D02/D04 OSED for Remote Provision of ATS to Aerodromes, including Functional Specification

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Abstract

This document is the Operational Services and Environment Description (OSED) relating to the Remote and Virtual Towers (RVT) element of the SESAR operational concept. This document covers the remote provision of Air Traffic Services (ATS):

- To single aerodromes - in a one to one relationship of one airport to one remote facility;
- To multiple aerodromes in parallel - in a one to many relationship of more than one airport to one remote facility;
- As a Contingency solution when the local Tower is not available, the ATCO cannot be located at the local Tower and the service is relocated to a remote contingency facility.

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00.05.02	2014-08-13	Update	Rainer Kaufhold	Feedback from 6.2 consistency check included

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Executive summary

This document is the Operational Services and Environment Description (OSED) for the Operational Focus Area “Remote Tower”.

It defines the operational services, environments, scenarios and use cases and requirements for the remote provision of ATS to aerodromes. This OSED is a top-down refinement of the SESAR Airports DOD produced by the P06.02. It also contains additional information which should be consolidated back into the higher level SESAR concepts using a “bottom up” approach.

Operational Improvement (OI) SDM-0201 “Remotely Provided ATS for Single Aerodromes” falls under SESAR Operational Step 1. This operational service is already reasonably mature, having been developed initially in the ROT and ART projects. Whilst not yet delivering any 4D trajectory capability, the RVT (Remote and Virtual Tower) concept does provide optimised airport surface operations and a more efficient and cost effective deployment of operational staff resources. It is expected that the initial technical and operational capability of remote provision of ATS for a single aerodrome will be available from 2014.

OI SDM-0205 “Remotely Provided ATS for Multiple Aerodromes” falls under SESAR Operational Step 2. It is expected that the initial technical and operational capability of remote provision of ATS for a multiple aerodrome will be available from 2017).

OI SDM-0204 “Remotely Provided ATS for Contingency situations at Aerodromes” is SESAR Operational Step 2. It is due to be implemented from the middle of 2015 and available from late 2017.

The main change to today’s traditional operations for single or multiple aerodromes is that the ATCO or AFISO will no longer be located at the aerodrome. They will be re-located to a Remote Tower Centre. The aerodrome view(s) will be captured and reproduced in the RTM. The visual reproduction of the aerodrome view(s) can be overlaid with information from additional sources and enhanced through technology for use in all visibility conditions.

The full range of ATS as defined in ICAO Documents 4444, 9426 and EUROCONTROL’s Manual for AFIS will still be provided remotely by an ATCO, (for some aerodromes a single ATCO fulfilling both TWR and APP) or by an AFISO (not applicable for the contingency). The airspace users should be provided with the same level of services as if the ATS were provided locally.

The main expected benefit for Single and Multiple remote controlled aerodromes is within the KPA of Cost Effectiveness. ATS facilities will be cheaper to maintain, able to operate for longer periods and enable lower staffing costs (through centralised resource pools) and training/re-training costs, by large scale effects. It will also significantly reduce the requirement to operate and maintain actual control tower buildings and infrastructure, leading to further cost savings, as well as eliminating the need to build replacement towers.

The expected benefits of the remote provision of ATS during contingency operations at aerodromes are increased safety, security, improved service continuity and a reduction in overhead costs; minimising the losses and costs that would occur in the event of a major outage if no mitigating measures would have been adopted. Minimising economic losses includes losses of revenues, for example airport taxes and charges, operating costs such as staff and compensation, reduced losses for the customers of airspace users and reduced costs for the local, regional or European economy.

It is expected that many updates to this OSED will be produced during the lifecycle of the P06.09.03 execution phase. In the latest version of the OSED, reference to the P06.02 Step 1 and Step 2 DOD has been incorporated, the SESAR Operational Timeline figure has been updated, a change of definition regarding single/multiple RVTs has been integrated, updates to the requirements section and partner reviews/comments have been considered and addressed.

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) within the scope of its Operational Focus Area (OFA).

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

The OSED is used as the basis for assessing and establishing operational, safety, performance and functional requirements for the related systems. The OSED identifies the operational services supported by several entities within the Air Traffic Management (ATM) community and includes the operational expectations of the related systems.

This OSED is a top-down refinement of the Single European Sky ATM Research Programme (SESAR) Airports DOD Step 1 [7] and Step 2 [8] produced by the federating OPS P06.02 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.

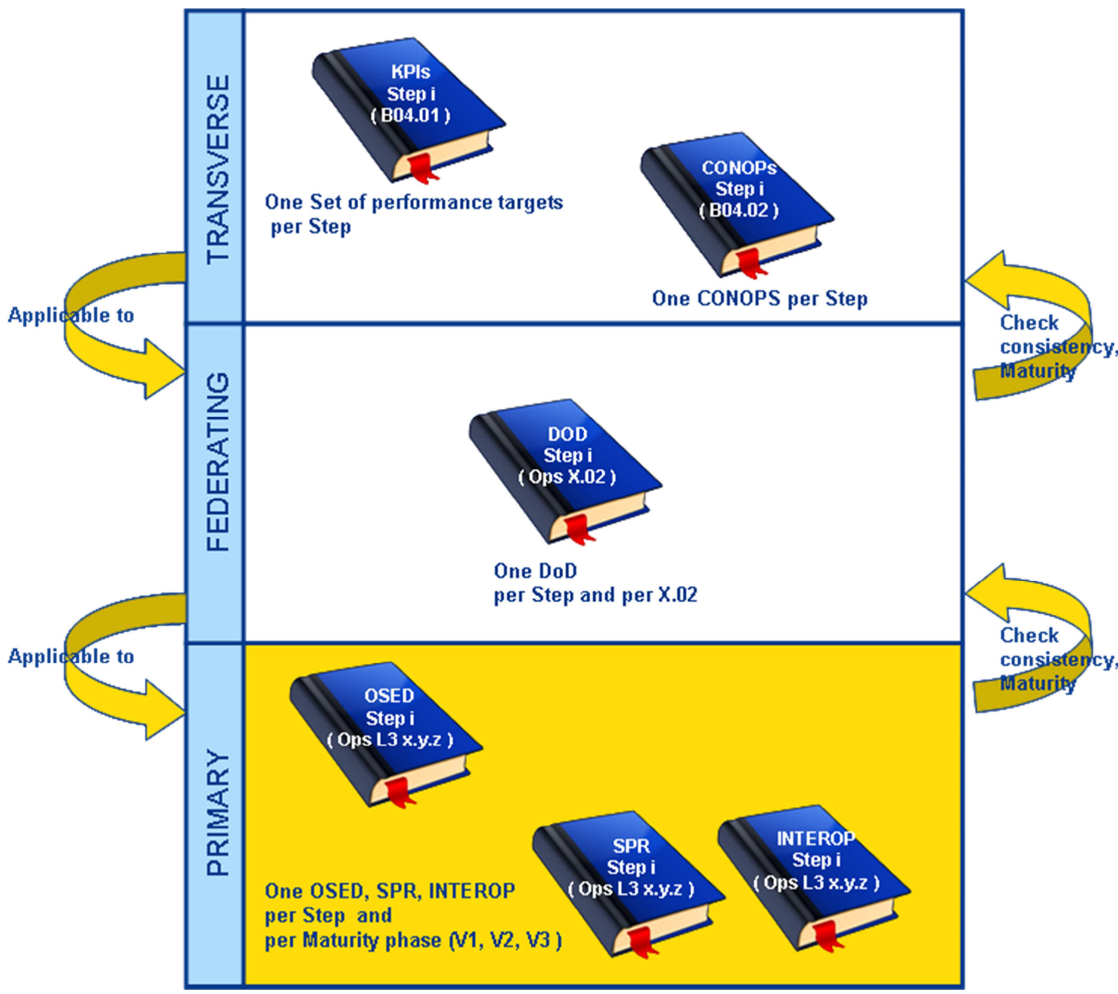


Figure 1 – OSED document with regards to other SESAR deliverables

1.2 Scope

This document is the OSED relating to the RVTs element of the SESAR operational concept. It will be a top down refinement of the SESAR Operational Concept Description (OCD) and Concept of Operations (ConOps) produced by SESAR PB.04.02 and the Airports Detailed Operational Description (DOD) produced by P06.02. It will also contain new information which should be consolidated back into the higher level SESAR concepts using a “bottom up” approach.

It is expected that many updates to this OSED will be produced during the lifecycle of the project execution phase. The OSED is structured as shown in Figure 2. At the top level is the general concept; from that can be derived three operational services for Single Aerodrome, Multiple Aerodrome and Contingency Situations.

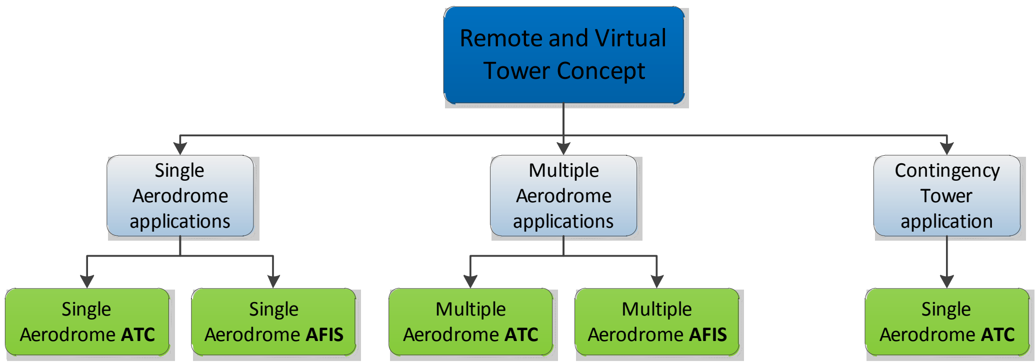


Figure 2 – OSED Hierarchy

Some parts of the document refer to work yet to be done within other P06.09.03 working areas. <u>This document should therefore be considered as part of a set of project deliverables that includes work and documents on Operational Requirements, Rules and Regulations, Human Performance, Safety, Validation and Cost Benefit.</u> This OSED will be updated as the project progresses with the outputs of these other working area deliverables. Input from related Remote Tower activity in P06.08.04 will also be considered.

1.3 Intended readership

The intended audience for this document are other P06.09.03 team members and those in the corresponding technical projects of P12.04.06 and P12.04.07. Those working onP12.04.08, P06.08.04, P06.09.02 and P12.04.09 may also have an interest.

At a higher project level, P06.02 and WP B are expected to have an interest in this document. External to the SESAR project, other stakeholders are to be found among:

- National Safety Authority (NSA);
- Affected employee unions;
- Air Navigation Service Providers (ANSP);
- Airport owners/providers;
- Airspace users.

1.4 Structure of the document

The structure of the document is as follows:

- §1 (this section) introduces the document;
- §2 scopes the concept and puts it in the context of the overall SESAR concept;

- §3 provides a description of the ATM services offered by the Remote and Virtual Tower concept for single aerodromes, multiple aerodromes and the contingency case;
- §4 characterises the operational environments in which the Remote and Virtual Tower concept implementation is foreseen for single aerodromes, multiple aerodromes and the contingency case;
- §5 outlines some key use cases;
- §6 lists the operational and functional requirements for the Remote and Virtual Tower concept for single aerodromes, multiple aerodromes and the contingency case;
- §7 lists the reference documents used in the production of this OSED.

1.5 Background

A preliminary operational concept was defined in the Remotely Operated Tower (ROT) project, led by LFV and Saab. This was further enhanced by developments made during the Advanced Remote Tower (ART) project led also by LFV and Saab. Both projects investigated the feasibility of an initial concept and a set of technical enablers for remotely provided Air Traffic Service (ATS) to a single aerodrome.

Shadow mode trials were performed at Malmö Airport for the remote Ängelholm Airport 100 km away. A number of licensed Air Traffic Control Officers (ATCOs) participated in the trials. The trials were safety assessed concerning impact on real ATS operations in collaboration with the national Swedish flight safety authority (SCAA).

1.6 Glossary of terms

The document uses the following important top level naming conventions:

Where reference is made to the actual Control Tower building, the full word “**Tower**” is used e.g. the local Tower is 87 metres tall.

Aerodrome Control Service (**TWR**) is the air traffic control (ATC) service provided by the Air Traffic Control Officer (**ATCO**) for an aerodrome.

AFIS is the Aerodrome Flight Information Service provided by an **AFISO** (Aerodrome Flight Information Service Officer).

APP (Approach control service) is the service for Arrival and Departing traffic (before and after they will be/have been under the TWR control. APP is provided by a single ATCO for one or more airports, either separate or in combination with TWR (TWR & APP from the Tower).

ATS (Air Traffic Service) is a generic term for the three services Flight Information Service (FIS), Alerting Service (ALRS) and Air Traffic Control Service (ATC). ATC is then subdivided into the three services of TWR, APP and ACC (Area Control Service). In this document, when the term ATS is used, it is usually referring to TWR or AFIS in the context of Single & Multiple applications, however referring to TWR only in the context of Contingency applications.

Advanced Visual Features (AVF) refers to the additional features envisaged for potential inclusion in an RTM. The AVFs are optional features that enhance vision and operator situational awareness, including during low visibility conditions. AVFs are likely to include an Infra-Red (IR) Camera, information overlays, Hot-Spot cameras and Visual Tracking Labels.

Technical Enablers refer to additional features and functions within an RTM that enable the provision of ATS using the concept. These technical features will assist in the areas of visualisation, operational performance, safety of operations or reliability. Some technical enablers are considered mandatory (such as bincoluar functionaility), whilst some, including AVFs (which are a subset of Technical Enablers) are considered optional. Further information on the requirement status of the Technical Enablers is given within this document.

CWP (Controller Working Position) is the operator (ATCO / AFISO) work station including necessary ATS systems.

Remote Tower is where ATS are remotely provided through the use of direct visual capture and visual reproduction e.g. through the use of cameras.

Remote Tower Module (RTM) is the term for the complete module including both the CWP(s) and the Visual Reproduction display screens. An RTM is defined as a work station for an operator. The RTM will enable the remote tower operator to maintain a view over the aerodrome including the manoeuvring area and surfaces as stipulated in regulation. The RTM may be located on the aerodrome site or at a location remote to the aerodrome. Independent of the exact location of the RTM a specialist facility/building is not required to house the RTM and location of the facility is flexible. The RTM is independent of the concept of operations being applied within and hence may be used to provide an ATS to single or multiple aerodromes or during contingency.

A **Remote Tower Centre** (RTC) is a centralised facility housing one or more RTMs where the provision of a remote ATS may be provided to one or more aerodromes.

Remote Tower Centre Supervisor (RTC SUP) The role of an RTC supervisor may be established in order to provide an efficient set up at all times and guarantee a flexible system by means of; maintaining overall supervision of all aerodromes within the RTC; managing the allocation of staff and RTM; performing planning, administration, allocation of tasks and supervision of technical systems.

A **Remote Contingency Tower** (RCT) facility is a facility used to provide remote ATS, including a visual reproduction, to an aerodrome in contingency situations.

Remote and Virtual Tower (RVT) refers to either the RVT Project (this project, P06.09.03 of SESAR) or the RVT Concept. The RVT Concept consists briefly of the system elements as laid out by Figure 3 below (***Please note:*** The system picture below is only an example of an RTC set up, the number and configuration of airports/RTMs/CWPs will/can differ with every implementation).

Traditional Operations refers to the current operational practices used within air traffic control and applied within the time frame of the compilation and publication of this document. With specific reference to the current standards and regulations applied to the provision of a TWR service provided by the ATCO and AFIS provided by the AFISO for an aerodrome.

Virtual Tower is where ATS are remotely provided through the use of computer generated images of the aerodrome, aircraft and vehicles and/or surveillance e.g. through the use of terrain mapping and computer modelling of aerodromes.

Visual Reproduction is the term for the collected aerodrome sensor data (from cameras and/or other sensors) and presented to the ATCO/AFISO in order to provide situational awareness.

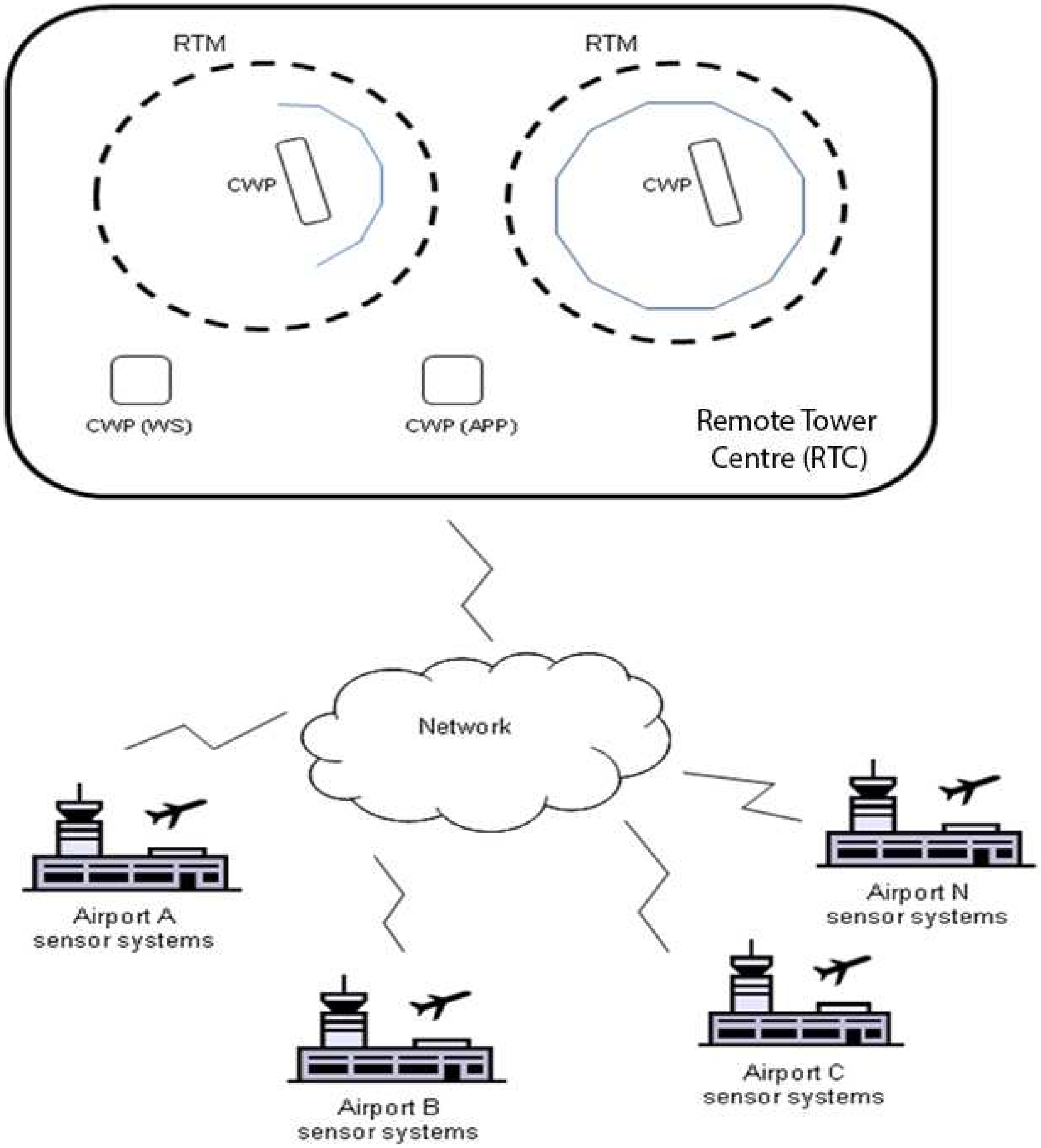


Figure 3 – RVT concept system overview

1.7 Acronyms and Terminology

Term	Definition
AATS	Aerodrome ATS
ACARS	Aircraft Communications Addressing and Reporting System
ACC	Area Control Centre
ADI	Aerodrome Control Instrument Rating
ADS-B	Automatic Dependent Surveillance-Broadcast
AFIS	Aerodrome Flight Information Service
AFISO	Aerodrome Flight Information Service Officer
AGL	Aerodrome Ground Lighting
AIP	Aeronautical Information Publication
ALRS	Alerting Service
ALT	Altitude
ANSP	Air Navigation Service Provider
APOC	AirPort Operations Centre
APP	Approach Control
APS	Approach Control Surveillance
ART	Advanced Remote Tower
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATCO	Air Traffic Control Officer
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATS	Air Traffic Service
ATSEP	Air Traffic Electronic Personnel
ATSU	Air Traffic Service Unit
AVF	Advanced Visual Features
AWOS	Advanced Weather Observation System
CAA	Civil Aviation Authority
CAVOK	Ceiling and Visibility OK
ConOps	Concept of Operations
NMOC	Network Manager Operations Centre
CPDLC	Controller Pilot Data Link Communication
CTR	Control Zone
CWP	Controller Working Position
DCL	Data Communications Link
DME	Distance Measuring Equipment
DOD	Detailed Operational Description
EAATS	En-route/Approach ATS
EXE	Exercise
FDPS	Flight Data Processing System
FIS	Flight Information Service
FIZ	Flight Information Zone

FPL	Flight Plan
GND	Ground controller position in a tower
GPS	Global Positioning System
HMI	Human Machine Interface
IAF	Initial Approach Fix
ICAO	International Civil Aviation Organisation
IFATCA	International Federation of Air Traffic Controllers' Associations
ILS	Instrument Landing System
INT	Intermediate Controller
KPA	Key Performance Area
LVO	Low Visibility Operations
LVP	Low Visibility Procedures
MET	Meteorological
METAR	Meteorological Aerodrome Report
MLS	Microwave Landing System
MSL	Mean Sea Level
MSSR	Mono pulse secondary surveillance radar
NATMIG	North European ATM Industry Group
NAV	Navigation
NDB	Non-Directional Beacon
NORACON	NORth European and Austrian CONsortium
NOTAM	Notice to Airmen
NSA	National Supervisory Authority
OCD	Operational Concept Description
OFA	Operational Focus Area
OPS	Operations
OSED	Operational Services and Environment Descriptions
OTW	Out-The-Window
PAC	Sub Work Package
PPR	Prior Permission Required
PSR	Remote Contingency Tower
PTZ	Pan-Tilt-Zoom
QNH	barometric pressure adjusted to mean sea level
RCT	Remote Contingency Tower
RDP	Radar Data Processing
REQ	Requirement
RFFS	rescue and firefighting services
RNAV	Area Navigation
RNP	Required navigation performance
ROT	Remotely Operated Tower (Saab and LFV project)
RTC	Remote Tower Centre
RTM	Remote Tower Module
RTO	Remote Tower Operations
RVR	Runway Visual Range

RVT	Remote and Virtual Tower
RWY	Runway
SAR	Search and Rescue
SBT	Shared Business Trajectory
SCAA	Swedish flight safety authority
SESAR	Single European Sky ATM Research
SFC	Surface
SJU	SESAR Joint Undertaking
SMR	Surface Movement Radar
SPC	Operational Sub-Package
SPR	Safety and Performance Requirements
STAR	Standard Terminal Arrival Route
STCA	Short Term Conflict Alert
SUP	Supervisor
SWIM	System Wide Information Management
SWP	Sub Work Package
TIA	Traffic Information Area
TIZ	Traffic Information Zone
TMA	Terminal Manoeuvring Area or Terminal Movement Area
TMZ	Terminal Manoeuvring Zone
TWR	Tower (ATC)
TWY	Taxiway
UHF	Ultra High Frequency (radio spectrum band)
UTC	Coordinated Universal Time
VCS	Voice Communications System
VFR	Visual Flight Rules
VHF	Very High Frequency (radio spectrum band)
VOR	VHF Omnidirectional Radio Beacon

Table 1 – Acronym Table

2 Summary of Operational Concept from DOD

For the purpose of the document, the operational concept is split into two groups:

1. The concepts that the project envisages being implemented for small aerodromes with low traffic as a *replacement* to the local tower. These are:
   a. Remote Provision of ATS to a Single Aerodrome (SDM-0201);
   b. Remote Provision of ATS to Multiple Aerodromes (SDM-0205);
2. The concept that the project envisages being implemented for medium to large aerodromes with high traffic, in *addition* to the local tower:
   a. Remote provision of ATS for Contingency Situations at Aerodromes (SDM-0204).

This section links this OSED to the Detailed Operational Descriptions (DOD) produced by SWP06.02 for Step 1 and Step 2.

A maturity assessment was performed against the SESAR Maturity Criteria. The OI Steps (SDM-0201, SDM-0205 and SDM-0204) fall under European Operational Concept Validation Methodology (E-OCVM) V2-V3 since they meet the following criteria:

- The operational concept is developed;
- The OI steps are confirmed and developed;
- The Operational and Performance Requirements are available and have been updated with feedback from V2 validation activities;
- The Operational and Performance Requirements are traceable to the DOD Requirements;
- The relationship with other concepts (OI steps & enablers) have been described and their interdependencies have been analysed;
- There is evidence that the related OI steps and enablers are at the expected level of maturity.

2.1 Remote Provision of ATS to Single and Multiple Aerodromes

2.1.1 Mapping tables

Table 2 lists the Operational Improvement steps (OIs from the Integrated Roadmap, within the associated Operational Focus Area addressed by the OSED.

Operational Package	**Operational Sub-package**	**Operational Focus Area name / identifier**	**Relevant OI Steps ref. (coming from the Integrated Roadmap)**	**Story Board Step**	**Master or Contributing (M or C)**	**Contribution to the OIs short description**
PAC06 Cooperative Asset Management	SPC06.03 Remotely provided Air Traffic Services for aerodromes	OFA 06.03.01 Remote Tower	SDM-0201 Remotely Provided ATS for Single Aerodromes	1	M	The Remote Provision of ATS to a Single Aerodrome (in a one to one relationship of one airport to one Remote

						Tower Module (RTM)
			SDM-0205 Remotely Provided ATS for Multiple Aerodromes	2	M	The Remote Provision of ATS to Multiple Aerodromes in parallel (in a one to many relationship of multiple airports to one RTM)

Table 2 – List of relevant OIs within the OFA

Table 3 shows the relevant enablers for each OI step mapped within the integrated road map. The dataset used reflect dataset 11 the current dataset for the integrated roadmap.

Relevant OI Steps ref. (coming from the Integrated Roadmap)	Relevant Enablers from integrated road map for OI step	Enabler Description
SDM-0201, SDM-0205	AERODROME-ATC-52	Provide Remote Tower Controller position with visual reproduction of both remote aerodrome views and other sensor data
SDM-0201, SDM-0205	AERODROME-ATC-53	Remote Tower controller position enhanced with additional sources for low visibility conditions
SDM-0205	AERODROME-ATC-54	Provide a Remote Tower Centre (RTC) position that enable one ATCO to control multiple remote towers simultaneously or in sequence.
SDM-0201	CTE-C8	Digital voice/VoIP for ground telephony
SDM-0201	CTE-C9	VoIP for ground segment of Air-Ground voice

Table 3 – Relevant enablers from the integrated roadmap

Table 4 identifies the link with the applicable scenarios and use cases of the DOD.

Scenario identification	Use Case Identification	Use Case Description	Reference to DOD section where it is described
Execution Phase	All	-	4.2.5.1 (DOD Step 1 and 2)

Table 4 – List of relevant DOD Scenarios and Use Cases

Table 5 identifies the link with the applicable environments of the DOD.

Operational Environment	Class of environment	Description/Examples	Reference to DOD section where it is described
Network Function	Third Level Node	A regional airport with a limited number of scheduled connections mainly operated by one or two (low fare) carriers. Examples of this class of airport are: Bern, Dortmund, Aarhus, Rotterdam, Girona etc.	Step 1 and Step 2 DOD 3.1.1.1
Network Function	Fourth Level Node	A (regional) airport with only a very few (<10) aircraft movements a day. Examples of this class of airport are: Mora (Sweden), Hof (Germany) etc.	Step 1 and Step 2 DOD 3.1.1.1
Network Function	General / Business Aviation	An Airport dedicated to General / Business Aviation close to important metropolitan areas. Examples for this class of airports are: Paris LBG, Farnborough, Egelsbach, Copenhagen-Roskilde etc.)	Step 1 and Step 2 DOD 3.1.1.1
Layout & Basic Operational Criteria	Single Runway, non-complex surface layout	Examples of this class of Airports might be Rotterdam, Bremen and Stuttgart	Step 1 and Step 2 DOD 3.1.1.2
Capacity Utilisation	Low utilised airports/runways less than 70% load during peak periods	Examples of this class of airports might be Ljubljana, Luxembourg Southampton	Step 1 and Step 2 DOD 3.1.1.3
External Influencing Factors	Moderately Constrained	Constrained by both Geographical/Weather and Political/Community	Step 1 and Step 2 DOD 3.1.1.4

Table 5 – List of relevant DOD Environments

Table 6 identifies the link with the applicable Operational Processes and Services defined in the DOD.

DOD Process	DOD Node - node which is responsible for the activities in the process	Activity - sub-process called to realize a part of the process	Description of the activity	Reference to DOD section where it is described
Prepare and execute off-block	AATS	Provide start-up instruction	Check start-up and provide push-back clearance.	Step 1 DOD 6.2 Ch 5.2.3
	AATS	Provide instruction to exit from the stand	Give instruction to exit from the stand and provide push-back clearance. Start-up may be delayed.	Step 2 DOD 6.2 Ch 5.2.3
Prepare and execute taxi-in routing	EAATS	Provide taxi-in route	Provide a taxi-in route to the aircraft during the	Step 1 DOD 6.2 Ch 5.2.4 Step 2 DOD 6.2

DOD Process	DOD Node - node which is responsible for the activities in the process	Activity - sub-process called to realize a part of the process	Description of the activity	Reference to DOD section where it is described
			approach phase.	Ch 5.2.3
	AATS	Provide taxi-in routing guidance	After vacating the runway, guide the aircraft until it reaches a stand. The taxi route may be revised.	Step 1 DOD 6.2 Ch 5.2.4 Step 2 DOD 6.2 Ch 5.2.3
	AATS	Provide runway crossing		Step 2 DOD 6.2 Ch 5.2.3
Prepare and execute taxi-out routing	AATS	Plan and provide taxi-out route	Plan and provide a taxi-out route to the aircraft during the turn-round phase.	Step 1 DOD 6.2 Ch 5.2.4 Step 2 DOD 6.2 Ch 5.2.3
	AATS	Provide instruction to exit from the stand	Provide instruction for push-back. In some cases, guide aircraft out of an open stand.	Step 1 DOD 6.2 Ch 5.2.4
	AATS	Provide taxi-out routing guidance	Guide the aircraft until it reaches the holding point for take-off. The taxi route may be revised.	Step 1 DOD 6.2 Ch 5.2.4 Step 2 DOD 6.2 Ch 5.2.3
	AATS	Provide runway crossing	TBC	Step 1 DOD 6.2 Ch 5.2.4 Step 2 DOD 6.2 Ch 5.2.3
Plan and provide routing for a vehicle	AATS	Provide vehicle routing guidance	Guide a ground vehicle (aircraft excluded) on the airport surface.	Step 1 DOD 6.2 Ch 5.2.4 Step 2 DOD 6.2 Ch 5.2.3
	AATS	Provide runway crossing clearance	TBC	Step 1 DOD 6.2 Ch 5.2.4 Step 2 DOD 6.2 Ch 5.2.3
Perform Conformance Monitoring	AATS	Manage Airport Conformance Alert	Do everything which is necessary to	Step 1 DOD 6.2 Ch 5.2.5

DOD Process	DOD Node - node which is responsible for the activities in the process	Activity - sub-process called to realize a part of the process	Description of the activity	Reference to DOD section where it is described
			cancel a non-conformance alert.	
Perform RWSL Operations	AATS	Manage RWSL issues	Solve conflicting clearances or any issues with the system.	Step 1 DOD 6.2 Ch 5.2.5

Table 6 – List of the relevant DOD Processes and Services

Table 7 summarizes the requirements including performance (KPA related) requirements relevant to this OSED. This table supports defining the performance objectives in the scope of the addressed OFA. The DOD performance requirements are structured to respond to Key Performance Indicators (PI) targets / decomposed PI's, so this table aids traceability of the performance framework.

