodromes part of the RTC.	Multiple (W2)	Validated (RTS)
SRD-85	The RTC Supervisor role shall be provided with an overview of ATCO availability and their valid endorsements	Multiple (W2)	Validated (workshop)
SRD-86	The RTC Supervisor shall be provided with up-to date information to facilitate decisions regarding how to combine aerodromes in the MRTM.	Multiple (W2)	Validated (workshop)

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-87	The RTC Supervisor shall be provided with Contingency Plan information for all involved aerodromes part of the RTC.	Multiple (W2)	Validated (workshop)
SRD-88	The RTC Supervisor role shall be provided with Emergency Response Plan information for all involved aerodromes part of the RTC.	Multiple (W2)	Validated (workshop)
SRD-89	RTC Supervisor role shall be able to communicate with ATCOs in all MRTMs within the RTC in order to coordinate transfer procedures at each aerodrome allocated to the MRTM	Multiple (W2)	Validated (workshop)
SRD-90	The RTC Supervisor role shall access functions for communicating the status of RTC and aerodromes and coordinating maintenance (to be carried out by a qualified engineer/technician).	Multiple (W2)	Validated (workshop)
SRD-91	RTC Supervisor shall be able to coordinate with all relevant external parties	Multiple (W2)	Validated (workshop)
SRD-93	The spare ATCOs shall have endorsement for all aerodromes within the RTC.	Multiple (W2)	Validated (workshop)
SRD-94	A spare MRTM, which is not used in day to day operational service, should be available	Multiple (W2)	Validated (workshop)
SRD-96	The receiving MRTM should not take over control from the transferring MRTM if any critical system is not available	Multiple (W2)	Validated (workshop)
SRD-98	The system enabling to transfer one of the controlled aerodromes to another MRTM should be intuitive enough to avoid unintentional or incidental split and merge initiation	Multiple (W2)	Validated (RTS & workshop)
SRD-99	The RTC should host a locally determined number of MRTMs to be able to split aerodromes.	Multiple (W2)	Validated (workshop)
SRD-102	A backup system should be available for the situation when coordination is not possible within the RTC	Multiple (W2)	Validated (workshop)
SRD-106	The border of each displayed aerodrome should be marked in the visual presentation and head-down displays with possible colour coding for the different positions or aerodromes.	Multiple (W2)	Validated (workshop)
SRD-107	In case of colour coding, consistent indication shall be used for the different aerodromes on visual presentation and head down displays.	Multiple (W2)	Validated (RTS & workshop)
SRD-108	Flexible positioning of aerodromes within the same MRTM shall be performed by the ATCO.	Multiple (W2)	Validated (RTS)

