REMOTE TOWER

Final Project Report

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PJ05 Remote Tower

PJ05 REMOTE TOWER FOR MULTIPLE AIRPORTS

This Final Project Report is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 730195 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document provides the Final Project Report of the SESAR2020 Project 05 "Remote Tower for Multiple Airport". It provides a summary and conclusions of the results out of three solutions:

- ***WP2 Solution PJ.05-02 „Multiple Remote Tower Module" (V1 → V3)***
- ***WP3 Solution PJ.05-03 „RTC with Flexible Allocation of Aerodromes to MRTMs" (V1 → V2)***
- ***WP5 Solution PJ.05-05 „Advanced Automated Met System for Remote Airport" (TRL2 → TRL4)***

The results are put into relation to the ATM Master Plan objectives and are proven for their fit for purpose to contribute standardization and regulatory activities. In a final step the remaining R&D steps are outlined.

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Executive Summary

"Remote Tower" is changing the provision of Air Traffic Services (ATS) in a way that it is more service tailored, dynamically positioned and available when and where needed, enabled by advanced surveillance solutions making the physical presence of Air Traffic Controllers (ATCOs) and Air traffic Control (ATC) towers at aerodromes dispensable. In a next step it enables centralised aerodrome ATC services in terms of Remote Tower Centers (RTC).

While Single Remote Tower has already been implemented at several locations, PJ05 addressed Remotely Provided Air Traffic Service for Multiple Aerodromes where one ATCO provides ATS for two or three aerodromes simultaneously from a Multiple Remote Tower Module.

The objective of PJ05 was to enlarge the scope of the multiple remote tower solutions to enable "multiple" control in more complex traffic and environmental situations, for two or three simultaneously controlled aerodromes, to further increase cost efficiency and job satisfaction. Special attention was laid on improved HMI design, planning support and workload balancing by a flexible allocation of aerodromes to a Multiple Remote Tower Module (MRTM). PJ05 validation approach mainly focussed on human performance and safety aspects to prove the operational feasibility, validated by two operational and one technological solution:

- ***Solution PJ.05-02***
  Multiple Remote Tower Module (V1 → V3)
- ***Solution PJ.05-03***
  RTC with Flexible Allocation of Aerodromes to MRTMs (V1 → V2)
- ***Solution PJ.05-05***
  Advanced Automated MET System (TRL2 → TRL4)

The two operational solutions describe the sequential steps for enlarging the scope of multiple remote tower services. Solution PJ.05-02 aimed for V3 maturity level at the end of this project, solution PJ.05-03 for V2 maturity level and V3 level to be reached at the end of next R&D phase. Technological solution PJ.05-05 was expected to reach TRL4 maturity and focuses on enhanced automatic provision of MET (facultative to Remote Tower concept).

The following table provides an overview on the main characteristics of the two operational solutions:

	Solution PJ.05-02	Solution PJ.05-03
Allocation of Aerodromes to MRTMs	Static allocation of aerodromes to dedicated MRTM(s)	Dynamic allocation of aerodromes to any MRTM in the RTC by split&merge procedures
Planning tool for ATCO & Supervisor	ATCO is supported by a planning tool to support in tasks ahead for all aerodromes the ATCO has control of.	ATCO is supported by a planning tool to support in tasks ahead for all aerodromes the ATCO/MRTM has control of. The supervisor is supported in an efficient & dynamic allocation of all related aerodromes to the MRTMs in order to balance ATCO workload and traffic complexity.

Table 1: Main characteristics for solution PJ.05-02 and PJ.05-03

Both solutions validated the concept for a variety of different ***traffic and environment complexities***, which are (among many other things) caused by:

- **Aerodrome layout**, e.g. amount and constellation of RWYs, aprons and stands and interconnecting taxiways, etc.)
- **Visibility conditions**, e.g. weather, daylight, night time, precipitation, obstructed LoS, etc.
- **Special procedures**, e.g. backtrack, dependent runways, restricted areas, special VFR, etc.
- **Traffic volumes** and their distribution over the controlled aerodromes
- **Mix of traffic**, e.g. VFR- IFR-mix, rotor-fixed wing, special, RPAS, etc.
- **Different other surveillance equipage**
- **Etc.**

PJ05 main conclusions

PJ05 moved forward the maturity of Multiple Remote Tower concept: In a user-centred approach improved HMI designs, new planning support tools, means and procedures to split & merge aerodromes to enable a flexible allocation of aerodromes to ATCOs/MRTMs to better balance individual workload (avoiding over- and underload situation), were evaluated and proven in various complex traffic and environment situations.

