6.8.4-S01V3 Final OSED

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Abstract

This Operational Services and Environment Definition (OSED) describes the coupled AMAN/DMAN for step 1 in the context of 04.01.01 Operational Focus Area (OFA) – Integrated AMAN/DMAN. This OSED is the final Step 1 version, collecting the results of all validations performed in Step 1 (VP-453, VP-663, VP-338 and VP-339).

A pattern based solution for Step 1 is described, where AMAN acts as master leading to an optimization of traffic flows (coupled pre-departure sequencing and arrival metering) rather than to provide a detailed integrated arrival/departure sequence (i.e. flow based integration).

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Executive summary

This Operational Service and Environment Definition (OSED) describes the coupled AMAN/DMAN for step 1 in the context of OFA 04.01.01 (Integrated AMAN / DMAN). This document is based on the previous version (P6.8.4 D13 Preliminary OSED [25]) but now considering results and operational feedback collected during v3 validation EXE6.8.4-VP-453.

The following operational improvement steps (as described in DS13) are addressed by the solution described in this OSED:

- **Solution #53 'Pre-Departure Sequencing supported by Route Planning'**
  - **TS-0202 - Pre-Departure Sequencing supported by Route Planning**

    Pre-Departure management has the objective of delivering an optimal traffic flow to the runway. Accurate taxi time forecasts provided by route planning are taken into account for TSAT-Calculation before off-block. Pre-Departure sequence (TSAT sequence) is set up by Tower Clearance Delivery Controllers who will follow TSAT-window when issuing startup approval.

  - **Solution #54 'Flow based Integration of Arrival and Departure Management'**

    TS-0308 - Flow based Integration of Arrival and Departure Management
    Integrated Arrival and Departure management aims at increasing throughput and predictability at an airport by improved co-ordination between En-Route/Approach and Tower controllers. Arrival and Departure flows to the same runway (or for dependent runways) are integrated by setting up fixed arrival-departure pattern for defined periods. The successive pattern might be chosen by the operators or provided by an optimization algorithm considering arrival and departure demand. Departure flow to the runway is managed by pre-departure sequencing (integrating route planning) while arrival flow to the runway is managed by arrival metering.

Gatwick airport and the related approach and tower operations have been considered as baseline to describe the current situation and to identify the main issues. Today coordination of sequence pattern and AFI-Size is performed on subjective supervisor assessment which leads to a reactive change of sequence pattern and subsequent increase of delay. The sequence pattern defines a certain sequence of arrivals and departures, i.e. the number of departures that will be placed in between successive landings. AMAN and DMAN are in use in the baseline but have no link between the systems.

The Coupled AMAN/DMAN primarily aims at increasing predictability and reducing or at least better manage delay. Apart from this a small increase in runway throughput and reduction of fuel consumption can be realised.

In the new operating method co-ordination between approach and tower will be improved as they will pro-actively agree on a defined sequence pattern and AFI-size (Arrival Free Interval) based on an integrated traffic picture for the respective runway. AMAN and DMAN will be coupled in this solution and provide the operators with an integrated view on the planned runway sequence. Coupling will be set up as a master/slave configuration with AMAN acting as the master and DMAN allocating departures in the AFIs. DMAN can be improved by considering estimated taxi times provided from surface routing and planning function (substituting static taxi-time tables currently used in A-CDM). In step 1 estimated taxi times will not be updated after start-up.

The solution described is defined as "flow-based" integration since it aims to optimize traffic flows, i.e. coupled pre-departure sequencing and arrival metering. Controllers are requested to follow the pattern but are not expected to exactly follow the planned sequence of aircraft.

This performance based approach could be further improved if the selection of the sequence pattern is supported by further system functionalities which can optionally be added to the solution. The optional functionalities could enhance the performance based approach allowing an even more

objective assessment of the situation, and are described in the present document even if they haven't been validated at this stage of the project. These can comprise of:

- KPI calculation
  based on the selected sequence pattern and AFI-size the KPIs can be calculated by the coupled AMAN/DMAN supporting the selection/adjustment of pattern with objective forecasted measures. KPIs can comprise of different parameters like delay, runway throughput or schedule adherence.
- What-if probing
  supervisors may have the functionality of a what-if probing available in order to give them information on what the consequences on the KPIs will be choosing a certain pattern allocation.
- Automatic pattern calculation
  Coupled AMAN/DMAN can calculate the most appropriate pattern allocation based on the expected traffic and the resulting KPI figures. This pattern allocation will be shown to approach and tower controllers, helping them to choose the most optimal pattern possible

In the OSED also the option of a Time-Based Spacing (as defined by SESAR P06.08.01) is described, supporting more accurate delivery by Approach Controllers of the arrival spacing agreed between Tower and Approach.

It is worthwhile to highlight that for Step 1 a single airport with a single runway used in mixed mode operations has been considered as the applicable environment for the integration.

1 Introduction

1.1 Purpose of the document

The Operational Service and Environment Definition (OSED) describes the operational concept defined in the Detailed Operational Description (DOD) in the scope of 04.01.01 **Integrated AMAN and DMAN** Operational Focus Area (OFA).

It defines the operational services, their environment, use cases and requirements.

The OSED is used as the basis for assessing and establishing operational, safety, performance and interoperability requirements for the related systems further detailed in the Safety and Performance Requirements (SPR) document. The OSED identifies the operational services supported by several entities within the ATM community and includes the operational expectations of the related systems.

This OSED is a top-down refinement of the Airport DOD for Step 1 [22] produced by the federating OPS 06.02 project. It also contains additional information which should be consolidated back into the higher level SESAR concepts using a “bottom up” approach.

The figure below presents the location of the OSED within the hierarchy of SESAR concept documents, together with the SESAR Work Package or Project responsible for their maintenance.

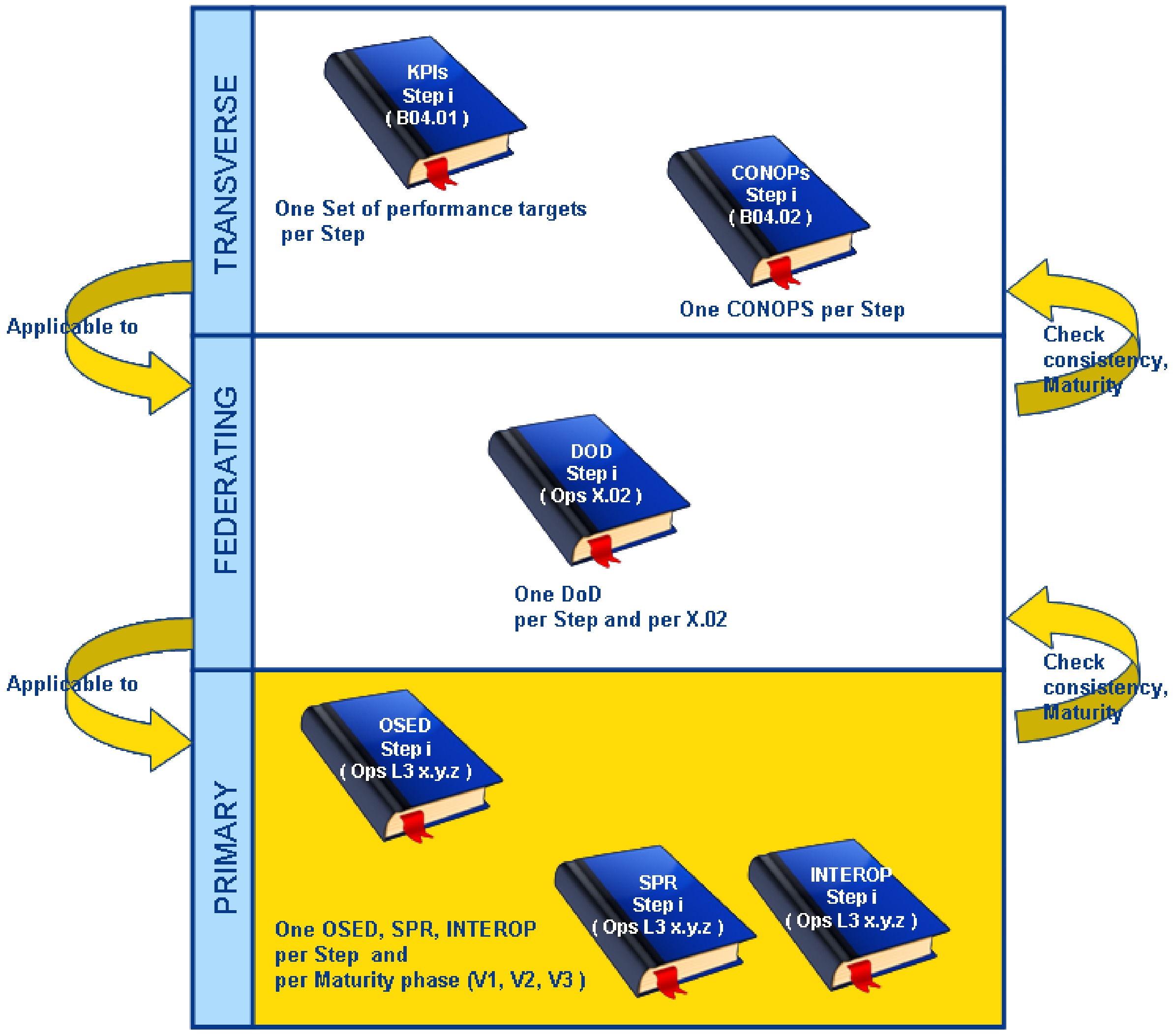

Figure 1: OSED document with regards to other SESAR deliverables

In Figure 1, the Steps are driven by the OI Steps addressed by the project in the Integrated Roadmap document [13].

1.2 Scope

This Final OSED details the operational concept for the 04.01.01 **Integrated AMAN/DMAN** Operational Focus Area (OFA). The document focuses on the integration between arrival and departure management and, as a mean to improve the output of the coupled AMAN/DMAN, the integration between departure management and surface management is described as well. Thus the OSED addresses the solution #53 and solution #54 as described below.

1.2.1 Solution #53

Solution #53 ‘Pre-Departure Sequencing supported by Route Planning’ covers OI step TS- 0202 which is described below (based on DS13):

- **TS-0202 - Pre-Departure Sequencing supported by Route Planning**
  Pre-Departure management has the objective of delivering an optimal traffic flow to the runway. Accurate taxi time forecasts provided by route planning are taken into account for TSAT-Calculation before off-block. Pre-Departure sequence (TSAT sequence) is set up by Tower Clearance Delivery Controllers who will follow TSAT-window when issuing startup approval.

The following Enablers are allocated to this OI step:

- **AERODROME-ATC-18**
  Interfacing between DMAN and Routing module
- **AIRPORT-36** :
  Provision by the Airport Operator of the relevant constraint to Aerodrome ATC

The following exercises contributed to development of this solution:

- EXE-06.08.04-VP231 V2 DMAN/A-SMGCS – Paris Charles de Gaulle (RTS)
- EXE-06.08.04-VP298 V2 DMAN/A-SMGCS – Malpensa Milano (RTS)
- EXE-06.08.04-VP339 V2 AMAN/DMAN/A-SMGCS – Gatwick (FTS)
- EXE-06.08.04-VP453 V3 AMAN/DMAN/TBS – Gatwick (RTS)

1.2.2 Solution #54

Solution #54 ‘Flow based Integration of Arrival and Departure Management’ covers OI step TS- 0308 which is described below (based on DS13):

- **TS-0308 - Flow based Integration of Arrival and Departure Management**
  Integrated Arrival and Departure management aims at increasing throughput and predictability at an airport by improved co-ordination between En-Route/Approach and Tower controllers. Arrival and Departure flows to the same runway (or for dependent runways) are integrated by setting up fixed arrival-departure pattern for defined periods. The successive pattern might be chosen by the operators or provided by an optimization algorithm considering arrival and departure demand. Departure flow to the runway is managed by pre-departure sequencing (integrating route planning) while arrival flow to the runway is managed by arrival metering.

The following Enabler is allocated to this OI step:

- **AERODROME-ATC-09a**
  Flow based improvement of operational orchestration among arrival / departure management and surface management services

The following exercises contributed to development of this solution:

- EXE-06.08.04-VP338 V2 AMAN/DMAN – Munich (Shadow Mode)
- EXE-06.08.04-VP339 V2 AMAN/DMAN/A-SMGCS – Gatwick (FTS)
- EXE-06.08.04-VP663 V2 AMAN/DMAN/TBS – Gatwick (RTS)
- EXE-06.08.04-VP453 V3 AMAN/DMAN/TBS – Gatwick (RTS)

In detail, one of the scopes of the document is to show how a pro-active way of handling movements could lead to reduce the delay or, at least, to improve its management. In addition to this as an optional feature a planning philosophy is introduced that is based on forecasts of the concerned key performance indicators, such as delay, runway throughput and schedule adherence. Forecasted performance will allow a more objective assessment of the situation in advance.

1.3 Intended readership

The intended audience for this OSED is the core projects of OFA04.01.01, including operational projects as well as the corresponding technical projects, which will develop new systems following the operational concept and aligned with the operational requirements described in this OSED. Furthermore this OSED is of interest for projects belonging to other OFAs, but which are linked to the aspects contained in this document as well as federating projects:

- Primary project P06.08.04 (Coupled Arrival and Departure Management) to consider the OSED and the related description of AMAN/DMAN operational concept as input for the development of other documents (e.g. SPR);
- Primary project P06.07.02 (A-SMGCS Routing and planning) as a full integration between departure management and Routing and Planning service is expected to optimize the departing traffic flow;
- Primary Project P06.08.01 (Flexible and Dynamic Use of Wake Vortex Separations) as the Time Based Separation (TBS) Tools might derive benefits from the availability of a planned runway timeline from the Coupled AMAN-DMAN
- P10.04.04 (Time Based Separation) and P12.02.02 (Runway Wake Vortex Detection, Prediction and decision support tools), as the operational requirements related to the integration with TBS tool have to be considered for future prototypes development;
- P12.04.04 (Integration of Departure Management and Surface Management), as the operational requirements related to the integration between departure and surface management have to be considered for future prototypes development;
- P12.03.05 (Enhanced Sequencing Tools) as technical project in charge of developing DMAN coupled with AMAN;
- P10.09.01 (Integration of Queue Management) and 10.09.02 (Multiple airport arrival/departure management) to provide the reference set of AMAN/DMAN operational requirements describing a basis for further operational improvements;
- P06.02 for consolidation, WPB for architecture and performance modelling, and Transverse and federating projects;
- And, more generally, the SESAR JU community.

1.4 Structure of the document

The structure of this OSED is as follows:

- **Chapter 1** (the present section) provides general information about the document;
- **Chapter 2** provides the traceability to the relevant DODs. It details the operational concept and scope.
- **Chapter 3** describes the current and the new operating methods and provides an analysis of the differences between those operating methods;
- **Chapter 4** defines the operational environment in which the future concept is presented. (main operational characteristics, actors and constraints);
- **Chapter 5** details the Use Cases describing the concept;
- **Chapter 6** lists the operational and performance requirements derived from the future concept. Some HMI requirements are defined as well. In addition, Information Exchange Requirements (IERs) are identified to clearly define what information is expected to be exchanged between the actors involved
- **Chapter 7** Lists the reference and applicable documents

1.5 Background

"State of the Art analysis" document ([15]) produced within P06.08.04, has been considered as baseline for defining the operational concept related to the coupled AMAN/DMAN. Information on the status of both arrival and departure manager has been of the utmost importance to identify and analyse the improvements required to implement an efficient AMAN/DMAN integration. Moreover, new procedures have been researched and defined on the basis of the ones described into the state of the art document.

Regarding the integration between departure and surface manager, as a mean to improve the output of the coupled AMAN/DMAN, useful information has been derived from the *Generic operational concept for Pre-departure runway sequence planning* [20].

Obviously the concept described is in line with the Airport CDM process [21].

The OSED dealing with the basic DMAN [14] has been considered as baseline to describe the current DMAN operating method.

All those documents have been considered as input mainly for producing the Initial OSED [16] and then the Preliminary OSED [25]. Final OSED is an updated version of the Preliminary OSED on the basis of the results collected during v3 validation exercises and reported in the EXE-06.08.04-VP-453 validation report [26].

1.6 Glossary of terms

A list of the important terms used in this document is presented below; they are taken, when available, from the SESAR ATM Lexicon [6]. In case of any difference between the definitions provided here and the SESAR Lexicon, the SESAR Lexicon should be taken as the authority. Definitions under refinement are included here and will be submitted to the Lexicon when they are mature and agreed across the Programme.

