Remote Tower Technical Specifications

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Abstract

The objective of this document is to produce a technical specification that should work as a generic specification for Remote Tower for the future, and not as a template for implementation of a specific prototype. The Remote Tower is a new area without any earlier specifications and there is a need to write a specification foundation for the total concept.
This technical specification will be produced in four iterations:

- Iteration1 (D05) - First draft of Single Remote Tower
- Iteration 2 (D06) - Finalizing Single Remote Tower draft and first draft of the Multiple Remote Tower & Contingency
- **Iteration 3 (D07) - Finalizing Multiple Remote Tower & Contingency**
- Final iteration(D09) - Finalizing all parts of the document

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None.

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Table of Contents

List of figures

Executive summary

This document defines the general functional capabilities and technical requirements that satisfy the P06.09.03 OSED for Remote Provision of ATS to Aerodromes. The purpose is not to answer *how* a remote/virtual tower is implemented nor to describe a specific solution, but to describe on a general level the functionality such a solution must provide in order to fulfil the operational methods and scenarios described in the OSED. The purpose is also to provide a requirement description that fulfil the operational and functional requirements, and that can be used by stakeholders to procure a specific implementation.

The OSED describes three new SESAR operational methods, all addressed from a technical perspective in this document:

- Remote Provision of Air Traffic Services for a Single Aerodrome;
    - 12.04.07 has developed three platforms, that have been validated by 06.09.03
        - Two platforms in (airport site -> RTM site) Ängelholm->Sturup, Sweden
        - One platform in Vaeröy->Bodö, Norway
- Remote Provision of Air Traffic Services for Multiple Aerodromes;
    - 12.04.07 has developed three platforms that have been validated by 06.09.03
        - One platform in Sundvall/Örnsköldsvik->Sundsvall
        - One platform in Röst/Vaeröy->Bodö
        - One platform for simulation in Växjö->Växjö
- Remote Provision of Air Traffic Services in Contingency Situations at Aerodromes
    - 12.04.08 has developed two platforms that have been validated by 06.09.03
        - Both in Landvetter->Landvetter.

The main change in the new operating methods is that the ATCO of AFISO will no longer be located at the aerodrome. They will be re-located to a Remote Tower Centre. The views of the aerodromes are then visually reproduced in the Remote Tower Centre using either Remote Tower technology (live video capture using cameras) and/or Virtual Tower technology (3D models supported by surveillance data). This document will not cover the virtual tower concept in any depth, since no validations have been made on that platform.

The content of this document will be based both on experience from previous projects as well as a series of P06.09.03 remote tower validations within all three mentioned operational applications.

1 Introduction

1.1 Purpose of the document

This document describes the functions of a remote tower solution and provides a requirement specification for those functions. The aim is not to answer *how* a remote tower is implemented nor to describe a specific remote tower solution, but to describe on a general level the functionality such a solution must provide in order to fulfil the operational methods and scenarios described in the P06.09.03 OSED for Remote Provision of ATS to Aerodromes. The purpose is also to provide a requirement description that can be used by stakeholders to procure such a technical solution.

Previous versions of this document aimed to define a “virtual tower” concept in addition to remote tower, but this ambition has been dropped since no validation platform of this concept has been produced or validated.

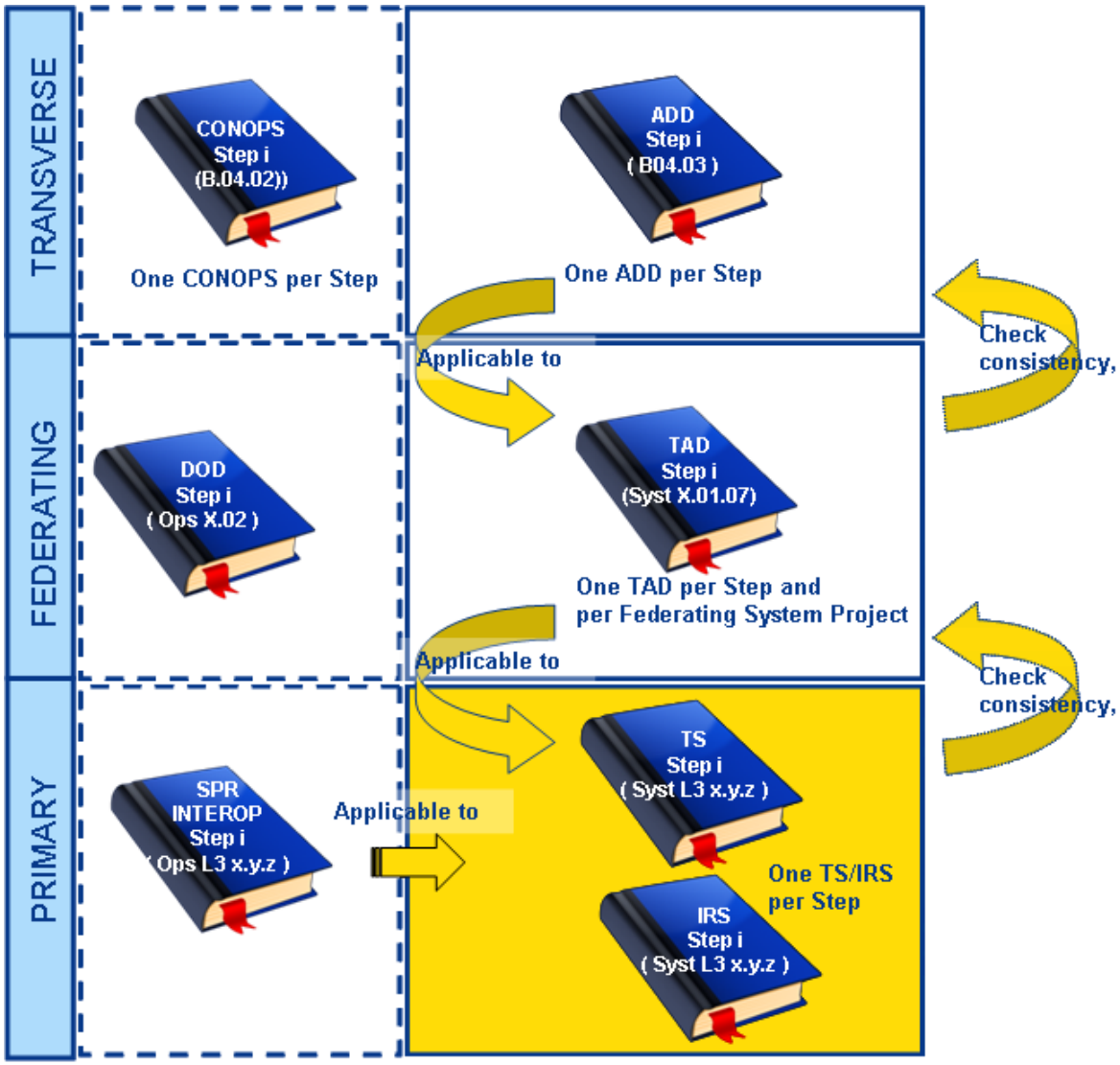

Figure 1 - The position of the technical specifications with regards to the other SESAR deliverables

The target architecture will be defined in the ADD, while the further breakdown will be done in the TAD for each ATM system and in the TS/IRS for each ATM ‘functional block’. This document will

address the P12.01.07 TAD functional blocks impacted by the concept. This information will be used in a “bottom-up” approach to extend the TAD with relevant architectural design.

In addition, the technical specifications will satisfy the operational and functional requirements described in the P06.09.03 OSED.

1.2 Intended readership

The intended audience for this document are corresponding operational project P06.09.03 and related technical project P12.04.06. The functional description is of interest to P12.01.07 for functional decomposition of the Tower CC domain using a “bottom-up” approach.

- In the extension of the SESAR programme, the document is aimed at air navigation service providers (ANSPs) or airport owners/providers for procurement of a remote or virtual tower solution, and for the concerned industry to develop such a solution.

1.3 Inputs from other projects

A proof of concept remote tower platform was developed by Saab and LFV in the Remotely Operated Tower (ROT) project. The purpose of the ROT project was to prove that air traffic services could be provided from a remote location. The platform was further enhanced during the Advanced Remote Tower (ART) project. This platform is used as a background technology base in the project for validating new features and concepts with SESAR.

P06.09.03 is providing all the operative input required to develop the technical specifications, including the OSED, safety assessments, human factors aspects etc.

- During the project lifetime, P12.04.06 is continuously providing technical enablers that are integrated into the validation platforms.

1.4 Structure of the document

This document is organized as follows:

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

Chapter 2: General functional blocks description

Chapter 3: Functional block Capabilities, Conditions and Constraints

Chapter 4: Assumptions

Chapter 5: Referenced documents

Appendix A: Human factors - CWP and OTW view

1.5 Requirements Definitions – General Guidance

The requirements in this document have been developed according to the SESAR Requirements and V&V Guidelines (ref.[2]) and the SESAR Template Toolbox (ref.[3]).

1.6 Functional Block Purpose

The Technical Architecture Description (TAD) [5] contains a functional breakdown of the Tower Capability Configuration (Tower CC), describing the Aerodrome ATC domain. The Aerodrome Voice Domain is also addressed in this technical specification, which is defined in the Architecture Description Document (ADD) [6]. The objective of the *Remote Provision of ATS to Aerodromes* concept is to provide *all* applicable functions within these domains, but to do so from a remote location i.e. not from the Control Tower local to the aerodrome.

- As the domains themselves are the target for the concept rather than the functional blocks within the domains, more than one functional block will be addressed in this document. The technical differences between the current operating method and Remote Provision of ATS are described in chapter 2.6, in the context of each functional block.

1.7 Functional Block Overview

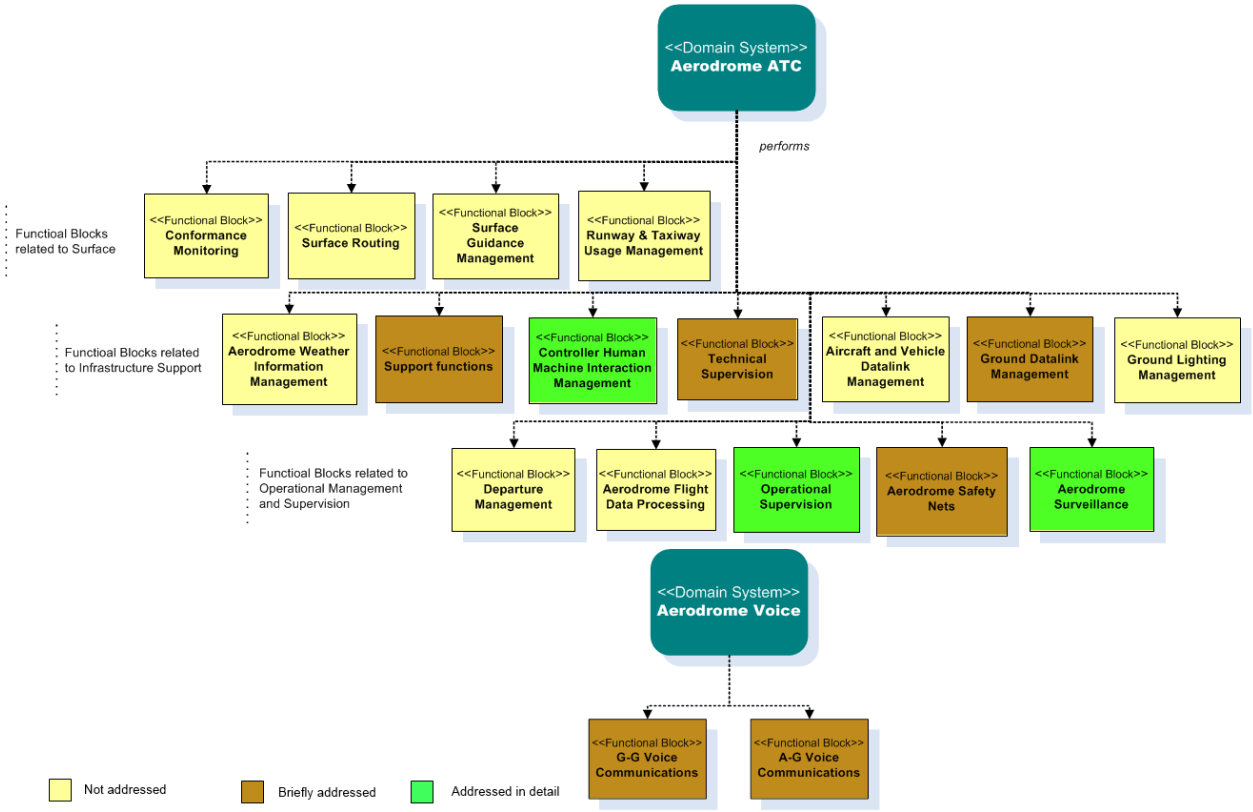

Figure 2 - Addressed functional blocks

Figure 2 shows the functional blocks within the domains impacted by the *Remote Provision of ATS* concept. Some blocks are substantially impacted (marked green in Figure 2) and will be addressed in detail in this document:

- **Controller Human Machine Interaction Management** provides the controllers with a graphical user interface and with the means to interact with the aerodrome ATC system. This document will address a graphical user interface that allows an ATCO or AFISO to remotely provide ATS to multiple aerodromes simultaneously from a single working position.
- **Aerodrome Surveillance** provides controllers with airport situational awareness on landing / take-off paths, apron(s), runways(s) by providing position and identification, using the ground correlation manager function, of all surface traffic (aircraft and vehicles). It merges the surveillance information provided by the different surveillance sources to provide a unique picture of the actual traffic situation. The remote tower implementation will use these sensors (with the possible addition of camera sensors) and provide the ATCO or AFISO with a visual reproduction of the aerodrome to allow ATS to be provided remotely.
- **Operational Supervision** allows the supervisor to manage the most appropriate operational configuration, according to traffic demands and needs, and to react in case of system fault, re-assigning and distributing available resources in order to maintain adequate safety levels and quality of service. The remote tower concept introduces a new description of the operational supervision in the context of a Remote Tower Centre.

Some of the functional blocks will be impacted in a minor way only (marked brown in Figure 2) and will only be briefly addressed in this document. They include:

- **Support functions:** Recording of visual aerodrome data.
- **Technical Supervision:** Increased focus on remote and centralised supervision.
- **Aerodrome Safety Nets:** New safety net opportunities with visual data available.
- **Ground Datalink management:** Increased focus on performance
- **G-G / A-G Voice communications:** Limitations on local aerodrome solutions.

1.8 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.

Actor is specified as role played by a user or any other system that interacts with the system (subject).

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.

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.

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.

Single Remote Tower is where a remote tower module is able to connect to a single airport at a time. (May connect to more than one airport, but not in parallel.)

Multiple Remote Tower is where a remote tower module is used to control several airports in parallel.

Local/Remote Control refers to the current state of a Remote Controlled Airport (RCA) in respects of from where ATS is provided for the aerodrome at the moment. It is either controlled from the local tower (Local Control) or from an RTC (Remote Control). Example use: "*The airport is controlled locally during day-time and controlled from the RTC during night-time*" or "*Local Control is transferred to the RTC during unforeseen events that does not allow ATS to be provided from the Tower*".

CWP (Controller Working Position) is the operator (ATCO/AFISO) work station including necessary ATS systems. Unlike Remote Tower Module (RTM), the term CWP excludes the visual reproduction.

Visual Presentation 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 of the aerodrome and its vicinity. Note that other terms such as Visual Reproduction and Visual

Representation have been applied throughout the lifetime of the projects. The definition of the terms should be taken as identical to the definition provided for visual presentation.

OTW view (Out-The-Window view) is a narrower term than visual reproduction and only refers to the actual view of the aerodrome (as the ATCO would have through the window of a tower, hence the name). Example use: "*The coverage of the OTW view is 42 degrees vertical and 360 degrees horizontal*".

Video image refers to the image produced by the airport camera sensors. It is either used to describe a data or network flow or when talking about characteristics of the image rather than the entire view (OTW view). Example use: "*The visual reproduction is in a degraded mode if one or more video images are delayed, frozen, corrupt or unavailable*".

Remote Tower Module (RTM) is the term for the complete module including both the CWP(s) and the Visual Reproduction display screens.

A **Remote Tower Centre** (RTC) is a building where ATS are provided to one or more aerodromes. It usually includes several RTMs (or only one, if that single RTM enables ATS to more than one aerodrome).

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

PTZ (Pan-Tilt-Zoom) is a technical solution used in the trials to fill the function of the binoculars in a Tower. It comprises (at least) a zoom camera mounted on a pan-tilt head. The movement and zoom can be controlled from the RTC.

1.9 Acronyms and Terminology

Term	Definition
ACC	Area Control Centre
ADD	Architecture Definition Document
ADS-B	Automatic Dependant Surveillance - Broadcast
AFIS	Aerodrome Flight Information Service
AFISO	Aerodrome Flight Information Service Officer
APOC	AirPort Operations Centre
APP	Approach
A-SMGCS	Advanced Surface Movement Guidance & Control System
ART	Advanced Remote Tower Research Project
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management

Term	Definition
ATS	Air Traffic Service
CPDLC	Controller Pilot Data Link Communications
CWP	Controller Working Position
D-ATIS	Digital Automatic Terminal Information Service
DCL	Departure Clearance
DLIC	Data Link Initiation Capabilities
DOD	Detailed Operational Description
E-ATMS	European Air Traffic Management System
ICAO	International Civil Aviation Organization
ILS	Instrumental Landing System
INTEROP	Interoperability Requirements
IRS	Interface Requirements Specification
MLAT	Multi-Lateration
OSED	Operational Service and Environment Definition
OTW	Outside The Window
ROT	Remotely Operated Tower (proof of concept project)
RTC	Remote Tower Centre
RTF	Remote Tower Facility
RTM	Remote Tower Module
RVT	Remote and Virtual Tower Project
SESAR	Single European Sky ATM Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SMR	Surface Movement Radar
SLG	Signal Light Gun

Term	Definition
SPR	Safety and Performance Requirements
TAD	Technical Architecture Description
TS	Technical Specification
TWR	Aerodrome Control Service (which is a subset of ATC Service)
VCS	Voice Communication System

2 General Functional Block Description

2.1 Context

The main change about Remote provision of ATS for Aerodromes is that the ATCO or AFISO will no longer be located at the aerodrome. They will be re-located to Remote Tower facility or a Remote Tower Centre (RTC) which will be remotely connected to (at least) one airport being able to perform all ATS tasks from this remote location.

In order to provide Remote TWR Air Traffic Control Service, the remote location will require a visual representation of the aerodrome in which ATS is to be provided through the use of cameras or other sensors that will be placed at the local aerodrome.

It should be noted that technical elements required for the provision of ATS from a Remote location are (usually) common to single, multiple or contingency concepts.

2.1.1 Visual reproduction

The visual reproduction in the Remote Tower replaces the OTW view from the local tower building.

The OTW view is obtained by a number of cameras, mounted on top of the local tower or on a separate tower structure, covering partial or totally the tower field of view.

Those cameras capture the image at the local aerodrome and reproduce it over display screens arranged around the controller.

- Binocular Function: A binocular functionality performed by Pan-Tilt Zoom (PTZ) cameras should replace the manually operated binocular which is currently used in the local aerodrome tower to facilitate the visualisation of certain items of interest. (e.g. engine on fire, landing gear extended..)

- Advanced Visual Features:
  - Automatic visual tracking: The PTZ camera will be used for the automatic visual tracking of objects. The automatic visual tracking may increase the ATCO's / AFISO's ability to spot and follow relevant objects.

  - Overlay information: The visual reproduction may be enhanced with additional overlaid information, such as meteorological conditions (e.g. QNH, actual wind, RVR…), flight information obtained from Flight Plan Data, etc.

  - Low Visibility conditions or darkness: Low Visibility Conditions require specific procedures even when operating from a remote location. That procedures can include advanced technology such as infrared cameras which provides a thermographic representation of the focused area, could be used as a supplement to the regular cameras enhancing controller vision during that periods.

  - Additional viewpoints: Additional cameras may be used at selected positions such as, hot spots or dead zones not visible from the local tower, to enhance the situational awareness of the controller.

2.1.2 Controller Working Position

The controller should be provided with a Controller Working Position (CWP) which enables the provision of ATS from an RTC. The system should fulfil the characteristics of the aerodrome to be controlled, along with new features that would help the controller.

As main features the CWP should contain:

- Electronic or Paper Flight Strips
- Ground/Air Communications

Some other functionalities should be also useful depending on the local needs

- Air situation display
- Ground situation display
- Functionality for manoeuvring and controlling:
    - Airport lights;
    - Signal Light Gun;
    - Navigation aids;
    - ILS;
    - Alarms;
    - Other airport systems.

2.1.3 Aerodrome Sound

In order to improve the situational awareness of the controller, aerodrome's background sounds can be captured with a microphone and played back in the RTC.

2.2 Functional Block Modes and States

Functional blocks Modes and States here analysed come from the Functional Breakdown of the Aerodrome ATC and Aerodrome Voice Domain Systems provided in the TAD [5] by 12.01.07, as depicted in section 1.7.