It can be concluded that a single ATCO providing air traffic service to more than two aerodromes simultaneously is a safe and feasible concept.

Following key results can be referred to:

- Several real time simulations where conducted and proved that a safe and well-mannered Air Traffic Service is possible. Not a single safety compromising situation has ever been reported, neither by the ATCO test subjects, nor by the ATCO expert observer, nor by the experimenter observer

- The ATCO's workload and situation awareness heavily correlate with the complexity of the ATC situation. Complexity contributing factors are mainly traffic load, VFR/IFR mix, aerodrome layout or staffing/shift situations but many more which effecting situation awareness and workload. By that consideration MRT is just another complexity contributing factor effecting workload and situation awareness. Like all other complexity contributing factors, also MRT has to be thoroughly investigated locally during deployment. The same requirement already exists with conventional towers or single remote towers, particularly workload must not be too high (excessive) but also not to low (underutilized) to avoid too high (excessive) but also not to low (underutilized) workload extrema. Both extrema have to be avoided in order not to impair safety. Particularly underutilized ATCOs can be observed at many low frequented aerodromes today. MRT is a proper candidate to address such problems to best balance ATCO workload.

- Planning tools for ATCOs and supervisors are proper candidates to predict traffic complexity in MRTM/RTC environments in order to better monitor and predict ATCO workload. In case of over- or underload situations, mitigation means, like support of a backup ATCOs and/or splitting & merging of aerodromes, can easily be applied to balance ATCO's workload.

- Essential for providing an appropriate ATS level is the actual and forecasted weather (MET) situation. For that purpose PJ05 dealt with a technological solution PJ.05-05 "Advanced Automated MET System" with the objective to enhance current possibilities of automatic observations remotely, using integrated VIS/IR camera in three the most problematic parameters: visibility, clouds, and significant MET phenomena. The validated technology showed big potential to help all airports in the world, either automated, or remotely observed, or with human observation to aid human observers or forecasting centres. Particularly IR camera may improve clouds observations (both daylight and nocturnal) even at airports with professional MET Observers on-site.

Next steps

Next steps will be the transitioning to industrialization and later deployment of solution PJ.05-02 "Multiple Remote Tower Module", which reached V3 maturity within PJ05. Solution PJ.05-03 "RTC with Flexible Allocation of Aerodromes to MRTMs" reached V2 maturity and is recommended to continue in next R&D phase. Results of PJ05 will also be exploited by EASA RMT.0624 as well as ICAO ATM Operational Panel (ATMOPSP) to update their existing guideline material w.r.t. remote ATS. Solution PJ.05-05 "Advanced Automated MET System" should be properly integrated also in next phases of PJ.05 project.

1 Project Overview

PJ05 addressed Remotely Provided Air Traffic Service for Multiple Aerodromes where one ATCO provides ATS for several aerodromes simultaneously from a Multiple Remote Tower Module in a Remote Tower Centre. The objective of PJ05 was to enable “multiple remote tower” in more complex traffic situations. This is achieved by the introduction of new enablers supporting the ATCO like automation assistance systems, a supervisor planning tool and the flexible allocation of aerodromes to MRTMs. Compared to conventional towers or single remote control towers this offers the great opportunity to better balance workload.

1.1 Operational Context

Providing air traffic control (ATC) for aerodromes is a safety critical task. It needs best educated controllers and highly sophisticated and well maintained equipment, which drives costs. Other and small environment airports commonly have costs exceeding the revenue from landing fees. These airports are often an important part of the infrastructure in rural regions wherefore cost efficient solutions such as Remote Towers add a possibility to keep airports open. Furthermore, today controllers became a rare source and direct visual observation of the aerodrome’s areas of interest from the Tower cabin might be impaired, either by low visibility, by far distant runways, taxiways or apron areas, or by buildings preventing a direct line of sight. ‘Remote Tower’ is a new and fast rising ATS concept to address those problems.

The remote tower concept is changing the provision of Air Traffic Services (ATS) in a way that it is more service tailored, dynamically positioned and available when needed, enabled by cost-efficient visual surveillance systems replacing the physical presence of controllers and control towers at aerodromes. The basic concept relies on cost efficient optical camera sensors, whose video images are relayed to a remote facility, situated anywhere, to be displayed on a video panorama in order to enable the provision of ATS from a Remote Tower Centre. Several aerodromes can be connected to a Remote Tower Centre. Depending on complexity and requested capacity an ATCO can provide Air Traffic Control to a single or multiple aerodromes. Providing ATS for Multiple Aerodromes and its flexible allocation of aerodromes to Remote Tower Modules is the core subject of SESAR2020 “PJ05 Remote Tower” project. “Single” remote tower solutions have already been deployed through the predecessor SESAR 1 projects, but more significant impacts in flexibility and cost-efficiency are to be expected with “multiple” remote control out of a remote tower centre that was only partly covered so far. PJ05 intended to bring the multiple/centre concept to airports with more complex traffic than tested in SESAR 1.