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD-109	The function enabling flexible positioning of aerodromes within the same MRTM should be intuitive enough to avoid unintentional or incidental changes	Multiple (W2)	Validated (RTS)
SRD-110	An alert shall be provided to the controller in case of failure of the transfer function.	Multiple (W2)	Validated (workshop)
SRD-111	An alert shall be provided to the supervisor in case of the Supervisor Planning Tool receives corrupted data from any critical systems	Multiple (W2)	Validated (workshop)
SRD-114	The ATCO may be supported in monitoring conformance to clearances on ground.	Multiple (W2)	Open
SRD-115	The ATCO may be supported in monitoring conformance to clearances for airborne movements	Multiple (W2)	Open
SRD-116	The ATCO may be supported by the system, indicating situations when contradictory (incompatible) clearances are delivered.	Multiple (W2)	Open
SRD-117	The ATCO may be supported by the system indicating when clearances can be given.	Multiple (W2)	Open
SRD 200	The likelihood of inappropriate flight data information being provided by the Flight Data Processing system in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 201	The likelihood of incorrect or missing arriving/departing procedures publications available to the controller in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 202	The likelihood of incorrect or missing information concerning restricted areas in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 203	The likelihood of failure or degradation of ground-ground communication with adjacent ATSU units in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 204	The likelihood of failure or degradation of Surface-ground communication with personnel operating on the apron or vehicles/personnel operating on the manoeuvring area in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD 205	In case surveillance data is available in the MRTM position, the likelihood that undetected inappropriate surveillance information on a flight is provided shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 206	In case surveillance data is available in the MRTM position, the likelihood of complete lack of traffic information shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 207	For a local implementation, corresponding assurance level for the software development process of the relevant components of the Visualisation System and its availability shall be defined based on applicable regulation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 208	The likelihood of failure or degradation of air-ground communication with traffic in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 209	The likelihood of incorrect MET/Weather information provided in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 210	The likelihood of loss or dysfunction of Visual Navigation Aids manoeuvred from a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 211	The likelihood of loss or dysfunction of Non-Visual Navigation Aids manoeuvred from a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	Mitigation mean identified from the hazard assessment of previous phases
SRD 212	The likelihood of loss of transfer functionality between aerodromes in charge (transferring one or more aerodromes to another MRTM in the same RTC) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 213	The likelihood of an inadequately executed transfer between aerodromes in charge (one or more critical functions of an aerodrome is not available from the receiving position) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD 214	The likelihood of an inadequately executed transfer between aerodromes in charge (one or more critical functions of an aerodrome is available from more than one MRTM) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 215	The likelihood of an inadequately executed transfer between aerodromes in charge (one or more critical functions of an aerodrome is not available from any MRTM) shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 216	For a local implementation, corresponding assurance level for the software development process of the relevant components of the transfer function and its availability shall be defined based on applicable regulation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 217	The likelihood of loss of coordination between MRTMs, and/or OPS SUP role and MRTMs within the same RTC shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 218	The likelihood that any critical information is not available for the receiving ATCO shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 219	The likelihood of loss of the Supervisor Planning Tool shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 220	The likelihood of partial loss of the Supervisor Planning Tool functionality due to missing data from any critical systems shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 221	The likelihood of partial loss of the Supervisor Planning Tool functionality shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Status
SRD 222	The likelihood that the Supervisor Planning Tool receives corrupted data from any critical systems shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 223	The likelihood that the information provided by the Supervisor Planning Tool becomes corrupted in the processing phase shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 224	For a local implementation, corresponding assurance level for the software development process of the relevant components of the Supervisor Planning Tool and its availability shall be defined based on applicable regulation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 225	The likelihood of loss of the flexible positioning function within one MRTM shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 226	The likelihood of partial loss of the flexible positioning function within one MRTM shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 227	The likelihood of an inadequately executed flexible positioning function within one MRTM shall be operationally acceptable as per regulation applicable to local implementation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results
SRD 228	For a local implementation, corresponding assurance level for the software development process of the relevant components of the flexible positioning function within one MRTM and its availability shall be defined based on applicable regulation.	Multiple (W2)	Mitigation mean identified from the hazard assessment, based on workshop results

Table 25: Status of the SRDs

Appendix I Assumptions, Safety Issues & Limitations

I.1 Assumptions log

Table 26 includes all the Assumptions that were necessarily raised in deriving the Safety Requirements. Provide in the last column the rationale or evidence on which is based the validity of the assumption.

Ref	Assumption	Validation
A001	ATC resources (modules and cluster of aerodromes, planning, staff allocation and rostering, etc.) is strategically and pre-tactically managed in a way that allows the concept of the MRTM	

Table 26: Assumptions log

I.2 Safety Issues log

No specific issue was identified.

I.3 Operational Limitations log

Table 30 includes the Operational Limitations that were raised in the safety assessment (if applicable at the current level of maturity of the design).

Ref	Operational Limitations
L001	As airspace users and respective airport services were not involved in the project, further assessment should be made, because the lack of information concerning multiple operation might cause confusion on airspace user's/vehicle driver's side.

