



Single Remote Tower Technical Specifications Remotely Operated Tower Multiple Controlled Airports with Integrated Working Position

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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, not a specific implementation of a 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 - First draft of Single Remote Tower (this version)
- Iteration 2 - Finalizing Single Remote Tower draft and first draft of the Multiple Remote Tower
- Iteration 3 - Finalizing Multiple Remote Tower Draft
- Final iteration – Finalizing all parts of the document

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104 **Executive summary**

105 This document defines the Technical Requirements (functional and non functional) on a general level
106 for Remote Tower.

107 This document will serve as a basis for the creation of a requirement specification for a specific
108 implementation of a prototype.

109 - Each prototype may implement only some or all of the capabilities

110 The Technical Specification will take in to account:

- 111 • Remote Tower
- 112 • Virtual Tower

113 Experience and background regarding these concepts are partly based on previous NATMIG remote
114 tower projects and SELEX real-time simulation and 3D representation projects.

115 Remote Tower is where ATS are remotely provided through the use of direct visual capture and visual
116 reproduction e.g. through the use of cameras. The ATS are provided using a Remote Tower Facility
117 (RTF), which includes the operator workstation(s), ATC systems and display screens.

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

1 Introduction

This document describes a generic set of system requirements for the Remote Tower concept.

It is assumed that the requirements mentioned in this specification are on a general level and for a specific implementation of a prototype there is a need to produce a complimentary specific requirements specification.

1.1 Purpose of the document

The relations between this technical specification and the other SESAR deliverables are illustrated in Figure 1.

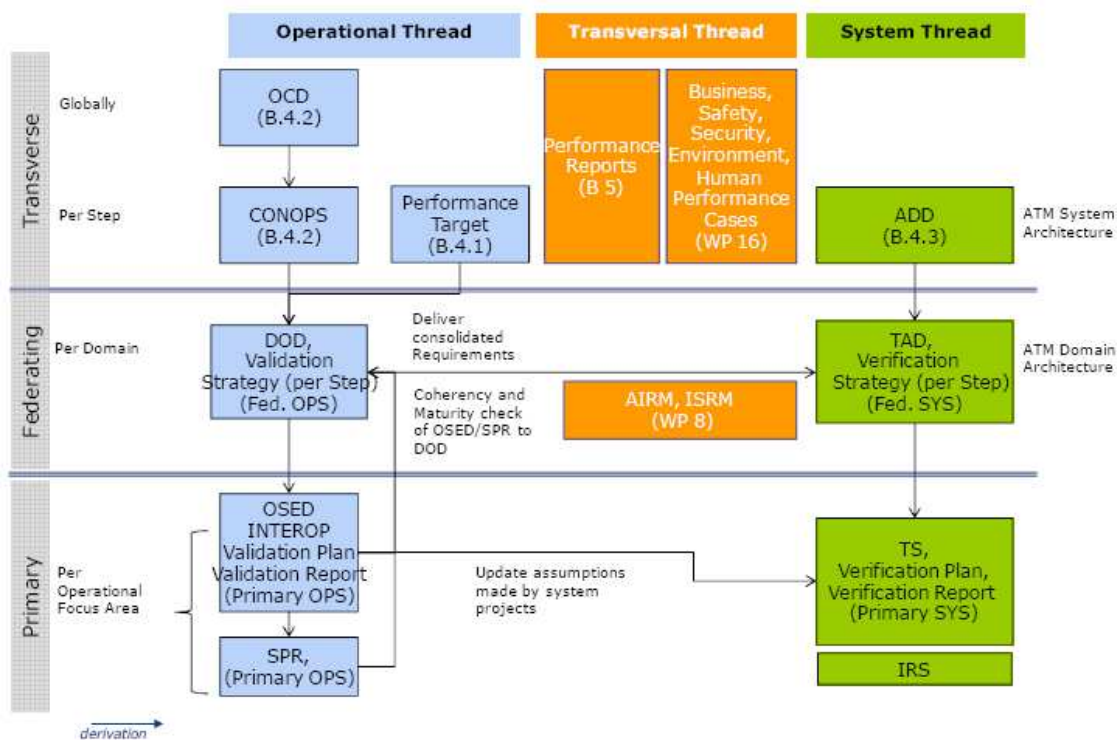


Figure 1: Flow of documentation overview [PMP] (ref.[1])

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This technical specification will be produced in four iterations:

- Iteration1 - First draft of Single Remote Tower (this version)
- Iteration 2 - Finalizing Single Remote Tower draft and first draft of the Multiple Remote Tower
- Iteration 3 - Finalizing Multiple Remote Tower Draft
- Final iteration – Finalizing all parts of the document

147 1.2 Intended readership

148 The following potential audience have been identified:

- 149 • P12.01.07 (Airport System Specification drafting and Maintenance) is interested in the
150 document to identify and maintain the consolidated list of requirements derived from each
151 WP12 projects,
- 152 • P06.09.03 (Remote and Virtual Towers), which has produced related operational
153 requirements

154 1.3 Inputs from other projects

155 The following input is used for requirements assessment:

- 156 • Project 06.09.03 (Remote and Virtual Towers) because it has provided the OSED document,
157 which is the basis of this technical specification.
- 158 • Project 12.04.06 (Remotely Operated Tower Technology Enablers)

159 1.4 Structure of the document

160 This document is organized as follows:

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

163 Chapter 2: General functional blocks description

164 Chapter 3: Functional block Capabilities, Conditions and Constraints

165 Chapter 4: Assumptions

166 Chapter 5: Referenced documents

167 1.5 Requirements Definitions – General Guidance

168 The requirements in this document have been developed according to the SESAR Requirements and
169 V&V Guidelines (ref.[3]) and the SESAR Template Toolbox (ref.[4]).

170

171 1.6 Functional block Purpose

172 The purpose of the development described in this specification is to provide a general specification for
173 Remote Tower.

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- 175 • Remote Tower
- 176 • Virtual Tower

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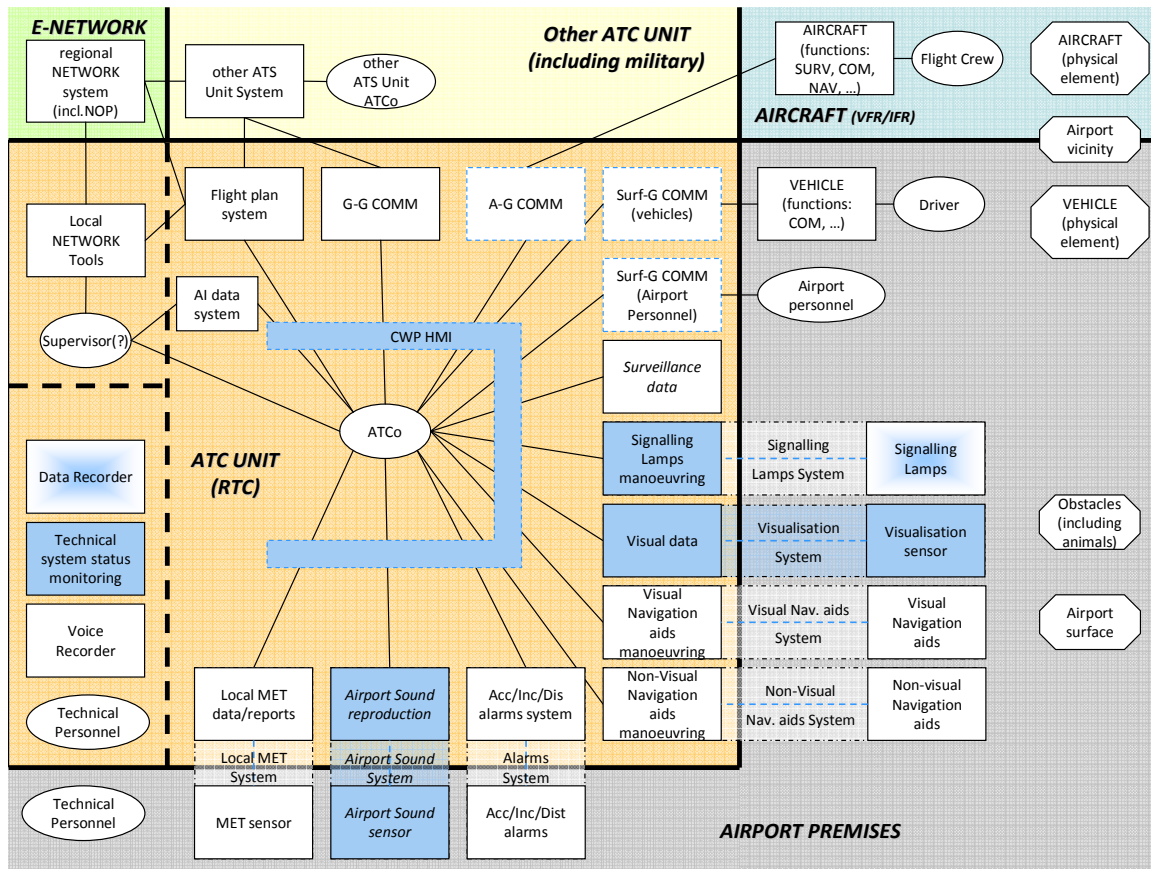
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186 **1.7 Functional block Overview**

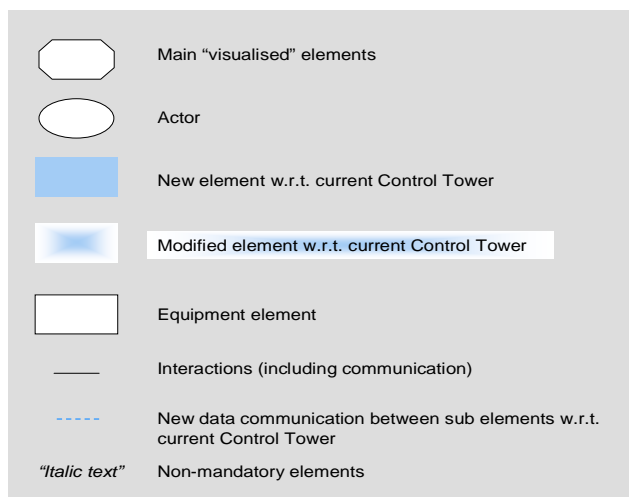
187 The Functional block Model in this context is a high-level architectural representation of the Single
 188 Remote Tower system design that is entirely independent of the eventual physical implementation.

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Figure 2: Functional block model Single Remote Tower



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Figure 3: Elements - Functional block model Single Remote Tower

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198 **1.7.1 Ground Elements**

199 **Remote Tower System – ATC Unit**

200 “Strategic-services” related elements:

Local Network Tools	Provides relevant information and tools for supporting the Supervisor’s tasks as managing the airport re-staffing resources.
Supervisor	Manages the airport/ATC unit resources/capacity in order to cope with the foreseen traffic (staffing, re-sectorisation, closure of the airport, ...)

201 “Pre-tactical/Tactical-services” related elements:

AI data system	Provides Aeronautical Information to the ATCo (AIP, NOTAMs, SNOWTAMs) to be used by supervisor and/or ATCo as necessary.
Flight plan system	Provides flight plan information to the ATCo for the aircraft flying/operating in the area of responsibility of the ATCo (TMA/Tower or Tower only) in form of paper strips or eventually electronic strips.
G-G COMM	Allows voice/data communication between ATCo and “other ATS unit ATCo”. This supports the aeronautical fixed service AFS as defined in ICAO Doc4444 .
A-G COMM	Allows voice (VHF) / data (CPDLC) communication between ATCo and Flight Crew. This support the aeronautical mobile service as defined in ICAO Doc4444.
Surf-G COMM (vehicles)	Allows voice communication (VHF) between ATCo and vehicles drivers on the airport surface
Surf-G COMM (Airport personnel)	Allows voice/data communication between ATCo and airport personnel
<i>Surveillance Data System</i>	When available, it provides “real-time” surveillance data for the (equipped) aircraft flying/operating in a delimited (from x feet to FLxxx) area of responsibility of the ATCo.
Signalling Lamps System	Allows the ATCo to remotely manoeuvre the Signalling Lamps located in the airport premises.
Visualisation System	Provides “real-time” images of the aerodrome*, the aerodrome traffic*, as well as any obstacle* in this area. A specific function allows a binocular view of particular element/objects. (* as defined in ICAO Annex 11: <u>aerodrome</u> : A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival,

	<p>departure and surface movement of aircraft.</p> <p><i>aerodrome traffic</i>: All traffic on the manoeuvring area of an aerodrome and all aircraft flying in the vicinity of an aerodrome.</p> <p>Note.— An aircraft is in the vicinity of an aerodrome when it is in, entering or leaving an aerodrome traffic circuit.</p> <p><i>obstacle</i>: All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that:</p> <p>a) are located on an area intended for the surface movement of aircraft; or</p> <p>b) extend above a defined surface intended to protect aircraft in flight; or</p> <p>c) stand outside those defined surfaces and that have been assessed as being a hazard to air navigation.</p>
Visual Nav. aids System	Allows the ATCo to remotely manoeuvre the different “lighting” systems to support aircraft in “finding their way” to the airport, on the vicinity of the runway and on the airport surface (approach lighting, PAPI, threshold lights, airport beacon, runway and taxiway lighting, etc.)
Non-Visual Nav. Aids System	Allows the ATCo to remotely manoeuvre the different “non-lighting” systems to support aircraft in “finding their way” to the airport/runway (ILS, VOR, DME, ...)
Accident, incident and distress alarms	Allows the ATCo to monitor and trigger accident, incident and distress alarms as applicable to the aerodrome.
<i>Airport Sound System</i>	When available, it provides “real-time” noise from the airport (aircraft engines, wind sound, ...)
Local MET system	Provides to ATCo the relevant weather information on the airport (temperature, pressure/QNH, snow on the runway (?), wind direction/strength, ...).
CWP HMI	Allows to ATCo to get information from all previous systems and to interact with them as necessary
ATCo	Provides ATC services (described in section xx) by using the information provided in the CWP HMI. The related ATCo tasks are described in section xxx (based on the Task Analysis activity carried out in the frame of the HP assessment).