1.2 Project Scope and Objectives

The main driver behind PJ.05 is increased cost efficiency by an increase of ATCO productivity. The increase of ATCO productivity is reached with the Multiple Remote Tower (MRT) concept where one ATCO controls more than one aerodrome. In comparison to SESAR OI SDM-0205 “Remotely Provided ATS for Multiple Aerodromes” by PJ.06.09.03 and PJ.06.08.04which validated simultaneous control of two airports by a single ATCO, PJ.05 aims to enlarge the scope of the MRT solutions to deal with more aerodromes and to better handle complex traffic situation by new planning assistance tools, the involvement of the supervisor and to split & merge aerodromes in between of different MRTM to

better balance ATCOs' workload. The validations focussed on the evaluation of human performance and safety aspects.

Solution PJ.05.02: The aim of all PJ.05.02 validation exercises was to develop and validate an MRT module (MRTM) that allows the ATCO to maintain situation awareness for 2 small environment or 3 other environment aerodromes simultaneously. An ATCO planning tool, enhanced voice communication together with improved HMI design served as technical enablers. Maturity level should progress from V1 to V3.

Solution PJ.05.03: The aim of PJ.05.03 was to provide means and procedures to allow a better planning of the anticipated future workload and a flexible allocation of aerodromes in between of different ATCOs and MRTMs. As a consequence the individual ATCO workload can be better balanced. Maturity level should progress from V1 to V2.

Solution PJ.05-05 aimed to provide automated/semi-automated MET observational data in a way that supports situational awareness for multiple airports even at the airports without human MET observer (by processing of data from remote location). Maturity level should progress from TRL2 → TRL4.

1.3 Work Performed

The PJ05 project idea attracted plenty of European organisations to contribute to PJ05: ANSPs, industries, R&D and airport stakeholders intended to provide their specific competences to broaden the operational and technological expertise. The PJ05 variety of partners and validation activities helped to adequately reflect the variety of operational needs and technical solutions, to be consolidated into a harmonised and accepted SESAR2020 PJ05 solutions. The complete work was structured in a collaborative way throughout all work packages to ensure the transfer of knowledge and know-how between all participants and external to SESAR2020 projects.

The concept and requirements were elaborated with suppliers and operational experts and fixed in the OSED and TS reports (see technical deliverables in §1.5). The respective validations exercises for the operational solutions were prototyped and designed as real-time simulations, which make it possible to stress different hazards and technical degradation without any risk compared to active mode trials, to have repeatable traffic scenarios and test subjects actively providing control to measure situation awareness and workload and assess acceptance to test the feasibility of the concept and its adapted procedures.

The real-time simulations were supplemented with one shadow mode exercise to investigate technical feasibility related to the visual relay and presentation of three aerodromes.

Trials were performed at different locations based on different prototypes in order to address and complement the different validation objectives. Overall workshops on solution level with ATCOs from all validation exercises were used as add-on debriefings to get more consolidated operational feedback to the validation reports, in particular for the Safety and Human Performance report in part II and part IV.

The following eight validations were executed in order to reach V3 maturity for Solution PJ.05-02:

- EXE-05.02-V2 - TVAL.001 – ON (B4)
  ON (B4), Frequentis (FSP) & DLR (AT-One) validation for other environment airports, simulated with three Lithuanian airports (Vilnius, Kaunas & Palanga) based on integrated

Frequentis prototype in a AT-One (DLR) HITL real-time simulation validation platform situated in Braunschweig, Germany

- EXE-05.02-V2- TVAL.002 & V3- TVAL.006 – COOPANS
  COOPANS partners validation for small environment airports, based on real time simulations platforms further developed from SESAR 1 by Saab (NATMIG) and V2 trials by COOPANS and NLR (AT-One).