Term	Definition	Source
A-CDM Process	*A-CDM is the process used to calculate and continuously update the Target Off-block Time (TOBT). It also covers the adjustment and alignment between DPI and the CFMU Slot Calculation process.* *Currently establishing the pre-departure sequence (TSAT) is also considered a CDM-process.*	*To be added to ATM-Lexicon*
AFI – Arrival Free Interval	*An AFI describes the amount of nautical miles (NM) to be maintained between two consecutive arrivals in order to process one or more departures in between. Internal to the system, those Nautical Miles shall have to be converted into times to be used by DMAN or in the case of TBS.*	*Internal 6.8.4*
Arrival Management Service	*Arrival Management Service describes the procedures used to establish sequences and target times planned by the arrival manager.*	*To be added to AMT-Lexicon*
Arrival Manager **(AMAN)**	*AMAN is a planning system to improve arrival flows at one or more airports by calculating the optimised approach / landing sequence and Target Landing Times (TLDT) and where needed times for specific fixes for each flight, taking multiple constraints and preferences into account.*	*ATM-Lexicon*
AOBT	*The actual date and time the aircraft has vacated the parking position (pushed back or on its own power).*	*ATM-Lexicon*
ASAT	*Time that an aircraft receives its start up approval..*	*ATM-Lexicon*
A-SMGCS (Advanced – Surface Movement Guidance and Control System)	*a system providing routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the aerodrome visibility operational level (AVOL) while maintaining the required level of safety.*	*ATM-Lexicon*
ATOT	*The Actual Take Off Time (ATOT) is the time that an aircraft takes off from the runway. (Equivalent to ATC ATD–Actual Time of Departure, ACARS = OFF).*	*ATM-Lexicon*
CTOT	*An Air Traffic Flow & Capacity Management (ATFCM) departure slot, forming part of an Air Traffic Control (ATC) clearance, which is issued to a flight affected by Network Management regulations. It is defined by a time and tolerance (-5 to +10 minutes) during which period the flight*	*ATM-Lexicon*

Term	Definition	Source
	is expected to take-off.	
Departure Management Service	*Departure Management Service describes the procedures used to establish sequences and target times planned by the departure manager.*	*To be added to ATM-Lexicon*
Departure Manager (DMAN)	*a planning system to improve departure flows at one or more airports by calculating the Target Take-Off Time (TTOT) and Target Start Up Approval Time (TSAT) for each flight, taking multiple constraints and preferences into account.*	*ATM-Lexicon*
DTOT	*DTOT is the earliest take-off time either given by time calculated by TOBT + unconstraint time to airborne or limited by start of CTOT window (CTOT – 5 min)*	*Internal 6.8.4*
ELDT	*The Estimated Landing Time (ELDT) is the estimated time that an aircraft will touchdown on the runway. (Equivalent to ATC ETA–Estimated Time of Arrival = landing). [A-CDM Manual]*	*ATM-Lexicon*
ELRP	*The Estimated Line-up and Roll to Airborne Period is the estimated time that an aircraft will take to line up and roll to airborne from the holding position*	*Internal 6.8.4*
EIBT	*The Estimated In-Block Time (EIBT) is the estimated time that an aircraft will arrive in-blocks. (Equivalent to Airline/Handler ETA – Estimated Time of Arrival).*	*ATM-Lexicon*
EOBT	*The estimated time at which the aircraft will commence movement associated with departure.*	*ATM-Lexicon*
ERBP	*Runway Delay Buffer (ERBP) is the buffer of delay planned at runway hold to maintain pressure on runway*	*Internal 6.8.4*
ERWP	*The Expected Runway Waiting Period (ERWP) is the planned delay at the runway holding point.*	*Internal 6.8.4*
ESWP	*Expected Stand Waiting Period (ESWP) is the planned delay waiting on the stand*	*Internal 6.8.4*
EWP	*Expected Waiting Period to be absorbed at Stand and Runway Holding Point (EWP = ESWP+ERWP)*	
ETA	*Estimated Time of Arrival (ETA)* *1. (SESAR) the time computed by the FMS for the flight arriving at a point related to the destination airport* *2. (ICAO) For IFR flights, the time at which it is estimated that the aircraft will arrive over that designated point, defined by reference to navigation aids, from which it is intended that an instrument approach procedure will be commenced, or, if no navigation aid is associated with the aerodrome, the time at which the aircraft will arrive over the aerodrome.*	*ATM-Lexicon*

Term	Definition	Source
	For VFR flights, the time at which it is estimated that the aircraft will arrive over the aerodrome.	
ETOT	*Forecast of time when aircraft will become airborne taking into account the EOBT plus EXOT*	*ATM-Lexicon*
EXIT	*The estimated taxi-in time between landing and in-block*	*ATM-Lexicon*
EXOP	*The estimated Outbound Taxi (EXOP) is the Expected Taxi Period from Off-Block to Take-Off (with no buffer or delay)*	*To be added to ATM-Lexicon*
EXOT	*The estimated time between off-block and take off. This estimate includes any delay buffer time at the holding point or remote de-icing prior to take off.*	*ATM-Lexicon*
Holding point	*A geographical location that serves as a reference for a holding procedure. (Holding Fix)*	*ATM-Lexicon*
Late tweaks	*Short term changes of the planned sequence when the aircraft have already entered the TMA and are on the final or approaching the final*	*Internal 6.8.4*
MDI	*An MDI (Minimum Departure Interval) is an augmented SID separation. NATS frequently applies MDI for de-bunching purposes for some Heathrow SIDs and Gatwick SIDs. For instance frequently applied is 1 in 4 for Heathrow flights using the WOBUN SID. This means on top of the minimum SID separation of 2 minutes for successive flights there is applied a 'Not more than 1 flight in 4 minutes'*	*Internal 6.8.4*
MTTT	*The Minimum Turn-round Time (MTTT) is the minimum turn-round time agreed with an AO/GH for a specified flight or aircraft type.*	*ATM-Lexicon*
Push-Back	*Movement of an aircraft on the ground consisting of leaving the parking area in reverse motion as far as alignment on the taxiway.*	*To be added to ATM-Lexicon*
Runway Pressure	*The Runway Pressure represents the number required by the controller to guarantee that RWY is not under-utilized.*	*Internal 6.8.4*
Sequence Pattern	*The sequence pattern agreed on between approach and tower describes the sequence of arrivals and departures on the runway following a pattern that is continuously repeated for a certain time period*	*Internal 6.8.4*
SIBT	*Scheduled In Block Time (SIBT) is the time an aircraft is scheduled to arrive at its parking position*	*ATM-Lexicon*
SID	*A designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a*	*ATM-Lexicon*

Term	Definition	Source
	flight commences.	
SOBT	*The time that an aircraft is scheduled to depart from its parking position.*	*ATM-Lexicon*
TBS Tool	*Time-Based Separation Tool. This tool displays indicators to support Approach Controllers deliver more accurate runway spacing, and it can be fed by Coupled AMAN-DMAN.*	*Internal 6.8.4*
TLDT	*Targeted Time from the Arrival management process at the threshold, taking runway sequence and constraints into account. It is not a constraint but a progressively refined planning time used to coordinate between arrival and departure management processes.*	*ATM-Lexicon*
TOBT	*The time that an aircraft operator / handling agent estimates that an aircraft will be ready, all doors closed, boarding bridge removed, push back vehicle present, ready to start up / push back immediately upon reception of clearance from the TWR.*	*ATM-Lexicon*
TSAT	*The time provided by ATC taking into account TOBT, CTOT and/or the traffic situation that an aircraft can expect to receive start up / push back approval.* *Note: The actual start up approval (ASAT) can be given in advance of TSAT. Pushback approval will be given according to ASAT.*	*ATM-Lexicon*
TSAT Window	*A time-frame of +/- 5 minutes around the TSAT, in which a Start-Up approval may be issued.*	*To be added to ATM-Lexicon*
TTOT	*An ATM computed take off time. It is not a constraint but a progressively refined planning time that is used to: - refine the departure airport sequencing and optimization of RWY throughput - plan the take-off in order to achieve targets at the destination and during flight, whilst maintaining optimum flight efficiency.*	*ATM-Lexicon*
Tower Clearance Delivery Controller	*The Clearance Delivery Role is part of the controller team responsible for providing an Air Traffic Service at controlled aerodromes. His main task is the verification of Flight data (for instance FPL, CTOT, Stand, TSAT etc.) and the delivery of ATC Clearance (Departure Clearance) and Start-Up Approval.*	*To be added to ATM-Lexicon*
Tower Controller	*Position(s) or person(s) in a control tower responsible for all traffic on the manoeuvring area of an aerodrome and all aircraft flying in the vicinity of an aerodrome*	*To be added to ATM-Lexicon*
Tower Ground Control	*The Tower Ground Controller Role is part of the controller team responsible for providing an Air Traffic Service at controlled aerodromes. His main task is the provision of ATS to aircraft and vehicles on the manoeuvring area. He must also ensure that airport maintenance vehicles*	*To be added to ATM-Lexicon*

Term	Definition	Source
	carrying out necessary improvements on an active manoeuvring area do not interfere with the movement of aircraft	
Tower Runway Controller	*The Tower Runway Controller Role is responsible for the provision of air traffic services to aircraft within the control zone, or otherwise operating in the vicinity of controlled aerodromes (unless transferred to Approach Control/ACC, or to the Tower Ground Controller), by issuing clearances, instructions and permission to aircraft, vehicles and persons as required for the safe and efficient flow of traffic*	*To be added to ATM-Lexicon*
Variable Taxi Time	*the estimated time that an aircraft spends taxiing between its parking stand and the runway or vice versa.* *Variable Taxi Time is the common name for inbound (EXIT) and outbound (EXOT) taxi times, used for calculation of TTOT or TSAT.*	*ATM-Lexicon*

1.7 Acronyms and Terminology

Term	Definition
ADD	Architecture Definition Document
AFI	Arrival Free Interval
ATM	Air Traffic Management
AO	Airport Operator
AxxT	Actual Times
CAT	Category
CONOPS	Concept of Operations
DOD	Detailed Operational Description
E-ATMS	European Air Traffic Management System
ExxT	Estimated Times
GH	Ground Handler
GS(A)	Ground Station (Approach)
IER	Information Exchange Requirement
iRBT/iRMT	Initial Reference Business / Mission Trajectory
IRS	Interface Requirements Specification
INTEROP	Interoperability Requirements
MDI	Minimum Departure Interval
OCD	Operational Concept Description
OFA	Operational Focus Areas
OSED	Operational Service and Environment Definition
RBT/RMT	Reference Business / Mission Trajectory
SESAR	Single European Sky ATM Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.

Term	Definition
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SPR	Safety and Performance Requirements
SUG	Start-up Given
SUR	Start-up requested
SV	Supervisor
TAD	Technical Architecture Description
TIAT	Targeted Initial Approach Fix Time
TS	Technical Specification
TTG	Time To Gain
TTL	Time To Lose
TxxT	**Target Time** Forecasted Time, considering demand and capacity (Except TOBT, which is a time requested by the Airspace User.)
UxxT	**Unimpeded Time** Forecasted Time, using a standard duration for arrivals and departures (ELDT is often used for unimpeded landing time.)
WTC	Wake Turbulence Category
WV	Wake Vortex

2 Summary of Operational Concept from DOD

2.1 Mapping tables

This section shows the link between this Final OSED and the applicable scenarios, use cases, environments, processes, services and requirements of the Airport DOD for Step 1 [22].

Table 1 lists the Operational Improvement steps within the associated Operational Focus Area addressed by the Final OSED. As each OIs could be allocated to multiple OSEDs, the tables details if this Final OSED is a master or contributing for that OIs.

Relevant OI Steps ref. (coming from the Integrated Roadmap)	Operational Focus Area name / identifier	Story Board Step	Master or Contributing (M or C)	Contribution to the OIs short description
TS-0202	OFA04.01.01 Integrated AMAN DMAN	1	M	Pre-Departure Sequencing supported by Route Planning
TS-0308	OFA04.01.01 Integrated AMAN DMAN	1	M	Flow based Integration of Arrival and Departure Management

Table 1: List of relevant OIs within the OFA

Table 2 identifies the link with the applicable scenarios and use cases of the Airport DOD for step 1 [22].

Scenario identification	Use Case Identification	Reference to DOD section where it is described
Short Term Planning Phase	Use Case UC6 14 – Revise / Update AOP during day of operation	4.2.4.2.3
Landing	Use Case UC6 17 – Go Around	4.2.5.3
Operations prior to Turn-Round	Use Case UC6 54 - In-Block	4.2.6.2.1.1
Operations prior to Turn-Round	Use Case UC6 55 – Aircraft Handling	4 2.6.2.1.2
Operations prior to Turn-Round	Use Case UC6 57 - Unable to respect TOBT	4 2.6.2.1.1
Operations prior to Turn-Round	Use Case UC6 58 -Pre-departure	4.6.2.1.2
Operations prior to Turn-round	Use Case UC6 62 – Off Blocks (General)	4.2.6.2.1.
Departure	Use Case UC6 76 Pushback	4.2.7.2.1
Departure	Use Case UC6 86 Take-Off	4.2.7.2.1.2
Departure	Use Case UC6 39 –Runway Inspection	4.2.7.2.1.2
Departure	Use Case UC6 90 Aborted take-Off	4.2.7.2.1.2
Departure	Use Case UC6 85 Aircraft blocking a taxiway	4.2.7.2.1.1

Table 2: List of relevant DOD Scenarios and Use Cases

Table 3 identifies the link with the applicable environments of the Airport DOD for Step 1 [22].

Operational Environment	Class of environment	Reference to DOD section where it is described
Network Function	1: Intercontinental Hub 2: European Hub	3.1.1.1
Layout & Basic Operational Criteria	1: Multiple Independent Runways, complex surface layout 2: Multiple Dependent Runways, complex surface layout 3: Single Runway, complex surface layout 4. Multiple Independent Runways, non-complex surface layout 5: Multiple Dependent Runways, non-complex surface layout 6: Single Runway, non-complex surface layout	3.1.1.2
Capacity Utilisation	1: Highly utilised airports/runways, traffic mix of heavy, medium and light aircraft. More than 90% load during 3 or more peak periods a day.	3.1.1.3

Operational Environment	Class of environment	Reference to DOD section where it is described
	2: Highly utilised airports/runways, homogeneous traffic (dominant heavy or medium or light). More than 90% load during 3 or more peak periods a day 3: Normally utilised airports/runways. 70 – 90% load during 1 or 2 peak periods a day	

Table 3: List of relevant DOD Environments

Table 4 identifies the link with the applicable Operational Processes and Services defined in the Airport DOD for Step 1 [22].

DOD Process / Service Title	Process/ Service identification	Process/ Service short description	Reference to DOD section where it is described
Manage Movement on the Airport Surface	Prepare and Execute Off Block	Compute TSAT, issue TSAT and TTOT, publish the RBT/iRMT, determine priorities and provide departure clearance. Give instruction to exit from the stand and provide push-back approval. Start-up may be delayed. Receive take-off information, upload the aircraft part of the RBT/iRMT and request departure clearance. Request push-back approval. Start-up may be delayed. In some cases, aircraft may forward to exit from an open stand or use engine reverse power.	5.2.3
Manage Runway	Prepare and Execute Landing	Send preferred runway exit to ATC or check if exit given by ATC is applicable. Land. Touch and go. Perform a go around. Brake to vacate the runway at the intended runway exit. Receive preferred runway exit, accept it or propose another exit. Publish agreed exit. Record ALDT and publish aircraft position on airport surface. Through the use of ADS-B to improve the accuracy in positioning. Give instruction during final approach. Optimize sequence.	5.2.2
Manage Runway	Prepare and Execute Take-Off	Optimize sequence, provide line-up clearance, check that the runway is clear and provide take-off clearance. Through the use of ADS-B to improve the accuracy in positioning. Inspect runway.	5.2.2

Table 4: List of the relevant DOD Processes and Services

Table 5 identifies the link with the applicable DOD requirements defined in the Airport DOD for Step 1 [22].

DOD Requirement Identification	DOD requirement title	Reference to DOD section where it is described
REQ-06.02-DOD-6200.0015	Time Based Separation for Final Approach - Full Concept	6.2
REQ-06.02-DOD-6200.0060	Flow based Integration of Arrival and Departure Management	6.2
REQ-06.02-DOD-6200.0061	Co-ordination of Pre-departure Management and Arrival Metering	6.2
REQ-06.02-DOD-6200.0062	Fixed arrival-departure pattern	6.2
REQ-06.02-DOD-6200.0080	Pre-Departure Sequencing supported by Route Planning	6.2

Table 5: List of the relevant DOD Requirements

2.2 Operational Concept Description

The Coupled AMAN/DMAN primarily aims at increasing predictability and reducing or at least better manage delay. Apart from this a small increase in runway throughput and reduction of fuel consumption can be realised.

In the new operating method co-ordination between approach and tower will be improved as they will pro-actively agree on a defined sequence pattern and AFI-size (Arrival Free Interval) based on an integrated traffic picture for the respective runway. AMAN and DMAN will be coupled in this solution and provide the operators with an integrated view on the planned runway sequence.

Coupling will be set up as a master/slave configuration with AMAN acting as the master and DMAN allocating departures in the AFIs. DMAN can be improved by considering estimated taxi times provided from surface routing and planning function (substituting static taxi-time tables currently used in A-CDM). In step 1 estimated taxi times will not be updated after start-up.

The solution described is defined as “flow-based” integration since it aims to optimize traffic flows, i.e. coupled pre-departure sequencing and arrival metering. Controllers are requested to follow the pattern but are not expected to exactly follow the planned sequence of aircraft.

The performance based approach is further underlined if the selection of the sequence pattern is supported by further system functionalities which can optionally be added to the solution. The optional functionalities enhance the performance based approach allowing an even more objective assessment of the situation and can comprise of:

- KPI calculation
  based on the selected sequence pattern and AFI-size the KPIs can be calculated by the coupled AMAN/DMAN supporting the selection/adjustment of pattern with objective forecasted measures. KPIs can comprise of different parameters like delay, runway throughput or schedule adherence.

- What-if probing
  supervisors may have the functionality of a what-if probing available in order to give them information on what the consequences on the KPIs will be choosing a certain pattern allocation.

- Automatic pattern calculation
  Coupled AMAN/DMAN can calculate the most appropriate pattern allocation based on the expected traffic and the resulting KPI figures.

In the OSED also the option of a Time-Based Spacing (as defined by SESAR P06.08.01) is described, supporting more accurate delivery by Approach Controllers of the arrival spacing agreed between Tower and Approach.

It is worthwhile to highlight that for Step 1 a single airport with a single runway used in mixed mode operations has been considered as the applicable environment for the integration.

Establishment of an integrated arrival/departure sequence is directly linked to the optimization of the departure sequence. For that reason, this Final OSED addresses also the integration between departure and surface management. However, for Step 1 that integration is limited just to a more accurate taxi-out time provided by Routing and Planning service. This is an improvement respect to the current situation where DMAN, operating in a standalone solution, takes as input static taxi-out time. However, it is important to highlight that the magnitude of this improvement depends on how the "static taxi-out time" is defined (as explained in the sections 3.1 and 3.2).

As no full integration (e.g. live traffic monitoring) between departure and surface management is envisaged for Step 1, the main expected benefits regard more the optimization of the pre-departure sequences than the accuracy of the departure sequence. Therefore:

- The pre-departure sequences based on the TSAT times (window) provided by the departure management is expected to be followed by the controllers in charge of issuing start-up approval;
- The departure sequence based on the TTOT times calculated by the departure management provides the controllers with the overall traffic picture. It has to be highlighted that it remains the controllers task to further optimise the departure sequence whenever possible, i.e. controllers do not have to adhere to TTOT.

2.3 Processes and Services (P&S)

The following sub-section presents the high-level airport operational process associated to P06.08.04. The table presents the following data:

- Process: name of the high level airport operational process;
- Node: node which is responsible for the activities in the process;
- Activity: sub-process called to realize a part of the process;
- Description: description of the activity;
- OFA: OFA addressed by the activity
- OI step: OI step addressed by the activity (only Step 1);
- Associated Use Cases: Use Cases associated to the current activity.

2.1 Manage Movement on Airport Surface

The following table lists the processes providing guidance to aircraft or vehicles on the airport surface.

Process	Node	Activity	Description	OFA	OI step	Associated Use Cases
Prepare and execute off-block	AATS	Manage pre-departure	Compute TSAT, issue TSAT and TTOT, publish the RBT/iRMT, determine priorities and provide departure clearance.	04.01.01 04.02.01	TS-0202 AUO-0308	UC 6 58

Table 6: Processes providing guidance to aircraft or vehicles on the airport surface

2.2 Manage Runway

The following table lists the processes providing guidance to aircraft or vehicles in the runway volume.

Process	Node	Activity	Description	OFA	OI step	Associated Use Cases
Prepare and Execute Landing	AATS	Manage runway sequence	Optimize sequence, provide line-up instruction, check that the runway is clear and provide take-off clearance.	01.03.01 04.01.01	AO-0303 AO-0306 AO-0309 AO-0310 TS-0308	UC 6 99
Prepare and Execute Take-Off	AATS	Manage runway sequence	Optimize sequence, provide line-up instruction, check that the runway is clear and provide take-off clearance.	01.03.01 04.01.01	AO-0303 AO-0304 AO-0306 TS-0308	UC 6 86

Table 7: processes providing guidance to aircraft or vehicles in the runway volume

2.3 Services

The following services given in the ISRM are under the scope of this OSED:

- RunwayMixSequence service
- CalculatedPreDepartureSequenceDelivery service

2.4 Mapping to Service portfolio and Systems (optional for V1 and V2)

Services and systems supporting these processes are not available in the Airport Step 1 DOD at the time of writing.