202 “Technical supervision” related elements:

Data Recorder	Allows to record operational data (ICAO requirement) including visualisation information.
Technical System status monitoring	Allows to monitor and detect any technical failure mode / degraded mode of the system
Voice Recorder	Allows to record voice communication on the applicable radio channels (ICAO requirement)
Technical personnel	In charge of the maintenance of the “Technical

	supervision" elements
--	-----------------------

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204 **Airport Premises**

Signalling Lamps System	Signalling Lamp is located in the airport premises, and remotely manoeuvred by ATCO from the remote ATC unit (RTC)
Visualisation System	Captures "real-time" images on the airport premises to be provided to the ATCo in the remote ATC unit (RTC)
Visual Nav. aids System	Visual Navigation aids are located in the airport premises, and remotely manoeuvred by ATCO from the remote ATC unit (RTC)
Non-Visual Nav. Aids System	Non-Visual Navigation aids are located in the airport premises, and remotely manoeuvred by ATCO from the remote ATC unit (RTC)
Ground Lights System	Ground Lights are located on the airport manoeuvring area, and remotely manoeuvred by ATCO from the remote ATC unit (RTC)
Airport Sound System	Captures "real-time" noise from the airport to be provided to the ATCo in the remote ATC unit (RTC)
Local MET system	Captures the relevant weather information on the airport to be provided to the ATCo in the remote ATC unit (RTC)

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207 **1.7.2 External Entities**

208 **"Aircraft" elements:**

Flight Crew	Pilots the aircraft using airborne information/systems and ATC instructions/clearances. They apply the corresponding rules and procedures as per ICAO Annex 2 and PANS OPS.
Aircraft (functions: SURV, COM, NAV, ..)	Encompasses all the onboard information/systems needed for the flight.
Aircraft (physical element)	The aircraft are captured by the Visualisation system in order to be remotely provided to ATCo

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210 **"Other ATC Unit" elements:**

Other ATS Unit ATCo	ATCo coordinates with other ATS Unit ATCo for transferring departing/arriving aircraft, (with military) for activating / deactivating restricted areas, ...
Other ATS Unit System	Needed?

211 “E-Network” elements:

Regional NETWORK system	Provides Regional flight plans for the day of operations (CFMU) to local Network
-------------------------	--

212 “Airport premises” elements:

Driver	Drives the vehicle in the manoeuvring area as instructed by the ATCo
Vehicle (functions: COM, ...)	Encompasses all the information/systems needed for driving it and communicate with ATCo and other airport personnel
Vehicle (physical element)	The vehicles are captured by the Visualisation system in order to be remotely provided to ATCo
Airport Personnel	Management of the airport stands, pushback services, runway inspections, ...
Technical Personnel	Is in charge of the maintenance of the “remote” equipment located in the airport premises
Airport Surface	The airport surface is captured by the Visualisation system in order to be remotely provided to ATCo
Obstacles	Fixed (temporary or permanent) and mobile objects (including animals) that are captured by the Visualisation system in order to be remotely provided to ATCO
Airport Vicinity	Area close to the aerodrome (it includes aircraft which are in, entering or leaving an aerodrome traffic circuit) that is captured by the Visualisation system in order to be remotely provided to ATCo.

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215 **1.8 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

Term	Definition
ART	Advanced Remote Tower Research Project
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATCO	Air Traffic COntroller
ATM	Air Traffic Management
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
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)

Term	Definition
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SMR	Surface Movement Radar
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

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221 2 General Functional block Description

222 2.1 Context

223 The SESAR Concept Storyboard defines three ATM Operational Steps (Step 1, Step 2, Step 3) which
 224 correspond to the original SESAR ATM Service Levels (Service Levels 2, 3 and 4 respectively). The
 225 Operational Steps tell the ‘story’ of what the SESAR ATM system will look like at key milestones in the
 226 implementation phase of 2010 to 2020.

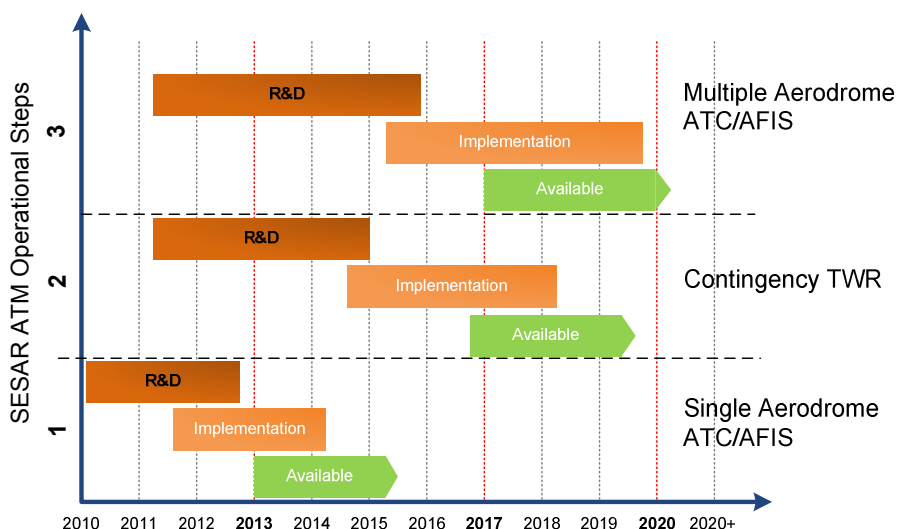
227 P06.09.03 focuses on an *initial* concept for remotely provided ATS for single and multiple
 228 aerodromes, for both ATC and AFIS as well as contingency operations.

229 The remote provision of ATS for a single aerodrome falls under SESAR Operational Step 1 (ATM
 230 Service Level 2). This operational service is already quite mature, having been developed initially in
 231 the ROT and ART projects. Whilst not yet delivering any 4D trajectory capability, the concept does
 232 provide optimised airport surface operations and a more efficient and cost effective deployment of
 233 operator resources. It is expected that the initial technical and operational capability of remote
 234 provision of ATS for a single aerodrome will be available from 2013.

235 The remote provision of ATS for a multiple aerodrome falls under SESAR Operational Step 3 (ATM
 236 Service Level 4). It is expected that the initial technical and operational capability of remote provision
 237 of ATS for a multiple aerodrome will be available from 2017 (see [Figure 4](#)).

238 The provision of ATS for contingency situations falls under SESAR Operational Step 2 (ATM Service
 239 Level 3). Whilst not yet delivering any 4D trajectory capability, the concept does provide optimised
 240 airport surface operations and a more efficient and cost effective deployment of operator resources. It
 241 is expected that the initial technical and operational capability of remote provision of ATS for
 242 contingency operations will be available from late 2016.

243



244

245 Figure 4 – SESAR ATM Operational Step Timeline

246

247 The objective of Remote Provision for Aerodromes is to provide the air traffic services (ATS) defined
 248 in ICAO Documents 4444, 9426 and EUROCONTROL’s Manual for AFIS for one or several
 249 aerodromes from a remote location i.e. not from a Control Tower local to the aerodrome. The full
 250 range of ATS should be offered in such a way that the airspace users are not negatively impacted
 251 (and possibly benefit) compared to local provision of ATS. The overall ATS will remain broadly
 252 classified into either of the two main service subsets of TWR or AFIS.

253 The Remote Provision of ATS for Aerodromes is expected to be applied mostly to low density
 254 aerodromes (where low density is determined as being mostly single simultaneous operations, rarely

255 exceeding two simultaneous movements). In the long-term the concept may also be applied for larger
256 airports or small airports with occasionally more traffic density (for example touristic airports/remote
257 airports during a particular event etc.)
258

259 The main change is that the ATCO or AFISO will no longer be located at the aerodrome. They will be
260 re-located to Remote Tower facility or a RTC. It is likely that an RTC will contain several remote tower
261 modules, similar to sector positions in an ACC/ATCC. Each tower module will be remotely connected
262 to (at least) one airport and consist of one or several Controller Working Positions (CWP), dependent
263 on the size of the connected airport. The ATCO will be able to perform all ATS tasks from this CWP.
264

265 2.2 Functional block Modes and States

266 2.2.1 Technical implementations

267 The Remote and Virtual Tower objective is to provide the air traffic services already provided by local
268 aerodrome control Towers from a remote location.

269 This document is focused on the single remote TWR in its iteration one and two. This specification will
270 be extended for a multi remote tower deployment in its iteration three and four. The main difference
271 between Remote and a Virtual Tower is the technical solution used to implement the Outside The
272 Window (OTW) vision service and related functions and services, as detailed in 2.2.1.1 and 2.2.1.2
273 paragraphs, while other ATS services could be more similar in both implementations.

274 The distinction between remote and virtual tower can be found in P06.09.03 OSED chapter 1.6, (ref
275 [8]), glossary of terms:

276

277 • In the **Remote Tower**, the OTW vision is remotely provided through the use of direct visual
278 capture and visual reproduction through the use of cameras.

279

280 • In the **Virtual Tower** the OTW vision is remotely provided through the use of computer
281 generated images of the aerodrome, aircraft and vehicles, and through the use of terrain
282 mapping and computer modelling to represent aerodromes. The virtual tower requires that the
283 remote airport has radars, ground sensors and/or an A-SMGCS system to provide the Virtual
284 Tower with data (system tracks) describing type and kinematics of all mobiles in the
285 aerodrome.

286

287 Both Remote and Virtual Tower share the concept that ATS services are provided using a **Remote**
288 **Tower Facility** (RTF), which includes the operator workstation(s), ATC systems and display screens.
289 The building where one or more RTF are housed is defined as **Remote Tower Centre** (RTC).
290

291 Most of ATS function/services implemented by the Integrated CWP are the same for both
292 Remote/Virtual Tower:
293

- 294 • Radio communications between ATCO/AFISO in RTF and flight crews.
- 295 • Radio communications between ATCO/AFISO in RTF and remotely controlled tower/airport.
- 296 • Phone communications between ATCO/AFISO in RTF and remotely controlled tower/airport.
- 297 • Presentation of surveillance data.
- 298 • ATC and voice data recording.

299

300 Local control systems at the airport (such as ground lights and navigational aids) adapted for remote
301 control.
302

303 Radar, A-SMGCS and surveillance data and weather information will be gathered and displayed at
304 the Remote Tower Centre. Technical implementation of these functions may vary, but generally it
305 does not depend on type of the tower (Remote/Virtual). The multi sensor surveillance data, optional in
306 the Remote the Remote Tower, are among the main requirements for the Virtual Tower.

307 2.2.1.1 Remote tower

308 The Remote Tower includes controller working positions for remote airport control. They incorporate
309 all necessary control systems, live video presentation and additional remote tower specific systems.

310
311 The OTW vision in Remote Tower is based on live video image captured at the remote airport and
312 sent to the remote tower centre. The live video image will provide the ATCO/AFISO with an out-the-
313 window view similar to an actual ATS tower.

314
315 A set of fixed cameras on the dismissed local tower (or other airport structure/building) in the remotely
316 controlled airport send to the RTC live images of the airport and it surrounding as viewed by a local
317 ATCO/AFISO. Each camera could be a multi spectral camera (B&W/RGB/IR) or a set of dedicated
318 single spectral cameras to enhance the vision in cases of low visibility operations. A secondary set of
319 cameras could provide an alternative point of view.

320
321 One or more remotely controlled (by ATCO/AFISO) electro-optical system implements the “binocular”
322 function to have more detailed vision.

323
324 A multi display system or a circular video wall reproduces the OTW vision of the remotely controlled
325 aerodrome.

326
327 Ground radar, ground sensors data, A-SMGCS data received from remote controlled airport are
328 presented on the CWP display.

329
330 The ATCO could select a subset of data presented on CWP and display them on a graphic overlay on
331 OTW representation implementing a head up display function.

- 332
333
 - Data recording function will provide video and voice communication recording and playback.

334
 - Sounds and noises of remotely controlled airport are delivered in RTC

335

336 2.2.1.2 Virtual tower

337 The Virtual Tower includes controller working positions for remote airport control. They incorporate all
338 necessary control systems, OTW vision is remotely provided through the use of computer generated
339 images of the aerodrome, aircraft and vehicles, and additional remote tower specific systems.

340
341 The OTW vision in Virtual Tower is remotely provided through the use of computer generated images
342 of the aerodrome, aircraft and vehicles. The 3D model of the remote aerodrome is generated through
343 the use of terrain mapping and computer modelling. System tracks gathered from remote airport are
344 represented in a 3D real time animation on the digital 3D model of remote airport. The digital
345 animation will provide the ATCO with a virtual out-the-window view.

346 System tracks are multi sensor tracks received by Virtual Tower as A-SMGCS real time messages.
347 The track fusion of radars tracks and other surveillance sensors of remotely controlled airport
348 generate the A-SMGCS system tracks.

349 Radar and A-SMGCS system tracks received from remote controlled airport shall presented on CWP
350 display.

351
352 A dedicated software gateway real time translates A-SMGCS system tracks in DIS/HLA entities, used
353 as input of the 3D model/display system. A mobiles database contains a complete set of known
354 aircraft, ground mobiles as truck, buses and cars. Tracks matching with database entities are
355 visualized with their attributes (e.g. aircraft model with proper airline skin) Tracks without a match
356 inside the database will display as intruders or obstructions depending on their kinematics.

357
358 Time of day, data about daylight/night/dawn/dusk and meteo in remote controlled aerodrome
359 generate the environmental data for 3D airport model, enabling the simulation of day and night, sun
360 position, rain or fog. ATCO could switch on/off the visualization of environmental data in 3D
361 representation.