- EXE-05.02-V2 - TVAL.003 & V3- TVAL.007 - INDRA
  INDRA validation for other environment airports based on INDRA prototype and INDRA (Avinor ANS Linked Third Party) real time simulations validation platform

- EXE-05.02- V2- TVAL.004 & V3a+b- TVAL.008 – HC (FSP)
  FREQUENTIS SESAR Partners (Frequentis (FSP) & HungaroControl (FSP)) validation for other environment airports, simulated with one runway of Budapest, a small civil Hungarian airport Debrecen and a military small Hungarian airport Papa based on integrated Frequentis prototype in a AT-One (DLR) HITL real-time simulation validation platform situated in Braunschweig, Germany and in a passive shadow mode environment in Budapest (V3b).

- EXE-05.02-V3-TVAL.009 - ENAV
  ENAV partners validation for two small environment airports, based on the ENAV real-time simulation platforms situated in Ciampino.

The OI step addressed by the validations was SDM-0207: “Multiple Remote Tower Module (for up to 3 airports)”. The different validation exercises focussed on the following aspects showing the complementary nature of the validations:

	B4	COOPANS	INDRA	HC (FSP)	ENAV
Two simultaneous aerodromes		X			X
Three simultaneous aerodromes	X		X	X	
Split of aerodormes		X			X
Degraded mode testing		X	X	X	X
Emergency Situation		X		X	
Wind related RWY changes				X	
Network quality of Service				X	
Enhanced VCS	X	X		X	X
Radar	X (with Kaunas and Palanga only down to 1000ft)	X	X	X (with Debrecen and Papa only down to 1000ft)	X

Table 2: PJ.05-02 V2/V3 Validation Exercises visulizing their complementary nature by showing their different validation focusses

PJ.05.03 aimed for to provide means and procedures to enable a more long-term planning of the anticipated taskload and a flexible allocation of aerodromes in between of different ATCOs and

MRTMs. Following illustrations shows an example of how one or two aerodromes (AD) are splitted & merged in case of over/underload or even in case of unpredictable emergency scenarios .

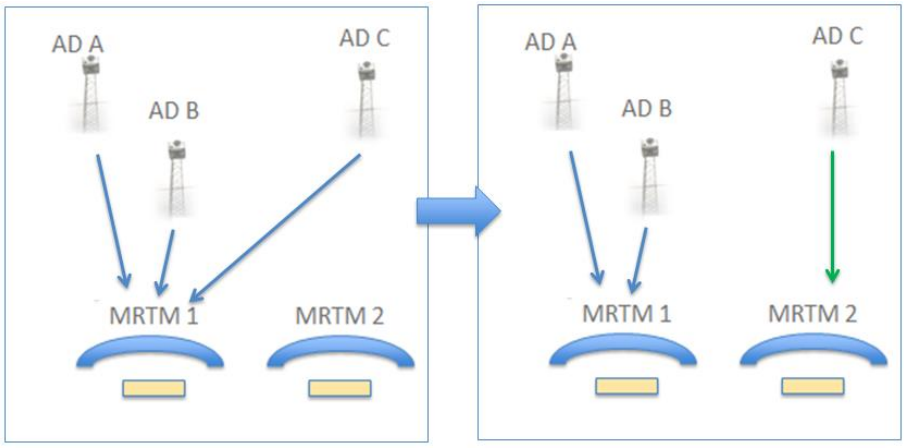


Figure 1 Example to handover (split) one aerodrome to a spare position (MRTM2) to cover overload situations

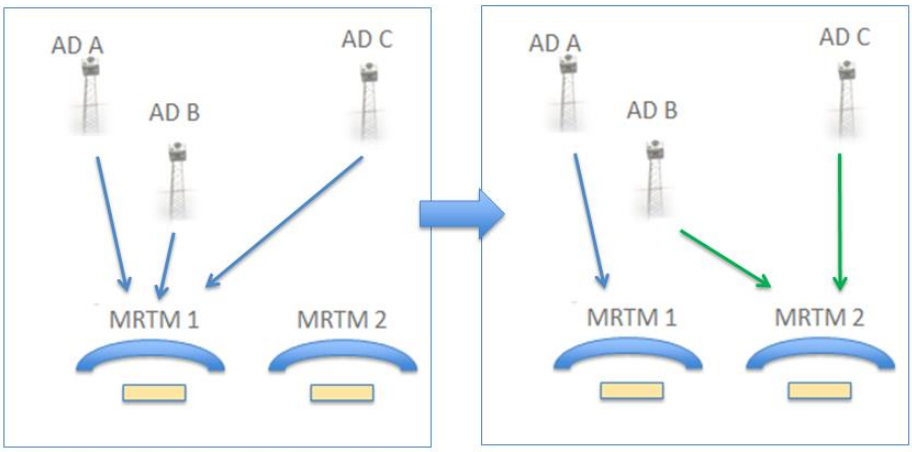


Figure 2 Example to handover (split) two aerodromes to a spare position (MRTM2) to cover an emergency situation at aerodrome A

