Step 1 Technical Specification

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Abstract

This document is the Technical Specification (TS) for AMAN for SESAR Step1. This technical Specification has been jointly developed by the projects P10.9.1 and P10.9.2. It covers all the AMAN enhancements addressed in SESAR Step1 by each project It includes final technical requirements for SESAR solutions 5 (Extended Arrival Management (AMAN) horizon) and solution 54 (Flow based Integration of Arrival and Departure Management), and draft requirements for solution 6 (Controlled Time of Arrival (CTA) in Medium density / medium complexity environment).

The document is a common deliverable of projects P10.9.1 and P10.9.2.

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Executive summary

This document is the Technical Specification (TS) for AMAN for SESAR Step1, based on operational requirements developed by projects P5.6.4, P5.6.7, P6.8.4 and P5.6.1.

This technical Specification has been jointly developed by the projects P10.9.1 and P10.9.2. It covers all the AMAN enhancements addressed in SESAR Step1 by each project. It includes final technical requirements for SESAR solutions 5 (Extended Arrival Management (AMAN) horizon) and 54 (Flow based Integration of Arrival and Departure Management), and draft requirements for solution 6 (Controlled Time of Arrival (CTA) in Medium density / medium complexity environment). This unique TS ensures the consistency and coherence of the AMAN specifications for the scope of the two projects.

The document is unique and is a common deliverable of projects P10.9.1 and P10.9.2. It has been developed based on the Integrated Roadmap/Master Plan Dataset 14. ([23])

This technical specification covers the following AMAN enhancements addressed in SESAR Step1 by projects P10.9.1 and P10.9.2:

- Extension of AMAN horizon
- Use of CTA (Controlled Time of Arrival) in Arrival Management
- Handling of departures from nearby airports
- AMAN/DMAN coupling on local airport
- Introduction of PMS (Point Merge Structure) in Arrival Management
- Cross Border Arrival Management

1 Introduction

1.1 Purpose of the document

This document describes the technical requirements for the AMAN for Step 1, mainly derived from the operational requirements developed by P5.6.4, P5.6.7, P5.6.1 and P6.8.4 available at the time this TS has been elaborated.

This technical specification covers the AMAN enhancements addressed in SESAR Step1 by projects P10.9.1 and P10.9.2

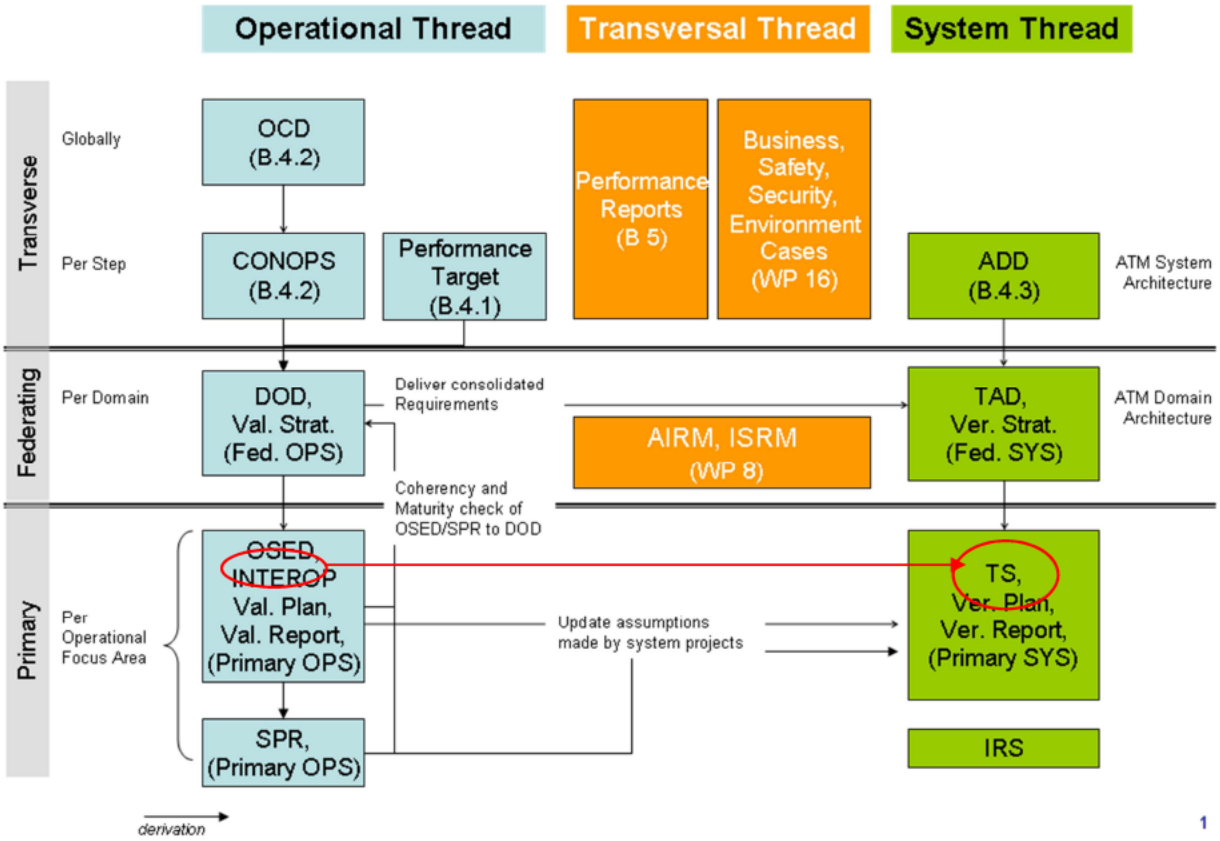

Figure 1: Flow of documentation overview [PMP]

1.2 Intended readership

The intended audience for this document encompasses but is not limited to the following projects within SESAR programme:

- P10.1.7 (ATC System Specification) as federating project, in charge of ensuring coherence among all the system requirements derived from all WP10 projects
- P5.6.4 (QM-4 – Tactical TMA and En-route Queue Management) as operational project dealing with the extension of the AMAN Horizon and the handling of departures from nearby airports.
- P5.6.7 (QM-7 – Integrated Sequence Building/Optimisation of Queues) as operational project dealing with Point Merge Structures (PMS) and Extended AMAN.
- P5.6.1 Ground and Airborne Capabilities to Implement Sequence as operational project dealing with CTA.

- P6.8.4 (Coupled AMAN/DMAN) as operational project dealing with AMAN and DMAN coupling
- P12.3.5 (Enhanced Sequencing Tools) for developing coherent DMAN requirements for coupling AMAN and DMAN
- P12.4.4 (Integration of departure management and surface management) for developing coherent DMAN SMAN requirements for coupling AMAN with DMAN integrated to SMAN.
- P10.9.4 (CDA/CCD in high density traffic) for review to ensure that results from its supported validation exercises are taken into account.
- P10.9.1 (Integration of queue management) for the implementation of the AMAN requirements relative to the scope of the project. P10.9.1.
- P10.9.2 (Multiple airport arrival/departure management) for the implementation of the AMAN requirements relative to the scope of the project. P10.9.2.
- 14.2.9 (SWIM Platform development and Demonstrator delivery) for the SWIM implementation aspects.
- P8.1.3 (AIRM Deliverable) for the SWIM modelling aspects.

1.3 Inputs from other projects

. The following documents have been used for this Technical Specification as relevant inputs from other projects:

- [10] WP10.01.07-D38-Pilot AMAN Baseline Specification 00.01.00 provides a baseline set of AMAN requirements in the context of Pilot 1
- [22] P10.01.07 D115 -Technical Architecture Description - Cycle 2014-, edition 00.01.01-20/05/2015
- [13] 05.06.07 D14 Step 1 AMAN + Point Merge in E-TMA OSED 00.01.01 15-04-2013
- [15] 05.06.04-D35 Final OSED – 02.00.00 10-09-2014
- [16] 05.06.01-D74 Step 1 OSED - Iteration 3 01.00.00 11-09-2013
- [17] P06.08.04.D17 S01V3 Final OSED, edition 01.01.00, 22/07/2015
- [18] P06.08.04.D18 S01V3 Final SPR, edition 00.01.00, 04/05/2015
- [19] P06.08.04.D82 S01V3 Final INTEROP, edition 00.01.01, 05/08/2015
- [20] P05.06.07.D15-Update of 5 6 4 OSED-Step 1, edition 00.01.01-03/08/2015
- [21] PP05.06.07.D16 Update of 5.6.4 SPR-INTEROP - Step 1, edition 00.01.00, 30/09/2015

1.4 Structure of the document

Chapter 1: Purpose and scope; Requirements structure; Component purpose and high level overview

Chapter 2: General component description;

Chapter 3: Component Capabilities, Conditions and Constraints

Chapter 4: Referenced documents

1.5 Requirements Definitions – General Guidance

Requirements have been developed according to the [8] SESAR Requirements and V&V Guidelines 03.01.00 and [7] SESAR Template Toolbox.

The requirement identifiers in the document follow the following syntax:

REQ-10.09.02-XXXX-YYYY

XXXX is the reference number1 which identifies the section of the document where the requirement is defined – 031x are used in the current version of the document for each subsection 3.1.x.

YYYY is the reference number2 which identifies the requirement for the subset of requirements REQ-10.09.02-TS-XXXX-YYYY is used from 0010 and by increment of 10 (0010, 0020, 0030,..)

The layout to be used in this document is the following:

[REQ]

Identifier	
Requirement	
Title	
Status	
Rationale	
Category	
Validation Method	
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<Enabler>	Enabler code	<Full>
<SATISFIES>	<ATMS Requirement>	INTEROP or SPR Requirement Identifier	<Full>
<ALLOCATED_TO>	<Functional block>	Functional block Identifier	N/A
<APPLIES_TO>	<Operational Focus Area>	Operational Focus Area Identifier	N/A
<CHANGED_BECAUSE_OF>	<Change Order>	Change reference	N/A
<ALLOCATED_TO>	<Project>	Project Identifier	N/A

Table 1: Requirements layout

1.6 Functional block Purpose

The Arrival Manager (AMAN) is intended to:

- Support air traffic controllers in the management of the flow of arriving traffic.
- Act as a collaborative tool in the arrival management process for the controller and airport.

The aims of the AMAN are to:

- Allocate the optimal runway
- Optimise the arrival sequence at the runway and in TMA,
- Regulate/manage (meter) the flow of arrival aircrafts,
- Provide advisories (TTL/TTG, CTA…) to controllers to support them in the management of arrival traffic.