3 Detailed Operating Method

As the solution described in this OSED addresses TS-0202 (solution #53) as well as TS-0308 (solution #54), the operating method will be described in separate subchapters, each of them addressing one OI:

1. The first deals with integration between departure management and surface routing and planning service to detail the way to improve the predictability of (pre-) departure sequencing (corresponding to TS-0202);
2. The second focuses on the operating method related to the integration between arrival and departure management (AMAN/DMAN) (corresponding to TS-0308).

3.1 Previous Operating Method without departure management integrating Routing and Planning service

The previous operating method reflects the Basic DMAN as described within the Basic OSED [14]. The main objective of the basic DMAN is to control the departure traffic flow to the runway. The following procedures are used:

- The Clearance Delivery Controller will provide start-up approval based on the TSAT (considering the TSAT window).
- Tower Ground Controller and Tower Runway Controller are not provided with any sequence information.

Basic DMAN uses the Target Off-Block Time (TOBT) provided by the A-CDM process as input for elaborating both pre-departure sequence (i.e. Target Start-Up Approval Time, TSAT) and departure sequence (i.e. Target Take Off Time, TTOT). DMAN calculates TTOT and TSAT by taking as input estimated taxi-out times derived from static parameters tables. Depending on the local implementation these static taxi times might be manually adjusted by the controller (either for a single flight or for all flights using a factor).

The following picture allows a better understanding of the mentioned times used in Basic DMAN:

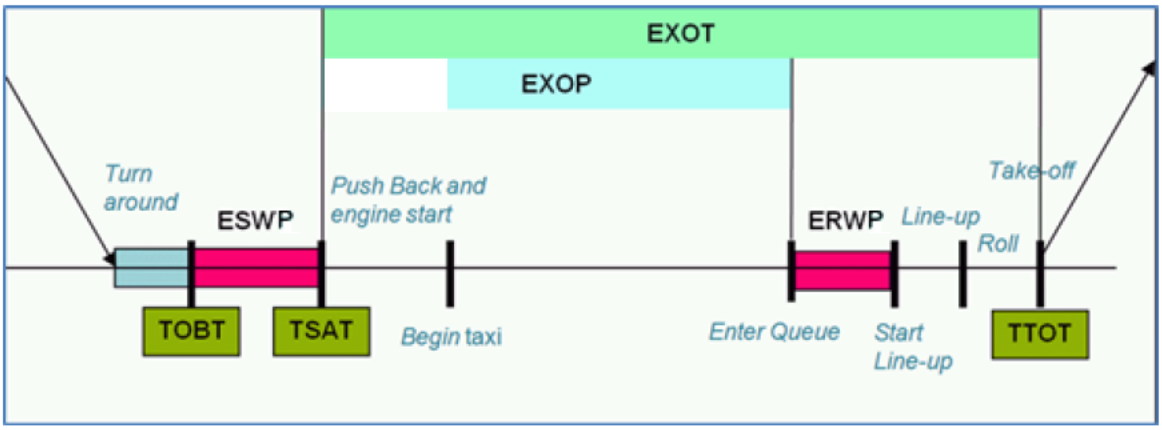

Figure 2: Times and Waiting periods

The following aspects should be highlighted:

- EWP
  represents the total waiting time for a flight to access the next available take-off slot if leaving

at TOBT. The total delay for each flight that has to be absorbed is the EWP. This delay is split into two parts that are considered on block and at the runway hold respectively:

- ESWP – Estimated Stand Waiting Period
  Waiting time at the stand used to reduce fuel burn.
- ERWP – Estimated Runway Hold Waiting Period
  Waiting time at the runway hold in order to provide some buffer in order to maintain pressure on runway and not to lose any runway slots if an aircraft is not perfectly in time. The runway buffer needs to be minimised.

- EXOP
  EXOP is the estimated taxi time from pushback to runway hold not considering and buffer or delay. It has to be noted that neither startup, pushback, de-icing, lineup and roll times are part of the EXOP.

- TTOT
  is defined as (Others being times for startup, pushback, de-icing, lineup and roll times)
  - TTOT = TOBT + EXOP + EWP + Others
  - TTOT = TOBT + EXOP + (ESWP + ERWP) + Others

3.2 New SESAR Operating Method (Solution #53)

The operating method describes in this chapter addresses the SESAR solution #53 'Pre-Departure Sequencing supported by Route Planning'.

Introduction of Routing and Planning service is expected to increase the accuracy of the taxi-out times, as detailed in the P06.07.02 Updated OSED [24]. The estimated taxi-times (EXOP) provided by surface routing and planning will be used by DMAN (instead of the static taxi-time tables) and accuracy of TTOT and TSAT will be improved. DMAN will use the same rules for calculating TTOT and TSAT as in previous operations.

An increased number of aircraft is expected to leave the stand on time (i.e. producing a reduction of runway waiting time).

The following procedures are used:

- The Clearance Delivery Controller
  will provide start-up approval based on TSAT (considering that TSAT is a window of -/+ 5 minutes) provided by DMAN as in the previous operating method. The only change to previous operations is that TSAT calculation will be based on more accurate estimated taxi times provided by routing and planning service.
- Tower Runway Controller
  as in previous operations verifies that the runway is clear and that the aircraft will meet arrival/departure separation requirements. It has to be highlighted that it remains the controller's task to further optimise the departure sequence whenever possible, i.e. controllers do not have to adhere to TTOT.
- Flight Crew
  requests a departure clearance by voice (R/T) or by datalink communications as in previous operations.

The Routing and Planning service will provide estimated taxi times only up to start-up. After that no update on remaining taxi times will be provided (this will follow in step 2 solution).

The benefit of the calculation of estimated taxi times based on the routing functionality compared to static tables used in A-CDM depends on different factors:

- Static Taxi-Time Tables
  the more sophisticated the static tables are, the less improvement is expected by taxi times provided by routing and planning.
  - Stand Areas
    the more granular the stands are modelled in the tables the less the potential improvement is. The granularity might reach from using just one taxi time for the whole airport, using taxi times for stand areas up to using taxi times for each stand.
  - Traffic Density
    if increased taxi times due to high traffic density can be adjusted in the tables (modelling reduced taxi speeds), the less the potential improvement is.
  - Weather Influence
    if different taxi times due to different weather conditions can be adjusted in the tables (modelling various taxi speeds), the less the potential improvement is.

- Taxiway Layout
  the more complex the taxiway layout is, the more improvement is expected by taxi times provided by routing and planning.
  - Taxi route length
    the more the length of the taxi routes varies due to different factors (like closed taxiways or taxiways depending on traffic situation), the higher the potential for improvement is.

When departure management is integrated with the Routing and Planning service the following results were collected during v2 validation exercises [for further details see [17], [18], [19]],:

- Nominal Situations
  no great improvement of both TTOT and TSAT accuracy was shown in nominal situations (DSNA EXE-06.08.04-VP-231)
- Non-nominal situation (e.g. closed taxiway)
  slight improvement of both TTOT and TSAT accuracy was shown in non-nominal situations (DSNA EXE-06.08.04-VP-231)

When departure management used only one average taxi-out time regardless the place where is located the stand (ENAV EXE-06.08.04-VP-298), the resulting TTOT and TSAT were not enough accurate to be fully followed respectively by the Tower Runway and Tower Clearance Delivery Controller.

The following phases are affected by the integration of routing and planning service:

- Turn-round Phase
  Turn-round phase starts from AIBT and ends when the aircraft leaves the block – which is at the Actual Off-Block Time (AOBT). A-CDM is considered as already implemented and, as such, the description of the new operating method starts when TOBT is received by the DMAN from the A-CDM process triggering DMAN calculation. Following the receipt of the TOBT, the Routing and Planning service provides DMAN with an estimated taxi-out period (EXOP) taking into account gate/stand location and runway in use.

- Surface-out phase
  Surface-out phase starts from AOBT and ends when the aircraft takes off, that is at the Actual Take-Off Time (ATOT). As there is no live traffic monitoring, any deviations of the aircraft in comparison with the issued taxi-out route doesn't trigger DMAN to update/optimize the pre-departure sequence.

3.3 Differences between new and previous Departure management / Routing and Planning service Operating Methods

The main benefits are related to the more accurate taxi-out times expected to be provided by the Routing and Planning service. However, the magnitude of the potential benefits depends on how accurate is the static taxi-out time DMAN takes as input when it works as standalone solution distinguishing between the following two cases:

1. In case static taxi-out time is quite tuned taking into account the allocated stands and the selected runway threshold, no great improvement is expected to be achieved when the Step 1 integration between departure management and Routing and Planning service is implemented, as this result is expected to improve significantly in step 2;
2. In case static taxi-out time is an average time regardless where the parking position is located, the integration between departure management and Routing and Planning service will bring higher accuracy of both TTOT and TSAT.

Regardless how tuned is the static taxi-out times, the main benefits will concern with accuracy and stability of the pre-departure sequence. It means that the TSAT order established by the DMAN, when integrated with Routing and Planning service, will be so reliable that the operational controller in charge of issuing start-up approval will adhere to it.

Regarding the departure sequence, it is important to highlight that TTOT order is expected to provide initial benefits which will be further improved in Step 2 solution.

3.4 Previous Operating Method AMAN/DMAN

Gatwick airport and the related approach operations are given here as a baseline example to describe the current situation. The runway is operated in mixed mode. Those operating methods are similar to the ones used in Munich.

The approach function is divided into 2 positions:

- Intermediate Director (INT): responsible for taking traffic from the holding stacks and combining them into a single stream to be handed to the Final Director.
- Final Director (FIN): The Final Director takes the stream (4.000 ft.) and establishes the traffic on the ILS in a safe and expeditious manner.

At busy times they are assisted by a support controller (SUPP).

Final approach spacing depends on the weather conditions. Here the different cases can be analysed:

1. **Number of arrivals is equal to the departures**.
   Arrivals are spaced just to allow one departure between each pair. According to the weather conditions different miles separation can be applied.
2. **Number of arrivals is greater than the departures**.
   Packing procedures are applied. It means that, generally speaking, a separation of 3NM is ensured between the arrivals. But also wake vortex separations have to be considered. Separations might have to be increased if departures need to be integrated. In these cases departures will preferably be placed in the bigger wake vortex gaps.
3. **Number of departure is greater than the arrivals**.
   Gapping procedures are applied. It means that arrivals are spaced of 8NM allowing two intervening departures.

Coordination between executive controller FIN and tower controller is executed by telephone. Quiet periods – up to 25 or 30 movements per hour – do not require coordination. On the other hand, during busier periods, tower controller for example requests a sequence pattern that allows more departures to take-off. The sequence pattern which is complemented by an Arrival Free Interval (AFI) is explained in the next paragraph.

3.4.1 Sequence Pattern

The sequence pattern agreed on between approach and tower describes the sequence of arrivals and departures on the runway following a pattern that is continuously repeated for a certain time period. With ‘A’ for an arrival and ‘D’ for a departure, with the last character in the pattern just indicating the beginning of the new pattern, a pattern might look like

- ADA results in (ADADADADADA …) describing case #1 in above list
- ADDA results in (ADDADDADDA ….) describing case #3 in above list

An important topic to be taken into account is that the agreed sequence pattern is usually kept up for a certain time period due to the high workload for the two busy positions in tower and approach.

In the table below some examples for sequence pattern are given describing different packing and gapping sequence pattern.

Pattern – packing	Pattern – gapping
DAD	ADA
DAAD	ADDA

DAADAD	ADDADA

Table 8: Examples of Sequence Pattern (packing and gapping)

3.4.2 Arrival Free Interval (AFI)

The sequence pattern needs to be complemented by the AFI-Size that describes the amount of nautical miles (NM) to be maintained between two consecutive arrivals in order to process one or more departures in between. AFI-Sizes need to be adjusted to various different conditions like different wind or visibility conditions.
Internal to the system, those Nautical Miles have to be converted into times to be used by DMAN. In case TBS is used, operators will use AFI-Size in terms of time (instead of distance).

Instead of coordinating a sequence pattern and an AFI-Size different phraseology might be used. For example, “ADDADA”, “gap & pack”, or “6 & 3” might all be used to describe the same pattern.

For each pattern the related AFI will be defined keeping in mind that it might vary according different factors like the weather conditions (e.g. IMC or VMC, wind conditions), number of departures between arrivals, prevailing vortex category. For that reason, it could assume various configurations alternating arrival and departure flows:

Pattern	Day 1	Day 2
ADA	**3 NM**	**4 NM**
ADDA	**6 NM**	**7 NM**
ADDADA	**6-3 NM**	**7-4 NM**

Table 9: Example of AFI-Sizes

The choice of pattern to be made available at different locations shall be defined individually depending on the local needs. Hence at some locations it might be sufficient to offer ADA pattern and ADDA pattern, where at other locations even the availability of ADDADA pattern is needed.

3.4.3 Late Tweaks

The approach controller (feeder controller) is in charge of providing AFIs as generally agreed on. Nevertheless the Tower Runway Controller can request ‘late tweaks’, i.e. adjustments to the sequence pattern or AFI-Size. However, those requests have to be considered as an exception to maintain workload at an acceptable level.

In some case the sequence pattern will have to be revised due to wake vortex reason, for example from “6-3-6-3 to 6-6-3-3” through a call between FIN and tower controllers. The coordination is facilitated by a good Tower controller view of the arrival operations on his radar approach display. FIN can usually adjust spacing any time before turn to Base Leg.

3.4.4 Shortcomings

Main problems we have to deal with today are:

- Reactive change of sequence pattern (which induces delay that might have been avoided by proactive adjustment of sequence pattern).
- Subjective supervisor assessment on which basis coordination of sequence pattern is performed.

3.5 New SESAR Operating Method (Solution #54)

The operating method describes in this chapter addresses the SESAR solution #54 'Flow based Integration of Arrival and Departure Management'.

The Coupled AMAN/DMAN primarily aims at increasing predictability and reducing or at least better manage delay. Apart from this a small increase in runway throughput and reduction of fuel consumption can be realised.

In the new operating method co-ordination between approach and tower will be improved as they will pro-actively agree on a defined sequence pattern and AFI-size (Arrival Free Interval) based on an integrated traffic picture for the respective runway. AMAN and DMAN will be coupled in this solution and provide the operators with an integrated view on the planned runway sequence.
The previously used operating method of co-ordination between approach and tower will be supported by the coupled AMAN/DMAN reflecting the co-ordination based on sequence pattern and AFI-Size.

The solution described is defined as "flow-based" integration since it aims to optimize traffic flows, i.e. coupled pre-departure sequencing and arrival metering. Controllers are requested to follow the pattern but are not expected to exactly follow the planned sequence of aircraft.

The following procedures are used:

- Approach and Tower Supervisor
  will agree on sequence pattern and AFI-Size. It is decided at local level if it is the Approach Supervisor or Tower Supervisor who will input the respective values for pattern and AFI-Size into AMAN.
- Approach controllers
  will as in previous operating method establish the landing sequence considering the agreed sequence pattern and AFI-Sizes.
- The Clearance Delivery Controller
  will provide start-up approval based on TSAT (considering that TSAT is a window of -/+ 5 minutes) as in the previous operating method. The only change to previous operations is that TSAT calculation will be based on more accurate calculation provided by coupled AMAN/DMAN.
- Tower Runway Controller
  as in previous operations verifies that the runway is clear and that the aircraft will meet arrival/departure separation requirements. It has to be highlighted that it remains the controller's task to further optimise the departure sequence whenever possible, i.e. controllers do not have to adhere to TTOT.
  TTOT can be used as a "tie-breaker" when there are two equivalent aircraft.

The integrated sequence of arrivals and departures and the allocated sequence pattern is displayed to the supervisors, Approach controllers and Tower Runway Controllers. It is decided at local level if it is the approach supervisor or the tower supervisor who should be the operator responsible for providing input on sequence pattern and AFI-Size to the coupled AMAN/DMAN. Approach and Tower Runway Controller can manually adjust the sequence to reflect 'late tweaks'.

Procedures for establishing pre-sequencing/metering should remain mainly unchanged compared to previous operating method of just using AMAN and DMAN with no coupling of both systems.
On the arrival management side, en-route procedures aim at building a pre-arrival sequence. Correspondingly the ATCOs in the en route sectors adjacent to the TMA are requested to establish the planned sequence as well as the planned time at the respective metering fix (TIAT) applying speed control, vectoring / path-stretching or holding procedures as necessary. The controller will be supported by strategic advisories generated by the system, such as Time to Lose (TTL) or Time to Gain (TTG).

Procedures for adjusting the Arrival and Departure sequence should also remain unchanged compared to previous operating method of just using AMAN and DMAN with no coupling of both systems!

3.5.1 Optional operating methods

The performance based approach is further underlined if the selection of the sequence pattern is supported by further system functionalities which can optionally be added to the solution. The optional functionalities enhance the performance based approach allowing an even more objective assessment of the situation and can comprise of KPI-calculation, What-If probing or automated pattern calculation. None of these optional methods have been validated so far.

3.5.1.1 Optional Method - KPI-calculation

Based on the selected sequence pattern and AFI-size the KPIs can be calculated by the coupled AMAN/DMAN supporting the selection/adjustment of sequence pattern with objective forecasted measures. KPIs can comprise of different parameters like delay, runway throughput or schedule adherence.

The following additional procedures are used:

- Approach and Tower Supervisor
  Supervisors can take their decision on sequence pattern and AFI-Size based on the display of forecasted KPIs for arrivals, departures and integrated sequence.

The procedures for all other operators are not affected by this optional operating method.

3.5.1.2 Optional Method - What-if Probing

Supervisors may have the functionality of a what-if probing available in order to give them information on what the consequences on the KPIs will be choosing a certain pattern allocation. The What-if Probing should be complemented by the KPI calculation

The following additional procedures are used:

- Approach and Tower Supervisor
  Supervisors can take their decision on sequence pattern and AFI-Size based on the evaluation of different scenarios they have tested with the what-if probing.

The procedures for all other operators are not affected by this optional operating method.

3.5.1.3 Optional Method – Automatic Pattern Calculation

Coupled AMAN/DMAN can calculate the most appropriate pattern allocation based on the expected traffic and the resulting KPI figures. The automatic pattern calculation is an option that can be implemented alternatively to the What-if Probing.

The following additional procedures are used:

- Approach and Tower Supervisor
  Supervisors will either select the sequence pattern proposed by the automatic pattern calculation or replace the proposal with a manual selection of sequence pattern.

The procedures for all other operators are not affected by this optional operating method.

3.5.1.4 Optional Method - AMAN/DMAN drives Spacing Indicators

A further option refers to the benefits that Time Based Separation (TBS) Tools might derive from the availability of a planned runway timeline from the Coupled AMAN-DMAN. The P06.08.01 OSED [23] specifies a Time-Based Separation (TBS) Tool which displays Indicators to Approach Controllers to support more accurate delivery of separation and planned spacing. More accurate delivery means there is less need for buffers in planning, and runway throughput can be increased. The OSED states:

> "The final approach controller and the tower runway controller are to be provided with the necessary TBS tool support to enable consistent and accurate delivery and monitoring to time based wake turbulence radar separation rules on final approach. A separation indicator is to be displayed on the extended runway centre-line of final approach of the separation or spacing required behind the lead aircraft of each arrival pair as a separation or spacing reference for the follower aircraft."