DOD Requirement Identification	DOD requirement title	Reference to DOD section where it is described
REQ-06.02-DOD-6200.0057	The Tower Runway and Ground controllers and AFISO shall be provided with the information collected from remote tower sensor systems in order to perform Air Traffic Services from a facility located elsewhere than at the relevant airport.	Step 1 DOD 6.2
REQ-06.02-DOD-CEF1.0631	KPA Cost Effectiveness.	Step 1 DOD 6.3.5
REQ-06.02-DOD-CEF2.0631	KPA Cost Effectiveness.	Step 2 DOD 6.2.4
REQ-06.02-DOD-SEC1.0001	KPA Security.	Step 1 DOD 6.3.3
REQ-06.02-DOD-SEC2.0001	KPA Security.	Step 2 DOD 6.2.2
REQ-06.02-DOD-ENV1.0001	KPA Environment	Step 1 DOD 6.3.4
REQ-06.02-DOD-ENV2.0001	KPA Environment	Step 2 DOD 6.2.3
REQ-06.02-DOD-FLX1.0001	KPA Flexibility	Step 1 DOD 6.3.8
REQ-06.02-DOD-FLX2.0001	KPA Flexibility	Step 2 DOD 6.2.7
REQ-06.02-DOD-ANE1.0001	KPA Access and Equity	Step 1 DOD 6.3.10
REQ-06.02-DOD-ANE1.0002	KPA Access and Equity	Step 1 DOD 6.3.10
REQ-06.02-DOD-ANE1.0003	KPA Access and Equity	Step 1 DOD 6.3.10
REQ-06.02-DOD-ANE1.0004	KPA Access and Equity	Step 1 DOD 6.3.10
REQ-06.02-DOD-ANE2.0001	KPA Access and Equity	Step 2 DOD 6.2.9
REQ-06.02-DOD-ANE2.0002	KPA Access and Equity	Step 2 DOD 6.2.9
REQ-06.02-DOD-ANE2.0003	KPA Access and Equity	Step 2 DOD 6.2.9
REQ-06.02-DOD-ANE2.0004	KPA Access and Equity	Step 2 DOD 6.2.9
REQ-06.02-DOD-PRT1.0001	KPA Participation	Step 1 DOD 6.3.11
REQ-06.02-DOD-PRT1.0002	KPA Participation	Step 1 DOD 6.3.11
REQ-06.02-DOD-PRT2.0001	KPA Participation	Step 2 DOD 6.2.10
REQ-06.02-DOD-PRT2.0002	KPA Participation	Step 2 DOD 6.2.10
REQ-06.02-DOD-INT1.0001	KPA Interoperability	Step 1 DOD 6.3.12
REQ-06.02-DOD-INT2.0001	KPA Interoperability	Step 2 DOD 6.2.11
REQ-06.02-DOD-6200.0260	The Tower Runway and Ground controllers and AFISO shall be provided with the information collected from remote tower	Step 2 DOD 6.1

DOD Requirement Identification	DOD requirement title	Reference to DOD section where it is described
	sensor systems located on several aerodromes in order to perform Air Traffic Services from a facility located elsewhere than at the concerned airports	

Table 7 – List of the relevant DOD Requirements

2.1.2 Operational Concept Description

The SESAR Concept Storyboard defines three ATM Operational Steps (Step 1, Step 2 and Step 3). The Operational Steps tell the 'story' of what the SESAR ATM system will look like at key milestones in the implementation phase of 2010 to 2020.

P06.09.03 focuses on an *initial* concept for remotely provided ATS for single and multiple aerodromes, for ATC and AFIS as well as contingency operations.

The remote provision of ATS for a single aerodrome falls under SESAR Operational Step 1. This operational service is already quite mature, having been developed initially in the ROT and ART projects. Whilst not yet delivering any 4D trajectory capability, the concept does provide optimised airport surface operations and a more efficient and cost effective deployment of operator resources. It is expected that the initial technical and operational capability of remote provision of ATS for a single aerodrome will be available from 2014.

The remote provision of ATS for a multiple aerodrome falls under SESAR Operational Step 2. It is expected that the initial technical and operational capability of remote provision of ATS for a multiple aerodrome will be available from 2017.

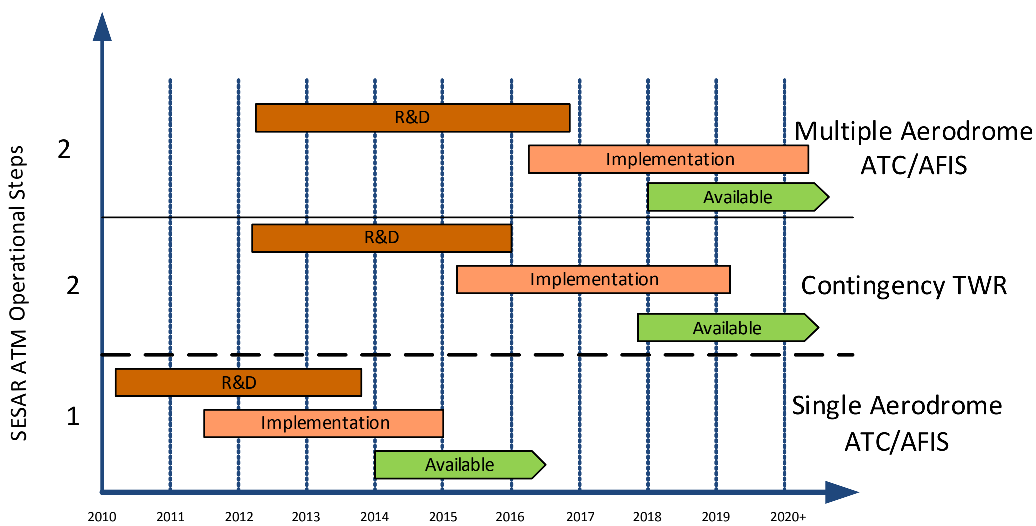


Figure 4 – SESAR ATM Operational Step Timeline

2.2 Remote Provision of ATS for Contingency Situations at Aerodromes

2.2.1 Mapping Tables

Table 8 lists the Operational Improvement steps (OIs from the Integrated Roadmap, within the associated Operational Focus Area addressed by the OSED.

Operational Package	**Operational Sub-package**	**Operational Focus Area name / identifier**	**Relevant OI Steps ref. (coming from the Integrated Roadmap)**	**Story Board Step**	**Master or Contributing (M or C)**	**Contribution to the OIs short description**
PAC06 Cooperative Asset Management	SPC06.03 Remotely provided Air Traffic Services for aerodromes	OFA06.03.01 Remote Tower	SDM-0204 Remotely Provided ATS for Contingency Situations at Aerodromes	2	M	The Remote Provision of ATS to an Aerodrome during Contingency Situations. This provides a Contingency solution when the local Tower is not available, the ATCO cannot be located at the local Tower and the service is relocated to a Remote Contingency Facility.

Table 8 – List of relevant OIs within the OFA

Table 9 shows the relevant enablers for each OI step mapped within the integrated road map. The dataset used reflect dataset 11 the current dataset for the integrated roadmap.

Relevant OI Steps ref. (coming from the Integrated Roadmap)	Relevant Enablers from integrated road map for OI step	Enabler Description
SDM-0204	AERODROME-ATC-51	RTC position that in contingency situation hosts ATCO that will no longer be located at the local Tower.
SDM-0204	AERODROME-ATC-52	Provide Remote Tower Controller position with visual reproduction of both remote aerodrome views and other sensor data.

Relevant OI Steps ref. (coming from the Integrated Roadmap)	Relevant Enablers from integrated road map for OI step	Enabler Description
SDM-0204	AERODROME-ATC-53	Remote Tower controller position enhanced with additional sources for low visibility conditions

Table 9 – Relevant enablers from the integrated roadmap

Scenario identification	Use Case Identification	Use Case Description	Reference to DOD section where it is described
Execution Phase	All	-	4.2.5.1 (DOD Step 1 and 2)

Table 10 – List of relevant DOD Scenarios and Use Cases

Table 11 identifies the link with the applicable environments of the DOD.

Operational Environment	Class of environment	Description/Examples	Reference to DOD section where it is described
Network Function	Intercontinental Hub	Large intercontinental airport acting as transfer hub for one or more major European airlines with a wide route network spanning to a large number of destinations inside and outside Europe. Examples for this of airports are: Luton LHR, Paris CDG, Frankfurt, Amsterdam, Madrid etc.	Step 2 DOD 3.1.1.1
Network Function	European Hub	Large European airport acting as a transfer hub for at least one European airline with a wide route network spanning to a wide range of European destinations. Only a limited number of destinations outside Europe are served directly from this airport. Examples of this class of airport are: Copenhagen, Helsinki, Vienna, Brussels, Palma, Milan-MXP etc.	Step 2 DOD 3.1.1.1
Network Function	Primary node	Medium sized airport with a limited hub function and intercontinental P2P connections. Examples of this class of airport are: London-STN, Lyon-Saint Exupéry, Budapest, Warsaw, Athens etc.	Step 2 DOD 3.1.1.1
Network Function	Secondary Node	An airport with limited or no intercontinental traffic, mainly scheduled connections to the large intercontinental (class 1) or European (class 2) hubs, a significant size of	Step 2 DOD 3.1.1.1

Operational Environment	Class of environment	Description/Examples	Reference to DOD section where it is described
		charter/leisure operations and acting as a major base for one or more low fare carriers. Examples of this type of airport are:, London-LTN, Nuremberg, Gothenburg, Leeds Bradford, Milan-BGY, Rome –CIA, Valencia etc.	
Layout & Basic Operational Procedures	Multiple Independent Runways, complex surface layout	Example of this class of airports might be Madrid Barajas	Step 2 DOD 3.1.1.2
Layout & Basic Operational Procedures	Multiple Dependent Runways, complex surface layout	Examples of this class of airports might be London Heathrow, Paris CDG, Frankfurt and Amsterdam	Step 2 DOD 3.1.1.2
Layout & Basic Operational Procedures	Multiple Independent Runways, non-complex surface layout	Examples of this class of airports might be London Gatwick	Step 2 DOD 3.1.1.2
Layout & Basic Operational Procedures	Multiple Dependent Runways, non-complex surface layout	Example of this class of airports might be Munich	Step 2 DOD 3.1.1.2
Capacity Utilisation	Highly utilised airports/runways, traffic mix of heavy, medium and light aircraft. More than 90% load during 3 or more peak periods a day.	Examples of this class of airports might be London Heathrow, Amsterdam, Paris CDG and Madrid	Step 2 DOD 3.1.1.3
Capacity Utilisation	Highly utilised airports/runways, homogeneous traffic (dominant heavy or medium or light). More than 90% load during 3 or more peak periods a day	Examples of this class of airports might be Barcelona, Palma and Oslo	Step 2 DOD 3.1.1.3
Capacity Utilisation	3 Normally utilised airports/runways. 70 – 90% load during 1 or 2 peak periods a day	Examples of this class of airports might be Düsseldorf, Manchester and Hamburg	Step 2 DOD 3.1.1.3
External Influencing Factors	Highly Constrained (Geographical / Weather issues)	Example of this class of airports might be Funchal	Step 2 DOD 3.1.1.4
External Influencing	Highly Constrained (Political / Community	Examples of this class of airports might be Amsterdam, Madrid	Step 2 DOD 3.1.1.4

Operational Environment	Class of environment	Description/Examples	Reference to DOD section where it is described
Factors	issues)		
External Influencing Factors	Moderately Constrained (both Geographical / Weather and Political / Community)	Example of this class of airports might be Cologne	Step 2 DOD 3.1.1.4
External Influencing Factors	Lightly or Unconstrained	No major weather, topographical, political or community issues.	Step 2 DOD 3.1.1.4

Table 11 – List of relevant DOD Environments

Table 12 identifies the link with the applicable Operational Processes and Services defined in the DOD.

DOD Process / Service Title	Process/ Service identification	Process/ Service short description	Reference to DOD section where it is described
Review of and preparation for the response to extraordinary and emergency situations	ATS, APO, NM	Define/update response to emergency Publish response to emergency	Step 2 DOD A.1.1

Table 12 – List of the relevant DOD Processes and Services

Table 13 summarises the requirements including performance (KPA related) requirements relevant to the OSED. This table supports defining the performance objectives in the scope of the addressed OFA. The DOD performance requirements are structured to respond to Key Performance Indicators (KPI) targets / decomposed PIs, so this table will support traceability to the performance framework.

DOD Requirement Identification	DOD requirement title	Reference to DOD section where it is described
REQ-06.02-DOD-6200.0260	The Tower Runway and Ground controllers shall be provided with the information collected from remote tower sensor systems located on several aerodromes in order to perform Air Traffic Services from a facility located elsewhere than at the concerned airports.	Step 2 DOD 6.1.2

Table 13 – List of the relevant DOD Requirements

2.2.2 Operational Concept Description

The provision of ATS for contingency situations falls under SESAR Operational Step 2. Whilst not yet delivering any 4D trajectory capability, the concept does provide optimised airport surface operations and a more efficient and cost effective deployment of operator resources. It is expected that the initial technical and operational capability of remote provision of ATS for contingency operations will be available from late 2017.

3 Detailed Operating Method

The main objective of the RVT concept is to provide an ATS, as in traditional operations from local aerodrome control towers, from a remote location. The ATS itself should remain unchanged, with only the way in which it is delivered changing. The overall RVT concept includes the following services:

1. Remotely Provided Air Traffic Services (TWR & AFIS) for a Single Aerodrome;
2. Remotely Provided Air Traffic Services (TWR & AFIS) for Multiple Aerodromes;
3. Remotely Provided Air Traffic Services (TWR) for Contingency situations at Aerodromes.

3.1 Conceptual and Technical Foundations for the Remote Provision of Air Traffic Services to Aerodromes

The Remote Provision of ATS features some elements that are communal to all OI steps. The following sections introduce these elements as foundations for the overall concept, independently of the precise operating method.

The operating methods accompanying each concept are detailed in the subsequent sections (3.2 – *Single Remote Tower*; 3.3 – *Multiple Remote Tower*; and 3.4 – *Contingency Remote Tower*).

3.1.1 Technical Enablers

The Remote Provision of ATS is based on technical concept elements of which some are mandatory while others are optional and might be chosen depending on specific local needs.

[redacted] Mandatory Elements

While the mandatory elements are expected to be realised for each remote tower application, different technical solutions might be chosen. In order to facilitate implementation some high level standards seem to be necessary (and are currently being developed by EUROCAE WG 100).

[redacted] Visual Reproduction

A visual reproduction is the core of the Remote Provision of ATS and replaces the OTW view from the local tower building.

The visual reproduction can take one of several forms and in order to remain applicable to many technical interpretations, the operational and functional requirements in this document will not specify exactly what form the visual reproduction should take.

The visual reproduction could therefore be:

- A camera based solution, where cameras capture the image at the local aerodrome and these are relayed on video screens to the ATCO/AFISO;
- A synthetic, computer generated “virtual” solution where a range of sensors capture information at the local aerodrome and these are relayed on screens to the ATCO/AFISO;
- An A-SMGCS based solution;
- A combination of the above.

[redacted] Controller Working Position

As a basis the ATCO/AFISO will be provided with a CWP enabling the provision of an ATS from a remote location. Hence all the systems and tools required for the operator to fulfil the required tasks shall be provided at the CWP. The introduction of new technical systems coupled with a large modernisation of the CWP shall feature in the Remote Provision of ATS. However the underlying principals shall remain familiar to the ATCO/AFISO and in line with those used in traditional operations.

The ATS systems currently used in the tower environment have to be connected to the remote CWP. The list below shows some examples:

- Flight Progress Strips (electronic or paper);
- Radio Telephony Communications (ground and air);
- Functionality for manoeuvring and controlling:
    - o Airport lights;
    - o Signal Light Gun;
    - o Navigation aids;
    - o ILS;
    - o Alarms and;
    - o Other airport systems.

[redacted] Binocular Function

A binocular functionality shall replace the manually operated binocular which is currently used in the local aerodrome tower; hence the inclusion of this function is a mandatory requirement.

In addition to the overall visual reproduction the ATCO / AFISO may be facilitated with a functionality to look at certain items of interest more closely whenever necessary (e.g. engine on fire, landing gear extended RWY condition / objects on RWY etc.). For this purpose a binocular function will provide the ATCO / AFISO with the option to angle the view and zoom into objects as required. An easy to use interface is an essential requirement on this functionality, alongside the necessity for a sufficient image quality to support ATS tasks.

Moreover certain aerodrome “hotspots” may be configured enabling the ATCO / AFISO to quickly jump to frequently recurring areas of interest (e.g. waypoints, thresholds, RWY sweep etc.) utilising predefined positions and automatic scans set for the binocular function.

The automatic visual tracking of objects may increase the ATCO’s / AFISO’s ability to spot and follow relevant objects. This feature of a binocular function would be especially pertinent during non-nominal or distress situations where quick reactions are required.. The automatic tracking may provide close-up images of the relevant objects (on a binocular function screen) or highlight the relevant objects in the overall context (visual reproduction screen).

[redacted] Optional Elements

In addition to the mandatory technical enablers a wide variety of optional technical enablers can be chosen depending on the specific local needs. In the chapters below some examples are given (the list is not intended to be exhaustive).

The level of support provided by the system through optional elements is expected to have an impact on the ATOC’s /AFISO’s capacity in terms of the number of traffic movements that can remotely be controlled.

[redacted] Advanced Visual Features

3.1.1.2.1.1 Overlay Information

The visual reproduction may be overlaid with additional information pertinent to the general area of interest or area of responsibility, in order to increase ATCO/AFISO situation awareness and head-up times. The fundamental classes of information that may be incorporated into visual reproduction overlays includes: geographic, meteorological, operations and service and visual reminder information.

The ATCO/AFISO may be provided with additional information regarding aircraft under their control (e.g. Flight Plan Data) via the main visual reproduction. Such information can range from an aircraft

label through to additional information like distance from the aerodrome, height, intentions etc. In this way situational awareness may be increased as well as reducing head-down times.

Relevant MET information (i.e. actual wind, gusts, QNH, ATIS identifier) may be displayed within the visual reproduction as this information is frequently used by the ATCO/AFISO.

Other examples are the tracking of objects (e.g. by highlighting moving objects like aircraft or flocks of birds) and outlining of the runway at night.

3.1.1.2.1.2 Infrared Information

The visual reproduction may be enhanced with information received from infrared sensors. This could potentially further improve the visual reproduction in CAT II/III low visibility conditions or in darkness.

[redacted] Additional Viewpoints

3.1.1.2.2.1 Enhancement of traditional OTW viewpoint

The provision of ATS from a local tower building (as in traditional operations) has some constraints at certain airports due to the single operational viewpoint from a central, high up perspective and subject to prevailing viewing conditions at the time (e.g. clear, foggy). This can create some minor limitations in capability which are accepted in 'traditional' air traffic control. With the use of reproduced views these limitations can potentially be eliminated.

Operational viewpoints may be provided, based on information captured from a range of different positions, not necessarily limited to the original tower position. This may provide an enhanced situational awareness and/or a progressive operational viewpoint.

Moreover the use of additional viewpoints may solve problems related to the obscuring of views over time. Obscuring can occur naturally due to things like tree growth, or from development of the aerodrome and newly built runways, taxiways, gate positions etc. For such circumstances additional viewpoints may provide potential solutions.

In all cases, the visual reproduction shall enable visual observation of the airport surface and surrounding area. Visual information capture and reproduction can still be done in order to replicate the operational viewpoint obtained from a traditional tower view and this may ease the transition from traditional operations to remote operations and also provide some common reference points.

3.1.1.2.2.2 View during Low Visibility Operations

Low Visibility Operations will still require specific LVP when operating remotely. However, the visual enhancements are expected to lower the limit of visibility value when LVP have to be implemented (above the minimum limit of RVR 550m set by ICAO) and the point of visibility after which only single movements are allowed on the manoeuvring area. These enhancements will need to be considered as part of an updated Pre-LVP. With AVFs and updated LVP it is anticipated that the movement rate during Pre-LVP and LVP could be less restrictive, as long as aircraft and vehicles on the manoeuvring area are visible through the visual reproduction. In case of the visual reproduction becoming temporarily unavailable, it is foreseen that procedures similar to LVP will be implemented.

3.1.1.2.2.3 Views during Darkness

The provision of ATS during darkness may continue as in traditional operations. However the addition of infra-red functions may enhance the ATCO/AFISO view during darkness. This may result in improved safety and flexibility during these operational conditions.

[redacted] Aerodrome Sound

To further improve ATCO/AFISO situational awareness the aerodrome's background sounds may be captured and relayed.

[redacted] Air Situation Display

Depending on the local needs the CWP might be equipped with an air situation display (radar or ADS-B information). It is expected that an air situation display will primarily be used if already implemented at the local tower.

[redacted]Ground Situation Display

Depending on the local needs the CWP might be equipped with a ground situation display. The information presented in the ground situation display can be based on different sensors like a ground radar, ADS-B or MLAT. A multi sensor fusion might be applied where necessary.

[redacted]Information Sharing

This concept may include visual information sharing and enhanced local operations. Critical visual information on the traffic situation may be collected and provided (internally to the system) to other remote tower centres for increased situational awareness. That information and technology might prove useful for other airport stakeholders as well as personnel in ordinary control towers.

External sharing with airport rescue and firefighting services (RFFS) units could positively impact upon response times and enable improved detection and localisation of emergences, especially beneficial during low visibility. This information sharing would also reduce the RFFS dependence on information gained solely and directly through ATS personnel. Airfield security and ground handling could be alerted of unauthorized infringements on the manoeuvring area, debris on the runway and other safety and/or security related issues. AirPort Operations Centre (APOC) could utilize the visual reproduction for situation assessment and short term planning.

3.1.2 Remote Tower Module (RTM)

The Remote Provision of ATS is to be provided from a CWP and visual reproduction which together are known as a Remote Tower Module (RTM). Figure 5 overleaf shows some potential configurations of an RTM, independent of the number of aerodromes and the level of detail depicted on the visual reproduction. With reference to Figure 5:

- **RTM 1:** Consists of one CWP having its own dedicated set of screens for visual reproduction (CWP 1);
- **RTM 2:** Consists of one CWP featuring two positions (CWP 2) sharing the same visual reproduction. This provides the option of placing an additional role in the RTM (for example a supervisory position or a second operational controlling position).
- **RTM 3:** Consists of two CWPs (CWP 3 and 4) adding flexibility in the use of the RTM. The most common use of this set up would be a shared service provision to one aerodrome (similar to the method of operating RTM 2 when two positions are utilised, however in RTM 3 each position has its own dedicated screens for visual reproduction and hence the two CWPs may have the same or differing views). Further to this CWP 3 and 4 could also be used to provide an ATS to two individual aerodromes, with each CWP being independent and utilising half of the RTM;
- **CWP 5:** A position featuring no screens for visual reproduction (CWP5). This CWP would be used for roles where visual is not required e.g. Approach or supervisor, but other surveillance equipment would then be required;

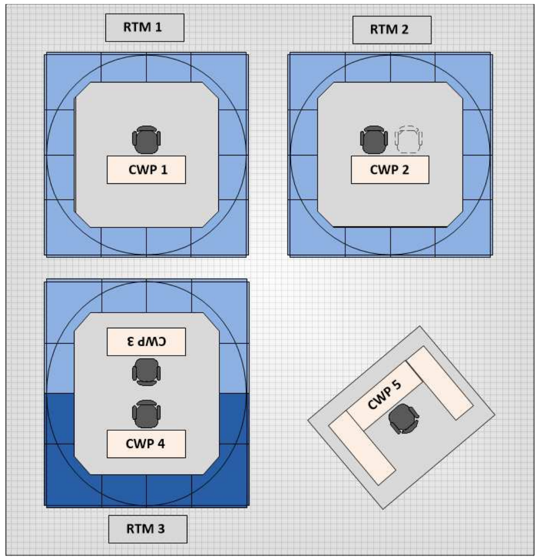


Figure 5 – Potential configurations of the RTM

Unified and standardised RTMs would be preferred, integrating all concerned systems into a comprehensive solution and taking all Human Machine Interface (HMI) aspects into consideration. In current local tower environments the CWP and HMI from one tower to another can be very different. The use of a standardised RTM solution will eliminate the many different HMI interfaces seen in operation currently.

This will make it much easier for an ATCO/AFISO to provide a service and be licensed for several aerodromes. Interaction technology options may also be deployed on the user interfaces for more efficient and optimal user interaction.

3.1.3 Remote Tower Centre (RTC)

[redacted] Overview of an RTC

In order to maximise the benefits proposed by the concept it is likely that in many instances the provision of a remote ATS from an RTM will be from a centralised facility to be known as a RTC. The centralisation of many RTMs in one RTC will bring about increased cost effectiveness due to economies of scale brought about through increased sharing. It is likely that an RTC would contain several RTMs, similar to sector positions in an Area Control Centre (ACC / ATCC).

An RTC could be laid out as shown in Figure 6, with multiple RTMs and one or more supervisor positions (depending on the size and requirements of the RTC). As detailed above a unified and standardised RTM would be required to provide the most efficient setup, facilitating sharing and thus economies of scope.

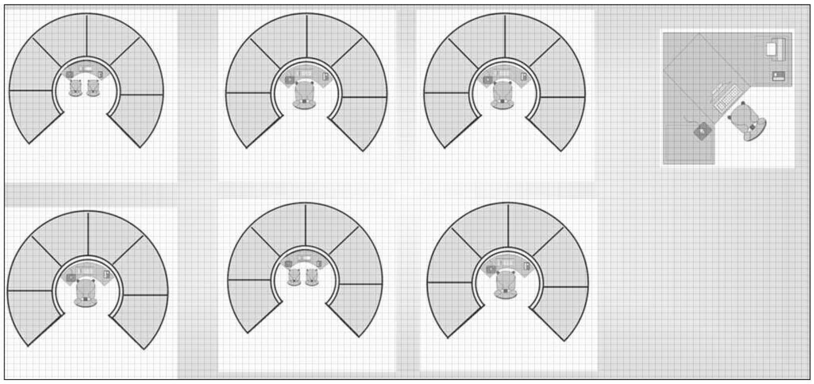


Figure 6 – Illustration of an RTC layout

Depending primarily on the traffic density, it can be decided to open, close or merge the number of aerodromes handled by a single ATCO / AFISO in an RTM. The ability to merge will be reliant on many factors such as ATCO license, size of the aerodromes and technical ability to add aerodromes (with the key constraint being number of screens, as this will limit how many aerodromes can be viewed in one RTM).

Depending primarily on the traffic density, it can be decided to open, close or merge the number of RTM and staffing levels.

The number of available RTMs in an RTC depends of the following factors:

- The number of aerodromes connected;
- The maximum number of parallel movements possible (per each ATCO / AFISO / RTM);
- Another number, depending on ability to combine RTM and aerodromes.

Note: Additional/Spare RTMs to be considered based on contingency requirements.

ATCOs / AFISOs would be required to obtain a full license for every aerodrome they are to provide and ATS. In order to maximise the utility of an RTC it would be beneficial for ATCOs operating from one RTC to hold a license for all the aerodromes being provide with an ATS from the RTC.

[redacted] Operating methods and Roles within the RTC

The configuration of the RTC and operating methods applied within shall be non-prescriptive, with RTCs being fully flexible and configurable to many applications under the Remote Provision of ATS concept.

It is expected that there will be up to three different primary roles in an RTC (not necessarily all at once, in the same RTC or to the same aerodrome):

- ATCO;
- AFISO;
- RTC supervisor.

The ATCOs / AFISOs main responsibility will be regarding the provision of ATS. The (optional) RTC supervisors main responsibilities will be with regard to staff/RTM allocation.

At RTC level it is expected that management would conduct a study to determine the optimal number of staff according to their own configurations. A more efficient shift pattern with reduced overall staffing is envisaged. This would be especially efficient in large RTCs if ATCOs / AFISOs held licenses for all aerodromes being provided with an ATS from that RTC. If the RTC ATCOs / AFISOs only held licenses for specific aerodromes RTC resource management would be limited in the combination of aerodromes to operators they could provide.

During a shift, an RTC supervisor role can be used to manage the allocation of staff and RTM at any one time during the shift in order to provide an efficient set up at and guarantee a flexible system. The RTC supervisor role can be performed by a dedicated person or can be handled by one of the shift staff in addition to their ATCO/AFISO role.

The RTC will have a predefined number of ATCO/AFISO resources available during a shift period. Shift configuration and resource pool size should consider:

- Expected traffic load;
- The number of RTMs;
- The ability to combine aerodromes to be controlled using one RTM;
- ATCO licenses;
- Relief staff requirements.

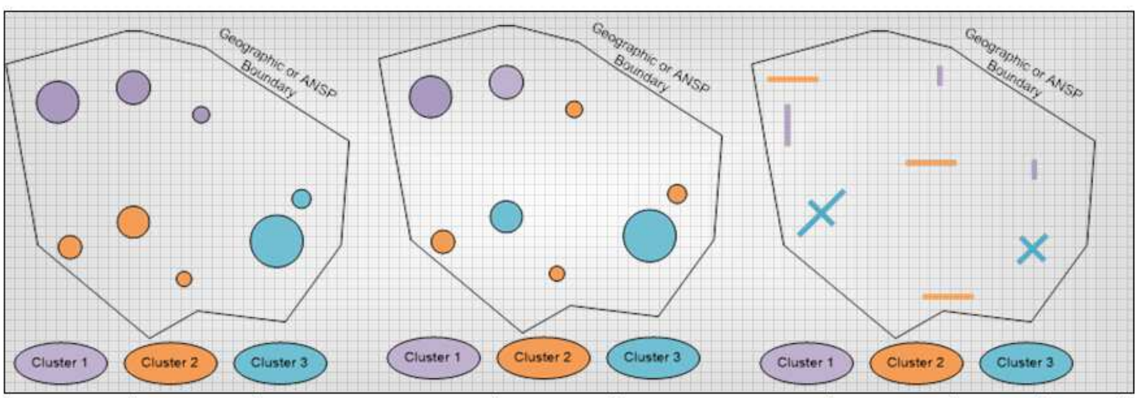
[redacted] Aerodrome Clustering within an RTC

Within an RTC, the multiple aerodromes may be grouped into sub-sets. These sub-sets may be used to decide:

- Which aerodromes would be used in a Multiple Tower configuration with several ATCO/AFISO;
- Which multiple aerodromes a single ATCO/AFISO could provide ATS to in parallel;
- How any internal RTC "sub-centres" might be organised or managed in larger RTC.

Aerodromes could be clustered according to (with reference to Figure 7 below):

- Their location, where aerodromes in the same geographic area or which share the same TMA/APP are grouped (as shown in Example 1);
- Their size, where large aerodromes are in smaller clusters and small aerodromes are more often grouped together in large clusters (as shown in Example 2);
- Their runway characteristics, where aerodromes with the same runway numbers/direction are clustered together (as shown in Example 3).