The main functional blocks addressed in this process are:

- Controller Human Machine Interaction Management: This functional block provides controllers with a graphical user interface and with the means to interact with the Aerodrome ATC system.

  CHMIM functional block main responsibility is to provide any relevant information to the external actor and provide any support for actor's insertion of new information or modification of the existing information through the HMI.

- Aerodrome Surveillance: This functional block is dedicated to the acquisition, handling and processing of video that will be displayed in the remote tower as replacement of the OTW view from the local tower.

- Operational Supervision: This functional block allows the Supervisor to manage the most appropriate operational configuration, according to traffic demand and aerodrome needs, and to react in case of system fault, re-assigning and distributing available resources in order to maintain adequate safety levels and quality of service.

Being partially addressed the following functional blocks:

- Technical Supervision: This functional block is in charge of the technical supervision of an Aerodrome ATC system. The Technical Supervision encompasses the following functions:
    - Presenting technical and functional systems status.
    - Acquire, synthesize and display technical and functional status on all the system hardware/software resources.
    - Providing failure detection and analysis assistance.
    - Provide support for analysis of supervision data.
    - Providing supervision commands and actions.
- Support Functions: The Support functions do not affect directly the provision of ATM Services at operational time. They contain at least the following:
    - Recording - performing the recording of the ATM System data related to the Aerodrome ATC, and buffering those data on a persistent database.
    - Playback - providing support for display and voice recording, display and voice playback, other data recording and reduction, etc.
    - Data analysis - providing support for maintenance, investigation etc.
    - Airport Sound - providing real time environment sound from the airport to increase situation awareness for the controller.

    In context of a video based remote tower supporting functions will be extended by recording of video streams and additional audio feed (from the airport environment).
- Aerodrome Safety Nets: This functional block detects and triggers alerts within manoeuvring areas, potential conflicts **between two objects** or between an object and a restricted area, by processing the actual traffic situation. It is also extended on final approach and take-off path.
- Ground Datalink management: The Ground Datalink Management provides the front-end processing to exchange flight data and environmental data with the other systems, aircraft operators, other civil ATS Units.
- G-G / A-G Voice communications: This functional block is responsible for the air-ground communication. Its main role is to handle datalink messages, supporting the exchange of the messages between the TWR and the vehicles and/or the aircraft-aircraft on ground.

2.2.1 Modes

As outlined in the P06.09.03 OSED chapter 1.2, the remote tower concept can be divided into three configurations according to the type of operation:

- Single Remote Tower:
    - Allows the controller to provide ATS to one airport from a single remote tower module.
- Multiple Remote Tower:
    - Allows a single controller to provide ATS to multiple airports from a single remote tower module.
    - Clustered control with an RTC supervisor position.
- Contingency Remote Tower:
    - The controller provides ATS from an alternate facility due to a planned or unplanned event.
    - In case of Remote Tower locations available, trained and licensed ATCOs that could take over control are required.

Each configuration has its particular characteristics and functional block adaptations that will be described hereafter.

2.2.1.1 Single Remote Tower

The following characteristics and functional block adaptations for the Single Remote Tower will be taken in to account:

- Aerodrome Surveillance: One controller provides ATS to one airport from a single remote tower module. So the image to be displayed should be individual from the airport to be controlled.
- Operational Supervision: This function is hosted in the remote tower centre and will be equivalent to the standard tower.
- Support Functions: This functional block is independent to the configuration to be used.
- Technical Supervision: This functional block is independent to the configuration to be used.
- Controller Human Machine Interaction Management: The controller working position should be equivalent to the standard tower.
- Aerodrome Safety Nets: This functional block is independent to the configuration to be used.
- Ground Datalink management: This functional block is independent to the configuration to be used.
- G-G / A-G Voice communications: This functional block is independent to the configuration to be used.

2.2.1.2 Multiple Remote Tower

The following characteristics and functional block adaptations for the Multiple Remote Tower will be taken in to account:

- Aerodrome Surveillance: For a multi remote tower scenario, in which one controller can provide ATS to multiple airports, the images should be managed in a way that conflicting situations are avoided (e.g.: CWP and OTW view are the same tower, OTW view and PTZ camera displays information of the same tower, etc). Special attention should be paid to control functions for dedicated resources such as PTZ control or camera settings to avoid change the settings or take the control of the wrong PTZ.
- Operational Supervision: This function will be extended to provide some planning and resource allocation capabilities to the supervisor (see chapter 2.4.2).
- Technical Supervision: This functional block is independent to the configuration to be used.
- Support Functions: This functional block is independent to the configuration to be used.
- Controller Human Machine Interaction Management: The controller working position has to handle information of multiple Aerodromes. This is related to the visualisation part, flight data display, support information and surveillance information.

  The supervisor role defines which airports are assigned to a dedicated controller and which information needs to be displayed on the HMI.
- Aerodrome Safety Nets: This functional block is independent to the configuration to be used.
- Ground Datalink management: This functional block is independent to the configuration to be used.
- G-G / A-G Voice communications: This functional block is independent to the configuration to be used.

2.2.1.3 Contingency Remote Tower

The following characteristics and functional block adaptations for the Contingency Remote Tower will be taken in to account:

- Aerodrome Surveillance: Both single and multiple characteristics can be applied depending on the configuration used and the airport characteristics.
- Operational Supervision: Both single and multiple characteristics can be applied depending on the configuration used and the airport characteristics.
- Technical Supervision: This functional block is independent to the configuration to be used.
- Support Functions: This functional block is independent to the configuration to be used.
- Controller Human Machine Interaction Management: The CWP will be made to be as similar to the local tower CWP as possible in order to reduce the familiarisation time and the potential stress induced by a contingency event.

  An existing RTC which is used for either single or multiple aerodromes could be used in contingency cases
- Aerodrome Safety Nets: This functional block is independent to the configuration to be used.
- Ground Datalink management: This functional block is independent to the configuration to be used.
- G-G / A-G Voice communications: This functional block is independent to the configuration to be used.

2.2.2 States

The remote tower can be in one of the following states:

- Connected: Remote Tower Centre is connected to an airport or multiple airports.
- Disconnected: Remote Tower Centre is disconnected to an airport.

Besides the states of the remote tower, different causes could lead to a non-normal provision of remote control. The functional blocks depicted should foresee the following operating states:

- Normal:
  - The extended visualisation is working fine;
  - The CWP provides continuous operational service. All functions are in use.
- Degraded:
  - The extended visualisation is affected from some kind of malfunctioning (i.e. delay in presenting remote situation to the operator);
  - As a result of failure, a function can automatically or manually be switched off leading to a degraded mode of operation. The user can continue working with the CWP but some functions are missing.
- Failed/Unavailable:
  - The OTW visualisation is unavailable (i.e. picture frozen, delayed, lost or defect);
  - A significant set of CWP functions, necessary for the continuation of the operational service, are not available. The user cannot use the system anymore.

2.2.2.1 Switch from local TWR to Remote TWR

In order to successfully manage the remote provisioning of air traffic services from a location rather than the local tower (if such exists), functional blocks have to be extended to manage the 'context switch' from local to remote provisioning.

The switch between local and RTC can be performed during different times according to the level of operation:

- Nights or seasonal time periods of low density traffic that can be easily managed from a remote location.
- Planned events such as planned maintenance/outage in the Control Tower.
- Unplanned events which would tend to be emergency situations.

This transition is performed through three main steps.

- **Local Control:** the air traffic service is performed by the local tower.
- **Transferring Control**: the air traffic service is still provided locally, but data is also being transferred to the remote location for shadow operations / transfer of control initiation.
- **Remote Control:** the remote site is ready to assume responsibility of the service. Upon successful completion of this protocol, the responsibility for providing air traffic services will fall under remote site personnel.

In a multi remote tower setup additional transition steps are required to handle a switch over from one airport to another. In such a concept an operational supervisor need to dispatch resources and assign and coordinate an airport to a dedicated controller working position in the remote tower centre.

In an unplanned contingency operation, when the disruption of the service is caused by an unforeseen event, which could lead to immediate interruption of local operation (sudden event), the switchover could not be handled in the same manner.

2.3 Major Functional Block Capabilities

The requirements are structured as follows

- Baseline concept requirements
- General service/functional requirements
- Remote functional requirements
- Additional requirements for Multiple aerodrome applications
- Contingency applications

This structure mirrors the structure for the OSED requirements as in ref [4].

Since it is assumed that this specification is on a general level, many of the requirements will be written as 'may', which means there may be a need to write a requirement about this topic. Then for a specific implementation of a prototype there is a need to produce a complementary specific requirements specification where there should be a 'shall' or 'should' requirement addressing that topic.
Each requirement is prioritised as one of the following:

- **Essential:** Indicates that the requirement is mandatory. A failure to meet an essential requirement implies that the implementation does not fully support the concept of remote control as defined in the WP06.09.03 *OSED for Remote Provision of ATS to aerodromes*. Essential requirements are indicated by the word ***shall*** in the requirement text.
- **Important:** Indicates that the requirement is important. A failure to meet an important requirement implies a limited performance of the implementation. Important requirements are indicated by the word ***should*** in the requirement text.

- **Desirable:** Indicates that the requirement is optional. Desirable requirements should be taken into account if they not significantly affect cost or schedule. Desirable requirements are indicated by the word ***may*** in the requirement text.

A configuration field is included in the trace table of each requirement. The configuration states for which of the following implementation configurations that the requirement applies to. Requirements that apply to all of the configurations are marked ***All***. Note that a single installation can support several configurations. For example, a CWP can be used both for simultaneous control of multiple airports and still act as a contingency CWP for one (or more) of those airports.

- **Single:** The single remote tower configuration is where a module and CWP can be connected to and support a single remote tower at a time. The module and CWP can be switched from one airport to another in sequence. Requirements that are specifically for single configurations are marked ***S***.

- **Multiple:** In a multiple configuration implementation, a module and CWP enable ATS to be provided for two or more airports in parallel, at the same time. Requirements that are specifically for multiple configurations are marked ***M***.

- **Contingency:** The contingency configuration is referring to when a module and CWP is used as a redundancy for an ordinary tower. Control is transferred to the remote tower system from a local tower during emergency or planned maintenance. Requirements that are specifically for contingency configurations are marked ***C***.

2.4 User Characteristics

2.4.1 ATCO/AFISO

The ATCO/AFISO will have main responsibility for the provision of ATS.

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, arrival management, departure management and flight data processing. The AFISO is responsible for the provision of the AFIS.

2.4.2 RTC Supervisor

A new role for consideration when providing ATS remotely is the RTC Supervisor. In the same way that an ACC/Approach Supervisor is responsible for the general management of all activities in the Operation 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 a separately appointed person.

During a shift, an RTC Supervisor role can manage the allocation of staff and CWP´s at any one time during the shift in order to provide an efficient set up at all times and guarantee a flexible system. The 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.

In order to maintain the overall traffic picture required for the staff/CWP allocation, the Supervisor may either:

- Be a separate and extra role with overall responsibility for the management of the RTC. The Supervisor maintains overall vision 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 Supervisor CWP. The Supervisor would be expected to perform the planning, administration, staff management and staff 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;

- Perform the role in combination with the duties of a regular ATCO/AFISO, and therefore not be a separate role.

2.4.3 Airspace Users

The airspace users (Flight Crews) 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.

2.4.4 Technical personnel

Matters regarding calibration, maintenance and testing will be addressed by qualified engineers and technicians such as Air Traffic Electronic Personnel (ATSEP) who may monitor the status of systems and perform maintenance as appropriate, both on the remote facility site and the airport side and related systems.

2.4.5 Other stakeholders

Other stakeholders might be:

- Airport Rescue Units; could utilize by external sharing of the visual reproduction for quick response and localization of the emergency, even during low visibility and without being dependent on information passed on by ATCO personnel.
- Airport 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.
- Ordinary control tower personnel; could benefit from increased situational awareness by the introduction of parts of the RVT technology into ordinary control towers.
- Local airport officers

2.5 Operational Scenarios

The operational scenarios are described in the OSED [4] chapter 5.

2.6 Functional

2.6.1 Functional decomposition

The functional decomposition of the remote tower system (see Figure 3: Aerodrome ATC Domain system and Aerodrome Voice Domain system - Functional Breakdown) is based on the component structure defined for the standard tower (project B4.3 ref [6]). Some of the components defined in the ATC Domain System will be not used for airports categorized for remote tower usages in terms of movements and capacity (as defined in the operation concept DEL-06.09.03-D04-OSED ref.[4]). On the other hand, specific components might be enhanced with additional functionality required to support the remote tower operational scenario.

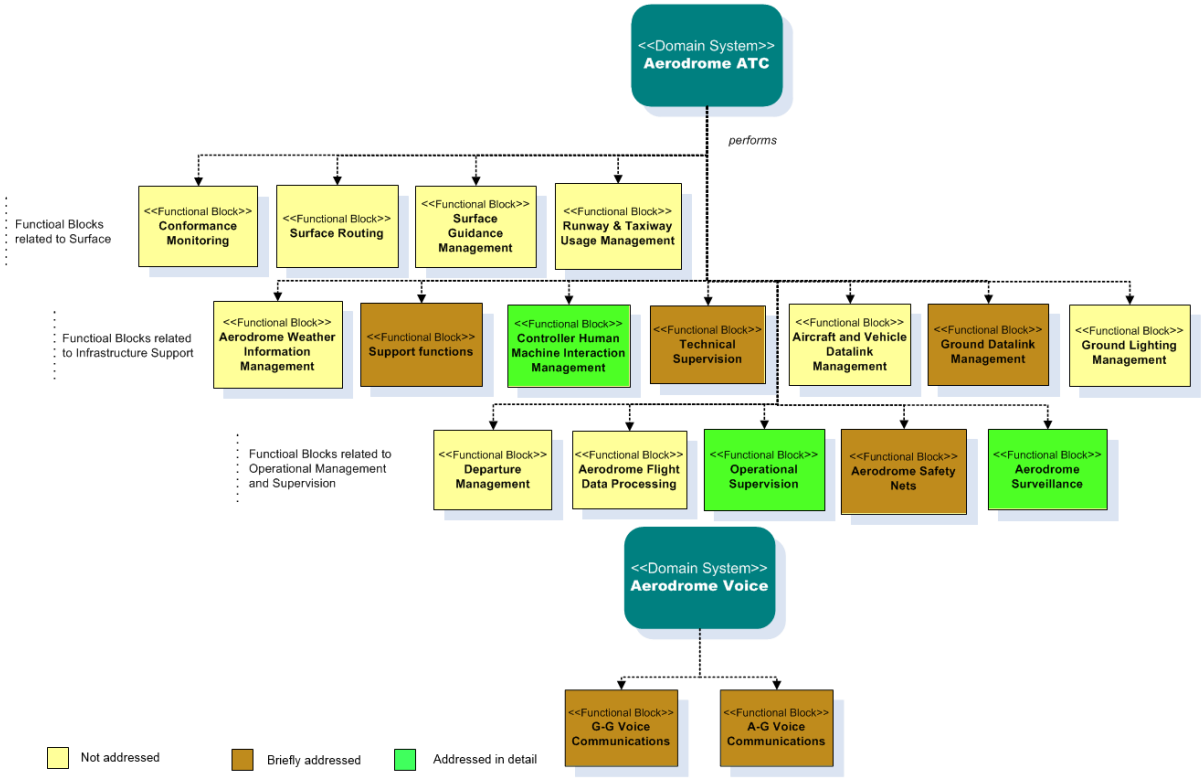

Figure 3: Aerodrome ATC Domain system and Aerodrome Voice Domain system - Functional Breakdown

This chapter will provide an overview of the functional components that are mainly involved in Remote Tower system as defined by B4.3 and in the P12.01.07 TAD and highlight the remote tower specific capabilities and extension.

The functions are grouped under the following functional blocks:

- Aerodrome ATC Domain system :
  - Aerodrome surveillance
  - CHMIM (Controller Human Machine Interaction Management)
  - Aerodrome safety nets
  - Operational supervision
  - Support functions
  - Technical supervision
  - Ground Datalink Management
- Aerodrome Voice Domain system
  - Air-Ground Voice Communication
  - Ground-Ground Voice Communication

2.6.1.1 Aerodrome Surveillance

Aerodrome Surveillance Function provides ATCO/AFISOs in the Remote Tower with airport situational awareness on the apron(s), taxiway(s), runway(s) and landing/take-off paths by providing position and identification of air traffic and surface traffic (aircraft and vehicles).

The Aerodrome Surveillance Functional block could manage two main functions:

- It merges the surveillance information provided by the different surveillance sources providing a unique picture of the actual traffic situation.
- Performs the flight plan and track correlation (if the tracking function is required by the system).

Inside the Aerodrome Surveillance functional block, different functions, that will be better explained in the next paragraphs, are included:

- OTW - Out The Window;
- PTZ cameras
- Additional views, e.g. IR cameras;
- Tracking function

2.6.1.1.1 OTW (IR/Overlay)

The OTW (Out The Window) function allows to ATCO/AFISOs to have an opportune HMI with the information he/she needs for the control of the remote airport. The OTW functionality provides to the Tower Controllers with a clear view of what usually ATCO/AFISO can see out the airport tower window and with all the necessary traffic data concerning a Remote Tower of Aerodrome ATC system, in order to assist them in their control tasks.

The specificity of the OTW affects the Aerodrome ATC Domain System because it is connected with the following Function Blocks (FB):

- Controller Human Machine Interaction Management
- Aerodrome Surveillance
- Ground Data Link Management

OTW can also help the Tower Controller to identify targets in Low Visibility with the support of the Aerodrome Surveillance Data. These data are the result of merging the surveillance information provided by the different surveillance sources providing a unique picture of the actual traffic situation.

The remote tower data will be captured by the OTW video sensors and sensors of the Aerodrome Surveillance. The OTW (Remote Tower) compresses the captured data and send it through the Ground Datalink. The OTW (Remote Tower Center) decompresses the captured data and send it to the CHMIM in order to let the ATCO/AFISO to see the actual view of the controlled tower on the OTW displays.

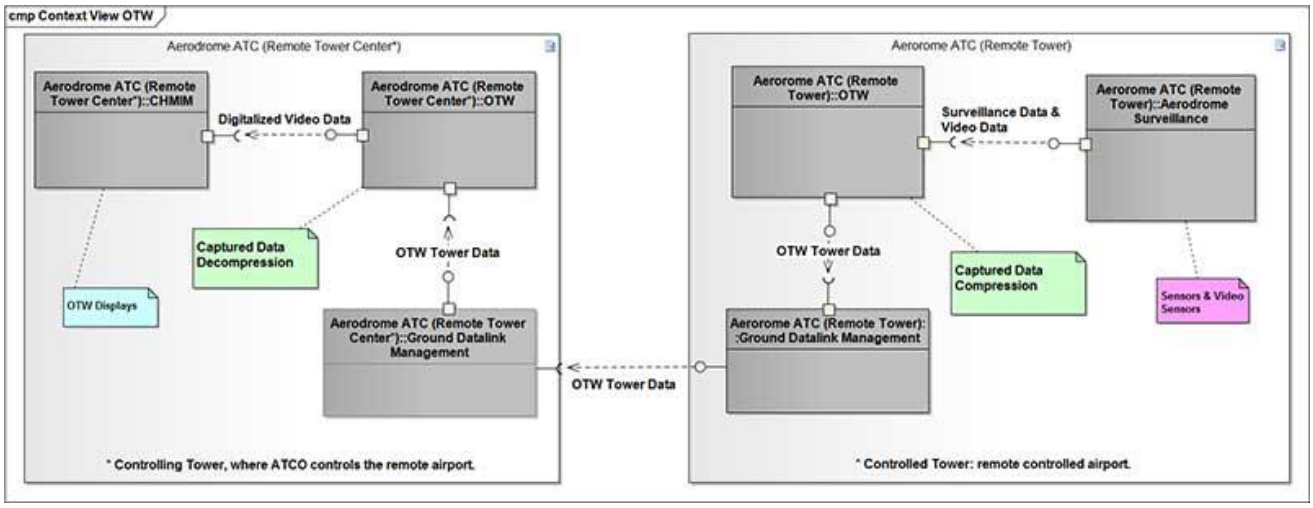

Figure 4: OTW Context View

2.6.1.1.2 Pan-Tilt-Zoom (PTZ) Cameras

In the Remote tower field, the system makes a large use of cameras that collect and send to the RTM images of the airport in order to provide to the remote ATCO/AFISOs the possibility to have the same view as conventional ATCO/AFISOs. Moreover there is the possibility to have PTZ (Pan Tilt Zoom) cameras that the ATCO/AFISO can remotely manage in order to focus the image on a specific area of

the airport with the correct zoom. Thanks to the use of PTZ cameras additional functionalities could be incorporated in the system, such as, automatic tracking, anomalies detection, etc.

For a multi remote tower scenario all control functions for dedicated resources (e.g. PTZ control or camera settings) have to be managed in a way that conflicting situations are avoided, such as .the interference of vehicles in the aircraft movement.