362
363 A multi display system or circular video wall emulates the OTW vision of the remotely controlled
364 airport.

365
366 The ATCO could select an entity on CWP display, the corresponding entity on the virtual OTW is
367 highlighted and a graphic overlay will display a subset of the entity data.

368

- Data recording function will provide system tracks recording and playback.

369

- Radio communication recording function to record/reply radio.

370

- Sounds and noises of remotely controlled airport are delivered in RTC

371

372 2.2.2 Operating modes

373 2.2.2.1 Remote provision of air traffic services to a single aerodrome

374 Not in the scope of this first iteration

375 2.2.2.1.1 Shared operation with single aerodrome

376 Not in the scope of this first iteration

377 2.2.2.2 Remote provision of air traffic services to multiple aerodromes

378 Remote provision of air traffic services to multiple aerodromes are not within the scope of iteration
379 one of this specifications. Technical specifications for a solution covering the provision of air traffic
380 services on multiple aerodromes will be produced by iteration 3 and 4 of this document.

381 2.2.2.3 Contingency operations

382 Contingency operations are not within the scope of these specifications. Technical specifications for a
383 solution covering contingency operations will be produced by P12.04.08 *Remote Tower Technologies*
384 *used for contingency and enhanced local operations.*

385 2.2.3 Operational environments

386 2.2.3.1 ATC

387 Not in the scope of this first iteration

388 2.2.3.2 AFIS

389 Not in the scope of this first iteration

390

391

392

393

394

2.3 Major Functional block Capabilities

2.3.1 Context

The approach for the major functional block decomposition and capabilities for remote tower systems is based on enhancements over component structure of a standard tower (as defined in project B4.3). It should cover all the main functional parts which need to be addressed for a standard tower as well as the enhancements and extensions needed for a remote tower. Dedicated components might be enhanced with additional functionality required to support the remote tower operation scenario.

This chapter will provide an overview of all functional blocks as defined by B4.3 and highlight the remote tower specific capabilities and extension. A further component breakdown will be done in 2.6 chapter.

This description is focused on the single remote TWR scenario. This description will be extended in the future for a multi remote tower deployment and for contingency situation scenarios.

2.3.2 Design decisions

According to the profiles defined in the operation concept description DEL-06.09.03-D02-OSED some of the component might not be of use for airports categorized for remote tower usages in terms of movements and capacity.

This diagram, based on B4.3 decomposition, shows the functional blocks which should be taken into account and those ones to be taken into account (at least for initial phases of the remote tower).

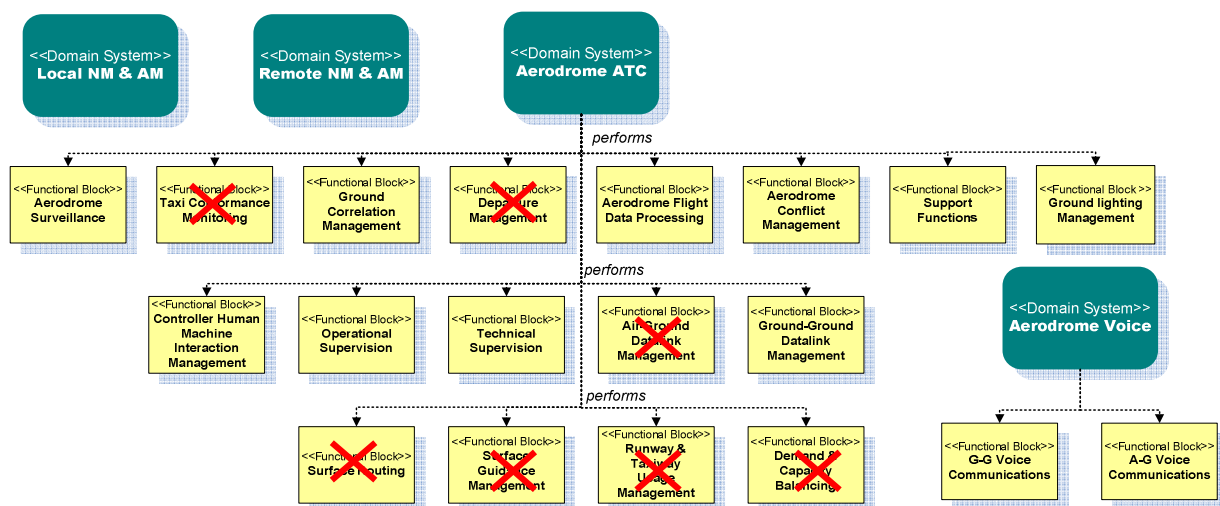


Figure 5: Functional Components for TWR as defined in B4.3

This design decision leads the project to focus on the design of definition of the next functional blocks:

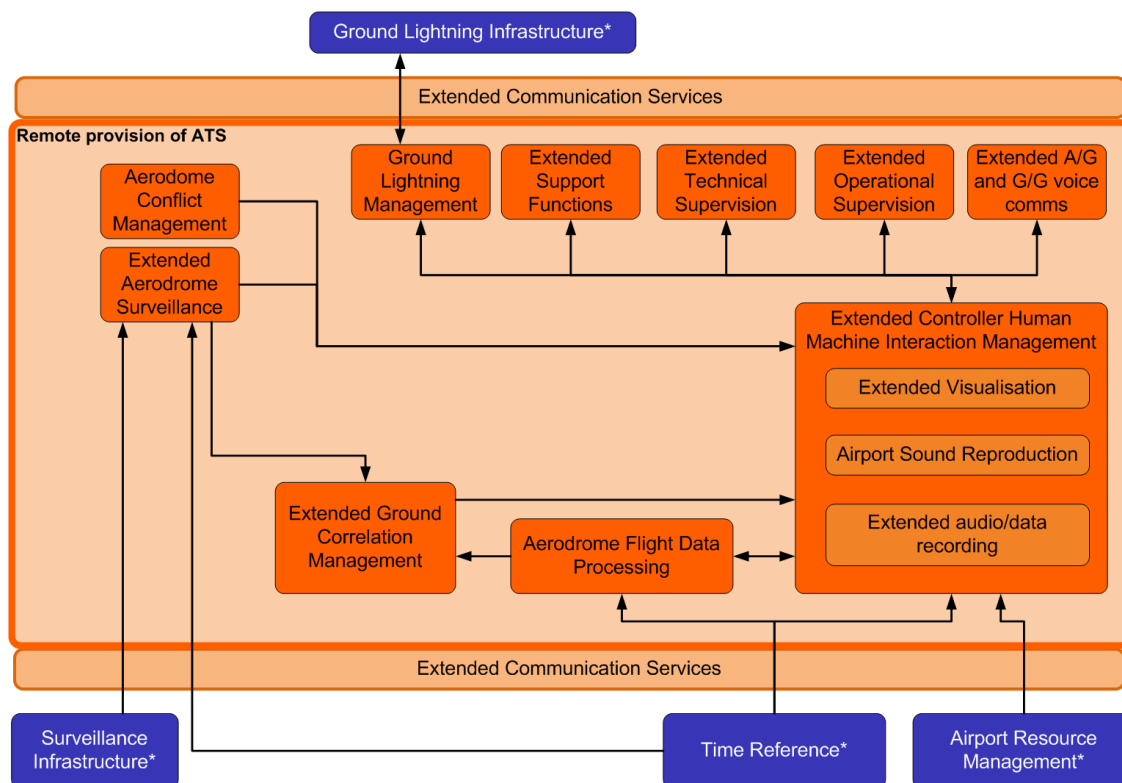
- Extended Aerodrome Surveillance for remote TWR
- Extended Ground Correlation Management for remote TWR
- Aerodrome Flight Data Processing
- Aerodrome Conflict Management
- Extended Support Functions for remote TWR
- Ground Lighting Management
- Extended Controller Human Machine Interaction Management for remote TWR
- Extended Operational Supervision for remote TWR
- Extended Technical Supervision for remote TWR

- 426 ▪ Extended G-G Voice Communications for remote TWR
- 427 ▪ Extended A-G Voice Communications for remote TWR
- 428 ▪ Extended Visualization using multispectral cameras in Remote video based Tower.
- 429 ▪ Extended visualization using synthetic 3D representation in Virtual Tower,

430 2.3.3 Major functional block capabilities diagram

431 The following diagram describes the external functional blocks connected with the remote provision of
432 air traffic services to a single aerodrome and it's internal functional blocks.

433



* Not part of the Aerodrome ATC System Architecture

434

435

Figure 6: Functional blocks and their interactions

436

The requirements defined in this document are grouped for services (please refer to [8]) in order to meet the approach followed by Operational requirements.

437

438

This diagram is focused on the single remote TWR scenario. This diagram will be extended in the future for a multi remote tower deployment and for contingency situation scenarios.

439

440 2.4 User Characteristics

441 2.4.1 ATCO/AFISO

442

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

443

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.

444

445

446

447 2.4.2 Watch supervisor

448 The (optional) Watch Supervisor could have main responsibility for staff/CWP allocation in an RTC
449 with several workstations connected to several airports.

450 During a shift, a Watch Supervisor role can be used to manage the allocation of staff and CWP at any
451 one time during the shift in order to provide an efficient set up at all times and guarantee a flexible
452 system. The Supervisor role can be performed by a dedicated person, or can be handled by one of
453 the shift staff in addition to their ATCO/AFISO role.

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

456 •Be a separate and extra role with overall responsibility for the management of the RTC. The
457 Supervisor maintains overall vision of all aerodromes within the RTC at all times in addition to
458 the ATCO/AFISO providing ATS. This role could be performed from a dedicated Supervisor
459 CWP. The Supervisor would be expected to perform the planning, administration, staff
460 management and staff allocation tasks, and supervision of technical systems, allowing the
461 ATCO/AFISO to concentrate solely on the provision of ATS. Since this is an “extra” role, it is
462 expected that this type of role would only be required for the larger or more complex RTC;

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

465

466 2.4.3 Airspace user

467 The airspace users (through the pilots but also for example vehicle drivers on the airport manoeuvring
468 area) are receivers of the ATS service. However, as previously stated, neither their role nor their
469 responsibility should change as a result of introducing the remote aerodrome ATS.

470

471 2.4.4 Technician

472 Technicians will monitor the status of systems and perform maintenance as appropriate, both on the
473 remote facility site and the airport side and related systems.

474

475 2.4.5 Other stakeholders

476 Other stakeholders might be:

477 •Airport Rescue Units; could utilize by external sharing of the visual reproduction for quick
478 response and localization of the emergency, even during low visibility and without being
479 dependent on information passed on by ATCO personnel.

480 •Airfield security and ground handling; could be alerted of unauthorized infringements on the
481 manoeuvring area, debris on the runway and other safety and/or security related issues.

482 •AirPort Operations Centre (APOC); could utilize the visual reproduction for situation assessment
483 and short term planning.

484 •Ordinary control tower personnel; could benefit from increased situational awareness by the
485 introduction of parts of the RVT technology into ordinary control towers.

486 •Local airport officers

487

488 2.5 Operational Scenarios

489 The operational scenarios are described in the OSED chapter 5. (ref [8])

490 **2.6 Functional**

491 **2.6.1 Functional decomposition**

492 The functional breakdown is focused on the single remote TWR scenario. In a multi remote tower
493 deployment certain capability will be extended.

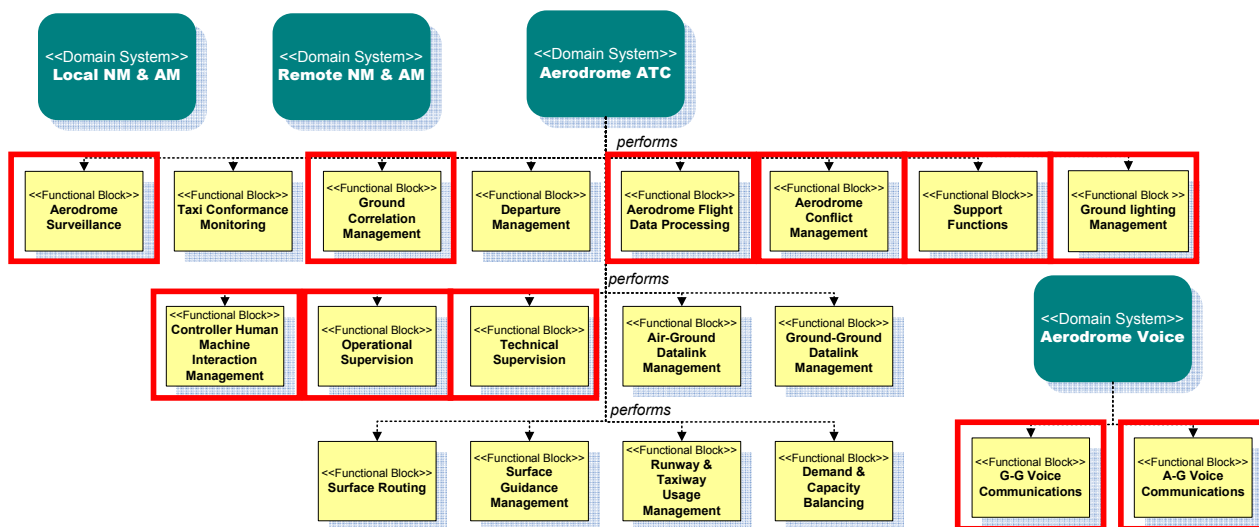
494 The functional decomposition of the remote tower system is based on the component structure
495 defined for the standard tower (project B4.3 ref [7]). Some of the components will not be of use for
496 airports categorized for remote tower usages in terms of movements and capacity (as defined in the
497 operation concept DEL-06.09.03-D02-OSED ref.[8]). Specific components might be enhanced with
498 additional functionality required to support the remote tower operational scenario.