The TBS Tool requires as input a high-integrity arrival sequence together with the current spacing policy, which can be provided by Coupled AMAN-DMAN.

P06.08.01 has focused on use of the TBS Tool to deliver arrival pairs separated at the wake vortex minimum, in line with its remit to investigate "Coupled AMAN-DMAN". P06.08.01 addresses the Operational Improvement AO-0303:

> "The application of time based wake turbulence radar separation rules on final approach (TBS) provides a consistent time spacing between arriving aircraft in order to maintain runway approach capacity independently of any headwind component. The final approach controller and the Tower runway controller are to be provided with the necessary TBS tool support to enable consistent and accurate delivery to the TBS rules on final approach. The minimum radar separation and runway related spacing constraints will be required to be respected when applying the TBS rules."

The P06.08.01 OSED states that the TBS Tool should be capable of supporting accurate delivery of gaps for departures on a mixed-mode runway, in addition to wake vortex and radar spacing. The TBS Tool for a Mixed Mode Runway support delivery of arrivals according to an agreed timeline, so it is closely linked with Coupled AMAN-DMAN.

Under this option the outputs from the Coupled AMAN-DMAN are used to place Spacing Indicators on the radar display of approach controllers to guide the turn to base leg and the intercept of Final Approach. This will support more accurate delivery of planned spacing, thereby increasing runway throughput.

The following additional procedures are used:

- Approach and Tower Supervisor
  When using Time-Based Operations, it should be possible to input AFI sizes into AMAN in seconds, rather than in minutes and seconds as in the current prototype. This would directly reflect the time-based requests from Tower, and avoid the extra workload for the GS(A) in performing a mental conversion.
- Approach Controllers
  will establish the arrival sequence and separation supported by the TBS-Indicators.

The procedures for all other operators are not affected by this optional operating method.

3.5.2 Technical Aspects

3.5.2.1 AMAN and DMAN – System Integration

Coupling will be set up as a master/slave configuration with AMAN acting as the master and DMAN allocating departures in the AFIs.

Generally speaking, the AMAN, as master, will be in charge of calculating the arrival sequence (considering the Arrival Free Intervals; AFI) where the DMAN will allocate the departure sequence. The time period between two successive TLDTs corresponds with an Arrival Free Interval (AFI).

AMAN and DMAN planning horizons might be different. Synchronisation of the planning horizons is not expected since TOBT will always be provided as input to AMAN coupling before AMAN starts planning activities.

The picture below better clarifies the coupling solution and the related data flows:

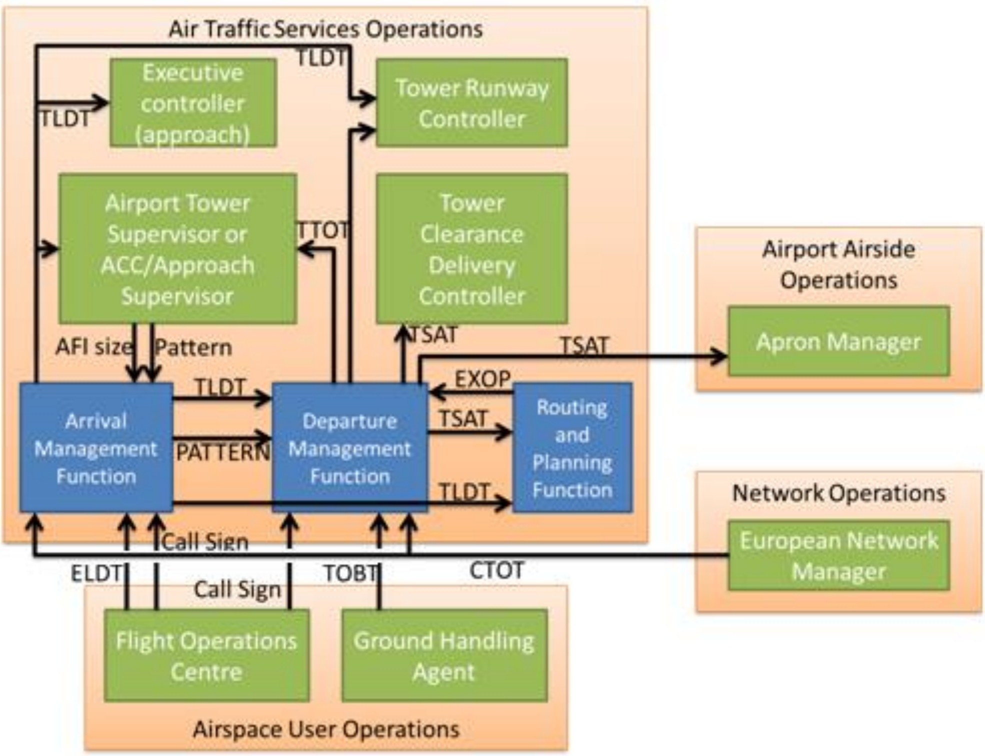

Figure 3: Coupling Input-Output Diagram

Once ASAT has been issued it is not foreseen to update the sequence. Instead it rather shall be attempted to stick to the original planning as far as feasible. Thus TTOT shall be kept stable as long as possible in order to come back to the initial planning. But when it is seen that the TTOT cannot be met or is not useful anymore the TTOT has to be updated.

3.5.2.2 AMAN and DMAN - HMI

Input of Information

It will depend on local procedures if it is the approach supervisor or the tower supervisor who is responsible for providing input on sequence pattern and AFI-Size (either in in NM for distance based operations or in seconds for time based operations) to the coupled AMAN/DMAN.

The input of Sequence pattern might be realised in different ways. For example, “ADDADA”, “gap & pack”, or “6 &3” might all be used to describe the same pattern with the last version directly adding the AFI-Size.

Manual switching of Arrivals and Departures must be enabled as it is today in the AMAN and DMAN which are not coupled. In addition to this, switching of arrivals and departures in the integrated sequence needs to be enabled (to consider ‘late tweaks’).

Display of Information

The integrated sequence of arrivals and departures and the allocated sequence pattern is displayed to the supervisors, Approach controllers and Tower Runway Controllers. Approach and Tower Runway Controller can manually adjust the sequence to reflect 'late tweaks'.

The display of the integrated sequence may be adjusted according to local needs and according to the respective working position. The level of detail displayed for the integrated sequence needs to be selectable/individually adjustable by the operators. Approach and Tower Runway Controller need to be able to fully suppress the display of the integrated sequence.

Approach Controllers might be provided with a reduced set of information on the departures, i.e. only the callsign or just the Indicator for a departure flight (even without callsign) might be displayed.

Approach Controllers might also be provided with additional information on departures like Vortex Category and Status of Flight (i.e. SUR, SUG, Begin Taxi).

For Tower Runway Controllers the information on arrivals (TLDT and Vortex Category) shall be integrated in sequence of departures (this information is required for coordination of late tweaks). The call sign shall also be displayed in order to facilitate phone co-ordination if necessary.

3.5.2.3 Sequence Pattern - Manual Selection

The sequence pattern is continuously repeated until a change is implemented by the supervisor.

To manually apply a new runway pattern, the supervisor has to indicate the callsign of the aircraft after which this change will become effective; during v3 validations, indeed, it was highlighted to be a more intuitive way respect to indicating the time when the pattern will be applied. Allocating a change of a sequence pattern to a flight requires high stability of the sequence (i.e. if the flight is moved in the sequence, also the change of the sequence pattern will be moved in time).

3.5.2.3.1 Manual changes (APP / TWR supervisor)

In more detail the manual changes regarding the pattern allocation by the APP / TWR supervisor shall encompass the:

- starting time
- selected pattern
- associated AFI-Sizes

It shall be possible for the SV to enter additional subsequent patterns, thus representing a transition from the previous pattern to the next specified pattern. In practical implementation more than two transitions probably do not make sense due to the manageable time horizon of the AMAN / DMAN.

3.5.2.3.2 Manual changes (TWR- / APP ATCO)

Regarding both the TWR ATCO as well as the APP ATCO manual changes will mainly occur in the form of late tweaks (i.e. short term changes of the planned sequence when the aircraft have already entered the TMA and are on the final or approaching the final).

In detail this means that consultation between the two ATCOs allows for an optimization of the AFI size in order to change the RWY sequence. More specifically such a coordination would e.g. be communicated between the TWR controller and the ARR controller by stating the favoured deviation from the current pattern. The information by the requesting controller should include the position at which a deviating AFI is needed and the desired size.

3.5.2.4 Sequence Pattern - Implementation

3.5.2.4.1 Separations

The sequence pattern will be established by coupled AMAN/DMAN taking into account the following separation constraints:

- Separations between Arrivals
    - Minimum ARR separations used as today (like minimum Radar separations - which might either be distance or time based, minimum WV, CAT separations)
    - AFI-size depending on sequence pattern
- Separations between departures
    - Depending on the local implementation, DMAN may apply the minimum DEP separations (like minimum radar, Wake Vortex separation, CAT separation, MDI separation)
    - Depending on the local implementation DMAN may just add the number of departures between AFIs based on the sequence pattern.
- Separations between arrivals and departures (and vice versa)
    - Departures are placed in between successive TLDTs (in the middle or equally distributed if there are two or more successive departures)

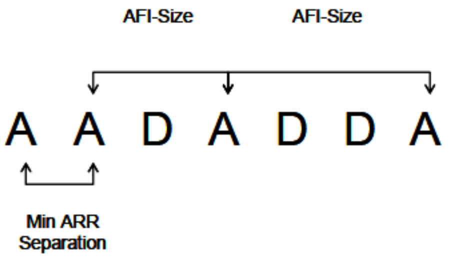

Figure 4: Pattern and Separations

3.5.2.4.2 Adherence to sequence pattern

There might be different implementations on how to plan the Sequence pattern. The following strategies might be applied:

- Based on the rationale that DMAN is the expert in providing TTOTs, DMAN can sequence as many departures as possible between two TLDTs (regardless of the pattern, i.e. DMAN does not care whether it received an “ADDA” pattern or an “ADA” pattern). DMAN is free to optimise departures, subject to ensuring that they do not conflict with the arrival TLDTs.
- Based on the rationale that DMAN plans a traffic flow rather than an exact runway sequence, DMAN fills up the pattern as closely as possible. This results in some considerations described below.

Due to the high workload approach controllers and tower runway controllers have to deal with, the sequence pattern needs to be stable over a certain minimum time duration (this was also verified in initial validation exercises). This might result in a planning which shows sequence pattern that are not completed and an AFI remains empty if the demand is not high enough (middle row in figure below). These gaps might be closed by the approach controller if workload allows it (without need for adjusting the planned sequence).
But where AFIs recurrently can’t be filled it becomes obvious to the operators that there is a need to update the chosen pattern. An example is given in the figure below where a transition from an ADDA pattern to an ADA pattern might be recommendable in the right column.

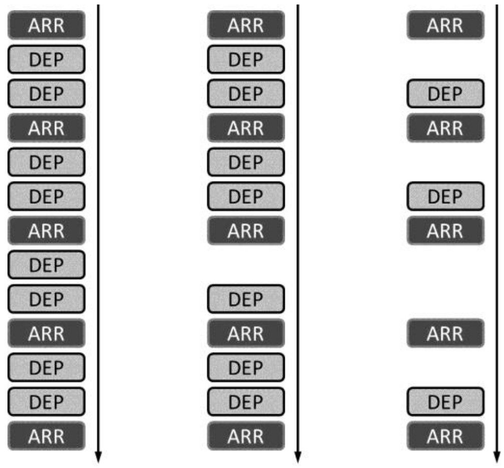

Figure 5: Maintaining of specified pattern

On the other hand situations might occur where a certain pattern has been specified but where the required ARR demand is not available. In such cases the intervals between two successive ARRs shall be filled as much as possible with available DEPs.

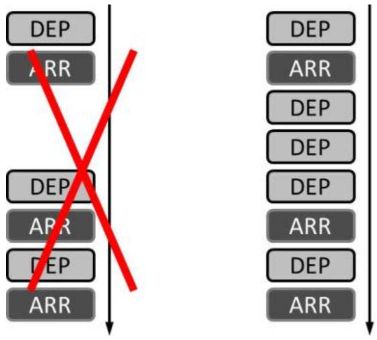

Figure 6: Filling up of isolated ARR gaps

Recurring lacks of ARR demand might again indicate the need to update the chosen pattern (e.g. from ADA to ADDA).
Throughout the initial validation exercises it was experienced that, during phases where traffic demand is well below the available capacity values, no need for the display of constant succession of pattern is necessary. In those cases it is, instead, essential to implement the first come first served principle (FCFS) in order to provide a traffic picture to the ATCO which represents his actual way of working. Thus no specific pattern is implemented, but instead the order of traffic based on FCFS is displayed.
The selection of when to use which mode (defined sequence pattern or FCFS) shall either be carried out manually by the SV (approach or tower) or may automatically be adapted by the coupled AMAN / DMAN system.

3.5.2.5 Sequence Pattern – Automatic Calculation (Optional)

The coupled AMAN / DMAN may optionally also be operated in an automatic mode where it will calculate the most appropriate pattern allocation based on the expected traffic and the resulting KPI figures. The algorithm comprised within the coupled AMAN/DMAN shall update the pattern allocation whenever a certain KPI threshold (ΔKPI) is exceeded for improvement. This in turn then might change the initially suggested pattern or the initially suggested duration of a pattern.

However, also in automatic mode the controller can still manually change both the sequence pattern and related duration at any time. Based on the input, AMAN will update its calculation. Based on the new situation resulting from the manual changes the coupled AMAN/DMAN shall subsequently update its calculation. However it has to be safeguarded that the update must not overwrite the afore conducted manual changes by the ATCO. In any case, for the system planning it has to be ensured that if a pattern change is foreseen, the previous sequence pattern shall be run through to the end before the new sequence pattern is activated.

In the following subchapters some rules are describes of how the pattern needs to be implemented.

3.5.2.5.1 „No change time“

It always has to be considered that there is a „no change time“ value of XX minutes (in this illustration e.g. 20 minutes) ahead of TLDT in which the planned pattern shall be adhered to.

Exception: manual changes by the Approach or Tower Supervisor or ATCO.

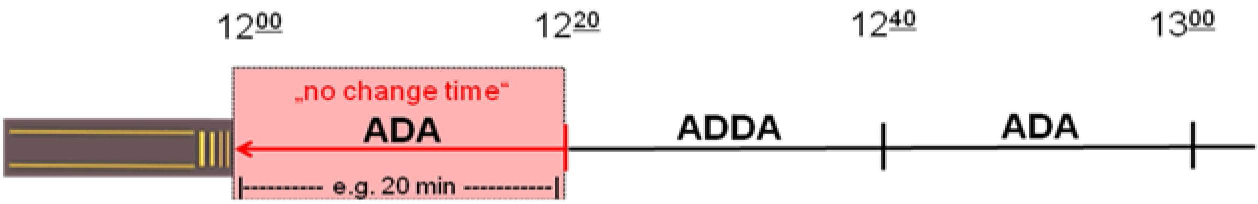

Figure 7: Pattern “no change time”

3.5.2.5.2 Minimum duration

The minimum duration of a proposed pattern shall be equal to the „no change time“ value in order to avoid frequent changes of the pattern.

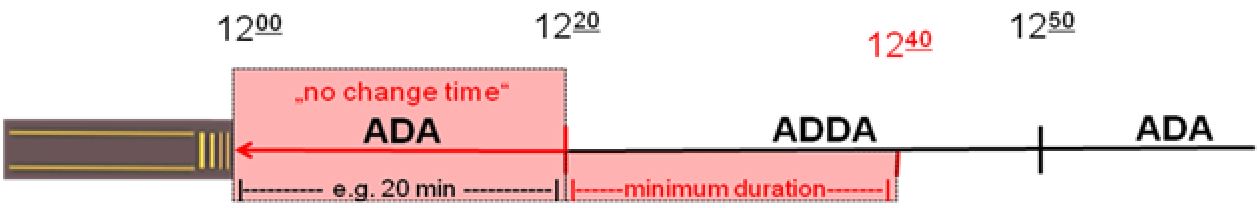

Figure 8: Minimum duration (equal to the “no change time”) of pattern

In the upper example a pattern ADDA is planned from $12^{\underline{20}}$ until $12^{\underline{50}}$. This planning is permitted as the minimum duration of 20 minutes is maintained.

3.5.2.5.3 Pattern stability

Once the starting point of a suggested pattern has reached into the interval of the „no change time“, this pattern is required to be conducted for at least the minimum duration of e.g. 20 minutes. Hence in this example the ADDA pattern will have to be applied at least until 1240 o‘clock.

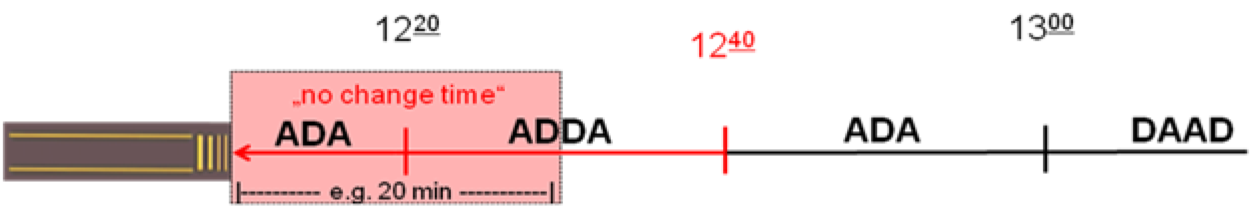

Figure 9: Pattern stability

3.5.2.5.4 Pattern changes

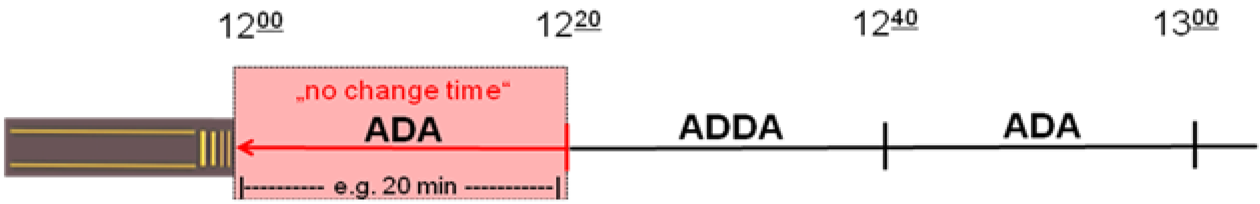

Figure 10: Pattern changes - initial situation

A pattern allocation might be updated in case of a deviation in the forecasted KPI values (e.g. due to modified traffic demand). However the deviation of the forecasted KPI values must be greater than the specified ∆KPI.
Hence, in this example departure demand might have increased resulting in an ADDADA pattern instead of an ADA pattern.