Example 1 - Aerodrome clustered according to location | Example 2 – Aerodromes clustered according to size | Example 3 – Aerodromes clustered according to runway charateristics

Figure 7 – Examples of aerodrome clusters

One ATCO will be providing ATS to all the aerodromes in one "cluster" and hence from one RTM, there are other factors to consider. These include consideration for:

- The validity of the ATCOs/AFISOs license for the aerodromes within that RTM;

- Human performance - considering the influence that traffic level and hence aerodrome combination will have on ATCO/AFISO capacity/ability to handle the traffic at all aerodromes;
- Weather and visibility conditions – as reduced conditions will influence the maximum capacity that one RTM with one operator. Also differences in visibility and weather between aerodromes may negatively impact on ATCO situational awareness and ability to maintain a high standard of service provision.

3.1.4 ATCO/AFISO Ratings, Endorsements and Licensing

It is not within the remit of SESAR to make decisions on matters relating to ratings, endorsements and licensing. A potential suggestion for the way forward regarding the licensing of remote tower ATCOs is that they shall hold an ADI rating with appropriate endorsements (i.e. radar, etc.) and additionally hold an RTC unit endorsement, complemented with specific local endorsements for the appropriate aerodromes that the skills will be applied to. Note: the different aerodromes in an RTC should be treated similarly to the sectors in an ACC, from a licensing point of view. AFISO shall hold an AFIS licence, complemented with a specific local licence for the appropriate aerodrome.

Cross licensing enables ATCOs / AFISOs to provide ATS to various aerodromes. Hence flexible staffing may be achieved and thusly costs may be reduced as ATCOs / AFISOs are not bound to one aerodrome.

The above should be valid for the Single Remote TWR as well as for Multiple Remote TWR applications.

3.2 Remote Provision of Air Traffic Services for a Single Aerodrome

3.2.1 Scope and Objective

The objective of remote provision for a single aerodrome is to provide the air traffic services (ATS) defined in ICAO Documents 4444 [10], 9426 [13] and EUROCONTROL's Manual for AFIS [12] for one aerodrome from a remote location i.e. not from a control tower local to the aerodrome. The full range of ATS should be offered in such a way that the airspace users are not negatively impacted (and possibly benefit) compared to local provision of ATS. The overall ATS will remain classified into either of the two main service subsets of TWR or AFIS.

The typical operating environments for remote tower services are airports below third level node, with a single runway, non-complex runway layout and low capacity utilization. But remote tower services are not limited to those environments

The remote provision of ATS for a single aerodrome is expected to be applied to low density aerodromes (where low density traffic is determined as being mostly single operations, rarely exceeding two simultaneous movements) as well as to some medium traffic density aerodromes (where more than two simultaneous movements can be expected). In the long-term the concept may also be applied for larger airports or small airports with occasionally more traffic density (for example tourist airports/remote airports during a particular event etc.).

The remote provision of ATS for a single aerodrome is defined in such a way that is appropriate and operable for a single aerodrome, but can ultimately be expanded and scaled to apply to more than one aerodrome under the multiple aerodromes concept.

This section, and the sections that follow, describe the key parts of the remote provision of ATS under OI step SDM-0201. Many elements and functions of the ATS provision will be the same when provided remotely as if they had been provided locally and so these may not be repeated in detail in this OSED.

3.2.2 Current Operating Method

[redacted] Principles

In traditional operations, remotely operated TWR / AFIS does not exist. The range of ATS defined in ICAO Documents 4444 [10], 9426 [13] and EUROCONTROL's Manual for AFIS [12] are provided by local ATCOs or AFISOs from local tower building facilities. In some aerodromes, a single ATCO fulfils both TWR and APP services.

The TWR ATCO is responsible for assuring safe operations and provision of air traffic control services for the aerodrome manoeuvring area and the vicinity of the aerodrome. This includes responsibility for clearance delivery, ground control, management of inbound and outbound flow and flight data processing. The AFISO is responsible for the provision of the AFIS.

With a local, physical presence at the aerodrome, the ATCO or AFISO has the ability to perform local physical tasks such as direct runway inspections, checking local weather stations or basic maintenance if required. However at numerous aerodromes the ATCO/AFISO in principal is mandated with the provision of ATS, thus the ATCO/AFISO basically determines the necessity for certain tasks and delegates these to other local officers (such as airport operator, technicians, firefighters etc.). Staffing is usually provided by operators living within a reasonable range of the aerodrome itself.

ICAO Doc. 9426 (Part III) [13] states that an aerodrome control tower is required to fulfil two main operational requirements:

a) the tower must permit the controller to visually survey those portions of the aerodrome and its vicinity over which he exercises control;

b) The tower must be equipped so as to permit the controller rapid and reliable communications with aircraft with which he is concerned.

The requirements within Doc 9426 [13] also state that the controller must be able to distinguish between aircraft and between aircraft and vehicles while they are on the same or different runways and/or taxiways. The most significant factors contributing to adequate visual observation are the siting of the tower and the height of the control tower cab. The optimum tower site will normally be as close as possible to the centre of the manoeuvring part of the aerodrome, provided that at the intended height of the tower structure does not become an obstruction or hazard to flight.

The ATCO or AFISO uses several means and systems to provide the ATS, however a principal information source is the visual “out-the-window” (OTW) view. The OTW view is from a single viewpoint, typically high above the ground from the centre of the aerodrome. Airport sound (e.g. engine noise, birdsong, wind noises) is obtained directly as the control tower is not sound insulated. Other functions/systems that are required for the provision of an ATS include:

- Voice communications systems;
- Flight Plans and ATS message handling ability;
- Manoeuvring of Aerodrome Ground Lighting (AGL), navigation aids, Instrument Landing Systems (ILS), alarms and other airport systems;
- Binoculars and a signal light gun;
- Additional sensors (e.g. radar information) can be used to facilitate surveillance, subject to coverage.

[redacted] Considerations in Low Visibility Conditions

ATC operators shall apply Low Visibility Procedures (LVP) when all or part of the manoeuvring area cannot be visually monitored from the aerodrome tower. During LVP stricter rules are applied regarding the number and position of aircraft and vehicles on the manoeuvring area and the separation to be applied between movements. The appropriate ATS authority is responsible for establishing the procedures that shall be applicable when implementing LVP operations. These are applied during CAT II / III operations and departure operations when the Runway Visual Range (RVR) is less than 550m, e.g. it could be stated in local regulations that implementation of LVP will start at visibility 2000m and will become stricter as RVR decreases, finally allowing only one movement at a time on the manoeuvring area.

LVP guidelines are defined in various documents and regulations such as ICAO Annex 11 [9], Doc 4444 [10] and EUR Doc 13 [11] and mainly concern restrictions on operations, traffic movement and clearances. They include procedures such as:

a) persons and vehicles operating on the manoeuvring area of an aerodrome shall be restricted to the essential minimum and particular regard shall be given to the requirements to protect the Instrument Landing System/Microwave Landing System (ILS/MLS) sensitive area(s) when Category II or Category III precision instrument operations are in progress;

b) ... the minimum separation between vehicles and taxiing aircraft shall be as prescribed by the appropriate ATS authority taking into account the aids available;

The application of procedures such as the above typically results in a reduction in airport capacity and restriction on arrival and departing traffic flows. The movement rate that the aerodrome wishes to sustain is determined according to the aerodrome licence holders in consultation with local ATS staff and fully supported by the LVPs developed.

[redacted] Issues under Current Operating Methods

The focus of the concept is set on reducing the cost of providing ATS without reducing the level of safety. The reason for this primary objective is in response to a need to reduce the cost of ATS provision generally but with a particular focus on less financially secure aerodromes.

In the aviation industry the provision of a transparent cost-regime makes it possible for the customer to see the costs passed on to them. The current costs associated with the provision of ATS are high and need to be reduced, particularly at low to medium density airports. The high costs are then passed onto the customer through increased aerodrome/landing fees, which in turn result in higher airfares and lowers the propensity of customers to remain users of aerodromes. It is necessary to maintain commercial air traffic services at small/medium density airports, as many of these routes act as public service routes for isolated communities. If the ATS costs are not lowered and reasonable business margins cannot be made, many low and medium density airports will find it hard to financially survive without subsidies.

A large proportion of the ATS costs are associated with the building, maintenance and upkeep of the physical ATS facilities and the costs of personnel to provide the ATS.

The maintenance and upkeep of older tower facilities can be inefficient and expensive, aging equipment and infrastructure to maintain. Unique competences are required for maintenance and components can be difficult and expensive to repair when they fail. Construction of a new aerodrome control tower would be very expensive and disruptive to operations and hence is not a viable option for less financially secure aerodromes ATS systems, equipment, specific operating methods and procedures currently vary according to aerodrome. This lack of standardisation has an impact on cost efficiency for Air Navigation Service Providers (ANSPs) and airport operators who own groups of aerodromes. Cost inefficiencies relate to equipment and systems as well as to the training of controllers (methods, equipment and procedures).

The Control Working Position (CWP) provided in many local towers, particularly at smaller less financially stable aerodromes is often deficient in space and in consideration for human performance features/elements that should be incorporated into modern day CWPs and the set-up of required equipment. The variability and subsequent controller training issues (in combination with geographical considerations) mean that many controllers will only be valid / rated for their local aerodrome. This reduces flexibility for ANSPs and increases costs further.

Local facilities sometimes are required to remain open and staffed all day despite perhaps having only a sparse number of scheduled Instrument Flight Rules (IFR) flights. This again contributes to rising costs and efficiencies for the aerodromes, aerodrome operators and ANSPs.

3.2.3 New SESAR Operating Method

[redacted]Principles

The full range of ATS defined in ICAO Documents 4444 [10], 9426 [13] and EUROCONTROL's Manual for AFIS [12] will still be provided remotely by an ATCO (for some aerodromes a single ATCO fulfilling both TWR and APP) or by an AFISO. The airspace users must be provided with the same level of services as if the ATS were provided locally.

The main change to operating methods between the current and proposed concept is that the ATCO or AFISO will no longer provide ATS from a local aerodrome control tower and will not necessarily be located at the aerodrome.

The remote location of the provision of ATS will necessitate a visual representation of the aerodrome to be provided at the remote location. In order to facilitate the visual representation cameras or other sensors will be placed at the local aerodrome in order to provide the remote operators with a view of the aerodrome consistent with regulation. Various sensors will also be required in order to provide the remote operator with all the information they would normal have access to if providing ATS locally under current operating methods.

As detailed in Section 3.1, the visual observation will be provided by a reproduction of the aerodrome OTW view, by using visual information capture via cameras and/or other sensors. The visual reproduction can be overlaid with information from additional sources where available. For example; surface movement radar, surveillance radar, ADS-B, multilateration or other positioning and surveillance implementations providing the positions of moving objects within the airport movement area and vicinity. The collected data, either from a single source or combined, is reproduced for the ATCO/AFISO on data/monitor screens, projectors or similar technical solutions.

The use of technologies to enhance the visual reproduction in all visibility conditions may be introduced in order to maintain the ability to provide an ATS. The exact type and number of AVFs will vary with the requirements of individual ANSPs, airport operators and aerodromes.

Through the use of enhanced technology and digital information a wider range of information will be available and possible to share with other stakeholders, airport users and other ATSs. The concept will also introduce the ability to record visual information this may create enhanced and unique opportunities to support incident/accident investigators when working at aerodromes.

Ideally an integrated and modular technical solution shall be developed to facilitate the concept. Consequently changes to digital information would automatically be forwarded to all relevant areas of the system, making the exchange and use of information more collaborative. Additionally, in the case of a malfunction of a part of the system the specific part may be exchanged and easily embedded into the overall system again, Minimising disruption and making upgrades easier to apply.

It is foreseen that the concept will have minimal or zero negative impact on IFR traffic. However the handling of visual flight rules (VFR) traffic may on the other hand be affected somewhat for the TWR environment. The methods of separating VFR and IFR traffic (in class C airspace typically) may require additional precautions and procedures due to the nature of the visualisation within the proposed solutions. Such precautions may affect the operational methods for separating the traffic and may have some marginal impacts on the capacity for VFR operations. Although the aim is that no aircraft shall be delayed. For the AFIS application and environment the impact on both IFR and VFR traffic is foreseen to be minimal or non-existent compared with traditional operations.

The new concept must aim at enhancing operations already in place and this project should integrate any precautionary measures deemed necessary. While reduction in costs are welcomed in order to secure some level of ATC services in small airports, airspace users of small airports want to see operation and services enhanced. Small airports usually have airspace classes ranging from G to E. Improvement should be expected in particular in unmanaged airspaces (AFIS operation).

The ATCO/AFISO will not have the ability to perform any tasks that are external to the control facility e.g. physical runway inspection. Therefore the role of the ATCO / AFISO as seen under the traditional operations of some ANSPs will change, with the focus being almost solely on pure ATS tasks with secondary non ATS tasks performed by non ATS personnel local to the aerodrome. At other ANSPs this distinction of responsibilities is anyhow already the case.

Although it is not necessary, it will be possible to remove the local control tower as it will no longer be used for the provision of air traffic services. The infrastructure (service, maintenance etc.) that goes along with maintaining such a building will also become dispensable. Instead, a local installation consisting of systems/sensors will be maintained by central maintenance teams. The remote facility will also require maintenance, but it is expected that a more 'traditional' building using common systems and components will lead to a reduction in overall maintenance costs. When replacing exiting infrastructure a more optimal location may be found for the placement of aerodrome cameras, or the existing location used as a basis. If single aerodromes share a remote location with other aerodromes then overall building costs will also reduce as they become shared.

[redacted] Single Remote Tower Module (RTM)

In relation to this OI Step each RTM would be remotely connected to a single aerodrome, with one ATCO/AFISO providing the ATS. The operator would be able to perform all ATS tasks, as normally provided from the local aerodrome tower, from the RTM.

This would be primarily achieved via the visual representation screens included within the RTM. A typical RTM used to provide ATS to a single aerodrome will have its own dedicated set of screens displaying the visual reproduction of the aerodrome. A 360° visual representation of the aerodrome may be provided however this will be dependent on the traffic pattern and requirements of individual aerodromes.

RTMs to be used to provide ATS to single aerodromes may have more than one position for a second operator or supervisor. This will be largely dependent on the traffic levels being experienced.

[redacted] Example Operating Scenarios

The following examples illustrate some operating scenarios based on how ATS may be provided to an aerodrome. In each scenario a single ATCO/AFISO provides ATS to only one aerodrome at a time (as is the operational procedure being assessed under SDM-0201).

The examples are presented with some key summary information, then a table showing how the RTM and ATCO/AFISO may be deployed. Table 14, Table 15 and Table 16 below, show how configuration of the CWP may change as the traffic situation becomes more complex.

[redacted] Example operating scenario 1 – Single Remote Tower Module

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
1	1	1	No	No	No

# Aerodromes with aircraft movements	ATS for Aerodrome	Resource Pool	RTM
	A	ATCO1	RTM1
0	ATCO1	Airport A	Airport A
1	ATCO1	Airport A	Airport A

Table 14 – Example 1 – Single Remote Tower Module

This is the simplest operating scenario where a single remote ATCO/AFISO provides ATS from a dedicated facility to a single aerodrome. A single RTM is configured to provide ATS to a single nominated aerodrome. No other aerodromes are provided with ATS from that RTM. Especially when looking at medium type aerodromes with relatively high traffic numbers and thus low capabilities of the ATCO to concentrate on additional tasks this operating scenario might be applicable throughout long periods of the day.

The RTM may be located anywhere. However, to capitalise on shared infrastructure and economies of scope, the RTM may be located in a Remote Tower Centre (RTC).

[redacted] Example operating scenario 2 – Co-located Single ATS (RTC)

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
2	2	2	No	No	No

# Aerodromes with aircraft movements	ATS for Aerodrome		Resource Pool		RTM	
	A	B	ATCO1	ATCO2	RTM1	RTM2
0	ATCO1	ATCO2	Airport A	Airport B	Airport A	Airport B
1	ATCO1	ATCO2	Airport A	Airport B	Airport A	Airport B
2	ATCO1	ATCO2	Airport A	Airport B	Airport A	Airport B

Table 15 – Example 2 – Co-located Single ATS (RTC)

This configuration is an application of the single tower service, but for two aerodromes and from the same co-located facility (RTC). One RTM and one ATCO is required for each aerodrome and they will be located in the same RTC or an additional RTM could be placed in a local facility. The RTM could be permanently configured to a specific aerodrome.

If a remote facility and a local facility are co-located (e.g. ATS for Aerodrome B is provided from the Tower of Aerodrome A), RTM1 would provide service to the local facility using a direct OTW view (and

therefore no relayed visual reproduction). RTM2 would provide ATS to the Aerodrome B using a visual reproduction.

In this example, because it is an extension of the single tower service, ATS is provided to the aerodromes by a dedicated ATCO/AFISO regardless of the traffic situation. Therefore the staffing levels remain constant regardless of the number of movements at either aerodrome.

In other words one ATCO/AFISO will be in charge for one aerodrome at all times. However just one back-up ATCO/AFISO is needed for both aerodromes instead of one back-up ATCO/AFISO for each aerodrome (subject to the support personnel holding the sufficient licensing).

Already, for this example there are cost efficiency gains since it would be sufficient to operate the two aerodromes with one back-up ATCO/AFISO, as opposed to one back up staff member at each aerodrome, as is the case with today's local operations.

[redacted] Example operating scenario 3 – ATS to Single Aerodromes with Traffic Coordination

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
3	Max 2	Max 2	No	No	Yes

# Aerodromes with aircraft movements	ATS for Aerodrome			Resource Pool		RTM	
	A	B	C	ATCO1	ATCO2	RTM1	RTM2
1	ATCO1			Airport A	Available	Airport A	Spare
1		ATCO1		Airport B	Available	Airport B	Spare
2	ATCO1		ATCO2	Airport A	Airport C	Airport A	Airport C
2	ATCO1	ATCO2		Airport A	Airport B	Airport A	Airport B

Table 16 – Example 3 – ATS to Single Aerodromes with Traffic Coordination

In this example the task of providing ATS service to 3 aerodromes is shared among 2 ATCO/AFISO. The RTM are configurable to any of the aerodromes. When there is traffic at a third aerodrome simultaneously, the aerodrome may still be open but ATS is not provided.

At any given time the ATCO/AFISO can switch from one aerodrome to another. The ATCO/AFISO can therefore provide ATS service to any of the three aerodromes. The use of collaborative planning and/or traffic coordination would increase the ability of a single ATCO/AFISO to provide ATS service to multiple aerodromes in sequence.

Airspace and ATS at a specific aerodrome will normally be established in conjunction with an IFR departure or arrival, allowing the Remote ATCO/AFISO to then *sequentially* handle traffic from/to more than one airport.

ACC will at all times be able to inform pilots about the status of airspace. All relevant information about operating hours will be stated in national AIP/NOTAM etc.

This example could be scaled up to facilitate a large number of aerodromes by implementing an increased number of RTMs and ATCOs/AFISOs since it is still a 1-to-1 relationship.

As with Example 2, cost efficiency gains could be achieved through reduction in back up staff numbers.

Anyhow this operating scenario is primarily useful at aerodromes with relatively low traffic numbers.

3.2.4 Differences between new and previous Operating Methods

The primary high level differences between the RVT concept and traditional operations include:

- Removal of ATCO/AFISO from the local aerodrome control tower;

- Replacement of direct OTW aerodrome view with relayed visual reproductions.

The aim of the RVT concept is to provide the same set of services that are provided from conventional towers, albeit in a more efficient and improved way. In some cases there is also a need to deal with tasks that are not, by definition, requirements included within air traffic services. However these additional tasks that may exist in traditional operations merely as a product of how conventional towers have operated historically. This section addresses the community expectation on the project to identify differences in operating methods between the concept and traditional operations and how these are to be managed under the concept.

[redacted]Visual Observation and ICAO Doc 4444

A profound difference between traditional and remote/virtual tower operations lies in the treatment of visual information. According to ICAO Doc 4444 (Ed 15; 7.1.1.2) [10], the aerodrome controllers

> "*shall keep a continuous watch on all flight operations on and in the vicinity of an aerodrome as well as vehicles and personnel on the manoeuvring area. Watch shall be maintained by visual observation, augmented in low visibility conditions by an ATS surveillance system when available*".

On the one hand the above statement underlines that the foundation of aerodrome control service provision rests on the ability of the controller to see the manoeuvring area including aircraft, vehicles and personnel on it. On the other hand it also implies that visual observation is a sufficient means of observation during normal visibility conditions, i.e. the limitations of human vision are inherently 'built into' the concept, thus in a sense relieving the ATCO of the responsibility for maintaining watch on things that are not visually observable. However, the same ICAO document (Ed 15, 7.12) also defines procedures for low visibility operations that apply "*whenever conditions are such that all or part of the manoeuvring area cannot be visually monitored from the control tower*".

The above statements are of fundamental interest in the application of the remote and virtual tower solutions, since they show that current regulations imply that a component of visual observation must exist, but also that if visibility is impaired, for whatever reason, mitigation by procedure and/or augmentation by ATS surveillance systems is possible. (Note also that the use of ATS surveillance systems is treated in Chapter 8 of ICAO Doc 4444 [10]).

Additionally, ICAO Doc 4444 (Ed 15; 7.1.1.1e) [10] states that one objective of the aerodrome control service is to *"prevent collision(s) between aircraft on the manoeuvring area and obstructions on that area"*. Although not explicitly stated, the use of visual observation is an implicit component in the accomplishment of the objective. Another example of the use of visual information can be found in the prerequisites for reduction of separation minima in the vicinity of aerodromes, where ICAO Doc 4444 (Ed 15; 6.1) states that separation minima "*may be reduced in the vicinity of aerodromes if:*

a) adequate separation can be provided by the aerodrome controller when each aircraft is continuously visible to this controller; or

b) each aircraft is continuously visible to flight crews of the other aircraft concerned and the pilots thereof report that they can maintain their own separation; or

c) in the case of one aircraft following another, the flight crew of the succeeding aircraft reports that the other aircraft is in sight and separation can be maintained."

If the aircraft are not visible to the ATCO, for whatever reason, then the separation might be delegated to the flight crews; or otherwise the reduction in separation minima cannot be obtained. Instead normal separation minima would have to be applied and the means of separating aircraft would be based on applicable procedures or supported by ATS surveillance systems (such as radar). **It is reasonable to assume that the same methods or principles will apply regardless of whether insufficient visibility is caused by meteorological factors or by a visual reproduction that is for some reason degraded. However, in the case of degraded mode operations care must be taken to ensure all actors involved are aware of what each other can see.**

[redacted] Visual Reproduction

In order to fulfil the task of keeping watch by visual observation while not being physically present at the aerodrome, a technical solution is needed that takes the sensor data collected from the aerodrome and its vicinity and transmitted to the RTM and presents it to the ATCO/AFISO in a way that provides him/her with the situational awareness required for conducting the associated services. This technical solution will be termed the *Visual Reproduction*.

For an accurate situational awareness to be achieved, it is important that sensor data of adequate completeness and quality is available. It is equally important that the visual reproduction presents the data in a logical and comprehensible way. This will lead to considerations on continuity, scale orientation and positioning of the presented data that will generate requirements and recommendations for the design of the technical system, see Section 6.

By using visual reproduction technology some benefits can be achieved compared to the standard OTW view. For example sensor data from multiple, sometimes non-optical, sensors (ground based and aircraft based) may be fused, analysed and presented together on the visual reproduction in a way that further enhances situational awareness and thus the capability of the ATCO/AFISO to perform the service. On the other hand the replacement of the OTW view with a visual reproduction might potentially lead to limitations in the way the service can be performed if the quality of the ATCO's perception is changed (typically depth perception and limited possibilities to apply visual separations). However different types of technical aids such as automatic tracking of objects could support the Remote ATCO in his/her judgements, thus compensating for such circumstances.

[redacted] Meteorological Observation

In today's operations in some conventional towers, the ATCO/AFISO performs meteorological observation and reporting tasks. This is not strictly an ATS task and is outside the scope of this project. The assumption throughout is that such tasks will instead have to be performed by automatic means (Automated Weather Observing System (AWOS), Auto-Meteorological Aviation Report (METAR) or similar systems) or by dedicated accredited personnel (where it is noted that any additional staff/equipment will have a cost). The MET data will still be presented and accordingly updated to the ATCO/ AFISO in the RTC.

However, despite operating remotely, it would still be of value for the ATCO/AFISO to be able to observe changing weather situations that are of operational significance (compare with ICAO Annex 11, Chapter 2.20) [10] and also to be able to judge if an automatically generated Meteorological (MET) report seems to be reasonable.

[redacted] Runway Checks

Runway checks and related procedures that are not ATS tasks by definition but happen to require a person to be physically present at the aerodrome will be performed by ground staff and reported to the remote ATCO/AFISO. Today this is already common practice at a large number of aerodromes.

[redacted] Capacity & Capability

Before being approved for operation with any service provider, a system must go through a certification process. In this process, the achieved ATCO/AFISO situational awareness provided by the system will be measured in relation to the requirements imposed by the operational environment. Although the OSED outlines typical environments for both ATC and AFIS, the actual implementation environment could potentially differ from this e.g. in terms of the needed airport capacity. It is therefore assumed that a particular implementation will need to be certified for operations with a particular service provider in a particular operational environment to ensure safety is not compromised.

When different technical implementations become certified and available, the service provider could choose between these in order to find the solution that is best tailored to match the required capability at their aerodrome of interest and its associated cost benefit case. In this process it will be taken into consideration that the actual traffic capacity threshold for a particular system may differ from airport to airport depending on local conditions.

[redacted] Reliability

For any remote tower implementation, there will be a requirement to define reliability and availability of technical equipment such as sensors, transmission and presentation equipment. However it should be noted that such analysis must not focus on technical systems alone, but rather study the functional system of humans, methods and technology together when determining the criticality of events and thus the requirements on reliability of technical equipment, which is only one of the means that can be used to achieve safe operations.

3.3 Remote Provision of Air Traffic Services for Multiple Aerodromes

3.3.1 Scope and Objective

The objective of remote tower control for multiple aerodromes is to provide the ATS defined in ICAO Annex 11 [9], Documents 4444 [10], 9426 [13]and EUROCONTROL's Manual for AFIS [12] for more than one aerodrome, by a single ATCO/AFISO and implemented from a remote location i.e. not from individual control towers local to the individual aerodromes. The full range of ATS should be offered in such a way that the airspace users are not negatively impacted (and possibly benefit) compared to local provision of ATS. The overall ATS will remain classified into either of the two main service subsets of TWR or AFIS.

The remote provision of ATS for multiple aerodromes is expected to be applied to low density aerodromes, where low density is determined as being mostly single operations, rarely exceeding two simultaneous movements. The concept may also be feasible to apply to medium density aerodromes where simultaneous movements at all aerodromes can be expected. It is not expected that the concept be applied to larger aerodromes with multiple simultaneous movements.

3.3.2 Current Operating Method

ATS are not currently provided to multiple aerodromes by a single ATCO/AFISO. Currently a single local ATCO/AFISO provides ATS for a single aerodrome as described in Section 3.2.2.

The baseline for Multiple Remote Towers will be the Single Remote Tower described in section 3.2.

3.3.3 New SESAR Operating Method

[redacted]General

The remote provision of ATS to multiple aerodromes can be operated in a number of ways depending on several factors. The following section lays out the principles of the Multiple Aerodrome Service, where elements or options for each may be chosen for a given RTM or RTC.

The common, general principle is that an RTC will provide ATS for a number of aerodromes. A number of staff resources (ATS personnel) and a number of RTMs will be co-located in the RTC. An RTC may be a separate facility located far from any airport or it may be an additional facility co-located with a local facility at an aerodrome.

[redacted]Multiple Remote Tower Module (RTM)

When providing ATS to multiple aerodromes from an RTM there are certain specific considerations that should be taken, due to the requirement to share or duplicate certain features required for the provision of ATS to more than one aerodrome.

Technical enablers, AVFs, communications, radar displays and other features/function to assist with the provision of ATS shall have varying degrees of integration and sharing between aerodromes. It is thought that many features that cannot be used on more than one aerodrome at a time will be "switchable". This will enable the controller to switch that feature so that it operates which ever aerodrome the controller selects. Other features that are required continuously (such as the strip bay etc.) may require duplication for each aerodrome. Any duplication of equipment/features that occurs in the RTM may be accompanied by distinctive features to allow easy and instant recognition of the aerodrome the feature relates to.

The provision of ATS to more than one aerodrome will be made possible by the provision of visual representations that allow for the constant monitoring of each aerodrome. The screens will display each aerodrome at the same time and continue to do so even when the ATCO is providing ATS to one specific aerodrome (see section 3.3.3.3). It is vitally important that the operator is, at all times,

able to distinguish which aerodrome they are currently operating and which aerodrome any single set of displays or peripherals are linked to.

[redacted] Visual Layouts in the RTM

The screen layout options available within the multiple RTM will enable the provision of ATS to multiple aerodromes simultaneously. The primary methods to achieve this will depend on the number of aerodromes being controlled. It is predicted that the continuous visual monitoring of aircraft shall be provided via a visual representation set up to view aerodromes horizontally (side-by-side) or vertically (up-down). Alternatively the concept of switching the visual reproduction screens between aerodromes will be validated.

Due to usability constraints screens placed vertically (up-down) are not likely to be used when providing ATS to more than two aerodromes at a time. The RTM will not allow for the switching between horizontal and vertical screen views as these screen layouts call for a different technical layout of the screens. Although one RTC could provide RTMs with both horizontal and vertical screen presentations.

The distribution of screens may be switchable and hence fluid, allowing the RTM operator to change the number of screens each aerodrome is displayed on. This will allow the controller to select which aerodrome to have on the larger visual representation (likely to be the aerodrome with active traffic) or to view all aerodromes on an equal screen split. The requirements for screen size and minimum viewable area are to be defined during validation activities.

There may also be the option to completely hide the visual display of an aerodrome (as would be the case if providing ATS using a switch mode of operations).

[redacted] Operating Methods and Roles

It is expected that the controller’s ability to increase the number of aerodromes to which he is providing ATS will depend largely on the number of parallel aircraft (and vehicle) movements as well as the number of movements per time frame (e.g. per hour) at those aerodromes.

In the exemplary illustration shown in Figure 8, the left hand column represents 5 aerodromes, each with only ground vehicle movements and/or overflights. It is expected that a single ATCO/AFISO will be able to provide ATS to a number of these aerodromes in parallel. The right hand column represents the same 5 aerodromes, this time each with a current arriving/departing aircraft movement. It is expected that a single ATCO/AFISO would not be able to provide ATS to all 5 aerodromes in parallel. The same is true once the number of movements per hour exceeds a certain value. This value is of course also dependant on the number of aerodromes the ATCO/AFISO is having responsibility for. As a consequence different solutions would be possible:

1. The traffic is sequenced in such a way that aircraft / vehicles are handled one at a time;
2. Traffic is generally reduced during preplanning;
3. The number of ATCOs/AFISOs is increased;
4. Tasks are outsourced (e.g. ground control is executed by a dedicated additional Controller) in order to provide the ATCO/AFISO load relief.

The concept aims to allow the ATCO/AFISO to provide ATS to multiple aerodromes in parallel in various ways, all allowing for the continuous visual watch of all of the aerodromes being provided with an ATS.