2.6.1.1.3 Additional View

Moreover the cameras, conventional or PTZ, the remote tower system can be equipped with additional sensors able to support the ATCO/AFISOs, for example in case of low visibility or during the night hours. The additional sensors usually are placed in the aerodrome in order to support the viewing of critical and obscure areas where the visibility is avoided or reduced.

The system can be supported by Infra-Red (IR) cameras, or by A-SMGCS, or by laser system that provide additional information on the position of the aircraft and/or vehicle on the runway.

2.6.1.1.4 Tracking

This component performs automatic object tracking functions based on the managed video streams. Output of this component is position information of the identified object or marking of the identified object in the video stream. The tracking can be made exploiting only the video data or exploiting a combination of the position information coming from different sensors.

Data fusion combines different inputs from surveillance sensors and generates an aggregated system track for a dedicated object.

The data fusion could take data both from the conventional surveillance sensors (like radars, Mode s, A-SMGCS, etc.) and sensors dedicated to the remote tower purpose (like cameras, IR, etc.) and will provide to the remote ATCO/AFISO a common picture, for normal and Low visibility, in a OTW dedicated or separate display.

2.6.1.2 Controller Human Machine Interaction Management (CHMIM)

The CHMIM Functional Block provides ATCO/AFISOs with a graphical user interface and with the means to interact with the Aerodrome ATC system. The main responsibility is to provide any relevant information concerning the domains (see Figure 3, page 25) and provide an friendly user interface to the ATCO/AFISO.

In addition to the information that usually the ATCO/AFISO needs for the ATC, in the remote tower the CHMIM shall provide further information related to the environment Out of the Window (OTW), such as video from external cameras, real-time weather information, reproduction of airport sound, etc.

2.6.1.2.1 RTC

The Remote Tower Center (RTC) allows the ATCO/AFISO to access to the module that he/she needs for the managing the remote airport. It is connected with the different services offered by the other functional blocks in order to connect in an unified HMI all the information the ATCO/AFISO needs: this aspect is covered by Controller Human Machine Interaction Management (CHMIM) Functional Block.

The RTC allows to ATCO/AFISO to have access to all the active service for a specific airport. Among the others, the RTC should allow to the ATCO/AFISO to move the control of a remote airport from a RTM to another one.

In context of remote tower additional components capture and generate surveillance information to replace the Out of The Window (OTW) view of classical towers. Dependent on the selected solution approach (virtual tower / video based tower) different technologies for acquisition of surveillance data might be used.

Surveillance data will be gathered and displayed at the Remote Tower Centre. Technical implementation of these features may vary, but generally it does not depend on type of the tower

(Remote/Virtual). The multi sensor surveillance data, optional in the Remote Tower, are among the main requirements for the Virtual Tower.

2.6.1.2.2 RTM

The Remote Tower Module is the functionality that allows to ATCO/AFISO to remotely access the function of the control tower. The remote tower system can add additional sensors for aerodrome surveillance. For example, static and manoeuvrable cameras for visual surveillance and sound capture to augment the impression of the events at the remote airport. These sensors supports a representation of the OTW view the officer would have while working in the airport control tower, along with a reproduction of the sounds he/she would hear in its usual workplace. As outlined in the P06.09.03 OSED two different approaches can be followed:

- Remote Tower Approach
- Virtual Tower Approach

2.6.1.2.2.1 Remote Tower

In the video based remote tower approach there are dedicated subcomponents for acquisition, handling and processing of video and audio information which are replacing/ enhancing classical radar based surveillance technologies.

- Video stream management
- Camera Control
- Visual Tracking
- Video Data Fusion

2.6.1.2.2.2 Virtual Tower

A Virtual remote Tower is mainly using classical surveillance technologies for acquisition of target information for presentation in a virtual environment. This approach is focusing on the visualization part and not on the surveillance area, therefore no additional components are used.

For the multi remote tower scenario, a single RTC shall allow to provide information and allow to the ATCO/AFISO to manage more aerodromes simultaneously. In that case all the functional blocks shall be extended in order to cover more than a single airport.

For a multi remote tower scenario the technical supervision functions are extended information of multiple airports. The control centre needs to provide an aggregated view of all relevant status information of multiple remote airports. In a multi remote tower scenario the controller working position has to handle information of multiple Aerodromes.

2.6.1.2.3 OTW display

In the Remote Tower, together with the conventional CWP, an opportune OTW display function will allow to the ATCO/AFISOs to have a digital view of the tower window that will support them in the air traffic management.

2.6.1.2.4 Airport Connection HMI

This function allows to the ATCO/AFISO through an opportune HMI, instruction for management of the airport and to monitor the state of the airport.

2.6.1.3 Operational Supervision

This functional block allows the Supervisor to manage the most appropriate operational configuration, according to traffic demand and aerodrome needs, and to react in case of system fault, re-assigning and distributing available resources in order to maintain adequate safety levels and quality of service.

In context of the single remote tower this function is hosted in the remote tower centre and will be equivalent to the standard tower. In a multi tower scenario this function will be extended to provide some planning and resource allocation capabilities to the supervisor (see chapter 2.4.2).

2.6.1.4 Aerodrome Safety nets

This functional block detects within manoeuvring areas (runway/s and taxiways) potential conflicts between two objects (i.e. aircraft or vehicles), or between an object and a restricted area, by processing the actual traffic situation, It is also extended to final approach and take-off paths. The potential safety hazards situations on the airport movement area encompass: runway incursion, intrusion in protected areas, aircraft/aircraft and aircraft/vehicle collisions.

In context of remote tower this function is particularly important and will exploit the capabilities provided by the aerodrome surveillance functions in order to provide alarm and alert to ATCO/AFISO. Especially for a multi remote tower setup some additional alerting functions might be introduced to increase situation awareness for the ATCO/AFISO and reduce the workload. In the remote tower approach, in order to increase the potentiality of the Aerodrome safety nets, it is important to exploit all the available technologies: cameras, PTZ, visual tracking. Exploiting fixed and moving cameras, and implementing solutions for the visual tracking, it is possible to support the ATCO/AFISOs with alerting and warning.

2.6.1.4.1 Anomaly Detection

Thanks to the use of cameras., tracking, data fusion, radar, A-SMGCS etc., anomaly detection function could provide alert to the ATCO and to AFISO (aerodrome flight information service officer) in case of detection of anomaly in airport area.

2.6.1.4.2 A-SMGCS

As in the conventional airport, the A-SMGCS system detects and monitors the movement of vehicle and aircraft on the airport exploiting radar data. Usually the data coming from A-SMGCS are displayed on the CWP in order to have the position of the aircraft on the runway and to manage the movement on the airport. The data coming from A-SMGCS can be simply displayed or used in the anomaly detection function in order to discover anomalies in the localization of vehicles/aircraft.

2.6.1.5 Support Functions

In context of a video based remote tower supporting functions will be extended by recording of video streams and additional audio feed (from the airport environment).

The Support functions do not affect directly the provision of ATM Services at operational time. They contain at least the following:

1. Recording - performing the recording of the ATM System data related to the Aerodrome ATC, and storing those data on a persistent database.
2. Playback - providing support for display and voice recording, display and voice playback, other data recording reproduction, etc.
3. Data analysis - providing support for maintenance, investigation etc.

The data distribution system will collect data from the sensors located in the remote airport and, after opportune processing and compressions, distributed, by datalink, in the Remote Tower Centre where the information will be opportunely displayed in the HMI systems.

The Video Stream Management component includes handling of video data from several local cameras and transferring this data to the remote tower centre. It includes bandwidth management and compression, monitoring of delay times, frame rate and access control

2.6.1.5.1 Recording

The recording function allows to collect and store all the data (ATC data, cameras, audio, IR, etc.) used for the monitoring. On needs, the ATCO/AFISO can access and use the recorded data.

2.6.1.5.2 Playback

The Playback function allows to the ATCO/AFISOs to see or to hear again image or audio data exploiting the recording function. This can help the ATCO/AFISO to have a better awareness of the airport situation. Other important uses of the payback function are the analysis in case of incident (with the objective to understand the dynamics of the incident/event) and training of the ATCO/AFISO that can be trained on real stored data.

2.6.1.5.3 Outdoor sound

The airport sound reproduction functional block provides to the ATCO/AFISOs the possibility to increase the awareness of the airport status also exploiting the reproduction of the sound in the remote airport. In the conventional airport the ATCO/AFISO is inside the airport environment and can exploit all the senses to make the situation awareness, in the case of the remote tower, specific instrument (like microphone) have to collect the sounds in the airport and send them to the RTM.

2.6.1.6 Technical Supervision

This functional block is in charge of the technical supervision of an Aerodrome ATC system (e.g. monitoring the services provided by the system, starting, stopping or re-starting the system or part of it).

The Technical Supervision encompasses the following functions:

- Presenting technical and functional systems status: monitor system availability. Acquire, synthesize and display technical and functional status on all the system hardware/software resources.
- Providing failure detection and analysis assistance: generate alarm or warning on failure detection. Provide support for analysis of supervision data (enable queries on historic of events).
- Providing supervision commands and actions: accept supervision commands/actions (e.g. (Re) start/stop/stand-by/reset/switch-over) from eligible operators and give the capability to perform maintenance activities.

In context of the remote tower the technical supervision is deployed in a distributed environment and has to cover equipment hosted at the airport and the remote tower centre.

2.6.1.6.1 Security Management system

The Security management system is connected to all the functional blocks/systems and monitors the status of each system in order to detect and identify threats/faults and to implement the defined countermeasures to avoid impact of these events on the operability of the remote tower. In the field of remote tower the security management system is very important for the communications service, because all the functionality are based on the data exchange among the airports and the remote tower.

2.6.1.7 A-G Voice Communication

This functional block provides, as main function, the functions performed by a Radio VCS

In the remote tower operation scenario the air ground communication is not directly interconnected to the local radio. The remote located remote tower centre needs a dedicated connection to the local radio to access air ground communication. Therefore additional infrastructure and an access gateway for the radio will be required.

Especially for a backup or emergency radio system a dedicated backup connection between the local tower and the remote tower centre will be required. Standard fall back solution such as handheld radios used directly in the tower is not applicable for the remote tower scenario.

In a multi remote tower scenario the VCS system has to combine and handle all frequencies of the related airports. Based on a role concept an assigned function of frequencies or coupling of frequencies has to be provided to a ATCO/AFISO.

2.6.1.7.1 Aeronautical mobile service

The aeronautical mobile service allows the ATCO/AFISO to enter in contact directly with the pilot in the aircraft, as for the conventional ATCO/AFISOs. An opportune data link for the air-ground communication have to be considered.

2.6.1.7.2 SLG

In the case of a radio failure or aircraft not equipped with a radio, or in the case of a deaf pilot, air traffic control may use a signal lamp to direct the aircraft. The signal lamp or Signal Light Gun (SLG) has a focused bright beam and is capable of emitting three different colours: red, white and green. The remote ATCO/AFISO, in this case, needs a connection with SLG that have to be remotely controlled.

2.6.1.8 G-G Voice Communication

This functional block provides the function that allows to the ATCO/AFISO using the communication infrastructure to connect the remote ATCO/AFISO with the remote airports, in particular aeronautical services and the surface vehicles.

This connection can be performed exploiting traditional voice system or innovative Ground Datalink.

2.6.1.9 Ground Datalink Management

The Ground Datalink Management provides the Datalink functionalities necessary to materialise the data exchange of the interfaces among the Functional Blocks outside the Aerodrome ATC Domain System.

In particular, it provides communications among the systems in the Aerodrome Domain System and to the Data Communication Infrastructure. Remote Tower specific enhancements for this component are related to management of remote systems and an optional local VCS position for backup or transition purpose.

2.6.1.10 Other functions

The functions described in this section are the same functions used in the conventional airport management and can be used just as in a traditional tower. Therefore a detailed description of these function is not included in this deliverable, because they are not changed for usage in a remote tower.

2.6.1.10.1 Functions for receiving meteo information

This function block provides to the ATCO/AFISO the access to the meteorological information that he/she needs to understand the status of the weather in the remote airport. All the meteorological information have to be provide continuously and in the real time in order to allow to the ATCO/AFISO to take into account this information to manage the air traffic.

2.6.1.10.2 Function for control of airport systems (visual and non-visual)

The functions conventionally used for the control of the airport system, such as navigational aids, ground lighting, etc, could be used also for the remote airports. The main difference among the conventional and the remote airport is that in the conventional airport the control system are locally controlled while in the remote airport we needs external system that have to manage the control systems (navigational aids, ground lighting, etc.)

2.6.1.10.3 Functions for receiving radar data and ATS messages

A function that manage the connection among the system that collects ATM data (primary and secondary radar, a-SMGC, etc.) should be foreseen in order to allow to the ATCO/AFISO to have the view of the position of the different vehicles on the airport.

2.6.1.10.4 Functions for access and update flight plan and control data

In order to manage the airport resources (especially runways and parking bays), the ATCO/AFISO should have access to the flight plan data.

2.6.1.10.5 Functions for monitoring and manage accident, incident and distress alarms

This functions allows the Supervisor and ATCO/AFISO to monitor the airport in order to detect and manage accident, incident and distress alarms. This functions used the sensors and systems described in the previous section in order to allow to the Supervisor to have the right figure of the airport status and to reach in case of need.

2.6.2 . Functional analysis

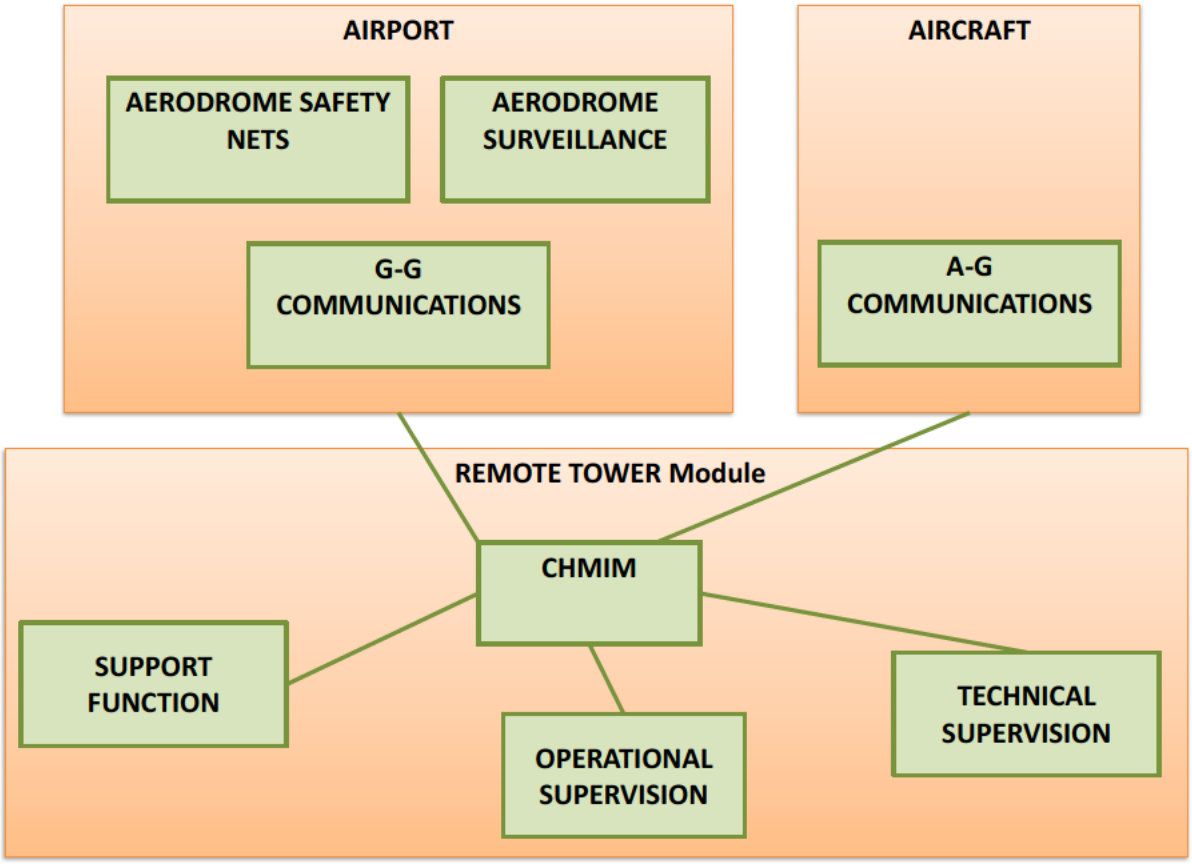

Figure 5 lists all functional components of the remote tower solutions and their dependencies and relations. Furthermore external systems or sensors which are related to the remote tower systems are shown. The logical information flow of flight data, support information and voice communication is the same as for the standard tower. Main difference is the remote connection to dedicated information sources at the local airport and the acquisition of this information via the WAN infrastructure.

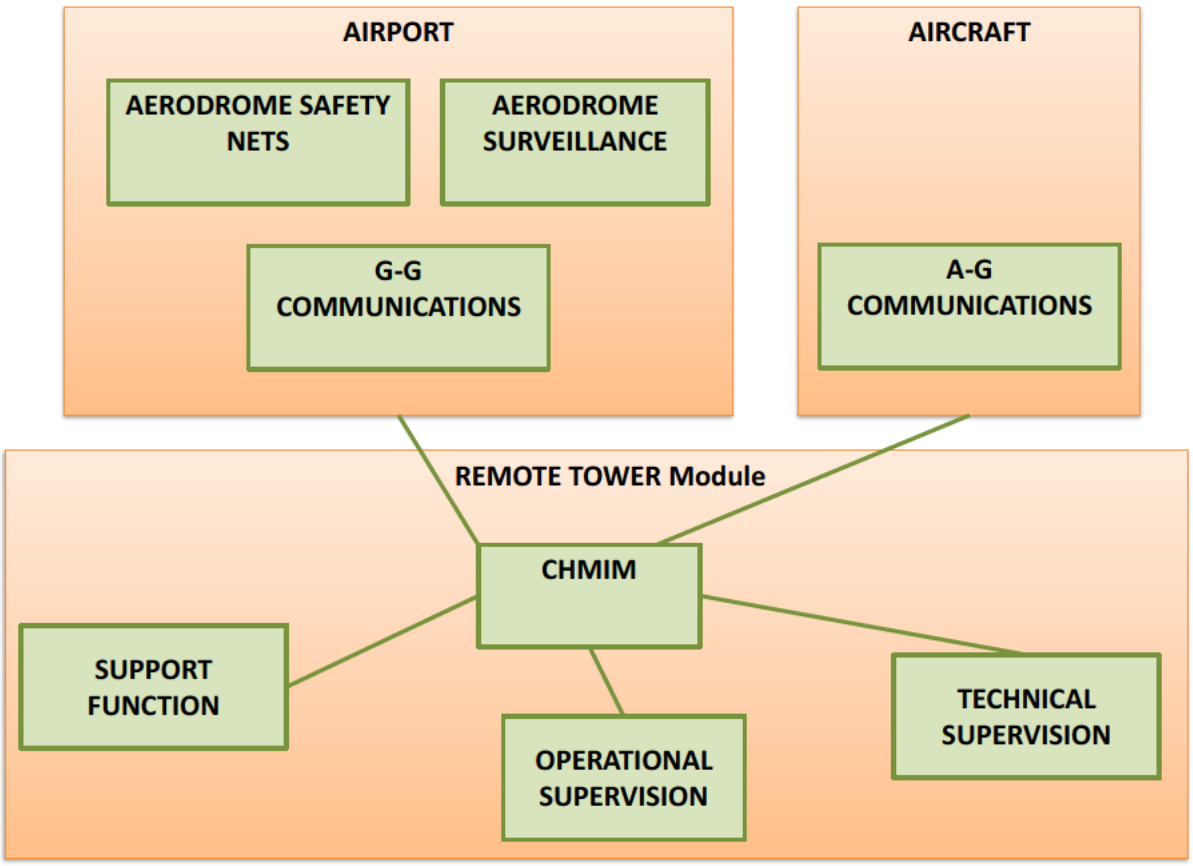

Figure 5 Functional block interrelations

The central element is the Controller HMI, which combines functions from the other components to an integrated controller working position. A remote tower specific part is the OTW View component. It uses mainly the Aerodrome Surveillance functions to replicate the out of the window view.

The Aerodrome Surveillance block is processing surveillance sensor data (including radar data and video streams) from the local airport, which are transferred via the network infrastructure. Parts of the processing may be performed locally at the airport or at the RTC. The exact deployment is a matter of detailed design and specific for a dedicated implementation.

Other data such as support information or status and control of airfield light are also integrated in the controller working position. Selected support information might be directly embedded into the visualization component (e.g. as overlay information).

The information flow for technical supervision starts at the acquisition of status information of all technical equipment at the local airport or in the remote tower centre. Status information is aggregated and processed for presentation.

Voice Communication is interconnecting local radios and standard phone interfaces. All data are transferred via the common network infrastructure. Voice Communication functions should be integrated in the controller HMI.

As evident in the Figure 3, the CHMIM functional block represents the contact point between ATCO/AFISOs which use the system and the internal functional block. The CHMIM contains and supports all interaction between ATCO/AFISO and functional blocks.

The number of provided/required interfaces shows the degree of architectural complexity linked to the CHMIM functional block.