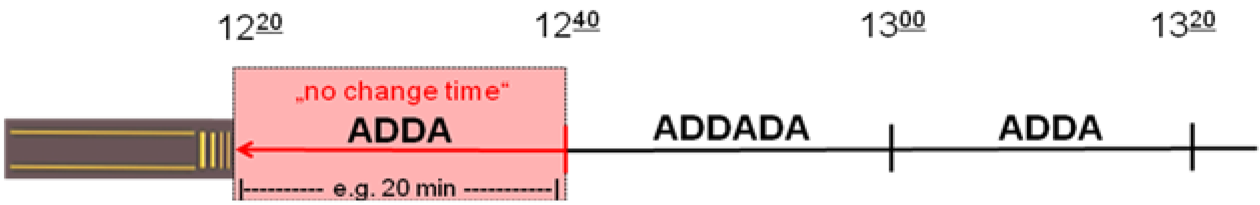

Figure 11: Pattern changes – increased departure demand

3.5.2.5.5 Duration changes

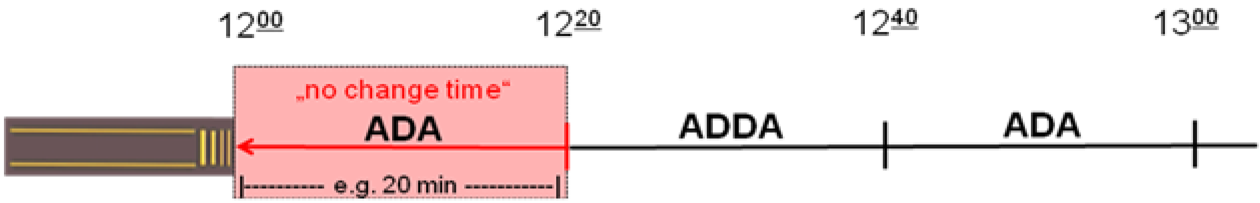

Figure 12: Duration changes - initial situation

As the case may be the coupled AMAN/DMAN forecasts that an extension or reduction of the pattern duration would be recommended due to a positive effect on the KPI figures. This update shall automatically be processed provided that neither the regarded pattern nor the following pattern undercuts the minimum duration of e.g. 20 minutes.
Hence in the lower example the coupled AMAN/DMAN forecasts that an extension of the ADDA pattern from $12^{\underline{20}}$ up to $12^{\underline{50}}$ o‘clock (instead of $12^{\underline{40}}$ o‘clock) is recommended.

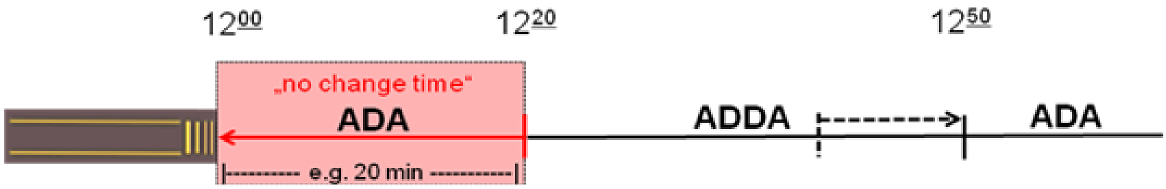

Figure 13: Duration changes – extension of pattern duration

3.5.2.6 KPIs

As described before KPIs may be calculated in order to support decision making on sequence pattern. Different KPIs might be calculated depending on the local implementation.

Forecasted KPIs information for both arriving and departing flight will be displayed on the supervisors HMI with the aim of supporting the coordination and allowing an objective assessment.

In the following paragraphs an example for two KPIs is given:

- Forecasted Delay – it is expected to at least reduce imbalance between ARR/DEP delay distributions. The system will provide information to supervisors to apportion delays between ARRs and DEPs (which today is performed by humans). For this reason it may be recommendable to display average delay values per flight in order to safeguard comparability between ARR flows and DEP flows. This results in an improvement of prioritization between arriving and departing flights through a reliable forecasted demand and, as such, predictive information.
  The KPI "Delay" on the one hand can be used in order to balance DEP delay and ARR delay. To enable comparability between ARR delay and DEP delay, it may be beneficial to indicate the average delay per traffic flow. On the other hand the total delay (sum of DEP delay and ARR delay) can be used in order to analyse which pattern to be used ideally.

- Forecasted Scheduled Deviation – it could be impacted by an increased predictability by reducing uncertainties. With regard to that it could be useful to monitor estimates once planned and then appropriately modify it.

In more detail the KPIs can be defined as below:

- Forecasted Runway Delay – It can be considered as an indicator of the ATM performance defined as a difference between "Airline desired time" and "ATC target times". Delay parameter will be calculated taking into account threshold times for both departing and arriving flights. Therefore, regarding the arrival processes, the delay will be related to the landing times:

    - ARR Delay = Σ (Flights) TLDT – ELDT

  where ELDT is the first-time calculated landing time of an aircraft once penetrating AMAN horizon, therefore not yet influenced by any steering and control measures initiated by the airport of destination.

  In order to focus only on the delays and not to take into account "early flights", a cut-off at zero is considered to be the best option to apply (e.g. MAX [TLDT – ELDT, 0]). It's the same for the departure delay.

  Regarding the departure processes, the delay will be related to the take-off event. However, today the term used for defining the estimated taxi-time (i.e. EXOT) is used inconsistently.

  It means that sometimes it includes a delay or buffer, sometimes it doesn't. In order to avoid confusion, the following new formula will be applied on the basis of new terms introduced [Appendix B]:

    - DEP Delay = ERWP = TTOT – DTOT, where

        - ERWP is the planned time waiting at runway hold;
        - DTOT is the earliest departure take-off time calculated as
          DTOT = Max (TTOT, CTOT–5)
        - EXOP stands for the Expected Taxi Time from Off-Block to Take-Off (with no buffer or delay and not including time to line up and roll to airborne). Since it doesn't include any delay or buffer we could define it as minimum taxi-out time.
        - CTOT–5 in order to take into account the CTOT window.

- "Forecasted Schedule Deviation" – It can be considered as an indicator of the airline performance defined as a difference between "Scheduled Airline times" and "ATC target times". The parameter should be calculated based on the "block" times (in order to be consistent with airline and airport KPIs):

- DEP Forecasted Schedule Deviation = Σ (Flights) TSAT – SOBT
- ARR Forecasted Schedule Deviation = Σ (Flights) TIBT – SIBT

For schedule adherence cut-off at zero shall apply as well.

3.6 Differences between new and previous AMAN/DMAN Operating Methods

Today's process for adjusting traffic flow in order to balance arrival and departure demand is based on subjective decision of the supervisors or controllers taking into account the different experience they have. Due to the reactive way of proceeding great delay could result.

For Step 1 involved controllers are presented an integrated arrival and departure sequence calculated from the sequence pattern coordinated among tower and approach supervisors, which is expected to increase their situational awareness. Other benefits expected are a reduction of delays as well as an increase of runway throughput.

Furthermore, in the case where a proper automatic forecast performance process (e.g. KPIs forecasts) is performed, an objective assessment is carried out which will allow the controller to make decision in a pro-active way.

4 Detailed Operational Environment

4.1 Operational Characteristics

This section provides the main characteristics of the Operational Environment in which coupled AMAN/DMAN is applied.

4.1.1 Runway Layout and Operating Mode

The Coupled AMAN/DMAN concept (TS-0308) in general is applicable for all airport layouts from Single Runway Layout (and thus mixed mode operations) to Multiple Dependent Runway Layout (where dependent runways include closely spaced parallel, converging and crossing runways).

However the airport layout may bring constraints on the traffic flow management flexibility and then yield less coupling potential. The single runway in mixed mode is currently recognised to be the most constrained situation.

4.1.2 Taxiway Layout

The coupled DMAN/SMAN concept (TS-0202) applies to complex as well as to non-complex taxiway layouts. The more complex the taxiway layout is the more integration of surface movement planning is required.

4.1.3 Traffic Volumes

Coupled AMAN/DMAN yields highest benefit in airports classified by 6.2 as ‘highly utilised with more than 90% utilisation during 3 or more peak periods a day’. The coupled AMAN/DMAN is most beneficial in phases when arrival and departure peaks overlap.

4.1.4 Weather

The concept for the Coupled AMAN/DMAN applies to all weather conditions. While the main objective of the concept changes focus between increasing throughput and improving predictability the same operational procedures apply (just different separation values have to be considered in the system).

- **Nominal** weather conditions, which are the conditions in which the airport operates in more than 90% of time and which form the basis of the declared capacity for scheduling purposes Nominal conditions use in the scheduling round may differ for Summer and Winter seasons Nominal conditions translate into conditions such as no wind, no snow, no visibility constraints etc.

  The coupled AMAN/DMAN aims at optimising throughput and predictability in nominal weather conditions.

- **Adverse,** degraded, weather conditions within the operational envelope of the airport, which have a significant negative impact on operations unless an appropriate response is organised. Adverse weather conditions may be reduced visibility conditions (e.g. Cat II) or strong and gusting wind.

  The coupled AMAN/DMAN aims mainly at increasing predictability in adverse weather conditions. (Separations are generally higher in adverse weather conditions compared to nominal conditions and do not allow for much optimisation of throughput)

- **Disruptive** weather, describes adverse conditions which are generally rare and would have a severe impact on airport performance. The airport cannot be expected to provide resources to mitigate such conditions e.g. snow at a Mediterranean airport.

  The coupled AMAN/DMAN aims mainly at increasing predictability in adverse weather conditions.

(Separations are generally higher in adverse weather conditions compared to nominal conditions and do not allow for much optimisation of throughput)

4.1.5 Separations

All applicable separations need to be considered (e.g. radar separation, vortex separation, MDI separation). Separations need to be considered between arrivals, between departures and between arrivals and departures.

As separations also depend on wind and other weather conditions they need to be dynamically updated (if necessary by manual operator inputs)

Separations might be required for operations on one single runway as well as on multiple runways having dependencies.

In general the same separations will be chosen for a certain pattern for a longer time interval in order to provide some flexibility to the ATCO (capacity might be lost if separations between two successive arrivals are too small for a certain type of departure aircraft).

Further optimisation of separations is subject to step 2 advanced coupling of AMAN and DMAN.

4.2 Roles and Responsibilities

This section describes the actors involved in the usage of services supported by coupled AMAN/DMAN. This description relies on the hierarchical organisation of actors of the ATM system defined in the annex C of the: SESAR B4.2 ConOPS [7].

This description is not limited to actors interacting directly with coupled AMAN/DMAN but encompasses all actors contributing to Arrival and Departure Management at an airport.

Described responsibilities focus on the day of operations, which is relevant in the coupled AMAN/DMAN context.

4.2.1 Aircraft Operator

For the purposes of this document, the Airspace User is considered as an Aircraft Operator (AO) either with scheduled air services or without scheduled air services.

The aircraft operator is expected to run sophisticated support tools for flight route planning, including 4D flight trajectory calculation, management of route catalogue, management of relevant aeronautical information, meteorological information, route cost estimations and airspace reservations.

In the context of Coupled AMAN/DMAN these supporting systems will be used for pre-tactical and tactical flight planning. When restrictions are unavoidable and changes to their plans become necessary, the aircraft operator will negotiate with Network Management, ATC and Airport Operator/APOC to determine the best possible alternatives suitable to all and feasible under the given circumstances.

The main assumption is that the aircraft operator provides coupled AMAN/DMAN with an accurate off-block time (called TOBT) via its AOCC or via airport's CDM interface.

Anyhow even minor operators which don't have any sophisticated support tools will be able to provide all the required information (even if less accurate), starting from the flight plan.

These responsibilities are assumed either by the Aircraft Operator/Airspace User or by the Ground Handling Agent.

Responsibilities in coupled AMAN/DMAN context:

- Agrees/updates target aircraft ready time (TOBT),
- Manages the turn-round in accordance with the TOBT,
- Provides turn-around progress information (milestones) through Airport CDM,

- Optimizes the RBT (execution phase) to ensure the users' business objectives for a flight are met.

During the winter season, the de-icing operator is integrated in the process; the output data from the de-icing management system are included in the Airport Operational Data Base and other dedicated tools (A-SMGCS).

4.2.2 Airport Airside Operations

4.2.2.1 Airport Operator

The Airport Operator is responsible for the physical conditions on the airport. This includes assurance that the scale of equipment and facilities provided are adequate for the scheduled flying activities which are expected to take place at that Airport

Responsibilities in coupled AMAN/DMAN context:

- Management of airport resources on the day of operation (gates, vehicles, stands etc.) on behalf of the Airspace User. Provide information on unavailable resources for assessment of capacity.
- Computation of Target Start-up Times (TSATs) based on A-CDM rules and information received by the coupled AMAN/DMAN (i.e AMAN being the master system).
- Ensures that all necessary data are available, consistent and transmitted timely to the specialized tool (A-CDM, etc.),
- Coordinates the operations with other stakeholders through the A-CDM principles.

4.2.2.2 Apron Manager

The apron manager issues the push-back approval according to ASAT sequence.
In some airports, this function is performed by the Tower Clearance Delivery Controller.

4.2.3 Air Traffic Services Operations

4.2.3.1 Airport Tower Supervisor

The Airport Tower Supervisor is responsible for the safe and efficient provision of air traffic services by the Tower crew. He decides on staffing and manning of controller working positions in accordance with expected traffic demand.

He represents the Tower when coordinating with the Airport Operator on operational issues.

Responsibilities in coupled AMAN/DMAN context:

- Decides on runway(s) for take-off in co-operation with all concerned partners.
- Decides on nominal Departure Capacity in terms of separations
- Coordinates with the Approach Supervisor regarding the measures related to Demand Capacity Balancing and traffic smoothing measures.
- Coordinates with Approach Supervisor on the size of AFIs for the different possible runway patterns (e.g. ADA, ADDA) depending on the current and future weather situation (used in the coupled AMAN/DMAN).
- Maintains close liaison with the Airport Operator with respect to the daily inspection of the movement area, the aerodrome lighting system, the marking of obstructions, snow clearance etc.

- Coordinates with the Approach Supervisor on the runway configuration and associated capacity depending on the current and future traffic demand and weather situation (used in the coupled AMAN/DMAN),

4.2.3.2 ACC/Approach Supervisor

The Approach Supervisor is responsible for the safe and efficient provision of air traffic services by the Approach crew. He decides on staffing and manning of controller working positions in accordance with expected traffic demand.

He represents the Approach when coordinating with the Airport Tower Supervisor on operational issues**.**

Responsibilities in coupled AMAN/DMAN context:

- Decides on nominal Arrival capacity in terms of separation values
- Coordinates with the Airport Tower Supervisor and ACC regarding the measures related to Demand Capacity Balancing
- Coordinates with Airport Tower Supervisor on the size of AFIs for the different possible runway patterns (e.g. ADA, ADDA) depending on the current and future weather situation (used in the coupled AMAN/DMAN).
- Coordinates with ACC the flow admitted into TMA based on arrival capacity

4.2.3.3 Tower Runway Controller

No change in roles or responsibilities

4.2.3.4 Tower Ground/Apron Controller

No change in roles or responsibilities

Apron ATCO / TWR Ground ATCO is not expected to follow the TTOT order but shall anyhow have information on the RWY sequence. Moreover he shall have information on the TSAT windows in order to know what flexibility he has regarding his planning.

The Apron ATCO / TWR Ground ATCO may be provided with an estimated taxi time as well.

During the winter season, The Tower Ground Controller takes the de-icing procedure into account; the relevant information is integrated in the supported system.

Responsibilities in coupled AMAN/DMAN context:

- Issues clearances, instructions and permissions to aircraft, vehicles and persons operating on the manoeuvring area as required for the safe and efficient flow of traffic, especially he/she:
  - Provides taxi instructions to arriving and departing flights,
  - Follows and complies as much as possible with TSAT sequence for departure flights, in order to perform the TTOT sequence,
  - Informs on de-icing procedures.

4.2.3.5 Tower Clearance Delivery Controller

In the Coupled AMAN/DMAN context, his role and responsibilities are concentrated on the Start-Up approval according to the TSAT and sequence provided coupled AMAN/DMAN.

In some airports, he provides Push-back approval as well, while in others this role is performed by the Apron Manager.

4.2.3.6 Approach Controller

The Approach Executive Controller is responsible for the safe and efficient air traffic management service for the aircraft approach to the runway.

Responsibilities in coupled AMAN/DMAN context:

- Sequences arrivals (clearances) to conform with the sequence pattern provided by the Coupled AMAN/DMAN function proposals
- Ensures sufficient spacing between successive arrivals upon their turn onto final and departures according to the pattern proposed by AMAN/DMAN coupled function.

4.3 Constraints

No particular technical constraint has been identified that might impact the concept or the solution

4.3.1 General assumptions

The following assumptions apply for the development of this Operational Concept in STEP1:

1. Integration of Arrival and Departure management and Surface Management will be addressed at a single airport only;
2. Merging departure information from neighbouring airports is out of scope;
3. The concept will address mainly airports operating mixed mode runway (e.g. Gatwick) but will also consider airports with dependencies between runways (e.g. crossing runways or runways with crossing SIDs and missed approach paths).

4.3.2 Systems Environment relevant to AMAN/DMAN coupling

The systems that have an information exchange with coupled AMAN/DMAN are defined in the IER part of the OSED and are further detailed in the Technical projects.

5 Use Cases

5.1 Overview of the Use Cases Departure management integrating Routing and Planning service

Application services	Use cases		What needs to be done? What shall be proposed by the system?	Result following scenario
	ID	Title		
DMAN calculates TTOT on the basis of the taxi time provided by Routing and Planning service	**UC1**	Planned departure times	Basic integration between departure management and surface management.	A more accurate TTOT will be calculated by the system taking into account the taxi time provided by the Routing and Planning service.

Table 10: Overview of the Use Cases Departure management/integrating Routing and Planning service

5.1.1 UC1 – Planned departure times

5.1.1.1 Summary

Integration between departure and surface management expected for Step1 focuses just on the routing and planning service in charge of providing departure management DMAN with the estimated taxi-out time on demand for any aircraft.

No further procedures will be researched and defined. Since the CDM process is out of scope of the project, it can be considered as already implemented. TOBT could be considered as the trigger to whole flow. It means that use case starts when the DMAN receives TOBT from the A-CDM process. Then, the taxi-out time provided by the Routing and Planning service is used to calculate a more accurate TTOT taking into account the constraints.

Therefore, this Use case addresses a specific operational situation of the Use Case 6 58 (i.e. Pre departure, general) described in the P06.02 Airport DOD for Step 1 [22].

5.1.1.2 Actors

Tower Clearance delivery controller
The Tower Clearance Delivery controller checks the flight status on the basis of the planned information displayed on the dedicated HMI. Then, on the basis of their knowledge they will issue appropriate clearances to the aircraft.

Tower runway controller
It is worthwhile to highlight that the Tower Runway Controller is not obliged to adhere to the TTOT calculated by the DMAN. It means that the take-off sequence will be optimised for runway throughput by the tower controller.

Pre-Conditions
The subject flight plan is known to the System.

The actual aircraft operational status[1] is maintained by the System.
Actual and estimated time[2] information is known to the System.