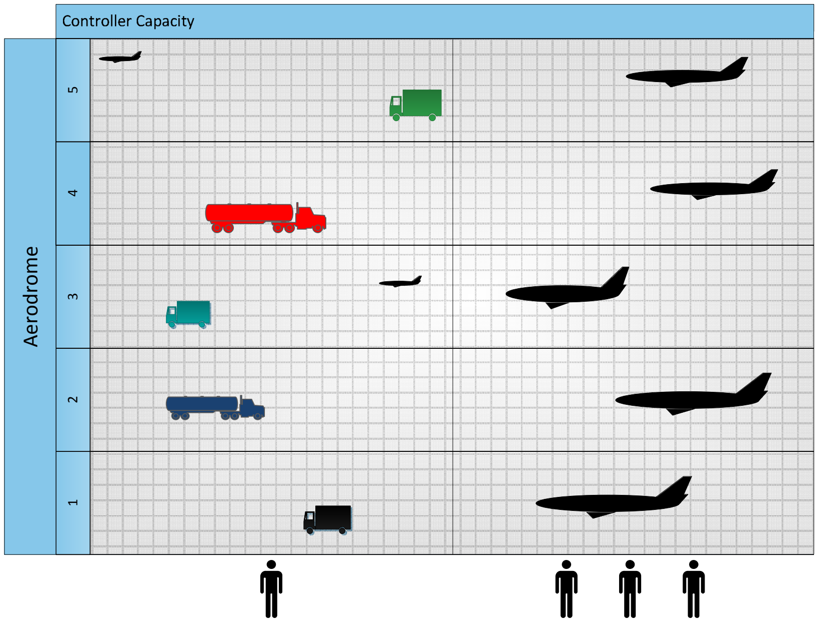


Figure 8 – Controller Capacity

The ATCO/AFISO could provide ATS to multiple aerodromes in one of the following ways, as illustrated in Figure 9(with detailed descriptions provided overleaf):

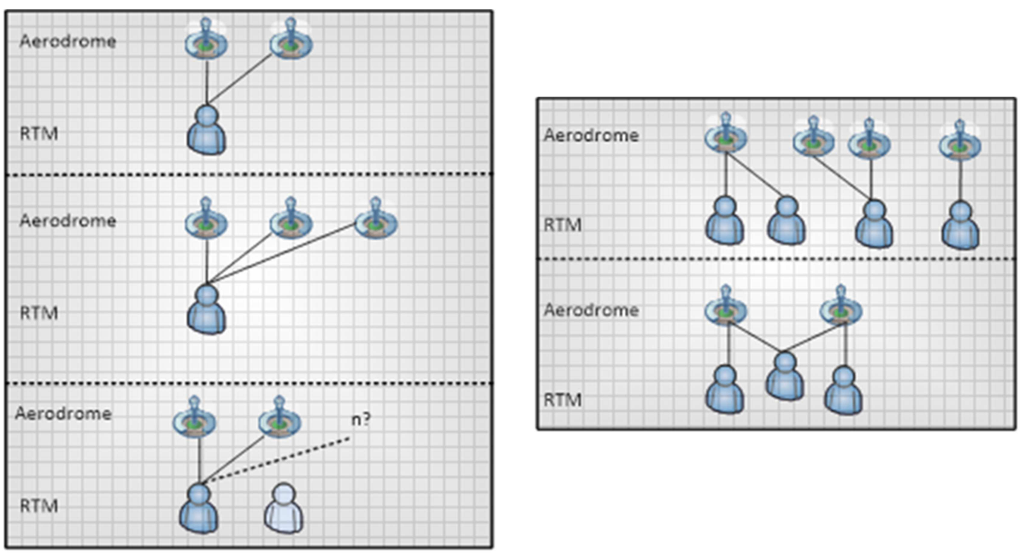


Figure 9 – RTC to aerodrome mapping

Two aerodromes (thus a 1:2 relationship between RTM and aerodrome):

The traffic demand at certain aerodromes might be of such composition that the ATCO/AFISO is restricted to the control of two aerodromes and is capable of managing both aerodromes simultaneously. Thus several movements at both aerodromes might be executed in parallel.

Three aerodromes (thus a 1:3 relationship between RTM and aerodrome):

When there are imminent or current aircraft movements at an aerodrome, the ATCO/AFISO would provide ATS to that aerodrome and require all inputs from the actual aerodrome. This aerodrome would be the primary aerodrome and hence would be displayed on the visual reproduction. The remaining aerodromes would either be visualised on a visual reproduction equal in size to that of the live aerodrome or on a reduced number, on periphery screens.

A supervisor role may be necessary in order to provide additional support due to workload.

Several aerodromes (thus a 1: *n*/many relationship between RTM and aerodrome):

Utilising the same methods of operation as detailed in the 1:3 principle but with additional screens for the additional aerodromes.

Due to the potential for higher traffic numbers there would be the optional to split the RTM so that control is provided in a 2-to-many (2:n) principle and would likely to be provided by a supervisor. This would ease pressure and the requirement to co-ordinate between many aerodromes with potentially overlapping peaks.

Providing a service without the use of a visual representation

An alternative option within an RTM is to provide an advisory service to aerodromes where a visual reproduction may not necessarily be required. This could be used when small aerodromes are experiencing long periods of zero scheduled traffic. [*Note: If no IFR traffic is expected for a longer period of time (1-2 hours or more) ATS could be closed and no CTR/Traffic Information Zone (TIZ) is established. The actual aerodrome could still be open e.g. for VFR traffic.*]

The ATCO/AFISO would listen to the radio frequencies (and any other type of communication means as applicable, such as Controller Pilot Data Link Communications (CPDLC), monitor for upcoming aircraft movements and issue clearances for vehicles to enter the manoeuvring area or to aircraft movements (over flights) within the Terminal Manoeuvring Area/Control Zone (TMA/CTR). This could be done via Radio Telephone (R/T) and surveillance aids.

The primary use cases for the provision of an advisory service with no visual reproduction include:

1) In a 1:*n* set-up, as the redundant screens could be used to give a wider visual of the remaining aerodromes.
2) It would also be used at the wider RTC level to merge RTMs. Quiet aerodromes could hence be merged into existing RTMs at certain periods of the day. The RTM increasing from a 1:3 to a 1:4 relationship RTM.

It is predicted this form of operating would only be used at certain times and would not be the preferred method of operating. It would be more acceptable to use for aerodromes that previously (prior to their introduction to the RTC) only had an advisory service, hence the service downgrade only reflects a return to normal pre RTC operations.

Multiple operators (thus a 2:*n* relationship)

It is likely that a supervisor would be required to provide additional support and/or co-ordination when many aerodromes are being provided with ATS from one RTM (1:3 or 1:n). Supervisors/additional operators may also be required during non-nominal situations or extremely busy periods (although it is forecast that overlapping traffic peaks at aerodromes will not pose a probably as the target aerodromes for the concept are small to medium traffic aerodromes).

Bandboxed/merged operations

In RTCs the supervisor may choose to merge aerodromes in different RTM configurations dependant on traffic and conditions. This may result in an RTM of three aerodromes being reduced to two aerodromes (if experiencing heavy traffic), with a separate RTM taking control of the removed

aerodrome. In certain cases an aerodrome may be removed and placed in a single remote tower set-up.

Multiple small and quiet aerodromes may be band boxed into one RTM during quiet periods, thus a 1:n/many relationship prevails until the traffic situation increases.

Other operating methods:

In addition to the above working principles it may be an option to implement an additional controller for clearance delivery, coordination tasks and approach and/or ground control tasks. Hence instead of cutting down traffic in order to reduce the ATCO/AFISO workload, those tasks are delegated to a discrete controller. In doing so the ATCOs / AFISOs is able to accept all upcoming traffic whilst maintaining the efficient use of staff. For example compositions like 3:4 might be accomplished where two ATCO/AFISO each provide ATS to two aerodromes and the additional controller provides ground related tasks at all four aerodromes.

In order to maintain the overall traffic picture required for the staff/RTM allocation, an RTC supervisor may be deployed and either:

- Be a separate and extra role with overall responsibility for the management of the RTC. The RTC supervisor maintains overall supervision of all aerodromes within the RTC at all times in addition to the ATCO/AFISO providing ATS. This role could be performed from a dedicated RTC supervisor CWP. The RTC supervisor would be expected to perform the planning, administration, staff management and allocation tasks and supervision of technical systems, allowing the ATCO/AFISO to concentrate solely on the provision of ATS. Since this is an “extra” role, it is expected that this type of role would only be required for the larger or more complex RTC. (Technical issues may have to be resolved by designated engineers and technicians responsible for the calibration, maintenance and flight testing employed by ANSPs such as Air Traffic Electronic Personnel (ATSEP);
- Perform the role in combination with the duties of a regular ATCO/AFISO and therefore not be a separate role.

[redacted] Controller Tool Support

In addition to the controller tool support introduced in chapter 3.1.1, supplementary support tools may be introduced in the context of Multiple Remote Tower Operations (RTO). However the controller support tools presented in the context of Single RTO may of course be applicable for Multiple RTO as well. Examples for controller support tools in the context of Multiple RTO are:

- Integrated flight data processing systems FDPS

  The configuration of the ATCO/AFISO working desk could consist of consolidating the flight data information of all relevant aerodromes into one FDPS. Thus all flight strips are merged into one system and for example distinguished through colour coding.

- Indication from which aerodrome a radio transmission is received

  On the CWP (e.g. visual reproduction screen) an indication could be made highlighting where a radio transmission is coming from. Thus the ATCO/AFISO may easily bring together a station calling and its origin – situational awareness may be increased.

[redacted] Air Traffic Management

Scheduled IFR traffic is planned well in advance. Other IFR operations are also obliged to follow the flight planning procedures, which means they are normally predicted at least a few hours in advance. VFR traffic can operate on a flight plan and also without one, which can create much less advanced warning to ATS prior to its appearance. VFR traffic may file IFR in flight due to bad weather and become an IFR flight on short notice.

To provide the most optimal balance between ATS staff required and daily traffic demand while providing ATS to multiple aerodromes, traffic coordination might be necessary. Coordination may have to be done between aerodrome owners and the ANSP, to ensure that planned scheduled IFR-

traffic at the involved aerodromes are not all scheduled at the same time. For scheduled flights this could be done when time tables are being approved. For non-scheduled IFR flights arrival/departure times could be granted or a slot time could be set on a daily "tactical" basis by the RTC supervisor in the RTC. The same procedures could take place in the case of revised arrival/departure times (most common cause of delays).

As an interim level of traffic coordination, the existing Prior Permission Required (PPR) function could be utilised for flights which are not scheduled. PPR (e.g. on 30 minutes' notice to the aerodrome) can prevent ATS receiving sudden traffic or service requests. As the case may be ANSPs might want to provide Transponder Mandatory Zones (TMZ) in order to allow enhanced classification of traffic. This especially applies to aerodromes with high amount of traffic or to aerodromes with a lot of additional noise (e.g. neighbouring CTR, frequent overflights etc.).

Even with PPR and/or traffic coordination it may not be possible to predict totally accurate times for actual aircraft arrival and departures. Instead they are more likely to be used to give higher level estimates of predicted activity at an aerodrome within a certain timeframe e.g. within the next 30 to 60 minutes. This should be sufficient to allow medium term (resource allocation, staffing) and short term ("tactical") planning within the RTC. In case of an aircraft declaring emergency, it will be given priority and if necessary other aircraft will have to be delayed or diverted.

In instances where PPR, traffic allocation and coordination do not allow full prior warning of aircraft movements, or where they are not used at all, service could still be provided to multiple aerodromes by a single ATCO/AFISO. This may lead to occasions when the RTC reaches "capacity" and cannot accommodate any more movements or unexpected requests. Aircraft who have not sought PPR or who have not been coordinated and who still wish to arrive/depart during such times may be instructed to hold in the air or on the ground until they can be accommodated by the RTC.

[redacted] Approach Control

At some aerodromes APP service is provided by the Tower controller. In this case APP service can be provided for one or more aerodromes. The allocation of APP service to CWP would depend on workload and the possibility to use ATS surveillance equipment. APP service could be provided from a common/shared CWP or it may be provided from a dedicated ATS Surveillance CWP used for APP service only, using different equipment and simplified set up compared to the Tower ATC/AFIS CWP. Some examples of configurations are shown below:

A. At low traffic load, the Remote ATCO can provide combined TWR and APP for more than one airport simultaneously.

B. In this configuration the APP and TWR roles are split. One Remote ATCO performs the APP role for two or more aerodromes whilst another Remote TWR ATCO provides ATS to two or more aerodromes.

C. This configuration is similar to Configuration B (above) except that APP for the aerodromes is performed from a separate ATS surveillance CWP, dedicated for APP only. Remote TWR for both aerodromes is provided from another CWP.

D. In this example configuration the ATS for the aerodromes is performed on a one-to-one basis, with a separate TWR ATCO for each aerodrome provided from separate CWP. The APP role is combined, with APP for both aerodromes performed from an ATS surveillance CWP, dedicated for APP only.

Example	RTM 1	RTM 2	Dedicated APP Surveillance CWP
A	APP/TWR Airport A & B	x	x
B	TWR Airport A & B	APP Airport A & B	x

C	TWR Airport A & B	x	APP Airport A & B
D	TWR Airport A	TWR Airport B	APP Airport A & B

Table 17 – Approach Control Configurations

3.3.4 Example Operating Scenarios

The following examples illustrate some operating scenarios based on how an RTC might operate according to some of the principles above. Three main types of scenarios are presented:

- ATS to two aerodromes (1-to-Two);
- ATS to single aerodromes in conjunction with ATS to multiple aerodromes (1-to1 in combination with 1-to-Many);
- ATS to multiple aerodromes (1-to-Many).

The examples in sections 3.3.4.1.1 to 3.3.4.3.2 are presented with some key summary information first, then tables showing how the RTM and ATCO/AFISO would be deployed across two or more aerodromes. The tables (Table 18 to Table 22) show how the configuration may change as the traffic situation becomes more complex.

[redacted] ATS to Multiple Aerodromes (1-to-Two)

[redacted] Example 1 - 1-to-2; No RTC supervisor

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
2	1	1	Yes	No	Optional

	ATS for Aerodrome		Resource Pool	RTM
# Aerodromes with aircraft movements	A	B	ATCO 1	RTM 1
0	ATCO1		Airport A, B	Airport A, B
1	ATCO1		Airport A, B	Airport A, B
2	ATCO1		Airport A, B	Airport A, B

Table 18 – Example 1 - 1-to-2; No RTC supervisor

In this example, the ATCO / AFISO provides ATS to both aerodromes at the same time. There is not necessarily a second controller on standby available.

Consequently several movements (eventually at both aerodromes concurrently) might be controlled at the same time. When there are movements at airport A, the ATCO may be required to view the airport with movements on a primary (enlarged) screen. The ATCO may be required to quickly switch between the two airports on the primary screen. The secondary screen will still enable the ATCO to maintain a constant visual watch on airport B. Alternatively a solution where the visual representation of both airports is continuously available in 'full size' may be implemented, reducing operator workload for switching the aerodrome views.

In order for the ATCO / AFISO to properly provide ATS at both aerodromes it is essential that all relevant FPL data is provided simultaneously, possibly within one single FDPS. Furthermore it has to be assured that the ATCO / AFISO is supplied with the present situation at both aerodromes at all times (i.e. visual reproduction, FDPS information, actual weather information etc.) in order to be able to react on all events.

The frequencies of the aerodromes used for communication with the pilots need to be merged to one frequency. Traffic at both airports needs to be coordinated in order to avoid excessive traffic peaks. In case demand becomes too high, the ATCO therefore might also delay traffic in order to ensure safe operations.

[redacted] ATS to single aerodromes in conjunction with ATS to multiple aerodromes

[redacted] Example 2 – 1-to-1 in conjunction with 1-to-Many; No RTC supervisor

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
4	1 to 4	1 to 4	Yes	No	No

	ATS for Aerodrome			
# Aerodromes with aircraft movements	**A**	**B**	**C**	**D**
0	ATCO1			
1	ATCO1	ATCO2		
2	ATCO1	ATCO2	ATCO3	
3	ATCO1	ATCO2	ATCO3	ATCO4
4	ATCO1	ATCO2	ATCO3	ATCO4

	Resource Pool			
# Aerodromes with aircraft movements	**ATCO1**	**ATCO2**	**ATCO3**	**ATCO4**
0	Airport A, B, C, D	Available	Not on shift	Not on shift
1	Airport A	Airport B, C, D	Available	Not on shift
2	Airport A	Airport B	Airport C, D	Available
3	Airport A	Airport B	Airport C	Airport D
4	Airport A	Airport B	Airport C	Airport D

	RTM			
# Aerodromes with aircraft movements	**RTM1**	**RTM2**	**RTM3**	**RTM4**
0	Airport A, B, C, D	Spare	Spare	Spare
1	Airport A	Airport B, C, D	Spare	Spare
2	Airport A	Airport B	Airport C, D	Spare
3	Airport A	Airport B	Airport C	Airport D
4	Airport A	Airport B	Airport C	Airport D

Table 19 – Example 2 – 1-to-1 in conjunction with 1-to-Many; No RTC supervisor

In this example, ATS is provided to four aerodromes on a flexible basis, using a minimum of one ATCO / AFISO from a minimum of one RTM.

The key element of this example is that an ATCO can provide ATS to more than one aerodrome in parallel.

The planned shift starts with two ATCO / AFISO and more staff will then attend (and subsequently leave), according to the staff schedule.

When there are no aircraft movements at any of the aerodromes ATCO1 provides ATS to all four aerodromes from RTM1. When they are made aware of an upcoming aircraft movement at the first aerodrome (either by frequency, coordination, schedule, flight plan or PPR) they will call for ATCO2, who was on standby at the RTC, to provide ATS to Aerodromes B, C and D. ATCO1 will then provide ATS only to Aerodrome 1 (ATS to a single aerodrome). ATCO3 will come onto shift at (or be called into) the RTC.

When ATCO2 is providing ATS on RTM2, if the second aerodrome has an aircraft movement, ATCO2 will decide to call for ATCO3 to provide ATS to Aerodrome C and D, while ATCO2 focuses on Aerodrome B (providing ATS to a single aerodrome).

Using this method, the ATCO/AFISO will always have had a period of time providing ATS to multiple aerodromes in low (or zero) traffic before providing ATS when there are aircraft movements, meaning they will have built up some sort of traffic picture already. All aerodromes have ATS provided and airspace established at all times. When 3 aerodromes have arriving/departing traffic movements and a 4th ATCO/AFISO is required, ATCO4 provide ATS for Aerodrome D even if it has no current aircraft movements. Since each ATCO is providing ATS for one aerodrome, this scenario would fall under ATS to a single aerodrome (not multiple).

For VFR unplanned traffic requests, a short delay may be necessary in order for the single ATCO/AFISO to brief the ATCO/AFISO taking over, ensuring that he/she is completely aware of the traffic situation.

[redacted] Example 3 – 1-to-1 in conjunction with 1-to-Many; RTC supervisor

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
4	1 to 5	1 to 5	Yes	Yes	No

# Aerodromes with aircraft movements	ATS for Aerodrome			
	A	**B**	**C**	**D**
0	RTC supervisor (ATCO1)			
1	ATCO2	RTC supervisor (ATCO1)		
2	ATCO2	ATCO3	RTC supervisor (ATCO1)	
3	ATCO2	ATCO3	ATCO4	RTC supervisor (ATCO1)
4	ATCO2	ATCO3	ATCO4	ATCO5

# Aerodromes with aircraft movements	Resource Pool				
	ATCO1	**ATCO2**	**ATCO3**	**ATCO4**	**ATCO5**
0	Airport A, B, C, D	Available	Not on shift	Not on shift	Not on shift
1	Airport B, C, D	Airport A	Available	Not on shift	Not on shift
2	Airport C, D	Airport A	Airport B	Available	Not on shift
3	Airport D	Airport A	Airport B	Airport C	Available
4	Available	Airport A	Airport B	Airport C	Airport D

# Aerodromes with aircraft movements	RTM				
	RTM1	**RTM2**	**RTM3**	**RTM4**	**RTM5**
0	Airport A, B, C, D	Spare	Spare	Spare	Spare
1	Airport B, C, D	Airport A	Spare	Spare	Spare

2	Airport C, D	Airport A	Airport B	Spare	Spare
3	Airport D	Airport A	Airport B	Airport C	Spare
4	Spare	Airport A	Airport B	Airport C	Airport D

Table 20 – Example 3 – 1-to-1 in conjunction with 1-to-Many; RTC supervisor

This example is an extension of Example 2, with the main difference being the introduction of an RTC supervisor who is acting in the combined RTC supervisor-ATCO/AFISO role. The role of the RTC supervisor here is to provide ATS to the 4 aerodromes when there are no aircraft movements and coordinate the deployment of the other ATCOs/AFISOs when dedicated ATS is required. The RTC supervisor can be a dedicated role or an ATCO/AFISO as ATCO1 in this example.

When there are no aircraft movements at any of the aerodromes the RTC supervisor (ATCO1) is the only member of staff required and provides ATS to all 4 aerodromes from RTM1. When made aware of an upcoming aircraft movement at the first aerodrome (either by frequency, coordination, schedule, flight plan or PPR) they will bring in ATCO2 to provide dedicated (single) ATS for that aerodrome. ATCO1 will continue to provide ATS to the other 3 aerodromes.

When the RTC supervisor is made aware of an upcoming movement at the second aerodrome they will bring in ATCO3, to provide dedicated ATS for that aerodrome on RTM3 and so on.

When there are 4 aerodromes with aircraft movements with ATS provided by 4 ATCOs and the RTC supervisor then this scenario would fall under ATS for single aerodromes.

[redacted] ATS to multiple aerodromes (1-to-Many)

[redacted] Example 4 – 1-to-Many; No RTC supervisor

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
4	1 to 3	1 to 3	Yes	No	No

# Aerodromes with aircraft movements	ATS for Aerodrome			
	A	**B**	**C**	**D**
0	ATCO1			
1	ATCO1			
2	ATCO1	ATCO2	ATCO1	
3	ATCO1	ATCO2		ATCO1
4	ATCO1	ATCO2		ATCO3

# Aerodromes with aircraft movements	Resource Pool		
	ATCO1	**ATCO2**	**ATCO3**
0	Airport A, B, C, D	Available	Not on shift
1	Airport A, B, C, D	Available	Not on shift
2	Airport A, C, D	Airport B	Available
3	Airport A, D	Airport B, C	Available
4	Airport A	Airport B, C	Airport D

# Aerodromes with aircraft movements	RTM		
	RTM 1	RTM 2	RTM 3
0	Airport A, B, C, D	Spare	Spare
1	Airport A, B, C, D	Spare	Spare
2	Airport A, C, D	Airport B	Spare
3	Airport A, D	Airport B, C	Spare
4	Airport A	Airport B, C	Airport D

Table 21 – Example 4 – 1-to-Many; No RTC supervisor

In this example, the ATCO/AFISO can continue to provide ATS to aerodromes with no movements while also providing ATS to an aerodrome(s) with traffic movements. This combination of service provision extends the period when only 1 ATCO/AFISO is needed.

When there are no movements, ATCO1 provides ATS to all 4 aerodromes on RTM1. When they are made aware of an upcoming aircraft movement at Aerodrome A, they will provide ATS to the aircraft at Aerodrome A, while also providing ATS for Aerodromes B, C and D. They will set RTM1 to show the visual reproduction of Aerodrome A. As visual reproduction is not a requirement when there are no aircraft movements, they can continue to provide ATS to Aerodromes B, C and D whilst showing the visual reproduction of only Aerodrome A.

When ATCO1 is made aware of an upcoming aircraft movement at the second aerodrome, he/she will decide if they can provide ATS to that aerodrome/aircraft in parallel with the other aerodromes. If they cannot, they will bring in ATCO2 to provide ATS to Aerodrome B. ATCO2 will provide ATS from RTM2 (ATS to a single aerodrome). ATCO1 will continue to provide ATS for Aerodrome A, C and D on RTM1.

When ATCO1 is made aware of an upcoming aircraft movement at the third aerodrome, they can ask ATCO2 to provide ATS to Aerodrome C in parallel with their ATS to Aerodrome B on RTM2. ATCO1 will continue to provide ATS for Aerodrome A and Aerodrome D on RTM1.

Finally, when ATCO1 is made aware of an upcoming aircraft movement at aerodrome D, they will bring in ATCO3 to provide ATS for Aerodrome D since, in this example, ATCO1 is not able to provide ATS to both Aerodrome A and Aerodrome D in parallel when both have current aircraft movements. ATCO3 will provide ATS from RTM3. ATCO1 is now only providing ATS to Aerodrome A. (ATCO1 and ATCO3 would be providing ATS to a single aerodrome whilst ATCO2 would be providing ATS to multiple aerodromes).

[redacted] Example 5 - 1-to-Many; RTC supervisor

Aerodromes	RTM required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
4	1 to 4	1 to 3	Yes	Yes	No

# Aerodromes with aircraft movements	ATS for Aerodrome			
	A	B	C	D
0	RTC supervisor			
	ATCO1			
1	RTC supervisor			
	ATCO1	ATCO2		
2	RTC supervisor			
	ATCO1		ATCO2	
3	RTC supervisor			
	ATCO1		ATCO2	
4	RTC supervisor			

	ATCO1	ATCO2	ATCO3

	Resource Pool			
# Aerodromes with aircraft movements	RTC supervisor	ATCO1	ATCO2	ATCO3
0	RTC supervisor	Airport A, B, C, D	Available	Not on shift
1	RTC supervisor	Airport A	Airport B, C, D	Available
2	RTC supervisor	Airport A, B	Airport C, D	Available
3	RTC supervisor	Airport A, B	Airport C, D	Available
4	RTC supervisor	Airport A, B	Airport C	Airport D

	RTM			
# Aerodromes with aircraft movements	RTC supervisor RTM/CWP	RTM1	RTM2	RTM3
0	All Airports	Airport A, B, C, D	Spare	Spare
1	All Airports	Airport A	Airport B, C, D	Spare
2	All Airports	Airport A, B	Airport C, D	Spare
3	All Airports	Airport A, B	Airport C, D	Spare
4	All Airports	Airport A, B	Airport C	Airport D

Table 22 – Example 5 - 1-to-Many; RTC supervisor

In this example the ATCO/AFISO are permitted to provide ATS to more than one aerodrome in parallel.

An RTC supervisor maintains responsibility for staff management and RTM allocation for all 4 aerodromes at all times. In this example, the RTC supervisor is a dedicated role and does not take on any ATS provision tasks. Using this method, there is always one person with overall continuous awareness of all aerodromes and with sole responsibility for staff deployment. Additionally, the ATCO/AFISO does not have to perform any staff coordination tasks in addition to their ATS provision tasks.

ATCO1 initially provides ATS to all 4 aerodromes from RTM1. When the RTC supervisor and/or ATCO1 are made aware of an upcoming movement at Aerodrome A, the RTC supervisor brings in ATCO2 on RTM2 to provide ATS for Aerodromes B, C and D while ATCO1 provides dedicated ATS for Aerodrome A (ATS to a single aerodrome).

When the RTC supervisor and/or ATCO2 are made aware of an upcoming aircraft movement at Aerodrome B, the RTC supervisor will check with ATCO1 to ensure they are able provide ATS to Aerodrome B in parallel with Aerodrome A. If ATCO1 confirms this, they will then provide service to Aerodrome B, also on RTM1. The RTM must be able to display a visual reproduction for both aerodrome A and B simultaneously.

The RTM must be designed in such a way as to avoid any mistakes such as mixing up the aerodromes and equipment controls (e.g. runway lighting and radio transmitters/ receivers). Since the RTM will have to be configured for Aerodrome B whilst being used for Aerodrome A, it is critical that the configuration is not disruptive and can be done quickly.

When the RTC supervisor and/or ATCO2 are made aware of an upcoming aircraft movement at Aerodrome C, the RTC supervisor will instruct ATCO2 to maintain ATS provision for Aerodrome C on RTM2 since (in this example) ATCO1 cannot provide ATS to more than 2 aerodromes with movements in parallel. Meanwhile the RTC supervisor will bring in ATCO3 to provide ATS for Aerodrome D on RTM3 (ATS to a single aerodrome).

When the RTC supervisor and/or ATCO3 are made aware of an upcoming aircraft movement at Aerodrome D, ATCO3 will continue to provide ATS to Aerodrome D (ATS to a single aerodrome).

[redacted] Example 6 – Flexible role application

The final example describes the flexible application of roles. Thus additional roles may be introduced during overload situations in order to distribute workload and to assure reasonable load share. Instead of activating an extra ATCO/AFISO working position, hence it might be more appropriate to introduce new roles, not exclusively providing core ATC services but rather being in charge of legwork like coordination with other sectors, ground movements, clearance delivery, special request etc.

An exemplary position could be the Ground ATCO which is deployed in situations where the primary ATCO needs load reduction. In such case the primary ATCO/AFISO may just concentrate on airborne traffic (incl. traffic on the RWY) while all remaining traffic and duties are outsourced to the discrete Ground ATCO

For this purpose an RTM is provided from which the Ground ATCO/AFISO will be provided with all relevant information. He may not need a panorama view, he might just need a surface radar and all relevant flight plan data.

Such a Ground ATCO may particularly be introduced at aerodromes with high traffic load where the ATCO/AFISO is responsible for a lot of movements. As the case may be the Ground ATCO is capable of providing his duties to several aerodromes wherefore he might relieve ATCOs / AFISOs responsible for other aerodromes as well. Consequently this procedure does not contradict to the idea of ATCOs / AFISOs still providing ATS to multiple aerodromes. Accordingly, looking at the exemplary table below a Ground ATCO will take over responsibility for certain tasks at all four aerodromes. For the core ATC services at aerodrome A and B one ATCO each will be in charge and as aerodrome C and D might consist of fewer movement numbers ATCO 3 will take care of the ATC service provision at these two aerodromes together.

Aerodromes	CWP required	ATCO/AFISO required	ATS provided to aerodromes in parallel	RTC supervisor	Traffic Coordination
4	4	4	Yes	No	No

	ATS for Aerodrome			
# Aerodromes with aircraft movements	A	B	C	D
4	GND ATCO			
4	ATCO1	ATCO2	ATCO3	

	Resource Pool			
# Aerodromes with aircraft movements	GND ATCO	ATCO1	ATCO2	ATCO3
4	Airport A, B, C, D	Airport A	Airport B	Airport C, D

	RTM			
# Aerodromes with aircraft movements	CWP/RTM1	RTM2	RTM3	RTM4
4	Airport A, B, C, D	Airport A	Airport B	Airport C, D

Table 23 – Example 6 – Flexible role application

[redacted] Deployment and Transition

ANSP can decide to begin with 1-to-1 methods either for reasons of cost, complexity, need, safety or regulations.

If, over time, the concept proves to be successful, the complexity can be increased towards the "full" 1-to-Many or 1-to-Two operating method. The ANSP can stop at any point along the deployment path depending on time and need etc.

3.3.5 Differences between new and previous operating method

The difference between the new and previous operating method, in addition to the differences already described for Single Tower, is mainly concerned with the ATCOs / AFISOs ability to provide ATS to more than one aerodrome in parallel. In traditional operations this is not possible.

3.4 Remote Provision of Air Traffic Services for in Contingency Situations at Aerodromes

3.4.1 Introduction

[redacted] Contingency Definition

Contingency plans are "*developed and implemented in the event of a disruption or potential disruption, of air traffic services and relating supporting services in the airspace for which they are responsible for the provision of such services*" [9]. Contingency plans are intended to provide alternate facilities and services to "local procedures" when those facilities/services are not available. Therefore they are temporary in nature.

Contingency events can be broken down into:

- **Planned** events such as planned maintenance/outage in the Control Tower;
- **Unplanned** events which would tend to be emergency situations. These unplanned events can be sudden (where there is little/no warning e.g. a fire alarm or bomb threat) or they could be events where staff are alerted beforehand and therefore have time to do some preliminary planning e.g. setting up the contingency facility ready for the switch-over of ATS. Unplanned events can also be further broken down into frequency that an event occurs and scope of event.