499 This chapter will provide an overview of all functional components as defined by B4.3 and highlight
500 the remote tower specific capabilities and extension. A further component breakdown is done on
501 functional blocks dedicated to remote tower enhancements (e.g. Surveillance / Visualization and HMI)

502 The main building blocks are independent of a specific implementation of a remote tower solutions
503 (video based or virtual tower).If components are only applicable for one solution approach this is
504 clearly indicated.

505 All components marked in red are considered as relevant for remote tower solutions.

506



507

508 Figure 7: Functional Component for TWR as defined in B4.3 (ref [7])

509

510

511 **2.6.1.1 Aerodrome Surveillance**

512 This functional block provides controllers with airport situational awareness on the SID(s), STAR(s),
513 apron(s), taxiway(s), runway(s) and landing/take-off paths by providing position and identification of all
514 surface traffic (aircraft and vehicles). It merges the surveillance information provided by the different
515 surveillance sources providing a unique picture of the actual traffic situation. For each aircraft, vehicle
516 and obstacle a system track is generated.

517 In context of remote tower mainly the Airport Surface Surveillance Infrastructure will be adapted.
518 There will be no remote tower specific enhancements for the EnRoute TA Ground SUR Infrastructure.

519

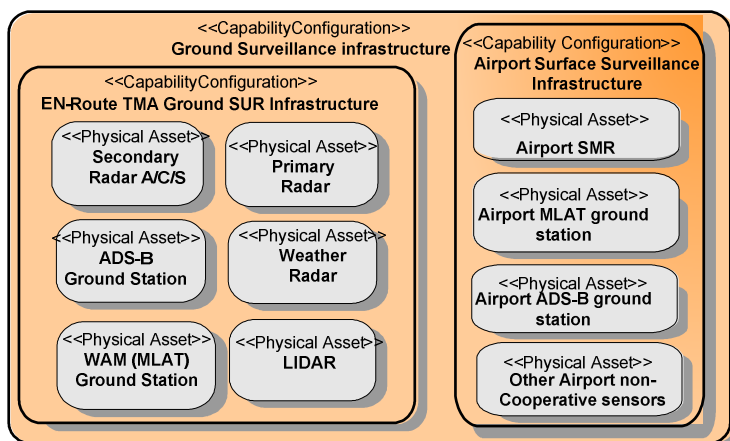


Figure 8: Surveillance Infrastructure as define in B4.3 (ref [7])

520

521

522

523

524 The aerodrome surveillance component will be extended in a remote TWR system by introducing a
525 dedicated function to gather data for visualization to replace the classical out of the window view of
526 traditional towers. Visualization and surveillance capabilities will be combined to enhance situation
527 awareness for the remote control scenario. Specific issues such special weather conditions, different
528 sun light conditions and replacement of binocular view have to be addressed by this component.

529

530 Standard surveillance sensors such as SMR or MLAT might not be applicable for remote towers in a
531 first step and will be considered for virtual remote towers.

532 In addition new components are introduced for the video based remote tower approach:

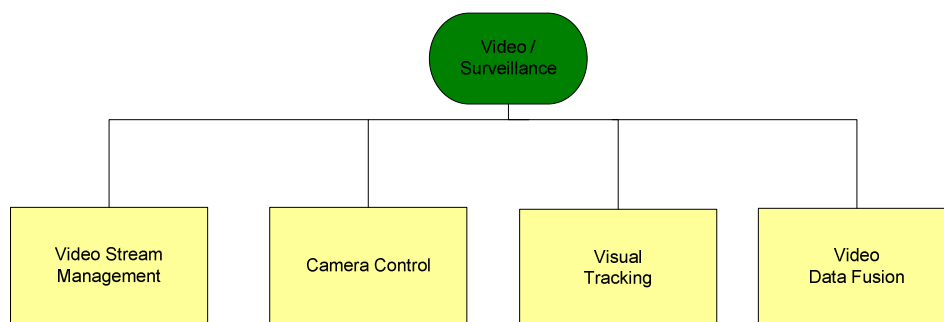
533 - Video stream management

534 - Camera Control

535 - Visual Tracking

536 - Video Data Fusion

537



538

539 Figure 9: Functional decomposition of Surveillance / Visualization for video based remote twr

540

541 Video Stream Management:

542 This component includes handling of video data from several local cameras and transferring this data
543 to the remote tower centre. It includes bandwidth management and compression, monitoring of delay
544 times, frame rate and access control.

545 Camera Control:

546 The component provides access to control functions of cameras. This functional block includes
547 authentication functions and control function related to image adjustments/optimization and PTZ
548 control.

549 Visual Tracking:

550 This component performs automatic object tracking functions based on the managed video streams.
551 Output of this component is position information of the identified object or marking of the identified
552 object in the video stream.

553 Video Data Fusion:

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

556 Future additions for other low cost surveillance technologies shall be considered.

557 2.6.1.2 Ground Correlation Manager

558 This functional block has the responsibility of logically associating surveillance data with an aircraft or
559 vehicle. This association is called ground correlation.

560 In context of remote tower this function might be used in a limited way dependant on the available
561 surveillance capabilities.

562 2.6.1.3 Aerodrome Flight Data Processing

563 This functional block manages the creation, update and modification of system flight plans up to/from
564 the moment the aircraft takes-off/lands. In addition, it calculates the predicted trajectory by taking into
565 account applicable constraints and relevant data (e.g. aircraft performance, weather data, airport
566 configuration data, wake vortex characteristics associated to each aircraft). Aerodrome Flight Plan
567 should be updated at the occurrence of identified significant events such as, for example: request and
568 approval clearance for Start-Up, Push Back, Taxi, Line-Up, Take-Off and similarly for landing aircraft.

569 In context of single remote tower this function is used as defined for the standard tower.

570 2.6.1.4 Aerodrome Conflict Management

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

576 In context of remote tower this function will be limited due to restricted capabilities provided by the
577 aerodrome surveillance functions.

578 2.6.1.5 Support Functions

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

- 581 - Recording - performing the recording of the ATM System data related to the Aerodrome
582 ATC, and buffering those data on a persistent database.
- 583 - Playback - providing support for display and voice recording, display and voice playback,
584 other data recording and reduction, etc.
- 585 - Data analysis - providing support for maintenance, investigation etc.
- 586 - Automatic Safety Data Gathering Tool - providing support for safety aspects.

587

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

2.6.1.6 Ground Lighting Management

This function provides the functionalities, for the Aerodrome ATC users, to control and monitoring in real time that the entire "light system" is constantly able to support the operative needs, in order to assure all the airport operations in an appropriate way under all conditions (e.g. CAT I, CAT II, CAT III). This system is also the main enabler to support and implement the Surface Guidance.

In context of remote tower this component will be used in a limited way. Focus is the standard control and status feedback of all airfield light segments via the remote tower centre. Surface Guidance functions are not in scope for this category of airports.

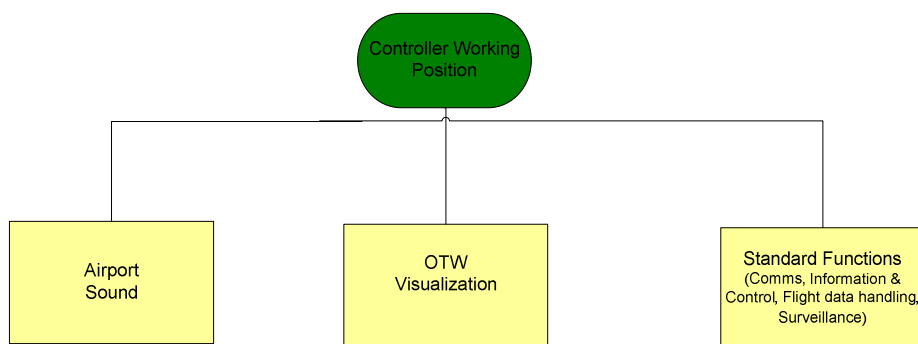
2.6.1.7 Controller Human Machine Interaction Management

This functional block provides controllers with a graphical user interface and with the means to interact with the Aerodrome ATC system.

The Controller Human Machine interface will be extended by visual representation to replace the traditional out of the window view and other capabilities such as acoustic information.

A further functional breakdown will lead to:

- OTW Visualization
- Standard Functions (Communication, Information & Control, Flight Data Display, Surveillance Display)
- Airport Sound



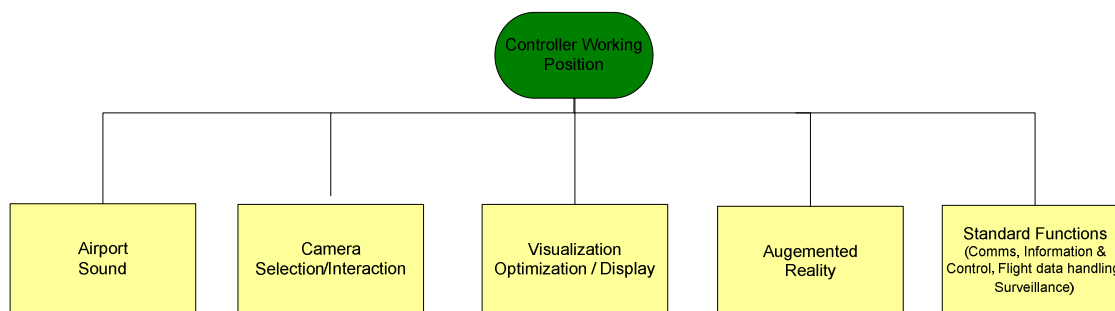
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Figure 10: Functional decomposition of Remote TWR Controller Working Position

A further functional breakdown will lead to:

- Visualization Optimizations/ Display
- Augmented Reality
- Camera Selection / Interaction
- Virtual 3D airport model and ground traffic display
- Standard Functions (Communication, Information & Control, Flight Data Display, Surveillance Display)
- Airport Sound

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630
631



632

633

634

635 OTW Visualization:

636 This component will depend on the selected implementation approach for the remote tower. For a
637 video based solution visualization will cover layout and display of multiple camera streams, selection
638 and interaction of specific camera views and overlay of additional support information in the video
639 display.

640 In case of a virtual tower solution this component will handle rendering of a virtual display for the
641 tower view, selection of view points and embedding of objects and other information in the virtual
642 view.

643

644 Airport Sound:

645 This component provides real time environment sound from the airport to increase situation
646 awareness for the controller.

647

648 Standard Functions:

649 This block is covering HMI of all systems used in traditional towers.

650

651

652 2.6.1.8 Operational Supervision

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

656 In context of the single remote tower this function is hosted in the remote tower centre and will be
657 equivalent to the standard tower (may be extended for the multi tower scenario).

658 2.6.1.9 Technical Supervision

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

662 The Technical Supervision encompasses the following functions:

663 - Presenting technical and functional systems status: monitor system availability.
664 Acquire, synthesize and display technical and functional status on all the system
665 hardware/software resources.

666 - Providing failure detection and analysis assistance: generate alarm or warning on failure
667 detection. Provide support for analysis of supervision data (enable queries on historic of
668 events).

669 - Providing supervision commands and actions: accept supervision commands/actions (e.g.
670 (Re)start/stop/stand-by/reset/switch-over) from eligible operators and gives the capability to
671 perform maintenance activities.

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

674 **2.6.1.10 Aerodrome Voice**

675 The Aerodrome Voice Domain system provides Voice front-end functionalities (Telephone and Radio
676 Voice Communication Switching functionalities, typically).

677 **Air-Ground Voice Communications:**

678 This functional block provides the functions performed by a Radio VCS

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

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

686

687

688 **Ground-Ground Voice Communications:**

689 This functional block provides the functions performed by a Telephone VCS.

690

691 Remote Tower specific enhancements for this component are related to management of remote and
692 an optional local VCS position for backup or transition purpose.

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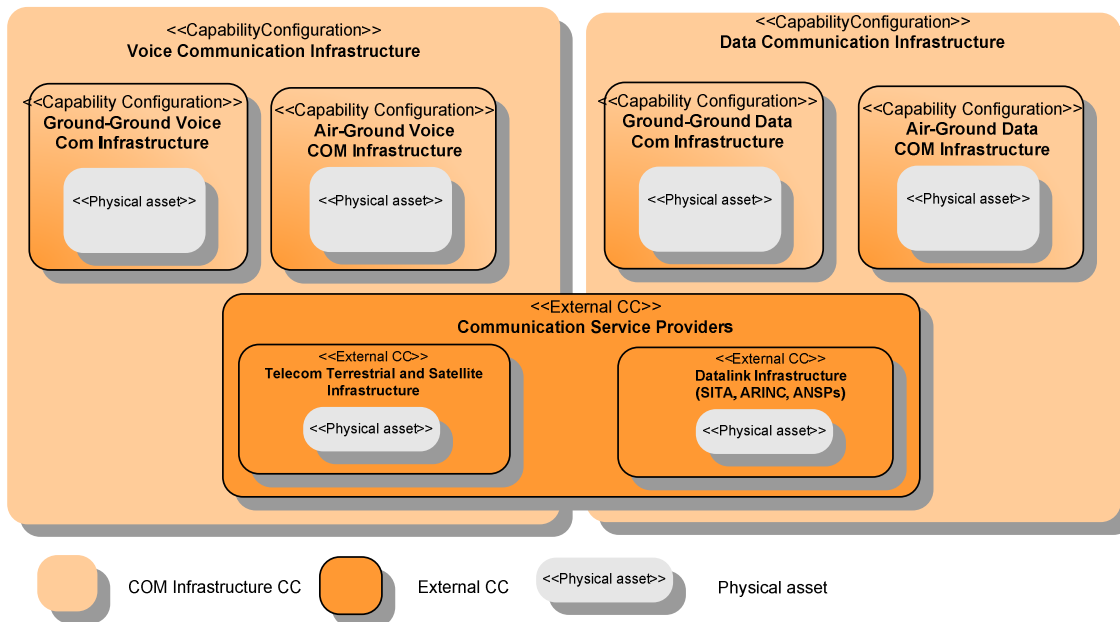
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2.6.1.11 Network Infrastructure



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Figure 11: Communication Infrastructure as define in B4.3 (ref [7])

Network infrastructure for remote controlled airports needs to cover transmission of relevant operational and supervision information to the remote tower centre. Also control information has to be sent out to the remote controlled airport.