Nominal Flow

1. DMAN receives TOBT from the A-CDM process.
2. DMAN considers as input the EXOP provided by the Routing and Planning service
3. DMAN calculates TTOT
4. DMAN derives TSAT from TTOT
5. TSAT is displayed on the Clearance Delivery controller HMI
6. TTOT can be displayed on the Tower Ground and Runway Controller HMI

Alternative flow

1. [3]DMAN calculates TTOT and checks that SID/MDI separation between the current aircraft and the following/preceding one is respected. The flow continues at step [4]

2. **[6] Tower Runway controller does not agree with the proposed TTOT**
3. Tower Runway controller issues take-off clearance to the pilot at a time deviating from TTOT

[1] The Airport CDM concept has identified the following aircraft operational status: INI (INITIAL), SCH (SCHEDULED), AIR (AIRBORNE), FIR (flight entered local FIR), FNL (FINAL), ARR (LANDED), IBK (IN-BLOCK), BRD (BOARDING), RDY (READY), OBK (OFF-BLOCK), DEP (DEPARTED)

[2] E.g. Actual Landing Time (ALDT), Actual In-Block Time (AIBT), Estimated Off-Block Time (from the flight plan), Estimated Take Off Time (ETOT).

5.2 Overview of the Use Cases coupled AMAN/DMAN

Application services	Use cases		What needs to be done? What shall be proposed by the system?	Result following scenario
	ID	Title		
Arrival / Departure imbalance	**UC1**	Arrival overload: ARR peak will build up	A pattern allowing ARR to land more frequently needs to be established (e.g. DAAD). Thus also allowing more traffic to enter the TMA.	Handling of traffic is adjusted to the increased ARR demand. Thus a well-balanced processing of traffic can take place. Amount of traffic within TMA will increase.
	UC2	Departure overload: DEP peak will build up	A pattern allowing DEP to take off more frequently needs to be established (e.g. ADDA). Consequently feeding into the TMA will have to be reduced.	Handling of traffic is adjusted to the increased DEP demand. Thus a well-balanced processing of traffic can take place. Amount of traffic within TMA will decrease.
	UC3	Simultaneous overload of arrivals and departures: Concurrent ARR and DEP peak	Control of traffic with respect to most efficient spacing allocation, taking into account the reduction of overall delay (ATM performance based) and the increase of punctuality (airline performance based).	Traffic will be processed in the most efficient manner. Concurrently overall delay (ATM performance) will be reduced and punctuality (airline performance) will be increased as far as practical. As the case may be congestion might still accumulate however.
Traffic mix imbalance	**UC4**	Change of traffic mix on ARR side: Action required due to changing WTC mix (only relevant if the trend goes towards a general increase in complexity)	Gaps between inbound traffic to be enlarged in order to comply with the more complex WTC mix.	Tendency will arise that the amount of overall processed ARR will reduce while the amount of processed DEP will increase as the bigger gaps will be filled with additional DEP.
	UC5	Change of traffic mix on DEP side / SID separation: Action required due to changing WTC mix (only relevant if the trend goes towards a general increase in complexity) or due to provision for SID separation	Gaps between outbound traffic to be enlarged in order to comply with the more complex WTC mix respectively SID separation.	Tendency will arise that the amount of overall processed DEP will reduce while the amount of processed ARR will increase as the bigger gaps will be filled with additional ARR.
Runway capacity	**UC6**	Runway capacity will reduce due to: Contamination on RWY, weather influences etc. Generally this will affect both ARR and DEP	Effects will result in use case 3. Thus refer to the descriptions above.	Refer to descriptions in use case 3.

Occurrences	**UC7**[3]	Go-Around: An aircraft needs to conduct a Go-Around because of some reason (e.g. traffic on RWY, technical problems etc.)	The aircraft conducting the Go-Around needs to be re-sequenced. Furthermore a previously planned subsequent DEP gap might be lost and needs to be re-planned.	A gap will be provided for the aircraft conducting the Go-Around when necessary (the aircraft might either want to land immediately or wait in order to solve any problems while still in the air). Absolute priority will be given to the requests of the concerned flight. A new gap will be provided for the previously retained DEP.
	UC8[4]	Take-Off abortion: An aircraft has to abort Take-Off because of some reason (e.g. engine failure)	Due to RWY blockage Go-Arounds need to be planned. All ARR behind might need to be put in a holding position. All ARR and DEP then need to be re-sequenced or in case of diversion need to be taken out of consideration. TSAT allocation needs to be rechecked.	ARR and DEP queue will build up until RWY is not blocked anymore. DEP will be kept in-block as far as practical.
	UC9	Departure abortion: An aircraft has to abort departure while taxing because of some reason and return to its stand position	The aircraft aborting departure has to be re-sequenced. Its previously planned DEP gap might be lost and needs to be re-planned. TSAT allocation needs to be rechecked	A new TSAT and TTOT will be assigned to the aircraft. No impact on other ARR and DEP in the sequence
	UC10[5]	RWY inspections: Traffic cannot be planned onto the RWY because of required runway inspections	Gaps will have to be provided in order to allow for required RWY inspections. Consequently the sequence planning will have to be delayed for the concerned ARRs and DEPs. Depending on local implementation the RWY inspection might be planned based on one long interval or based on multiple consecutive gaps	A gap for the required RWY inspection will be provided resulting in ARRs and DEPs being slightly delayed. DEP will be kept in-block as far as practical.
	UC11	Time Based Separations	The Coupled AMAN-DMAN can be used to drive Time-Based Separation Indicators on the Approach radar display. AMAN-DMAN operates as normal, and the Indicators guide Approach Controllers in turning aircraft onto base leg and onto final to achieve the planned	The aircraft on final are spaced correctly using the time based separation calculations.

[3] As this UC does not occur frequently it shall not receive major consideration.
[4] As this UC does not occur frequently it shall not receive major consideration.
[5] This UC is under consideration of P06.07.03. Thus for the time being it will not receive major consideration internally to our project.

			separation.	

Table 11: Overview of the Use Cases coupled AMAN/DMAN

In order to ensure consistency with what has been defined by P06.02, the following table shows the traceability between the Use Cases identified in the P06.08.04 Final OSED and the ones described in the P06.02 Airport DOD for Step 1 [22].

Application services	Use cases AMAN / DMAN		Use Cases P06.02. DOD Step 1	
	ID	**Title**	**ID**	**Title**
Arrival / Departure imbalance	**UC1**	Arrival overload: ARR peak will build up	**UC 6 14**	Revise / Update AOP during day of operation
	UC2	Departure overload: DEP peak will build up	**UC 6 14**	Revise / Update AOP during day of operation
	UC3	Simultaneous overload of arrivals and departures: Concurrent ARR and DEP peak	**UC 6 14**	Revise / Update AOP during day of operation
Traffic mix imbalance	**UC4**	Change of traffic mix on ARR side: Action required due to changing WTC mix (only relevant if the trend goes towards a general increase in complexity)	**UC 6 14**	Revise / Update AOP during day of operation
	UC5	Change of traffic mix on DEP side / SID separation: Action required due to changing WTC mix (only relevant if the trend goes towards a general increase in complexity) or due to provision for SID separation	**UC 6 14**	Revise / Update AOP during day of operation
Runway capacity	**UC6**	Runway capacity will reduce due to: Contamination on RWY, weather influences etc. Generally this will affect both ARR and DEP	**UC 6 14**	Revise / Update AOP during day of operation
Occurrences	**UC7**[6]	Go-Around: An aircraft needs to conduct a Go-Around because of some reason (e.g. traffic on RWY, technical problems etc.)	**UC 6 17**	If, for whatever reason, the aircraft has to perform a go around, the general landing procedure starts again
	UC8[7]	Take-Off abortion: An aircraft has to abort Take-Off because of some reason (e.g. engine failure)	**UC 6 41**	If a flight aborts its take off, the runway occupancy will be longer than expected. When the flight is clearing the runway, the Tower Runway Controller transfers the flight to the Tower Ground Controller (instructing a frequency change). If the flight is ready to depart, the Tower Ground Controller may re-sequence the affected aircraft into the departures. If not, the flight will taxi back to a stand (assigned by Airport Operations after coordination with Airport Tower Supervisor).
	UC9[8]	Departure abortion: An aircraft has to abort departure while taxing because of some reason	**UC 6 85**	If an aircraft is unable to continue taxi (e.g. due to technical, emergency, accident reasons), delay is to be expected. In case of

[6] As this UC does not occur frequently it shall not receive major consideration.
[7] As this UC does not occur frequently it shall not receive major consideration.
[8] As this UC does not occur frequently it shall not receive major consideration.

		and return to its stand position		emergency, fire fighters have to secure and maybe evacuate the aircraft. Technicians have to inspect the aircraft, if it can be towed away and a tow tug has to be ordered and make its way to the aircraft. The Tower Ground Controller will coordinate the temporary closure of the taxiway.
	UC10[9]	RWY inspections: Traffic cannot be planned onto the RWY because of required runway inspections	**UC 6 39**	A runway inspection is done on a regular basis, or if requested by Tower Runway Controller or Airport Tower Supervisor. The movement of the inspection car has to be handled as an aircraft movement as long as it moves on the runway or within the safety boundaries of it. This therefore implies a delay on succeeding air-traffic.
	UC11	Time Based Separation	No DOD link	N/A

Table 12: Traceability to the Use Cases described in the P06.02 Airport DOD for Step 1

The Use Cases described hereafter are only guidelines.

5.2.1 Use Case 0: General Description

In the use cases describes in the following chapters some procedures generally apply. In order to avoid duplicating information again and again, these procedures are described in this chapter and are only referenced in the following chapters.

APP Controller

Approach controllers will establish the landing sequence considering the agreed sequence pattern and AFI-Sizes.

Approach controller has the opportunity to request changes to the planned sequence pattern. If agreed by Tower Runway controller, the sequence change can be updated in the coupled AMAN/DMAN.

Tower Runway Controller

Tower runway controller verifies based on radar information, visual surveillance and flightplan information that the runway is clear and that the aircraft will meet arrival/departure separation requirements. It has to be highlighted that it remains the controller's task to further optimise the departure sequence whenever possible, i.e. controllers do not have to adhere to TTOT.
TTOT can be used as a "tie-breaker" when there were two equivalent aircraft.
It has to be highlighted that the Tower runway controller generally holds a rather passive role by filling the AFIs provided by the APP controller with the appropriate outbound traffic.

Nevertheless also the Tower runway controller has the opportunity to request changes to the planned sequence pattern. If agreed by Approach Controller, the sequence change can be updated in the coupled AMAN/DMAN.

[9] This UC is under consideration of P06.07.03. Thus for the time being it will not receive major consideration internally to our project.

Supervisors

Different scenarios are described for the Supervisors role in the following paragraphs depending on the availability of the optional functionality.

5.2.1.1 Scenario 1 – manual pattern selection

Supervisor

Tower and Approach Supervisor will detect any imbalance between arrivals and departures based on the display of the integrated arrival and departure sequence. They will co-ordinate the need for adjustment of the sequence pattern before implementing any change in the coupled AMAN/DMAN.

5.2.1.2 Scenario 2 – pattern selection supported by KPIs

Supervisor

Tower and Approach Supervisor will detect the imbalance between arrivals and departures based on the imbalance in the KPIs for arrivals and departures. They will co-ordinate the need for adjustment of the sequence pattern before implementing any change in the coupled AMAN/DMAN.

5.2.1.3 Scenario 3 – pattern selection supported by What-If Probing

Supervisor

By providing a what-if probing tool within the AMAN/DMAN coupling function both the Tower Supervisor and the Approach Supervisor will be supported in their decision making regarding which sequence pattern allocation to be chosen and what effects a certain pattern allocation has on the KPI figures.
Furthermore coordination between Tower and Approach supervisors needs to take place before one What-if scenario is selected in the coupled AMAN/DMAN.

5.2.1.4 Scenario 4 – automated pattern selection

Supervisor

From a system point of view the increase of inbound traffic will be observed through the information available internal to the AMAN. By the means of the calculation within the coupled AMAN/DMAN, the most suitable pattern will then be assessed and depicted on the controllers' HMIs. This recommendation represents the best analytical solution taking all relevant KPIs into account.

Both the Tower Supervisor and the Approach Supervisor in this situation is assigned to evaluate if the overall AMAN/DMAN system proposal is acceptable from an operational point of view.

If neither the Tower Supervisor nor the Approach Supervisor has any objections, the proposal will be accepted and the coupled AMAN/DMAN system continues its calculations on this basis.

If there are objections, the Approach / Tower Supervisor (based on local procedures) has the possibility to carry out manual changes as described in chapter 3.5.2.3. These changes have to be implemented within the coupled AMAN/DMAN and must not be subject to any additional system changes – only the controllers (Approach Supervisor or TWR- / APP ATCO) are entitled to provoke further changes. On the basis of the resulting situation the system will update its pattern assessment instantaneously taking into account the manual changes by the controller.

5.2.2 Use Case 1: Arrival overload

This Use Case describes a situation where the arrival demand at an airport grows up. As a result a sequence pattern has to be established which allows to handle the increasing level of inbounds, in order to prevent accretion of delay. Thus, a pattern prioritizing arrivals will be chosen (e.g. DAAD or DAADAD). Consequently the landing rate as well as the amount of traffic within the TMA will be increased.

The procedures described in Use Case 0 fully apply.

5.2.3 Use Case 2: Departure overload

This Use Case describes a situation where the departure demand at an airport grows up. As a result a pattern has to be established which allows handling the increasing level of outbounds in order to prevent accretion of delay. Thus, a pattern prioritizing departures will be chosen (e.g. ADDA or ADDADA). Consequently the departure rate will be extended simultaneously as the flow of inbound traffic into the TMA will have to be reduced.

The procedures described in Use Case 0 fully apply.

5.2.4 Use Case 3: Simultaneous overload of arrivals and departures

This Use Case describes a situation where both the arrival and the departure demand at an airport grow up concurrently. In this case a pattern needs to be established, which provides the best possible weighing of both traffic flows with respect to the lowest possible accretion of delay. Anyhow, due to the preponderance of demand versus available capacity, an accretion of delay is almost indispensable.

The procedures described in Use Case 0 fully apply.

5.2.5 Use Case 4: Traffic mix change on arrival side

This Use Case describes the situation where the traffic mix, in terms of wake turbulence categories of the arrivals, changes (for example to a higher ratio of heavy aircraft). In this case AMAN automatically considers the need for wake vortex separations between successive arrivals.

Supervisors will co-ordinate whether due to the predominantly increased arrival separations a different sequence pattern might be more appropriate. This use case can significantly benefit from What-If probing or automated pattern calculation.

The procedures described in Use Case 0 fully apply. Especially Approach controller needs to ensure separation constraints.

5.2.6 Use Case 5: Traffic mix change on departure side

This Use Case describes the situation where the traffic mix, with respect to SID mixture or Wake Vortex mixture, changes (for example to a higher ratio of heavy aircraft or a higher ratio of aircraft with the same SID).

Supervisors will co-ordinate whether due to the predominantly increased departure separations a different sequence pattern might be more appropriate (e.g. AADA instead of ADA) or whether the AFI size needs to be adjusted with the sequence pattern remaining the same. This use case can significantly benefit from What-If probing or automated pattern calculation.

The procedures described in Use Case 0 fully apply. Especially Tower Runway controller needs to ensure separation constraints.

5.2.7 Use Case 6: Runway capacity reduction

This Use Case refers to a reduction in runway capacity due to various reasons. Examples could be contamination of the runway in form of snow / ice or adverse weather conditions. The result generally impacts both arrivals and departures equally. Thus the effect will be consistent with Use Case 3 . In order to derive input regarding the treatment of this Use Case, therefore refer to the description above.

5.2.8 Use Case 7: Go-around[10]

It might happen that a go-around needs to be initiated due to special occurrences (e.g. aircraft on runway, technical failure etc.). In this case the aircraft conducting a go-around as well as the aircraft detained from take-off need to be re-sequenced.

From a system point of view the re-sequencing will be done automatically. However the controller has the possibility to adjust the sequence at discretion.

Supervisor
As the supervisor does not focus on single flights, but instead ensures that the flow of traffic in general proceeds appropriately, no additional work is expected to encounter.

TWR controller
The TWR controller will be provided with an update of the sequence. On this basis he will continue his ordinary work.

APP controller
The APP controller will be provided with an update of the sequence. On this basis he will continue his ordinary work.

5.2.9 Use Case 8: Take-off abortion[11]

It might happen that a take-off needs to be aborted due to certain occurrences (e.g. engine failure, bird strike etc.). In that case typically the runway will be closed for a certain amount of time in order to vacate and examine the runway. Consequently inbound traffic needs to be held in the sky or diverted to the alternate airport and outbound traffic needs to be held on ground.

From a system point of view an updated runway sequence will be calculated instantaneously to warrant resumption of work once the runway is ready for use again.

Supervisor
As the supervisor does not focus on single flights, but instead ensures that the flow of traffic in general proceeds appropriately, no additional work is expected to encounter.

TWR controller
The TWR controller will initially be occupied with de-rating the outbound flow. When the situation is clarified again the TWR controller will be advocated to implement the recommended sequence. It has to be expected that the resulting workload will have built up for the time being.

[10] As this UC does not occur frequently it shall not receive major consideration.
[11] As this UC does not occur frequently it shall not receive major consideration.

APP controller

The APP controller will initially be occupied with de-rating the inbound traffic into the TMA as well as establishing holdings and diverting traffic if necessary. When the situation is clarified again the APP controller will be advocated to implement the recommended sequence. It has to be expected that the resulting workload will have built up for the time being.

5.2.10 Use Case 9: Departure abortion[12]

It might happen that a departure needs to be aborted while the aircraft is taxing due to certain occurrences (e.g. engine failure, technical problems, fire etc.). In that case typically the taxi will be closed for a certain amount of time in order to vacate and examine the aircraft. The aircraft needs to be towed to a stand and after problems are solved has to be rescheduled. There will be no consequences for inbound and outbound traffic.

From a system point of view an updated pre-departure and runway sequence will be calculated instantaneously.

Supervisor
As the supervisor does not focus on single flights, but instead ensures that the flow of traffic in general proceeds appropriately, no additional work is expected to encounter.

TWR RWY controller
The TWR RWY controller will be provided with an update of the sequence. On this basis he will continue his ordinary work.

APP controller
The APP controller will be provided with an update of the sequence. On this basis he will continue his ordinary work.

[12] As this UC does not occur frequently it shall not receive major consideration.

5.2.11 Use Case 10: Runway inspection[13]

Throughout the day of operation typically RWY inspections are required. These might take place as a matter of routine, but might also arise extraordinary. However, for the given period the RWY must be closed for other traffic. Depending on local implementation the RWY inspection can be planned as one event containing a complete RWY check or as multiple fragmented checks in order to allow aircraft to move on the RWY in between.

Mostly the RWY checks are predictable in advance. Thus they can be taken into consideration at an early stage when planning the sequence.

Supervisor

The identification of the right point in time to include RWY inspections to the sequence planning will not differ too much from today's operation. Hence for the supervisor no exceptional work is to be expected.

TWR RWY / APP controller

Both the TWR RWY controller and the APP controller will be told when a RWY inspection is planned to take place. During this time outbound flights should be planned accordingly (i.e. for example by keeping the aircraft on the parking position with engines not running). Inbound flights should also be (re)planned accordingly (i.e. for example by vectoring or slowing).