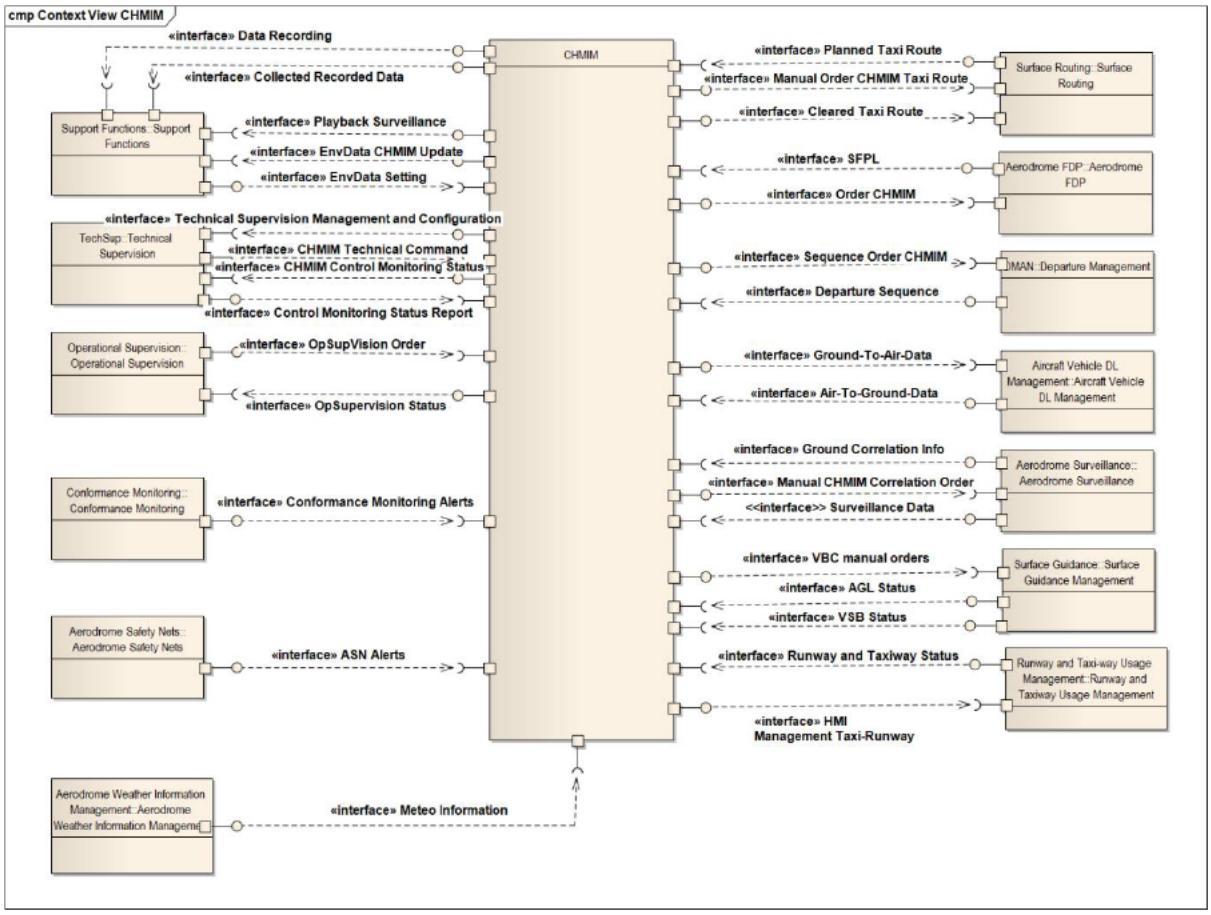

Figure 6: CHMIM 's Context View

Data Flow In/Out	Origin	Destination
SFPL	Aerodrome Flight Data Processing	CHMIM
Order CHMIM	CHMIM	Aerodrome Flight Data Processing
Cleared Taxi Route	CHMIM	Surface Routing
Manual Order CHMIM Taxi Route	CHMIM	Surface Routing
Planned Taxi Route	Surface Routing	CHMIM
Departure Sequence	Departure Management	CHMIM
Sequence Order CHMIM	CHMIM	Departure Management
Conformance Monitoring Alerts	Conformance Monitoring	CHMIM
ASN Alerts	Aerodrome Safety Nets	CHMIM
Surveillance Data	Aerodrome Surveillance	CHMIM
Manual CHMIM Correlation order	CHMIM	Aerodrome Surveillance
Ground Correlation Info	Aerodrome Surveillance	CHMIM
VBC manual orders	CHMIM	Surface Guidance Management
AGL Status	Surface Guidance Management	CHMIM
VSB Status	Surface Guidance Management	CHMIM
Air-To-Ground Data	Aircraft & Vehicle DL	CHMIM

Data Flow In/Out	Origin	Destination
	Management	
Ground-To-Air Data	CHMIM	Aircraft & Vehicle DL Management
Data Recording	CHMIM	Support Functions
Collected Recorded Data	CHMIM	Support Functions
Playback Surveillance	CHMIM	Support Functions
EnvData Setting	Support Functions	CHMIM
EnvData CHMIM Update	CHMIM	Support Functions
CHMIM Control Monitoring Status	CHMIM	Technical Supervision
Technical Supervision Management and Configuration	CHMIM	Technical Supervision
CHMIM TechSup Command	Technical Supervision	CHMIM
Control Monitoring Status Report	Technical Supervision	CHMIM
OpSupVision Order	Operational Supervision	CHMIM
OpSupervsion Status	CHMIM	Operational Supervision
HMI Management Taxi-Runway	CHMIM	Runway and Taxi-way Usage Management
Runway/Taxiway Status	Runway and Taxi-way Usage Management	CHMIM

The CHMIM functional block is in charge of displaying and providing relevant information to ATCO/AFISOs: in the remote tower context, the CHMIM is the only access to the airport information.

In short the CHMIM FB is able to provide the relevant configuration capability concerning information display (e.g. range scale selection, pan/zoom, brightness, and map overlays, OTW).

The interface supports also the graphical format of controller traffic position and trajectory with label and supports actors and controllers providing a clear indication concerning the traffic with respect to their area of responsibility. The interface also provides the flight plan display capability requested by operational needs. The interface is able to present the list of movement plans for all targets present in movement area to the controller, and update them in real time.

In a multi remote tower scenario the main difference is that there are multiple instances of interfaces to the dedicated airports. The relevant functional blocks have to handle multiple data streams and their assignment to the relevant position. The different function of the remote tower are strictly connected. In particular, one of the core function, on which is based all the functionalities of Remote Tower, is the WAN and the data connection, because all the functionalities is based on the replication of the airport environment (in term of video, sound and data) in the RTC where the ATCO/AFISO can operate as it is physically present in the airport.

An detailed example of relationship among different functions, focused on video data, is reported in Figure 7. The data collected by the fixed cameras or PTZ are exploited by different functions:

- Visual tracking: that analyse the data and track the vehicle on the airport;
- Sound and video recording function: this function collects the data from cameras and store the recorded sound and video that have to be sent to the ATCO/AFISOs to allow him to have the situation awareness.

The data from Visual tracking and Sound/Video recording are sent, through the Ground Datalink, to the Remote Tower Centre (RTC) where the ATCO/AFISOs and the supervisors can visualize the data exploiting the following functions:

- Out The Window (OTW): that replicate the airport environment;

- CHMIM: that provide to the ATCO/AFISOs the instrument for the visualization of all the information for the remote air traffic control
- Aerodrome Safety Nets: that exploits the data from Visual tracking to identify anomalies.

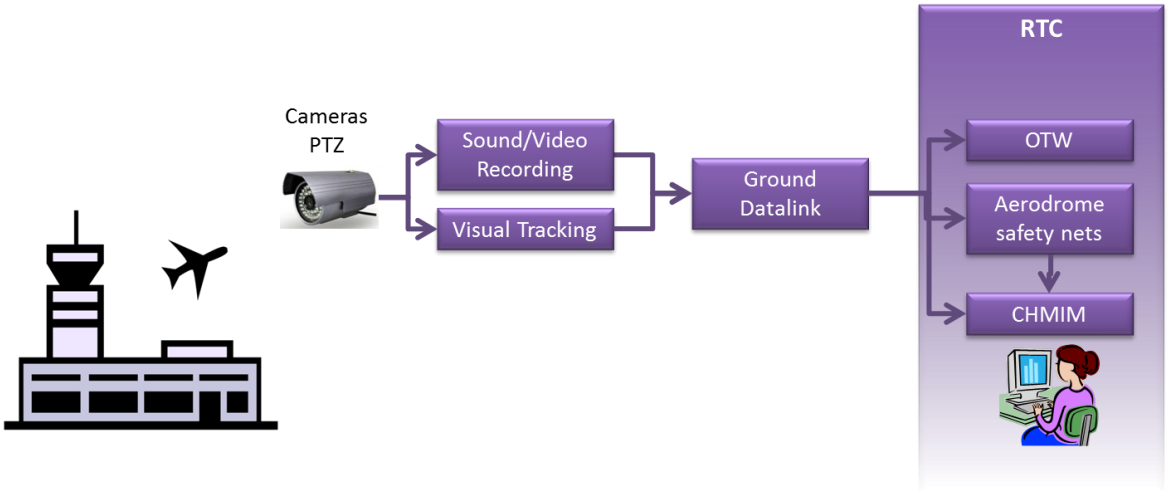

Figure 7 – Data flow of Video

2.7 Service View

TBD (because no services are specified within SESAR 1)

3 Functional Block Functional and non-Functional Requirements

3.1 Baseline Concept Requirements

[REQ]

Identifier	REQ-12.04.07-TS-0010.0001
Requirement	Each RTM shall allow an ATCO to provide Aerodrome Control Service (TWR) for the active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0010.0002
Requirement	Each RTM shall allow an AFISO to provide Aerodrome Flight Information Service (AFIS) for the active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0010.0003
Requirement	All technical failures on an RTM or remote airport shall be categorized by severity and technical procedures shall be defined how to handle each severity level.

[REQ]

Identifier	REQ-12.04.07-TS-0010.0004
Requirement	The RTMs in the RTC should be designed uniformly so that it is possible to operate any airport connected to that RTC from any of its RTMs.

3.2 General Service / Functional requirements

3.2.1 Communications

[REQ]

Identifier	REQ-12.04.07-TS-0100.0001
Requirement	The RTM shall provide access to aeronautical mobile services (air-ground communications) to the ATCO/AFISO for active Remote Airport(s), in accordance with ICAO Annex 11, Chapter 6.1

[REQ]

Identifier	REQ-12.04.07-TS-0100.0002
Requirement	The RTM shall provide access to aeronautical fixed service (ground-ground communications) to the ATCO/AFISO for active Remote Airport(s), in accordance with ICAO Annex 11, Chapter 6.2

[REQ]

Identifier	REQ-12.04.07-TS-0100.0003
Requirement	The RTM shall provide access to surface movement control service (communications for the control of vehicles other than aircraft on manoeuvring areas at controlled aerodromes) to the ATCO/AFISO for active Remote Airport(s)

[REQ]

Identifier	REQ-12.04.07-TS-0100.0004
Requirement	The RTM shall provide a signalling lamp functionality to the ATCO/AFISO on the active Remote Airport(s), in accordance with ICAO Annex 14 section 5.1.3.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0005
Requirement	The RTM visual presentation shall allow an ATCO/AFISO to observe the visual communication from aircraft that are within the Remote Airport visual range, if meteorological conditions permits.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0006
Requirement	The RTM visual presentation shall allow an ATCO/AFISO to observe the visual communication from aircraft that are on the aerodrome manoeuvring area, if meteorological conditions permits.

3.2.2 MET-functions

[REQ]

Identifier	REQ-12.04.07-TS-0101.0001
Requirement	The RTM shall provide the ATCO/AFISO access to meteorological info from the active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0101.0006
Requirement	The meteorological info provided by an RTM shall be in accordance with ICAO Annex III and national regulations.

[REQ]

Identifier	REQ-12.04.07-TS-0101.0007
Requirement	The RTM shall continuously present the current MET report from the currently active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0101.0003
Requirement	The RTM shall continuously present the actual wind information from the currently active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0101.0004
Requirement	The RTM shall continuously present the actual QNH from the currently active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0101.0005
Requirement	The RTM shall, if measured for the particular airport, continuously present the RVR values from the active Remote Airport(s).

3.2.3 Visualization

3.2.4 NAV functions

[REQ]

Identifier	REQ-12.04.07-TS-0103.0001
Requirement	The RTM shall include functionality for the ATCO/AFISO to monitor, adjust intensity and on/off status of visual navigational aids for the active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0103.0002
Requirement	The RTM shall include functionality for the ATCO/AFISO to monitor and adjust the status of non-visual aids for the active Remote Airport(s).

3.2.5 Other ATS Systems / Functions

[REQ]

Identifier	REQ-12.04.07-TS-0104.0001
Requirement	The RTM shall allow the ATCO/AFISO to access surveillance data such as radar presentation, when available, from the active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0104.0002
Requirement	The RTM shall allow the ATCO/AFISO to access and handle ATS messages (as described in ICAO Doc 4444 Chapter 11).

[REQ]

Identifier	REQ-12.04.07-TS-0104.0003
Requirement	The RTM shall allow the ATCO/AFISO to 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).

[REQ]

Identifier	REQ-12.04.07-TS-0104.0004
Requirement	The RTM shall allow the ATCO/AFISO to monitor and manage accident, incident and distress alarms as applicable to the active Remote Airport(s).

[REQ]

Identifier	REQ-12.04.07-TS-0104.0005
Requirement	The RTM shall include functionality to present the correct time, in the format of hours, minutes and seconds in UTC, to the ATCO/AFISO.

[REQ]

Identifier	REQ-12.04.07-TS-0104.0006

Requirement	The RTM shall include functionality to notify the ATCO/AFISO about any technical status of systems that can affect the safety or efficiency of flight operations and/or the provision of air traffic service for the RTC and for the active Remote Airport(s).

3.2.6 Voice and Data Recording

[REQ]

Identifier	REQ-12.04.07-TS-0105.0003
Requirement	ATCO/AFISO direct-speech communication via Aeronautical mobile service, Aeronautical fixed service and Surface movement control service shall be recorded.

[REQ]

Identifier	REQ-12.04.07-TS-0105.0004
Requirement	Data-link communication via Aeronautical mobile service (air-ground communications), Aeronautical fixed service (ground-ground communications) , Surface movement control service and Aeronautical radio navigation service shall be recorded.

3.3 Remote Functional Requirements

3.3.1 Concept Requirements Single aerodrome Applications

[REQ]

Identifier	REQ-12.04.07-TS-1001.0001
Requirement	An RTM shall be able to connect to a remote airport.

[REQ]

Identifier	REQ-12.04.07-TS-1001.0002
Requirement	An RTM should be able to connect to and be connected to multiple remote airports sequentially, one at a time.

3.3.2 RTC level requirements

[REQ]

Identifier	REQ-12.04.07-TS-1002.0001
Requirement	The HMIs shall be unified between RTMs

[REQ]

Identifier	REQ-12.04.07-TS-1002.0002
Requirement	The hardware used by ATCO/AFISO to operate the RTM shall be unified between RTMs within a RTC

[REQ]

Identifier	REQ-12.04.07-TS-1002.0003
Requirement	The RTM should enable the ATCO/AFISO to a transfer the active Remote Airport and all the associated services active in an RTM (source RTM) to another RTM (destination RTM).

[REQ]

Identifier	REQ-12.04.07-TS-1002.0004
Requirement	The RTM shall enable ATCO/AFISO in the destination RTM to see the state of all active services from the source Remote Airport before assuming control over it

[REQ]

Identifier	REQ-12.04.07-TS-1002.0005
Requirement	All services active in the source RTM shall remain active until the transfer is finalized

[REQ]

Identifier	REQ-12.04.07-TS-1002.0006
Requirement	The RTM shall enable the ATCO/AFISO in the destination RTM to acknowledge the transfer of the active Remote Airport and all the associated services before it is finalized

[REQ]

Identifier	REQ-12.04.07-TS-1002.0007
Requirement	The ATCO/AFISO/RTC Supervisor shall be able to see the state of all active services of a Remote Airport before assuming control

3.3.3 RTC Supervisor

[REQ]

Identifier	REQ-12.04.07-TS-1003.0001
Requirement	If the RTC enables transfer of responsibility of ATS for aerodromes between RTMs within the RTC, the 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.

[REQ]

Identifier	REQ-12.04.07-TS-1003.0002
Requirement	The RTC supervisor role shall have access to flight plan data, slot coordination, communications and surveillance data for all aerodromes connected to the RTC.

[REQ]

Identifier	REQ-12.04.07-TS-1003.0003
Requirement	The RTC supervisor role shall have access to information about - what aerodromes are connected to each RTM

	- transfer status for each RTM (if transferral of responsibility is ongoing) - what aerodromes are selectable for each RTM

[REQ]

Identifier	REQ-12.04.07-TS-1003.0004
Requirement	The RTC supervisor role shall have access to airport system status for all aerodromes connected to the RTC.

[REQ]

Identifier	REQ-12.04.07-TS-1003.0005
Requirement	The RTC supervisor role shall have access to RTC system status.

[REQ]

Identifier	REQ-12.04.07-TS-1003.0006
Requirement	The RTC supervisor role shall have access to weather status for all aerodromes connected to the RTC.

[REQ]

Identifier	REQ-12.04.07-TS-1003.0007
Requirement	The technical status of each RTM and all aerodrome(s) connected to the RTC shall be accessible to the RTC supervisor.

3.3.4 Visualization

3.3.4.1 General

[REQ]

Identifier	REQ-12.04.07-TS-0102.0015
Requirement	The RTM shall provide access to live video image of flight operations on and in the vicinity of the aerodrome as well as vehicles and personnel on the manoeuvring area through the use of static camera(s) and/or manoeuvrable camera(s), to the ATCO/AFISO.

[REQ]

Identifier	REQ-12.04.07-TS-0102.0009
Requirement	The ATCO/AFISO should have access to live video image of flight operations on and in the vicinity of the aerodrome as well as vehicles and personnel on the manoeuvring area through the use of static camera(s).

[REQ]

Identifier	REQ-12.04.07-TS-0102.0010
Requirement	The visual presentation shall have a sufficient horizontal coverage to include the manouvring area and the vicinity of the aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0102.0011
Requirement	The vertical coverage shall be a sufficient number of degrees above the

	imagined horizon to include the manoeuvring area and the vicinity of the aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0102.0012
Requirement	The vertical coverage shall be a sufficient number of degrees below the imagined horizon to include the manoeuvring area and the vicinity of the aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0102.0003
Requirement	The visual presentation shall provide a clear view of the manoeuvring area, in order to make it possible for the ATCO/AFISO to be able to prevent collisions between aircraft and obstructions

[REQ]

Identifier	REQ-12.04.07-TS-0102.0013
Requirement	The RTM should include functionality for the ATCO/AFISO to be able to activate any additional sensors which improve visual range and resolution, compared to unaided viewing in the visual reproduction.

[REQ]

Identifier	REQ-12.04.07-TS-0102.0014
Requirement	The RTM shall enable the ATCO/AFISO to see if additional sensors are activated in the visual reproduction

[REQ]

Identifier	REQ-12.04.07-TS-0110.0002
Requirement	The visual reproduction may include additional (digital) information to provide the ATCO/AFISO with a greater level of information and/or situational awareness.

3.3.4.2 Characteristics

[REQ]

Identifier	REQ-12.04.07-TS-0110.0003
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.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0006
Requirement	The video image of the visual presentation (including any additional sensors and the binocular functionality) shall be captured and rendered on the display at a frequency of a sufficient amout of frames per second to provide a smooth and regular impression of moving objects to the human eye.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0007
Requirement	The implementation requirement specification shall define the maximum allowed delay from the capturing of the video image to displaying the video image on the visual presentation.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0005
Requirement	The visual reproduction should provide a non-flickering impression to the human eye.

3.3.4.3 Quality

[REQ]

Identifier	REQ-12.04.07-TS-0110.0008
Requirement	The visual presentation shall have a resolution of a sufficient number of pixels per degree to be able to detect an aircraft of type A320, ATR72 or similar size on 4NM final during daylight CAVOK.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0011
Requirement	During daylight CAVOK conditions, the visual presentation shall enable the ATCO/AFISO to 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).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0048
Requirement	During daylight and good visibility conditions, the visual presentation should enable the ATCO/AFISO to detect obstructions on the manoeuvring area.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0049
Requirement	Depending on visibility and daylight/darkness conditions, the visual presentation may enable the ATCO/AFISO to observe significant meteorological conditions in the take-off and climb-out area.

[REQ]

Identifier	REQ-12.04.07-TS-0102.0005
Requirement	The visual reproduction shall include functionality that reduces the negative impact caused by counter light on the visual reproduction (as applicable depending on the technical solution)

[REQ]

Identifier	REQ-12.04.07-TS-0102.0006
Requirement	The visual reproduction should include functionality that reduces the negative impact caused by variable light conditions across the field of view of the visual reproduction (as applicable depending on the technical solution).