All these capabilities need to be deployed via one harmonized network which guarantees reliable communication and provides required QoS for different data characteristics.

729 **2.6.2 Functional analysis**

730

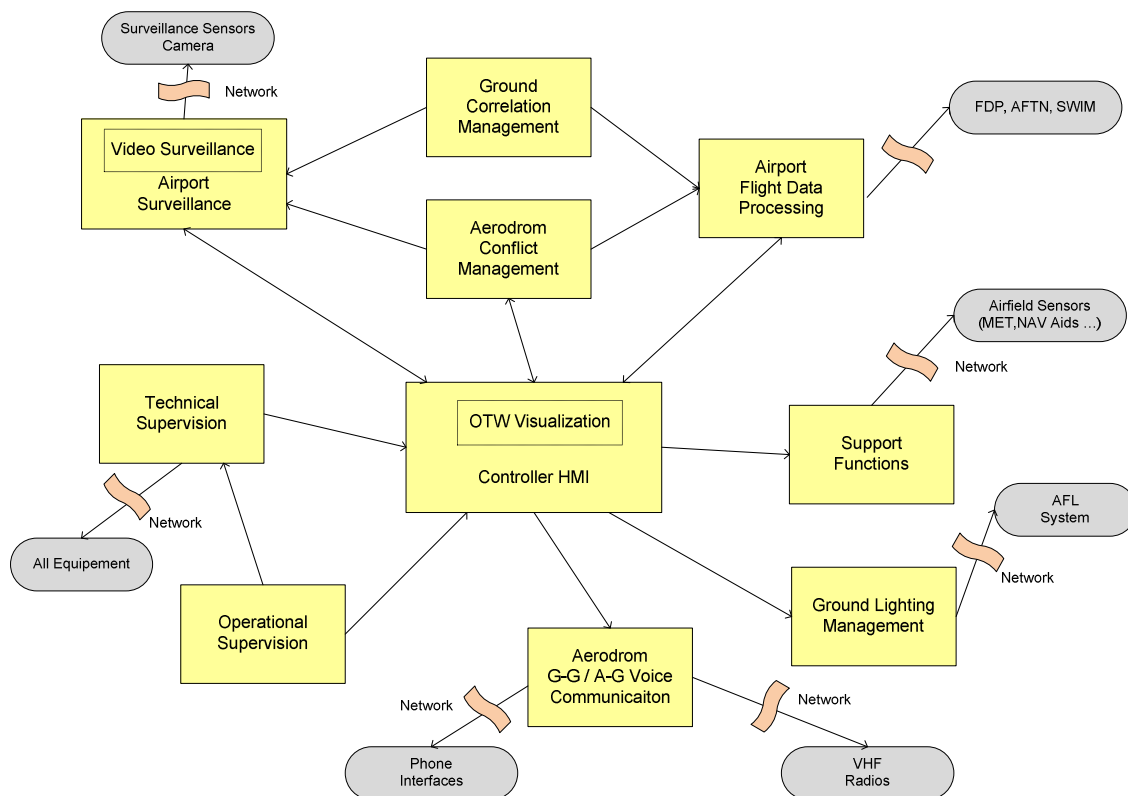


Figure 12: Functional relation

731

732

733

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

740 The central element is the Controller HMI, which combines functions from the other components to an
 741 integrated controller working position. A remote tower specific part of the HMI is the OTW
 742 Visualization component. It uses mainly the Airport Surveillance functions to replicate the out of the
 743 window view. In case of the video based remote tower implementation the visualization is based on
 744 the video surveillance component which is attached to local camera sensors.

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

749 Other data such as support information or status and control of airfield light are also integrated in the
 750 controller working position. Selected support information might be directly embedded into the
 751 visualization component (e.g. as overlay information). A similar process is applied for events
 752 generated by the Aerodrome Conflict Management, which will be shown in the controller HMI as
 753 warning or alert.

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

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

760

761 2.7 Service View

762 As no 12.1.7 TAD is available at this stage of the project, this service view is not applicable for step1.

763

764

765 **3 Functional block Functional and non-Functional**
766 **Requirements**

767 **3.1 General functional requirements**

768 **3.1.1.1 Communications services**

769

Identifier	REQ-12.04.07-TS-0100.0001
Requirement	The RVT shall provide the ATCO/AFISO with access to aeronautical mobile service (air-ground communications) in the area of responsibility.
	Air-ground communications

771

772

<SATISFIES>	<Enabler>	REQ-06.09.03-OSED-0002.1001	
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773

Identifier	REQ-12.04.07-TS-0100.0002
Requirement	The RVT shall provide the ATCO/AFISO with access to aeronautical fixed service (ground-ground communications, in accordance with ICAO Annex 11, Chapter 6.2) in the area of responsibility.
	Ground-ground communications

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<SATISFIES>	<Enabler>	REQ-06.09.03-OSED-0002.1002	
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777

Identifier	REQ-12.04.07-TS-0100.0003
Requirement	The RVT shall provide the ATCO/AFISO with access to surface movement control service (communications for the control of vehicles other than aircraft on manoeuvring areas at controlled aerodromes) for the aerodrome and its vicinity.
	Ground-ground vehicle communications

779

<SATISFIES>	<Enabler>	REQ-06.09.03-OSED-0002.1003	
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781

Identifier	REQ-12.04.07-TS-0100.0004
Requirement	The RVT shall provide the ATCO/AFISO with signalling lamp functionality (characteristics according to ICAO Annex 14 section 5.1.3). <i>Note: The means of directing the signalling lamp towards the applicable aircraft may be combined with the binocular function, see RVT-VIS-30a/b/c/d (REQ-06.09.03-OSED-0003.0035 to 38).</i>
	Signalling lamp functionality

783

<SATISFIES>	<Enabler>	REQ-06.09.03-OSED-0002.1004	
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785

Identifier	REQ-12.04.07-TS-0100.0005
Requirement	If meteorological conditions permit, the RVT shall enable the ATCO/AFISO to observe visual communication from aircraft that are within visual range, such as: <ul style="list-style-type: none"> • aircraft flashing landing lights or flashing navigation (in darkness) • aircraft repeatedly changing its bank angle – “rocking wings” (in daylight)

787

	Visual communication from aircraft
	REQ-06.09.03-OSED-0002.1005

789

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Identifier	REQ-12.04.07-TS-0100.0006
Requirement	If meteorological conditions permit, the RVT shall enable observation of visual communication from aircraft that are within visual range on the aerodrome manoeuvring area, such as: <ul style="list-style-type: none"> • moving ailerons (or rudder). (in daylight) • flashing landing lights (in darkness)
	Visual communication from aircraft on manoeuvring area

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Identifier	REQ-12.04.07-TS-0100.0007
Requirement	If the RVT is "Virtual Tower" it shall receive surveillance data from the controlled aerodrome to feed with live traffic the virtual 3D airport visualization
	Surveillance data from remote controlled airport.

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798 3.1.1.2 Voice Communication

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[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.
Title	Voice Communications Network Performance
Status	
Rationale	
Category	<Performance>
Validation Method	
Verification Method	

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[REQ Trace]

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[REQ]

Identifier	REQ-12.04.07-TS-0100.0009
Requirement	The system shall support a hierarchical side tone generation configuration.
Title	Hierarchical Side Tone Generation
Status	
Rationale	Local side tones improve audio quality since the round trip time from the CWP to the radio has no influence. Especially in the remote TWR setting network delays may occur, which shall not influence the audio experience of the controller.
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

	REQ-06.09.03-OSED-0002.0001	
	A-G Voice Communications	

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[REQ]

Identifier	REQ-12.04.07-TS-0100.0010
Requirement	The system shall support shared access to the radio infrastructure.
Title	Shared Radio Access
Status	
Rationale	Radios have to be accessed in parallel by a local and remote CWP if such exists.
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

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[REQ]

Identifier	REQ-12.04.07-TS-0100.0011
Requirement	The system shall support different priorities for radio access.
Title	Radio Access Priorities
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

		REQ-06.09.03-OSED-0002.0001	
		A-G Voice Communications	

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[REQ]

Identifier	REQ-12.04.07-TS-0100.0012
Requirement	The system shall support a pre-emption mechanism at the radio (gateway).
Title	Radio Pre-emption
Status	
Rationale	Radios have to be accessed in parallel by a local and remote CWP if such exists.. Clear rules based on priorities ensure the operational correct access to a shared radio in case the local and remote operator are logged in.
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

		REQ-06.09.03-OSED-0002.0001	
		A-G Voice Communications	

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[REQ]

Identifier	REQ-12.04.07-TS-0100.0013
Requirement	The system shall provide an HMI that combines A/G and G/G communications on one controller working position.
Title	Combined A/G – G/G HMI
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	OSED	REQ-06.09.03-OSED-0002.0001	<Full>
<SATISFIES>	OSED	REQ-06.09.03-OSED-0002.0002	<Full>
<ALLOCATED_TO>	Functional Block	A-G Voice Communications	<Full>

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<ALLOCATED_TO>	Functional Block	G-G Voice Communications	<Full>
<APPLIES_TO>	<Operational Focus Area>	OFA06.03.01	N/A
<ALLOCATED_TO>	<Project>	12.04.07	N/A

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824 3.1.1.3 Meteorological services

Identifier	REQ-12.04.07-TS-0101.0001
Requirement	The RVT shall provide the ATCO/AFISO with access to the relevant meteorological information, according to ICAO Annex III and national regulations.
	Access to meteorological information

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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 and actual.
	Current MET report

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		REQ-06.09.03-OSED-0002.2002	
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833 3.1.1.4 Visualisation services

Identifier	REQ-12.04.07-TS-0102.0001
Requirement	The RVT shall provide a presentation enabling the ATCO to be provided of a <i>continuous watch on all flight operations on and in the vicinity of an aerodrome as well as vehicles and personnel on the manoeuvring area.</i>
	Continuous visualisation for ATCO

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Identifier	REQ-12.04.07-TS-0102.0002
Requirement	The RVT shall provide a presentation enabling the AFISO to maintain a continuous watch by visual observation on all flight operations on and in the vicinity of an aerodrome as well as vehicles and personnel on the manoeuvring area.
	Continuous visualisation for AFISO

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Identifier	REQ-12.04.07-TS-0102.0003
Requirement	The RVT shall provide a visualisation the ATCO/AFISO including information in order to detect obstructions on the manoeuvring area.
	Continuous visualisation for AFISO

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846 [REQ]

Identifier	REQ-12.04.07-TS-0102.0004
Requirement	It shall be defined how much of the "normal" tower view to be replicated

847 [REQ Trace]

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849 **3.1.1.5 Navigation services**

Identifier	REQ-12.04.07-TS-0103.0001
Requirement	The RVT shall enable the ATCO/AFISO to monitor and manoeuvre the status of the next runway and field lighting systems (visual navigational aids) applicable to the aerodrome, such as: <ul style="list-style-type: none"> - approach - PAPI - runway - taxiway - RGL - stopway - and obstacle lighting.

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Identifier	REQ-12.04.07-TS-0103.0002
Requirement	The RVT shall enable the ATCO/AFISO access to adjust and monitor the status of aerodrome NAV systems applicable to the aerodrome (non-visual navigational aids), such as: <ul style="list-style-type: none"> - ILS LOC/GP, - LO NDB, - OM/MM/IM, - And VOR, DME.

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858 **3.1.1.6 Other ATS Systems / Functions**

Identifier	REQ-12.04.07-TS-0104.0001
Requirement	If available for the particular airport, the RVT shall include presentation of surveillance data (for example radar data presentation).

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Identifier	REQ-12.04.07-TS-0104.0002
Requirement	The RVT shall enable access to and handling of ATS messages (as described in ICAO Doc 4444 Chapter 11)

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Identifier	REQ-12.04.07-TS-0104.0003
Requirement	The RVT shall provide functions/procedures for the presentation and updating of flight plan and control data for all flights being provided with the ATS service (in accordance with ICAO Doc 4444 Chapter 4.13)

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Identifier	REQ-12.04.07-TS-0104.0004
Requirement	The RVT shall enable the ATCO/AFISO to monitor and manoeuvre accident, incident and distress alarms as applicable to the aerodrome.

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

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Identifier	REQ-12.04.07-TS-0104.0006
Requirement	The RVT shall enable the ATCO/AFISO (or other personnel if applicable) to monitor the technical status of systems that can affect the safety or efficiency of flight operations and/or the provision of air traffic service.

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[REQ]

Identifier	REQ-12.04.07-TS-0104.0007
Requirement	The system shall provide means to monitor all voice communication equipment centrally from the RTC.
Title	Central VCS Monitoring
Status	
Rationale	All VCS related components, such as CWPs, radios, radio gateways, shall be monitored from the RTC.
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

		G-G Voice Communications	
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[REQ]

Identifier	REQ-12.04.07-TS-0104.0008
Requirement	The system shall provide remote controller working position monitoring.
Title	Remote CWP Monitoring
Status	
Rationale	If local CWPs at the airport or remote CWPs at the RTC may monitor each other, either for training/supervisor purposes or during the briefing before handover of responsibility.
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

		G-G Voice Communications	
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3.1.1.7 Voice and data recording services

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

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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 system shall provide an analogue legal recording output at each CWP.
Title	Analogue Legal Recording Output at CWP
Status	
Rationale	

Category	<Functional>
Validation Method	
Verification Method	

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		REQ-06.09.03-OSED-0002.0021	
		G-G Voice Communications	

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Identifier	REQ-12.04.07-TS-0105.0004
Requirement	The system shall provide an IP legal recording output at each CWP.
Title	IP Legal Recording Output at CWP
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

		REQ-06.09.03-OSED-0002.0021	
		G-G Voice Communications	

3.1.2 Remote functional requirements

3.1.2.1 Visualisation services

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

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

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Identifier	REQ-12.04.07-TS-0110.0003
Requirement	The RVT shall include a visual reproduction configured 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.