To meet these objectives AMAN provides:

- Sequence at the runway or at the metering point
- Scheduled target time at the runway or at the metering point (APTT/APTO)
- Advisories to implement the target sequence (time to lose/time to gain, and optionally speed, route, manoeuvres advisories).

1.7 Functional block Overview

The Arrival Management function is defined in [22] P10.01.07 D115 -Technical Architecture Description - Cycle 2014-, edition 00.01.01 as a function in charge of:

- Providing optimal arrival sequence planning
- Supporting arrival delays optimization
- Distributing arrivals information to external clients
- Allowing manual actions over the sequence

In step 1 the Arrival Management function may interact with a Departure Management function in Master/Slave configuration in order to manage arrivals on a runway in mixed mode operations.

The Arrival Management function is a part of the global ER/APP ATC system, the figure below shows a high level functional decomposition of the ER/APP ATC System for Step1.

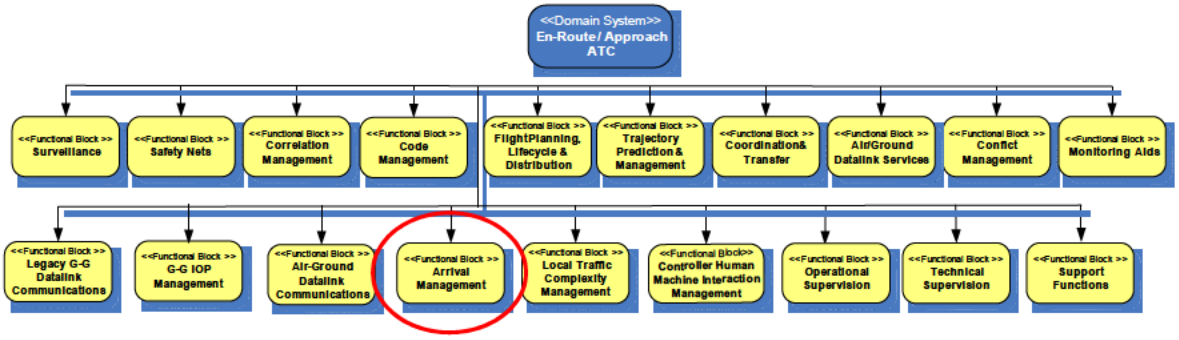

Figure 2: ER/APP ATC System Functional View

1.8 Glossary of terms

N/A

1.9 Acronyms and Terminology

Term	Definition
ADD	Architecture Definition Document
AFI	Arrival Free Interval
AGDL	Air Ground Data Link
AMA	Arrival Management Message

Term	Definition
AMAN	Arrival MANager function
APTO	Arrival Planned Time Over
APTT	Arrival Planned Threshold Time
ATM	Air Traffic Management
ATSU	Air Traffic Service Unit
CTA	Controlled Time of Arrival
CTOT	Calculated Take-Off Time
DCB	Demand and Capacity Balancing
DCT	DireCt To
DMAN	Departure MANager
DOD	Detailed Operational Description
E-ATMS	European Air Traffic Management System
E-TMA	Extended TMA
ETA	Estimated Time of Arrival
ETOT	Estimated Take Off Time
HMI	Human Machine Interface
IAF	Initial Approach Fix
IRS	Interface Requirements Specification
INTEROP	Interoperability Requirements
NM	Nautical Miles
OSED	Operational Service and Environment Definition
PMS	Point Merge Structure
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SM	Sequence Manager
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.

Term	Definition
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
STAR	Standard Terminal Arrival Route
SPR	Safety and Performance Requirements
TTG	Time To Gain
TTL	Time To Lose
TTOT	Target Take Off Time
TS	Technical Specification
TAD	Technical Architecture Description

Table 2: Acronyms

2 General Functional block Description

2.1 Context

This document is the Technical Specification (TS) for the SESAR Step1 AMAN.

The document [10] WP10.01.07-D38-Pilot AMAN Baseline Specification 00.01.00 has been considered as a baseline and has been taken as an input to develop this Technical Specification

This TS contains some essential baseline requirement and new ones developed over the analysed baseline, based on the operational concept developed by the operational thread, mainly in P5.6.1, P5.6.4, P5.6.7 and P6.8.4.

P5.6.1 is focussing its work in STEP 1 on:

Investigation of procedures and tools taking advantage of ground system support and airborne capability to implement sequences by issuing and applying CTA's.

P5.6.7 is focussing its work in STEP 1 on:

- Evaluation of the use of CTA techniques by AMAN in a mixed mode environment where not all aircraft are CTA (RTA) capable.
- Impact on AMAN of mixed equipage operations and/or of the use of different techniques to integrate arrivals in the sequence.

P5.6.4 is focussing its work in STEP1 on:

- The effect of extending the arrival management horizon into En Route airspace, especially on feasibility, including the En Route controllers workload, sequence stability issues and integration of flights departing from airports within the expended horizon
- The implementation of AMAN directives through advanced 'closed loop' procedures
- The identification of aspects of aircraft derived data (ADD) that may be useful in Arrival Management processes

P6.8.4 is focussing its work in STEP 1 on:

- Optimize traffic flow rather than to provide a proper integrated arrival/departure sequence.
- AMAN/DMAN will be coupled in a Master/Slave configuration, where the AMAN, as master, will be in charge of calculating the arrival sequence and providing Arrival Free Intervals (AFIs) where DMAN will allocate the departure sequence.

2.2 Functional block Modes and States

The state is a technical configuration of the system. The system can be in only one state at a time even if it is possible to switch from one state to another by a supervision command.

The system can be configured in three different states to provide operational and test capabilities:

- **Operational** state identifies AMAN running in the operational environment of the system for ER/APP ATC control purposes.
- **Shadow** state offers the same capacities as the operational state, but the AMAN is not being used for control purpose.
- **Test** state identifies the AMAN running in the ATC system test environment.

The mode characterises the way the system is operating in respect to the availability of its functions.

The system can be in three different modes:

- **Operational:** In operational state, the system is designed to provide continuous operational service despite the failure of a function. Under normal circumstances all functions are in use, and actively processing data. This mode is the operational one which is the system's normal mode of operation.
- **Degraded**: A function can automatically (as a result of failure) or manually be switched off at any time, leading to a degraded mode of operation.
- **Failure**: A significant set of functions, necessary for the continuation of the ER/APP ATC service, are not available.

Transitions between these three modes can be illustrated as follows:

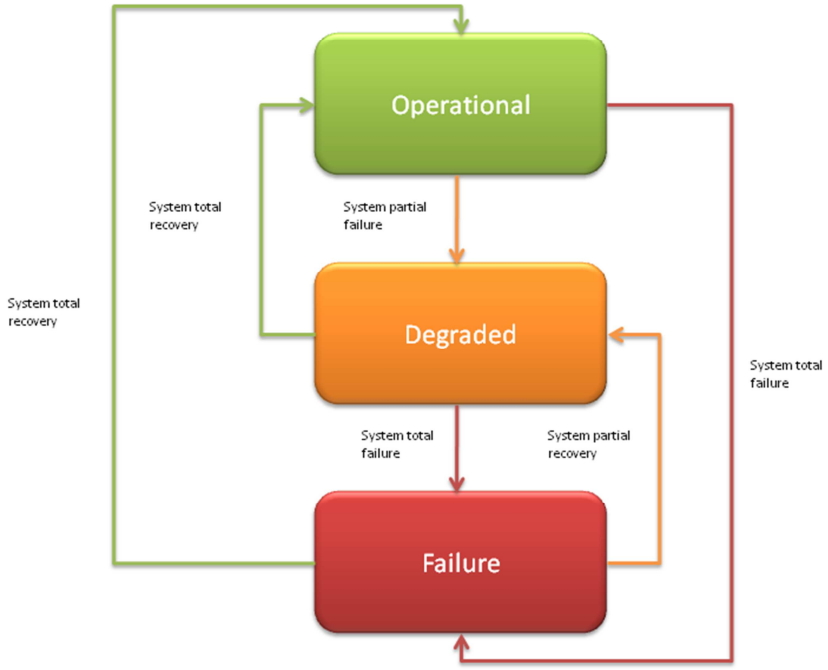

Figure 3: Functional blocks modes and states

2.3 Major Functional block Capabilities

To cover AMAN STEP 1 SESAR scope the following capability topics have been identified to be improved:

- AMAN Horizon
- Sequence & Stability
- AMAN & CTA
- AMAN extended Horizon
- Cross Border Arrival Management

- Departure from nearby airports
- AMAN/DMAN coupling
- AMAN & PMS
- AMAN HMI

In Chapter 3.1 a set of requirements has been established for each of these topics.

2.4 User Characteristics

This section describes the main actors involved in using AMAN.

2.4.1 Sequence Manager

The Sequence Manager (SM) plays an essential role in the AMAN operational environment, being responsible for the whole arrival traffic management in the overall airspace. He has to monitor a wide working area, must be familiar with the applied procedures and local practices and his key role should be recognised and accepted by the other ATCOs involved in terminal and approach operations. Although responsible for the sequence management in the overall airspace involved, the SM does not intervene tactically and directly in arrival sectors (ARR), in order not to interfere with the arrival operations, but coordinates with the Sequence Manager of adjacent airports the most suitable strategy and/or tactical action. This position has been designed to be coherent with the current Coordinator position. Basically he is an enhanced Coordinator, playing the same role of Coordinator with the addition of the AMAN Decision Support Tool.

The Sequence Manager ensures the provision of the pattern based on the Demand Vs Capacity planning expected for the next x [minutes]. The role of the Sequence Manager is the monitoring of the approach sequence defined by AMAN and the adjustments aiming at the smoothing of the arrival traffic management and the reduction of the overall delay. For these purposes, the SM has two main strategies:
The primary strategy is to intervene manually on the Arrival sequence and schedule to resolve the problem. This can be achieved by:

- Swapping the aircraft position in the sequence,
- Changing the aircraft scheduled arrival time,
- Removing a flight temporarily from the sequence and manually re-inserting it when traffic permits.

If the primary strategy is not applicable, the SM applies a secondary strategy involving the Planning Controller of the concerned sectors, providing him with a specific instruction to apply. This strategy may involve one of the following actions:

- Apply speed control, early descent, or a combination of both, if this has not already been implemented by the sector inside his/her intervention area.
- Apply strategic headings, re-routing or change of IAF.