[REQ]

Identifier	REQ-12.04.07-TS-0102.0007
Requirement	The visual reproduction shall include functionality that reduces the negative impact caused by precipitation (rain, snow, etc) on the visual reproduction (as applicable depending on the technical solution).

[REQ]

Identifier	REQ-12.04.07-TS-0102.0008
Requirement	The visual reproduction shall include functionality that reduces the negative impact caused by insects, birds, etc on the visual reproduction (as applicable depending on the technical solution).

3.3.4.4 Augmentation

[REQ]

Identifier	REQ-12.04.07-TS-0110.0050
Requirement	The implementation requirement specification should specify if the visual presentation shall include overlaid information regarding elements or specific targets (tracks, labels, obstacles, runways, and other objects of interest).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0033
Requirement	The implementation requirement specification should specify if the visual presentation shall include overlaid information to indicate / high light specific parts of the aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0034
Requirement	The implementation requirement specification should specify if the visual presentation shall include overlaid information to present information pertinent to the general area of interest or area of responsibility.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0035
Requirement	Tracked targets presented as overlaid information within the visual reproduction shall be possible to toggle on/off as well as adjust in light intensity by the ATCO/AFISO.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0036
Requirement	Aerodrome indications/high lights presented as overlaid information within the visual reproduction shall be possible to toggle on/off as well as adjust in light intensity by the ATCO/AFISO.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0037
Requirement	Areas of responsibility or areas of interest presented as overlaid information within the visual reproduction shall be possible to toggle on/off as well as adjust in light intensity by the ATCO/AFISO.

3.3.4.5 Binocular functionality

[REQ]

Identifier	REQ-12.04.07-TS-0110.0052
Requirement	The airport shall be equipped with at least one camera with pan, tilt and zoom capabilities. (Corresponding to binoculars in a local tower.)

[REQ]

Identifier	REQ-12.04.07-TS-0110.0038
Requirement	The binocular functionality shall be as simple, quick and easy to use as manually operated binoculars (in a local tower).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0039
Requirement	It shall be possible to manoeuvre the zoom camera to any given location and be presented with an image of that location within ATCO/AFISO operational acceptable limits.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0040
Requirement	The direction of bore sight shall be visually indicated to the ATCO/AFISO.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0046
Requirement	The implementation requirement specification should specify the required zoom factor for the zoom camera.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0041
Requirement	It shall be possible for the ATCO/AFISO to change the zoom level of the zoom camera.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0047
Requirement	The implementation requirement specification should specify the required zoom speed for the zoom camera.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0027
Requirement	It should be possible to predefine and user-define positions (direction, zoom and focus) for the zoom camera.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0028
Requirement	It should be possible to predefine and user-define automatic scanning patterns, such as runway sweeps, for the zoom camera.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0029
Requirement	The zoom camera should be able to automatically track moving aircrafts, vehicles or obstructions (e.g. personnel or large animals).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0042
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.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0043
Requirement	The resolution of the zoom camera shall be sufficient to produce at enough pixels per degree for the ATCO/AFISO to be able to recognise an aircraft of type A320, ATR72 or similar size on 4NM final, in combination with visual presentation, during daylight CAVOK conditions.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0051
Requirement	The resolution of the zoom camera should be sufficient to produce enough pixels per degree for the ATCO/AFISO to be able to judge the position of a light aircraft (e.g. C172 or P28A) in the traffic circuit.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0044
Requirement	The contrast of the zoom camera image shall be of sufficient quality to support the related ATCO/AFISO tasks.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0045
Requirement	It should be possible to display the image from the zoom camera in the same presentation area as the static visual reproduction (if applicable).

3.3.5 Airport sound reproduction

[REQ]

Identifier	REQ-12.04.07-TS-0111.0004
Requirement	The airport may be equipped with at least one microphone for collecting the outdoor sound.

[REQ]

Identifier	REQ-12.04.07-TS-0111.0005

Requirement	The airport may be equipped with two or more microphones pointed, or placed, at different parts of the manoeuvring area to create stereo sound.

[REQ]

Identifier	REQ-12.04.07-TS-0111.0006
Requirement	The RTM may be equipped with at least one speaker for reproducing the airport sound.

[REQ]

Identifier	REQ-12.04.07-TS-0111.0007
Requirement	The RTM may be equipped with two or more speakers able to reproduce airport stereo sound.

[REQ]

Identifier	REQ-12.04.07-TS-0111.0003
Requirement	The ATCO/AFISO shall be able to adjust the volume, and turn off, any reproduced sound from the airport.

3.3.6 Other ATS System/Functions

[REQ]

Identifier	REQ-12.04.07-TS-0112.0001
Requirement	The implementation requirement specification should specify if the RTC shall be equipped with an electronic system for presentation and updating of flight plan and control data.

[REQ]

Identifier	REQ-12.04.07-TS-0112.0002
Requirement	If the RTC enables transfer of responsibility of ATS for aerodromes between RTMs within the RTC, the RTC shall be equipped with an electronic system for presentation and updating of flight plan and control data .

[REQ]

Identifier	REQ-12.04.07-TS-0112.0003
Requirement	If the RTM is equipped with an electronic system for presentation and updating of flight data, the implementation requirement specification should specify what pre-sets to use to access common actions .

[REQ]

Identifier	REQ-12.04.07-TS-0112.0004
Requirement	The implementation requirement specification should specify that updates for flight plan and control data to other ATS units shall be done automatically

[REQ]

Identifier	REQ-12.04.07-TS-0112.0005
Requirement	The implementation requirement specification may specify that functionality shall exist to notify when an aircraft or vehicle is entering or vacating a runway.

[REQ]

Identifier	REQ-12.04.07-TS-0112.0006
Requirement	The implementation requirement specification may specify that functionality shall exist to warn when an aircraft or vehicle is entering a runway without clearance.

[REQ]

Identifier	REQ-12.04.07-TS-0112.0007
Requirement	The implementation requirement specification may specify that functionality shall exist to warn when an aircraft or vehicle is entering the manoeuvring area without clearance.

3.3.7 Voice and Data Recording

[REQ]

Identifier	REQ-12.04.07-TS-0113.0001
Requirement	The video image produced at each aerodrome shall be recorded.

[REQ]

Identifier	REQ-12.04.07-TS-0113.0003
Requirement	It shall be possible to access the video image up to 30 days after it has been recorded.

[REQ]

Identifier	REQ-12.04.07-TS-0113.0004
Requirement	It shall be possible to reproduce the recorded video image at the same quality as it was presented to the ATCO at the time of the recording.

3.3.8 Work Environment

[REQ]

Identifier	REQ-12.04.07-TS-0114.0001
Requirement	Any information presented within a RTM shall still be visible in office daylight conditions .

[REQ]

Identifier	REQ-12.04.07-TS-0114.0002
Requirement	The technical solution shall describe the temperature and noise levels generated.

[REQ]

Identifier	REQ-12.04.07-TS-0114.0003

Requirement	It shall be possible to adjust the lighting conditions for each RTM separately

[REQ]

Identifier	REQ-12.04.07-TS-0114.0004
Requirement	Each CWP shall have a place available for taking notes, not less than roughly the size of an A5 sheet.

3.4 Additional requirements for multiple aerodrome applications

3.4.1 Concept requirements multiple aerodrome applications

[REQ]

Identifier	REQ-12.04.07-TS-0115.0001
Requirement	It shall be possible to connect an RTM to more than one Remote Airport, in parallel.

3.4.2 Remote functional requirements

3.4.2.1 Multiple Handling

[REQ]

Identifier	REQ-12.04.07-TS-0116.0001
Requirement	Each RTM shall be able to provide ATC/AFIS services simultaneously for all aerodrome(s) served by that RTM

[REQ]

Identifier	REQ-12.04.07-TS-0116.0002
Requirement	The visual presentation shall clearly indicate which aerodrome(s) are currently being served by an RTM.

[REQ]

Identifier	REQ-12.04.07-TS-0116.0003
Requirement	The aerodrome that is being affected when manoeuvring airport systems shall be clearly shown within the RTM.

[REQ]

Identifier	REQ-12.04.07-TS-0116.0004
Requirement	Each RTM shall provide the ATCO/AFISO with all systems and data required to perform the ATS for all connected aerodromes.

3.4.2.2 Communication

[REQ]

Identifier	REQ-12.04.07-TS-0117.0001
Requirement	Each RTM that is able to provide ATC/AFIS services for multiple airports shall be able to receive and play aeronautical mobile services (air-ground

	communications) communication channels for all aerodromes being served to the ATCO/AFISO.

[REQ]

Identifier	REQ-12.04.07-TS-0117.0002
Requirement	Each RTM that is able to provide ATC/AFIS services for multiple airports shall enable the ATCO/AFISO to transmit aeronautical mobile services (air-ground communications) either to "all aerodromes" being served or to an "individual aerodrome" when ATS is performed to more than one aerodrome simultaneously.

[REQ]

Identifier	REQ-12.04.07-TS-0117.0003
Requirement	Each RTM that is able to provide ATC/AFIS services for multiple airports simultaneously shall enable retransmission and relay of aeronautical mobile service (air-ground communications) between all aerodromes being served from the RTM.

3.4.3 Visualization

[REQ]

Identifier	REQ-12.04.07-TS-0119.0001
Requirement	The visual reproduction should include additional (digital) information to enhance visibility (e.g. in identifying the runway and key areas).

3.5 Contingency requirements

3.5.1 Concept requirements

[REQ]

Identifier	REQ-12.04.07-TS-0122.0001
Requirement	The RTC shall not be located in the primary ATS tower.

[REQ]

Identifier	REQ-12.04.07-TS-0122.0002
Requirement	The RTC should not be any single points of failure affecting both the RCT and the primary ATC tower.

3.5.2 Performance and functional requirements

[REQ]

Identifier	REQ-12.04.07-TS-0122.0003
Requirement	The implementation specification shall define the minimum requirements on safety, security, reliability and adaptability, for each contingency application.

[REQ]

Identifier	REQ-12.04.07-TS-0122.0004
Requirement	The implementation specification shall define the minimum requirements on capacity, duration of service and switchover time, for each contingency application.

[REQ]

Identifier	REQ-12.04.07-TS-0122.0005
Requirement	The implementation specification shall define the required level of commonality of HMI for each application with respect to the tower being served by the contingency application.

[REQ]

Identifier	REQ-12.04.07-TS-0122.0006
Requirement	The implementation specification shall for each contingency application define the character and form of visual reproduction, airport sound reproduction, other ATS systems/functions and working environment.

4 Assumptions

It is assumed that this document is generic and will serve as a basis for the creation of a requirement specification

5 References

[1] SESAR Template Toolbox, Edition 03.01.03
[2] SESAR Requirements and V&V Guidelines, Edition 03.01.00
[3] SESAR Templates and Toolbox User Manual, Edition 03.01.01
[4] SESAR 06.09.03 Operational Service and Environment Definition (OSED), Edition 00.05.03
[5] SESAR 12.01.07 Step1-3rd Iteration- Airport Technical Architecture Description, Edition 00.03.00
[6] SESAR B04.03 ADD Step 1 (2013 edition), Edition 00.01.12
[7] ICAO Document 4444 “Procedures For Air Navigation Services - Air Traffic Management”, 15th Edition, 2007 (amendment 4, November 2012)
[8] ICAO Document 9426 “Air Traffic Services Planning Manual”, 1st Edition, December 1992
[9] EUROCONTROL “Manual for Aerodrome Flight Information Service (AFIS)”, Edition, 1.0, June 2010
[10] Convention on International Civil Aviation, Annex 2, Air Traffic Services, July 2005
[11] Convention on International Civil Aviation, Annex 3, Air Traffic Services, July 2010
[12] Convention on International Civil Aviation, Annex 11, Air Traffic Services, November 2013
[13] Convention on International Civil Aviation, Annex 14, Air Traffic Services, July 2013

5.1 Use of copyright / patent material /classified material (NATMIG)

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There is no sensitive information contained in this technical specification.

Appendix A Human factors – CWP and OTW view

A.1 Introduction

The aim of Human Factors is to create a working environment that (to the largest extent possible) contributes to achieving healthy, effective and safe operations.

Appendix A compares multiple Human Factors standards for the attainable visual field. This information is the base to present different types of OTW views in order to discuss advantages and disadvantages for their arrangement in the RTM, thus providing a foundation for comparison of different RTM types. It provides recommendations for the Remote & Virtual Tower concept from an Human Factors point of view. These recommendations are based on the requirements, recommendations, and suggestions derived by the SESAR project 06.09.03. Referenced documents include:

Project	Definition	Deliverable ID	Edition
06.09.03	Remotely Provided Air Traffic Service for Single Aerodrome VALR	D08-02	00.05.02
06.09.03	D02/D04 OSED for Remote Provision of ATS to Aerodromes, including Functional Specification	D04	00.05.02
06.09.03	HP Assessment Report for Single remote Tower	D15	00.01.01
10.10.02	Human Factors Design Document TMA/En-Route	D04	00.01.00

Table 1 –Referenced Documents

Note: Some Synonyms are to be found in this appendix, as they are used interchangeably in the project documentation of P06.09.03:

- situation awareness | situational awareness
- controller | operator | ATCO/AFISO

A.2 Related Standards

This chapter answers the question: “Which standards are available for the design of RMT module?”. The larger the visual field, the more eye-, head, and body movements are involved. The less movements necessary, the lesser the strain for the body. the lesser the fatigue. However, too little movement also adds to an operator’s fatigue, which makes it vital to find a balance between these two opposites.

A.2.1 Visual field

The human visual field is determined by the limitations of the visual system (e.g. eye movement, accommodation) and the limitations of body movements (e.g. head tilt).

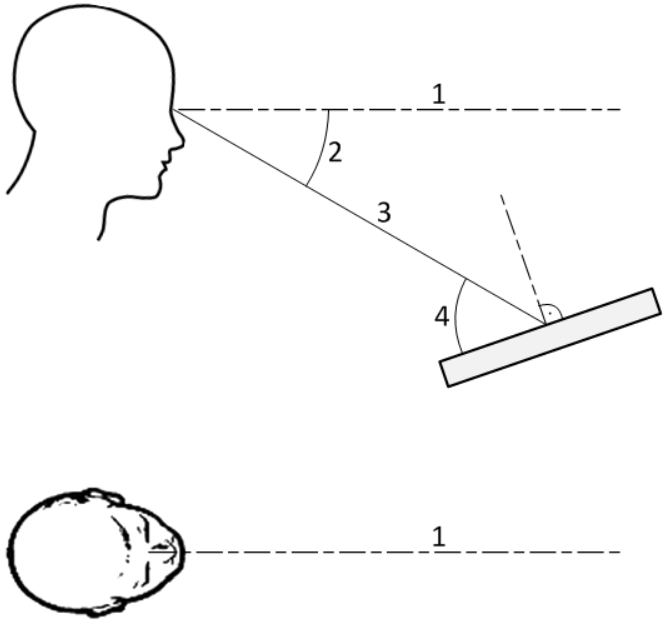
There is a trade-off between human performance on the one side, and the size of the visual field, the rate and the frequency of body movement and accommodation of the eyes on the other side.

The larger the visual field and the more often the operator has to move her body and/or eye has to accommodate to ‘*extreme*’ values, the more impact is made on the operator’s performance.

Additionally, accommodation, change between targets in the visual field take time.

A.2.1.1 Terms and definitions

Following terms will be used:



1: the horizontal
2: gaze angle
3. line of sight
4. viewing angle

Figure 5-1: Visual angles

A.2.1.1.1 Viewing Distance

The viewing distance (=length of the *line of sight (3)* in *Figure 5-1*) is the distance from the operator’s eye to the display (centre). Viewing distance in this context has important implications, as it is directly related to the perceived size of the display, it affects the minimum resolution of the display, and it influences the gaze angles to specific points on the display.

The optimal viewing distance is determined by factors such as the desired field of view, the required resolution of the image (which is based on the expected content), and limitations of the human visual system (such as accommodation)

Viewing distance dictates the maximum dimensions of an OTW view as well as the minimum resolution the visual representation needs to feature.

A.2.1.1.2Viewing Angles

Touch-screen viewing angle.
Touch-screens shall be perpendicular to the user's line of sight while the user is in a normal operating position when possible. A reduced viewing angle, less than 90 degrees from horizontal, may reduce arm fatigue for frequent actions; however, changes to viewing angle shall be evaluated in relation to the negative impact on parallax, specular glare, and readability.
[MIL-STD-1472G]

Working position - Display location in relation to the angle of view
The angle of view shall not exceed 40 degrees anywhere on the visual display.
[REQ-10.10.02-HFDD-2002.002]

A.2.1.2 Standards on gaze angles and head movement

A.2.1.2.1Viewing Distance

The **minimum** comfortable viewing distance is **500 mm**.
The **optimum** comfortable viewing distance is **700 mm**.
[DEF STAN 00-250 part3 section9]

The **optimum** ratio between viewing distance to screen diagonal is **3.0** to **6.0.**
The **maximum** ratio between viewing distance to screen diagonal is **2.0** to **10**.
[MIL-STD-1472G]

Minimum viewing distance for large-screen displays.
The display shall not be closer than one-half the display width or height, whichever is greater.
[MIL-STD-1472G]

A.2.1.2.2Horizontal gaze angles

The **maximum** horizontal gaze angle is **30°** on either side.
[DEF STAN 00-250 part3 section15]

The **optimum** horizontal gaze angle is **15°** on either side.
The **maximum** horizontal gaze angle is **35°** on either side.
[ISO 9241-5:1998]
[MIL-STD-1472G]

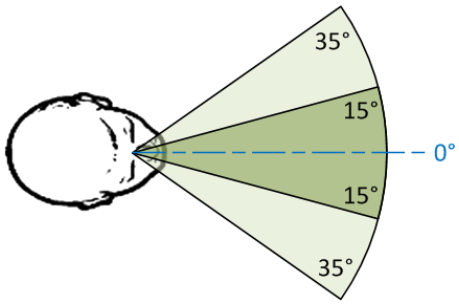


Figure 5-2: Horizontal gaze angles

A.2.1.2.3Horizontal head rotation

The **optimum** head rotation angle is **45°** on either side.
["The Measure of Man and Woman", Henry Dreyfuss Associates; John Wiley & Sons]
*Note: No ISO standards describe the **optimum** horizontal head rotation angle.*

The **maximum** head rotation angle is **60°** on either side.
[MIL-STD-1472G]

A.2.1.2.4Horizontal zones

Combining the standards for gaze angles (from A.2.1.2.2) and head rotation (from A.2.1.2.3) leads to three different horizontal viewing zones. Content should be placed within the appropriate borders, according to their importance and frequency of use. E.g. content of high importance which needs to be frequently viewed or interacted with, should be placed within viewing zone A.

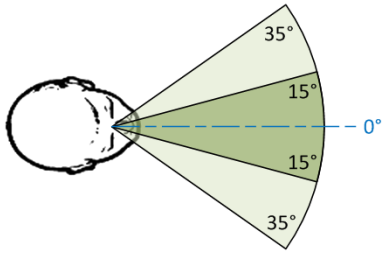


Figure 5-3: Viewing zone A

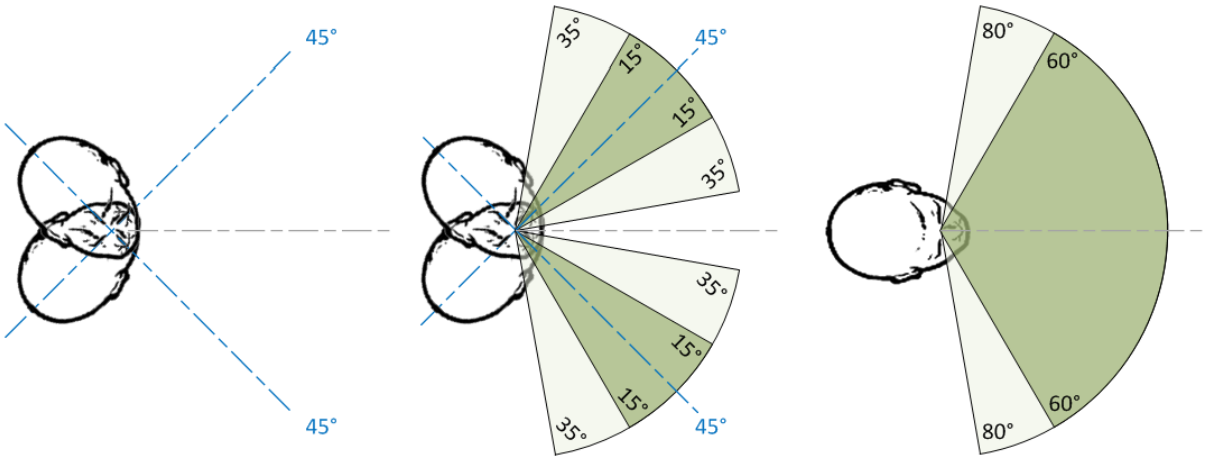


Figure 5-4: Progression of viewing zone B

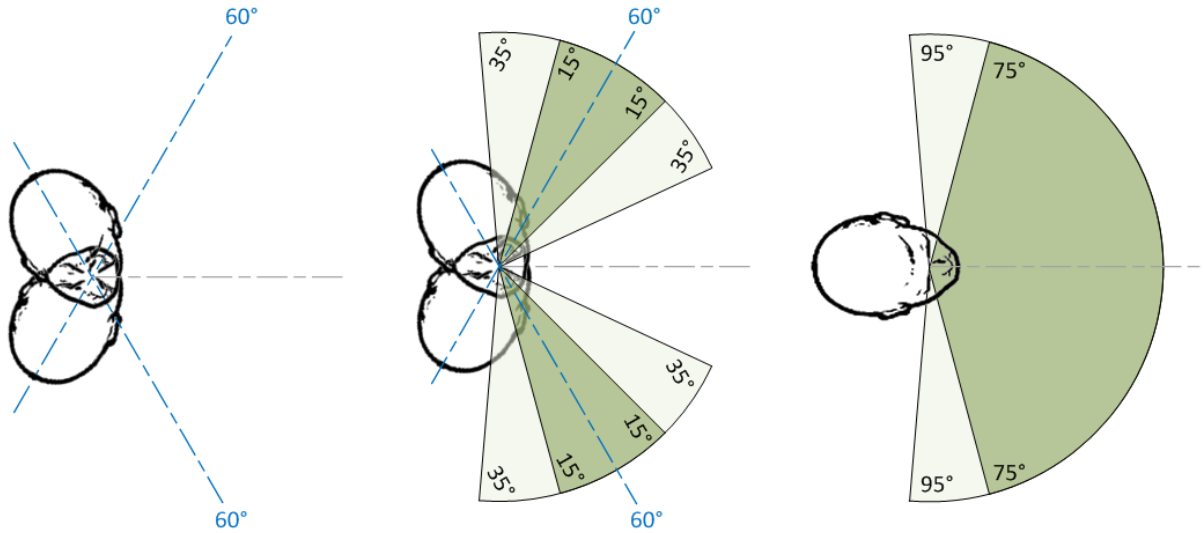


Figure 5-5: Progression of viewing zone C

A.2.1.2.5 Vertical line of sight

Vertical angles within this chapter refer to a horizontal line drawn at eye level.