[13] This UC is under consideration of P06.07.03. Thus for the time being it will not receive major consideration internally to our project.

5.2.12 Use Case 11: Use of Time-Based Separation Tool

The Coupled AMAN-DMAN can be used to drive Time-Based Separation Indicators on the Approach radar display. AMAN-DMAN operates as normal, and the Indicators guide Approach Controllers in turning aircraft onto base leg and onto final to achieve the planned separation.

Regarding the link with the Use Cases defined by P06.02, it was noted that the current 06.02 DOD does not include a scenario with TBS Indicators and AMAN-DMAN. The TBS tool was validated for an arrival-only runway by P06.08.01, addressing Operational Improvement AO-0303, and it will be validated in P06.08.04 for a mixed-mode runway.

TWR controller
TWR controllers will have a view of the TBS Indicators on their arrival radar display, which will aid them in anticipating the spacing of the aircraft currently on Final Approach and on Downwind and Base Leg. The indicators can be used as reference against the requested time, for aircraft currently on final, and to anticipate the spacing for aircraft that will shortly be turned to Final.

APP controller
The APP controller will be presented with Indicators showing Separation or Spacing according to the AMAN timeline, moving along the Final Approach centreline. A different format will be used to distinguish between Separation Minima and Planned Spacing. The APP controller will use the indicators to guide the timing of their turn to Base Leg and their instruction to intercept Final Approach.

5.2.13 Use Case 12: Failure Modes

The following failure modes might occur:

- Coupled AMAN/DMAN provides intolerable proposals
  Supervisor changes AMAN/DMAN to work independent of each other. All parameters have to be set in AMAN and DMAN separately (as in current operations).
- AMAN does not work properly
  Supervisor changes AMAN/DMAN to work independent of each other. Failure procedures as in current operations apply to AMAN while DMAN works in uncoupled mode (with all parameters to be set in DMAN separately.
- DMAN does not work properly
  Supervisor changes AMAN/DMAN to work independent of each other. Failure procedures as in current operations apply to DMAN while AMAN works in uncoupled mode (with all parameters to be set in AMAN separately.

6 Requirements

The requirements identifiers are set accordingly to the rules defined in the chapter 4 of the *Requirements and V&V Guidelines* document (See doc.[4]).

The generic pattern applied is as follows:

<Object type>-<Project code>-<Document code>-<Reference number 1>.<Reference number 2>

Where:

- <Object type> is **REQ**
- <Project code> is **06.08.04**
- <Document code> is **OSED**
- <Reference number 1> reflects the following organization:
  - 1100 – Requirements related to the basic AMAN/DMAN coupling
  - 1200 – Requirements related to the AMAN
  - 1300 – Requirements related to the DMAN
  - 1500 – Requirements related to the HMI
  - 1600 – Requirements common to AMAN and DMAN

Where the first digit (i.e. 1) highlights that the solution dealt with in this document is for Step 1.

- <Reference number 2> is a sequence number for each series of requirements

Operational requirements reported in this section focus just on what is needed for a coupled AMAN/DMAN. It means that the availability of standard input data in AMAN and DMAN (e.g. ELDT, CTOT, call sign, TOBT…) is not covered by the operational requirements identified in the Final OSED as it is taken for granted.

All requirements are allocated to solution #54. Requirements in chapter 6.9 (Requirements on DMAN HMI) and Requirement .REQ-06.08.04-OSED-1300.0040 are also applicable to solution #53.

6.1 Basic AMAN-DMAN coupling

Identifier	REQ-06.08.04-OSED-1100.0010
Requirement	AMAN and DMAN shall be able to cooperate by exchanging information in a Master/slave configuration, where AMAN is the Master and DMAN is the Slave.

6.2 AMAN Inputs

Identifier	REQ-06.08.04-OSED-1200.0010
Requirement	In case that the optional AMAN-calculated pattern is implemented, the AMAN may receive initial TTOT for all expected departures <parameter tbd> minutes in advance. This will be used as the take-off demand time (i.e. the earliest possible time to schedule that departure).

Identifier	REQ-06.08.04-OSED-1200.0020
Requirement	In case that the optional AMAN-calculated pattern is implemented, the AMAN may receive a revised value of (TTOT), whenever it changes by more than <parameter tbd> minutes.

Identifier	REQ-06.08.04-OSED-1200.0030

Requirement	The AMAN shall receive the AFIs as input by APP or TWR supervisor (depending on local procedures). These correspond to the size of the gap (provided in distance or time) needed to accommodate a departure between successive arrivals. If these are provided in distance, the NM will be internally converted to a time value using a default speed.

Identifier	REQ-06.08.04-OSED-1200.0040
Requirement	The AMAN shall be able to receive a specific pattern for arrivals and departures, as input by Approach or Tower Supervisor depending on local procedures. The sequence pattern, agreed between approach and tower supervisors, describes the sequence of arrivals and departures on the runway following a pattern that is continuously repeated for a certain time period. The pattern specifies the number of departures between two consecutive arrivals. The chosen pattern might ask for two values regarding the size of the gaps (e.g. ADDADA – 6:3).

Identifier	REQ-06.08.04-OSED-1200.0045
Requirement	Consistent terminology shall be agreed by Tower and Approach Units for runway patterns, and used for all AMAN and DMAN data entry and display.

6.3 AMAN Outputs

Identifier	REQ-06.08.04-OSED-1200.0050
Requirement	In case that the optional AMAN-calculated pattern is implemented, the AMAN may be able to calculate a specific pattern for arrivals and departures, which optimises a determined KPI, to support ATCO decision making. The pattern shall be defined as a set of gaps between arrivals in both Nautical Miles and seconds, and the expected number of departures in each gap

Identifier	REQ-06.08.04-OSED-1200.0055
Requirement	In case that the optional AMAN-calculated pattern is implemented, the optimal pattern calculated by AMAN, proposed to the ATCO to support decision making, shall be always modifiable by controller manual input.

Identifier	REQ-06.08.04-OSED-1200.0060
Requirement	In case that the optional AMAN-calculated pattern is implemented, the AMAN may compute sequence pattern and the associated TLDT for all arrivals in such a way that the KPI measures for arrivals and departures (Forecasted Delay and Forecasted Schedule Adherence) will be optimised.

Identifier	REQ-06.08.04-OSED-1200.0070
Requirement	The AMAN shall send to the DMAN the TLDTs of all arrival flights.

Identifier	REQ-06.08.04-OSED-1200.0080
Requirement	The AMAN shall send to the DMAN the sequence pattern (e.g. ADDA).

Identifier	REQ-06.08.04-OSED-1200.0085
Requirement	In case that TBS procedures are in place, the AMAN shall send to the Time-Based Spacing function the information needed to place Indicators to support Approach Controllers in accurate delivery to the plan.

Identifier	REQ-06.08.04-OSED-1200.0090
Requirement	The AMAN may provide supervisors with a What-If probing that allows evaluation of scenarios with different sequence pattern. What-if Probing may be supported by calculation of KPIs for each scenario.

Identifier	REQ-06.08.04-OSED-1200.0092

Requirement	The AMAN may calculate different KPIs for the selected sequence pattern and display the KPI to the supervisors.

6.4 DMAN Inputs

Identifier	REQ-06.08.04-OSED-1300.0010
Requirement	The DMAN shall receive TLDT for all arrivals from the AMAN.

Identifier	REQ-06.08.04-OSED-1300.0020
Requirement	The time period between two successive TLDTs is consistent with an Arrival Free Interval (AFI), in which DMAN can sequence departures whenever all other constraints are respected.

Identifier	REQ-06.08.04-OSED-1300.0030
Requirement	The DMAN shall be able to receive a specific pattern for arrivals and departures, as input by AMAN. The pattern specifies the number of departures between two consecutive arrivals.

Identifier	REQ-06.08.04-OSED-1300.0040
Requirement	Departure Management shall consider as input the taxi-out time (EXOP) provided by the Routing and Planning service.

6.5 DMAN Outputs

Identifier	REQ-06.08.04-OSED-1300.0060
Requirement	The DMAN shall calculate a TSAT and TTOT for all departures according to its inherent DMAN rules and considering the pattern and the AFIs.

Identifier	REQ-06.08.04-OSED-1300.0050
Requirement	The DMAN shall respect the following constraints when calculating TTOTs and TSATs (if applicable to DMAN type respectively): a) AFI-size b) departure separations

6.6 Common AMAN and DMAN input

Identifier	REQ-06.08.04-OSED-1600.0010
Requirement	AMAN/DMAN may become aware of a missed approach as soon as possible. This may be from radar tracking or manual input. Once aware, AMAN and DMAN should re-plan, and AMAN should allow the missed approach to be re-inserted into the arrival sequence.

Identifier	REQ-06.08.04-OSED-1600.0020
Requirement	It shall be possible to input a runway blockage, either of a fixed duration or unlimited duration, during which no arrivals or departures will be planned.

6.7 Requirements on AMAN HMI

Identifier	REQ-06.08.04-OSED-1500.0010
Requirement	Information on TLDT/TIAT and TTL/TTG of each arrival flight taking into account dependencies between arrivals and departures may be provided on electronic flight strip of AMAN-Display for En-route and TMA controllers.

Identifier	REQ-06.08.04-OSED-1500.0020
Requirement	Information on TTOT, Call sign, Vortex Category and Status of the Flight (i.e. SUR, SUG, Begin Taxi) of each departing flight shall be displayed in the sequence of arrivals, allowing the ATCO to individually insert or mask out each one of these fields.

Identifier	REQ-06.08.04-OSED-1500.0030
Requirement	Information on the active pattern shall be displayed on the Approach supervisor display – both as Nautical Miles for spacing and as the number of departures expected in each gap. The HMI shall allow manual modification of the active pattern at any time.

6.8 Common requirements on AMAN and DMAN HMIs

Identifier	REQ-06.08.04-OSED-1500.0130
Requirement	The active pattern shall be displayed to Approach Controllers and Tower Controllers. 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-06.08.04-OSED-1500.0080
Requirement	Information on KPIs may be displayed for arrival and departures separately on the supervisor display. This may include forecasted delay (difference between “Airline desired time” and “ATC target times”) and Forecasted Schedule deviation (difference between “Scheduled Airline times” and “ATC target times”).

Identifier	REQ-06.08.04-OSED-1500.0160
Requirement	In case the what-if probing function is implemented, the tower and approach supervisors may be allowed to enter different scenarios applying various sequence patterns. The system displays the integrated sequence based on the selected sequence pattern to the supervisors. The KPI associate with each scenario may be displayed to the supervisors in order to support decision making

Identifier	REQ-06.08.04-OSED-1500.0170
Requirement	ATCO’s HMI may inform the controller of the status of the Coupled AMAN/DMAN service and alert him in case of a system failure.

6.9 Requirements on DMAN HMI

Identifier	REQ-06.08.04-OSED-1500.0051
Requirement	Information on TTOT of each flight taking into account dependencies between arrivals and departures should be provided in DMAN-Display for Tower Runway Controller.

Identifier	REQ-06.08.04-OSED-1500.0060
Requirement	Information on TLDT, Vortex Category and call sign of each arrival flight may be shown as well on DMAN HMI.
Identifier	REQ-06.08.04-OSED-1500.0090
Requirement	DMAN information for Tower Controllers should be shown on the Electronic Flight Strip Display if possible.

Identifier	REQ-06.08.04-OSED-1500.0100
Requirement	ATCO in charge of issuing start-up approval (i.e. Tower Clearance Delivery Controller) shall be provided with the TSAT pre-departure sequence established by the DMAN.

Identifier	REQ-06.08.04-OSED-1500.0120
Requirement	ATCO in charge of issuing push-back approval (Tower Clearance Delivery Controller or Apron Manager, depending on local procedure) may be provided with the TSAT pre-departure sequence information established by

	the DMAN.

6.10 Deleted Requirements

Identifier	REQ-06.08.04-OSED-1400.0020
Requirement	ATCO in charge of issuing push-back approval and/or taxi instruction (depending on local procedure) may be provided with a taxi-out time associated to the taxi-out route proposed by the Routing and Planning service.

Identifier	REQ-06.08.04-OSED-1500.0070
Requirement	Information on the active pattern shall be displayed on the Tower supervisor display.

Identifier	REQ-06.08.04-OSED-1400.0010
Requirement	Departure Management shall consider as input the taxi-out time (EXOP) provided by the Routing and Planning service.

Identifier	REQ-06.08.04-OSED-1500.0110
Requirement	ATCO in charge of issuing push-back approval and/or taxi instruction (depending on local procedure) shall be provided with a TTOT departure sequence established by the DMAN.

6.11 Information Exchange Requirements

The following table provides a list of the Information Exchange Requirements identified on the basis of the operational requirements reported in this Preliminary OSED. They list the minimum inputs and outputs of both the Arrival Management Function and the Departure Management Function. Some comments on the chosen values for performing the table follow:

1. Identifier

Generic pattern applied to establish a unique Information Exchange identifier is as follows:

<Object type>-<Project code>-<Document code>-<Reference number 1>.<Reference number 2>

Where:

- <Object type> is **IER** Requirements
- <Project code> is **06.08.04**
- <Document code> is **OSED**
- <Reference number 1> reflects the following organization:
  - 01 – to indicate that the solution dealt with in this document is for Step 1;
  - 03 – to indicate the current version of the document v03.

If some of the requirements correspond to a previously written s1v2 requirement, this fact is indicated in the rationale. D13 OSED s1v2 deleted requirements are listed at the end of the table as <deleted>.

2. Issuer and Intended Addressees

As this IER lists includes the minimum inputs and outputs of both the Arrival Management Function and the Departure Management Function, all “Issuer” and “intended addresses” except “Arrival Management Function”, “Departure Management Function”, and “Routing and Planning function” are listed according to latest Step ConOPS [7] Appendix C “Actors, Roles and Responsibilities”.

3. Service identifier

This attribute classifies the requirements according to the 2 services defined in section 2.3:

- RunwayMixSequence service
- CalculatedPreDepartureSequenceDelivery service

RunwayMixSequence service

CalculatedPreDepartureSequenceDelivery service

[IER]

Identifier	Name	Issuer	Intended Addressees	Information Element	Involved Operational Activities	Interaction Rules and Policy	Status	Rationale	Satisfied DOD Requirement Identifier	Service Identifier
IER-06.08.04-OSED-0103.0010	Flight identifiers from Flight Plans filled by the Airspace Users – Flight identifier / Call sign	Flight Operations Centre	Arrival Management Function; Departure Management Function	Flight identifier / Call sign	Arrival Management Function input; Departure Management Function input		<Validated>	Call sign is identified as input both for Arrival Management Function and for Departure Management Function for sequence computation. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0061 <Partial>	CalculatedPreDepartureSequenceDelivery service RunwayMixSequence service.
IER-06.08.04-OSED-0103.0020	Arrival Information to Arrival Management Function from Flight Plans filled by the Airspace Users - Estimated Landing Time (ELDT)	Flight Operations Centre	Arrival Management Function	ELDT	Arrival Management Function input		<Validated>	ELDT is identified as the main Arrival Management Function input for calculating TLDTs. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service .
IER-06.08.04-OSED-0103.0030	ATCO Input on required size of Arrival Free Intervals (AFIs)	Airport Tower Supervisor or ACC/Approach Supervisor	Arrival Management Function	AFI sizes	Arrival Management Function input		<Validated>	Sizes of AFIs are manually inputted by Airport Tower Supervisor or Approach supervisor (depending on local procedures) and used by the Arrival Management Function to plan arrival sequence. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0030.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service.

Identifier	Name	Issuer	Intended Addressees	Information Element	Involved Operational Activities	Interaction Rules and Policy	Status	Rationale	Satisfied DOD Requirement Identifier	Service Identifier
IER-06.08.04-OSED-0103.0040	ATCO Input on required sequence pattern to Arrival Management Function	Airport Tower Supervisor or ACC/Approach Supervisor	Arrival Management Function	Sequence Pattern	Arrival Management Function-input		<Validated>	Airport Tower Supervisor or Approach supervisor (depending on local procedures) shall always be able to input the sequence pattern, which can be based on his own judgement or supported by the optional Arrival Management Function-calculated sequence pattern. According to REQ-06.02-DOD-6200.0062, they have to do so coordinating with En-Route and Approach controllers and considering arrival and departure flows on the same or dependent runways. This requirement corresponds to a unification of D13 S1V2 IER-06.08.04-OSED-0102.0040 and IER-06.08.04-OSED-0102.0050.	REQ-06.02-DOD-6200.0062 <Full>; REQ-06.02-DOD-6200.0060 <Full>	RunwayMixSequence service.
IER-06.08.04-OSED-0103.0050	Departure demand information to Arrival Management Function (Optional) – Target Off-Block Time (TOBT)	Ground Handling Agent	Arrival Management Function	TOBT	Arrival Management Function input		<In Progress>	TOBT value is considered as input by the Arrival Management Function to derive departure demand in order to set sequence pattern in case Arrival Management Function proposes to ATCO an optimal sequence pattern. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0010.	REQ-06.02-DOD-6200.0060 <Partial>	RunwayMixSequence service.

Identifier	Name	Issuer	Intended Addressees	Information Element	Involved Operational Activities	Interaction Rules and Policy	Status	Rationale	Satisfied DOD Requirement Identifier	Service Identifier
IER-06.08.04-OSED-0103.0060	Departure demand information to Arrival Management Function (Optional) – Calculated Take-off Time (CTOT)	European Network Manager	Arrival Management Function	CTOT	Arrival Management Function input		<In Progress>	CTOT value is considered as input by the Arrival Management Function to take into account while estimating departure demand in order to set sequence pattern in case Arrival Management Function proposes to ATCO an optimal sequence pattern. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service.
IER-06.08.04-OSED-0103.0070	Departure demand information to Arrival Management Function (Optional) – Expected Taxi-out Period (EXOP)	Routing and Planning service	Arrival Management Function	EXOP	Arrival Management Function input		<In Progress>	EXOP value is considered as input by the Arrival Management Function to take into account while estimating departure demand in order to set sequence pattern in case Arrival Management Function proposes to ATCO an optimal sequence pattern. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0020.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service.
IER-06.08.04-OSED-0103.0080	Departure demand information to Departure Management Function – Target Off-Block Time (TOBT)	Ground Handling Agent	Departure Management Function	TOBT	Departure Management Function input		<Validated>	TOBT value, as an output of the A-CDM process, is considered as the main input considered by the Departure Management Function to calculate TTOT and TSAT. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0060 <Partial>	CalculatedPreDepartureSequenceDelivery service.
IER-06.08.04-OSED-0103.0090	Departure demand information to Departure Management Function – Calculated Take-off Time (CTOT)	European Network Manager	Departure Management Function	CTOT	Departure Management Function input		<Validated>	NM issued CTOTs have to be taken into account by Departure Management Function for departure and pre-departure sequence computation. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service.