The upstream sector planner informs the tactical controller in order to evaluate the applicability of the proposal. If unable to comply, the planning or tactical controller may reject the proposal. In case the instruction is provided to the SM, this latter in turn informs the Arrival Controllers and evaluates with them the applicability of the solution proposed.
In case of a rejected proposal, the SM may:

- Provide the concerned (en-route) sector with an alternative strategy
- Apply one of the primary strategies if now possible or it has not already been addressed

In all cases the SM monitors the strategy applied or the instruction given.

2.4.2 E-TMA Controller

E-TMA controllers conform to the standard Tactical and Planning Controller roles in use, apply delay actions suggested by the Sequence Manager. They are requested to apply specific speed reduction/adjustment rules or act according to the AMAN advisories or SM approach strategy.
If necessary they coordinate different delay actions with the SM in order to absorb the delay. In dealing with AMAN advisories, the main Planner tasks are to:

- Comply with the instruction received from the Sequence Manager (in this case the planner evaluates the applicability of the proposed strategy in co-operation with the Executive Controller if needed, and if unable to comply rejects the proposal).
- Monitor the delay advisories, assessing the sequence proposed by AMAN
- Ensure handover of aircraft to the sectors in the correct order.

In detail, each Executive Controller shall apply the following rules when dealing with the AMAN advisories:

- Act on the advisory only when it is stable (e.g. when the trend of Advisories or number in sequence is constant)
- Act on the advisories only when the a/c is in the intervention area

Therefore when the a/c enters the intervention area with a stable advisory, the Executive Controller should react to the advisory by applying:

- Speed reductions
- Early descent
- A combination of speed reduction and early descent.

Coordination with the SM is necessary in the case a deviation from the principles above is needed. In this case the Executive Controller may have to:

- Deal with advisories outside the intervention area
- Deal with the advisory in a different way (e.g. different speed reduction, earlier descent, heading, re-routing, etc.)

In order to allow AMAN to operate efficiently, the upstream sector controllers are requested to follow AMAN advisories.

2.4.3 Approach Controller

Approach controllers clear the traffic to comply with a pre-sequencing phase as established by the Sequence Manager and comply with AMAN advisories associated with the inbound traffic in his sector. In case of PMS airspace, they manage the aircraft entrance into the sequencing legs and the navigation through the sequencing legs until the instruction to the merge point.

2.5 Operational Scenarios

The operational scenarios are described in section 5 of:

- [20] P05.06.07.D15-Update of 5 6 4 OSED-Step 1, edition 00.01.01-03/08/2015.
- [17] P06.08.04.D17 S01V3 Final OSED, edition 01.01.00, 22/07/2015

2.6 Functional

2.6.1 Functional decomposition

2.6.1.1 ER/APP ATC System Context

The Arrival Management function is a part of the global ER/APP ATC system. The figure below shows a high level functional decomposition of the ER/APP ATC System for Step1 (provided by [22] P10.01.07 D115 -Technical Architecture Description - Cycle 2014-, edition 00.01.01- 20/05/2015)

The main functions of the ER/APP ATC system that are involved in Arrival Management operations are highlighted with a red circle.

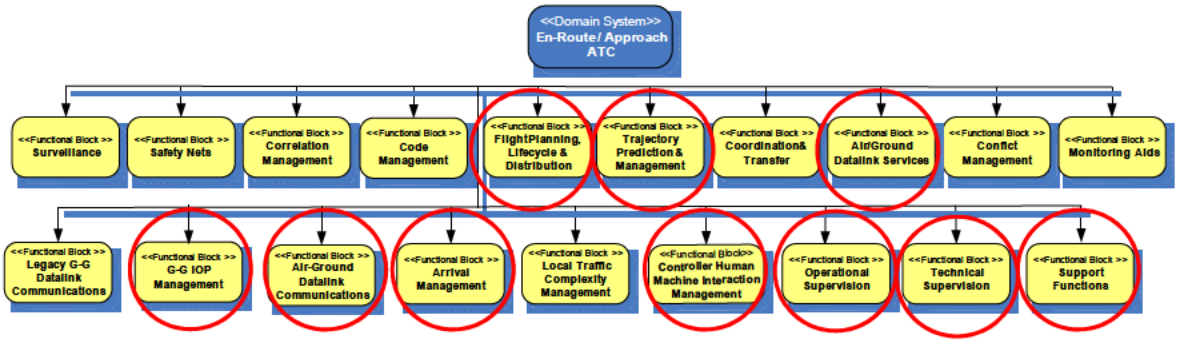

Figure 4: ER/APP ATC System Context

It is also possible to find, in this document, some requirements allocated to the Functional Block "*En-Route Sequence and Flow Management*" (ESFM). This FB is not defined in the current TAD mentioned above [22], but it was agreed with 10.07.01 that this new FB will be defined in the next version of the TAD. This is why the traceability to ESFM is already done.

2.6.1.2 AMAN Functional decomposition

Below is the functional decomposition of the Arrival Management function as defined in [11] 10.01.07 D37 Pilot ATC System Architecture – Arrival Management 00.04.00. The Technical Management sub function has been reintroduced as an initial Pilot architecture. The nature of the AMAN enhancements in Step 1 developments does not require a more detailed decomposition. These evolutions do not introduce new functions but improve the existing ones.

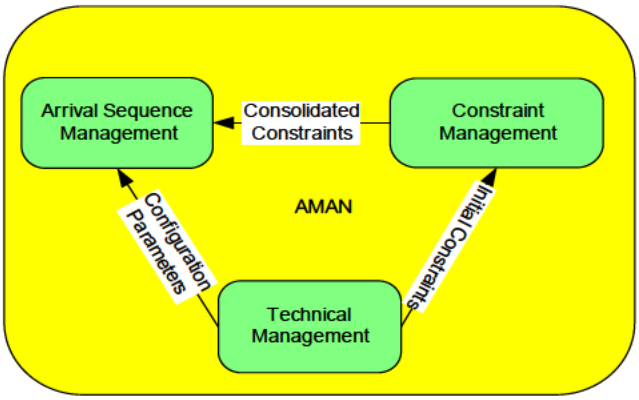

Figure 5: Arrival Management – Functional Decomposition

The Arrival Management function can be divided into three main sub functions:

- Arrival Sequence Management

This function calculates an optimized arrival sequence at pre-defined sequencing points (Metering Fixes, runway threshold…) for the incoming traffic. This function allocates for each sequenced flight the arrival runway and the metering fix. The sequence is optimised according to the density of traffic and the performance characteristics of the aircrafts. It generates control actions advisories necessary to achieve the computed arrival sequence and ensures distribution of this information. The arrival sequence on the sequencing point is determined from the ETO calculated by a trajectory prediction function.

- Constraint Management

This function is in charge of the management of all the constraints to be taken into account by the Arrival Sequence Management for the computation of the arrival sequence (initialisation of the constraints from the off-line defined data, controller action modifying the AMAN configuration, Aerodrome ATC runway changes, departure slots). In order to keep the controller informed, this function is also in charge of providing the controller HMI with the current AMAN configuration.

- Technical Management

This function is in charge of the technical support of the Arrival Management function. It interfaces the Support function for initial configuration of the AMAN function and the recording. It has also an interface with the technical supervision for monitoring of the function.

2.6.2 Functional analysis

The following NSV-4 diagram represents a functional decomposition analysis of the Arrival Management function. It gives a high level picture of different ATC system sub functions that are involved in the realisation of Arrival Management operational needs and different necessary data flows between these sub functions. The purpose here is not to give detailed architecture views, but to ease an initial understanding of how Step 1 AMAN system requirements will impact the global system from a functional point of view.

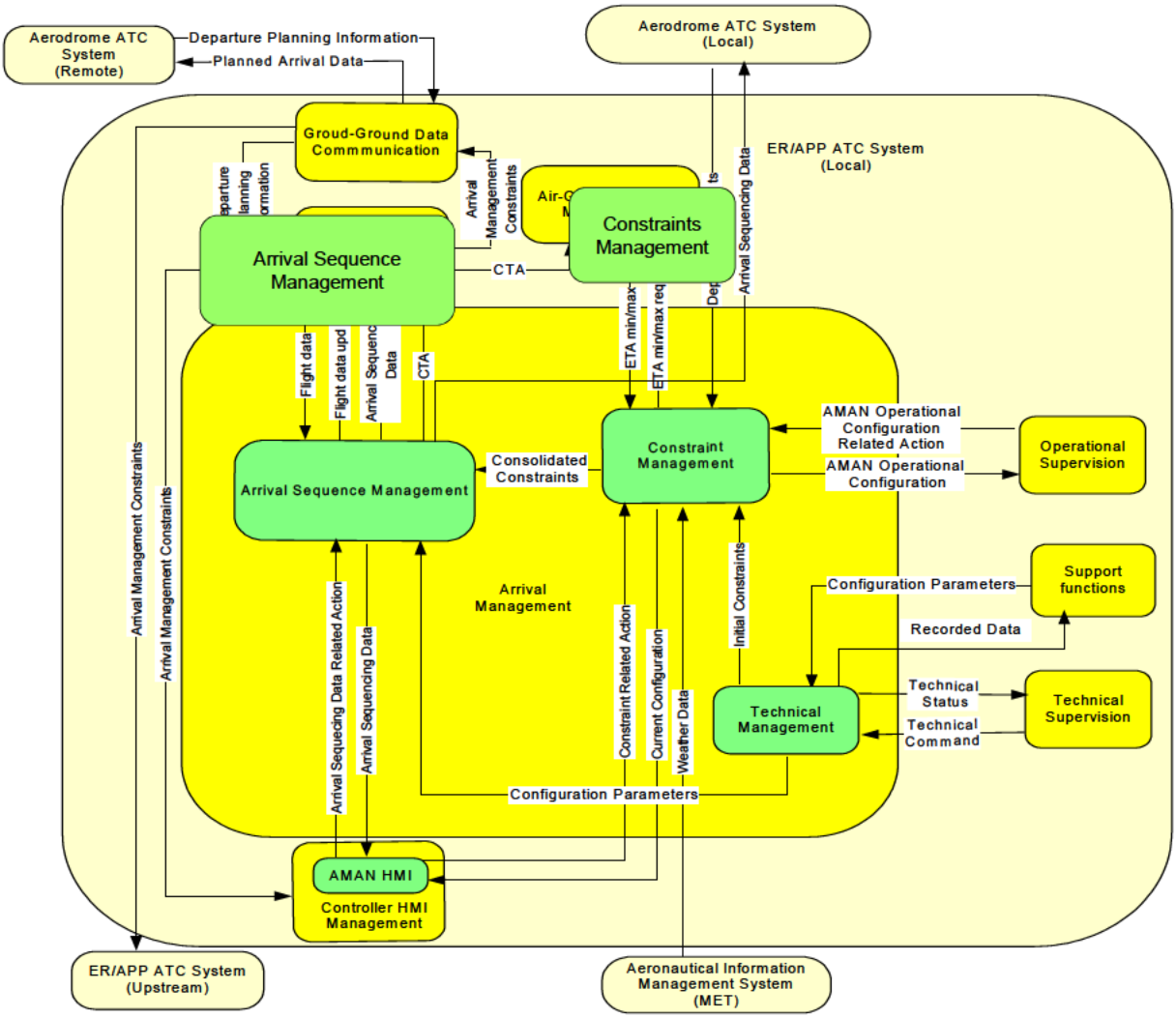

Figure 6: Arrival Management – Functional Analysis

The detail of data flows description can be found in [12] 10.09.01 10.09.02 Architecture Definition Report .