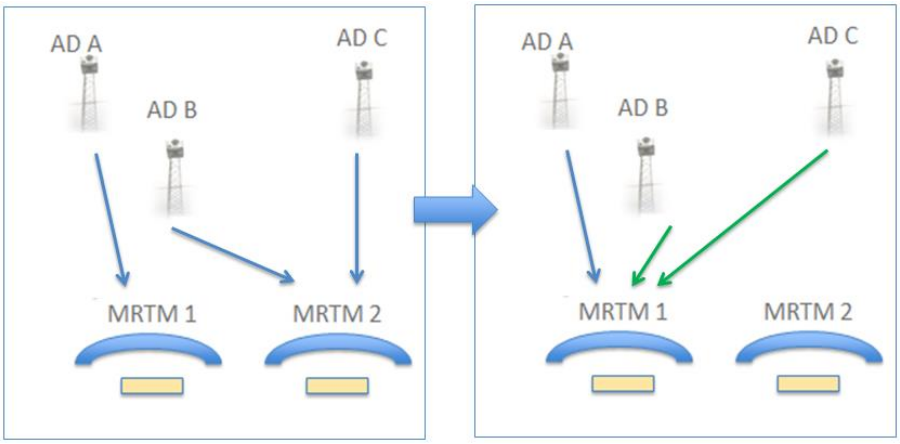


Figure 3 Example to takeover (merge) two aerodromes from position MRTM2 after an emergency situation at aerodrome A has been solved

For solution PJ.05-03 the following four validations with four different prototypes with slightly different design concepts were executed in order to reach V2 maturity for Solution PJ.05-03:

- EXE-05.03-V2-3.1 – TVAL.010 – ON (B4)
  ON (B4), Frequentis (FSP) & DLR (AT-One) validation for three airports, simulated with three Lithuanian airports (Vilnius, Kaunas & Palanga) based on integrated Frequentis prototype in a AT-One (DLR) HITL real-time simulation validation platform with two MRTMs situated in Braunschweig, Germany with focus on workload balancing in emergency and overlast scenarios by the new procedure of splitting&merging of aerodromes

- EXE-05.03-V2-3.2 – TVAL.011 – COOPANS
  COOPANS partners validation for 3 small environment airports, based on platforms further developed from Solution 02 by Saab (NATMIG) and by NLR (AT-One), based on Solution 02 (Real Time Simulation for MRTM complemented with a fast time simulation for RTC).

- EXE-05.03-V2-3.3 – TVAL.012 – INDRA
  INDRA validation for small operating environment Norwegian airports based on INDRA prototype and INDRA (Avinor ANS Linked Third Party) validation platform (Fast Time Simulation)

- EXE-05.03-V2-3.5 – TVAL.014 – DFS
  DFS validation for small operating environment German airports based on integrated Frequentis/DFS prototype and DFS platform (Real Time Simulation)

	ON (B4)	COOPANS	INDRA	DFS
Supervisor functionality / role	X	X	X	
Supervisor planning tool		X	X	
Aerodrome Handover between MRTMs	X	X	X	X
Advanced Voice Communication integrated in CWP	X	X		X
Radar	X (with Kaunas and Palanga only down to 1000ft)	X	X	X

Table 3: PJ.05-03 V2 Validation Exercises visulizing their complementary nature by showing their different validation focusses

Solution PJ.05-05 aimed for to investigate:

- possibilities of automatic measurement of visibility/prevailing visibility (automatic recognition of pictures by artificial intelligence methods/HMI for manual processing of pictures),
- possibilities of automatic measurement of clouds - evaluation of cloud cover (automatic recognition of pictures by artificial intelligence methods/HMI for manual processing of pictures) and height (and significant cloud type in manual processing = human in the loop concept)
- investigate possibilities of enhanced automatic detection of MET phenomena

The Advanced Automated MET System was validated in two modes:

  - fully automated
    - automatic data processing from various sensors, especially VIS and IR camera imagery, installed at remote aerodrome (LZTT - Poprad-Tatry airport, small regional Slovak airport) and their presentation to controller at airport Bratislava airport
    - the fully automated observations were compared to currently operational MET observation at Poprad-Tatry airport (locally sited professional human observer + operational state-of-the-art AWOS)
  - human in the loop
    - automatic MET assessment of meteorological data, especially VIS and IR camera imagery, from remote airport LZTT and presentation to the human MET Observer (located in Bratislava) and comparison with operational MET observation at Poprad-Tatry airport

For more details refer to the Validation Plans & Reports referenced in the technical deliverables table in §1.5 below.