Table 27: Operational Limitations log

Appendix J Safety Requirements at Design level – Wave1

In SESAR 2020 W1 within the PJ05 we were looking at two different types of requirements:

- Those that are to be guaranteed for any Single Remote Tower before it can be added to a MRTM, also named as part of the “Pack” of Requirements from here on, are the SESAR 1 requirements also taken into account for PJ05 in SESAR 2020
- Those that are particular to the integration of two or more aerodromes into the same MRTM, also named as particular to the “Multiple” setting, are the SESAR 2020 W1 (PJ.05.02 and PJ.05.03) requirements also taken into account for PJ05 in SESAR 2020 W2

J.1 Safety Requirements at Design level (SRD) – Normal conditions of operation – Wave1

Table 2628 includes all the Safety Requirements on Design level – Normal conditions of operation from Wave1.

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-01	Flight plan information shall be provided to ATCO for each aerodrome allocated to the MRTM	Pack	SRS-01 SRS-02 SRS-03 SRS-11 SRS-29
SRD-02	ATCO shall be able to distinguish between aerodromes in the MRTM from which flight plan information is provided	Multiple	SRS-01
SRD-03	ATCO shall be able to communicate with adjacent ATS units for each aerodrome allocated to the MRTM	Pack	SRS-01 SRS-61 SRS-65
SRD-04	ATCO shall be able to distinguish between ATSUs (APP units) from different aerodromes in the MRTM that communication is established with	Multiple	SRS-01 SRS-61 SRS-65
SRD-05	ATCO shall be able to communicate with A/C in all aerodromes to which ATC is being provided	Pack	SRS-02 SRS-03 SRS-04 SRS-05 SRS-09 SRS-10 SRS-11 SRS-12 SRS-13 SRS-14 SRS-18 SRS-19 SRS-20 SRS-21 SRS-24 SRS-25 SRS-27 SRS-28 SRS-32 SRS-29 SRS-33 SRS-37 SRS-61 SRS-68 SRS-69

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-06	ATCO shall be able to distinguish between aerodromes in the MRTM that communication with A/C is established with	Multiple	SRS-02 SRS-03 SRS-04 SRS-05 SRS-09 SRS-10 SRS-11 SRS-12 SRS-13 SRS-14 SRS-18 SRS-19 SRS-20 SRS-21 SRS-24 SRS-25 SRS-27 SRS-28 SRS-32 SRS-29 SRS-33 SRS-37 SRS-61 SRS-68 SRS-69
SRD-07	A-G Comm in the MRTM shall allow to receive communication from all traffic in all aerodromes allocated to the MRTM and to communicate with A/C	Multiple	SRS-02 SRS-03 SRS-04 SRS-05 SRS-09 SRS-10 SRS-11 SRS-12 SRS-13 SRS-14 SRS-18 SRS-19 SRS-20 SRS-21 SRS-24 SRS-25 SRS-27 SRS-28 SRS-32 SRS-29 SRS-33 SRS-37 SRS-61 SRS-68 SRS-69
SRD-08	MRTM shall allow to communicate with A/C and Vehicles – coupling A/C frequencies from all aerodromes allocated to the same MRTM and keeping vehicles in separate frequencies for each aerodrome	Multiple	SRS-02 SRS-03 SRS-04 SRS-05 SRS-09 SRS-10 SRS-11 SRS-12 SRS-13 SRS-14 SRS-18 SRS-19 SRS-20 SRS-21 SRS-24 SRS-25 SRS-27 SRS-28 SRS-32 SRS-29 SRS-33 SRS-37 SRS-61 SRS-68 SRS-69
SRD-09	ATCO shall be able to communicate with and give control instructions to Vehicles in manoeuvring areas at each aerodrome under control responsibility in the MRTM	Pack	SRS-15 SRS-18 SRS-21 SRS-23 SRS-27 SRS-28 SRS-37
SRD-10	ATCO shall be able to distinguish between aerodromes in the MRTM that communication with Vehicles is established with	Multiple	SRS-15 SRS-18 SRS-21 SRS-23 SRS-27 SRS-28 SRS-37
SRD-11	Communication function in the MRTM shall allow to transmit communication to Vehicles independently (not combined with A/C) for each aerodrome allocated to the MRTM	Multiple	SRS-15 SRS-18 SRS-21 SRS-23 SRS-27 SRS-28 SRS-37
SRD-12	ATCO shall be able to communicate with Airport Personnel at each aerodrome under control responsibility (start-up, push-back, other services)	Pack	SRS-12 SRS-13 SRS-65 SRS-66