The following table summarizes the impact of AMAN Step 1 enhancements on the ATC systems functions and the involved external systems.

Step 1 Enhancement	Impacted ER/APP ATC system Functions	Involved external system
Sequence & Stability	Arrival Sequence Management	

Extension of the AMAN Horizon	Arrival Sequence Management Flight Data Processing Ground-Ground Data Communication	ER/APP ATC System (Upstream)
Handling of departures from nearby airports	Arrival Sequence Management Flight Data Processing Ground-Ground Data Communication	Aerodrome ATC System (Remote)
AMAN/DMAN coupling	Arrival Sequence Management Constraint Management	Aerodrome ATC System (Local)
AMAN and Point Merge System	Arrival Sequence Management	
AMAN & CTA	Arrival Sequence Management Constraint Management Flight Data Processing Air-Ground Datalink	

2.7 Service View

In the scope of Extended Arrival Management “Arrival Management Information Service (SCV005)” has been defined in the ISRM 1.3 ([24]) and the Yellow Profile ([24]).

3 Functional block Functional and non-Functional Requirements

3.1 Capabilities

3.1.1 AMAN Horizon Requirements

The following configurable horizons are considered for arrival management:

- **The eligibility horizon**: AMAN shall build the arrival sequence taking into account the flights located at least in the Eligibility Horizon (Eligible flights). While inserting flights entering the eligibility horizon in the sequencing process, the arrival sequence is built and may be unstable due to optimisation computation in this elaborating phase and is not intended to be applied by the controllers.
- **The active advisory horizon**: AMAN shall provide advisories for the flights located in the Active Advisory horizon in order to provide Controllers with guidance to implement the arrival sequence. The controllers are responsible for issuing the control actions in order to achieve the arrival sequence.
- **Frozen horizon**: Within this horizon no automatic update of the sequence by AMAN will occur (no automatic swapping of flights, no automatic optimization of the sequence position, no automatic update of arrival sequence). But manual updates of the sequence are allowed within this horizon.

Note: ETA referred in the requirements below is ground system computed time. The ground system could use aircraft derived data in its calculation.

Identifier	REQ-10.09.02-TS-0311.0010
Requirement	AMAN shall compute a arrival sequence for a set of runways of a list of managed airports.

Identifier	REQ-10.09.02-TS-0311.0020
Requirement	AMAN shall create a Flight upon the first reception of data for the flight if the destination airport is a managed airport.

Identifier	REQ-10.09.02-TS-0311.0030
Requirement	AMAN shall update a Flight upon the reception of updated data for this Flight.

Identifier	REQ-10.09.02-TS-0311.0040
Requirement	AMAN shall consider a Flight eligible for the Arrival sequence computation if the flight satisfies either the [Eligibility_Horizon_Time] or the [Eligibility_Horizon_Geographic] criteria.

Identifier	REQ-10.09.02-TS-0311.0050
Requirement	AMAN shall consider a Flight within the Active Advisory Horizon if the Flight satisfies either the [Active_Horizon_Time] or the [Active_Horizon_Geographic] criteria.

Identifier	REQ-10.09.02-TS-0311.0060
Requirement	AMAN shall be provided with Flight Plan information for flights arriving at airports managed by AMAN once they reach the defined Eligibility Horizon.

3.1.2 Sequence & Stability Requirements

These requirements present the different steps of the arrival sequence computation for each flight and the stability model to be applied:

- Arrival runway allocation,
- Metering point allocation,
- Sequence computation
- Schedule, APTO, APTT and delay computation
- Delay apportionment strategy,
- Priority and stability model.

Identifier	REQ-10.09.02-TS-0312.0010
Requirement	AMAN shall update the arrival sequence upon the following events : • periodically according to the [Sequencing Period] and possibly event-based on a receipt of Flight data update • on receipt of a command from a sequence manager. • airport configuration change (runway configuration change, capacity change, runway closure..).

Identifier	REQ-10.09.02-TS-0312.0020
Requirement	AMAN shall allocate a landing runway to sequence a Flight taking into account the TMA configuration (runway orientation and dependencies, runway rates and closures), the Arrival Runway Allocation rules and the Flight ETA for the possible landing runways.

Identifier	REQ-10.09.02-TS-0312.0030
Requirement	For each eligible flight AMAN shall set a route point in the Active Advisory Horizon as the Metering Point according to the allocated runway and the TMA configuration.

Identifier	REQ-10.09.02-TS-0312.0040
Requirement	AMAN should allow the manual assignment of the Metering Point for a Flight.

Identifier	REQ-10.09.02-TS-0312.0050
Requirement	AMAN shall apply a Flow constraint on each Metering point to determine the spacing between two successive flights over the Metering Point when computing the APTO on the Metering Point.

Identifier	REQ-10.09.02-TS-0312.0060
Requirement	For each sequenced Flight, AMAN shall compute the APTT at the runway threshold taking into account the Flight ETA, the TMA configuration, the allocated landing runway and the separation constraints (at the runway and at the allocated metering point).

Identifier	REQ-10.09.02-TS-0312.0070
Requirement	The APTOs on any allocated metering point and intermediate points shall be computed from the flight's APTT at the runway threshold.

Identifier	REQ-10.09.02-TS-0312.0080
Requirement	The arrival sequence shall be revised on any arrival sequence update.

Identifier	REQ-10.09.02-TS-0312.0090
Requirement	For each Flight AMAN shall compute the total delay at the runway to be

	absorbed after each schedule update for the allocated runway.
	Total delay is the difference between the APTT at the runway threshold and the current ETA at the runway threshold.

Identifier	REQ-10.09.02-TS-0312.0100
Requirement	For each Flight, AMAN shall compute the total delay at the Metering Point to be absorbed after each schedule update for the allocated Metering Point.
	Total delay shall be the difference between the APTO at the Metering Point and the current ETA on the Metering Point of this Flight.

Identifier	REQ-10.09.02-TS-0312.0110
Requirement	AMAN shall allow splitting the total delay for a Flight to different segments of the Flight route according to a predefined delay apportionment strategy.

Identifier	REQ-10.09.02-TS-0312.0115
Requirement	AMAN shall allow allocating the resulting partial delays to different segments of the Flight route according to a predefined delay apportionment strategy.

Identifier	REQ-10.09.02-TS-0312.0120
Requirement	AMAN should provide delay absorption advisories for any scheduled Flight.

Identifier	REQ-10.09.02-TS-0312.0130
Requirement	The AMAN shall implement a priority model to manage the sequence of the flights to cope with specific operational situations such as emergency flights, state flights.

Identifier	REQ-10.09.02-TS-0312.0140
Requirement	The AMAN shall implement a stability model to cope with different levels of automation of the arrival management between the system and the controllers: • Unstable : the arrival sequence is managed by the system • Stable : the management of the arrival sequence is shared by the system and the controllers, controllers commands enable to adjust the sequence • Frozen : the arrival sequence is managed by the controllers The level of automation applied to a flight schedule shall decrease as the flight advances to its destination depending on the stability model configuration. In addition specific triggers set the stability for a given Flight prevailing on the above standard rule.

Identifier	REQ-10.09.02-TS-0312.0150
Requirement	AMAN shall take into account applicable ATC strategies in the sequence computation.

Identifier	REQ-10.09.02-TS-0312.0160
Requirement	AMAN shall provide Arrival Management Information to be distributed to all concerned actors.

Identifier	REQ-10.09.02-TS-0312.0170
Requirement	Arrival Management Information items referring to a time constraint established for the purposes of Arrival Management shall be made available with precision of one second.

3.1.3 AMAN & CTA Requirements

The Arrival Management uses i4D operations and capabilities in the sequencing process. In this section “i4D capable” means that aircraft and airground ATC system support the ETA min/max dialog and the uplink and application of CTA. For i4D capable aircraft, the system allows to first get a time window on the metering point (ETA min/max). AMAN takes into account the aircraft ETA min/max when received for the flight sequencing and proposes a CTA on the metering point. The AMAN proposed CTA value is the APTO value resulting of the sequencing and scheduling process. For i4D capable aircraft the CTA is uplinked to the aircraft by datalink.

neither i4D equipped nor CTA equipped, AMAN does not propose a CTA but only advisory (including APTO). The controller may negotiate with the aircraft and set directly a CTA on the metering point to implement the sequence advisory. In such a case the Arrival Management shall update the sequence for the traffic, taking into account this contracted time constraint for this flight if it is compatible with the global sequence.

When a CTA is set for a flight on the metering point, the arrival management shall handle the flight as collaborative in the sequence since it is more predictable.

Identifier	REQ-10.09.02-TS-0313.0010
Requirement	For i4D capable aircraft, AMAN shall request the ETA min/max on the metering point.

		REQ-05.06.01-OSED-SG05.0400	

Identifier	REQ-10.09.02-TS-0313.0020
Requirement	The system shall uplink the request for the ETA min/max to the aircraft and make available to AMAN the ETA min/max received from the aircraft.

Identifier	REQ-10.09.02-TS-0313.0030
Requirement	AMAN should allow a controller to manually request the ETA min/max on the metering point.

Identifier	REQ-10.09.02-TS-0313.0040
Requirement	For i4D capable aircraft, AMAN shall schedule the flight taking into account the ETA min/max when available and propose a CTA on the metering point.

Identifier	REQ-10.09.02-TS-0313.0050
Requirement	The system shall inform AMAN of any CTA acceptance on the metering point once performed by system and aircraft.

Identifier	REQ-10.09.02-TS-0313.0060
Requirement	If the flight is not under control of the system hosting or associated with the AMAN, the system shall transmit the AMAN proposed CTA to the upstream ATC system.

Identifier	REQ-10.09.02-TS-0313.0070
Requirement	When the AMAN proposed CTA is set for a flight on the metering point, AMAN shall handle the flight as collaborative in the sequence and increase flight’s stability in the sequencing process.