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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.

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

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Identifier	REQ-12.04.07-TS-0110.0006
Requirement	The RVT should provide a visual reproduction with smooth and regular impression of moving objects to the human eye.

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Identifier	REQ-12.04.07-TS-0110.0007
Requirement	The RVT shall ensure that the time delay between image/data capture and presentation on the visual reproduction does not affect the ability to perform the ATS service.

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Identifier	REQ-12.04.07-TS-0110.0008
Requirement	The RVT visual reproduction shall enable the ATCO/AFISO to visually observe an aircraft in order to satisfactorily perform the ATS service.
	When meteorological conditions and the topography of the surrounding terrain so permit, the RVT visual reproduction (presenting the manoeuvring area and the vicinity of the aerodrome) shall enable the ATCO/AFISO to visually observe an aircraft in order to satisfactorily perform the ATS service (for example on final).

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Identifier	REQ-12.04.07-TS-0110.0009
Requirement	The RVT should enable the ATCO to visually judge the position of a light aircraft in the traffic pattern and in published VFR holdings.
	When meteorological conditions and the topography of the surrounding terrain so permit, the RVT should enable the ATCO to visually judge the position of a light aircraft (e.g. C172 or P28A) in the traffic pattern and in published VFR holdings.

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

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Identifier	REQ-12.04.07-TS-0110.0011
Requirement	When meteorological conditions so permit, the RVT shall enable the ATCO/AFISO to visually detect irregularities during landing or take-off of aircraft that requires the ATCO/AFISO to perform any alarming services (e.g. engine fire/smoke, collapsing nose-wheel).

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Identifier	REQ-12.04.07-TS-0110.0012
Requirement	In low visibility conditions, the RVT may enable the ATCO/AFISO to monitor an aircraft vacating the runway.

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

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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).

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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).

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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.

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

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

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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).
	obstructions / foreign objects
	REQ-06.09.03-OSED-0003.1409
	REQ-06.09.03-OSED-0003.1410

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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).
	obstructions / foreign objects

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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).
	obstructions / foreign objects

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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).
	Depth of vision for the ATCO/AFISO (position)
	REQ-06.09.03-OSED-0003.1413

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Identifier	REQ-12.04.07-TS-0110.0023
Requirement	The RVT visual reproduction may incorporate features that facilitate judging aircraft altitude.
	Depth of vision for the ATCO/AFISO (altitude)

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Identifier	REQ-12.04.07-TS-0110.0024
Requirement	The RVT visual reproduction may incorporate overlaid information to indicate specific parts of the aerodrome - such as the runway, taxiways and any building, obstruction or terrain of interest - in order to increase the ATCO/AFISO awareness of such objects in darkness or low visibility conditions.
	Visualisation of overlaid information of the aerodrome

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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),
	Visualisation of overlaid information for ATCO/AFISO

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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).
	Visualisation with binocular effect emulation
	REQ-06.09.03-OSED-0003.1501

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Identifier	REQ-12.04.07-TS-0110.0027
Requirement	The RVT visual reproduction binocular functionality should include predefined positions (automatic functions including zoom, pan-tilt and focus).
	Visualisation with binocular effect emulation parameters

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Identifier	REQ-12.04.07-TS-0110.0028
Requirement	The RVT visual reproduction binocular functionality may include automatic (pre-defined) scanning patterns.

1023	Visualisation with binocular effect emulation automatic scanning patterns
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Identifier	REQ-12.04.07-TS-0110.0029
Requirement	The RVT visual reproduction binocular functionality should include automatic tracking of aircraft, vehicles or obstructions (e.g. personnel or large animals).
	Visualisation with binocular effect emulation automatic tracking of aircraft, vehicles or obstructions

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Identifier	REQ-12.04.07-TS-0110.0030
Requirement	The RVT "Virtual Tower" shall provide the visualization of the remote aerodrome through its 3D syntetic visual reproduction
	Visualisation of 3D airport model
	TBD

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Identifier	REQ-12.04.07-TS-0110.0031
Requirement	The RVT "Virtual Tower" shall provide the visualization of the ground traffic in the remote aerodrome through the 3D virtual representation of the surveillance data.
	Visualization of ground traffic on remote aerodrome

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Identifier	REQ-12.04.07-TS-0110.0032
Requirement	The RVT "Virtual Tower" 3D visualization of the remote aerodrome shall reproduce on the virtual airport model the environmental data as day, night, rain, fog, sun position.
	3D virtual visualisation of the environmental data at the controlled airport

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1042 3.1.2.2 Airport sound reproduction services

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

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Identifier	REQ-12.04.07-TS-0111.0002
Requirement	The RVT sound reproduction volume shall be adjustable and possible to be turned off by the operator.
	Sound reproduction volume control

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1051 3.1.2.3 Other ATS systems/functions services

Identifier	REQ-12.04.07-TS-0112.0001
Requirement	The RVT should include an electronic system for presentation and updating of flight plan and control data (in accordance with ICAO Doc 4444 Chapter

	4.13).
	Flight plan and control data presentation and updating

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1056 3.1.2.4 Voice and data recording services

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Identifier	REQ-12.04.07-TS-0113.0001
Requirement	The RVT voice and data recording shall include airport visualisation video data.
	Video data recording

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Identifier	REQ-12.04.07-TS-0113.0002
Requirement	The RVT voice and data recording may include actual outdoor sound from the airport, if included in the particular installation.
	Video outdoor sound recording

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1066 3.1.2.5 Work environment services

Identifier	REQ-12.04.07-TS-0114.0001
Requirement	The RVT working conditions should permit day light conditions equal to ordinary office establishments.
	Working conditions - light

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Identifier	REQ-12.04.07-TS-0114.0002
Requirement	The RVT working environment (noise, temperature etc) shall be according national regulations for normal office establishments.
	Working conditions – environment regulations

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1075 3.1.3 Additional functional requirements for multiple TWRs

1076 Depending on the evolution of the requirements of the 6.4 chapter of the OSED. (ref[8]).

1077 3.1.4 Additional functional requirements for contingency

1078 Depending on the evolution of the requirements of the 6.4 chapter of the OSED (ref[8]).

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1080 3.2 Adaptability

1081 3.2.1 Modularity Requirements

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.

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

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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.

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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.

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[REQ]

Identifier	REQ-12.04.07-TS-0201.0005
Requirement	The RVT system shall be modular with respect to applications, such as, Aerodrome Surveillance, Flight Data Processing, Voice Communication System, Information & Control and Visual Reproduction.
Title	Modular Applications
Status	
Rationale	The customer shall be able to choose any combination of applications necessary to fulfil its operational needs.
Category	<Functional>
Validation Method	
Verification Method	

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		G-G Voice Communications	
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[REQ]

Identifier	REQ-12.04.07-TS-0201.0006
Requirement	The RVT system shall be modular allowing procurement of modules from different suppliers.
Title	Modular Vendors
Status	
Rationale	The customer shall be able to choose any combination of vendors necessary to fulfil its operational needs.
Category	<Functional>
Validation Method	
Verification Method	

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		G-G Voice Communications	
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1107 3.2.2 Scalability Requirements

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

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

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[REQ]

Identifier	REQ-12.04.07-TS-0202.0003
Requirement	The system shall be scalable with respect to voice communication equipment (radios, radio gateways, controller working positions).
Title	VCS Equipment Scalability
Status	
Rationale	The need to add an additional radio, radio gateway, or working position shall not cause the whole system to be replaced.
Category	<Functional>
Validation Method	
Verification Method	

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		G-G Voice Communications	
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[REQ]

Identifier	REQ-12.04.07-TS-0202.0004
Requirement	The system shall be scalable with respect to operated airports/heliports.
Title	Operated Airport Scalability
Status	
Rationale	The need to add an additional airport to be operated from a RTC shall not cause the whole system to be replaced, but only additional components to be added.
Category	<Functional>
Validation Method	
Verification Method	

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		G-G Voice Communications	
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1128 3.2.3 Adaptability Requirements

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

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

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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. Note: As an example, good visibility operations with high traffic throughput will require a different A-SMGCS set-up than that required for low visibility operations with reduced throughput.

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Identifier	REQ-12.04.07-TS-0203.0004
Requirement	The system shall provide a role management system that unites all functions in CWP.
Title	Role Management
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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		G-G Voice Communications	
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[REQ]

Identifier	REQ-12.04.07-TS-0203.0005
Requirement	The role system shall be independent from the physical controller working position.
Title	Role Management Independent from CWP
Status	
Rationale	A role can be selected at any given CWP, especially necessary when local and remote operations are possible.
Category	<Functional>
Validation Method	
Verification Method	

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		G-G Voice Communications	
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3.2.4 Configurability Requirements

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

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Identifier	REQ-12.04.07-TS-0204.0002
Requirement	The system shall provide means to define the radio layout (HMI).
Title	Radio Layout Configuration
Status	
Rationale	Operating airports flexible requires different radio layouts.
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

		A-G Voice Communications	
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[REQ]

Identifier	REQ-12.04.07-TS-0204.0003
Requirement	The system shall provide means to define the phone layout (HMI).
Title	Phone Layout Configuration
Status	
Rationale	Operating airports flexible requires different phone layouts.
Category	<Functional>
Validation Method	
Verification Method	

[REQ Trace]

		REQ-06.09.03-OSED-0002.0001	
		A-G Voice Communications	

3.3 Performance Characteristics

3.3.1 Capacity Requirements

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

Identifier	REQ-12.04.07-TS-0301.0002
Requirement	The amount of access to aeronautical mobile service (ground-ground communications) shall be specified for the RVT.

Identifier	REQ-12.04.07-TS-0301.0003
Requirement	What capabilities the RVT CWP must provide should be specified.

Identifier	REQ-12.04.07-TS-0301.0004
Requirement	It shall be defined how much of the "normal" tower view to be replicated

Identifier	REQ-12.04.07-TS-0301.0005
Requirement	The 3D System Viewer in RVT "virtual tower" shall be capable of interpreting received High Level Architecture (HLA) 1516 data or Distributed Interactive Simulation (DIS) data in order to provide a user with real time 3D visualisation that is representative of the received data.

Identifier	REQ-12.04.07-TS-0301.0006
Requirement	The 3D System Viewer in RVT "virtual tower" shall be able to provide representative visualisation of visibility range, wind speed, wind direction,

1193	cloud cover, cloud height, rain, snow.
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Identifier	REQ-12.04.07-TS-0301.0007
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.

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1202 3.3.2 Accuracy Requirements

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Identifier	REQ-12.04.07-TS-0302.0001
Requirement	The remoted video OTW Viewer in RVT “remote tower” shall provide a visual detail that match OTW direct vision.

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Identifier	REQ-12.04.07-TS-0302.0002
Requirement	The 3D System Viewer in RVT “virtual tower” shall provide a visual detail that match OTW direct vision.

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Identifier	REQ-12.04.07-TS-0302.0003
Requirement	The 3D System Viewer in RVT “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.

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1217 3.3.3 Timing performances Requirements

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Identifier	REQ-12.04.07-TS-0303.0001
Requirement	The RVT shall provide the ATCO/AFISO with access to aeronautical mobile service (air-ground communications) and to aeronautical fixed service (ground-ground communications) with a maximum delay that shall be specified in the implementation requirement specification

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Identifier	REQ-12.04.07-TS-0303.0002
Requirement	The RVT shall provide the ATCO/AFISO with live video images of the OTW in he remote controlled aerodrome with a maximum delay that shall be specified in the implementation requirement specification.

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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.
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Identifier	REQ-12.04.07-TS-0303.0004
Requirement	The RVT shall provide the 3D viewer with surveillance data from the remote controlled aerodrome with a maximum delay that shall be specified in the implementation requirement specification.

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Identifier	REQ-12.04.07-TS-0303.0005
Requirement	The RVT 3D viewer 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

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Identifier	REQ-12.04.07-TS-0303.0006
Requirement	In case of a single fault the RVT shall provide an automatic reconfiguration in order to resume the service in less than TBD seconds.

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Identifier	REQ-12.04.07-TS-0303.0007
Requirement	The RVT shall sustain at least for TBD minutes a temporary workload exceeding its maximum standard workload by TBD %

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[REQ]

Identifier	REQ-12.04.07-TS-0303.0008
Requirement	The RVT shall ensure that the time delay variation between image capture and presentation on the visual reproduction <i>does not</i> differ in a way that it affects the ability to perform the ATS service.
	REQ-06.09.03-OSED-0003.1106

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1250 [REQ Trace]

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3.3.4 Software and resource usage Requirements

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Identifier	REQ-12.04.07-TS-0304.0001
Requirement	Specify the resolution requirements
	Horizontal resolution depends on field of view angle resolution must be defined in requirement based on these

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Identifier	REQ-12.04.07-TS-0304.0002
Requirement	The 3D System Viewer in RVT “virtual tower” shall be capable of visualising within a 3D scenario environment the same number of 3D object models as tracks in the CWP up to the max. tracks number

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Identifier	REQ-12.04.07-TS-0304.0003
Requirement	The 3D System Viewer in RVT “virtual tower” shall be capable of refreshing its 3D Visualisation Window at a rate of 30Hz +/- a 25% tolerance.

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Identifier	REQ-12.04.07-TS-0304.0004
Requirement	The Presentation System Viewer in RVT “remote tower” shall be capable of refreshing images at a rate of 30Hz +/- a 25% tolerance.