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-13	ATCO shall be able to communicate with Airport Personnel in order to coordinate runway inspections to determine runway conditions and detect potential FODs/animals at each aerodrome allocated to the MRTM	Pack	SRS-34
SRD-14	ATCO shall be able to communicate with Airport Personnel (in the different services present there) at each aerodrome under control responsibility (service initiation, termination)	Pack	SRS-42 SRS-45 SRS-49 SRS-50 SRS-69
SRD-15	ATCO shall be able to distinguish between aerodromes in the MRTM that communication with Airport Personnel is established with	Multiple	SRS-42 SRS-45 SRS-49 SRS-50 SRS-68
SRD-16	ATCO shall perform all tasks (procedures) to provide ATC Tower service to all aerodromes allocated to the MRTM	Pack	SRS-01 SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-11 SRS-12 SRS-13 SRS-14 SRS-15 SRS-17 SRS-18 SRS-16 SRS-19 SRS-20 SRS-21 SRS-22 SRS-23 SRS-24 SRS-25 SRS-27 SRS-28 SRS-31 SRS-32 SRS-29 SRS-33 SRS-34 SRS-35 SRS-36 SRS-37 SRS-38 SRS-39 SRS-59 SRS-60 SRS-61 SRS-65
SRD-17	ATCO shall be able to prevent overload and manage workload by: <ul style="list-style-type: none"> giving the responsibility of one or several ADs to an additional ATCO (or assistant) in the same MRTM reducing capacity by slowing traffic down terminating ATC service for one or several aerodromes if no other option is possible. transferring it/them to another MRTM 	Multiple	SRS-01 SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-11 SRS-12 SRS-13 SRS-14 SRS-15 SRS-17 SRS-18 SRS-16 SRS-19 SRS-20 SRS-21 SRS-22 SRS-23 SRS-24 SRS-25 SRS-27 SRS-28 SRS-31 SRS-32 SRS-29 SRS-33 SRS-34 SRS-35 SRS-36 SRS-37 SRS-38 SRS-39 SRS-59 SRS-60 SRS-61 SRS-65

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-18	In case a spare controller takes responsibility of one or several aerodromes from the same MRTM, handover/coordination procedures between both controllers shall be applied	Multiple	SRS-01 SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-11 SRS-12 SRS-13 SRS-14 SRS-15 SRS-17 SRS-18 SRS-16 SRS-19 SRS-20 SRS-21 SRS-22 SRS-23 SRS-24 SRS-25 SRS-27 SRS-28 SRS-31 SRS-32 SRS-29 SRS-33 SRS-34 SRS-35 SRS-36 SRS-37 SRS-38 SRS-39 SRS-59 SRS-60 SRS-61 SRS-65
SRD-21	ATCO allocated to an MRTM position shall apply the relevant MRT start-up procedure for each aerodrome before providing ATC service from that MRTM position (this start-up procedure includes check of the MRT capability)	Pack	SRS-41
SRD-22	ATCO shall inform Airport Personnel at each aerodrome allocated to the MRTM about the remote provision of ATC service (initiation, termination)	Pack	SRS-42 SRS-45 SRS-50 SRS-69
SRD-23	ATCO shall ensure that ATC services can be appropriately (safely) stopped at each aerodrome allocated to the MRTM in case the service has to be terminated	Pack	SRS-43 SRS-45
SRD-24	ATCO shall inform Airspace Users at each aerodrome allocated to the MRTM about the unplanned termination of the ATC service provision.	Pack	SRS-45
SRD-26	Clusters of aerodromes allocated to an MRTM shall be defined at local level in order to ensure that traffic levels and complexity do not exceed limitations so the ATCO can safely provide ATS services in nominal, abnormal and degraded conditions	Multiple	SRS-49
SRD-27	RTC Supervisor shall be able to access functions for planning, coordination (staffing, RTC, etc.) and monitoring of the upcoming and present traffic flow	Multiple	SRS-40 SRS-50
SRD-28	RTC Supervisor shall be able to provide relevant support to controllers in a the RTC in order to ensure safe ATC service (staffing, allocation of aerodromes)	Multiple	SRS-40 SRS-50
SRD-29	RTC Supervisor shall be able to access functions for the monitoring of weather for all the aerodromes in the RTC	Multiple	SRS-40