Normal line of sight may be as much as **30**° below the horizontal.
[DEF STAN 00-250 part3 section15]

The **normal line of sight** falls into the range between **10°** and **30°** below the horizontal.
[DEF STAN 00-250 part3 section9]

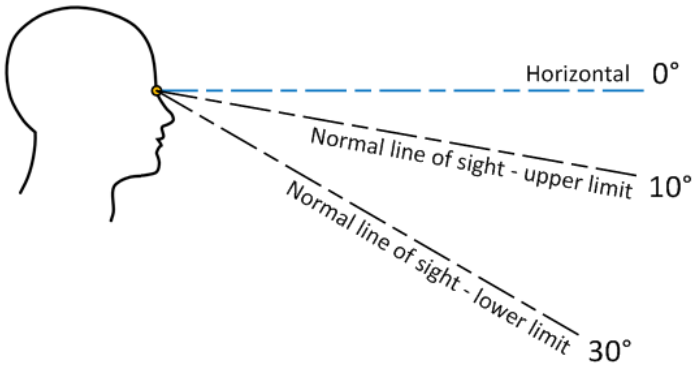


Figure 5-6: Range of line of sight

A.2.1.2.6Vertical gaze angles

Vertical gaze angles are the result from the combination of head and eye movement.

The **optimum** vertical gaze angles are within **40° above** and **20° below** the viewer's **line of sight**.
[DEF STAN 00-250 part3 section15]

Combining the values for the line of sight (cf. A.2.1.2.5) translates to **optimum** gaze angles between **30° above** and **50° below** the horizontal.
(Comment:
30° above horizontal, i.e. 40° above a line of sight leading 10° downwards;

50° below horizontal, i.e. 20° below a line of sight leading 30° downwards)

The **optimum** vertical gaze angle is between **0° to 45° down**.
[ISO 13406-2:2001]
[ISO 9241-302:2008]

The **maximum** vertical gaze angle is **70° down**.
[ISO 13406-2:2001]

A.2.1.2.7Vertical zones

Zone V1: Information most often used
Zone V2 + V3: Other information

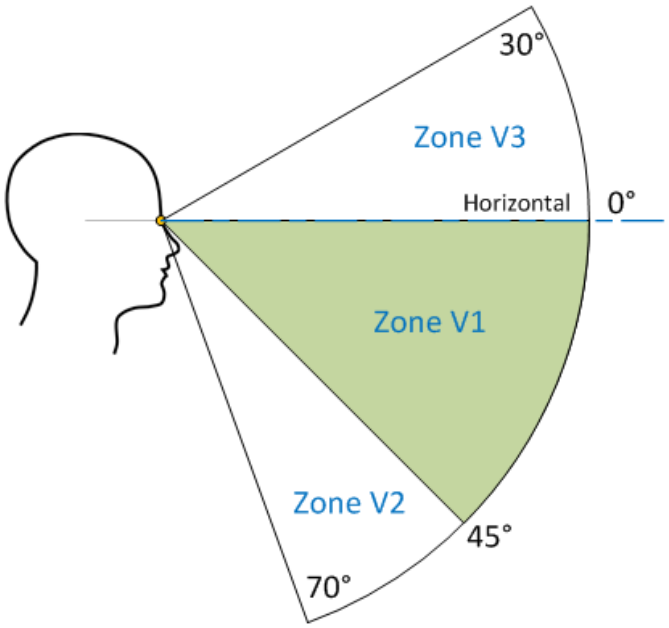


Figure 5-7: Vertical zones

A.2.2 Reach areas

Following requirements apply:

- Working positions should be designed by taking into account the 5th percentile up to the 95th percentile of the designated user group.
  [REQ-10.10.02-HFDD-2002.0036]

- Space within reach should be the 5th percentile.
  [REQ-10.10.02-HFDD-2002.0037]

- [Reach area measurements according to *Figure 5-8*.]

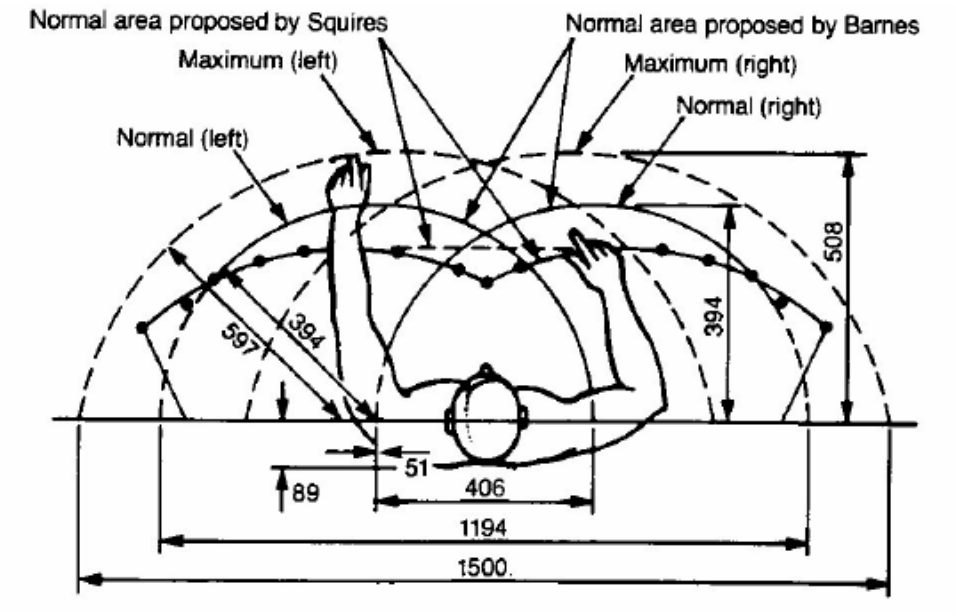


Figure 5-8: Reach areas
[DEF STAN 00-250 part3 section13]

Combining the reach area and the information in A.2.1.2.4 lead to horizontal zones, where the most often used interaction objects need to be found (e.g. on an interactive surface).

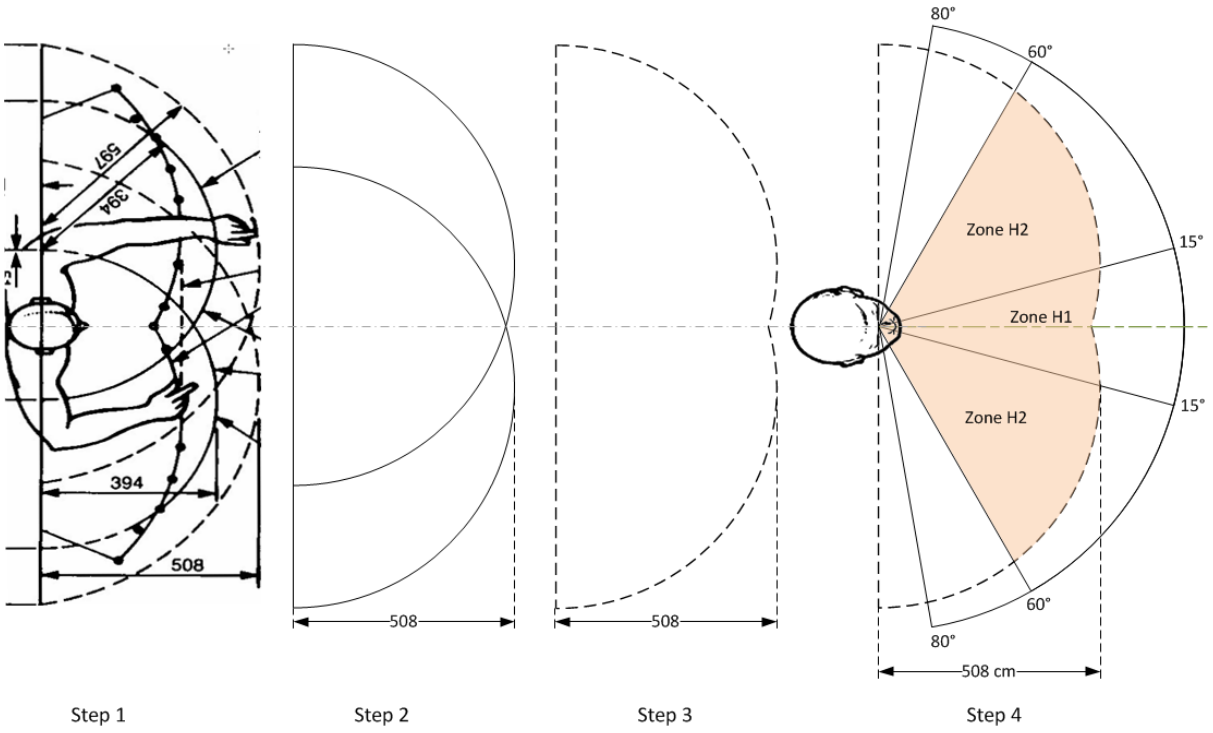


Figure 5-9: Horizontal reach area zones

Combining the reach area and the information in A.2.1.2.4 lead to horizontal zones, where the most often used interaction objects need to be found (e.g. on an interactive surface).

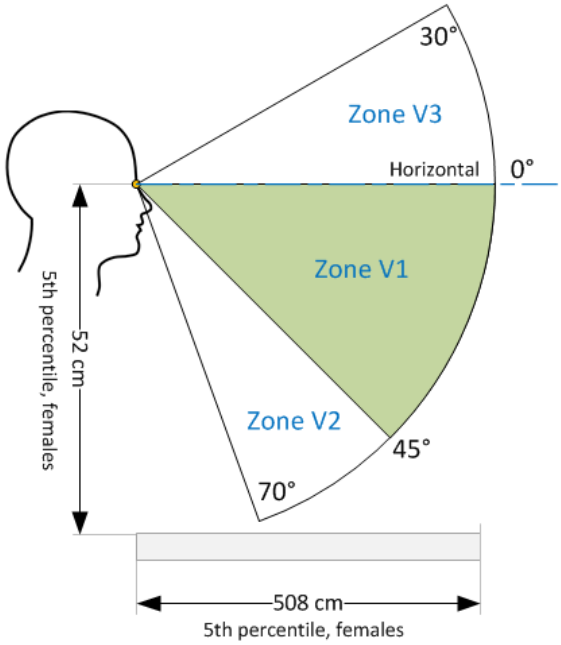


Figure 5-10: Horizontal reach area zones

A.3 OTW Views – Large and Medium Sized Layouts

The big dimensions of some layouts put emphasis on following topics:

- Critical information (e.g. alarms, warnings) should be made perceivable regardless of the operators' current focus area (gaze direction) within the RTM.
- If front projection is used, a person standing close to the OTW view should not interfere with the visualization presented. E.g. the operator should be able to move quite close to the OTW view without casting a shadow on the screen.
- Especially layouts featuring OTW view screens in the back of the operator (when having a horizontal gaze angle of 0°) have a high risk of producing reflections on other screens of the RTM.
- As the visual reproduction should be free of noticeable pixelation, the resolution of the OTW view screens / projection (for the set viewing distance) must be chosen accordingly.

For Large-screen optical projection displays:
The ratio of viewing distance to screen size (measured diagonally) shall be more than 2:1 and less than 8:1. The optimum ratio is 4:1; the preferred range is more than 3:1 or less than 6:1.
[FAA HF-STD-001:2003, Ch5]

A.3.1 Layout P1: Projection Screen 360° /360°

360° of the OTW view are seamlessly projected onto a 360° cylindrical screen. Measures have to be taken that objects within the projection cylinder (e.g. a person standing near the screen) do not hide important information, e.g. by casting shadows.

For this setup, the ISO 9241-307, 5.4 applies.

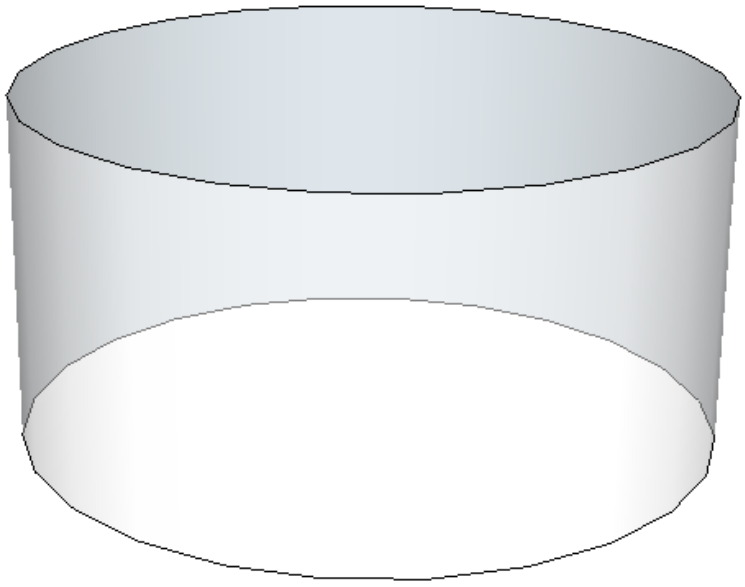


Fig. 5-1: 360° Cylindrical projection screen

Benefits:

- real-world 1:1 mapping
- big projection area (depending on height)

- intuitive, familiar representation (known from local towers; congruence with compass directions: if North is in front, South is in the back)
- seamless representation (except for the door, if at all)

Drawbacks:

- poor gross overview (events in the back of the operator)
- extensive head and body movements
- office space requirements
- entrance needed
- possible adaption of room ventilation needed
- additional viewers cannot watch unless they enter
- using a door for entering briefly disturbs a part of the OTW view (door; the disturbed part may be undeterminable in its momentary importance)

A.3.2 Layout P2: Large Screen Array 360° /360°

360° of the OTW view are presented on a 360° cylinder made up of large screens. Measures have to be taken that persons entering or leaving the central area do not hide important information, e.g. by “opening” a screen door.

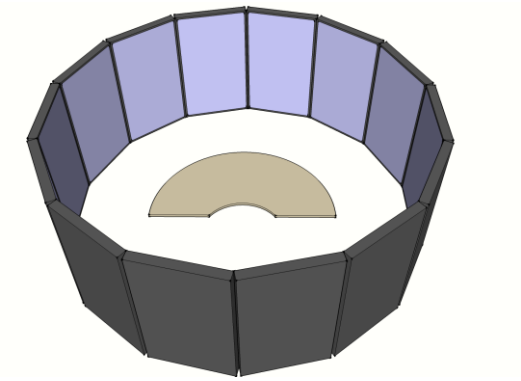


Fig. 5-2: 360° Large Screen Array

Benefits:

- real-world 1:1 mapping
- big projection area (depending on height)
- intuitive, familiar representation (known from local towers; congruence with cardinal directions: if North is in front, South is in the back)

Drawbacks:

- seams (with current technology)
- poor gross overview (events in the back of the operator)
- extensive head and body movements
- office space requirements

- entrance needed
- possible adaption of room ventilation need
- additional viewers cannot watch unless they enter
- using a door for entering briefly disturbs a part of the OTW view (door; the disturbed part may be undeterminable in its momentarily importance)

A.3.3 Layout P3: Large Screen Array 360°/280°

360° of the OTW view are presented on a 270° cylindrical surface made up of large screens that features a 80° wide opening.

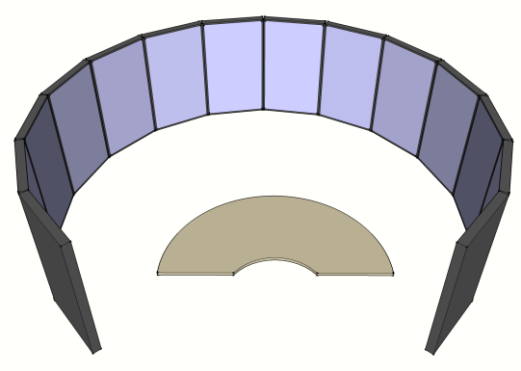


Fig. 5-3: 280° Large Screen Array

Benefits:

- big projection area (depending on height)
- somewhat intuitive representation
- entrance available

Drawbacks:

- seams (with current technology)
- poor gross overview (events near the back of the operator)
- somewhat extensive head and body movements
- office space requirements
- possible adaption of ventilation need

A.3.4 Layout P4: Split Large Screen Arrays 360° /360°

360° of the OTW view are presented on a split 360° cylinder made up of large screens.

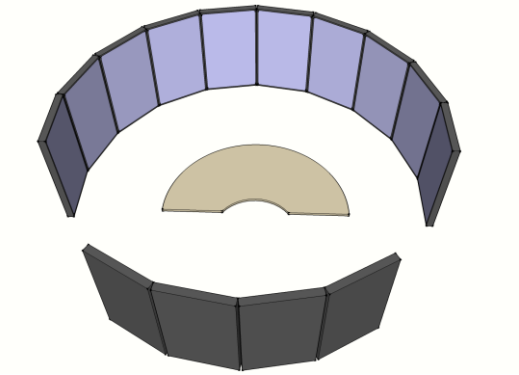


Fig. 5-4: 360° Split Large Screen Arrays

Main benefits:

- big projection area (depending on height)
- somewhat intuitive representation
- entrance available

Drawbacks:

- seams (with current technology)
- poor gross overview (events in the back of the operator)
- extensive head and body movements
- office space requirements
- The split introduces discontinuities in the representation

A.3.5 Layout P5: Medium Sized Screen Array 360° /180°

360° of the OTW view are presented on a 180° cylindrical surface made up of medium sized screens.

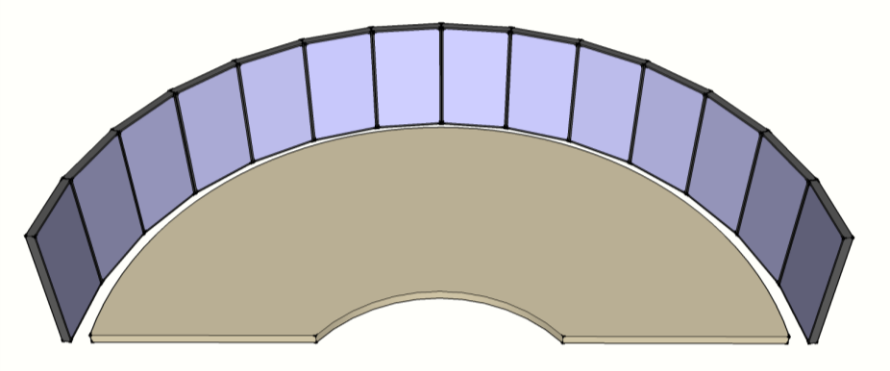


Fig. 5-5: 180° Small Screen Array

Main benefits

- large projection area (depending on height)

Drawbacks

- office space requirements
- unintuitive representation
- small seams (with current technology)

A.3.6 Layout P6: Medium Sized Screen Array 180° /180°

180° of the OTW view are presented on a 180° cylindrical surface made up of medium sized screens.