1.4 Key Project Results

PJ05 moved forward the maturity of Multiple Remote Tower concept: In a user-centred approach improved HMI designs, new planning tools, new procedures and means to split & merge aerodromes to enable a flexible allocation of aerodromes to ATCOs/MRTMs to better balance workload in over- and underload situation, to mitigate degraded mode or emergency situation, were evaluated and proven in various complex traffic and environment situations.

It can be concluded that a single ATCO providing air traffic service to more than one aerodrome simultaneously is a safe and feasible concept, prerequisite that the ATCO's workload and situation awareness are kept on reasonable levels. Following key results can be referred to:

- Several real time simulations where conducted and proved that a safe and well-mannered Air Traffic Service is possible. In several validation campaigns not only a single safety compromising situation has ever been reported, neither by the ATCO test subjects, nor by the ATCO expert observer, nor by the experimenter observer.

- The ATCO's workload and situation awareness heavily correlate with the complexity of the ATC situation. Complexity contributing factors are mainly traffic load, VFR/IFR mix and aerodrome environment. All complexity contributing factors, also MRT has to be thoroughly

investigated locally during deployment. The same requirement already exists with conventional towers or single remote towers, particularly workload must be balanced, which can perfectly by addressed in a remote tower center.

- ATCO planning tool and supervisor planning tool enable prediction of traffic complexity. In case of high workload, mitigation means, like support of a backup ATCOs and/or splitting & merging of aerodromes, can easily be applied to balance ATCO's workload.

In case of PJ05-05 Advanced Automated MET System the main objective to enhance current possibilities of automatic observations using integrated VIS/IR camera in three most problematic parameters, visibility, clouds and significant MET phenomena was accomplished. Discussion with professional aviation MET Observers during validation concluded that utilization of IR camera may improve clouds observations (both daylight and nocturnal) even at airports with professional MET Observers on-site. The new validated technology has big potential to improve its results via further research in next R&D phases.

Operational and Technical Key Results:

Human performance and new procedures:

- ATCOs' workload and situation awareness were generally acceptable and safe operations ensured
- Flexible allocation of aerodromes in between of MRTMs is a feasible mitigation means to balance ATCOs' workload in high workload or exceptional situations
- The supervisor role is a helpful human resource to provide assistance in forecasting the traffic load, as a backup ATCO and to facilitate the aerodrome split & merge procedure
- Adding aerodrome name in radio communications proved to be beneficial for ATCOs' situation awareness and is also supposed to add situation awareness for pilots

Technical system:

- ATCOs' performance can be improved with higher system support, e.g. ATCO planning tools, and electronic systems to support silent coordination with adjacent sectors or aerodrome operators
- Electronic flight strips was generally assessed as extremely useful in a MRT environment
- Supervisor planning tool can support flexible allocation of aerodromes and staff to MRTMs in a remote tower centre
- Side by side, on top of each other or combination of both visual panorama presentations were considered as a possible way to present the aerodrome view
- "Advanced Automated MET System" technology showed big potential to help any airport in the world, either automated, or remotely observed, or with human observation to aid human observers or forecasting centres.

1.5 Technical Deliverables

Reference	Title	Delivery Date[1]	Dissemination Level[2]
	Description		
D2.2.001	D2.2.001 - OSED PJ05-02 V3 final	01.08.2019	PU
This document is the OSED (Operational Services and Environment Description), SPR and INTEROP relating to the Multiple Remote Towers development of the SESAR operational concept for the operational solution 2 to a V3 maturity level.			
D2.2.002	D2.2.002 - VALP PJ05-02 V3 final	01.10.2018	CO
This document describes the Validation Plan for PJ05-Solution 02 “Remotely Provided Air Traffic Services from a Multiple Remote Tower Module, MRTM” targeting at V3 maturity.			
D2.2.003	D2.2.003 - VALR PJ05-02 V3 final	03.07.2019	PU
This document describes the Validation Report for PJ05-Solution 02 “Multiple Remote Tower Module" MRTM” targeting V3 maturity level.			
D2.2.004	D2.2.004 - TS PJ05-02 V3 final	01.08.2019	PU
This document describes the functions of a remote tower solution, and provides a requirement specification for those functions. It is developed aiming for final V3 maturity for Solution PJ05-02. It is based on SESAR1 project 12.04.07 D09 Remote Tower Technical Specifications. While the SESAR1 TS was written to separate operation of a single aerodrome from the one of a multiple aerodrome, this TS views operation of a single aerodrome to be included in a multiple aerodrome operation.			
D2.2.005	D2.2.005 - PJ.05-02: CBA (V3)	31.07.2019	PU
This document provides the Cost Benefit Analysis (CBA) related to SESAR Solution PJ05-02 that has been validated during validation activities at a V3 level. The CBA aims to provide results at ECAC level about the economic and financial viability of deploying PJ05 Solution 02 at European scale. Therefore, it will not provide sufficient detail to fully support individual deployment decisions that must take into account local environment/situation (e.g. lifespan of equipment, replacement timing, etc.).			
D3.1.003	D3.1.003 - OSED PJ05-03 V2 final	01.08.2019	PU
This document is the OSED (Operational Services and Environment Description), SPR and INTEROP relating to the Multiple Remote Towers development of the SESAR operational concept for the operational solution 3 to a V2 maturity level.			
D3.1.005	D3.1.005 - VALP PJ05-03 V2 final	28.09.2018	CO
This document describes the Validation Plan for PJ05-Solution 03 “Highly Flexible Allocation of			