Identifier	REQ-10.09.02-TS-0313.0080
Requirement	When a CTA on the metering point is cancelled, AMAN shall handle the flight

	as in normal operations in the sequence and re-evaluate flight's stability in the sequencing process.

Identifier	REQ-10.09.02-TS-0313.0090
Requirement	When a CTA is set for a flight on the metering point, without being proposed by AMAN, AMAN shall try to update the sequence for the traffic taking into account this contracted time constraint for this flight. When the sequence update is possible, AMAN shall update the sequence, handle the flight as collaborative in the sequence and increase flight's stability in the sequencing process.
	neither i4D equipped nor CTA equipped

Identifier	REQ-10.09.02-TS-0313.0100
Requirement	When a CTA is set for a flight on the metering point, without being proposed by AMAN, AMAN shall try to update the sequence for the traffic taking into account this contracted time constraint for this flight. When the sequence update is not possible, AMAN shall provide a feedback to the appropriate controllers.
	neither i4D equipped nor CTA equipped

Identifier	REQ-10.09.02-TS-0313.0110
Requirement	Ground computed constraints shall only be proposed as a CTA when the CTA is known (i4D flights) or estimated by the ground system (non i4D flights) to be within the aircraft's performance and navigation capability or to indicate to the ATCO that the proposed CTA is outside the aircraft's performance.

Identifier	REQ-10.09.02-TS-0313.0120
Requirement	In the Arrival Management process where a CTA is to be applied, the ground unit(s) should complete the process (CTA assigned to and agreed by the Flight Crew) 5-10 minutes prior Top of Descent. When Flight is still under Upstream ATSU control, downstream ATSU shall provide the upstream ATSUs with any required time constraint in a time consistent with the requirement to complete the CTA allocation and agreement process 5-10 minutes prior to border crossing time

Identifier	REQ-10.09.02-TS-0313.0130
Requirement	2D trajectory synchronisation shall be performed and completed before starting CTA process by AMAN (ETA min/max request …)

Identifier	REQ-10.09.02-TS-0313.0140
Requirement	Only one CTA shall be proposed by AMAN automatically.
	Once a CTA proposal was withdrawn as lapsed, or cancelled by operator, AMAN shall not automatically propose a new CTA.

3.1.4 AMAN Extended Horizon Requirements

The system informs the upstream ATC system of the arrival management constraints for flight under the control of the upstream ATC unit and subject to transfer to the ATC system, in order to allow the upstream ATSU to perform the required control actions in its area of responsibility to implement the arrival management sequence.

Note: Extended AMAN may require or include cross border arrival management operations, depending in the local context where it is implemented. (3.1.9 Cross Border Arrival Management requirements)

Identifier	REQ-10.09.02-TS-0314.0010
Requirement	If the flight is not under control of the system, the system shall transmit to the

	upstream ATC system arrival management constraints applicable for the flight in order to implement the arrival sequence. According to the LoAs between the ATSUs, the arrival management information to be transferred shall include one or more of the following data: • metering point and time over metering point • total delay to be absorbed at metering fix • advisory to implement the target (time at COP, or speed or route advisory) • Sequence number of the flight
	The information is transferred via the OLDI AMA message or via SWIM service.

Identifier	REQ-10.09.02-TS-0314.0020
Requirement	According to LoAs between the ATSUs and to the delay apportionment strategy, AMAN shall allow to allocate a part of the delay to be absorbed by the upstream ATC system prior to the transfer of the flight.

Identifier	REQ-10.09.02-TS-0314.0030
Requirement	The system should make available to the appropriate controller working position the arrival management constraints applicable for a flight and notified to the upstream ATSU in order to support the coordination/transfer dialog with the upstream ATSU.

Identifier	REQ-10.09.02-TS-0314.0040
Requirement	The system should allow to identify discrepancy between coordination data with the upstream ATSU and applicable arrival management constraints for the corresponding flight (such as on time at COP).

Identifier	REQ-10.09.02-TS-0314.0050
Requirement	In case the discrepancy between coordination data with the upstream ATSU and applicable arrival management constraints for the corresponding flight exceeds a predefined value, an indication should be presented at the appropriate working position

3.1.5 Departure from nearby airports Requirements

Some requirements in this section are allocated to the aerodrome system of the regional airport and not to the ATC system.

In order to prevent disturbance of the arrival sequence for late appearing flight and to reduce the delay to be absorbed while the flight is airborne, flight departing from a nearby airport within the AMAN horizon is considered in the arrival sequencing process prior to its departure when departure planning information is available with a reasonable confidence in its planned estimated departure time.

AMAN at the destination sequences the flight and computes a APTO on the metering point taking into account the flight data and trajectory estimates based on the airport ETOT.
The computed APTO is made available at regional airport. The aim here is to allow the aircraft to absorb some delay on the ground. The regional airport will issue a TTOT compatible with the departing traffic and the delay absorbable on ground.
Prior to departure, updates of ETOT/TTOT will not trigger flight re-sequencing at the destination as long as these updates are compatible with the APTO.

The provision of requirements for handling departures from nearby airports with Airport system with a complete DMAN and integrating the CDM process is not in the scope of Step1.

In Step1 we only consider the interaction with regional airports with airport system with a simplified set of functions to handle the airport traffic.

In this section the requirements are presented in two subsections, the first one with the requirements allocated to the ATC system, the second one with the requirements allocated to the aerodrome system of the regional airport.

3.1.5.1 Requirements allocated to ATC system

Identifier	REQ-10.09.02-TS-0315.0010
Requirement	AMAN shall receive updates of flight data and trajectory estimates taking into account the departure planning information (ETOT/TTOT, departure route) from the departure airport for a flight departing from a nearby regional airport in AMAN horizon..

Identifier	REQ-10.09.02-TS-0315.0020
Requirement	AMAN shall sequence a flight departing from a nearby airport in the AMAN horizon prior to departure when reliable departure planning information is available. AMAN shall compute a APTO on the metering point for such a flight.

Identifier	REQ-10.09.02-TS-0315.0030
Requirement	Updates of departure planning information shall trigger a revision of APTO only if the updated planned trajectory is incompatible with the currently allocated APTO.
	APTO

Identifier	REQ-10.09.02-TS-0315.0040
Requirement	The system shall publish planned arrival data for each flight departing from a nearby airport and sequenced at destination prior to departure with the following data : • Flight identification data that allows external systems to uniquely identify the flight • APTT for runway threshold • APTO for metering point • STAR if applicable • TTL/TTG. The data has to be transferred to the nearby airport. Time delivery shall not exceed 10 seconds.

3.1.5.2 Requirements allocated to aerodrome system

Identifier	REQ-10.09.02-TS-0315.0050
Requirement	The Aerodrome System shall publish departure planning data for each flight departing from the aerodrome with the following data : • Flight identification data that allows external systems to uniquely identify the flight • ETOT / TTOT • Departure route Revision of departure planning data shall be published along the departure planning process. Departure planning data time of delivery shall not exceed 10 seconds.

Identifier	REQ-10.09.02-TS-0315.0060
Requirement	The Aerodrome System shall receive and shall take APTO, TTL/TTG advisory from AMAN into account and computes TTOT for the departing flight from the aerodrome.

Identifier	REQ-10.09.02-TS-0315.0070
Requirement	The Aerodrome system shall have the capacity to display the planned arrival data and allow to manually input a TTOT for departing flight from the aerodrome.

3.1.6 AMAN/DMAN coupling Requirements

For step 1 operations, AMAN/DMAN coupling is expected to optimise traffic flows rather than to provide a proper integrated arrival/departure sequence. Therefore, for step1, AMAN/DMAN coupling will only achieve a flow-based integration supported by a Master/Slave configuration between AMAN (Master) and DMAN (Slave).

In principles, AMAN, as master, will elaborate the arrival sequence and offer some so-called Arrival Free Intervals (AFIs) for departure where DMAN will allocate the departure sequence.
AFIs will only be modifiable by AMAN and will always represent constraints for DMAN.

AMAN will calculate AFIs by taking into account departure demand and sequence patterns that reflect the strategy to allocate AFIs i.e. the standard order for processing in- & outbound flights (in other terms the number of departures that can be placed between two successive arrivals).

The sequence patterns should be established taking into account the following separation constraints:

- Separations between Arrivals
- AFIs
- No separations between Departures (neither SID nor Vortex separation, like with basic DMAN only capacity is considered)

The supervisor should be the one that manually adjusts the pattern based on the forecasted KPIs (for the time being, we are considering only the runway rate). Sequence patterns will be established automatically by the system if no pattern is established by the Sequence Manager.

An AFI describes the standard amount of nautical miles (gap) to be maintained between two consecutive arrivals in order to process one or more departures in between, according to the pattern. Sequence Manager should provide as an input to AMAN (also available by adaptation data):

- Size of gap in NM needed to accommodate a departure between successive arrivals
- Size of gap in NM needed to accommodate two departures between successive arrivals
- Minimum gap in NM between arrivals when there is no vortex separation.

The separations associated to each pattern might vary on a daily basis (e.g. due to different weather conditions) and have to be adjusted by the Sequence Manager whenever necessary in distance – but the system has to transfer these distances into times in order to be able to provide the times as output.

Identifier	REQ-10.09.02-TS-0316.0010
Requirement	AMAN and local DMAN shall manage the arrival sequence and the departure sequence at the airport in a master/slave configuration where AMAN is the Master and DMAN is the slave.

Identifier	REQ-10.09.02-TS-0316.0020
Requirement	AMAN shall be able to use ETA as the runway threshold arrival demand time for all expected arrivals, a configurable value of minutes in advance. (i.e. the earliest possible time to schedule that aircraft to land).

Identifier	REQ-10.09.02-TS-0316.0030
Requirement	AMAN shall be able to use a revised value of ETA, whenever it changes by more than a configurable value of minutes.

Identifier	REQ-10.09.02-TS-0316.0040
Requirement	AMAN shall be able to use TOT (Take-Off Time) as the take-off demand time for all expected departures, a configurable value of minutes in advance (i.e. the earliest possible time to schedule that departure).

Identifier	REQ-10.09.02-TS-0316.0050
Requirement	AMAN shall be able to use a revised value of TOT (Take-Off Time) whenever it changes by more than a configurable value of minutes.

Identifier	REQ-10.09.02-TS-0316.0060
Requirement	AMAN shall receive the size of gap in NM needed to accommodate the required number of departures between two successive arrivals, to be able to satisfy the established pattern.