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-31	Surveillance data shall be provided to ATCO to support tasks for all aerodromes. Air surveillance data is mandatory while ground surveillance is optional	Pack	SRS-01 SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-026 SRS-027 SRS-029 SRS-030 SRS-31 SRS-32 SRS-61 SRS-65
SRD-32	Visual information on the vicinity of each aerodrome and the traffic in those areas shall be provided to ATCO to support tasks as in single remote tower operations	Pack	SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-31 SRS-32 SRS-29 SRS-59 SRS-60 SRS-61 SRS-65
SRD-33	Visual indication supporting A/C identification in the vicinity of each aerodrome allocated to the MRTM should be provided to the ATCO	Pack	SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-31 SRS-32 SRS-29 SRS-59 SRS-60 SRS-61 SRS-65
SRD-35	Visual information on the apron of each aerodrome allocated to the MRTM and traffic in those areas may be provided to ATCO to support tasks as in single remote tower operations	Pack	SRS-11 SRS-12 SRS-13 SRS-14 SRS-15 SRS-17 SRS-18 SRS-19 SRS-20 SRS-21 SRS-24 SRS-25 SRS-28 SRS-34 SRS-35 SRS-37 SRS-60 SRS-61 SRS-65
SRD-36	Visual indication supporting A/C and Vehicle detection (i.e. object bounding) in the manoeuvring area of each aerodrome allocated to the MRTM should be provided to the ATCO	Pack	SRS-14 SRS-15 SRS-17 SRS-18 SRS-60 SRS-61 SRS-65
SRD-37	Visual indication supporting detection of A/C, Vehicle, Personnel and Obstacle entering/being close to a runway of each aerodrome allocated to the MRTM should be provided to the ATCO	Pack	SRS-14 SRS-15 SRS-17 SRS-18 SRS-60 SRS-61 SRS-65
SRD-38	Visual presentation (VP) on the relevant parts of the manoeuvring area and the vicinity of each aerodrome shall be provided to ATCO to support tasks as in single remote tower operations	Pack	SRS-33 SRS-38
SRD-39	Visual presentation (VP) of the runway area for each aerodrome shall be provided to ATCO to support tasks as in single remote tower operations	Pack	SRS-34