[1] Delivery data of latest edition

[2] Public or Confidential

Aerodromes to Remote Tower Modules" targeting at V2 maturity.			
D3.1.007	D3.1.007 - VALR PJ05-03 V2 final	24.07.2019	PU
This document describes the Validation Report for PJ05-Solution03 "Highly Flexible Allocation of Aerodromes to Remote Tower Modules" targeting at V2 maturity.			
D3.1.010	D3.1.010 - TS PJ05-03 V2 final	02.08.2019	PU
This document describes the functions of a remote tower solution, and provides a requirement specification for those functions. It is developed aiming for final V2 maturity for Solution PJ05-03. It is based on SESAR1 project 12.04.07 D09 Remote Tower Technical Specifications. While the SESAR1 TS was written to separate operation of a single aerodrome from the one of a multiple aerodrome, this TS views operation of a single aerodrome to be included in a multiple aerodrome operation.			
D3.1.011	D3.1.010 - TS PJ05-03 CBA (V2)	02.08.2019	PU
This document provides the Cost Benefit Analysis (CBA) related to SESAR Solution PJ05-03 that has been validated during validation activities at a V2 level. The CBA aims to provide results at ECAC level about the economic and financial viability of deploying PJ05 Solution 03 at European scale. Therefore, it will not provide sufficient detail to fully support individual deployment decisions that must take into account local environment/situation (e.g. lifespan of equipment, replacement timing, etc.).			
D5.1.002	D5.1.002 - TS PJ05-05 TRL4 final	15.05.2019	PU
This document provides the Technical specification for SESAR Solution PJ05-05 "Advanced Automated MET System", that consists of two options – Automated and Semi-Automated (with MET Observer in the loop), with the initial maturity level being TRL2.			
D5.1.004	D5.1.004 - TVALP PJ05-05 TRL4 final	04.05.2018	CO
This document describes the Validation Plan for PJ05-Solution 05 "Advanced Automated MET System for Remote Airport". Remote provision and monitoring of full MET information (in comparison to human MET observations) is subject of validation exercise which will bring this technological solution to TRL4 maturity level.			
D5.1.005	D5.1.005 - TVALR PJ05-05 TRL4 final	25.02.2019	PU
This SESAR Solution PJ.05-05: Technical Validation Report describes the results coming out of the TRL4 validation activity undertaken for Solution PJ.05-05 – "Advanced Automated MET System".			
D5.1.007	D5.1.007 - PJ.05-05: CBA (TRL4)	30.04.2019	PU
This document provides the Cost Benefit Analysis (CBA) for SESAR Project PJ.05 - Solution 05 – Advanced Automated MET System. The CBA forms part of the data pack supporting the TRL4 maturity gate session.			
D5.1.008	D5.1.008 - TVALP PJ05-05 TRL6 interim	30.04.2019	CO
This document describes the Technical Validation Plan for PJ.05-Solution 05 "Advanced Automated MET System for Remote Airport". Remote provision and monitoring of full MET information (in comparison to local human MET observations) should be a subject of validation exercise which will elevate this technological solution to TRL6 maturity level.			