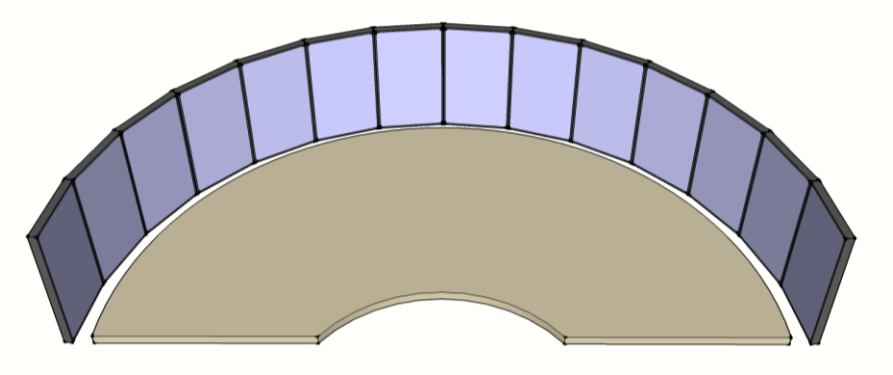


Fig. 5-6: 180° Small Screen Array

Main benefits:

- large projection area (depending on height)
- intuitive representation

Drawbacks:

- office space requirements
- small seams (with current technology)

A.4 OTW Views – Small Sized Layouts

Up to 360° of the OTW view are presented on an array of small screens. Representing a full 360° OTW view can be used for overview purposes only. Therefore, this setup is best used if a monitor row (e.g. a row of four monitors) presents a certain section, e.g. 180°.

A.4.1 Layout P7: Monitors in rows

The usage of four monitors in a row provides mainly the view to the runway or another selected section. If the user needs a 360° view, the system has to provide a possibility to **switch** or **rotate** the view.

Fig. 5-7: Four monitors in a row

Fig. 5-8: Three monitors in a row

Fig. 5-9: Four monitors in two rows

Main benefits:

- Use of standard-size displays
- standard office equipment
- cost effective
- space effective
- overview
- little head/body movements

Drawbacks:

- little screen real estate
- unintuitive representation
- small seams (with current technology)

A.4.2 Layout P8: Small Projection Screen

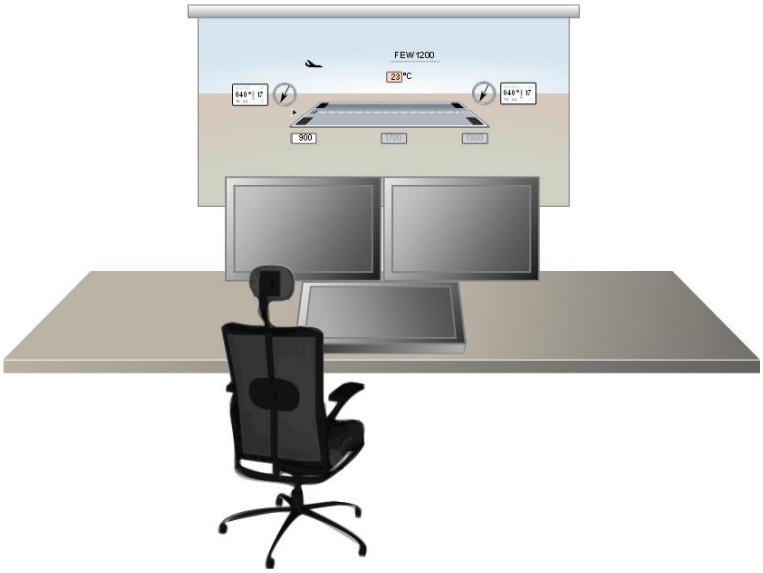


Fig. 5-10: Projection Screen

Main benefits:

- Use of standard-size displays
- standard office equipment
- cost effective
- space effective
- overview
- little head/body movements

Drawbacks:

- little screen real estate
- unintuitive representation
- small seams (with current technology)

A.5 Control Device

Control devices must be place within the reach area as shown in A.2.2, *Figure 5-8*. Depending on the overall width of the interaction devices, the operator may need to change her seating or standing position. An example placement is shown in the image below (marked orange)

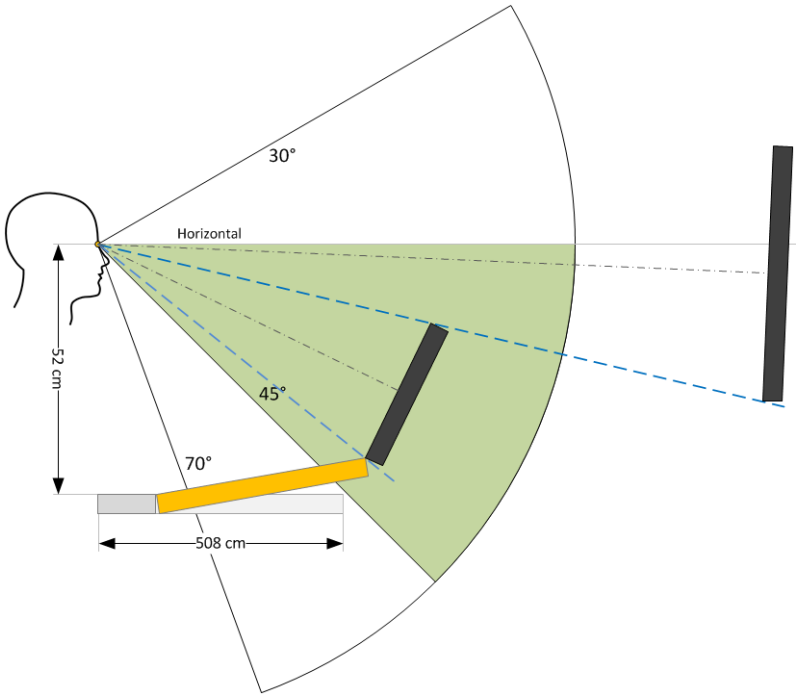


Fig. 5-11: Example placement of control device (orange)

Depending on the interaction concept, a various number of interactive devices in various dimensions can be employed.

Fig. 5-12: One Touch Screen

Fig. 5-13: Two Touch Screens side by side

Fig. 5-14: Three touch screens side by side.

Fig. 5-15: One horizontal and one vertical touch screen

Regarding the PTZ, the operator should be able to control the PTZ's elementary functions (pan, tilt, zoom) without having to watch the PTZ control area (or control device) itself.

A.6 Examples

This chapter includes some examples of combinations between the OTW view, control device, and information view. The aim is not completeness in examples (as possibilities of combinations are huge) but to get insight on the advantages and disadvantages the combinations bear.

A.6.1 Example A

The background shows an airport OTW view of 360°, positioned around the controller. In front of the operator there is a vertical screen with Radar, and a somewhat flat multi-touch panel for direct interactions (e.g. Strips, Voice, PTZ control, MET, display handling, etc.).

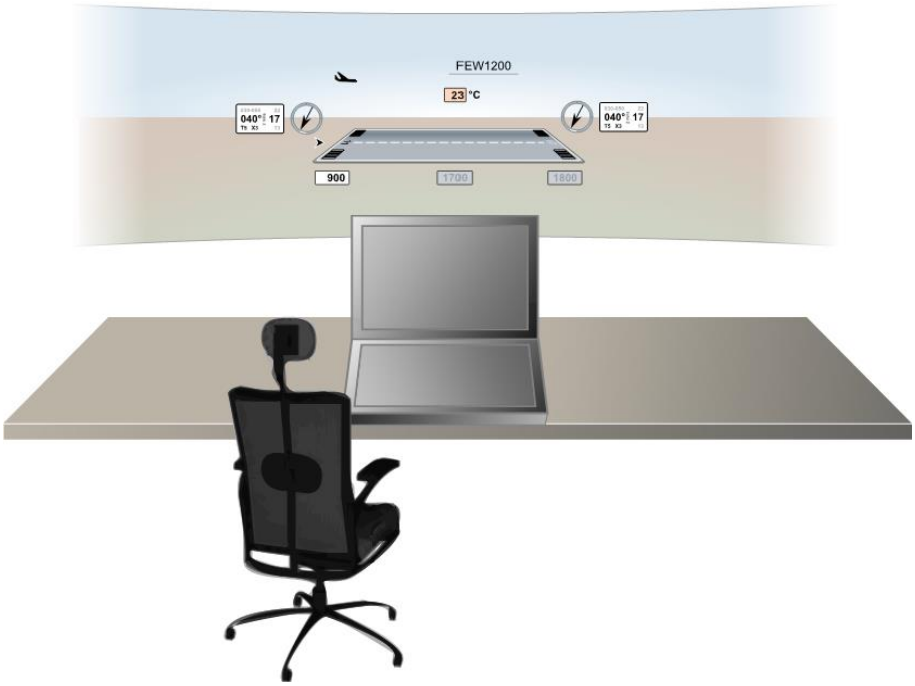


Fig. 5-16: 360° Setup A

A.6.2 Example B

Using two multi-touch screens would makes the mouse or trackball for radar unnecessary. Additionally, the line of sight to the OTW view is undisturbed.

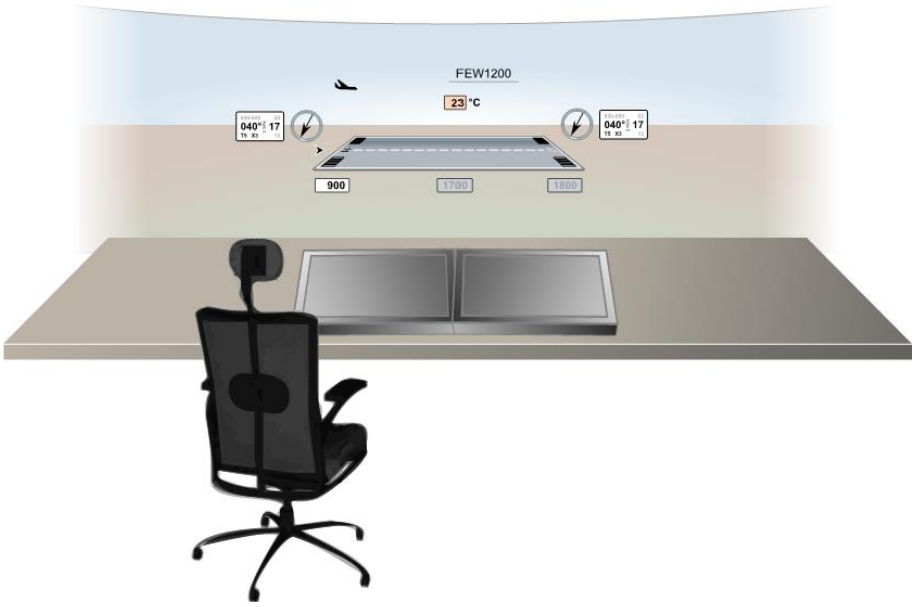


Fig. 5-17: 360° Setup B

A.6.3 Example C

Fig. 5-18: Setup C 1

Fig. 5-19: Setup C2

A.6.4 Example D

When using two rows of monitors, or one row and a small projection screen, most of the important information can be seen all the time (vertical and horizontal viewing angle). The disadvantage lies more in the ergonomics, because the user has to look up and move his head backwards, to fully see the top of the above information.

Fig. 5-20: Setup D1

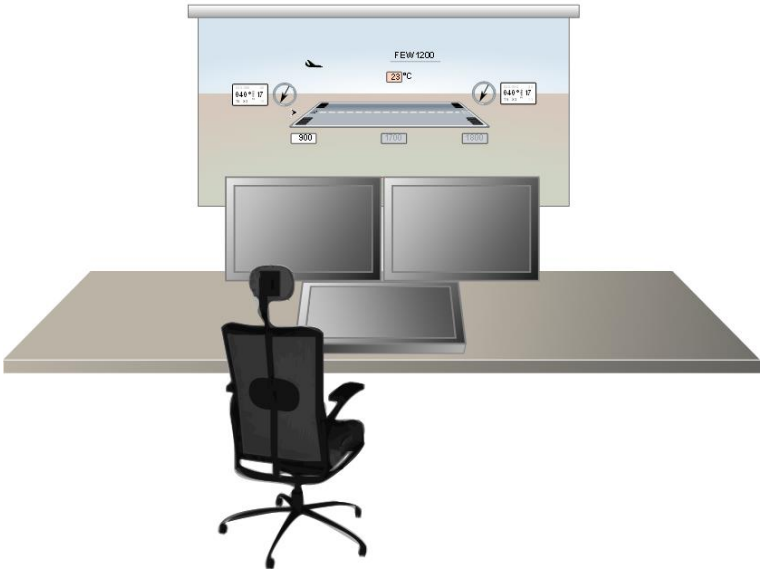


Fig. 5-21: Setup D2

A.7 Comparison parameters

To make the different OTW view setups comparable, a set of characteristics is used. The following set is the base for comparison.

A.7.1 Accommodation

The lens of the human eye accommodates each time the distance to an object in view changes.

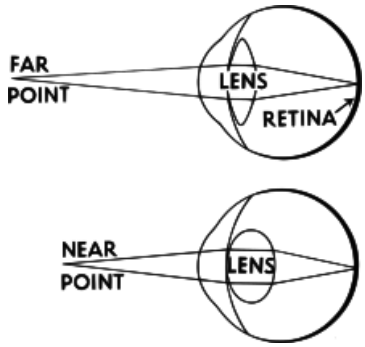


Fig. 5-22: Accommodation of the eye

“Accommodation” indicates, how much accommodation is necessary to switch from the interaction area to the OTW view surface. Additionally, the more viewing distances a setup for a given task consists of, the more often the operator has to accommodate her eyes.

The combination of high accommodation values with the repetitiveness of accommodation necessary for a given task increases fatigue.

Compared to a local tower, where the operator’s eyes have to accommodate to hundreds and thousands of metres, even the largest values (of some metres) of some layouts appear negligible as far as solely accommodation is concerned.

[The influence of this characteristic has to be evaluated during the prototyping phase.]

Note:

OTW views use digital representation techniques. Properties of digital representation techniques include flicker, artificial light sources with spectral gaps and peaks, as well as contrast and brightness values very different from natural light. These properties - in combination with accommodation - may play a role in straining the operators eyes.

A.7.2 Spatial Awareness

Spatial awareness indicates to what extend the compass directions correspond to the special directions of the OTW view.

An operator is supposed to be fully aware of the compass directions if the 360° of the OTW view are presented and visible all the time. Spatial awareness is supposed to be degraded if the operator faces “north” in the middle of a half-circle screen array, and “south” is represented to the operator’s left hand and right hand side simultaneously.

[The influence of this characteristic has to be evaluated during the prototyping phase.]

A.7.3 Distance Between Operators

The distance between operators is influenced by the size and layout of the OTW view.

This characteristic may only apply in special situations, where there is a need that operators need to talk to each other in person across different RTMs.

A.7.4 Space Used

The space used by one RTM influences the number of RTMs that can be installed within a given space (i.e. the available space within a building or room).

This characteristic may only apply in special situations, where the available space is given, or the financial resources for creating new space are limited.

A.7.5 Familiarity

Familiarity indicates the change an remote tower OTW view represents in comparison to the OTW view on a local tower.

This characteristic may only apply in special situations, when operators who currently work on a local tower are retrained to operator a remote tower.

[The influence of this characteristic has to be evaluated during the prototyping phase.]

A.7.6 Capital Expenditures

Capital expenditure describes the equipment cost for setting up the solution.

This characteristic may only apply in special situations, when the number of RTMs necessary is large compared to the financial resources.

[This characteristic will not be evaluated for the time being.]

A.8 Overview table

Each characteristic is rated by how much impact a given solution imposes on the characteristic on a scale from zero to four (with zero being the lowest), according to following table:

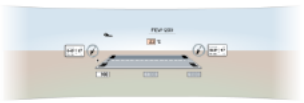
Value	Impact
0	Not present / Negligible
1	Limited
2	Moderate
3	Substantial
4	Serious

Table 2 –Impact values

The reader has to evaluate for her *own situation*:

- The emphasis a certain characteristic is given within a project
- Whether the characteristic and its impact represent an advantage or a disadvantage

[Values within in this table are an estimate and should serve as a starting point for further refinement]

OTW View Setup	Reference	Accommodation	Spatial Awareness	Distance btw. Operators	Space Used	Familiarity	Capital Expenditures				
Projector 360°/360° 	P1	2	0	3	3	0	tbd				
Screens 360°/360° 	P2	2	0	3	3	0	tbd				
Screens 360°/split 360° 	P3	2	1	3	3	0	tbd				

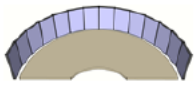
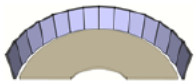
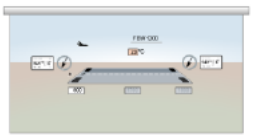
OTW View Setup	Reference	Accommodation	Spatial Awareness	Distance btw. Operators	Space Used	Familiarity	Capital Expenditures				
Screens 360°/280° 	P4	2	1	2	3	1	tbd				
Screens 360°/180° 	P5	1	3	1	2	3	tbd				
Screens 180°/180° 	P6	1	2	1	2	0	tbd				
Screens 	P7	1	3	0	1	1-3	tbd				
Projector 	P8	1	3	0	1	1-3	tbd				

Table 3 – Comparison of OTW View Setups

Appendix B Deleted requirements

The following requirements have been included in previous editions, but have been deleted during the course of 12.04.07 as part of requirement updating and refinement.

Reasons for deletion are one or more of the following:

- Requirement not supported by OSED requirements.
- Requirement is Virtual Tower specific, which has not been validated
- Requirement has been redefined or split into multiple requirements.
- Requirement was a duplicate of another requirement.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0008
Requirement	The voice distribution ***shall*** be compliant with EUROCAE Working Group 67 recommendations if it is an IP-solution.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0009
Requirement	The voice distribution system ***shall*** support a hierarchical side tone generation configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0010
Requirement	The voice distribution system ***shall*** support shared access to the radio infrastructure.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0011
Requirement	The voice distribution system ***shall*** support different priorities for radio access.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0012
Requirement	The voice distribution system ***shall*** support a pre-emption mechanism at the radio (gateway).

[REQ]

Identifier	REQ-12.04.07-TS-0100.0013
Requirement	The voice distribution system ***should*** provide an HMI that combines A/G and G/G communications on one controller working position.

[REQ]

Identifier	REQ-12.04.07-TS-0101.0002
Requirement	The RVT ***shall*** present continuously to the ATCO/AFISO the current MET report with actual wind information.

[REQ]

Identifier	REQ-12.04.07-TS-0102.0001
Requirement	The RVT ***shall*** provide a presentation enabling the ATCO/AFISO to 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.”

[REQ]

Identifier	REQ-12.04.07-TS-0102.0004
Requirement	How much of the tower field of view is replicated ***shall*** be specified in the implementation requirement specifications.

[REQ]

Identifier	REQ-12.04.07-TS-0104.0007
Requirement	The RVT ***shall*** provide means to monitor all voice communication equipment centrally from the RTC.

[REQ]

Identifier	REQ-12.04.07-TS-0104.0008
Requirement	The RVT ***shall*** provide remote CWP monitoring.

[REQ]

Identifier	REQ-12.04.07-TS-0105.0001
Requirement	The RVT ***shall*** have a voice recording system/function.

[REQ]

Identifier	REQ-12.04.07-TS-0105.0002
Requirement	The RVT ***shall*** have necessary data recording systems/functions.

[REQ]

Identifier	REQ-12.04.07-TS-0105.0003
Requirement	The RVT ***shall*** provide an analogue legal recording output at each CWP.

[REQ]

Identifier	REQ-12.04.07-TS-0105.0004
Requirement	The RVT ***shall*** provide an IP legal recording output at each CWP.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0001
Requirement	The RVT ***shall*** provide visual surveillance by a reproduction of the aerodrome view.

[REQ]

Identifier	REQ-12.04.07-TS-0100.0007
Requirement	The virtual tower ***shall*** receive surveillance data from the controlled aerodrome to feed the OTW with live traffic.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0031
Requirement	The RVT ***shall*** provide surveillance of the ground traffic by a reproduction of the manoeuvring area.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0032
Requirement	The virtual tower visual reproduction of the remote aerodrome ***shall*** reproduce environmental data as day, night, rain, fog and sun position.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0004
Requirement	The RVT ***shall*** adequately indicate in the visual reproduction any existing discontinuities or non-uniformities in terms of the presented scale, orientation and field of view of the area under observation by the ATCO/AFISO, so as not to cause any misleading impressions regarding the spatial geometry of the area of responsibility.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0009
Requirement	The RVT ***should*** provide functions to visually judge the position of a light aircraft in the traffic pattern and in published VFR holdings.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0010
Requirement	When meteorological conditions so permit, the RVT ***should*** provide functions to visually judge gear down on an aircraft in the vicinity of the aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0012
Requirement	In low visibility conditions, the RVT ***may*** provide functions to monitor an aircraft vacating the runway.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0013
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate the detection and recognition of aircraft.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0014
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate the identification of aircraft (i.e. correlation with flight plans or position reporting).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0015
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate tracking of aircraft (i.e. labels directly in the visual reproduction).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0016
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate the detection and recognition of vehicles on the manoeuvring area.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0017
Requirement	The RVT visual reproduction ***shall*** incorporate features that facilitate the identification of vehicles on the manoeuvring area (i.e. correlation with position reporting).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0018
Requirement	The RVT visual reproduction ***should*** incorporate features that facilitate tracking of vehicles on the manoeuvring area (i.e. labels directly in the visual presentation).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0019
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate the detection and recognition of obstructions / foreign objects on the manoeuvring area (e.g. personnel or large animals).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0020
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate the identification of obstructions / foreign objects on the manoeuvring area (e.g. personnel or large animals).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0021
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate tracking of obstructions / foreign objects on the manoeuvring area (e.g. personnel or large animals).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0022
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate judging aircraft position (depth of vision for the ATCO/AFISO).