Safety Req. ID	Safety Requirement (functionality & performance)	Type	Derived from SRS (ID)
SRD-40	Visual information available in the Visualisation System shall be provided in the several visibility conditions (CAVOK, darkness,...) for all aerodromes allocated to the MRTM	Pack	SRS-39
SRD-41	The PTZ shall be available for each aerodrome allocated to the MRTM in order to support ATC tasks as for Single Remote Tower	Pack	SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-31 SRS-32 SRS-29 SRS-59 SRS-60 SRS-61 SRS-65
SRD-42	Time, compass rose and aerodromes names should be provided on the visual presentation for each aerodrome allocated to the same MRTM	Pack	SRS-02 SRS-03 SRS-04 SRS-05 SRS-06 SRS-07 SRS-08 SRS-09 SRS-10 SRS-31 SRS-32 SRS-29 SRS-59 SRS-60 SRS-61 SRS-65
SRD-43	Managing visual navigation aids shall be provided to ATCO to support tasks for each aerodrome allocated to the MRTM	Pack	SRS-16 SRS-22
SRD-44	ATCO shall be able to manoeuvre non-visual navigation aids in order to support AC on landing operations for each aerodrome allocated to the MRTM	Pack	SRS-36
SRD-45	Local MET information shall be provided to ATCO to support tasks for all aerodromes	Pack	SRS-02 SRS-03 SRS-12 SRS-33 SRS-38
SRD-46	Information on present and incoming traffic (as well as real time airport capacity if applicable) and weather forecast shall be provided to the ATCO in order to be able to plan and manage ATCO resources adequately for a specific MRTM position.	Multiple	SRS-40
SRD-47	Published AIP information for each aerodrome allocated to the same MRTM shall be provided to ATCO	Pack	SRS-02 SRS-03 SRS-05 SRS-08
SRD-48	Airspace users shall be informed about the (planned) provision of remote ATC services though AIP	Pack	SRS-42 SRS-50 SRS-45

Table 28: SRD Normal Wave1

J.2 Safety Requirements at Design level (SRD) – Normal conditions of operation – Wave1

Table 2629 includes all the Safety Requirements on Design level – Abnormal conditions of operation from Wave1.

Safety Req. ID	Safety Requirement (functionality & performance) for abnormal operation	Type	Derived from SRS (ID)
SRD-24	ATCO shall inform Airspace Users at each aerodrome allocated to the MRTM about the unplanned termination of the ATC service provision.	Pack	SRS-45
SRD-30	Airport Personnel shall inform RTC about emergency or abnormal situation in the aerodrome premises that may affect the safe provision of ATC service	Pack	SRS-61 SRS-66
SRD-49	ATCO shall be able to remotely use signalling lamps to communicate with concerned traffic in each aerodrome allocated to the same MRTM	Pack	SRS-61
SRD-50	ATCO shall be able to activate accident/incident/distress alarms in order to alert relevant services in the correspondent aerodrome of the MRTM and to launch corresponding emergency procedures for that aerodrome	Pack	SRS-61 SRS-65
SRD-51	ATCO shall be able to activate accident/incident/distress alarms from one or more aerodromes allocated to the MRTM with relevant information	Multiple	SRS-61 SRS-65
SRD-52	ATCO shall be able to recognise alarms in order to prioritise and solve the possible situations	Multiple	SRS-61 SRS-65

Table 29: SRD Abnormal Wave1

J.3 Safety Requirements at Design level (SRD) addressing Internal Functional System Failures – Wave1

Table 2630 and Table 31 includes all the Safety Requirements on Design level addressing internal functional system failures from Wave1.

Safety Req. ID	Safety Requirement at Design level (SRD) (functionality & performance)	Type	Derived from SRS (ID) or Common cause failure
SRD-55	An alert should be provided to the controller in case of failure of the ground-ground communication service.	Pack	Mitigation mean identified from the hazard assessments of former project phases.
SRD-57	An alert should be provided to the controller in case of failure of the communication with personnel operating on the apron or vehicles/personnel operating on the manoeuvring area.	Pack	Mitigation mean identified from the hazard assessments of former project phases.
SRD-61	An alert shall be provided to the controller in case of failure or inappropriate information (delayed, corrupted, frozen, etc.) is provided on the visualisation system.	Pack	Mitigation mean identified from the hazard assessments of former project phases.
SRD-62	Data recorder system shall not negatively impact (corrupting data or inducing malfunction) the system from which data is recorded, including the data from the Visualisation system.	Pack	Mitigation mean identified from the hazard assessments of former project phases.
SRD-64	An alert should be provided to the controller in case of failure of the air-ground communication system.	Pack	Mitigation mean identified from the hazard assessments of former project phases.
SRD-68	In case of loss or degradation of ground-ground communication with adjacent ATSU units in a MRTM position relevant fallback procedures shall be applied.	Pack	Mitigation mean identified from the hazard assessments of former project phases.
SRD-69	In case of failure or degradation of ground-ground communication with personnel operating on the apron or vehicles/personnel operating on the manoeuvring area relevant fallback procedures shall be applied (e.g. use of flash gun lights).	Pack	SRS-70 Mitigation mean identified from the hazard assessments of former project phases.
SRD-70	In case surveillance function is available in the MRTM position, but the function is lost or the information provided is inappropriate and detected, relevant fallback procedures shall be applied	Pack	Mitigation mean identified from the hazard assessments of former project phases.