[redacted] Objective of Contingency

The objective of ATS during contingency events is to provide the ATS defined in ICAO Documents 4444 [10] and 9426[13] for one aerodrome from a remote location i.e. not from a Control Tower local to the aerodrome.

Contingency plans fall under the jurisdiction of the aerodrome emergency plan, which in turn is a standards and recommended practice for aerodromes under ICAO Annex 11, Chapter 9. "***An aerodrome emergency plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome".[9]***

"Aerodrome emergency planning is the process of preparing an aerodrome to cope with an emergency occurring at the aerodrome or in its vicinity. The objective of aerodrome emergency planning is to minimize the effects of an emergency, particularly in respect of saving lives and maintaining aircraft operations".[9]

The contingency operations should address safety, security, continuity and adaptability. The target level of safety and security for contingency measures must be the same as for local operations. Continuity is also an important factor when transferring ATS from the local Tower to the contingency facility to ensure as little service disruption as possible. The contingency method should also be adaptable, so that it can easily be adopted in a range of different events and situations.

Whilst the driving factors behind contingency planning for "emergency/degraded modes of operations" are safety, security, continuity and adaptability. The driver behind Contingency Plans for Service Continuity is economics, minimising the losses and costs that would occur in the event of a major outage if no mitigating measures would have been adopted. Minimising economic losses includes losses of revenues, for example airport taxes and charges, operating costs such as staff and compensation, reduced losses for the customers of airspace users and reduced costs for the local, regional or European economy.

The Remote Provision of ATS for a Single Aerodrome during contingency is defined in such a way that is appropriate and operable for a single aerodrome, but can ultimately be expanded and scaled to apply to more than one aerodrome.

Remotely provided ATS during contingency can include visual reproduction and/or other equipment/technology such as A-SMGCS. For the scope of this project, when referring to remotely provided ATS, the focus is including visual reproduction. The A-SMGCS only solution already exists,

with a lower operational flexibility and sometimes also lower capacity. Some aerodromes may want to keep their current A-SMGCS only solution if the circumstances when contingency is needed are rare and short term. These aerodromes may accept a lower operational flexibility and capacity if it is cost effective. With the visual reproduction, the aim is to achieve a flexibility that is as close as possible to normal operations and maintain a capacity which is as close as possible to 100% with the help of technical equipment. Cameras (or other visual reproduction technology) aim to enable a better operational flexibility, a higher capacity, improve safety and provide a low cost solution.

In this document, the Contingency *Lifecycle* (Figure 10 overleaf) as defined in the "EUROCONTROL Guidelines for Contingency Services" [15]will be referred to. Actions and procedures will be described from the outage until recovery to normal local operations. The lifecycle for both planned and unplanned is very similar; however unplanned events would have a more server impact on operations and ability to establish contingency operations. This OSED will therefore mainly consider unplanned contingency situations. The Contingency lifecycle below is adapted from the "EUROCONTROL Guidelines for Contingency Services" [15] and shows the phases referred to as "transition into and out of contingency".

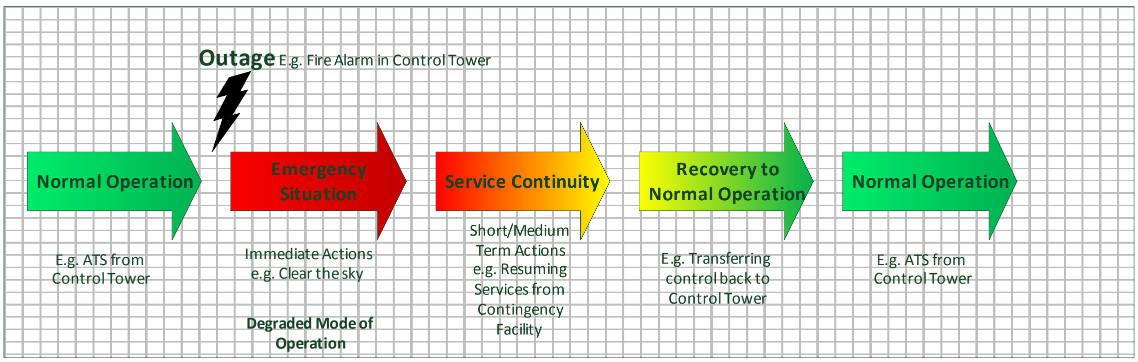


Figure 10 – Contingency Lifecycle

The Contingency Process defined in the "EUROCONTROL Guidelines for Contingency Services" will be considered throughout this document but not addressed specifically.

The exact type of contingency solution that an aerodrome can implement based on Remote Provision of ATS will depend on a number of factors and is subject to constraints such as safety levels and capacity targets. The effectiveness of the RCT solution as proposed by this project will be highly dependent on external factors. These factors include the type and speed of outage, any capacity constraints brought about due to technical setup or ATCO proficiency in using the RCT and other mandatory safety or procedural constraints.

[redacted] Required Performance

[redacted] Safety

When describing the use of Remote Tower for Contingency Situations, safety of ATS provision is the number one factor to be considered. It is recognised that during contingency situations safety levels could fluctuate according to the circumstances or events. However, it is vital that safety levels during contingency situations are always acceptable and that operations personnel are able to identify any points where the level of safety becomes unacceptable. Short term "closures" of airspace or an aerodrome may also be necessary in emergency and degraded mode situations in order to ensure safety and cope with the immediate effects of a developing situation.

[redacted] Cost Effectiveness

Important considerations for the contingency solution as described in this document are desired capacity during contingency situations and the cost of the required solution. Smaller aerodromes are

unlikely to make a large investment in a contingency facility if it is more cost effective in the long term to simply close the airport and/or divert the traffic involved to a neighbouring aerodrome.

The hypothesis in this document is that the greater the investment into the contingency plan and contingency facility (equipment, staffing etc.) the higher the contingency capacity of the airport as illustrated in Figure 11 (overleaf). This is due to the increased technical capability that may be added to the RCT with additional funding. Added expenditure would importantly allow for additional ATCO training, which would ultimately would increase ATCO familiarity with the RCT and improve the level of service that could be provided from an RCT.It is expected that the cost per % of capacity will increase as the target tends towards 100% of local service capacity. The cost of enabling the ability to provide the final few percentage of capacity may be high and the return on investment in terms of cost versus capacity will tails off.

In many/most cases the cost to achieve 100% of capacity compared to local provision of ATS is too high. There is then likely to be an optimum contingency level of service which balances the capacity at the aerodrome against the cost outlay required for the contingency facility. This will be the most cost effective point and would vary at each airport depending on a range of factors such as size and facilities available.

In terms of remote provision of ATS, for busy airports, this is also the reason why a contingency facility would be unlikely to permanently replace the local facility at a busy airport.

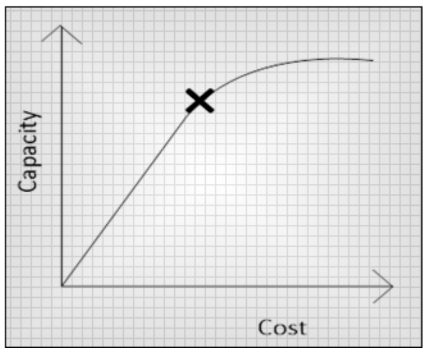


Figure 11 – Cost Effectiveness of Contingency Operations

3.4.2 Current Operating Method

[redacted] Principles

Currently, there are many different contingency options when a Tower has to be evacuated.

Many aerodromes (mainly smaller aerodromes) find contingency facilities or secondary Tower facilities not cost effective. In emergency situations the traffic is initially instructed to hold at nearby waypoints and then transferred to the neighbouring aerodrome approach control. In fact this is the default and valid, contingency measure for the majority of airports worldwide.

There are also existing contingency solutions that permit the continued provision of ATS. At some aerodromes, this takes the form of a secondary local tower/control room that can be used in case of an emergency. It is normally located on the aerodrome, often in an old Tower or other building and the view for the controller is often impaired leading to increased spacing. Other airports use operations buildings where they have a dedicated workstation.

At very large aerodromes where continued air traffic services are imperative, some have a “virtual” contingency facility which replicates many of the operational and technical systems present in the local Tower. During the transfer from the Tower to the contingency facility the air traffic movement rate is reduced and there is a transferal time of approximately 25-30 minutes until the contingency facility is operational. When the contingency facility is operational the landing rate is normally decreased[1]

[1] A well known example of this type of facility is at London Heathrow, where lack of OTW view leads to a 70% capacity restriction.

(depending on airport local procedures, for some A-SMGCS equipped airports full capacity may still be possible) since these virtual facilities have no OTW view.

[redacted] Issues under Current Operating Methods

There are many limitations of the current contingency plans.

When the contingency measure is too close to the aerodrome and air traffic has to divert to a nearby aerodrome the greatest problems arise. The most important problem is the degraded safety level when a high number of aircraft (many low on fuel) have to divert to secondary aerodromes or other large airports that are usually experiencing their own capacity problems. The chance of an emergency situation is increased. Aircraft are then displaced from their intended destination and this causes problems for the arriving passengers who have to be transported to the original aerodrome. The airlines have an aircraft out of place, affecting not only the departing passengers who were meant to board the aircraft after turnaround, but this also has a knock-on effect for the airlines route network. Crew shifts and location can also be affected due to the extra time taken to locate from one aerodrome to the next. It can take several hours or even days to re-align the aircraft locations with the schedule. As a result delays during that period can be high with more cancellations than usual. In extreme circumstances the aerodrome may decide to close completely leading to lost revenue and further inconvenience for passengers.

When using a secondary visual control facility, there is often little or no view of the runway. Secondary visual control facilities also may not have the full equipment package which is found in the Tower. Capacity is therefore reduced leading to increases in delay.

When using a virtual contingency facility, there is no OTW view and only radar, communications and A-SMGCS (if available) are used. Without an OTW view the aerodrome may need to use procedures similar to those used in low visibility operations, meaning that restrictions have to be put in place, spacing has to be increased, capacity decreases and again delays increase.

Another issue is the fact that during the switch of ATS from the Tower to the contingency facility, operations temporarily stop. No landings or take-offs are permitted and any traffic that was on final approach is broken off and held tactically or diverted to their alternate aerodrome.

3.4.3 New SESAR Operating Method

[redacted] Scope and Objective

The following sections refer to the provision of an ATS to aerodromes during contingency situations. The provision of an AFIS during contingency is not considered. The location of the contingency solution is to be referred to as the RCT. It is envisaged that the target environment for the majority of RCTs will be large aerodromes that are economically and socially important on a national or international level. This would most likely include international hub aerodromes with the capability (to cover capital costs) and need to facilitate running a contingency solution. It may also be applied at aerodromes from nations wishing to provide widespread aerodrome contingency plans, regardless of aerodrome status or size or for application to aerodromes vital for public service routes, however this is a less likely target environment.

The solution presented in this OSED is based on the following principles:

- The ATS will be provided from a remote facility during contingency situations, referred to as a Remote Contingency Tower (RCT) facility;
- The remote provision of ATS in contingency is targeted at ATC and not AFIS;
- Visual reproduction of the aerodrome view will be a key part of the solution. Other non-visual solutions are not included in the scope of this solution within this document;
- The target environment for whom the remote provision of ATS in contingency is suitable is envisaged to be medium, large and very large;

- The RCT will be mainly designed for unplanned contingency events (e.g. emergencies) but may also be used for planned contingency or training;
- The remote provision of ATS in contingency will include TWR ATC only. APP control is not considered within the scope of the solution;
- The aim of remote provision of ATS in contingency is to provide the full range of services defined ICAO Documents 4444, 9426 [13];
- The aim of remote provision of ATS in contingency is to achieve as close to full operating capacity as possible (when compared to ATS provided from a local Tower);
- The ability to provide full capacity during contingency will depend on several factors, described in Section 3.4.1.3 of this document.

[redacted] Factors Impacting Ability to Maintain Operational Performance during Contingency Situations

[redacted] Location

The location of the RCT facility will influence the overall capacity available during contingency events and effectiveness of the contingency facility during contingency events. The subsequent sections provide further detail.

3.4.3.2.1.1 Operating an RCT on-airport site

When located at the aerodrome the RCT will be required to be placed away from the local tower, to prevent the contingency event affecting the local tower from impacting the RCT. It is likely that the RCT will be based at the RFFS site or possible other locations such as the terminal building.

For an on-site RCT the CWP shall be made to be as similar to the local tower CWP as possible. This is facilitated as an on-site RCT and would not be shared between aerodromes. A replication of the layout and features as found in the tower would provide ATCOs with a reduced familiarisation time. CWP replication would also ease the potential stress induced by a contingency event (and may hence reduce the potential for error) as well as reducing the requirement for frequent RCT training sessions.

3.4.3.2.1.2 Operating an RCT off-airport site

An off-airport site RCT facility may consist of one or more RTMs. In this case off-airport site RTMs are likely to be generic and unified enabling them to be applied to many aerodromes within the vicinity. The primary benefit of operating off-site would be the facilitation of shared operating and capital costs. However during a contingency event an off-airport location could significantly lengthen the transition time require going into contingency, both due to distance from the aerodrome and increased ATCO familiarisation periods.

Staff in the local Tower would have to be transferred to the remote site and this turnaround time could cause operations to temporarily stop. The further away the remote site is away from the local Tower, the longer it would take to transfer the controllers and the more the level of service would be affected.

Figure 12 below shows that if adjacent aerodromes are close to each other the RCT facility could potentially be shared amongst the airports since the controllers from all aerodromes could be transferred to the RCT facility relatively quickly. If this was a viable option then it would provide many cost effective benefits much like a Multiple Tower RTC in “local operations”. However, if the neighbouring aerodromes are not very close to each other a shared RCT facility would be ineffective since the transfer of controllers during a contingency event would take too long, leading to a decrease in capacity and reduction in the level of operations provided. However if the RCT is shared then it is of increased importance that the CWP be generic, which may not be suitable for large aerodromes.

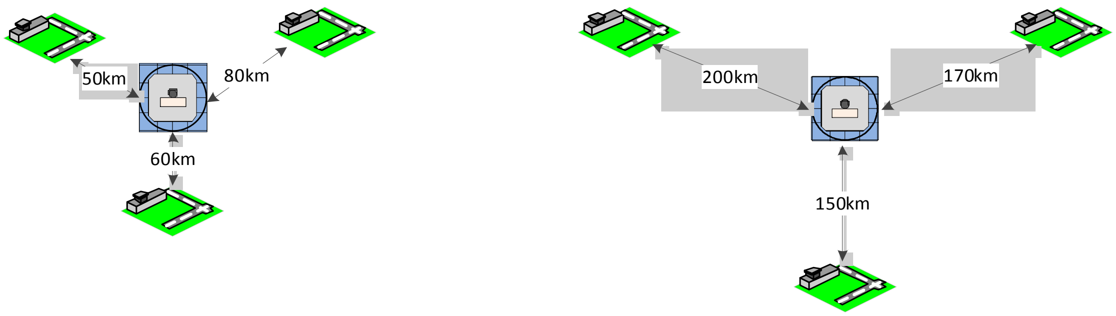


Figure 12 – Location of RCT facility for Multiple Aerodromes

An existing RTC which is used for either single or multiple aerodromes could be used in contingency cases. This would be beneficial for cost effectiveness.

The RTC would be required to have contingency RTMs available as well as trained and licensed ATCOs that could take over control (if local tower ATCOs were not transferred to the RCT). In addition, it may be that the RTC facilities would not be suitable for the larger aerodromes being targeted under this concept. More staff and possible flow restrictions at the airport being controlled from the RTC may be necessary. It is unlikely that an RTM used to provide ATS to a single aerodrome could act as a contingency tower as the facility would be in use as a permanent tower replacement.

[redacted] Type of Outage

The type of contingency event or outage is very important and will have a major impact on the effectiveness of any contingency plans, the service provision under contingency and the progression of the various stages of contingency as detailed in 3.4.3.2.2.2

3.4.3.2.2.1 Time of Outage

The time when the outage occurs can greatly affect the level of operations. For example, if the contingency event happens during peak hours then the traffic volume will be high so a greater number of aircraft could potentially be affected. However, there may be more personnel available in order to deal with the problem and/or move to the remote facility.

Conversely, if the incident takes place during off peak hours, for example in the middle of the night, there could be no/very low traffic so less aircraft would theoretically be affected but there would also be fewer staff to handle the situation and relocate to the remote facility if needed.

3.4.3.2.2.2 Nature and Speed of Outage

If the contingency event is *planned*, such as building or maintenance work which leads to closure of the Tower, then the RCT facility can be set up prior to the event starting. ATS are simply transferred from the local to remote facility leading to the same level of operations and no disruption to the service provided. There could be a need to staff both facilities whilst the transfer takes place.

If the contingency event is *unplanned and sudden*, staff will have had no time to transfer to the RCT facility (if there are not permanent staff on site) or set up/turn on the equipment and be given a brief on the current situation. Therefore, after the outage, the level of operations will be very low or even non-existent until the RCT facility is operationally ready. In the meantime, traffic will be transferred to neighbouring ATSU and NMOC (network manager operations centre) will be informed.

During the reinstatement of services back to the local Tower after the contingency event, the level of operations will not be affected as much since it will be more planned and the transfer of services will not be fully implemented until the local Tower is completely ready. Again, there could be a need for double manning while the transfer takes place.

If the contingency event is *unplanned but gradual*, the staff may be given some prior warning that the control room will have to be evacuated (such as forecast excessively strong winds). In these cases then the level of service may be affected, but not as much as during a sudden outage. This principle is illustrated in Figure 13.

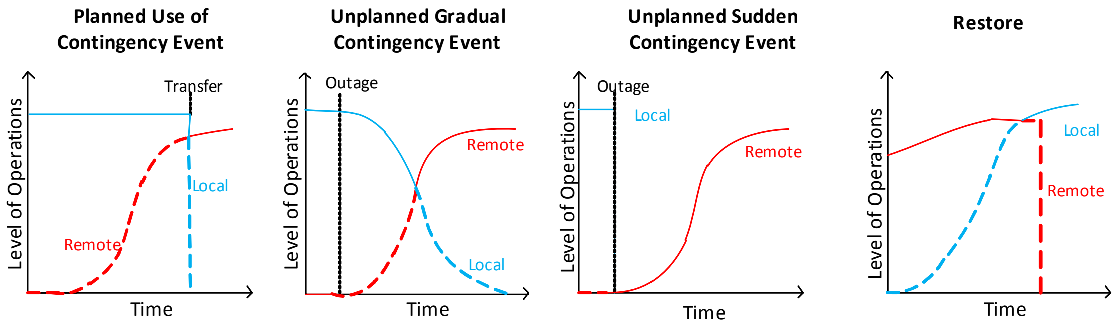


Figure 13 – Level of Operations for Different Types of Contingency Event

A more detailed investigation into the development of capacity over the course of planned and unplanned contingency events is taken in Figure 14 and Figure 15. The capacity capability in the RCT is seen to develop in steps, for both planned and unplanned events. These steps in capacity would likely be linked to external factors such as the human performance of ATCOs. The steps represent a manipulated progression in capacity; the steps would be set by pre-defined proficiency checklists to ensure that the ATCOs were ready to progress to the next capacity "step". The time in-between steps would hence be a factor of ATCO performance and the nature of the outage.

During unplanned events the initial capacity would be zero, only building once set proficiency limits had been reached. During planned events however, due to the possibility to overlap operations and slowly prepare the RCT (as shown in the graphs within 14 and Figure 15), capacity would not need to reduce to zero. The starting capacity during planned events would need to be pre-defined at a certain level specific to that aerodrome. After that the capacity steps would build in the same way as they would after an unplanned event.

The proficiency checklists to be used to define when the RCT is ready to step up capacity may be designed and designated at regulatory and/or ANSP level.

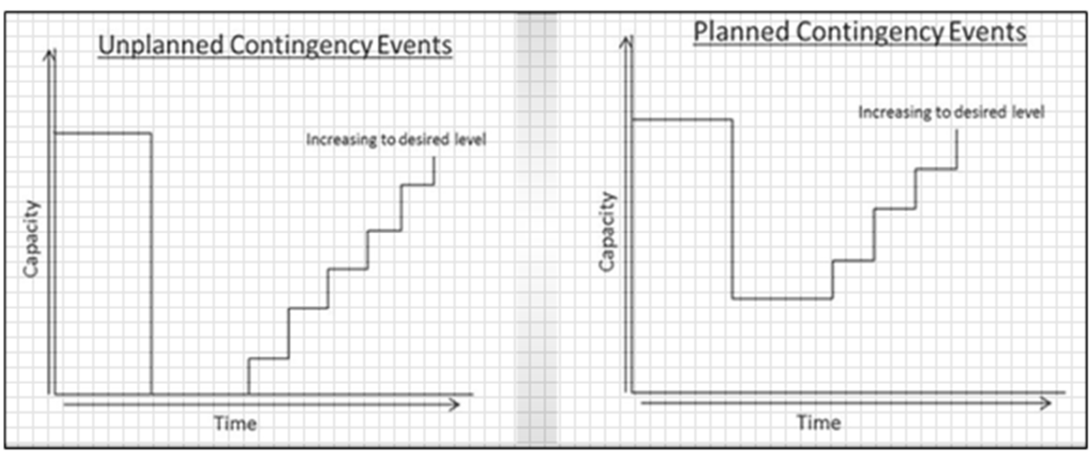


Figure 14 – Unplanned contingency capacity-time graph *Figure 15 – Planned contingency capacity-time graph*

The intensity of the capacity steps and the final RCT capacity being influenced by:

- The Operational Feasibility to regain capacity, influenced by:
    - Nature of outage;
    - Airport characteristics;
    - Time of outage;
    - Visibility and weather conditions.
- The Technical Capability to regain capacity, influenced by:
    - Technical configuration;
    - CWP configuration;
    - ATCO technical ability;
    - Provision of AVF.

As the primary objective of the RCT is to provide a service during a tower contingency event the factors that impact RCT capacity are those which impact the entire concept. As if an RCT is unable to regain air traffic capacity then its function is reduced. Further factors impacting on the ability to maintain operating performance during contingency events are discussed below.

3.4.3.2.2.3 Length of outage and transition times

The transition time into contingency and out of contingency will be a factor of the nature of the contingency event, the reason for the contingency and the time of the event. The "transition into contingency" phase will impose a constraint on aerodrome capacity. Dependant on the nature of the outage this phase may require the aerodrome to close for periods of up to 3 hours (to allow for a replacement shift of ATCOs to be sourced). For all unplanned emergencies the transitions phase is likely to result in zero capacity for periods of between 1-3hours. Capacity will continue to be reduced until ATCOs have fulfilled proficiency standards (to be designed and designated on a regulatory and/or ANSP level) so that capacity levels can be increased in stages. During planned events capacity will not reduce to zero, however staged capacity increases will still be required.

The length of outage is the period that service continuity is required from the RCT/contingency solution and is a factor of the nature of the contingency event. Due to the potential for service disruption (in the form of reduced or zero capacity) during the "transition into" phase, it is unlikely that the RCT will be used to provide service continuity for periods of less than one day.

If the contingency event caused major structural damage to the local tower then the requirement for contingency may be many months. The RCT is hence seen as short to long term solution. Switching between RCT and the local tower many times over a short period of time would not be beneficial to the aerodrome due to the service disruption that will occur during the "transition into" phase.

The "transition out of contingency" phase will always be planned and hence the return to normal operations should not result in much service disruption/reduction in capacity if there are no restrictions put on staffing levels etc.

[redacted] Airport Characteristics

The airport characteristics themselves will influence the capacity of operations during contingency. Very large aerodromes with more movements will have a higher capacity during normal operations and therefore may find it harder to achieve, in percentage terms, near normal service levels in contingency situations. Medium to large aerodromes with fewer movements and normal gaps in traffic may be able to be maintaining service levels closer to normal capacity.

Traffic type and traffic mix will ultimately have an influence on the ability to maintain full operations from the RCT. If an airport has mostly homogenous traffic, as is the case in most large international aerodromes in "class A" airspace, traffic will consist of purely IFR arrivals and departures. , This operational setting could be easier to deal with in contingency situations than airports with heterogeneous traffic including helicopters and helipads, general aviation traffic, ambulance and military traffic. The use of multiple runways and different arrival and departure procedures would likely reduce the operational feasibility of the RCT to maintain service, compared to a single runway operation with uniform procedures.

Consideration must be given to the added value of the visual representation this contingency solution offers. In contrast to the above the traffic mix that would benefit most from a visual representation would be VFR and more vulnerable traffic, due to the possibility of providing visual separation.

[redacted] Controller Support Tools

The availability and use of different technical enablers and AVFs at a specific aerodrome will affect the capacity under contingency situations and potentially may impact upon safety:

In addition to the features detailed within section 3.1.1the RCT will require certain technical differences due to the differing operational environment and content.

These include:

- Surveillance systems available:
  - A-SMGCS (full or partial);
  - Number, type and position of cameras;
  - Surface Movement Radar;
- Safety Nets available:
  - Lighting, stop lights;
  - Runway Guard Lights;
  - Other types of Lighting;
- Procedures:
  - Continuation of local operating procedures during contingency;
  - Use of extra safety measures e.g. extra spacing between aircraft;
- Training and familiarity with the RCT facility:
  - Regular Training will be required, in order to get and keep TWR ATCO´s certified to work in the RCT facility;
  - When not used for live operations, the RCT facility should be used as a simulator, to be able to train TWR ATCO in the contingency environment on a regular basis.

In general, the more advanced the technical and operational systems and the closer to local the procedures can be, then the closer to 100% capacity can be achieved.

Additionally the RCT may provide:

- An increase in the number, type and range of position of aerodrome cameras;
- More cameras at different viewpoints may be required for more runways and a larger manoeuvring area;
- More staff will need to be accommodated in the RCT, so the RTMs area will require extension with multiple CWPs for the various positions to be operated;

A 360^{o} view may be required due to the contingency/emergency situations that the RCT facility is primarily developed to operate in. During these situations being provided with a unbroken visual view of aircraft may be a necessity to maximise the added value of an RCT contingency solution over an A-SMGCS only contingency solution.

[redacted] Operating Methods during Contingency Operations

During the contingency situation, the operating methods will be based upon the operating methods for Remote provision of ATS to a Single Aerodrome as described in Section 3.2.3 and summarised below.

The full range of ATS defined in ICAO Documents 4444 and 9426 will still be provided remotely by an ATCO. The airspace users should be provided with the same level of services as if the ATS were provided locally. **The main change is that the ATCO will no longer be located at the local Tower; they will be re-located to the RCT facility.**

The RCT facility will consist of one or more RTMs and the ATCO will be able to perform all ATS tasks from this RTM. The RTM can be generic or tailored to the individual aerodrome as described in Section 3.4.3.2.

The visual observation will be provided by a reproduction of the OTW view, by using visual information capture and/or other sensors. The visual reproduction can be overlaid with information from additional sources if available, for example, surface movement radar, surveillance radar, multilateration or other positioning and surveillance implementations providing the positions of moving object within the airport movement area and vicinity. The collected data, either from a single source or combined, is reproduced for the ATCO on data/monitor screens, projectors or similar technical solutions.

Visual information capture and reproduction can be done in order to replicate the operational viewpoint obtained from the actual Tower view and this may allow for more familiar view during contingency. Additional operational viewpoints may be provided based on information captured from a range of different positions, not necessarily limited to the original Tower position. This may provide an enhanced situational awareness and/or a progressive operational viewpoint. In all cases, the visual reproduction shall enable visual observation of the airport surface and surrounding area.

To further improve the situational awareness, the airport audible background sounds can be captured and relayed in the RCT facility.

The ATCO will not have the ability to perform any tasks that are external to the control facility e.g. physical runway inspection. The aim is that that they primarily will focus on the pure ATS tasks and other tasks will be secondary and/or performed by personnel local to the aerodrome.

[redacted] Differences between operating methods for Provision of ATS to Single Aerodrome and Provision of ATS for Contingency Situations at Aerodromes

The following are the main differences between the Remote Provision of ATS to a Single aerodrome and the Remote Provision of ATS in Contingency Situations:

The primary differences between the Remote Provision of ATS to a single aerodrome and the remote provision of ATS to an aerodrome during contingency operations are detailed in Table 24.

Single Remote Tower SDM-0201	Contingency Remote Tower SDM-0204
Differences	
Simple and low complexity environment.	Complex operational environment.
Small quiet aerodrome.	Large international Aerodrome.
ATS, ATS and possibly APP.	ATS only.
One ATCO acting in various positions OR One AFISO acting in various positions.	Multiple ATCOs (TWR and Ground)
Permanent replacement for local tower.	Temporary operational usage.
One sole use case/function.	Secondary Additional uses, for example training.
Part of a collective group of RTMs as part of an RCT.	Not part of a collective group of RTMs as part of an RTC.

Similarities
Individual use not shared.
Technical configuration.
Technical enablers / AVF.

Table 24 – Similarities and Difference between a single and contingency remote tower

The principle difference between the two concepts is that the contingency remote tower is not aimed at providing a constant ATS but would only be required during contingency mode operations. A further key difference being that the operational environments of the two concepts very much differ.

Although it is forecast that the contingency remote tower and single remote tower will share technical capabilities it has to be appreciated that the contingency tower is aimed at a different operational environment. An RCT may have a wider visual representation than the single aerodrome RTM, providing a more complex view of the aerodrome. This would be due to the more complex nature and increased size of the aerodromes to be applied to the RCT, with more runways and a more extensive manoeuvring area. Using the same reasoning the RCT facility may include more additional systems.

The RCT facility is to be designed to include a range of positions as normally seen in the tower, under SDM-0201 this would only include one position as the target aerodromes are smaller. However under SDM-0204 the RCT would provide TWR and GRD positions, although it will not necessarily include APP control.

As the single remote tower is to provide a permanent replacement for the local tower it does not have the flexibility to be used for additional purposes unlike the RCT. In an ideal situation the RCT may never/rarely be used for its primary purpose and hence the airport operator will wish to gain added value through secondary functionality. The most feasible additional use for the RCT will be in training for both normal and emergency situations.

3.4.4 Differences between new and previous operating methods

The main difference between current operating methods and the proposed new operating methods are the introduction of the RCT facility, meaning:

Previous Operating Method	New Operating Method
Close/divert	Not all traffic may have to be diverted. The aerodrome will provide some level of service continuity.
Secondary Facility (Tower without A-SMGCS)	Remote provision of ATS. The OTW view is replaced with relayed visual reproductions. Possibility to relay/replay camera images onto other stakeholders (rescue, safety, air crew). Potentially lesser impact on safety / capacity.
Secondary Facility with A-SMGCS	Visual reproduction The OTW view is replaced with relayed visual reproduction, that should give a more complete awareness of vehicle and aircraft movements Increased performance/capacity Less expensive solution. Possibility to relay/replay camera images onto other stakeholders (slave system to fire/safety crew etc.)

Table 25 – Differences between new and previous operating methods

4 Detailed Operational Environment

4.1 Remote Provision of ATS to Single and Multiple Aerodromes

The environment for the remote provision of ATS can be viewed from two aspects, the actual aerodrome operating environment and the remote facility operating environment.

The services are envisaged in two different aerodrome operational environments, depending on whether the aerodrome is a controlled aerodrome or an AFIS aerodrome. The operational characteristics, roles and responsibilities and aerodrome (infrastructure) technical characteristics are different for each environment,

The remote facility technical and performance characteristics will most likely be common to both types of aerodrome operational environment.

4.1.1 Aerodrome Operational Characteristics

Guideline operational characteristics of the two candidate environments are outlined in Table 26 below. They should be interpreted as common characteristics across all candidate countries and ANSP and are not restrictive i.e. they represent a baseline operating environment that may be slightly different in each individual country or ANSP.