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Identifier	REQ-12.04.07-TS-0304.0005
Requirement	The RVT hardware/software usage shall be lower than 60% of the maximum available resources when running a load scenario

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Identifier	REQ-12.04.07-TS-0304.0006
Requirement	The RVT 3D visualization system hardware/software usage shall be lower than 60% of the maximum available resources when running a load scenario.

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3.3.5 Overload tolerance Requirements

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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

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3.4 Safety & Security

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1289 It is expected that 6.9.3 project delivers a safety assessment which is under work.

1290 The following requirements should be fulfilled as minimum requirements for a prototype.

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[REQ]

Identifier	REQ-12.04.07-TS-0306.0001
Requirement	The system shall be fail-safe
Title	Fail-safe system
Status	
Rationale	The term “fail-safe” in this context means that sufficient redundancy is provided to carry data to the display equipment to permit some components of the equipment to fail without any resultant loss of data displayed
Category	<Non Functional>
Validation Method	
Verification Method	

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1293 [REQ Trace]

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[REQ]

Identifier	REQ-12.04.07-TS-0306.0002
Requirement	The system shall be fail-soft
Title	Fail-soft system
Status	
Rationale	The term “fail-soft” means that the system is so designed that, even if equipment fails to the extent that loss of some data occurs, sufficient data remain on the display to enable the controller to continue operations
Category	<Non Functional>
Validation Method	
Verification Method	

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[REQ Trace]

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[REQ]

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Identifier	REQ-12.04.07-TS-0306.0003
Requirement	Specify the need for redundancy for the system so that a failure on any part of the system should not lead to a fall-off of the service
Title	redundancy
Status	
Rationale	
Category	<Non Functional>
Validation Method	
Verification Method	

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[REQ Trace]

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Identifier	REQ-12.04.07-TS-0306.0004
Requirement	All critical elements of the system should be provided with timely audio and/or visual indications of failure
Title	Indication of failure
Status	
Rationale	
Category	<Non Functional>
Validation Method	
Verification Method	

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[REQ]

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Identifier	REQ-12.04.07-TS-0306.0005
Requirement	The system design should preclude failures that result in erroneous data for operationally significant time periods
Title	Design constraint
Status	
Rationale	
Category	<Non Functional>
Validation Method	
Verification Method	

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Identifier	REQ-12.04.07-TS-0306.0006
Requirement	The system 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
Title	Validation of data
Status	
Rationale	
Category	<Non Functional>
Validation Method	
Verification Method	

[REQ Trace]

[REQ]

Identifier	REQ-12.04.07-TS-0306.0007
Requirement	A self-checking system with failure alerts should be included in the system design.
Title	self-checking
Status	
Rationale	
Category	<Non Functional>
Validation Method	
Verification Method	

[REQ Trace]

[REQ]

Identifier	REQ-12.04.07-TS-0306.0008
Requirement	The system shall follow Safety Case according to Eurocontrol SAMv2.1
Title	Safety Case
Status	
Rationale	
Category	<Non Functional>
Validation Method	
Verification Method	

[REQ Trace]

[REQ]

Identifier	REQ-12.04.07-TS-0306.0009
Requirement	The system shall support authentication in its components for management access.
Title	Authentication for Management Access
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

[REQ Trace]

	A-G Voice Communications	
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[REQ]

Identifier	REQ-12.04.07-TS-0306.0010
Requirement	The system shall support confidentiality in its components for management

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	access.
Title	Confidentiality for Management Access
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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		A-G Voice Communications	
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Identifier	REQ-12.04.07-TS-0306.0011
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Requirement	The system shall support authentication at each controller working position.
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Title	Authentication for CWP
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Status	
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Rationale	
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Category	<Functional>
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Validation Method	
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Verification Method	
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		A-G Voice Communications	
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Identifier	REQ-12.04.07-TS-0306.0012
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Requirement	The radio gateway shall only allow access from known clients (white list).
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Title	Radio Gateway White List
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Status	
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Rationale	
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Category	<Functional>
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Validation Method	
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Verification Method	
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		A-G Voice Communications	
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Identifier	REQ-12.04.07-TS-0306.0013
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Requirement	The system shall support monitoring mechanisms that ensures confidentiality.
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Title	Monitoring Confidentiality
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Status	
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Rationale	
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Category	<Functional>
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Validation Method	
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Verification Method	
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		A-G Voice Communications	
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Identifier	REQ-12.04.07-TS-0306.0014
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Requirement	The system shall support monitoring mechanisms that ensures integrity.
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Title	Monitoring Integrity
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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		A-G Voice Communications	
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Identifier	REQ-12.04.07-TS-0306.0015
Requirement	The system shall support monitoring mechanisms that provides authentication.
Title	Monitoring Authentication
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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		A-G Voice Communications	
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3.5 Maintainability

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Identifier	REQ-12.04.07-TS-0307.0001
Requirement	Requirements regarding maximum downtime for total OTW shall be specified.
	Downtime for total OTW

Identifier	REQ-12.04.07-TS-0307.0002
Requirement	Requirements regarding maximum downtime for a single OTW monitor shall be specified.
	downtime for a single OTW monitor

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Identifier	REQ-12.04.07-TS-0307.0003
Requirement	Requirements regarding maximum downtime for PTZ shall be specified.
	downtime for PTZ

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Identifier	REQ-12.04.07-TS-0307.0004
Requirement	Requirements regarding maximum downtime for communication between RTC and airport shall be specified.
	downtime for communication between RTC and airport

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Identifier	REQ-12.04.07-TS-0307.0005
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Requirement	Requirements regarding maximum downtime for total system and sub-system shall be specified.
	downtime for total system and sub-system

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1374 3.6 Reliability

Identifier	REQ-12.04.07-TS-0308.0001
Requirement	Requirements regarding maximum MTBF for total OTW shall be specified.
	maximum MTBF for total OTW

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Identifier	REQ-12.04.07-TS-0308.0002
Requirement	Requirements regarding maximum MTBF for a single OTW monitor shall be specified.
	maximum MTBF for a single OTW

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Identifier	REQ-12.04.07-TS-0308.0003
Requirement	Requirements regarding maximum MTBF for PTZ shall be specified
	maximum MTBF for PTZ

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Identifier	REQ-12.04.07-TS-0308.0004
Requirement	Requirements regarding maximum MTBF for XXX shall be specified
	maximum MTBF for XXX

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Identifier	REQ-12.04.07-TS-0308.0005
Requirement	The RVT shall provide the ATCO with warning indicating if picture is frozen.

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Identifier	REQ-12.04.07-TS-0308.0006
Requirement	The RVT shall provide the ATCO with warning indicating if picture is corrupt.

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Identifier	REQ-12.04.07-TS-0308.0007
Requirement	The RVT shall provide the ATCO with warning indicating if picture is delayed.

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Identifier	REQ-12.04.07-TS-0308.0008
Requirement	Requirements regarding maximum delay for picture in OTW shall be specified.
	maximum delay for picture in OTW

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1406 3.7 Functional block Internal Data Requirements

1407 Requirements regarding internal data structure should be specified in the implementation specific
1408 requirements specification.

1409 3.8 Design and Construction Constraints

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1411 [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 (e.g. Annex 14)
Title	Airport Constructions
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

1412 [REQ Trace]

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1414 [REQ]

Identifier	REQ-12.04.07-TS-0309.0002
Requirement	All major system components shall be decoupled and separated by clear defined interfaces.
Title	Modular Design
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

1415 [REQ Trace]

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1417 [REQ]

Identifier	REQ-12.04.07-TS-0309.0003
Requirement	The system construction shall utilize COTS hardware products.
Title	Modular Design
Status	
Rationale	Provide flexibility in terms of hardware procurement and avoid bespoke hardware solution.
Category	<Functional>
Validation Method	
Verification Method	

1418 [REQ Trace]

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1420 [REQ]

Identifier	REQ-12.04.07-TS-0309.0004
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Requirement	Network QoS monitoring and usage shall be taken into account in the design of system function.
Title	QoS monitoring
Status	
Rationale	Some critical RVT functionalities rely on wide-area network capacity. So the network in this case could be subject to degradation which has an immediate impact on operation unlike systems based solely on local network which are by construction more predictable. Possibly some function could automatically decide to self-deactive because the quality of the information they use is not good enough to be processed and would provide the user with bad quality information which can lead to wrong decisions.
Category	<Functional>
Validation Method	
Verification Method	

1421 [REQ Trace]

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1423 [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.
Title	Modular Design
Status	
Rationale	This provides service contingency in case of network provider failure (for example having data trafficking in one infrastructure, and voice (VoIP) through another one)
Category	<Functional>
Validation Method	
Verification Method	

1424 [REQ Trace]

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1426 3.9 Functional block Interface Requirements

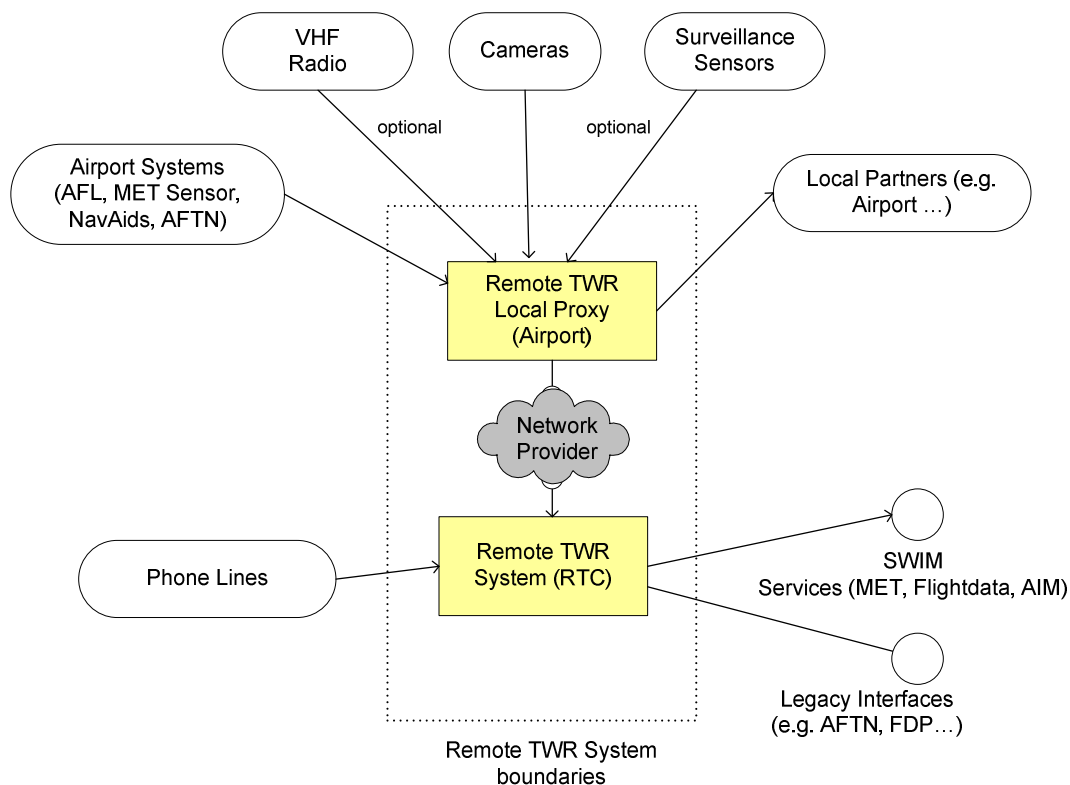
1427

1428 The remote tower system design consists of two parts. The core system in the RTC and a local proxy
1429 at the dedicated airport. These parts are connected via a wide area network which might be provided
1430 by an external partner (telco ...). This WAN interface is not considered as an external interface from a
1431 logical point of view.

1432 External interfaces are situated at the local airport or at the RTC. Dependant on the detailed
1433 implementation some of these interfaces and the systems/sensors behind might be included in the
1434 remote tower solution (e.g., cameras, VHF radios). In other cases such sensor might already be
1435 existing and will be integrated into the remote tower system. Such interfaces are considered as
1436 optional.