Identifier	Name	Issuer	Intended Addressees	Information Element	Involved Operational Activities	Interaction Rules and Policy	Status	Rationale	Satisfied DOD Requirement Identifier	Service Identifier
IER-06.08.04-OSED-0103.0100	Departure demand information to Departure Management Function – Expected Taxi-out Period (EXOP)	Routing and Planning service	Departure Management Function	EXOP	Departure Management Function-input		<Validated>	EXOP is identified as input for Departure Management Function for calculating TTOT and TSAT. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0090.	REQ-06.02-DOD-6200.0061 <Partial>	CalculatedPreDeparturesSequenceDelivery service RunwayMixSequence service
IER-06.08.04-OSED-0103.0170	Optional AMAN-calculated sequence pattern proposal to Airport Tower Supervisor and ACC/Approach Supervisor to optimise a set of KPIs	Arrival Management Function	APP/ Approach Supervisor; Airport Tower Supervisor	Sequence Pattern	Arrival Management Function-output		<In Progress>	This sequence pattern is provided to the ATCo to help him in the decision making process.	REQ-06.02-DOD-6200.0060 <Partial>	RunwayMixSequence service
IER-06.08.04-OSED-0103.0110	Seqeunce pattern information to Departure Management Function	Arrival Management Function	Departure Management Function	Active pattern	Arrival Management Function-output; Departure Management Function-input		<Validated>	Sequence pattern information is used by Departure Management Function to establish the number of departures that can be sequenced between two consecutive TLDTs. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0070.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service
IER-06.08.04-OSED-0103.0120	Arrival sequence information to Departure Management Function – Target Landing Time (TLDT)	Arrival Management Function	Departure Management Function	TLDT	Arrival Management Function-output; Departure Management Function-input		<Validated>	TLDTs are considered as input by the Departure Management Function from the Arrival Management Function to sequence departures between the AFIs set by two TLDTs according to sequence pattern in use. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0060.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service.

Identifier	Name	Issuer	Intended Addressees	Information Element	Involved Operational Activities	Interaction Rules and Policy	Status	Rationale	Satisfied DOD Requirement Identifier	Service Identifier
IER-06.08.04-OSED-0103.0130	Arrival sequence information to ATCO – Target Landing Time (TLDT)	Arrival Management Function	APP/ Approach Supervisor; Airport Tower Supervisor; Tower runway controller; Executive Controller (Approach)	TLDT	Arrival Management Function-output		<Validated>	TLDT is provided by the Arrival Management Function to both approach (to follow it in approach) and tower ATCOs (to provide landing clearance). It is also provided to both approach and tower supervisors in order to have a good visibility on arrival demand for estimating the optimal sequence pattern. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0061 <Full>	RunwayMixSequence service.
IER-06.08.04-OSED-0103.2000	Arrival sequence (TLDT) information to Routing and Planning Function	Arrival Management Function	Routing and Planning Function	TLDT	Arrival Management Function-output		<Validated>	TLDT is provided to RPF in order to estimate EXIP. This requirement is new – it wasn't included in D13 S1V2 OSED, and it was included upon P06.07.02 request.	REQ-06.02-DOD-6200.0061 <Partial>	RunwayMixSequence service.
IER-06.08.04-OSED-0103.0140	Pre-departure sequence information to ATCO issuing Start-Up approval - Target Start-Up Time (TSAT)	Departure Management Function	Tower Clearance Delivery Controller	TSAT	Departure Management Function-output		<Validated>	TSAT is provided by the Departure Management Function to ATCOs providing Start-up approval as it is the essential information element required to build the pre-departure sequence. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0100.	REQ-06.02-DOD-6200.0080 <Full>	CalculatedPreDepartureSequenceDelivery service.

Identifier	Name	Issuer	Intended Addressees	Information Element	Involved Operational Activities	Interaction Rules and Policy	Status	Rationale	Satisfied DOD Requirement Identifier	Service Identifier
IER-06.08.04-OSED-0103.0150	Pre-departure sequence information to ATCO issuing push-back approval - Target Start-Up Time (TSAT)	Departure Management Function	Apron Manager; Tower Clearance Delivery Controller	TSAT	Departure Management Function-output		<Validated>	TSAT is provided by the Departure Management Function to ATCOs providing push-back approval as it is the essential information element required to build the pre-departure sequence. In some airports this function is performed by the Airport's Apron Controller, why in others it is performed by the Tower Clearance Delivery Controller. This requirement corresponds to D13 S1V2 IER-06.08.04-OSED-0102.0130.	REQ-06.02-DOD-6200.0080 <Full>	CalculatedPreDepartureSequenceDelivery service.
IER-06.08.04-OSED-0103.0160	Departure sequence information to Tower Runway Controllers - TTOT (Target Take-Off Time)	Departure Management Function	Tower runway controller; APP/ Approach Supervisor; Airport Tower Supervisor;	TTOT	Departure Management Function-output		<Validated>	TTOT is provided by the Departure Management Function to ATCOs providing take-off clearance as it is the essential information element required to build the departure sequence. It is also provided to both approach and tower supervisors in order to have a good vis bility on departure demand for estimating the optimal sequence pattern. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0061 <Full>	RunwayMixSequence service.
IER-06.08.04-OSED-0103.0180	Pre-departure sequence (TSAT) information to routing and planning function	Departure Management Function	Routing and Planning Function	TSAT	Departure Management Function-output		<Validated>	RPF needs TSAT or TTOT to estimate EXOP. This requirement is new – it wasn't included in D13 S1V2 OSED.	REQ-06.02-DOD-6200.0080 <Partial>	CalculatedPreDepartureSequenceDelivery service.

Identifier	Name	Issuer	Intended Addressees	Information Element	Involved Operational Activities	Interaction Rules and Policy	Status	Rationale	Satisfied DOD Requirement Identifier	Service Identifier
~~IER-06.08.04-OSED-0102.0080~~	Departure capacity information to DMAN	AMAN	DMAN	Departure capacity			<Deleted>	This requirement, defined in D13 S1V2 OSED, was deleted because departure capacity (understood as the number of departures to be put between two arrivals) can be deduced by DMAN from the sequence pattern itself (i.e: ADDA, 2 departures in an AFI).		
~~IER-06.08.04-OSED-0102.0110~~	Target Take-Off Time on to ATCO	DMAN	ATCO in charge of issuing push-back approval	Target Take-Off Time (TTOT)			<Deleted>	This requirement, defined in D13 S1V2 OSED, was deleted because Apron Manager doesn't necessarily to have a visibility on TTOTs.		
~~IER-06.08.04-OSED-0102.0120~~	Taxi-Out Time on to ATCO	Routing and Planning service	ATCO in charge of issuing push-back approval	Estimated Taxi Out Time (EXOT)			<Deleted>	This requirement, defined in D13 S1V2 OSED, was deleted because Apron Manager doesn't necessarily need to have a visibility on EXOTs.		

Table 13: IER layout

7 References

7.1 Applicable Documents

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

[1] SESAR SEMP v2.0

[2] B4.2 Initial Service Taxonomy document

[3] Template Toolbox 03.00.00 https://extranet.sesarju.eu/Programme%20Library/SESAR%20Template%20Toolbox.dot

[4] Requirements and V&V Guidelines 03.00.00 https://extranet.sesarju.eu/Programme%20Library/Requirements%20and%20VV%20Guidelines.doc

[5] Templates and Toolbox User Manual 03.00.00 https://extranet.sesarju.eu/Programme%20Library/Templates%20and%20Toolbox%20User%20Manual.doc

[6] EUROCONTROL ATM Lexicon https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR

[7] B4.2 SESAR Concept of Operations Step 1, Edition 02.00.00, dated 2013 https://extranet.sesarju.eu/WP_B/Project_B.04.02/Project%20Plan/ConOps/ConOps/SESAR%20ConOps%20Document%20Step%201%20v01%2000%2000.docx

7.2 Reference Documents

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

[8] WPB 4 2 - High Level Process Models; edition 00.02.00; dated 2nd December 2010

[9] ED-78A Guidelines for Approval of the provision and use of Air Traffic Services supported by Data Communications, dated 1st December 2000

[10] ICAO Document 9694, Edition 1

[11] B4.1 D41 Performance Framework; Edition 01.01.00; dated 25th November 2014

[12] OATA Operational Scenario and Use Case Guide V1.0

[13] WPB.01 Integrated Roadmap (DS14)

[14] SESAR P06.08.04 – D32 - OSED Basic DMAN, Ed. 00.02.00, dated 30th November 2011

[15] SESAR P06.08.04 – D06 - State of the Art Analysis, Ed. 00.01.00, dated 14th February 2011

[16] SESAR P06.08.04 – D07 - Initial OSED, Ed. 00.02.00, dated 6th December 2012

[17] SESAR P06.08.04 – D09 - VALIDATION BASIC DMAN/ASMGCS Report, Edition 00.01.00, dated 3rd September 2012

[18] SESAR P06.08.04 – D11 - S01V2 Validation Report Basic AMAN/DMAN, Edition 00.01.00, dated 21st September 2012

[19] SESAR P06.08.04 – D12 - AMAN/DMAN/A-SMGCS V2 Validation Report, Edition 00.01.01, dated 25th October 2012

[20] EUROCONTROL Generic Operational Concept for Pre-departure Runway Sequence planning and Accurate Take-off Performance – V07A, dated 2009/06/09

[21] EUROCONTROL CDM Manual version 4, April 2012

[22] P06.02, Step1 Airport DOD Update 2014, edition 00.01.00, dated 30th December 2014

[23] SESAR P06.08.01 – D5 - OSED for Time Based Separation for Arrivals (TBS) Ed. 00.01.02, dated 25th June 2013

[24] SESAR P06.07.02 – Integrated Surface Management Interim OSED, Edition 00.01.00, dated 9th April 2014

[25] SESAR P06.08.04 – D13 - Preliminary OSED, Ed. 00.01.02, dated 08th August 2013

[26] SESAR P06.08.04 – D16 - Validation Report P06.08.04-VP453 Coupled AMAN/DMAN/A-SMGCS, Ed. 00.01.01, dated 2nd March 2015

Appendix A Justifications

Please provide in appendix, the material that justifies the requirements allocation.

Appendix B Terminology proposed

A new terminology has been discussed and proposed to be used within the 6.8.4 project in order to try to solve some inconsistencies with the terms in use today and, as such, to reach a shared understanding. The main aim is to better clarify the concept and the requirements related to the departure manager. New events (e.g. Reach Runway Hold) appear in the detail of the KPI definitions and the AMAN/DMAN coupling requirements. For instance, the definition of the Expected Runway Delay for departing flights required the introduction of new terms for Event Times and Interval Durations during Departure.

The proposal focuses on three main events: Off-Block, Reach Runway Hold, and Airborne. A proposal about the letters for identifying the terms has been included as well. Each of the 4 usual letter terms is used to identify a specific item:

- The first letter for indicating (Schedule, Estimate, Actual, Target, ...)
- The second / Third letter for indicating (special reference , like block or runway)
- The last letter for indicating (Time or Period/Duration)

The following table includes the new terms proposed so far which could be useful for refining the coupled AMAN/DMAN concept.

Ref	Event / Interval	Suggested Term	Full version	Notes
1.	Expected Taxi Period from Off-Block to Take-Off (with no buffer or delay)	EXOP	Estimated Outbound Taxi	Current outbound taxi time (i.e. EXOT) is used inconsistently today – sometimes it includes a delay or buffer, sometimes it does not.
2.	Take-Off Time if no delay (sometimes called Departure Demand Time)	DTOT	Time of Take-Off Demand	New proposal – a term for this would be useful because the equation for it is clumsy and involves CTOT.
3.	Planned time waiting at runway hold	ERWP	Expected runway waiting time	
4.	Buffer of delay planned at runway hold to maintain pressure on runway	ERBP	Runway Delay Buffer	New proposal. (This delay is not planned when departure delay is smaller than this value.)
5.	Planned time waiting at stand	ESWP	Expected stand waiting period	New proposal
6.	Estimated Taxi Out Time	EXOT	Expected time from TSAT to TTOT	As defined by A-CDM
7.	Expected time to Line-up and Roll to Airborne	ELRP	Estimated Line-up and Roll to Airborne	

Table 14: Suggested Terms for Event Times and Interval Durations during Departure

The Expected runway waiting time (ERWP) is split into the Expected stand waiting time (ESWP) and the Runway Delay Buffer (ERBP) by the DMAN.

On the basis of the above introduced terms, the following equations have been defined:

Ref	Equation	Explanation
a)	DTOT = Max (TTOT, CTOT–5)	Earliest possible take-off time is <Ready Time> + <Taxi Time to Hold> + <Line-Up and Roll to Airborne>, possibly limited by start of CTOT window
b)	Planned DELAY= ERWP = TTOT – DTOT	Planned take-off minus earliest take-off ERWP is determined by DMAN
c)	Planned DELAY = ERWP = ESWP + ERBP	Stand delay + runway hold delay ERWP is distributed to stand and runway hold by DMAN
d)	EXOT = TTOT – TSAT = EXOP + ERWP + ELRP	Relationship between EXOT and EXOP
e)	TTOT = TOBT + EXOP + ERWP + ELRP	Take-off at the above plus <runway waiting time>
f)	TSAT = TTOT – EXOP - ERBP - ELRP	Take-off at the above minus <outbound taxi> and <runway hold>

Table 15: Resulting equations proposed

As a sanity check, substitute for the other terms in (b) using the other equations, assuming no CTOT:

Planned DELAY = TTOT – DTOT = (TSAT + EXOP + ERBP + ELRP) – (TOBT + EXOP + ELRP) = TSAT + ERBP – TOBT
= ERBP + (TSAT – TOBT) = ERBP + ESWP

We reach equation (c), showing that these equations are consistent.

Appendix C New Information Elements

C.1 Information Element for Information Exchange Requirement IER-06.08.04-OSED-0103.0030

Identifier	IER-06.08.04-OSED-0001.0001
Name	AFI-Size
Description	An AFI describes the standard amount of nautical miles (NM) to be maintained between two consecutive arrivals in order to process one or more departures in between. Internal to the system, those Nautical Miles shall have to be converted into times to be used by DMAN.
Properties	An AFI must have an associated size measure in nautical miles (NM) or seconds.
Rules applied	An AFI-size shall be measured between two consecutive arrivals.
Comments	Not covered in the AIRM. To issue an AIRM CR.

C.2 Information Element for Information Exchange Requirement IER-06.08.04-OSED-0103.0040, IER-06.08.04-OSED-0103.0170

Identifier	IER-06.08.04-OSED-0001.0002
Name	Sequence Pattern
Description	The order in which aircraft are planned to use the RWY (either take-off or landing) describes the RWY sequence. Only looking at the departing aircraft describes the DEP sequence and only looking at the arriving aircraft describes the ARR sequence.
Properties	A sequence pattern is a combination of departures and arrivals.
Rules applied	Combining the ARR and DEP sequences results in the RWY sequence.
Comments	Not covered in the AIRM. To issue an AIRM CR.

C.3 Interoperability

For interoperability it is important to agree on the systems providing the respective information in the Departure and Surface processes. The following graph gives an overview.

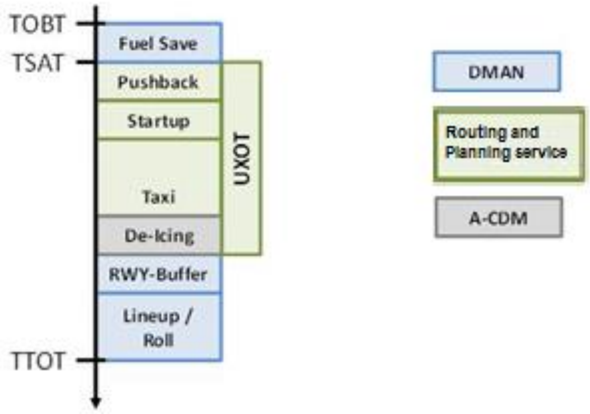

Figure 14: System providing times

This proposal includes De-icing times (if not on stand) in the unimpeded taxi time (according to the definition made by P06.07.02).

Forecasted line-up and roll durations will probably be constant times (an arrival that has not yet vacated, or a departure on its take-off roll cannot be part of the planning process) and will be allocated to DMAN. (Routing and Planning service is supposed to provide also remaining taxi times up to the holding point).

Appendix D Requirements Not Fully Validated

During v3 validation activities not all requirements have been validated since the prototype Coupled AMAN-DMAN and the Simulation Platform where the EXE-06.08.04-VP-453 was performed, did not meet some Technical, Requirements of P10.09.01 and P12.03.05, as detailed in Section 4.2 of the related Validation Plan.

It is believed that these do not have a major impact on the operational concept, and therefore they can be validated during the industrialisation stage.

This section lists the requirements which have not been validated, and comments on the rationale for their status.

Identifier	Title	Rationale for Status
REQ-06.08.04-OSED-1200.0050	Calculation of pattern	The Prototype AMAN-DMAN did not compute an optimised pattern because the current KPIs for Gatwick Approach and Gatwick Tower cannot be combined. All Patterns were input manually. Automatic calculation of patterns would affect only the Arrival Sequence Manager, who is not a tactical controller. Their role would change from coordinating and inputting a Pattern to monitoring the system-recommended pattern and adjusting it when necessary. This is not a major change of role.
REQ-06.08.04-OSED-1200.0055		The Prototype AMAN-DMAN did not compute an optimised pattern because the current KPIs for Gatwick Approach and Gatwick Tower cannot be combined. All Patterns were input manually. Automatic calculation of patterns would affect only the Arrival Sequence Manager, who is not a tactical controller. Their role would change from coordinating and inputting a Pattern to monitoring the system-recommended pattern and adjusting it when necessary. This is not a major change of role.
REQ-06.08.04-OSED-1200.0060		The Prototype AMAN-DMAN did not compute an optimised pattern because the current KPIs for Gatwick Approach and Gatwick Tower cannot be combined. All Patterns were input manually. Automatic calculation of patterns would affect only the Arrival Sequence Manager, who is not a tactical controller. Their role would change from coordinating and inputting a Pattern to monitoring the system-recommended pattern and adjusting it when necessary. This is not a major change of role.
REQ-06.08.04-OSED-1400.0020	Taxi-out time display	This was not displayed by the AMAN-DMAN. It is not displayed on the current operational DMAN, so it is not believed to be essential.
REQ-06.08.04-OSED-1500.0010	Arrival info on AMAN display	UK controllers in the TMA and En Route use paper strips, not electronic strips. Electronic strips are not a pre-requisite for Coupled AMAN-DMAN.
REQ-06.08.04-OSED-1500.0080		This function was not provided by the prototype. It would provide more supporting information to the supervisors, which is not a major change.
REQ-06.08.04-		This function was not provided by the prototype.

OSED-1500.0170		It would provide more supporting information to the Arrival and Departure Sequence Manager, which is not a major change.
IER-06.08.04-OSED-0103.0050	Departure demand information to Arrival Management Function – Target Off-Block Time (TOBT)	The automated calculation was not implemented as this is a rather complex issue and manual procedures need to be established in a first step
IER-06.08.04-OSED-0103.0060	Departure demand information to Arrival Management Function – Calculated Take-off Time (CTOT)	The automated calculation was not implemented as this is a rather complex issue and manual procedures need to be established in a first step
IER-06.08.04-OSED-0103.0070	Departure demand information to Arrival Management Function – Expected Taxi-out Period (EXOP)	The automated calculation was not implemented as this is a rather complex issue and manual procedures need to be established in a first step

Table 16: Requirements Not Fully Validated

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