Safety Req. ID	Safety Requirement at Design level (SRD) (functionality & performance)	Type	Derived from SRS (ID) or Common cause failure
SRD-71	In case of loss of information or detected inappropriate information on a critical view of the visualisation (due to technical failure), a specific procedure shall be applied taking into account the timeframe of the failure mode (e.g. provision of ATC services limiting the simultaneous operations in the area of responsibility, using PTZ camera to get the corresponding lost image, stopping the provision of the service, etc.).	Pack	SRS-71 Mitigation mean identified from the hazard assessments of former project phases.
SRD-72	In case of failure of degradation or air-ground communication with traffic in a MRTM position, relevant procedures from PANS ATM [12] shall be applied (e.g. issuing clearances through the relevant APP controller).	Pack	SRS-70 Mitigation mean identified from the hazard assessments of former project phases.
SRD-73	In case of incorrect MET/Weather information is provided in a MRTM position, or no information at all is provided, controller shall contact relevant airport personnel in the airport in order to obtain this information and any relevant update, if not possible to obtain such information from any other source (e.g. pilots, visual inputs from the visual presentation, MET-office, www/internet).	Pack	SRS-70 Mitigation mean identified from the hazard assessments of former project phases.

Table 30: SRD (functionality & performance) to mitigate the operational hazards – Wave1

Safety Req. ID	Safety Requirement at Design level (SRD) (integrity /reliability)	Type	Derived from SRS integrity & reliability (ID)
SRD 200	The likelihood of inappropriate flight data information being provided by the Flight Data Processing system in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation	Pack/Multiple	
SRD 201	The likelihood of incorrect or missing arriving/departing procedures publications available to the controller in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation	Pack/Multiple	
SRD 202	The likelihood of incorrect or missing information concerning restricted areas in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	

Safety Req. ID	Safety Requirement at Design level (SRD) (integrity /reliability)	Type	Derived from SRS integrity & reliability (ID)
SRD 203	The likelihood of failure or degradation of ground-ground communication with adjacent ATSU units in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	
SRD 204	The likelihood of failure or degradation of Surface-ground communication with personnel operating on the apron or vehicles/personnel operating on the manoeuvring area in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	
SRD 205	In case surveillance data is available in the MRTM position, the likelihood that undetected inappropriate surveillance information on a flight is provided shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	
SRD 206	In case surveillance data is available in the MRTM position, the likelihood of complete lack of traffic information shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	
SRD 207	For a local implementation, corresponding assurance level for the software development process of the relevant components of the Visualisation System and its availability shall be defined based on applicable regulation.	Pack/Multiple	
SRD 208	The likelihood of failure or degradation of air-ground communication with traffic in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	
SRD 209	The likelihood of incorrect MET/Weather information provided in a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	
SRD 210	The likelihood of loss or dysfunction of Visual Navigation Aids manoeuvred from a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	
SRD 211	The likelihood of loss or dysfunction of Non-Visual Navigation Aids manoeuvred from a MRTM position shall be operationally acceptable as per regulation applicable to local implementation.	Pack/Multiple	

Table 31: SRD (integrity/reliability) to mitigate the operational hazards – Wave1

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