[REQ]

Identifier	REQ-12.04.07-TS-0110.0023
Requirement	The RVT visual reproduction ***may*** incorporate features that facilitate judging aircraft altitude.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0024
Requirement	The RVT visual reproduction ***may*** incorporate overlaid information to indicate specific parts of the aerodrome, in order to increase the awareness of such objects in darkness or low visibility conditions.

[REQ]

Identifier	REQ-12.04.07-TS-0110.0025
Requirement	The RVT visual reproduction ***may*** incorporate overlaid information in order to assist the ATCO/AFISO (e.g. current wind and RVR values, status of airport systems such as runway and approach lighting),

[REQ]

Identifier	REQ-12.04.07-TS-0110.0026
Requirement	The RVT visual reproduction ***shall*** provide functionality corresponding to the binoculars in a local Tower (including a moveable zoom feature with a visual indication of the direction of boresight).

[REQ]

Identifier	REQ-12.04.07-TS-0111.0001
Requirement	The RVT ***may*** have a function for distributing the actual outdoor sound from the airport.

[REQ]

Identifier	REQ-12.04.07-TS-0113.0002
Requirement	The RVT voice and data recording ***may*** include actual outdoor sound from the airport.

[REQ]

Identifier	REQ-12.04.07-TS-0201.0001
Requirement	The RVT design ***shall*** be modular in the sense that no major design change shall be necessary to meet specific operational requirements of an aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0201.0002
Requirement	The RVT equipment ***shall*** comprise hardware and software modules.

[REQ]

Identifier	REQ-12.04.07-TS-0201.0003
Requirement	The RVT consists of many elements which, when integrated, are designed to meet the specific operational requirements of an aerodrome. In order to cover a wide range of requirements any element design ***should*** comply with the modularity concept.

[REQ]

Identifier	REQ-12.04.07-TS-0201.0004

Requirement	The RVT ***shall*** be modular so that the appropriate level of service can be provided to different aerodromes as well as to different areas of an aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0201.0005
Requirement	The RVT system ***shall*** be modular with respect to applications.

[REQ]

Identifier	REQ-12.04.07-TS-0201.0006
Requirement	The RVT system ***shall*** be modular allowing procurement of modules from different suppliers.

[REQ]

Identifier	REQ-12.04.07-TS-0202.0001
Requirement	The RVT ***should*** be such that further components can be added in order to expand the system in terms of functionality and numbers of users

[REQ]

Identifier	REQ-12.04.07-TS-0202.0002
Requirement	The modules ***should*** be such that the RVT can be dimensioned according to the needs of different aerodromes.

[REQ]

Identifier	REQ-12.04.07-TS-0202.0003
Requirement	The RVT ***should*** be scalable with respect to voice communication equipment (radios, radio gateways, controller working positions).

[REQ]

Identifier	REQ-12.04.07-TS-0202.0004
Requirement	The RVT ***should*** be scalable with respect to operated airports/heliports.

[REQ]

Identifier	REQ-12.04.07-TS-0203.0001
Requirement	Adaptation of the equipment to different local site configurations, procedures and working methods ***should*** be done through an appropriate database (sensor positions, airport topography/topology, etc.).

[REQ]

Identifier	REQ-12.04.07-TS-0203.0002
Requirement	The RVT services ***should*** be configurable to adapt to local ATC procedures and working methods.

[REQ]

Identifier	REQ-12.04.07-TS-0203.0003
Requirement	The RVT design ***shall*** take into account the working environment of the user under various operational conditions. In this respect, the RVT working positions shall be adaptable to the various circumstances of the user. Specific requirements need to be added.

[REQ]

Identifier	REQ-12.04.07-TS-0203.0004
Requirement	The RVT ***should*** provide a role management system that unites all functions in CWP.

[REQ]

Identifier	REQ-12.04.07-TS-0203.0005
Requirement	The role system ***shall*** be independent from the physical controller working position.

[REQ]

Identifier	REQ-12.04.07-TS-0204.0001
Requirement	The RVT visual reproduction ***shall*** be configurable in order to accommodate any change in the layout of the aerodrome (runways, taxiways and aprons), without modifying the core processing.

[REQ]

Identifier	REQ-12.04.07-TS-0204.0002
Requirement	The RVT ***should*** provide means to define the radio layout (HMI).

[REQ]

Identifier	REQ-12.04.07-TS-0204.0003
Requirement	The RVT ***should*** provide means to define the phone layout (HMI).

[REQ]

Identifier	REQ-12.04.07-TS-0301.0001
Requirement	The amount of access to aeronautical mobile service (air-ground communications) for the RVT ***shall*** be specified in the implementation requirement specifications.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0002
Requirement	The amount of access to aeronautical fixed service (ground-ground communications) for the RVT ***shall*** be specified in the implementation requirement specifications.
Identifier	REQ-12.04.07-TS-0301.0003
Requirement	What capabilities the RVT CWP must provide ***should*** be specified in the implementation requirement specifications.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0005
Requirement	The visual reproduction in the virtual tower ***shall*** provide the ATCO/AFISO with the real time 3D visualisation of the airport traffic.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0006
Requirement	The visual reproduction in the virtual tower ***shall*** be able to provide a realistic visualization of the airport and its surrounding area.
Identifier	REQ-12.04.07-TS-0301.0000
Requirement	The RVT ***shall*** provide a DR&A to record and playback the last TBD minutes of the complete RVT data. Air to Ground communications, Ground to Ground communications, Surveillance data, live video OTW, DIS/HLA

	entities for 3D Visualizer.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0008
Requirement	The RVT ***shall*** provide the DR&A "Data Recording and Analysis" function to record and playback RVT data. The Implementation requirement specification document defines the data set and the time period for the recording.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0009
Requirement	Maximum number of aerodromes to which remote service can be offered ***shall*** be defined by the Implementation Requirements Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0010
Requirement	Maximum number of aerodromes to which remote service can be offered *simultaneously* ***shall*** be defined by the Implementation Requirements Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0011
Requirement	The RVT ***shall*** have access to aeronautical mobile service for each aerodrome which the ATC / AFIS service could be offered to.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0012
Requirement	The RVT ***shall*** have access to aeronautical fixed service (ground-ground communications) for each aerodrome which the ATC / AFIS service could be offered to.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0013
Requirement	For each aerodrome which the ATC / AFIS service could be offered to, the RVT CWP ***should*** offer the capabilities specified in the implementation requirement specifications related to that aerodrome.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0014
Requirement	For each aerodrome the ATC/AFIS service could be offered to, a defined replica of the OTW view of the local tower ***shall*** be presented in the RTC.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0015
Requirement	The visual reproduction in the virtual tower ***should*** USE standard data protocols in order to provide the ATCO/AFISO with the real time 3D

	visualisation of each airport under management of RTC.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0016
Requirement	The visual reproduction in the virtual tower ***shall*** be able to provide a realistic visualization of each airport and its surrounding area, under management of the RTC.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0017
Requirement	The RVT ***shall*** provide the DR&A "Data Recording and Analysis" function to record and playback RVT data related to each aerodrome under management of the RTC. The Implementation requirement specification document defines the data set and the time period for the recording.

[REQ]

Identifier	REQ-12.04.07-TS-0301.0018
Requirement	The DR&A "Data Recording and Analysis" function offered by the RVT system ***shall*** record data for each aerodrome managed by the RTC also when the airport is not undergoing active control.
Identifier	REQ-12.04.07-TS-0301.0019
Requirement	Capacity requirements satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0302.0001
Requirement	The visual reproduction in the remote tower ***shall*** provide a visual detail that match OTW direct vision. Requirements on the visual detail in the remote tower need to be specified.

[REQ]

Identifier	REQ-12.04.07-TS-0302.0002
Requirement	The visual reproduction in the virtual tower ***shall*** provide a visual detail that match OTW direct vision. Requirements on the visual detail in the virtual tower need to be specified.

[REQ]

Identifier	REQ-12.04.07-TS-0302.0003
Requirement	The visual reproduction in the virtual tower ***shall*** allow a user to reduce the visualised detail of Entities in order to improve run time performance of the 3D System Viewer. Requirements on this in the virtual tower need to be specified
Identifier	REQ-12.04.07-TS-0302.0004
Requirement	Accuracy in visualization of the remote video stream in the remote tower for each airport managed by the RTC ***shall*** match that of single aerodrome visualisation.
Identifier	REQ-12.04.07-TS-0302.0005
Requirement	Visual detail in 3D reproduction of the OTW view from each remotely managed aerodrome ***shall*** match that of single aerodrome reproduction.
Identifier	REQ-12.04.07-TS-0302.0006
Requirement	Accuracy requirements satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0001
Requirement	The maximum delay in mobile aeronotical services (ground to air) and fixed aeronotical services (ground to ground) ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0002
Requirement	The delay of the visual reproduction images ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0003
Requirement	The RVT ***shall*** provide the CWP with surveillance data from the remote controlled aerodrome with a maximum delay that shall be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0004
Requirement	The virtual tower ***shall*** provide the visual reproduction with surveillance data from the remote controlled aerodrome with a maximum delay that shall be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0005
Requirement	The RVT visual reproduction ***shall*** provide the virtual 3D visualization of ground traffic on the remote airport with a maximum delay that shall be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0006
Requirement	If redundancy exists, requirements on maximum automatic reconfiguration time on resuming the service in case of a single fault ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0007
Requirement	The RVT ***shall*** sustain at least for X minutes,Y % workload minutes a temporary workload exceeding its maximum standard workload by X minutes,Y % workload. Requirements on X minutes and Y % workload shall be specified

[REQ]

Identifier	REQ-12.04.07-TS-0303.0008
Requirement	The RVT time delay variation between image capture and presentation on the visual reproduction ***shall not*** differ in a way that it affects the ability to perform the ATS service. Requirements on time delay need so be specified.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0009
Requirement	For each RTM present in the RTC, maximum time needed to connect the RTM to a new airport ***shall*** be defined by the Implementation Requirements Specifications.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0010
Requirement	Maximum delay introduced in access to aeronautical mobile service (air-ground communications) and to aeronautical fixed service (ground-ground communications) by the RVT ***shall*** be specified in the Implementation Requirement Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0011
Requirement	Maximum delay of images introduced in the visual reproduction for each remotely managed aerodrome ***shall*** be specified in the Implementation Requirement Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0012
Requirement	Maximum delay introduced in providing surveillance data to CWPs for each remotely managed aerodrome ***shall*** be specified in the Implementation Requirement Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0013
Requirement	Maximum delay introduced in providing surveillance data to the visual reproduction for each remotely managed aerodrome ***shall*** be specified in the Implementation Requirement Specification.
Identifier	REQ-12.04.07-TS-0303.0014
Requirement	The maximum delay for 3D visualisation of each remotely managed aerodrome ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0015
Requirement	For each remotely managed aerodrome, the RVT ***shall*** ensure that the delay introduced in visual reproduction for each remotely managed aerodrome *does n*ot affect the ability to perform the ATC/AFIS service. Requirement on time delay need to be specified.
Identifier	REQ-12.04.07-TS-0303.0016
Requirement	Timing performance requirements satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0303.0017
Requirement	Maximum time needed to switch service from the main tower to the contingency tower ***shall*** be defined by the Implementation Requirements Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0001
Requirement	The requirement of resolution ***shall*** be specified.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0002
Requirement	The visual reproduction in the virtual tower ***shall*** be capable of visualising within a 3D scenario environment as 3D object models all surveillance tracks visualized on the CWP.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0003
Requirement	The maximum number of tracks visualized on CWP ***shall*** be specified for RVT

[REQ]

Identifier	REQ-12.04.07-TS-0304.0005
Requirement	The refresh rate of the presented video stream ***shall*** be defined by the Implementation Requirements Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0006
Requirement	The RVT hardware/software usage ***shall*** be lower than X% of the maximum available resources when running a load scenario Requirements on load scenario need to be specified. Requirements on X shall be specified.
Identifier	REQ-12.04.07-TS-0304.0007
Requirement	The RVT 3D visualization system hardware/software usage ***shall*** be lower than X% of the maximum available resources when running a load scenario.
Identifier	REQ-12.04.07-TS-0304.0008
Requirement	For each remotely managed aerodrome, the Implementation Requirements Specification ***shall*** specify requirements about screen resolution.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0009
Requirement	For each remotely managed aerodrome, the visual reproduction in the virtual tower ***shall*** visualize as many 3D objects as would be visible from the ATCO/AFISO point of view in the local tower. Definition on 3D objects need to be defined in the requirement.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0010
Requirement	Maximum number of tracks visualized on CWP for each remotely managed aerodrome ***shall*** be specified in Implementation Requirements Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0011
Requirement	The visual reproduction of the virtual tower ***shall*** be capable of refresh its presentation for each remotely managed aerodrome at a rate specified in

	the Implementation Requirement Specification.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0012
Requirement	The frame rate of the video stream from each remotely managed aerodrome ***shall*** be specified in the Implementation Requirements Specification.
Identifier	REQ-12.04.07-TS-0304.0013
Requirement	Hardware/software resources used for each remotely managed aerodrome within the RVT system ***shall not*** exceed a value defined within the Implementation Requirements Specification.
Identifier	REQ-12.04.07-TS-0304.0014
Requirement	Software and Resource Usage requirements satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0304.0015
Requirement	Software and Resources used by the contingency tower ***may*** be used for training purpose when not needed for exceptional situations.

[REQ]

Identifier	REQ-12.04.07-TS-0305.0001
Requirement	The RVT ***shall*** sustain a temporary workload exceeding a percent its maximum standard workload, that percent ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0001
Requirement	The redundancy requirement of the RVT and components ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0002
Requirement	All critical elements of the RVT ***should*** be provided with timely audio and/or visual indications of failure.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0003
Requirement	The system design ***should*** prevent failures that result in erroneous data for operationally significant time periods

[REQ]

Identifier	REQ-12.04.07-TS-0306.0004
Requirement	The RVT ***should*** have the ability to provide continuous validation of data and timely alerts to the user when the system must not be used for the intended operation. The validity of data should be assessed by the system in accordance with the assigned priority given to these data

[REQ]

Identifier	REQ-12.04.07-TS-0306.0005
Requirement	A self-checking system with failure alerts ***should*** be included in the system

	design.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0006
Requirement	The RVT ***shall*** follow Safety Case according to Eurocontrol SAMv2.1

[REQ]

Identifier	REQ-12.04.07-TS-0306.0007
Requirement	The RVT ***shall*** support authentication in its components for management access.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0008
Requirement	The RVT ***shall*** support confidentiality in its components for management access.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0009
Requirement	The RVT ***shall*** support authentication at each controller working position.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0010
Requirement	The radio gateway ***shall*** only allow access from known clients (white list).

[REQ]

Identifier	REQ-12.04.07-TS-0306.0011
Requirement	The RVT ***shall*** support monitoring mechanisms that ensures confidentiality.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0012
Requirement	The RVT ***shall*** support monitoring mechanisms that ensures integrity.
Identifier	REQ-12.04.07-TS-0306.0013
Requirement	The RVT ***shall*** support monitoring mechanisms that provides confidentiality.
Identifier	REQ-12.04.07-TS-0306.0014
Requirement	The RVT shall support monitoring mechanisms that provides integrity.

[REQ]

Identifier	REQ-12.04.07-TS-0306.0015
Requirement	The RVT ***shall*** support monitoring mechanisms that provides authentication.

[REQ]

Identifier	REQ-12.04.07-TS-0307.0001
Requirement	Requirements regarding maximum downtime for total OTW ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0307.0002

Requirement	Requirements regarding maximum downtime for a single OTW monitor ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0307.0003
Requirement	Requirements regarding maximum downtime for PTZ ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0307.0004
Requirement	Requirements regarding maximum downtime for communication between RTC and airport ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0307.0005
Requirement	Requirements regarding maximum downtime for total system and sub-system ***shall*** be specified in the implementation requirement specification.
Identifier	REQ-12.04.07-TS-0307.0006
Requirement	Maintanability requirements satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0001
Requirement	Requirements regarding maximum MTBF for total OTW ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0002
Requirement	Requirements regarding maximum MTBF for a single OTW monitor ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0003
Requirement	Requirements regarding maximum MTBF for PTZ ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0004
Requirement	Requirements regarding maximum MTBF for XXX ***shall*** be specified in the implementation requirement specification.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0005
Requirement	The RVT ***shall*** provide the ATCO/AFISO with warning indicating if a visual reproduction image is frozen.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0006

Requirement	The RVT ***shall*** provide the ATCO/AFISO with warning indicating if a visual reproduction image is corrupt.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0007
Requirement	The RVT ***shall*** provide the ATCO/AFISO with warning indicating if a visual reproduction image is delayed.

[REQ]

Identifier	REQ-12.04.07-TS-0308.0008
Requirement	Requirements regarding maximum delay in the visual reproduction ***shall*** be specified in the implementation requirement specification.
Identifier	REQ-12.04.07-TS-0308.0009
Requirement	Reliability requirements satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0309.0001
Requirement	All constructions at the local airport ***should*** follow the guidelines defined in the applicable ICAO Standards.

[REQ]

Identifier	REQ-12.04.07-TS-0309.0002
Requirement	All major system components ***shall*** be decoupled and separated by clear defined interfaces.

[REQ]

Identifier	REQ-12.04.07-TS-0309.0003
Requirement	The system construction ***shall*** utilize COTS hardware products on standarized products.

[REQ]

Identifier	REQ-12.04.07-TS-0309.0004
Requirement	Network QoS monitoring and usage ***shall*** be taken into account in the design of system function. Requirements on Network QoS monitoring and usage ***shall*** be specified

[REQ]

Identifier	REQ-12.04.07-TS-0309.0005
Requirement	The design ***shall*** allow the distribution of the network traffic to different communication infrastructure or providers.

[REQ]

Identifier	REQ-12.04.07-TS-0309.0006
Requirement	The design for a multiple remote tower setup ***shall*** assure that a malfunction at a dedicated airport has no effect on control capabilities of other airports.
Identifier	REQ-12.04.07-TS-0309.0007
Requirement	Design and Construction constraints satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

[REQ]

Identifier	REQ-12.04.07-TS-0310.0001
Requirement	The design ***shall*** allow local or centralized deployment of interfaces

[REQ]

Identifier	REQ-12.04.07-TS-0310.0002
Requirement	The RVT ***shall*** provide an interface to needed local surveillance sensors.

[REQ]

Identifier	REQ-12.04.07-TS-0310.0003
Requirement	The RVT ***shall*** provide an interface to local cameras.

[REQ]

Identifier	REQ-12.04.07-TS-0310.0004
Requirement	The RVT ***shall*** provide an interface to local VHF radios via analogue interface or IP.

[REQ]

Identifier	REQ-12.04.07-TS-0310.0005
Requirement	The RVT ***shall*** provide an interface to local airport systems.

[REQ]

Identifier	REQ-12.04.07-TS-0310.0006
Requirement	The RVT ***may*** provide an interface to specific partners at the local airport (e.g. Airport Operator …) allowing read-only access to information the RTS can provider,

[REQ]

Identifier	REQ-12.04.07-TS-0310.0007
Requirement	The RVT ***shall*** provide a central interface for telephone lines

[REQ]

Identifier	REQ-12.04.07-TS-0310.0008
Requirement	The RVT ***should*** provide a central interface to the SWIM network for services MET, Flight Plan, Surveillance and AIM

[REQ]

Identifier	REQ-12.04.07-TS-0310.0009
Requirement	The RVT ***shall*** provide a central interface to the AFTN or other legacy FDP systems for flight data exchange.

[REQ]

Identifier	REQ-12.04.07-TS-0310.0010
Requirement	The RVT ***should*** provide a central interface to FDP systems in order to exchange sectorization data
Identifier	REQ-12.04.07-TS-0310.0011

Requirement	IP-based voice communication and recording ***shall*** be compliant with EUROCAE Working Group 67 recommendations.

[REQ]

Identifier	REQ-12.04.07-TS-0310.0012
Requirement	The RVT shall support handling of multiple instances of airport interfaces (cameras, met system. AFL control…)

[REQ]

Identifier	REQ-12.04.07-TS-0310.0013
Requirement	Scenario handling of information for multiple airports provided via centralized interfaces ***shall*** be supported.
Identifier	REQ-12.04.07-TS-0310.0014
Requirement	Functional Block Interface Requirements satisfied by RVT in contingency configuration ***shall*** match those defined for the Single Aerodrome Configuration.

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