Identifier	REQ-10.09.02-TS-0316.0070
Requirement	AMAN shall be able to use the minimum gap in NM between arrivals when there is no vortex separation.

Identifier	REQ-10.09.02-TS-0316.0080
Requirement	AMAN shall be able to use a specific pattern for arrivals and departures, as input by the Sequence Manager.
	The pattern specifies the number of departures between two consecutive arrivals, depending on early DCB processes.

Identifier	REQ-10.09.02-TS-0316.0090
Requirement	AMAN should have, as adaptation data, a default pattern for arrivals and departures, in the case that no pattern is provided as input by the Sequence Manager or no self-computed pattern could be calculated by AMAN

Identifier	REQ-10.09.02-TS-0316.0100
Requirement	When applying coupled AMAN/DMAN the maximum throughput to the runway must not exceed the capacity.

Identifier	REQ-10.09.02-TS-0316.0110
Requirement	AMAN shall send the APTO to DMAN.

Identifier	REQ-10.09.02-TS-0316.0120
Requirement	AMAN shall use the same patterns naming as the DMAN.

Identifier	REQ-10.09.02-TS-0316.0130
Requirement	AMAN should have an option to self-calculate on request a specific optimised pattern (one or more) for arrivals and departures to support ATCO. The calculated patterns shall be modifiable and selectable for use by ATCO.
	The self-calculated patterns shall be modifiable and selectable for use by ATCO.

Identifier	REQ-10.09.02-TS-0316.0140
Requirement	The AMAN shall send to the DMAN the sequence pattern under use.

	Pattern under use shall be shared between AMAN and DMAN.

Identifier	REQ-10.09.02-TS-0316.0160
Requirement	The AMAN should provide a “what-if” function to allow the operator to evaluate scenarios with different sequence patterns.

Identifier	REQ-10.09.02-TS-0316.0180
Requirement	When the traffic is below a predefined threshold, first-come-first-served (FCFS) principle shall be applied instead of a pattern. FCFS principle shall be applicable at any time on manual request by the operator.

Identifier	REQ-10.09.02-TS-0316.0190
Requirement	AMAN shall allow the manual adjustment of the sequence pattern and the AFI-size by Approach or Tower Supervisor in order to provide sufficient spacing for departures in a mixed mode environment.

Identifier	REQ-10.09.02-TS-0316.0200
Requirement	In mixed mode operations AMAN shall take the following inputs in the sequence computation : • AFI-size • CTOT.

3.1.7 AMAN & PMS Requirements

In the declared STARs, the shortest path of the PMS shall be published as the standard procedure to follow.

AMAN shall be able to use PMS based on one or two legs.
The AMAN stability horizon and the location of the PMS legs need to be compatible.

Identifier	REQ-10.09.02-TS-0317.0010
Requirement	AMAN should be able to use a Point Merge Structure (PMS), as an option, in the sequencing process to propose advisories to absorb delay inside the PMS by flying a PMS leg.

Identifier	REQ-10.09.02-TS-0317.0020
Requirement	When using a PMS, the arrival sequence shall be stabilized before the entrance in a leg of the Point Merge structure.

Identifier	REQ-10.09.02-TS-0317.0030
Requirement	When using a PMS, AMAN shall know the delay that each leg of the PMS structure may absorb

3.1.8 HMI Requirements

Identifier	REQ-10.09.02-TS-0318.0010
Requirement	AMAN shall display in the HMI the TTG/TTL for each aircraft in terms of minutes and seconds. Depending on local implementation the precision should be adaptable to local needs.

Identifier	REQ-10.09.02-TS-0318.0020
Requirement	AMAN should propose in the HMI some 2D manoeuvres in order to gain or lose time, those manoeuvres shall be: - 360 maneuvers - Different possible arrival procedures (STARs)

	- Different Runway paths (from IAF to Runway Threshold) - Holding - Direct To (DCT) - Speed constraints

Identifier	REQ-10.09.02-TS-0318.0030
Requirement	Upstream ATSU HMI shall be able to display the AMAN proposed CTA received from the downstream ATSU

Identifier	REQ-10.09.02-TS-0318.0040
Requirement	Current ATSU HMI shall be able to display the CTA calculated by the AMAN.

Identifier	REQ-10.09.02-TS-0318.0050
Requirement	Information on TTOT, Vortex Category and Status of the Flight (i.e. SUR, SUG, Begin Taxi) of each departing flight shall be available in the AMAN display of the arrival sequence.

Identifier	REQ-10.09.02-TS-0318.0060
Requirement	Information on the active pattern shall be displayed on the appropriate controller position. The HMI shall allow manual modification of the active pattern at any time. In addition, the next pattern to take effect shall be displayed, with the callsign of the last arrival before the change shall take effect.

Identifier	REQ-10.09.02-TS-0318.0070
Requirement	Information on KPIs (such as runway rate) shall be displayed for arrival and departures separately on the appropriate controller position.

Identifier	REQ-10.09.02-TS-0318.0080
Requirement	AMAN shall display in the HMI the CTA status for each i4D aircraft for which a CTA is proposed.

Identifier	REQ-10.09.02-TS-0318.0090
Requirement	AMAN shall allow manual update of the arrival sequence

Identifier	REQ-10.09.02-TS-0318.0100
Requirement	AMAN should implement a what-if function.

Identifier	REQ-10.09.02-TS-0318.0110
Requirement	Manual swap in a flight pair within the stable horizon should not impact aircraft other than those directly targeted.

Identifier	REQ-10.09.02-TS-0318.0120
Requirement	Runways configuration shall be displayed.

Identifier	REQ-10.09.02-TS-0318.0130
Requirement	When operating in mixed mode in a single runway, AMAN HMI shall display the arrival/departure integrated sequence

Identifier	REQ-10.09.02-TS-0318.0140
Requirement	The status of Coupled AMAN/DMAN function shall be continuously monitored. Any failure shall be notified in the HMI.

3.1.9 Cross Border Arrival Management requirements

The system supports ATCOs for smoother En-route delay absorption in Controlling Upstream ATSU prior to delivering traffic to Destination Downstream ATSU. The Upstream ATSU contributes to the implementation of the arrival sequence received from Downstream ATSU. According to local operational strategies the system translates D-ATSU sequence demands in control advisories to absorb some delay. The system delivers these advisories to relevant positions according to apportionment between sectors and supports ATCO's advisories implementation.

Identifier	REQ-10.09.02-TS-0319.0010
Requirement	The En-route Sequence and Flow Management of the Upstream ATSU shall receive arrival management constraints from the downstream ATSU. According to the LoAs between the ATSUs, the arrival management constraints applicable to a flight shall include one or more of the following data: • Target time over exit point (COP) • Total delay allocated to the flight • Delay allocated to the Upstream Unit.

Identifier	REQ-10.09.02-TS-0319.0020
Requirement	The En-route Sequence and Flow Management of the Upstream ATSU shall calculate control advisories (Speed reduction, CTA...) allowing meeting arrival management constraints applicable to each concerned flight. Theses advisories shall translate the applicable delay sharing strategy between concerned Upstream ATSU sectors.

Identifier	REQ-10.09.02-TS-0319.0030
Requirement	Cross Border Arrival Management constraints and control advisories shall be displayed to the appropriate ATCO of Upstream ATSU sectors.

Identifier	REQ-10.09.02-TS-0319.0040
Requirement	Feedback on the intended or applied control actions to meet Arrival Management Constraints should be provided to the Downstream ATSU.

3.1.10 What-if requirements

The system allows the controller to check the effect of clearances, before applying them. If the desired effect is achieved on the copy of the arrival sequence, the controller then performs the clearances on the original sequence in order to share the results and passes them to the aircraft as necessary.

Identifier	REQ-10.09.02-TS-0320.0010
Requirement	AMAN shall allow a What-if manual creation of a duplicated arrival sequence up to a maximum of a configurable parameter.

Identifier	REQ-10.09.02-TS-0320.0020
Requirement	The system shall provide a means to easily create and distinguish a duplicate AMAN arrival sequence from the original Sequence.

Identifier	REQ-10.09.02-TS-0320.0030
Requirement	The system shall allow the application of all the tactical constraints on any duplicated arrival sequence.

Identifier	REQ-10.09.02-TS-0320.0040
Requirement	All the system updates (e.g. deviation detection, beacon overflight, etc.) shall only be applied to the original arrival sequence.

Identifier	REQ-10.09.02-TS-0320.0050
Requirement	The system shall allow the cancellation of a duplicated arrival sequence.

Identifier	REQ-10.09.02-TS-0320.0060
Requirement	On the request of the controller, the system shall apply on the original sequence the orders and tactical constraints which has been applied on the duplicated sequence.

3.2 Adaptability

N/A

3.3 Performance Characteristics

3.3.1 Requirements

Identifier	REQ-10.09.02-TS-0331.0010
Requirement	The likelihood AMAN being not available or unserviceable shall be no more than once every 5.5 months.

Identifier	REQ-10.09.02-TS-0331.0020
Requirement	The likelihood of AMAN operating on an incorrect time reference shall be no more once every 5.5 months.

[REQ]

Identifier	REQ-10.09.02-TS-0331.0030
Requirement	The likelihood of AMAN failing to accept and correctly process human input shall be no more than once every 6 weeks.

Identifier	REQ-10.09.02-TS-0331.0040
Requirement	The likelihood of AMAN failing to provide applicable arrival management information to the controller shall be no more than once every 12 weeks.

Identifier	REQ-10.09.02-TS-0331.0050
Requirement	The trajectory prediction used within AMAN should be consistent and have a maximum drift of +/-30 seconds over the span of 30 minutes, or one second of drift per minute in the entirety of the implementation horizon.

3.4 Safety & Security

N/A

3.5 Maintainability

N/A

3.6 Reliability

N/A

3.7 Functional block Internal Data Requirements

N/A

3.8 Design and Construction Constraints

N/A

3.9 Functional block Interface Requirements

N/A

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[4] EUROCONTROL ATM Lexicon
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[5] B.04.03-D95-ADD Step 1 V00.02.02 30/04/2015

[6] IEEE / MIL Standards

[7] SESAR Template Toolbox 00.03.00

[8] SESAR Requirements and V&V Guidelines 03.01.00 - 05/02/2014

[9] SESAR Templates and Toolbox User Manual 03.00.01

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[12] 10.09.01 10.09.02 Architecture Definition Report

[13] 05.06.07 D14 Step 1 AMAN + Point Merge in E-TMA OSED 00.01.01 15-04-2013

[14] TAD Trace Extract in Support of Partial Requirements Consolidation Activity

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[16] 05.06.01-D74 Step 1 OSED - Iteration 3 01.00.00 11-09-2013

[17] P06.08.04.D17 S01V3 Final OSED, edition 01.01.00, 22/07/2015

[18] P06.08.04.D18 S01V3 Final SPR, edition 00.01.00, 04/05/2015

[19] P06.08.04.D82 S01V3 Final INTEROP, edition 00.01.01, 05/08/2015

[20] P05.06.07.D15-Update of 5 6 4 OSED-Step 1, edition 00.01.01-03/08/2015

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4.1 Use of copyright / patent material /classified material

4.1.1 Classified Material

N/A

-END OF DOCUMENT-

Appendix A Requirements to SESAR Solutions

The following table identifies for each requirement the SESAR solutions he contributes to.