		Environment 1 - AFIS	Environment 2 - ATC
Services	AFIS	Yes	-
	TWR	No	Yes (Including Clearance delivery / Ground Control / Tower Control / TWR Apron Control)
	APP	-	Optional
	Opening Hours	Up to 24H (including night)	Up to 24H (including night)
Staffing	Number of ATS staff	At most 1, rarely 2.	1 ATCO but sometimes up to 3.
	Ratings	AFIS	ADI, APP, possibly APS/RAD
Airspace	Airspace Classification	Class F, G (G+)	Class C and/or D
	CTR	-	10- 15 NM radius/rectangular, Vertical extension up to 3000 ft MSL
	TMA	-	Optional (dependant on regional regulations/procedures)
	TIA/TIZ	Typically around 15 NM radius, from surface to 5,000ft or FL095.	-
	Procedures	Specific IFR routes & approach procedures Established VFR routes	Specific IFR routes & approach procedures Established VFR routes
Aerodrome	Number of RWY	Typically 1	One runway (typically but might be more).
	Taxiway and runway entries	Typically 1, at end or middle of runway	Runway intersections (number varying)
	Aprons	Typically 1	1 to 4

Traffic	Number of movements	The typical operating environments for remote tower services are airports below third level node, with a single runway, non-complex runway layout and low capacity utilization. But remote tower services are not limited to those environments.	
	Number of simultaneous movements		
	Traffic Type	Mainly Scheduled and School flights. Also charter, taxi, ambulance, offshore helicopter and General Aviation (GA) and Business Aviation (BA).	VFR and IFR Mainly scheduled, charter and GA (School) flights and Business Aviation (BA).
	Aircraft Fleet mix	Some medium jets (B737, A320, MD80), Mainly medium Turbo Props (SB20, FK50, AT72) GA light aircraft (C172, P28A, PA31) BA and HOSP. medium/light jets and turboprops (Dassualt Falcons, Cessna Citations, BE20) Helicopters	All types of aircraft.

Table 26 – Environment Operational Characteristics

4.1.2 Aerodrome Technical Characteristics

Guideline technical characteristics of the two candidate aerodrome environments are outlined in Table 27 below. The technical characteristics of the actual aerodromes will not necessarily change as a result of providing the ATS remotely.

	Environment 1 - AFIS	Environment 2 - TWR
Communication	Air Traffic Control (ATC) Voice Communications. Very High Frequency (VHF)-transmitters/receivers, Ground Radio System, Autonomous VHF-radio, Search and Rescue (SAR) radio. Ultra High Frequency transmitters/ receivers Flight Data Processing: Paper strips or Electronic FDPS	ATC Voice Communications VHF-transmitters/receivers, Ground Radio System, Autonomous VHF-radio, SAR radio. Ultra High Frequency transmitters/ receivers Datalink optional. Flight Data Processing: Paper strips or Electronic FDPS
Navigation	Navigation specifications including ILS, Area Navigation (RNAV), Non Directional Beacon (NDB), Distance Measuring Equipment (DME).	Navigation specifications including ILS, RNAV, NDB, DME.
Surveillance	Not necessarily having radar surveillance available. Some informational use above given altitude, typically 4000-7000ft. ADS-B could be implemented Visual information (Out the Window view)	Visual information (Out the Window view) Possible radar surveillance available. Surveillance service above given altitude, typically 1000-2000ft. Optional: ADS-B and Radar.

Visual observation	Visual information capture and relay to Remote Tower of single or multiple airport views.	Visual information capture and relay to Remote Tower of single or multiple airport views.
Safety Nets	Typically none.	Stop Bars Runway Guard Lights Optional: Short Term Conflict Alert (STCA) for APP.

Table 27 – Environment Aerodrome Technical Characteristics

4.1.3 Remote Technical Centre Characteristics

In addition to the technical characteristics of the aerodrome environments, the Remote Technical Centre) environment will also have certain technical characteristics. These will likely be common to both aerodrome operating environments.

	Remote Facility Environment
Communication	The corresponding communication systems will be installed into the remote facility. Where necessary, short range transmitters/receivers will be replaced with longer range technical solutions.
Visual Features	The visual view(s) of the aerodrome(s) will be reproduced in the Remote Tower. The visual features aim at increased situational awareness through image enhancements (optional), camera placement (tower view and/or multiple viewpoints) and overlay of information in the visual view. Optional overlaid information includes position information (e.g. Radar, Multilateration, ADS-B and Video Tracking) and automatic identification and tracking of aircraft. Head up information such as flight plan information and weather information should also increase situational awareness. User acceptance is aimed to be increased by a uniform, smooth and high quality visual view (not necessarily 360 degree viewing angle).
Audio Features	Airport (ambient) audio such as engine noise, wind noise etc. may be relayed into the remote facility via speaker if necessary (optional).
Information Management	The remote facility could include systems to support and integrate SWIM. This will be used to share existing information and updates: - to be exchanged between different isolated ATS systems; - to be exchanged with other airports and ATS units; - and to other airport users such as, rescue dept., snow removal, bird strike, fuel, passenger service, airlines, etc.
RTM	The remote facility will be based around a unified RTM which is as generic as possible, minimising the number of screens and input devices by integrating all systems into a comprehensive solution.
Other systems	The remote facility shall include all other technical functions and systems, currently found in local facilities and necessary to provide the services e.g.: - Flight plan system; - Manoeuvring of ground lighting, nav aids, alarms, etc.; - Signal light gun; - System for reproducing the “binocular” view e.g. PTZ camera; - Surveillance – optional or alternative solution (Radar, Multilateration, ADS-B, Visual Tracking)

Table 28 – Remote Facility Environment Technical Characteristics

4.1.4 Roles and Responsibilities

The airspace users (through the pilots) are receivers of the ATS service. However, as previously stated, neither their role nor their responsibility should change as a result of introducing the remote aerodrome ATS.

The primary actors impacted by a remotely provided ATS are the ATCO/AFISO and the local airport officers. The overall roles and responsibilities of the ATCO/AFISO will not change, in so far as they will remain responsible for the provision of the required services. The main changes will be in relation to the tasks external to the tower currently done by ATCO/AFISO (whether or not these form part of documented ATS) or ATS tasks done by local officers and potentially an extra layer of responsibility due to the reliance on technical equipment.

In some current operational environments the ATCO/AFISO will be required to perform some tasks that actually are not a part of the ATS Service, e.g. physical runway inspections, gathering MET data, answering public telephone calls directed to tower just by tradition. Using the remotely provided ATS services, these tasks will require automation or delegation to a local agent (e.g. airport/rescue crew) or a remote technical solution will have to be implemented.

In some AFIS environments, some or all of the ATS services are not provided by a dedicated AFISO, but by suitably qualified local agents such as rescue crew or airport operators. When the ATS provision is removed from the aerodrome, it will be performed by a dedicated AFISO leading to potential task redundancy for local agents. This will require changes to staffing procedures and may impact overall cost effectiveness of service provision.

In traditional operations the ATCO/AFISO is responsible for providing the ATS and the airport authority / air traffic service provider is responsible for making sure that the equipment required to provide the service is in an acceptable working order. This extends to the local tower infrastructure itself e.g. visibility through tower windows. In the Remote Tower, there is a greater reliance on equipment in order to be able to provide the ATS. It will still be the responsibility of the airport authority / service provider to ensure that the equipment is properly maintained and kept in acceptable condition. The ATCO/AFISO will not be responsible for faults or failures due to lack of maintenance or design issues. These issues will be addressed by qualified engineers and technicians responsible for the calibration, maintenance and flight testing such as Air Traffic Electronic Personnel (ATSEP).

A new role for consideration when providing ATS remotely, especially from an RTC, is the RTC supervisor. In the same way that an ACC/Approach Supervisor is responsible for the general management of all activities in the Operations Room, an RTC supervisor is responsible for the general management of all activities in the RTC. This role may be filled by an ATCO or alternatively may be a distinct position.

4.1.5 Hours of Provision for ATS

ATS is mainly provided at smaller aerodromes to protect scheduled commercial IFR-traffic and utility IFR-traffic (ambulance/rescue flights etc.).

ATS for a specific aerodrome will normally be provided at published times (opening hours published in AIP or via Notice To Airmen (NOTAM)). Specific requests/agreements may be made in advance to provide ATS outside the normal opening hours. Extended opening hours will improve the availability of the aerodrome to business as well as ambulance/ rescue flights. Extended opening hours could be a political issue, setting environmental restrictions on flights (e.g. reducing night flights due to noise impacts). If no specific requests are made, ATS will not be provided outside normal opening hours, although the aerodrome may still choose to be open without ATS.

All traffic (IFR or VFR) as well as ground traffic/vehicles will be provided with ATS during opening hours.

4.1.6 Airspace status

The status of the Control Zone (CTR) can vary, either being Established or Not Established.

The CTR is Established according to the ATS opening hours and Not Established outside this. An air traffic information zone/ flight information zone (TIZ/ FIZ) is established around airports where AFIS is provided (i.e. not part of controlled airspace). TIZs and FIZs can also vary in status in the same way.

4.1.7 Constraints

There are a number of constraints on the actual service and solution design and further constraints that may result from usage of the service. It is not possible at this stage to state for definite what all the constraints will be and which of the pre-identified constraints may be removed or mitigated in the final concept.

- Constraints on potential designs of the service/concept:
  - The possible solution may have to be constrained by the existing (and anticipated) rules and regulations that apply to the provision of ATS at aerodromes;
  - The final service must include the ability to replicate existing back-up systems e.g. to replace local short range radio and to include new system redundancies;
  - The final service should be flexible enough to allow part time local operation of ATC/ATS service combined with part time remotely operated should the operators decide to operate in this way e.g. remote staff during night, local staff during day;
  - Results from previous research impose some technical constraints and minimum performance characteristics for the potential solutions;
  - Visual depth perception may be limited. Therefore, the possibility to apply visual separation may be limited;
- Pre-identified constraints as a result of the service/concept that should be addressed and/or mitigated through other means:
  - The technical solution (visual) *may* affect or require adjustments of the ATS working methods e.g. the amount of VFR flights could be limited when conflicting with IFR flights. Nevertheless, it is an objective of the project to minimise any negative impact on IFR or VFR flights and if possible to provide benefits to all;
  - Remote ATS personnel cannot perform local physical checks, if so required. Therefore a person or means to perform these checks will have to be identified;
  - The interaction between technical solutions and operational methods/procedures may lead to changes in any of those. It is not yet know if this will lead to constraints or in fact lead to mutual technical and operational improvements;
  - Redundancy in existing systems must remain;
  - Part time usage operations may remain (optional).

4.2 Remote Provision of ATS in Contingency Situations

The target environment for which the remote provision of ATS in contingency is suitable is based on the size of the airport and the technical systems available. According to the DOD, the size category of the airport is based on the number of air traffic movements a year. RCT facilities are envisaged in medium (40000-100000 air traffic movements annually), large (100000-400000 air traffic movements annually) and very large airports (over 400000 air traffic movements annually). It is not targeted at small airports of less than 40k air traffic movements a year since the cost of operating a contingency Tower would not be cost effective.

Once the size of the target aerodrome has been established the airports are categorised into two environments, based on their technical systems, in particular whether they have full/partial A-SMGCS or not. Typically the very large and some large airports have A-SMGCS whilst it is rare to find it on medium airports. These two environments have different operational and technical characteristics.

4.2.1 Aerodrome Operational Characteristics

Guideline operational characteristics of the two candidate environments are outlined in Table 29 below. They should be interpreted as common characteristics across all candidate countries and ANSP and are not restrictive i.e. they represent a baseline operating environment that may be slightly different in each individual country or ANSP.

		Primary Target Environment – Non A-SMGCS	Secondary target Environment – A-SMGCS
Services	TWR	Yes	Yes
	APP	Sometimes combined with TWR	Yes. Off Site.
	Opening Hours	24 H	24 H
Staffing	Number of ATS staff	1-2 in TWR	Up to 6 in TWR
Airspace	Airspace Classification	Class C, D	Class A, C
	CTR	10-15NM radius, 2500FT ALT/SFC	10-15NM radius, 2500FT Altitude (ALT)/Surface (SFC)
	TMA	In some cases FL95-, during low traffic periods mainly during night time	
	Procedures	Specific IFR routes & approach procedures Established VFR routes	Specific IFR routes & approach procedures Established VFR routes (Class C)
Aerodrome	Number of RWY	1-2	2-3
	Taxiway and runway entries	1-2 taxiways, 5 runway entry points	3 taxiways, 4-6 runway intersection points
	Aprons	3-4	8-12
Traffic	Number of movements	The typical operating environment for a contingency tower will include a range of aerodrome environments from intercontinental hubs to secondary node aerodromes. Typically aerodromes will portray one or more of the following complexities: multiple runways, runway independencies, a complex layout or a high capacity utilisation. The provision of this service is not limited to these environments.	
	Number of simultaneous movements		
	Traffic Type	Scheduled, Business, Charter, Some Military, Some GA.	Scheduled, Business, Charter
	Aircraft Fleet mix	Light to Medium (B737, A320, MD80, RJ100, E135, E145, CRJ) Occasionally Heavy (Normally Charter or Cargo) (B747, B767, A330) Light and medium Business jets and turbo props.	All types of aircraft

Table 29 – Environmental Operational Characteristics

4.2.2 Aerodrome Technical Characteristics

Guideline technical characteristics of the two candidate aerodrome environments are outlined in Table 30 below. The technical characteristics of the actual aerodromes will not necessarily change as a result of providing the ATS remotely.

	Primary Target Environment – Non A-SMGCS	Secondary Target Environment – A-SGMCS
Communication	VCS, VHF-transmitters/receivers, Ground Radio System, VHF radio, Autonomous VHF-radio, ATIS	Aircraft Communications Addressing and Reporting System (ACARS), Voice Communications System VCS, VHF, ATIS, UHF, Data Communications Link (DCL)
Navigation	ILS, DME, NDB. Some have RNP, RNAV, P-RNAV	RNP, RNAV, Precision Area Navigation (P-RNAV), ILS, NDB, DME
Radar Surveillance	SMR and MSSR	1 Primary Surveillance Radar (PSR), 2 Mono pulse secondary surveillance radar (MSSR), A-SMGCS
Safety Nets	STOP-BAR crossing, runway safety area penetration, unauthorized correlated tracks movements, collision alerts (Runway (RWY) and Taxiway (TWY)), STCA.	A-SMGCS Level 2 (automated monitoring and alerting functions)

Table 30 – Environment Aerodrome Technical Characteristics

4.2.3 Additional Technical Characteristics for RCT Facilities

The following are some initial additional technical considerations for the RCT, since the candidate operational environments are potentially larger and more complex:

- More cameras at different viewpoints may be required for more runways and larger manoeuvring area;
- More staff will need to be accommodated in the RCT, so more RTM may be required;

4.2.4 Roles and Responsibilities

The primary actors impacted by a remotely provided ATS are the ATCO and the local airport officers. The overall roles and responsibilities of the ATCO will not change, in so far as they will remain responsible for the provision of the required services. However, the RCT facility layout/responsibilities may not be exactly the same as the local tower since the contingency events are rare, costs are high and roles can be combined. These airports may accept a lower capacity. The RCT facility does not lead in a reduction in capacity – only if the full equipment/package is not installed.

4.2.5 Constraints

The primary constraint is a possible reduced safety and capacity level if there is a reduction in infrastructure in the RCT facility.

There are some constraints involved in the operation of a RCT facility. There will inevitably be a run-up time (of approximately 10 minutes to 1 hour). In addition, staff will have to relocate to the RCT facility. Moreover, there is a possibility of reduced capacity if there is a reduction in the infrastructure of the RCT facility. This depends on the cost effectiveness which is specific to each airport.

5 Use Cases

The selected use cases are based on certain criteria:

- Normal Operations to give coverage against ICAO Doc 4444 [10], ICAO Doc 9426 [13] and the Eurocontrol Manual for AFIS [12];
- To generate specific requirements for non-normal cases;
- As a means to provide examples and clarifications of how the Remote Tower concept may function in operational scenarios;

The OSED attempts to describe the key parts of remote provision of ATS. Many elements and functions of the service provision will be the same when provided remotely as if they had been provided locally and so may not be repeated in detail for the use cases in this OSED.

5.1 Remote Provision of ATS to Single and Multiple Aerodromes

Nine operational scenarios are considered in this OSED, in addition to the service descriptions given in Sections 3.2, 3.3 and 3.4. The scenarios presented below are all written from a Remote TWR ATCO point of view. However, the scenarios would also apply for Remote AFISO and Virtual TWR ATCO/Virtual AFISO.

The scenarios relating to a “single aerodrome/airport” are also all applicable to the environment of a remote tower being used to provide ATS to multiple aerodromes. The technical, operational and procedural elements remain unchanged. The primary difference being the multiple remote tower ATCO can provide a service to one of many aerodromes, has a more compressed visual representation of each aerodrome and has (in some cases) duplicated features in the CWP.

5.1.1 Arriving aircraft handled by remotely provided ATS

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in an RTM, located away from the aerodrome and/or local Tower.

GC2 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of the aerodrome view

GC3 - The Remote TWR ATCO is providing ATS to a single Aerodrome/Airport.

[redacted] Pre-Conditions

PreC1 - An inbound estimate is delivered from ACC

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for arrival aircraft, with the same or better levels of service as if the ATS had been provided locally

[redacted] Operating Method, Nominal Flow

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
1.	Establishes contact (R/T) with the inbound IFR flight crew when the aircraft is established on final approach.	Acknowledges contact.	Remote TWR ATCO may also relay potential updates of the actual MET Report, displayed on the RTM and other relevant information e.g. regarding runway conditions to the Flight Crew (if no ATIS is available).	Final Approach
2.	Verifies that the runway is free of obstacles for the landing of the aircraft and issues the landing clearance to the Flight Crew using R/T.	Acknowledges the landing clearance.	Remote TWR ATCO runway check is performed by visual reference gained from the relayed visual surveillance of the aerodrome and aerodrome ground personnel.	Final Approach
3.	Monitors the aircraft's final approach and landing to ensure safety and intervenes if required.	Proceeds with the approach and lands the aircraft.	Remote TWR ATCO monitors aircraft on relayed visual reproduction/visual surveillance. Technical enablers and AVFs may assist the Remote TWR ATCO in identifying and monitoring the aircraft on final approach e.g. additional viewpoints or enhanced views, MET and aerodrome status overlays (showing wind measurements, runway visual range values, runway lights status).	Final Approach and landing
4.	Issue a clearance where to exit the runway. Verifies that the aircraft has vacated the runway via the planned exit. Issues a taxi clearance via appropriate taxiway(s) to the allocated stand on apron.	Executes the clearance and vacates runway Acknowledges the taxi clearance.	Remote TWR ATCO monitors aircraft on relayed visual reproduction/visual surveillance The Remote TWR ATCO may use an alternative viewpoint at the taxiway (where provided) in order to be able to get an enhanced view and aid in establishing that the aircraft has left the RWY.	Landing / Runway
5.	Monitors the traffic situation for the detection of potential hazards and hazardous situations (e.g. converging airport traffic, temporary obstructions, debris). If the Taxi Clearance Limit is an active runway, the Remote TWR ATCO verifies that the runway is clear, confirms the aircraft can cross and issues a taxi route clearance(s) to the stand.	Acknowledges and accepts the route clearance, updating the aircraft system. Manoeuvre the aircraft assisted by the routing displayed on-board the aircraft and/or using visual navigation aids (e.g. taxiway markings and lighting).	Remote TWR ATCO monitors aircraft on relayed visual reproduction/visual surveillance with the aid of technical enablers (where relevant) and any AVFs (that may feature).	Taxi

Table 31 – Operating Method Nominal Flow - Arriving aircraft handled by remotely provided ATS

5.1.1.4b Operating Method, Alternative Flow 1, Large Animal on Manoeuvring Area

Flow continues from #2 in Table 31, section 5.1.1.4 above.

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
3.	Is made aware of a large animal moving on the manoeuvring area towards the RWY and immediately instructs the aircraft to go-around following the go-around procedure.	Acknowledges and immediately initiates the go-around procedure.	The Remote TWR ATCO may be made aware of the presence of the large animal or obstacle by various means including: The visual reproduction, communication with ground personnel or the binocular function. Further to this additional features that are non-mandatory may provide assistance (e.g. an IR camera tool or "hot-spot" cameras)	Final Approach
4.	Instructs ground personnel (Using a communications link between the Remote Tower module and the aerodrome) to immediately to go to the given position of the animal and commence methods to remove or scare off the animal.		The Remote TWR ATCO will monitor the aircraft on the visual reproduction. On the same display, the Remote TWR ATCO may bring up a different viewpoint to allow simultaneous monitoring of the area in which the animal is present. The Remote TWR ATCO will continue to monitor both aircraft and animal until the animal has been removed or scared off.	
5.	Updates Flight Crew on on-going situation and approximate time frame for being given a new approach and landing clearance	The flight crew will consider this in their planning for alternative aerodromes to land if necessary.		Approach
6.	Receives confirmation from ground personnel (via communications link) that the animal is no longer in the vicinity.		The confirmation form ground personnel verified by visual monitoring via the RTM.	Approach
7.	Remote TWR ATCO has confirmed that runway is clear and issues a clear to land again instruction to the aircraft.	Acknowledges the landing clearance.	Remote TWR ATCO runway check is performed by visual reference gained from the relayed visual reproduction of the aerodrome.	Final Approach
8.	Flow continues from 3 in 5.1.1.4 (Table 31 above).			

Table 32 – Operating Method, Alternative Flow 1, Large Animal on Manoeuvring Area

5.1.1.4c Operating Method, Alternative Flow 2, Landing Gear not Down

Flow continues from #2 in Table 31, section 5.1.1.4 above.

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
3.		Flight Crew observes an indication in the cockpit that the landing gear is not down and request to make a low pass above the aerodrome. The Flight Crew request the Remote Tower ATCO to observe if the landing gear seems to be down		Final Approach
4.	Informs the Flight Crew of the position of the landing gear using a binocular functionality to focus on the aircraft.	Acknowledges response and decide to land	If such a function is not available due to malfunction or other reasons, the Remote TWR ATCO may request, via communications link, that local airport personnel to perform a visual check of the aircraft and report back.	Final Approach
5.	Remote ATCO verifies landing gear failure, informs emergency unit and initiates emergency procedures to be followed.			Final Approach
6.	Monitors the aircraft's final approach and landing to ensure safety and intervenes if required.	Proceeds with the approach and lands the aircraft.	When the Flight Crew make a new approach to land, the Remote TWR ATCO again uses a binocular functionaility to observe the aircraft and reports any deviations to the Flight Crew and rescue units.	Final Approach and landing.
7.	Co- ordinates suitable spacing due to emergency		Co-ordinates emergency if APP performed by different ATCO	
8.	Flow continues from 4 in 5.1.4			

Table 33 – Operating Method, Alternative Flow 2, Landing Gear not Down

5.1.2 VFR flight in the traffic circuit is conflicting with an arriving IFR flight

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in an RTM, located away from the aerodrome and/or local Tower.

GC2 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of the aerodrome view.

GC3 - The Remote TWR ATCO is providing ATS to a single Aerodrome/Airport.

[redacted] Pre-Conditions

PreC1 -The VFR flight in the traffic circuit is conflicting with an arriving IFR flight.

PreC2 – Airspace class C.

PreC3 –The ATCO does not have both aircraft in sight.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the arrival aircraft, with the same or better levels of service as if the ATS had been provided locally.

[redacted] Operating Method

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
1	Contact VFR Flight (R/T) and clears the VFR flight to a published VFR holding point or any suited location.	VFR Flight crew acknowledges clearance and proceeds to VFR holding point or any suited location.	The VFR flight will stay in the VFR hold until one of the following occurs: The IFR flight has landed; The Remote TWR ATCO has both aircraft in sight on the visual reproduction and could maintain visual separation; The pilot in the VFR flight reports to have the IFR in sight and can maintain own visual separation.	Approach

Table 34 – Operating Method - VFR flight in the traffic circuit is conflicting with an arriving IFR flight

5.1.3 Two departing IFR flights during Low Visibility

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in a RTM, located away from the aerodrome and/or local Tower.

GC2 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of the aerodrome view.

GC3 - The Remote TWR ATCO is providing ATS to a single Aerodrome/Airport.

[redacted] Pre-Conditions

PreC1 - In this scenario there are two departing IFR flights.

PreC2 - Visibility is poor and LVP are in place.

PreC3 - En-route clearance is issued by the ATCO before start-up upon Flight Crew request, by use of R/T or Datalink.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the departing aircraft, with the same or better levels of service as if the ATS had been provided locally. The Advanced Visual Features enable simultaneous movements during LVP.

[redacted] Operating Method

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
1	Initiates LVP locally at the airport and informs the airport authority and departing aircraft.	Acknowledges LVP in operation		Start up
2	Clears departing aircraft No.1 for engine start-up when ready	Departing aircraft No.1 confirms engine start-up		Start up
3	Verifies that the runway (and manoeuvring areas if applicable) is free of obstructions and approves departing aircraft No.1 to push back.	Aircraft No.1 executes push back.	Technical enablers such as the binocular functionality may be used to assist the Remote TWR ATCO in identifying possible obstacles on the runway and key areas. AVFs may also assist where provided.	

4	Clears aircraft No.1 to taxi to the holding point of the runway-in-use and when approaching the holding clears departing aircraft No.1 to line up on the runway.	Acknowledges taxi and runway clearances		Taxi and Line-up
5	Clears departing aircraft No.2 for engine start-up when ready	Departing aircraft No.2 confirms engine start-up	Technical enablers and AVFs may be used to assist the Remote TWR ATCO in identifying any obstacles on runway and key areas. Enhancements may be used to highlight key areas along the taxiways, such as the holding points.	Start up
6	Verifies that the runway (and manoeuvring areas if applicable) is free of obstructions and approve departing aircraft No.2 to push back.	Aircraft No.2 execute push back	Technical enablers and AVFs may be used to assist the Remote TWR ATCO in identifying any obstacles on runway and key areas.	Push Back
7	Verifies that the runway (and manoeuvring areas if applicable) is free of obstructions Clears No.1 for take-off	No.1 acknowledges clearance and departs on runway-in-use	No. 2 for departure will be monitored and tracked using the visual reproduction or other sensors such as a binocular functionality or optional AVF enhancements in order to avoid a runway incursion or other deviation from issued clearance. Use of stop bars if available to avoid runway incursion.	Take Off
8	Clears the second departing aircraft (No.2 for departure) to taxi to the holding point of the runway-in-use.	Departing aircraft No.2 acknowledges taxi clearance	This is performed after Aircraft No. 1 has been cleared for take-off and is airborne.	Taxi
9	Clears the second departing aircraft (No.2 for departure) to line up on the runway.	Acknowledges clearance		Line Up
10	Verifies that the runway is free of obstructions Clears departing aircraft No.2 for take-off	Departing aircraft No.2 acknowledges clearance and departs on runway-in-use		Take Off

Table 35 – Operating Method - Two departing IFR flights during Low Visibility

5.1.4 Arrival aircraft with combined Remote TWR/APP

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in a RTM, located away from the aerodrome and/or local Tower.

GC2 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of the aerodrome view.

GC3 - The Remote TWR ATCO is providing ATS to a single Aerodrome/Airport.

[redacted] Pre-Conditions

PreC1 - A combined Remote APP/TWR ATCO is responsible for ATS in the CTR around a remotely serviced aerodrome and TMA FL95 and below.

PreC2 - Arriving aircraft are given inbound clearances direct to the Initial Approach Fix (IAF) for the runway-in-use.

PreC3 - No ATS surveillance service is provided by TWR/APP ATCO.

PreC4 - Two IFR flights are arriving at approximately the same time into the aerodrome.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the arrival aircraft, with the same or better levels of service as if the ATS had been provided locally.

[redacted] Operating Method

Step	Remote APP/TWR ATCO	Flight Crew	Notes	Phase
1	Issues an approach clearance to Aircraft No. 1 full procedure (VOR)/ILS on VHF omnidirectional radio.	Arriving aircraft No.1 acknowledges clearance	The ACC ATCO has decided the approach sequence and arranges the traffic. The aircraft are vertically separated when transferred from the ACC ATCO to the Remote APP/TWR ATCO.	Approach
2	Issues a clearance for Aircraft No. 2 to a published holding point, with vertical separation to Aircraft No. 1 and with expected approach time given.	Arrival aircraft No.2 acknowledges clearance.	Vertical separation is applied by use of step descend or by use of rate-of-descend. Aircraft No. 1 could continue with an instrument approach (full procedure) or at a certain point report field in sight and be cleared to make a visual approach.	Approach

3a	Verifies that the runway is free of obstacles for the landing of aircraft No.1 and clears the aircraft for a visual approach.	Aircraft No.1 acknowledges the approach clearance and report runway in sight.	Remote TWR ATCO runway check is performed by visual reference gained from the relayed visual reproduction of the aerodrome.	Approach
3b	Issues a landing clearance to aircraft No.1	Aircraft No.1 acknowledges the landing clearance and continues its VFR approach for landing.		Final Approach
4	Issues arrival aircraft No.2 with an approach clearance	Aircraft No.2 acknowledges the approach clearance and starts its approach.	Conditional that the Remote APP/TWR ATCO has Aircraft No. 1 in sight on visual reproduced view and reasonable assurance exists that a normal landing can be accomplished.	Approach
5	Monitors aircraft No.1's final approach and landing to ensure safety and intervenes if required.	Aircraft No.1 proceeds with the final approach and lands the aircraft.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. Technical enablers may assist in the monitoring of the aircraft. AVFs may overlay additional information onto the visual reproduction to assist the Remote TWR ATCO in identifying and monitoring the aircraft on final approach e.g. wind measurements, runway visual range values, runway lights status.	Final Approach and landing.
6	Issues a taxi clearance to aircraft No.1 via appropriate taxiway(s) to the allocated stand on apron. Verifies that the aircraft has vacated the runway via the planned exit.	Aircraft No.1 acknowledges the taxi clearance. Executes the clearance and vacates runway.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. Remote TWR ATCO verifies by visual reference gained from the visual reproduction and optionally enhanced by AVFs, that the aircraft has vacated the runway via the planned exit.	Landing / Runway.
7	Clears No.2 for landing and monitors aircraft No.2's final approach and landing to ensure safety and intervenes if required.	Aircraft No. 2 acknowledges the landing clearance and proceeds with its final approach and then lands the aircraft.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. Technical enablers may assist in the monitoring of the aircraft. AVFs may overlay additional information onto the visual reproduction to assist the Remote TWR ATCO in identifying and monitoring the aircraft on final approach e.g. wind measurements, runway visual range values, runway lights status.	Final Approach and landing.
8	The visual reproduction will then be used to monitor and control both aircraft.			

Table 36 – Operating Method - Arrival aircraft with combined Remote TWR/APP

5.1.5 Transition of ATS provision from local TWR to Remote TWR

[redacted] General Conditions

GC1 - The ATS is provided locally during some hours of the day and remotely during others.

GC2 - The Remote TWR ATCO is located in an RTM, located away from the aerodrome and/or local Tower.

GC3 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of the aerodrome view.

GC4 - The Remote TWR ATCO is providing ATS to a single Aerodrome/Airport.

[redacted] Pre-Conditions

PreC1 - The local TWR ATCO is ready to hand over to the Remote TWR ATCO.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the arrival aircraft, with the same or better levels of service as if the ATS had been provided locally.