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1441 [REQ]

Identifier	REQ-12.04.07-TS-0310.0001
Requirement	The design shall allow local or centralized deployment of interfaces
Title	Interface Surveillance Sensors
Status	
Rationale	Some interfaces could be provided locally or directly at the remote TWR site. The design shall not constraint a certain deployment solution.
Category	<Functional>
Validation Method	
Verification Method	

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1443 [REQ Trace]

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1445 [REQ]

Identifier	REQ-12.04.07-TS-0310.0002
Requirement	The system shall provide an interface to local surveillance sensors.
Title	Interface Surveillance Sensors
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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1447 [REQ Trace]

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1449 [REQ]

Identifier	REQ-12.04.07-TS-0310.0003
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Requirement	The system shall shall provide an interface to local cameras. Applicable standard e.g. ONVIF could be supported
Title	Interface Camera
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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1451 [REQ Trace]

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1453 [REQ]

Identifier	REQ-12.04.07-TS-0310.0004
Requirement	The system shall provide an interface to local VHF radios via analogue interface or IP (compliant to ED137).
Title	Interface Radios
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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1455 [REQ Trace]

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1457 [REQ]

Identifier	REQ-12.04.07-TS-0310.0005
Requirement	The system shall provide an interface to local airport systems such as Airfield Lights, Met System and Nav Aids.
Title	Interface Airport Systems
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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1459 [REQ Trace]

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1461 [REQ]

Identifier	REQ-12.04.07-TS-0310.0006
Requirement	The system 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,
Title	Interface
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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1463 [REQ Trace]

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1465 [REQ]

Identifier	REQ-12.04.07-TS-0310.0007
Requirement	The system shall provide a central interface for telephone lines
Title	Interface Phone
Status	

Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

[REQ]

Identifier	REQ-12.04.07-TS-0310.0008
Requirement	The system shall provide a central interface to the SWIM network for services MET, Flight Plan, Surveillance and AIM
Title	Interface SWIM
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

[REQ]

Identifier	REQ-12.04.07-TS-0310.0009
Requirement	The system shall provide a central interface to the AFTN or other legacy FDP systems for flight data exchange.
Title	Interface AFTN, FDP
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

[REQ]

Identifier	REQ-12.04.07-TS-0310.0010
Requirement	The system should provide a central interface to FDP systems in order to exchange sectorization data
Title	Interface FDP or SWIM if available
Status	
Rationale	The RTS shall inform or being informed about the airfields (and thus jurisdiction) it takes over.
Category	<Functional>
Validation Method	
Verification Method	

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[REQ Trace]

[REQ]

Identifier	REQ-12.04.07-TS-0310.0011
Requirement	IP-based voice communication and recording shall be compliant with EUROCAE Working Group 67 recommendations.
Title	EUROCAE Compliant
Status	
Rationale	
Category	<Functional>
Validation Method	
Verification Method	

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1483 [REQ Trace]
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1488 4 Assumptions

1489 It is assumed that this document is generic and will serve as a basis for the creation of a requirement
1490 specification

- 1491 ▪ In this first iteration, only Single Remote Tower has been taken into account.
- 1492 ▪ Next iteration - Iteration 2, will focus on the finalizing of the Single Remote Tower draft and
1493 produce the first draft of the Multiple Remote Tower

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1495

1496 **5 References**

- 1497 [1] SESAR PMP 02.00.00
1498 [2] Template Toolbox 02.00.00
1499 [3] Requirements and V&V Guidelines 02.00.00
1500 [4] Toolbox User Manual 02.00.00
1501 [5] SESAR Definition Phase – Task 2.4.x Milestone 3 – System Architecture (DLT-0612-244-00-
1502 10), September 2007
1503 [6] IEEE / MIL Standards
1504 [7] Architecture of the Technical Systems Description Document for Step 1. (B.04.03-D09-00-
1505 ADD_20110511.doc)
1506 [8] Project 06.09.03 – Operational Service and Environment Definition (OSD) – Ed 00.02.01
1507

1508 **5.1 Use of copyright / patent material /classified material**
1509 **(NATMIG)**

1510 This document needs no prior consent of copyright and patent owner.

1511 **5.1.1 Classified Material (NATMIG)**

1512 There is no sensitive information contained in this technical specification.

1513 **Appendix A Traceability**

1514 This section presents the traceability matrices, which identify, for every TS requirement:

- 1515 • The key elements of the TS requirement (identifier and title),
 1516 • The ATMS Requirement that the TS requirement satisfies,
 1517 • The higher level requirement that the TS requirement satisfies (identifier and title).

1518 These traceability matrices enable to check the coverage.

1519

TS Requirement		Satisfied Requirement / Enabler	
Identifier	Title	Identifier	Title
General functional requirements			
REQ-12.04.07-TS-0100.0001	Air-ground communications	REQ-06.09.03-OSED-0002.1001	
REQ-12.04.07-TS-0100.0002	Ground-ground communications	REQ-06.09.03-OSED-0002.1002	
REQ-12.04.07-TS-0100.0003	Ground-ground vehicle communications	REQ-06.09.03-OSED-0002.1003	
REQ-12.04.07-TS-0100.0004	Signalling lamp functionality	REQ-06.09.03-OSED-0002.1004	
REQ-12.04.07-TS-0100.0005	Visual communication from aircraft	REQ-06.09.03-OSED-0002.1005	
REQ-12.04.07-TS-0100.0006	Visual communication from aircraft on manoeuvring area		
REQ-12.04.07-TS-0100.0007	Surveillance data from remote controlled airport		
REQ-12.04.07-TS-0100.0008	Voice Communications Network Performance		
REQ-12.04.07-TS-0100.0009	Hierarchical Side Tone Generation	REQ-06.09.03-OSED-0002.0001	X
REQ-12.04.07-TS-0100.0010	Shared Radio Access		X
REQ-12.04.07-TS-0100.0011	Radio Access Priorities	REQ-06.09.03-OSED-0002.0001	x
REQ-12.04.07-TS-0100.0012	Radio Pre-emption	REQ-06.09.03-OSED-0002.0001	x
REQ-12.04.07-TS-0100.0013	Combined A/G – G/G HMI	REQ-06.09.03-OSED-0002.0001 REQ-06.09.03-OSED-0002.0002	

REQ-12.04.07-TS-0101.0001	Access to meteorological information		
REQ-12.04.07-TS-0101.0002	Current MET report	REQ-06.09.03-OSED-0002.2002	
REQ-12.04.07-TS-0102.0001	Continuous visualisation for ATCO		
REQ-12.04.07-TS-0102.0002	Continuous visualisation for AFISO		
REQ-12.04.07-TS-0102.0003	Continuous visualisation for AFISO		
REQ-12.04.07-TS-0102.0004			
REQ-12.04.07-TS-0103.0001			
REQ-12.04.07-TS-0103.0002			
REQ-12.04.07-TS-0104.0001			
REQ-12.04.07-TS-0104.0002			
REQ-12.04.07-TS-0104.0003			
REQ-12.04.07-TS-0104.0004			
REQ-12.04.07-TS-0104.0005			
REQ-12.04.07-TS-0104.0006			
REQ-12.04.07-TS-0104.0007	Central VCS Monitoring		
REQ-12.04.07-TS-0104.0008	Remote CWP Monitoring		
REQ-12.04.07-TS-0105.0001			
REQ-12.04.07-TS-0105.0002			
REQ-12.04.07-TS-0105.0003	Analogue Legal Recording Output at CWP	REQ-06.09.03-OSED-0002.0021	
REQ-12.04.07-TS-0105.0004	IP Legal Recording Output at CWP	REQ-06.09.03-OSED-0002.0021	
REQ-12.04.07-TS-0110.0001			
REQ-12.04.07-TS-0110.0002			
REQ-12.04.07-TS-0110.0003			
REQ-12.04.07-TS-0110.0004			
REQ-12.04.07-TS-0110.0005			
REQ-12.04.07-TS-0110.0006			
REQ-12.04.07-TS-0110.0007			
REQ-12.04.07-TS-0110.0008			

REQ-12.04.07-TS-0110.0009			
REQ-12.04.07-TS-0110.0010			
REQ-12.04.07-TS-0110.0011			
REQ-12.04.07-TS-0110.0012			
REQ-12.04.07-TS-0110.0013			
REQ-12.04.07-TS-0110.0014			
REQ-12.04.07-TS-0110.0015			
REQ-12.04.07-TS-0110.0016			
REQ-12.04.07-TS-0110.0017			
REQ-12.04.07-TS-0110.0018			
REQ-12.04.07-TS-0110.0019	obstructions / foreign objects		
REQ-12.04.07-TS-0110.0020	obstructions / foreign objects		
REQ-12.04.07-TS-0110.0021	obstructions / foreign objects		
REQ-12.04.07-TS-0110.0022	Depth of vision for the ATCO/AFISO (position)		
REQ-12.04.07-TS-0110.0023	Depth of vision for the ATCO/AFISO (altitude)		
REQ-12.04.07-TS-0110.0024	Visualisation of overlaid information of the aerodrome		
REQ-12.04.07-TS-0110.0025	Visualisation of overlaid information for ATCO/AFISO		
REQ-12.04.07-TS-0110.0026	Visualisation with binocular effect emulation		
REQ-12.04.07-TS-0110.0027	Visualisation with binocular effect emulation parameters		
REQ-12.04.07-TS-0110.0028	Visualisation with binocular effect emulation automatic scanning patterns		
REQ-12.04.07-TS-0110.0029	Visualisation with binocular effect emulation automatic tracking of aircraft, vehicles or obstructions		
REQ-12.04.07-TS-0110.0030	Visualisation of 3D airport model		

REQ-12.04.07-TS-0110.0031	Visualization of ground traffic on remote aerodrome		
REQ-12.04.07-TS-0110.0032	3D virtual visualisation of the environmental data at the controlled airport		
REQ-12.04.07-TS-0111.0001	Reproduction of actual outdoor sound from the airport		
REQ-12.04.07-TS-0111.0002	Sound reproduction volume control		
REQ-12.04.07-TS-0112.0001	Flight plan and control data presentation and updating		
REQ-12.04.07-TS-0113.0001	Video data recording		
REQ-12.04.07-TS-0113.0002	Video outdoor sound recording		
REQ-12.04.07-TS-0114.0001	Working conditions - light		
REQ-12.04.07-TS-0114.0002	Working conditions – environment regulations		
Adaptability			
REQ-12.04.07-TS-0201.0001			
REQ-12.04.07-TS-0201.0002			
REQ-12.04.07-TS-0201.0003			
REQ-12.04.07-TS-0201.0004			
REQ-12.04.07-TS-0201.0005	Modular Applications		
REQ-12.04.07-TS-0201.0006	Modular Vendors		
REQ-12.04.07-TS-0202.0001			
REQ-12.04.07-TS-0202.0002			
REQ-12.04.07-TS-0202.0003	VCS Equipment Scalability		
REQ-12.04.07-TS-0202.0004	Operated Airport Scalability		
REQ-12.04.07-TS-0203.0001			
REQ-12.04.07-TS-0203.0002			
REQ-12.04.07-TS-0203.0003			
REQ-12.04.07-TS-0203.0004	Role Management		

REQ-12.04.07-TS-0203.0005	Role Management Independent from CWP		
REQ-12.04.07-TS-0204.0001			
REQ-12.04.07-TS-0204.0002	Radio Layout Configuration		
REQ-12.04.07-TS-0204.0003	Phone Layout Configuration	REQ-06.09.03-OSED-0002.0001	
Performance Characteristics			
REQ-12.04.07-TS-0301.0001			
REQ-12.04.07-TS-0301.0002			
REQ-12.04.07-TS-0301.0003			
REQ-12.04.07-TS-0301.0004			
REQ-12.04.07-TS-0301.0005			
REQ-12.04.07-TS-0301.0006			
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REQ-12.04.07-TS-0302.0001			
REQ-12.04.07-TS-0302.0002			
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REQ-12.04.07-TS-0303.0002			
REQ-12.04.07-TS-0303.0003			
REQ-12.04.07-TS-0303.0004			
REQ-12.04.07-TS-0303.0005			
REQ-12.04.07-TS-0303.0006			
REQ-12.04.07-TS-0303.0007			
REQ-12.04.07-TS-0303.0008			
REQ-12.04.07-TS-0304.0001			
REQ-12.04.07-TS-0304.0002			
REQ-12.04.07-TS-0304.0003			
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REQ-12.04.07-TS-0304.0005			

REQ-12.04.07-TS-0304.0006			
REQ-12.04.07-TS-0305.0001			
Safety & Security			
REQ-12.04.07-TS-0306.0001	Fail-safe system		
REQ-12.04.07-TS-0306.0002	Fail-soft system		
REQ-12.04.07-TS-0306.0003	redundancy		
REQ-12.04.07-TS-0306.0004	Indication of failure		
REQ-12.04.07-TS-0306.0005	Design constraint		
REQ-12.04.07-TS-0306.0006	Validation of data		
REQ-12.04.07-TS-0306.0007	self-checking		
REQ-12.04.07-TS-0306.0008	Safety Case		
REQ-12.04.07-TS-0306.0009	Authentication for Management Access		
REQ-12.04.07-TS-0306.0010	Confidentiality for Management Access		
REQ-12.04.07-TS-0306.0011	Authentication for CWP		
REQ-12.04.07-TS-0306.0012	Radio Gateway White List		
REQ-12.04.07-TS-0306.0013	Monitoring Confidentiality		
REQ-12.04.07-TS-0306.0014	Monitoring Integrity		
REQ-12.04.07-TS-0306.0015	Monitoring Authentication		
Maintainability			
REQ-12.04.07-TS-0307.0001	Downtime for total OTW		
REQ-12.04.07-TS-0307.0002	downtime for a single OTW monitor		
REQ-12.04.07-TS-0307.0003	downtime for PTZ		
REQ-12.04.07-TS-0307.0004	downtime for communication between RTC and airport		
REQ-12.04.07-TS-0307.0005	downtime for total system and sub-system		
Reliability			
REQ-12.04.07-TS-0308.0001	maximum MTBF for total OTW		
REQ-12.04.07-TS-0308.0002	maximum MTBF for a single OTW		

REQ-12.04.07-TS-0308.0003	maximum MTBF for PTZ		
REQ-12.04.07-TS-0308.0004	maximum MTBF for XXX		
REQ-12.04.07-TS-0308.0005			
REQ-12.04.07-TS-0308.0006			
REQ-12.04.07-TS-0308.0007			
REQ-12.04.07-TS-0308.0008	maximum delay for picture in OTW		
Design and construction constraints			
REQ-12.04.07-TS-0309.0001	Airport Constructions		
REQ-12.04.07-TS-0309.0002	Modular Design		
REQ-12.04.07-TS-0309.0003	Modular Design		
REQ-12.04.07-TS-0309.0004	QoS monitoring		
REQ-12.04.07-TS-0309.0005	Modular Design		
Functional block interface requirements			
REQ-12.04.07-TS-0310.0001	Interface Surveillance Sensors		
REQ-12.04.07-TS-0310.0002	Interface Surveillance Sensors		
REQ-12.04.07-TS-0310.0003	Interface Camera		
REQ-12.04.07-TS-0310.0004	Interface Radios		
REQ-12.04.07-TS-0310.0005	Interface Airport Systems		
REQ-12.04.07-TS-0310.0006	Interface		
REQ-12.04.07-TS-0310.0007	Interface Phone		
REQ-12.04.07-TS-0310.0008	Interface SWIM		
REQ-12.04.07-TS-0310.0009	Interface AFTN, FDP		
REQ-12.04.07-TS-0310.0010	Interface FDP or SWIM if available		
REQ-12.04.07-TS-0310.0011	EUROCAE Compliant		

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