Validation status for the technical requirement has been stated as 'Validated' or 'In Progress' according to the following criteria:

- Baseline requirements are considered as validated.
- The others requirements are considered as :
  - Validated: All the operational requirements traced for the technical requirement had been stated as 'Validated' by the operational projects.
  - In Progress: At least one of the operational requirements for the technical requirement had been stated as 'In Progress' by the operational projects

Requirement Identifier	Requirement Text	SESAR Solution	Validation status
REQ-10.09.02-TS-0311.0010	AMAN shall compute a arrival sequence for a set of runways of a list of managed airports.	AMAN Baseline	Validated
REQ-10.09.02-TS-0311.0020	AMAN shall create a Flight upon the first reception of data for the flight if the destination airport is a managed airport.	AMAN Baseline	Validated
REQ-10.09.02-TS-0311.0030	AMAN shall update a Flight upon the reception of updated data for this Flight.	AMAN Baseline	Validated
REQ-10.09.02-TS-0311.0040	AMAN shall consider a Flight eligible for the arrival sequence computation if the flight satisfies either the [Eligibility_Horizon_Time] or the [Eligibility_Horizon_Geographic] criteria.	Solution 5	Validated
REQ-10.09.02-TS-0311.0050	AMAN shall consider a Flight within the Active Advisory Horizon if the Flight statisfies either the [Active_Horizon_Time] or the [Active_Horizon_Geographic] criteria.	Solution 5	Validated
REQ-10.09.02-TS-0311.0060	AMAN shall be provided with Flight Plan information for flights arriving at aiports managed by AMAN once they reach the defined Eligibility Horizon.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0010	AMAN shall update the arrival sequence upon the following events : • periodically according to the [Sequencing Period] and possibly event-based on a receipt of Flight data update • on receipt of a command from a sequence manager. • airport configuration change (runway configuration change, capacity change, runway closure..).	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0020	AMAN shall allocate a landing runway to sequence a Flight taking into account the TMA configuration (runway orientation and dependencies, runway rates and closures), the Arrival Runway Allocation rules and the Flight ETA for the possible landing runways.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0030	For each Flight AMAN shall set a point route in the Active Advisory Horizon as the Metering Point according to the allocated runway and the TMA configuration.	Solution 6	Validated
REQ-10.09.02-TS-0312.0040	AMAN should allow the manual assignment of the Metering Point for a Flight.	Solution 6	Validated
REQ-10.09.02-TS-0312.0050	AMAN shall apply a Flow constraint on each Metering point to determine the separation between two successive flights	Solution 6	Validated

	over the Metering Point when computing the APTO on the Metering Point.		
REQ-10.09.02-TS-0312.0060	For each sequenced Flight, AMAN shall compute the APTT at the runway threshold taking into account the Flight ETA, the TMA configuration, the allocated landing runway and the separation constraints (at the runway and at the allocated metering point).	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0070	The APTOs on any allocated metering point and intermediate points shall be computed from the flight's APTT at the runway threshold.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0080	The arrival sequence shall be revised on any arrival sequence update.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0090	For each Flight AMAN shall compute the total delay at the runway to be absorbed after each schedule update for the allocated runway.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0100	For each Flight, AMAN shall compute the total delay at the Metering Point to be absorbed after each schedule update for the allocated Metering Point.	Solution 6	Validated
REQ-10.09.02-TS-0312.0110	AMAN shall allow splitting the total delay for a Flight and allocating the resulting partial delays to different segments of the Flight route according to a predefined delay apportionment strategy.	Solution 5	Validated
REQ-10.09.02-TS-0312.0115	AMAN shall allow allocating the resulting partial delays to different segments of the Flight route according to a predefined delay apportionment strategy.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0120	AMAN should provide delay absorption advisories for any scheduled Flight.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0130	The AMAN shall implement a priority model to manage the sequence of the flights to cope with specific operational situations such as emergency flights, state flights.	AMAN Baseline	Validated

REQ-10.09.02-TS-0312.0140	The AMAN shall implement a stability model to cope with different levels of automation of the arrival management between the system and the controllers: • Unstable : the arrival sequence is managed by the system • Stable : the management of the arrival sequence is shared by the system and the controllers, controllers commands enable to adjust the sequence • Frozen : the arrival sequence is managed by the controllers The level of automation applied to a flight schedule shall decrease as the flight advances to its destination depending on the stability model configuration. In addition specific triggers set the stability for a given Flight prevailing on the above standard rule.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0150	AMAN shall take into account applicable ATC strategies in the sequence computation.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0160	AMAN shall provide Arrival Management Information to be distributed to all concerned actors.	AMAN Baseline	Validated
REQ-10.09.02-TS-0312.0170	Arrival Management Information items referring to a time constraint established for the purposes of Arrival Management shall be specified with precision of one second.	Solution 6	Validated
REQ-10.09.02-TS-0313.0010	For i4D capable aircraft, AMAN shall request the ETA min/max on the metering point.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0020	The system shall uplink the request for the ETA min/max to the aircraft and make available to AMAN the ETA min/max received from the aircraft.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0030	AMAN should allow a controller to manually request the ETA min/max on the metering point.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0040	For i4D capable aircraft, AMAN shall schedule the flight taking into account the ETA min/max and propose a CTA on the metering point.	Solution 6	Validated
REQ-10.09.02-TS-0313.0050	The system shall inform AMAN of any CTA acceptance on the metering point once performed by system and aircraft.	Solution 6	Validated
REQ-10.09.02-TS-0313.0060	If the flight is not under control of the system, the system shall transmit the AMAN proposed CTA to the upstream ATC system.	Solution 6	In Progress

REQ-10.09.02-TS-0313.0070	When the AMAN proposed CTA is set for a flight on the metering point, AMAN shall handle the flight as collaborative in the sequence and increase flight's stability in the sequencing process.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0080	When a CTA on the metering point is cancelled, AMAN shall handle the flight as in normal operations in the sequence and re-evaluate flight's stability in the sequencing process.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0090	When a CTA is set for a flight on the metering point, without being proposed by AMAN, AMAN shall try to update the sequence for the traffic taking into account this contracted time constraint for this flight. When the sequence update is possible, AMAN shall update the sequence, handle the flight as collaborative in the sequence and increase flight's stability in the sequencing process.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0100	When a CTA is set for a flight on the metering point, without being proposed by AMAN, AMAN shall try to update the sequence for the traffic taking into account this contracted time constraint for this flight. When the sequence update is not possible, AMAN shall provide a feedback to the appropriate controllers.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0110	Ground computed constraints shall only be proposed as a CTA when the CTA is known (i4D flights) or estimated by the ground system (non i4D flights) to be within the aircraft's performance and navigation capability or to indicate to the ATCO that the proposed CTA is outside the aircraft's performance.	Solution 6	In Progress
REQ-10.09.02-TS-0313.0120	In the Arrival Management process where a CTA is to be applied the ground unit(s) should complete the process (CTA assigned to and agreed by the Flight Crew) 5-10 minutes prior Top of Descent. When Flight is still under Upstream ATSU control, downstream ATSU shall provide the upstream ATSUs with any required time constraint in a time consistent with the requirement to complete the CTA allocation and agreement process 5-10 minutes prior to border crossing time	Solution 6	In Progress
REQ-10.09.02-TS-0313.0130	2D trajectory synchronisation shall be performed and completed before starting CTA process by AMAN (ETA min/max request …)	Solution 6	In Progress

REQ-10.09.02-TS-0313.0140	Only one CTA shall be proposed by AMAN automatically.	Solution 6	Validated
REQ-10.09.02-TS-0314.0010	If the flight is not under control of the system, the system shall transmit to the upstream ATC system arrival management constraints applicable for the flight in order to implement the arrival sequence. According to the LoAs between the ATSUs, the arrival management information to be transferred shall include one or more of the following data: • metering point and time over metering point • total delay to be absorbed at metering fix • advisory to implement the target (time at COP, or speed or route advisory) • Sequence number of the flight	Solution 5	Validated
REQ-10.09.02-TS-0314.0020	According to LoAs between the ATSUs and to the delay apportionment strategy, AMAN shall allow to allocate a part of the delay to be absorbed by the upstream ATC system prior to the transfer of the flight.	Solution 5	Validated
REQ-10.09.02-TS-0314.0030	The system should make available to the appropriate controller working position the arrival management constraints applicable for a flight and notified to the upstream ATSU in order to support the coordination/transfer dialog with the upstream ATSU.	Solution 5	Validated
REQ-10.09.02-TS-0314.0040	The system should allow to identify discrepancy between coordination data with the upstream ATSU and applicable arrival management constraints for the corresponding flight (such as on time at COP).	Solution 5	Validated
REQ-10.09.02-TS-0314.0050	In case the discrepancy between coordination data with the upstream ATSU and applicable arrival management constraints for the corresponding flight exceeds a predefined value, an indication should be presented at the appropriate working position	Solution 5	Validated
REQ-10.09.02-TS-0315.0010	AMAN shall receive updates of flight data and trajectory estimates taking into account the departure planning information (ETOT/TTOT, departure route) from the departure airport for a flight departing from a nearby airport in AMAN horizon.	Solution 5	Validated