[redacted] Operating Method

Step	Remote TWR ATCO	Local TWR ATCO	Notes	Phase
1	Prior to the nominated time of transfer, the Remote TWR ATCO coordinates with the Local TWR ATCO to see if conditions are sufficient to begin remote provision of ATS.	The Local TWR ATCO has the final decision.	The following items are taken into account: Division of responsibility between Remote TWR ATCO and Local TWR ATCO at any given moment; Received Flight plans; Requested flight permissions (PPR); Actual (known) traffic; Meteorological conditions; Possibility to actually observe traffic from the remote facility. Before and during transition, the Local TWR ATCO and the Remote TWR ATCO shall communicate and judge how the visual view in TWR and remote facility is experienced; Planned maintenance work.	-

2	Once satisfied that a transfer can take place, the Remote TWR ATCO performs various checks in the remote facility		RTM handover procedure checks will include, but is not limited to the following: Check MET briefing in remote facility; Check ground to air and ground to ground radio; Check relayed visual view from camera tower; Check that the various technical enablers and AVFs are functioning correctly; In coordination with Local TWR ATCO, check ILS mode, HMI and navigation aids; Check settings for systems such as airport lights and air situational display; Check connection by telephone to surrounding ATS units and inform of impending transfer to remote provision of ATS.	-
3	Once all checks have been complete to the satisfaction of the Remote TWR ATCO, the Remote TWR ATCO takes control of the relevant equipment from the Local TWR ATCO. The Remote TWR ATCO informs the Local TWR ATCO that they are ready to begin remote provision of ATS services.	This is confirmed by the Local TWR ATCO	The Remote TWR ATCO then calls the Local TWR ATCO by telephone to transfer information on: General information including deviations from normal procedures; Work in Progress on or close to manoeuvring area that could have an influence; AWOS – Check date and "letter" for current Met. Info; Traffic situation – actual air traffic, vehicles on manoeuvring area, issued clearances; If available air situational display settings – range, centre settings, additional maps; Any other pertinent information.	-
4	After transfer of relevant information, transfer of control is performed with the Remote TWR ATCO taking control. The Remote TWR ATCO performs final essential checks on radio and telephone functions and volume by conducting final transmissions to the Local TWR ATCO and ACC.			-

5	The Remote TWR ATCO then requests control by using the RTC supervisor telephone and initiating "Remote Provision of ATS". The Remote TWR ATCO accepts and states "Remote facility takes control".	The Local TWR ATCO then states "You take control" and acknowledges the initiation.		-
6		The Local TWR ATCO informs the airport agents, officers and ACC that the remote facility is now providing ATS		-

Table 37 – Operating Methods - Transition of ATS provision from local TWR to Remote TWR

5.1.6 Aircraft Arriving to an Aerodrome with no Present Visual Reproduction

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in an RTM, located away from the aerodrome(s) and/or local Tower(s).

GC2 - The Remote TWR ATCO is providing ATS to two Aerodromes sequentially.

GC3 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of only one aerodrome at a time but switching between the two aerodromes is possible.

[redacted] Pre-Conditions

PreC1 - Remote ATCO is providing ATS for aerodrome A and B sequentially. At the start of this use case ATS is being provided to aerodrome A and hence this is the only aerodrome being viewed on the visual reproduction.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the arrival aircraft, with the same or better levels of service as if the ATS had been provided locally.

[redacted]Operating Method

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
1.	Remote ATCO is providing ATS to aerodrome A.	A pilot in a single engine aircraft flying according to VFR, is calling Remote ATCO, declaring emergency and request to land at aerodrome B, time to landing is 10 minutes.	Reference to section 3.2.3.3.3 which describes the use of traffic co-ordination in the concept. This form of traffic co-ordination would have been in place prior to the establishment of an emergency at the aerodrome not currently being provided with an ATS (i.e. aerodrome B).	En-route
2	The Remote TWR ATCO switches the visual reproduction and all primary controls (e.g. e-strip) from aerodrome A to aerodrome B. The provision of ATS to aerodrome A from this RTM shall cease due to the switch of the service to aerodrome B.		ATS of aerodrome A may be handed to another Remote TWR ATCO if using an RTC or ATS may be halted at aerodrome A, however the aerodrome will remain open.	Approach
3	Issues a clearance to the aircraft landing at aerodrome B, informs rescue unit and ground staff.	The pilot approaches the aerodrome and passes all relevant information to remote ATCO.	Visual surveillance of the aerodrome shall be used to issues clearance. Technical enablers, AVFs and ground staff may be used to assist.	Approach
4	Verifies that the runway is free of obstacles for the landing of the aircraft and issues the landing clearance to the Flight Crew using R/T.	Acknowledge landing clearance. Proceeds with the approach and lands the aircraft.	Remote TWR ATCO runway check is performed by visual reference gained from the relayed visual reproduction of the aerodrome. AVFs may also be useful and or required to allow for a closer inspection. Ground personnel may also be required to perform the physical check or remove FOD.	Landing/ Runway
5			The Remote TWR ATCO can now switch the visual reproduction and controls to aerodrome A in order to recommence the provision of an ATS. When using the switch mode to operate multiple aerodromes there is likely to be advanced traffic coordination to negate the requirement for excessive switching.	Taxi

Table 38 – Operating Methods - Aircraft Arriving to an Aerodrome with no Present Visual Reproduction

5.1.7 Transition of Visual Reproduction from Aerodrome A to Aerodrome B

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in an RTM, located away from the aerodrome(s) and/or local Tower(s).

GC2 - The Remote TWR ATCO is providing ATS to two Aerodromes sequentially.

GC3 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of only one aerodrome at a time but switching between the two aerodromes is possible.

[redacted] Pre-Conditions

PreC1 - Remote ATCO is providing ATS for aerodrome A and B. At the start of this use case ATS is being provided to aerodrome A and hence this is the only aerodrome being viewed on the visual reproduction.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the arrival aircraft, with the same or better levels of service as if the ATS had been provided locally

[redacted] Operating Method, Nominal Flow

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
1	Remote TWR ATCO switches the visual reproduction and all primary controls (e.g. e-strip) from aerodrome A to aerodrome B. It will clearly be indicated on the visual reproduction that it now shows aerodrome B.	According to FPL, an aircraft shall request taxi for departure in 10 minutes at aerodrome B. At the present and within 20 minutes there are no aircraft moments expected at aerodrome A. Flight crew request taxi for departure at aerodrome B, according to FPL at least 10 minutes prior to departure.	Remote TWR ATCO will follow a checklist, to assure that the switch to aerodrome B is correctly done. Reference to section 3.2.3.3.3 which describes the use of traffic co-ordination in the concept. ATS of aerodrome A may be handed to another Remote TWR ATCO if using an RTC or ATS may be halted at aerodrome A. however the aerodrome will remain open.	On apron
2	Runway inspection performed at aerodrome B. Remote TWR ATCO approves start-up of the aircraft.	The flight crew request start up and when approved start the engines.	Runway inspection performed by visual reproduction, technical enablers, AVFs and/or ground personnel.	On apron

3	Issue a clearance for the departing aircraft to taxi to the holding point of the runway-in-use.	The flight crew request taxi clearance to RWY in use.	The Remote TWR ATCO shall use visual surveillance and any technical enablers or AVFs to assist in monitoring the departure during the whole taxi procedure, to be sure that there will be no deviation from issued clearances. Enhancements may be used to highlight key areas along the taxiways, such as the holding points.	Taxi
4	Clears the aircraft for take-off	Flight crew acknowledges clearance and departs on runway-in-use		Take Off
5.	Around 1 minute after departure Remote TWR ATCO will transfer the aircraft to APP or ACC	Flight crew switch to APP(ACC) frequency		Take Off
6.	After a predefined time Remote TWR ATCO can, if requested, change to visual reproduction of aerodrome A, following procedures as in 1 and 2.		When using the switch mode to operate multiple aerodromes there is likely to be advanced traffic coordination to negate the requirement for excessive switching.	

Table 39 – Operating Methods Nominal Flow - Transition of Visual Reproduction from Aerodrome A to Aerodrome B

5.1.8 Two arriving aircraft to two different aerodromes

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in an RTM, located away from the aerodrome(s) and/or local Tower(s).

GC2 - The Remote TWR ATCO is providing ATS to 2 Aerodromes/Airports simultaneously.

GC3 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of both aerodromes (Aerodrome A and B).

[redacted] Pre-Conditions

PreC1 - Two aircraft are approaching two different airports in a TMA, both aircraft are supposed to follow a Standard Terminal Arrival Route (STAR) to their destination.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the arrival aircraft, with the same or better levels of service as if the ATS had been provided locally.

[redacted]Operating Method, Nominal Flow

Step	Remote TWR ATCO	Flight Crew	Notes	Phase
1.			Not later than 10 min before landing ground staff from each aerodrome respectively will inform the Remote TWR/APP ATCO that the runway is inspected and allowed to be used for aircraft landings and departures. (Later on this inspection could be allowed to be done with the use of cameras only)	Approach
2.	When landing aircraft no.1 is on final to aerodrome A, Remote TWR ATCO will use a binocular tool to inspect the runway of aerodrome A and assure it is free from obstacles, where after they issues a landing clearance.	Flight Crew acknowledge landing clearance.	The RTM will feature a visual reproduction of both aerodromes being provided with a remote ATS. All equipment and technical features that require duplication shall be provided for each aerodrome in an separate or combined manner. The Remote TWR ATCO shall be able to easily distinguish between aerodromes and all duplicated features. With intuitive and swift switching of controls where required. Touch and control panels for each aerodrome are placed (and may be colour coded) to eliminate the risk of manoeuvring the wrong equipment and confusing.	Final Approach
3.	Monitors aircraft no.1 on final approach and landing to ensure safety and intervenes if required.	Proceeds with the approach and lands the aircraft.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. Technical enablers may assist in the monitoring of the aircraft. AVFs may overlay additional information onto the visual reproduction to assist the Remote TWR ATCO in identifying and monitoring the aircraft on final approach e.g. wind measurements, runway visual range values, runway lights status.	Final Approach and landing.
4.	Issues a taxi clearance to aircraft 1 via appropriate taxiway(s) to the allocated stand on apron. Verifies that aircraft 1 has vacated the runway via the planned exit.	Acknowledges the taxi clearance. Executes the clearance and vacates runway.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. The ATCO may use an alternative viewpoint if available to view the taxiway to enhance the view and monitor more closely that the aircraft has left the RWY.	Landing / Runway.

5.	When landing aircraft no.2 is on final to aerodrome B, Remote TWR ATCO will use a binocular tool to inspect the runway of aerodrome B and assure that the runway is free, where after he/ she issues a landing clearance.	Flight Crew acknowledge landing clearance.	The RTM will feature a visual reproduction of both aerodromes being provided with a remote ATS. All equipment and technical features that require duplication shall be provided for each aerodrome in an separate or combined manner. The Remote TWR ATCO shall be able to easily distinguish between aerodromes and all duplicated features. With intuitive and swift switching of controls where required. Touch and control panels for each aerodrome are placed (and may be colour coded) to eliminate the risk of manoeuvring the wrong equipment and confusing.	Final Approach
6.	Monitors the traffic situation for the detection of potential hazardous situations at aerodrome A (e.g. converging airport traffic, temporary obstructions, debris). If the Taxi Clearance Limit is an active runway, the Remote TWR ATCO verifies that the runway is clear and the aircraft can cross and issues taxi route clearance(s) to the stand.	Acknowledges and accepts the route clearance, updating the aircraft system. Manoeuvre the aircraft assisted by the routing displayed onboard the aircraft and/or using visual navigation aids (e.g. taxiway markings and lighting).	Remote TWR ATCO monitors aircraft on relayed visual reproduction and if required using technical enablers such as a binocular functionality or any available AVFs.	Taxi
7.	Monitors aircraft no.2 final approach and landing to ensure safety and intervenes if required.	Proceeds with the approach and lands the aircraft.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. Technical enablers may assist in the monitoring of the aircraft. AVFs may overlay additional information onto the visual reproduction to assist the Remote TWR ATCO in identifying and monitoring the aircraft on final approach e.g. wind measurements, runway visual range values, runway lights status.	Final Approach and landing.
8.	Issues a taxi clearance to aircraft no.2 via appropriate taxiway(s) to the allocated stand on apron. Verifies that aircraft no.2 has vacated the runway via the planned exit.	Acknowledges the taxi clearance. Executes the clearance and vacates runway.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. The ATCO may use an alternative viewpoint if available to view the taxiway to enhance the view and monitor more closely that the aircraft has left the RWY.	Landing / Runway.

9.	Monitors the traffic situation for the detection of potential hazardous situations at aerodrome B (e.g. converging airport traffic, temporary obstructions, debris). If the Taxi Clearance Limit is an active runway, the Remote TWR ATCO verifies that the runway is clear and the aircraft can cross and issues taxi route clearance(s) to the stand.	Acknowledges and accepts the route clearance, updating the aircraft system. Manoeuvre the aircraft assisted by the routing displayed onboard the aircraft and/or using visual navigation aids (e.g. taxiway markings and lighting).	Remote TWR ATCO monitors aircraft on relayed visual reproduction and if required using technical enablers such as a binocular functionality or any available AVFs.	Taxi

Table 40 - Operating Methods and Nominal Flow - Transition of ATS provision from local TWR to Remote TWR

5.1.9 Runway Inspection at Multiple Aerodromes during Night

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in a remote tower module, located away from the aerodrome(s) and/or local Tower(s).

GC2 - The Remote TWR ATCO is providing ATS to multiple Aerodromes/Airports (in this case 3 aerodromes).

GC3 - The Remote TWR ATCO is situated at a RTM where they are presented with simultaneous visual reproductions of all 3 aerodromes (Aerodrome A, B and C).

[redacted] Pre-Conditions

PreC1 - The ATCO is providing ATS to three aerodromes simultaneously, the ATCO is operating during darkness at all three aerodromes.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the arrival aircraft, with the same or better levels of service as if the ATS had been provided locally.

[redacted]Operating Method, Nominal Flow

Step	Remote TWR ATCO	Local Ground Staff	Notes	Phase
1.	A visual representation of all aerodromes is provided simultaneously. As in local operations aerodrome lighting enables the ATCO to maintain visual. The ATCO surveys all aerodromes.	Local ground staffs are on hand at the aerodromes to provide any technical assistance; this includes clearing obstructions from onsite cameras etc. Ground staff should also be available to assist the ATCO in performing runway checks, runway clearing and bird scaring duties etc.	The display of aerodromes on visual reproduction screens is determined by the RTM configuration. Aerodromes may be displayed on an equal number of screens or the ATCO may choose to have one aerodrome displayed on a larger number of screens for a clearer view (minimising the remaining aerodromes to be displayed on a reduced number of screens). However all aerodromes shall be provided with a visual reproduction continuously.	N/A
2.	The ATCO inspects the runway of a specific aerodrome. The ATCOs finds an obstacle on the manoeuvring area. Contact is made with the local aerodrome ground staff via phone. The situation is monitored from the remote tower, the ATCO remains in contact with ground personnel to advise on the location of the obstacle.	Clearance of the obstacle is performed. Remote TWR ATCOs are contacted.	To inspect a specific runway in greater detail during night time the ATCO may use technical enablers or AVFs such as the binocular functionality or (if provided) an IR camera to enhance the visual reproduction. The aerodrome should (in most cases, if possible) should displayed using a larger number of screens/uncompressed view. To enhance ATCO visibility of the aerodrome	
			The above steps 2-3 are repeated for each aerodrome. Contact with multiple aerodromes can be made via individual radio communications. If on performing runway checks etc. at Aerodrome A an aircraft makes contact at Aerodrome B full priority should be given to aerodromes with live traffic, however the ATCO remains responsible for all aerodromes and is continuously providing ATS to all.	

Table 41 – Operating Methods and Nominal Flow - Transition of ATS provision from local TWR to Remote TWR

5.1.10 Control of Vehicles in the Manoeuvring Area

[redacted] General Conditions

GC1 - The Remote TWR ATCO is located in a remote tower module, located away from the aerodrome and/or local Tower.

GC2 - The Remote TWR ATCO is situated at an RTM where they are presented with a visual reproduction of the aerodrome view.

GC3 - The Remote TWR ATCO is providing ATS to a single Aerodrome/Airport.

[redacted] Pre-Conditions

PreC1 - Ground vehicle requests to proceed for movement within the manoeuvring area

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for the manoeuvring vehicle, with the same or better levels of service as if the ATS had been provided locally

[redacted] Operating Method, Nominal Flow

Step	Remote TWR ATCO	Ground Crew	Notes	Phase
1.	Establishes contact (R/T) with the airside vehicle requesting movement within the manoeuvring area.	Call TWR on R/T and establish contact.		N/A
2.	Verifies that the manoeuvring area is free of obstacles and aircraft for drive of the vehicle and issues the "proceed to" clearance to the Ground Crew using R/T.	Acknowledges the clearance on R/T.	Remote TWR ATCO manoeuvring area check is performed by visual reference gained from the relayed visual reproduction of the aerodrome.	N/A
3.	Monitors the vehicle's driving to ensure safety and intervenes if required.	Proceeds to requested destination within the manoeuvring area.	Remote TWR ATCO monitors vehicle on relayed visual reproduction with the aid of technical enablers and where available AVFs.	N/A
4.	Acknowledge on R/T that the vehicle has reached its final destination.	Report on R/T that vehicle has reached final destination on the manoeuvring area.	Remote TWR ATCO monitors vehicle on relayed visual reproduction with the aid of technical enablers and where available AVFs.	N/A

Table 42 – Operating Methods - Control of Vehicles in the Manoeuvring Area

5.2 Remote Provision of ATS in Contingency Situations

The below operational scenarios correspond to events surrounding a contingency situation impacting the local tower. The three scenarios below are related to the speed and type of event, namely sudden or gradual speed of outage and planned or unplanned events. The target environment is that of a large aerodrome and the contingency tower solution is not considered as a permanent tower replacement.

5.2.1 Unplanned Sudden Event (e.g. Fire, Bomb)

[redacted] General Conditions

GC1 - The TWR ATCO is initially located in the local aerodrome tower.

GC2 - The TWR ATCO is providing ATS to a single aerodrome.

GC3 - The RCT is not initially in use, but is available at a location outside the local tower.

[redacted] Pre-Conditions

PreC1 –Local Tower ATCO´s are responsible for providing ATS at manoeuvring area and CTR.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for departing and arriving aircraft, with level of service and capacity as stated by airport authorities and ATS.

[redacted] Operating Method, Nominal Flow

Step	Remote TWR ATCO	Flight Crew	Notes	Phase	Mode
1.			Emergency event occurs. No warning is possible.		Emergency Situation
2.	Tower Evacuation is triggered according to local operating procedures. Temporary restrictions will be set and aircraft diverted as the aerodrome is immediately closed.	Flights approaching the aerodrome will be told to divert to an alternative aerodrome.	The aerodrome will be required to immediately close in accordance with local procedures for emergencies.	Approach Final Approach Landing	Service Continuity Degraded Mode of Operations
3.	ATCOs moved to a safe location (this may or may not be the RCT) and attended to. Once deemed acceptable ATCOs move to		A Technician on watch has been alerted and sets up the RCT facility. If deemed necessary a new supporting team		Service Continuity Degraded Mode of

Step	Remote TWR ATCO	Flight Crew	Notes	Phase	Mode
	the RCT.		of ATCOs is contacted to take over the shift.		Operations
4.	ATCO shift enters RCT and checklists are performed. Procedures for starting up the RCT are followed.		ATCOs may require increased transition time, depending on their familiarity with the RCT.		Service Continuity Degraded Mode of Operations
5.	RCT facility takes over the responsibility of providing ATS. The RCT capacity is capped and slowly builds. The development of capacity is set according to proficiency checklists.		The aerodrome is reopened but movements remained restricted. RTC Supervisor informs NMOC (network manager) about present capacity.	Approach Final Approach Landing	Service Continuity Degraded Mode of Operations
6.	The transition into contingency phase is complete and contingency operations are established. *(Capacity has increased in gradual steps in line with proficiency checklists. The aim being to reach the maximum capacity conditions will allow without safety detriment.)*				
7.	Establishes contact (R/T) with the inbound IFR flight crew when the aircraft is established on final approach.	Acknowledges contact.	RCT ATCO may also relay potential updates of the actual MET Report, displayed on the RTM and other relevant information e.g. regarding runway conditions to the Flight Crew (if no ATIS is available).	Final Approach	
8.	Verifies that the runway is free of obstacles for the landing of the aircraft and issues the landing clearance to the Flight Crew using R/T.	Acknowledges the landing clearance.	RCT ATCO runway check is performed by visual reference gained from the relayed visual reproduction of the aerodrome.	Final Approach	
9.	Monitors the aircraft's final approach and landing to ensure safety and intervenes if required.	Proceeds with the approach and lands the aircraft.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. Technical enablers may assist in the monitoring of the aircraft. AVFs may overlay additional information onto the visual reproduction to assist the Remote TWR ATCO in identifying and monitoring the aircraft on final approach e.g. wind measurements, runway visual range values, runway lights status.	Final Approach and landing.	

Step	Remote TWR ATCO	Flight Crew	Notes	Phase	Mode
10.	Issue a clearance where to exit the runway. Verifies that the aircraft has vacated the runway via the planned exit. Issues a taxi clearance via appropriate taxiway(s) to the allocated stand on apron.	Executes the clearance and vacates runway Acknowledges the taxi clearance.	Remote TWR ATCO monitors aircraft on relayed visual reproduction. The ATCO may use an alternative viewpoint if available to view the taxiway to enhance the view and monitor more closely that the aircraft has left the RWY.	Landing / Runway.	
11.	Monitors the traffic situation for the detection of potential hazardous situations (e.g. converging airport traffic, temporary obstructions, debris). If the Taxi Clearance Limit is an active runway, the RCT ATCO verifies that the runway is clear and the aircraft can cross and issues taxi route clearance(s) to the stand.	Acknowledges and accepts the route clearance, updating the aircraft system. Manoeuvre the aircraft assisted by the routing displayed on-board the aircraft and/or using visual navigation aids (e.g. taxiway markings and lighting).	RCT ATCO monitors aircraft on relayed visual reproduction and/or technical enablers or AVF.	Taxi	

Table 43 – Operating Method, Nominal Flow –Contingency Situations

5.2.2 Unplanned Gradual Event (e.g. excessive wind warning)

[redacted] General Conditions

GC1 - The TWR ATCO is initially located in the local aerodrome tower.

GC2 - The TWR ATCO is providing ATS to a single aerodrome.

GC3 - The Remote Contingency Facility is not initially in use, but is available at a location outside the local tower.

[redacted] Pre-Conditions

PreC1 - Local Tower ATCO´s are responsible for providing ATS at manoeuvring area and CTR.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for departing and arriving aircraft, with level of service and capacity as stated by airport authorities and ATS

[redacted] Operating Method, Nominal Flow

Step	Local Tower ATCO	RCT facility ATCO	Notes	Phase	Mode
1.			Forecast foresees wind speed above maximum allowed to keep local Tower manned.		Emergency Situation
2.	Tower Supervisor plans move to RCT facility. Part of local Tower ATCO´s move to RCT facility. Neighbouring ATS will be informed. NMOC (network manager) will be informed and temporary restrictions will be set.			Approach Final Approach Landing	Service Continuity Degraded Mode of Operations
3.		ATCO´s that have resettled from local Tower prepare to take over the responsibility of ATS at the aerodrome.	A Technician on watch has been alerted and sets up the RCT facility.		Service Continuity Degraded Mode of Operations
4.	Local Tower ATCO´s transfer, step by step, the responsibility of ATS to RCT facility ATCO´s,	RCT facility takes over the responsibility of providing ATS.		Approach Final Approach Landing	Service Continuity Degraded Mode of Operations
5.	Remaining local Tower personnel relocate to RCT facility.		RTC supervisor informs NMOC (network manager) about present capacity.	Approach Final Approach Landing	Service Continuity Degraded Mode of Operations
6.	The transition into contingency phase is complete and contingency operations are established. (capacity capped until proficiency checks have been fulfilled, return to normal operating capacity should there after only been impacted by external conditions)				

Table 44 – Operating Method, Nominal Flow – Unplanned Gradual Event

5.2.3 Planned Use of Contingency Facility (e.g. scheduled maintenance)

[redacted] General Conditions

GC1 - The TWR ATCO is initially located in the local aerodrome tower.

GC2 - The TWR ATCO is providing ATS to a single aerodrome.

GC3 - The Remote Contingency Facility is not initially in use, but is available at a location outside the local tower.

[redacted] Pre-Conditions

PreC1 - The local Tower ATCO´s are ready to handover responsibility of ATS to Contingency Tower ATCO´s.

[redacted] Post-Conditions

PostC1 - Safe and efficient provision of ATS for departing and arriving aircraft, with level of service and capacity as stated by airport authorities and ATS.

[redacted] Operating Method, Nominal Flow

Step	Local Tower ATCO	RCT facility ATCO	Notes	Phase	Mode
1.			An example of a planned contingency event would be that the local Tower is to be closed due to maintenance. The move to contingency Tower is planned well in advance and all authorities and companies are informed. A capacity rate is set during the period when the RCT is used for providing ATS. NMOC (network manager) is informed of the rate.		Outage
2.		Contingency Tower is manned and ready to take responsibility of ATS at the aerodrome and CTR.	To be done during a low traffic density period. All checks of equipment are performed and the RCT is fully up and running.	All	Service Continuity

3.	Local Tower ATCO´s gradually and according to plan are transferring the responsibility of ATS to Contingency ATCO´s.	Contingency Tower ATCO´s gradually and according to plan are to take over responsibility of ATC		All	Service Continuity
4.	Local Tower ATCO´s are closing Tower, after a period of shadow mode.	Contingency Tower ATCO´s are now responsible for ATS at the aerodrome and CTR.	Capacity at the aerodrome shall be as predefined at step 1.	All	Service Continuity
5.			When local Tower is ready to be used again, step 2-4 will occur in reverse order.		Recovery to Normal Operations

Table 45 – Operating Method, Nominal Flow - Planned Use of Contingency Facility

6 Requirements

Requirements produced within P06.09.03 (and within Working Area "Functional Specification") include conceptual, operational and functional level requirements for OFA06.03.01, as well as performance level requirements to some extent. These requirements form a direct input to P12.04.07 and will be further developed and detailed, where applicable, within the Technical Specification produced by P12.04.07.

It is expected that this requirement set will be amended during the course of the project as a result of validation activities as well as well as Safety and Human Performance assessments being performed. This OSED version, edition 00.05.00 includes;

- A final set of requirements for the Single aerodrome application, based on validation results from; EXE-06.09.03-VP-056, EXE-06.09.03-VP-057 and EXE-06.09.03-VP-058, as well as EXE-06.08.04-VP-638.
- An intermediate set of requirements for the Multiple aerodrome application, based on the first validation exercises performed so far; EXE-06.09.03-VP-060 as well as EXE-06.08.04-VP-641. (The final set of requirements for the Multiple aerodrome application is expected within an OSED update during the summer 2015, incorporating also results from EXE-06.09.03-VP-061, EXE-06.09.03-VP-063.)
- An intermediate, close to final, set of requirements for the Contingency application, based mainly on conceptual findings, but also incorporating validation results from EXE-06.09.03-VP-059. (The final set of requirements for the Contingency application is expected within an OSED update during the summer 2015, incorporating also results from EXE-06.09.03-VP-062.)
- Security requirements, based on the Security Risk Assessment Report produced by WP16.06.02 ("06.03.01 Remote and Virtual Tower Security Risk Assessment", Edition 00.00.02, 09/12/2013).
- Safety and Human Performance requirements, based on their respective assessment reports for the Single application produced within P06.09.03, are not yet incorporated in the OSED, however planned for inclusion in a forthcoming OSED update expected before the end of 2014. (Safety and Human Performance requirements for the Multiple and Contingency applications will be added at a later stage, when their respective assessments for the applications have been performed.)
- Traceability links to requirements appointed to OFA06.03.01 within the WP6 Airport Detailed Operational Descriptions for Step 1 and Step 2 (produced by P06.02.00), are included for those DOD requirements deemed applicable. These traceability links are to be found under the Baseline Concept Requirements Section and the Concept Requirements Sections for the respective application Single, Multiple and Contingency. (See below for a description of the different subsections within this Chapter 6.) (For those DOD requirements appointed to OFA06.03.01 but not deemed to be applicable by P06.09.03, this will be fed back to P06.02.00 for coordination.)

<u>The requirements are divided in the following subsections:</u>

Section **6.1** contains the baseline concept requirements derived for the RVT concept, stating what the project aims to achieve with the concept. Some the links to the P06.02 DOD requirements are to be found in this section.

Section **0** contains a review of applicable general service and functional requirements that exist on the service (today) in order to provide ATC/AFIS for aerodromes, regardless of whether that service is performed locally or remotely, such as requirements originating from current ICAO regulations.

Section **6.3** lists requirements that apply in the Remote environment, regardless if for Single or Multiple applications, explaining how to be able to fulfil the general requirements in Section 0 and also how to achieve/fulfil the aims/goals for the project as stated by the baseline requirements in Section

6.1. Some few of the requirements in section 6.3 however are only valid for the single application, which is then stated in the Rationale field of the requirement. Some of the links to the P06.02 DOD requirements are to be found in the subsection "Concept Requirements Single Aerodrome Applications" of this section.

Section **6.4** covers additional requirements that are needed specifically for the Multiple aerodrome application, for those circumstances where the requirements in section 6.3 are not enough when operation in a multiple environment. Some of the links to the P06.02 DOD requirements are to be found in the subsection "Concept Requirements Mingle Aerodrome Applications" of this section.

Section **6.5** includes a discussion around the Contingency application, some higher level placeholder type requirements and a set of recommendations, if building a ATS contingency solution based on the RVT concept. One of the links to the P06.02 DOD requirements is to be found in the subsection "Concept Requirements Contingency Applications" of this section.

All requirements except for some very few are applicable to both TWR and AFIS. For those not applicable to both, it is stated in the Rationale field of the requirement which one of the services ATC (TWR) / AFIS that is applicable.

All requirements are written and prioritised in accordance with the guidelines and instructions as laid out by the "Requirements and VV Guidelines", Edition 03.00.00 and the "Templates and Toolbox User Manual, Edition 03.00.00.

<u>The following prioritisation / importance level are used:</u>

Essential: indicates that the requirement is mandatory. A failure to meet an Essential requirement implies that the intended concept is of limited value.

Essential requirements are indicated by the word ***shall*** in the requirement text **and** by the text string <Essential> in the Importance field of each requirement table. (The latter only visible when showing "hidden text" of this document).

Important: indicates that the requirement is important. A failure to meet an Important requirement implies that the intended concept scope is reduced.

Important requirements are indicated by the word ***should*** in the requirement text **and** by the text string <Important> in the Importance field of each requirement table. (The latter only visible when showing "hidden text" of this document).

Desirable: indicates that the requirement is optional.

Desirable requirements are indicated by the word ***may*** in the requirement text and by the text string <Desirable> in the Importance field of each requirement table. (The latter only visible when showing "hidden text" of this document).

Each requirement table has a section with "hidden text" for easier reading of the document. To see the full tables, "hidden text" has to be enabled. If not, only the "Identifier" and "Requirement" fields of each table are visible. . "Hidden text" can also be toggled on/off via the ¶ button (if not enabled in "Word Options").

6.1 Baseline Concept Requirements

Identifier	REQ-06.09.03-OSED-BC01.0001
Requirement	ATCO/ATCOs shall provide Aerodrome Control Service (TWR) from a remote location.

Identifier	REQ-06.09.03-OSED-BC01.0002
Requirement	AFISO/AFISOs shall provide Aerodrome Flight Information Service (AFIS) from a remote location.