REQ-10.09.02-TS0315.0020	AMAN shall sequence a flight departing from a nearby airport in the AMAN horizon prior to departure when reliable departure planning information is available. AMAN shall compute a APTO on the metering point for such a flight..	Solution 5	Validated
REQ-10.09.02-TS-0315.0030	Updates of departure planning information shall trigger a revision of APTO only if the updated planned trajectory is incompatible with the currently allocated APTO.	Solution 5	Validated
REQ-10.09.02-TS-0315.0040	The system shall publish planned arrival data for each flight departing from a nearby airport and sequenced at destination prior to departure with the following data : • Flight identification data that allows external systems to uniquely identify the flight • APTT for runway threshold • APTO for metering point • STAR if applicable TTL/TTG. The data has to be transferred to the nearby airport. Time delivery shall not exceed 10 seconds.	Solution 5	Validated
REQ-10.09.02-TS-0315.0050	The Aerodrome System shall publish departure planning data for each flight departing from the aerodrome with the following data : • Flight identification data that allows external systems to uniquely identify the flight • ETOT / TTOT • Departure route Revision of departure planning data shall be published along the departure planning process. Departure planning data time of delivery shall not exceed 10 seconds.	Solution 5	Validated
REQ-10.09.02-TS-0315.0060	The Aerodrome System shall receive and shall take APTO, TTL/TTG advisory from AMAN into account and computes TTOT for the departing flight from the aerodrome.	Solution 5	Validated
REQ-10.09.02-TS-0315.0070	The Aerodrome system shall have the capacity to display the planned arrival data and allow to manually input a TTOT for departing flight from the aerodrome.	Solution 5	Validated
REQ-10.09.02-TS-0316.0010	AMAN and local DMAN shall manage the arrival sequence and the departure sequence at the airport in a master/slave configuration where AMAN is the Master and DMAN is the slave.	Solution 54	Validated
REQ-10.09.02-TS-0316.0020	AMAN shall be able to use ETA as the runway threshold arrival demand time for all expected arrivals, a configurable value of minutes in advance. (i.e. the earliest possible time to schedule that aircraft to	Solution 54	Validated

	land).		
REQ-10.09.02-TS-0316.0030	AMAN shall be able to use a revised value of ETA, whenever it changes by more than a configurable value of minutes.	Solution 54	Validated
REQ-10.09.02-TS-0316.0040	AMAN shall be able to use TOT (Take-Off Time) as the take-off demand time for all expected departures, a configurable value of minutes in advance (i.e. the earliest possible time to schedule that departure).	Solution 54	Validated
REQ-10.09.02-TS-0316.0050	AMAN shall be able to use a revised value of TOT (Take-Off Time) whenever it changes by more than a configurable value of minutes.	Solution 54	Validated
REQ-10.09.02-TS-0316.0060	AMAN shall receive the size of gap in NM needed to accommodate the required number of departures between two successive arrivals, to be able to satisfy the established pattern.	Solution 54	Validated
REQ-10.09.02-TS-0316.0070	AMAN shall be able to use the minimum gap in NM between arrivals when there is no vortex separation.	Solution 54	Validated
REQ-10.09.02-TS-0316.0080	AMAN shall be able to use a specific pattern for arrivals and departures, as input by the Sequence Manager.	Solution 54	Validated
REQ-10.09.02-TS-0316.0090	AMAN should have, as adaptation data, a default pattern for arrivals and departures, in the case that no pattern is provided as input by the Sequence Manager or no self-computed pattern could be calculated by AMAN	Solution 54	In progress
REQ-10.09.02-TS-0316.0100	When applying coupled AMAN/DMAN the maximum throughput to the runway must not exceed the capacity.	Solution 54	Validated
REQ-10.09.02-TS-0316.0110	AMAN shall send the APTO to DMAN.	Solution 54	Validated
REQ-10.09.02-TS-0316.0120	AMAN shall use the same patterns naming as the DMAN.	Solution 54	Validated
REQ-10.09.02-TS-0316.0130	AMAN should have an option to self-calculate on request a specific optimised pattern (one or more) for arrivals and departures to support ATCO.	Solution 54	In Progress
REQ-10.09.02-TS-0316.0140	The AMAN shall send to the DMAN the sequence pattern under use.	Solution 54	Validated
REQ-10.09.02-TS-0316.0160	The AMAN should provide a “what-if” function to allow the operator to evaluate scenarios with different sequence patterns.	Solution 54	In progress

REQ-10.09.02-TS-0316.0180	When the traffic is below a predefined threshold, first-come-first-served (FCFS) principle shall be applied instead of a pattern. FCFS principle shall be applicable at any time on manual request by the operator.	Solution 54	In Progress
REQ-10.09.02-TS-0316.0190	AMAN shall allow the manual adjustment of the sequence pattern and the AFI-size by Approach or Tower Supervisor in order to provide sufficient spacing for departures in a mixed mode environment.	Solution 54	Validated
REQ-10.09.02-TS-0316.0200	In mixed mode operations AMAN shall take the following inputs in the sequence computation : • AFI-size • CTOT.	Solution 54	Validated
REQ-10.09.02-TS-0317.0010	AMAN should be able to use a Point Merge Structure (PMS), as an option, in the sequencing process to propose advisories to absorb delay inside the PMS by flying a PMS leg.	AMAN Baseline	Validated
REQ-10.09.02-TS-0317.0020	When using a PMS, the arrival sequence shall be stabilized before the entrance in a leg of the Point Merge structure.	AMAN Baseline	Validated
REQ-10.09.02-TS-0317.0030	When using a PMS, AMAN shall know the delay that each leg of the PMS structure may absorb	AMAN Baseline	Validated
REQ-10.09.02-TS-0318.0010	AMAN shall display in the HMI the TTG/TTL for each aircraft in terms of minutes and seconds. Depending on local implementation the precision should be adaptable to local needs.	AMAN Baseline	Validated
REQ-10.09.02-TS-0318.0020	AMAN should propose in the HMI some 2D manoeuvres in order to gain or lose time, those manoeuvres shall be: - 360 maneuvers - Different possible arrival procedures (STARs) - Different Runway paths (from IAF to Runway Threshold) - Holding - Direct To (DCT) Speed constraints	AMAN Baseline	Validated
REQ-10.09.02-TS-0318.0030	Upstream ATSU HMI shall be able to display the AMAN proposed CTA received from the downstream ATSU	Solution 5	In Progress
REQ-10.09.02-TS-0318.0040	Current ATSU HMI shall be able to display the CTA calculated by the AMAN.	Solution 6	Validated
REQ-10.09.02-TS-0318.0050	Information on TTOT, Vortex Category and Status of the Flight (i.e. SUR, SUG, Begin Taxi) of each departing flight shall be available in the AMAN display of the arrival sequence.	Solution 54	Validated

REQ-10.09.02-TS-0318.0060	Information on the active pattern shall be displayed on the appropriate controller position. The HMI shall allow manual modification of the active pattern at any time.	Solution 54	Validated
REQ-10.09.02-TS-0318.0070	Information on KPIs (such as runway rate) shall be displayed for arrival and departures separately on the appropriate controller position.	Solution 54	In Progress
REQ-10.09.02-TS-0318.0080	AMAN shall display in the HMI the CTA status for each i4D aircraft for which a CTA is proposed.	Solution 6	Validated
REQ-10.09.02-TS-0318.0090	AMAN shall allow manual update of the arrival sequence	AMAN Baseline	Validated
REQ-10.09.02-TS-0318.0100	AMAN should implement a what-if function.	AMAN Baseline	Validated
REQ-10.09.02-TS-318.0110	Manual swap in a flight pair within the stable horizon should not impact aircraft other than those directly targeted.	AMAN baseline	Validated
REQ-10.09.02-TS-0318.0120	Runways configuration shall be displayed	Solution 54	In Progress
REQ-10.09.02-TS-0318.0130	When operating in mixed mode in a single runway, AMAN HMI shall display the arrival/departure integrated sequence	Solution 54	Validated
REQ-10.09.02-TS-0318.0140	The status of Coupled AMAN/DMAN function shall be continuously monitored. Any failure shall be notified in the HMI.	Solution 54	In Progress
REQ-10.09.02-TS-0319.0010	The En-route Sequence and Flow Management of the Upstream ATSU shall receive arrival management constraints from the downstream ATSU. According to the LoAs between the ATSUs, the arrival management constraints applicable to a flight shall include one or more of the following data: • Target time over exit point (COP) • Total delay allocated to the flight Delay allocated to the Upstream Unit.	Solution 5	Validated

REQ-10.09.02-TS-0319.0020	The En-route Sequence and Flow Management of the Upstream ATSU shall calculate control advisories (Speed reduction, CTA...) allowing meeting arrival management constraints applicable to each concerned flight. Theses advisories shall translate the applicable delay sharing strategy between concerned Upstream ATSU sectors.	Solution 5	Validated
REQ-10.09.02-TS-0319.0030	Cross Border Arrival Management constraints and control advisories shall be displayed to the appropriate ATCO of Upstream ATSU sectors.	Solution 5	Validated
REQ-10.09.02-TS-0319.0040	Feedback on the intended or applied control actions to meet Arrival Management Constraints should be provided to the Downstream ATSU.	Solution 5	Validated
REQ-10.09.02-TS-0331.0010	The likelihood AMAN being not available or unserviceable shall be no more than once every 5.5 months.	AMAN Baseline	Validated
REQ-10.09.02-TS-0331.0020	The likelihood of AMAN operating on an incorrect time reference shall be no more once every 5.5 months.	AMAN Baseline	Validated
REQ-10.09.02-TS-0331.0030	The likelihood of AMAN failing to accept and correctly process human input shall be no more than once every 6 weeks.	AMAN Baseline	Validated
REQ-10.09.02-TS-0331.0040	The likelihood of E-AMAN failing to provide applicable arrival management information to the controller shall be no more than once every 12 weeks.	AMAN Baseline	Validated
REQ-10.09.02-TS-0331.0050	The prediction used within AMAN should be consistent and have a maximum drift of +/-30 seconds over the span of 30 minutes, or one second of drift per minute in the entirety of the implementation horizon.	Solution 5	In Progress
REQ-10.09.02-TS-0320.0010	AMAN shall allow a What-if manual creation of a duplicated arrival sequence up to a maximum of a configurable parameter	AMAN Baseline	Validated
REQ-10.09.02-TS-0320.0020	The system shall provide a means to easily create and distinguish a duplicate AMAN arrival sequence from the original Sequence.	AMAN Baseline	Validated
REQ-10.09.02-TS-0320.0030	The system shall allow the application of all the tactical constraints on any duplicated arrival sequence	AMAN Baseline	Validated

REQ-10.09.02-TS-0320.0040	All the system updates (e.g. deviation detection, beacon overflight, etc.) shall only be applied to the original arrival sequence.	AMAN Baseline	Validated
REQ-10.09.02-TS-0320.0050	The system shall allow the cancellation of a duplicated arrival sequence.	AMAN Baseline	Validated
REQ-10.09.02-TS-0320.0060	On the request of the controller, the system shall apply on the original sequence the orders and tactical constraints which has been applied on the duplicated sequence.	AMAN Baseline	Validated