Identifier	REQ-06.09.03-OSED-BC01.0008
Requirement	For each Remote & Virtual Tower application, minimum Security Management levels and applicable minimum security measures shall be defined, in order to maintain airport operations at or above the current local operations level.

Identifier	REQ-06.09.03-OSED-BC01.0009
Requirement	The Remote & Virtual Tower Concept shall contribute to the overall cost reduction of the European gate-to-gate ATM, by reducing costs for performing ATS at low to medium density airports.

Identifier	REQ-06.09.03-OSED-BC01.0010
Requirement	The Remote & Virtual Tower Concept shall contribute to the overall improvement of uniformity of ATM services.

6.2 General Service/Functional Requirements

6.2.1 Communications

Identifier	REQ-06.09.03-OSED-CO02.1001
Requirement	The ATCO/AFISO shall use aeronautical mobile service (air-ground communications) in the area of responsibility, in accordance with ICAO Annex 11, Chapter 6.1. Note: If a separate ground controller position is introduced, a separate communication channel for the control of traffic operating on the manoeuvring area would be needed.

Identifier	REQ-06.09.03-OSED-CO02.1002
Requirement	The ATCO/AFISO shall use aeronautical fixed service (ground-ground communications) in accordance with ICAO Annex 11, Chapter 6.2.

Identifier	REQ-06.09.03-OSED-CO02.1003
Requirement	The ATCO/AFISO shall use surface movement control service (communications for the control of vehicles other than aircraft on manoeuvring areas at controlled aerodromes)for the aerodrome(s) under control, in accordance with ICAO Annex 11, Chapter 6.3.

Identifier	REQ-06.09.03-OSED-CO02.1004
Requirement	The ATCO/AFISO shall communicate via a signalling lamp with the respective aircraft, in accordance with ICAO Annex 14 section 5.1.3.

Identifier	REQ-06.09.03-OSED-CO02.1005
Requirement	The ATCO/AFISO shall observe visual communication from aircraft that are within the ATCO/AFISO's visual range, i.e.: - aircraft flashing or showing landing lights (in darkness). - aircraft repeatedly changing its bank angle - "rocking wings" (in daylight)

Identifier	REQ-06.09.03-OSED-CO02.1006
Requirement	The ATCO/AFISO shall observe visual communication from aircraft that are within visual range on the aerodrome manoeuvring area, i.e.: - moving ailerons (or rudder). (in daylight) - flashing or showing landing lights (in darkness)

6.2.2 MET-functions

Identifier	REQ-06.09.03-OSED-MT02.2001
Requirement	The ATCO/AFISO shall use relevant meteorological information, in accordance with ICAO Annex III and national regulations.

Identifier	REQ-06.09.03-OSED-MT02.2002
Requirement	The current MET report, actual wind information, actual QNH and, if measured for the particular airport, RVR values shall continuously be presented to the ATCO/AFISO.

6.2.3 Visualisation

Identifier	REQ-06.09.03-OSED-VS02.3001
Requirement	The ATCO shall, from the remote location, apply ICAO Doc 4444, Chapter 7.1.1.2: *"Aerodrome controllers shall maintain a continuous watch on all flight operations on and in the vicinity of an aerodrome as well as vehicles and personnel on the manoeuvring area. Watch shall be maintained by visual observation, augmented in low visibility conditions by an ATS surveillance system when available."*

Identifier	REQ-06.09.03-OSED-VS02.3002
Requirement	The AFISO shall, from the remote location, apply Eurocontrol Manual for AFIS Chapter 3.1.2: *"AFISOs shall maintain a continuous watch by visual observation and an ATS surveillance system when authorized by and subject to conditions prescribed by the appropriate authority (see Appendix A), on all flight operations on and in the vicinity of an aerodrome as well as vehicles and personnel on the manoeuvring area."*

Identifier	REQ-06.09.03-OSED-VS02.3003
Requirement	The ATCO/AFISO shall prevent collisions between aircraft and obstructions on the manoeuvring area.

Identifier	REQ-06.09.03-OSED-VS02.3004
Requirement	The ATCO/AFISO shall use a functionality corresponding to the binoculars in a traditional Tower, giving the possibility to zoom/enlarge specific areas and objects in the visual presentation.

6.2.4 NAV functions

Identifier	REQ-06.09.03-OSED-NV02.4001
Requirement	The ATCO/AFISO shall monitor and adjust intensity and on/off status of visual navigational aids.

Identifier	REQ-06.09.03-OSED-NV02.4002
Requirement	The ATCO/AFISO shall monitor and adjust the status of non-visual navigational aids.

6.2.5 Other ATS Systems / Functions

Identifier	REQ-06.09.03-OSED-FN02.5001
Requirement	The ATCO/AFISO shall access surveillance data, such as radar presentation, when available for the particular airport.

Identifier	REQ-06.09.03-OSED-FN02.5002
Requirement	The ATCO/AFISO shall access and handle ATS messages (as described in ICAO Doc 4444 Chapter 11).

Identifier	REQ-06.09.03-OSED-FN02.5003
Requirement	The ATCO/AFISO shall access and update flight plan and control data for all flights being provided with the ATS service (in accordance with ICAO Doc 4444 Chapter 4.13).

Identifier	REQ-06.09.03-OSED-FN02.5004
Requirement	The ATCO/AFISO shall monitor and manage accident, incident and distress alarms as applicable to the aerodrome.

Identifier	REQ-06.09.03-OSED-FN02.5005
Requirement	Correct time, in the format of hours, minutes and seconds in UTC, shall be continuously presented to the ATCO/AFISO.

Identifier	REQ-06.09.03-OSED-FN02.5006
Requirement	The ATCO/AFISO shall be notified about any technical status of systems that can affect the safety or efficiency of flight operations and/or the provision of air traffic service. Note: This corresponds to requirements on local tower operations, with the addition of systems that are specific to remote tower operation, such as detecting corrupt/delayed visual presentation.

6.2.6 Voice and Data Recording

Identifier	REQ-06.09.03-OSED-DR02.6001
Requirement	Communication of the ATCO/AFISO (with pilots, other units, vehicle drivers etc) via Aeronautical mobile service, Aeronautical fixed service and Surface movement control service shall be recorded.

Identifier	REQ-06.09.03-OSED-DR02.6002
Requirement	Necessary data, according to ICAO Annex 11 Chapter 6, shall be recorded.

6.3 Remote Functional Requirements

The requirements that are listed in Section 0 originate from the fact that in essence, the aim of the remote and virtual tower concept is to provide the same set of services that are provided from conventional towers, meaning that the functional requirements on a conventional tower should also be applicable to a remote or virtual tower.

Stopping there, however, one would fail to answer *how* these requirements are applicable to the Remote and Virtual Tower concept and most requirements would end up in the unanswered question of how this requirement should be handled in the remote environment.

This section is therefore dedicated to facilitating the advancement of the concept, by providing a set of requirements that apply specifically to the remote and virtual component of operations, i.e. can be seen as a recommendation on how to meet the general ATS requirements as stated in Section 0 and also how to meet the aim with the concept as stated by the requirements in Section 6.1.

As no method was identified by which the operational project 6.9.3 could define tolerance levels on performance requirements, the technical interpretation of requirements needs to be made in the corresponding system projects, after which the technical solution will be returned for validation within P06.09.03.

6.3.1 Concept Requirements Single Aerodrome Applications

Identifier	REQ-06.09.03-OSED-CS03.0001
Requirement	The ATCO/AFISO shall provide ATS to one aerodrome from a single RTM.

Identifier	REQ-06.09.03-OSED-CS03.0002
Requirement	The ATCO/AFISO should provide ATS to more than one aerodrome sequentially from a single RTM.

Identifier	REQ-06.09.03-OSED-CS03.0003
Requirement	The Single Aerodrome Application part of the Remote & Virtual Tower Concept shall reduce the direct cost of gate-to-gate ATM in OFA06.03.01 by 0,27%.

6.3.2 RTC level requirements

Requirements in this section are applicable when operations are performed from an RTC connected to several aerodromes and consisting of several RTMs.

Identifier	REQ-06.09.03-OSED-RTC3.0004
Requirement	The ATCO/AFISO shall use unified operating methods and procedures for all airports connected to a RTM/RTC (in order to contribute to the overall improvement of uniformity of ATM services).

Identifier	REQ-06.09.03-OSED-RTC3.0005
Requirement	All RTMs in a RTC shall be unified in terms of HMI and equipment (in order to contribute to the overall improvement of uniformity of ATM services).

Identifier	REQ-06.09.03-OSED-RTC3.0006
Requirement	RTC should enable transfer of responsibility of ATS for aerodromes between RTMs within an RTC.

Identifier	REQ-06.09.03-OSED-RTC3.0007
Requirement	If compliant with REQ-06.09.03-OSED-RTC3.0006, RTC shall enable the service provision to be uninterrupted during transfer of responsibility between RTMs.

Identifier	REQ-06.09.03-OSED-RTC3.0008
Requirement	The ATCO/AFISO/RTC Supervisor shall verify the status of an aerodrome and its related systems, before assuming responsibility for providing ATS to the aerodrome.

6.3.3 RTC Supervisor

Requirements in this section are applicable when operations are performed from an RTC connected to several aerodromes and consisting of several RTMs, and are specifically targeting the RTC Supervisor Role and its needed functionalities.

Identifier	REQ-06.09.03-OSED-SUP3.0009
Requirement	When RTC enables transfer of responsibility of ATS for aerodromes between RTMs within the RTC, RTC should enable a RTC Supervisor role for the RTC. Note: The RTC Supervisor role may be performed either from a separate stand-alone CWP/RTM or combined from a CWP/RTM in a RTC.

Identifier	REQ-06.09.03-OSED-SUP3.0010
Requirement	The RTC Supervisor role shall access functions for the planning, coordination and monitoring of the upcoming and present traffic flow, in the purpose of tactical opening and closure of RTMs and allocation of airports to them.

Identifier	REQ-06.09.03-OSED-SUP3.0011
Requirement	The RTC Supervisor role shall access functions for the monitoring and coordination of responsibilities between different RTMs within the RTC.

Identifier	REQ-06.09.03-OSED-SUP3.0012
Requirement	The RTC Supervisor role shall access functions for the monitoring of airport systems status for all aerodromes and all RTC systems.

Identifier	REQ-06.09.03-OSED-SUP3.0013
Requirement	The RTC Supervisor role shall access functions for the monitoring of weather conditions for all aerodromes.

Identifier	REQ-06.09.03-OSED-SUP3.0014
Requirement	The RTC Supervisor role shall access functions for communicating the status of RTC and aerodromes and coordinating maintenance (to be carried out by a qualified engineer/technician).

6.3.4 Visualisation

[redacted] Visualisation – General

Identifier	REQ-06.09.03-OSED-VG03.1001
Requirement	The ATCO/AFISO shall have access to a visual reproduction of flight operations on and in the vicinity of the aerodrome as well as vehicles and personnel on the manoeuvring area. Note: The vicinity of an aerodrome is defined in Doc 4444 as: "*aircraft in, entering or leaving an aerodrome traffic circuit*".

Identifier	REQ-06.09.03-OSED-VG03.1002
Requirement	The visual reproduction should incorporate enhancements that improve the visual range and resolution compared to unaided viewing.

Identifier	REQ-06.09.03-OSED-VG03.1004
Requirement	The visual reproduction should incorporate additional sensors that improve the visual range and resolution compared to unaided viewing. Note: Such sensors would be particularly helpful in darkness and low visibility conditions.

Identifier	REQ-06.09.03-OSED-VG03.1003
Requirement	The visual reproduction may be augmented with additional (digital) information to provide the ATCO/AFISO a greater level of situational awareness.

[redacted] Visualisation – Characteristics

Identifier	REQ-06.09.03-OSED-VC03.1101
Requirement	The visual reproduction shall be designed so as to avoid unnecessary discontinuities or non-uniformities in terms of the presented scale, orientation and field of view of the area under observation by the ATCO/AFISO.

Identifier	REQ-06.09.03-OSED-VC03.1104
Requirement	The visual reproduction shall provide a smooth and regular impression of moving objects to the human eye.

Identifier	REQ-06.09.03-OSED-VC03.1105
Requirement	The time delay between image/data capture and presentation on the visual reproduction shall not affect the ATCO/AFISO's ability to perform the ATS service.

[redacted] Visualisation – Quality

Identifier	REQ-06.09.03-OSED-VQ03.1201
Requirement	During daylight CAVOK conditions, the ATCO/AFISO shall recognise an aircraft of type ATR72 or similar size on 4NM final.

Identifier	REQ-06.09.03-OSED-VQ03.1202
Requirement	During CAVOK conditions and when the topography of the surrounding terrain so permits, the ATCO/AFISO should visually judge the position of a light aircraft (e.g. C172 or P28A) in the traffic circuit. *Note: This can be accomplished with help of the binocular functionality if needed.*

Identifier	REQ-06.09.03-OSED-VQ03.1203
Requirement	During daylight CAVOK conditions, the ATCO/AFISO should visually judge gear down on an aircraft in the vicinity of the aerodrome. *Note: This can be accomplished with help of the binocular functionality if needed.*

Identifier	REQ-06.09.03-OSED-VQ03.1204
Requirement	During daylight CAVOK conditions, the ATCO/AFISO shall visually detect irregularities during landing or take-off of aircraft that requires the ATCO/AFISO to perform alerting service (e.g. engine fire/smoke, collapsing nose-wheel).

Identifier	REQ-06.09.03-OSED-VQ03.1205
Requirement	During daylight and good visibility conditions, the ATCO/AFISO should detect obstructions on the manoeuvring area.

Identifier	REQ-06.09.03-OSED-VQ03.1206
Requirement	Depending on visibility and daylight/darkness conditions, the ATCO/AFISO may observe significant meteorological conditions in the take-off and climb-out area.

[redacted] Visualisation – Augmentation

Identifier	REQ-06.09.03-OSED-VA03.1401
Requirement	The visual reproduction may incorporate overlaid information associated with a specific element or target in the visual field, aiding or facilitating detection, recognition, identification and ranging.

Identifier	REQ-06.09.03-OSED-VA03.1402
Requirement	The visual reproduction may incorporate overlaid information to indicate / high light specific parts of the aerodrome, such as runways, taxiways, in order to enhance the ATCO/AFISO situational awareness, specifically in darkness and low visibility conditions.

Identifier	REQ-06.09.03-OSED-VA03.1403
Requirement	The visual reproduction may incorporate overlaid information pertinent to the general area of interest or area of responsibility, in order to assist the ATCO/AFISO and minimise head down time.

Identifier	REQ-06.09.03-OSED-VA03.1404

Requirement	If any overlaid information - as defined in REQ-06.09.03-OSED-VA03.1401, REQ-06.09.03-OSED-VA03.1402 or REQ-06.09.03-OSED-VA03.1403 - is implemented in the visual reproduction, such overlaid information shall be possible to toggle on/off as well as adjust in light intensity by the operator.

[redacted] Visualisation – Binocular functionality

Identifier	REQ-06.09.03-OSED-BF03.1501
Requirement	The binocular functionality shall be as simple, quick and easy to use as manually operated binoculars (in a local tower).

Identifier	REQ-06.09.03-OSED-BF03.1502
Requirement	The visual representation provided by the binocular functionality shall be of sufficient quality (image sharpness, magnification, contrast) to support the related ATCO/AFISO tasks.

Identifier	REQ-06.09.03-OSED- BF03.1503
Requirement	The binocular functionality shall include a moveable zoom feature with a visual indication of the direction of bore sight.

Identifier	REQ-06.09.03-OSED-BF03.1504
Requirement	The binocular functionality should include predefined and user-definable positions (where a position is based on automatic (predefined / user-definable) zoom, pan-tilt and focus).

Identifier	REQ-06.09.03-OSED- BF03.1505
Requirement	The binocular functionality should include predefined and user-definable automatic scanning patterns, such as runway sweeps.

Identifier	REQ-06.09.03-OSED- BF03.1506
Requirement	The binocular functionality should include automatic tracking of moving aircraft, vehicles or obstructions (e.g. personnel or large animals).

6.3.5 Airport Sound Reproduction

Identifier	REQ-06.09.03-OSED-AS03.2001
Requirement	The ATCO/AFISO may access the actual outdoor sound from the remote airport.

Identifier	REQ-06.09.03-OSED-AS03.2002
Requirement	If a function for actual outdoor sound reproduction is implemented, the volume shall be adjustable and possible to be turned off by the operator.

6.3.6 Other ATS Systems / Functions

Identifier	REQ-06.09.03-OSED-FN03.3001
Requirement	The ATCO/AFISO should access an electronic system for the presentation and updating of flight plan and control data (in accordance with ICAO Doc 4444 Chapter 4.13).

Identifier	REQ-06.09.03-OSED-FN03.3002
Requirement	When RTC enables transfer of responsibility of ATS for aerodromes between RTMs within the RTC, the ATCO/AFISO shall access an electronic system for the presentation and updating of flight plan and control data (in accordance with ICAO Doc 4444 Chapter 4.13).

Identifier	REQ-06.09.03-OSED-FN03.3003
Requirement	If the RTM is equipped with an electronic system for the presentation and updating of flight plan and control data, the ATCO/AFISO should use pre-set functions for the most common actions, e.g. creating a new strip for a pop up VFR flight.

Identifier	REQ-06.09.03-OSED-FN03.3004
Requirement	Updates for flight plan and control data (as in Doc 4444 4.13.2) to other ATS units may be done automatically (as in not being performed by manual coordination by the ATCO/AFISO).

Identifier	REQ-06.09.03-OSED-FN03.300503.1301
Requirement	In low visibility conditions, the ATCO/AFISO may be notified about an aircraft or vehicle entering or vacating the runway. Note: Such notifications can be particularly helpful in low visibility conditions.

Identifier	REQ-06.09.03-OSED-FN03.3006
Requirement	The ATCO/AFISO may be warned about an aircraft or vehicle entering the runway without clearance.

Identifier	REQ-06.09.03-OSED-FN03.3007
Requirement	The ATCO/AFISO may be warned about an aircraft or vehicle entering the manoeuvring area without clearance.

6.3.7 Voice and Data Recording

Requirements in this section (of previous OSED versions) have been moved to the P12.04.07 Technical Specification.

6.3.8 Work Environment

Identifier	REQ-06.09.03-OSED-WE03.5001
Requirement	Working Environment should permit day light conditions equal to ordinary office establishments. *Note: In order to use projector or similar presentation solution, a dark room is likely to be needed.*

Identifier	REQ-06.09.03-OSED-WE03.5002
Requirement	Working Environment (noise, temperature etc) shall be according national regulations for normal office establishments.

Identifier	REQ-06.09.03-OSED-WE03.5003
Requirement	The ATCO/AFISO shall adjust the lighting conditions in the RTM in order to adapt to the conditions at the remote airport.

Identifier	REQ-06.09.03-OSED-WE03.5004
Requirement	If several RTMs are collocated in a RTC, the ATCO/AFISO shall control the lights individually for each RTM in a RTC.

Identifier	REQ-06.09.03-OSED-WE03.5005
Requirement	Sufficient writing space shall be available in the CWP to the ATCO/AFISO in order to make manual notes.

6.4 Additional Requirements for Multiple Aerodrome Applications

6.4.1 Concept Requirements Multiple Aerodrome Applications

Identifier	REQ-06.09.03-OSED-CM04.0001
Requirement	The ATCO/AFISO shall provide ATS for more than one aerodrome simultaneously from a single RTM..

Identifier	REQ-06.09.03-OSED-CM04.0007
Requirement	The Multiple Aerodrome Application part of the Remote & Virtual Tower Concept shall reduce the direct cost of gate-to-gate ATM in OFA06.03.01 by 0,48%.

6.4.2 Remote Functional Requirements

[redacted] Multiple handling

Identifier	REQ-06.09.03-OSED-MH04.1001
Requirement	For each RTM, the ATCO/AFISO shall provide service for all aerodromes under the responsibility of that RTM, at any one time.

Identifier	REQ-06.09.03-OSED-MH04.1002
Requirement	For each RTM, it shall be clearly indicated to the ATCO/AFISO which aerodrome(s) that ATS is/are under the responsibility of that RTM.

Identifier	REQ-06.09.03-OSED-MH04.1003
Requirement	For each RTM, the design shall ensure that there is no ambiguity for the ATCO/AFISO as to which aerodrome's systems are manoeuvred.

Identifier	REQ-06.09.03-OSED-MH04.1007
Requirement	The ATCO/AFISO shall be provided with all systems and data required to perform the ATS for all aerodromes under his/her responsibility.

[redacted] Communication

Identifier	REQ-06.09.03-OSED-MC04.2001
Requirement	When ATS is performed to more than one aerodrome simultaneously from one RTM, the ATCO/AFISO shall listen to all aeronautical mobile service (air-ground communications) communication channels for all aerodromes being served. Note: If a separate ground controller position is introduced, a separate communication channel for the control of traffic operating on the manoeuvring area would be needed for each aerodrome served by a ground controller.

Identifier	REQ-06.09.03-OSED-MC04.2002

Requirement	When ATS is performed to more than one aerodrome simultaneously from one RTM, the ATCO/AFISO shall for the aeronautical mobile service (air-ground communications), be able to transmit either to “all aerodromes” being served or to an “individual aerodrome”.

Identifier	REQ-06.09.03-OSED-MC04.2003
Requirement	When ATS is performed to more than one aerodrome simultaneously from one RTM, aeronautical mobile service (air-ground communications) may be retransmitted / relayed between all aerodromes being served from the RTM.

[redacted] Visualisation

[redacted] Visualisation – General

Identifier	REQ-06.09.03-OSED-MV04.3001
Requirement	The visual reproduction should be augmented with additional (digital) information to provide the ATCO/AFISO a greater level of situational awareness.

[redacted] Visualisation – Augmentation

Identifier	REQ-06.09.03-OSED-MA04.3101
Requirement	The visual reproduction should incorporate overlaid information associated with a specific element or target in the visual field, aiding or facilitating detection, recognition, identification and ranging.

Identifier	REQ-06.09.03-OSED-MA04.3102
Requirement	The visual reproduction should incorporate overlaid information to indicate / high light specific parts of the aerodrome, such as runways, taxiways, in order to enhance the ATCO/AFISO situational awareness, specifically in darkness and low visibility conditions.

Identifier	REQ-06.09.03-OSED-MA04.3103
Requirement	The visual reproduction should incorporate overlaid information pertinent to the general area of interest or area of responsibility, in order to assist the ATCO/AFISO and minimise head down time.

Identifier	REQ-06.09.03-OSED-MA04.3104
Requirement	If any overlaid information - as defined in REQ-06.09.03-OSED-MA04.3101, REQ-06.09.03-OSED-MA04.3102 or REQ-06.09.03-OSED-MA04.3103 - is implemented in the visual reproduction, such overlaid information shall be possible to be toggled on/off as well as adjustable in light intensity by the operator.

[redacted] Other ATS Systems / Functions

Identifier	REQ-06.09.03-OSED-MF04.4002

Requirement	Updates for flight plan and control data (as in Doc 4444 4.13.2) to other ATS units should be done automatically (as in not being performed by manual coordination by the ATCO/AFISO).

6.5 Contingency Applications

Requirements defined for Remote Provision of ATS to Aerodromes in Contingency Situations are different in nature from those catering to the Single and Multiple Aerodrome ATS provision; the difference and its rationale is discussed below. Notably, this section comprises both requirements and a number of recommendations regarding ATS in Contingency situations, if performed with help of the Remote & Virtual Tower Concept/Technology (or parts thereof).

6.5.1 Discussion

Both the Remote Provision of ATS to Single Aerodromes and Remote Provision of ATS to Multiple Aerodromes Operational Improvements are new concepts and both rely on the reproduction of a visual aerodrome view. As such, defining requirements for the Remote Provision of ATS to Single and Multiple Aerodromes is necessary at a detailed level in this OSED.

In contrast, contingency applications already exist as a solution at some larger airports and these come in a variety of forms and operational designs, ranging from some very simple solutions to more advanced ones (refer to Section 3.4.2 for a more comprehensive description). Some of these solutions at larger aerodromes, particularly those equipped with A-SMGCS, may not necessarily feature a direct or reproduced visual view.

One of the principal benefits that the Remote Provision of ATS can contribute in contingency situations is the provision of the OTW view. The visual reproduction can be a direct substitute for the local tower OTW view and be the primary means of visual surveillance where no other systems are available. Even just components of the Remote Tower Concept could be used to support the overall contingency solution, adding valuable benefits, e.g. one or several hot spot camera(s) covering specific part(s) of the manoeuvring area, etc.

For contingency solutions where A-SMGCS is available a high contingency capacity may be reached without the addition of visual reproduction. For larger airports equipped with A-SMGCS, on the occasion when the ordinary tower is fully obscured by clouds but the visibility at ground level is OK, for instance; operations may still be run without restrictions (dependent on airport local procedures, some airports may be capable of full capacity, some will need reduced capacity in the same situation) even though the ATCOs cannot see anything “OTW”. With the help the A-SMGCS system and the fact that the aircraft/pilots can still visually observe/detect each other, no specific LVP needs to be used, instead operations can be performed with a high capacity, although still less than 100% in most cases since flexibility is somewhat lost without the visual view. The addition of a visual reproduction is therefore expected to anyhow bring additional benefits, enabling to deliver closer to 100% capacity by removing some or all of these restrictions. A cost benefit analysis centred on the potential improvement in operating capacity will be necessary to determine the value of the benefit.

Therefore the stance taken is that while the Remote Functional Requirements as defined in this document *may* be applied in contingency situations, the fact that solutions can exist independent of those requirements must be acknowledged.

Instead, this document defines higher level, placeholder type requirements and a separate set of recommendations, intended to guide and standardize the application design process. The process itself would be the responsibility of the service provider and with it, the determination of the cost benefit analysis of the chosen configuration.

Also, based on the discussion above, it is the belief of P06.09.03 that the target airports for the full concept of “Remote Provision of ATS to Aerodromes in Contingency Situations” will be divided into the two following categories:

- Primary target airports:
  Medium sized airports without A-SMGCS. Airports that are generally too big to be considered

to be in the primary scope of full time Remote Tower operations (primary target airports for full time Remote Tower operations are small rural airports, in the longer term possibly also medium/larger airports), but too small to bear the investment of an A-SMGCS system. (European example airports are: Stockholm/Nyköping Skavsta, Stockholm Bromma, Malmö Sturup, Stavanger, Bergen, Tampere, Rovaniemi, Oulu, Bilbao, Santiago, Valencia and Ibiza.)

- Secondary target airports:
  Medium to large airports equipped with A-SMGCS. Airports that would be more likely to implement a solution without a visual reproduction, but which could have high interest in using components from the Remote Tower Concept & technology.

6.5.2 Recommendations

For airports already equipped with A-SMGCS, it's likely that a contingency solution would make use of that system in the contingency TWR facility as well. However, as already mentioned, there would be many benefits from also including a visual reproduction of some kind as developed by the Remote Tower Concept.

For the ATCO it is much easier to handle traffic if he/she can visually see OTW, compared to only having the A-SMGCS as an input source. Traffic can be handled in a much more flexible way and with a more instinctive feeling, especially at airports with a complex airport design and complicated taxi procedures. Hence, even though formally there are no limitations in capacity, flexibility will increase greatly with the help of visual surveillance or a reproduction thereof. Fore mostly, if it is possible to visually observe the manoeuvring area and the vicinity of the aerodrome, safety is increased since phenomena can be seen that would not otherwise be seen, e.g. engine fire and obstructions / foreign objects on the runway. Also a quicker ATCO feedback in case of go-arounds etc is obtained. However it is acknowledged that these benefits (higher flexibility and increased safety) are hard to quantify.

If an ANSP or airport owner decides to build up an ATS contingency solution using the Remote Tower Concept, whether the airport is equipped with A-SMGCS or not, the Remote Functional Requirements from this project and document (as outlined in Section 6.3) can be used as a baseline set of requirements to support the implementation. However, in the context of Contingency Operations they are not mandatory.

6.5.3 Requirements

This section outlines the operational requirements for ATS to Aerodromes in Contingency Situations, if based on the Remote Tower Concept/Technology (or parts thereof).

[redacted] Concept Requirements Contingency Applications

Identifier	REQ-06.09.03-OSED-CC05.0001
Requirement	The ATCOs shall provide ATS for an aerodrome from a Remote Contingency Tower (RCT) in situations where the primary ATC tower is not usable.

[redacted] Performance and Functional Requirements

Identifier	REQ-06.09.03-OSED-CF05.1001

Requirement	For each contingency application, minimum requirements on safety, security, reliability and adaptability shall be defined.

Identifier	REQ-06.09.03-OSED-CF05.1002
Requirement	For each contingency application, minimum requirements on capacity, duration of service and switchover time shall be defined.

Identifier	REQ-06.09.03-OSED-CF05.1003
Requirement	For each contingency application, the required level of commonality of HMI shall be defined with respect to the tower being served by the contingency application.

Identifier	REQ-06.09.03-OSED-CF05.1004
Requirement	For each contingency application the character and form of visual reproduction, airport sound reproduction, other ATS systems/functions and working environment shall be defined.

6.5.4 Other considerations

Apart from the strict “visual reproduction related” aspects, there are some other general aspects to be considered when setting up a contingency solution for an airport:

- Split of infrastructure. Depending of the desired robustness of the contingency system, considerations regarding reduction of the number of common cause failures needs to be taken. An appropriate level depending on a local assessment needs to be found.
- There needs to be system support, routines and local solutions in place for the transition phases between normal and contingency operations.
- The Contingency solution, or elements thereof, can also support the ordinary tower service provision in various ways;
    - e.g. by providing blind spot coverage using video cameras,
    - and/or being used as a recurrent training facility.
- In terms of HMI commonality between the contingency solution and the Tower being served, a balance will need to be found between the benefit in controller confidence stemming from a high level of commonality, and adaptability of the solution to serve multiple aerodromes, whether on a contingency or full ATS provision basis (as in the Single or Multiple concepts).

7 References

7.1 Applicable Documents

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

[1] SESAR B4.2 Initial Service Taxonomy document

[2] SESAR Requirements and V&V Guidelines, Edition 03.00.00, March 2012

[3] SESAR Templates and Toolbox User Manual, Edition 03.00.00, March 2012

[4] SESAR Operational Service and Environmental Definition (OSED) Template, Edition 00.00.00, Version 03.00.00

[5] SESAR RVT Framework Regulatory Impact Assessment Report, C.03, Edition 00.03.00, April 2013

[6] SESAR RVT Rules and Regulations Assessment Report, D03, Edition 00.01.01, November 2012

7.2 Reference Documents

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

[7] SESAR WP6.2 Airport DOD for Step 1 – Yearly update 2013, Version 00.01.01, December 2013;

[8] SESAR WP6.2 Airport DOD for Step 2, Interim Version (Interim) 00.01.00, March 2014;

[9] The Convention on International Civil Aviation, Annex 11, Air Traffic Services, Chapter 2.30 (Amendment 46)

[10] ICAO Document 4444 "Procedures For Air Navigation Services - Air Traffic Management", 14th Edition, November 2005;

[11] EUR Doc 13 "European Guidance Material On Aerodrome Operations Under Limited Visibility Conditions", 3rd Edition, June 2008;

[12] EUROCONTROL "Manual for AFIS, 1st Edition, October 2010;

[13] ICAO Document 9426 "Air Traffic Services Planning Manual", 1st Edition, December 1992;

[14] CAA Air Navigation: The Order and the Regulations, CAP 393, 10TH August 2012.

[15] EUROCONTROL Guidelines for Contingency Planning of Air Navigation Services (including service continuity), Edition 2.0, April 2009

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