Table 4: Project Deliverables

2 Links to SESAR Programme

2.1 Contribution to the ATM Master Plan

Code	Name	Project contribution	Maturity at project start	Maturity at project end
PJ05-02	Multiple Remote Tower Module	Aimed to develop and validate a Multiple Remote Tower module (MRTM) that allows the ATCO to maintain situation awareness for 2 or 3 small aerodromes simultaneously.	V1	V3
PJ05-03	RTC with Flexible Allocation of Aerodromes to MRTMs	Aimed to allow a better planning of the anticipated future workload and a flexible allocation of aerodromes in a RTC between different ATCOs and MRTMs.	V1	V2
PJ05-05	Advanced Automated MET System	Aimed to provide automated/semi-automated MET observational data to be integrated in a way that supports situational awareness for multiple airports even at the airports without human MET observer.	TRL2	TRL4

Table 5: Project Maturity

No recommendations for updating of ATM Master Plan were identified.

2.2 Contribution to Standardisation and regulatory activities

Applicable standards and regulations

ICAO

The Air Traffic Management Operations Panel (ATMOPSP) developed proposed amendments to Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444) to facilitate the use of envisaged technology in the provision of remote aerodrome control service. This amendment was introduced in ICAO PANS-ATM Doc 4444 by Amendment 8, in force since 8 November 2018, thereby fully enabling remote aerodrome ATS in the ICAO context.

The amendments include, inter alia;

- A new definition ‘visual surveillance system’ definition.
- A new chapter 7.1.1.2.1 stating that visual observation can be achieved through direct out-of-the-window observation or through indirect observation utilizing a visual surveillance system.

- A new “Note” referring to the EASA Guidance Material, thereby giving it global recognition.

This standardisation activity is potentially covered by the enablers STD-HNA-04 and 05, linked to SDM-0201.

EUROCAE

EUROCAE Working Group 100 (WG-100), dealing with ““Remote and Virtual Towers”, published a first standard ED-240 ‘MINIMUM AVIATION SYSTEM PERFORMANCE SPECIFICATION FOR REMOTE TOWER OPTICAL SYSTEMS’, in September 2016, specifying the end-to-end performance of the optical (camera) system. However this first version did not consider/cover any augmentation functions or sensors other than cameras.

This standardisation activity is captured by the enabler STD-014, linked to SDM-0201. It could also be partly related to STD-HNA-06 and -07, also linked to SDM-0201.

A second revision (ED-240A) was published in October 2018 and included also performance requirements related to the visual tracking function and PTZ automatic object following.

WG-100 is now continuing its work with further revision/extension (ED-240B), which will include also performance requirements related to the incorporation of information from non-optical surveillance systems/sensors (e.i. the so called “radar tracking”/”radar labels” function), anticipated late 2020.

EUROCAE ED-240 is not specifically addressing single or multiple aerodrome remote control requirements, as it is considered that the requirements set forth by ED-240/ED-240A/ED-240B are applicable regardless of Single or Multiple mode of operation. PJ.05 baseline is Single Remote Tower wherefore requirements on optical systems remain unchanged.

A new system enabler specifically introduced for multiple remote towers is CTE-C14, “Advanced VCS (Voice Com System) for a Multiple Remote Tower Module (MRTM)” has been validated at V3level.

This standardisation activity is captured by the enabler STD-014, linked to SDM-0201.

EASA

EASA rulemaking task RMT.0624 (Remote aerodrome ATS) was established to provide/develop a regulatory framework and guidance for remote tower operations/remote aerodrome ATS. Following the first phase of RMT.0624, EASA published ‘Guidance Material on the implementation of the remote tower concept for single mode of operation’ (Executive Director Decision 2015/014/R), as well as ‘Requirements on Air Traffic Controller licensing regarding remote tower operations’ (Executive Director Decision 2015/015/R), in July 2015.

This regulatory activity is captured by the enabler REG-0509, linked to SDM-0201.

Following a second phase of RMT.0624, EASA issued 'Guidance Material on remote aerodrome air traffic services’ — Issue 2 and ‘AMC & GM to Part ATCO’ — Issue 1, Amendment 2 (Executive Director Decision 2019/004/R), in February 2019, replacing the previously published EASA guidance in 2015. This new updated guidance takes into consideration the further evolution of the concept as well as experiences gained from R&D activities (e.g. all the SESAR 1 validation activities and Solutions) and initial implementations throughout the EU and US and it addresses also multiple and more complex

modes of operation. Thus the regulatory support/framework needed for Mutiple mode of operation is now in place.

This regulatory activity is captured by the enabler REG-0525, linked to SDM-0205.

EASA RMT.0624 will monitor the implementation of remote aerodrome ATS and any future technological and operational developments (e.g. the PJ.05 Solutions/SESAR 2020 results). The RMT.0624 has been opened again to will amend and/or further evolve the existing guidance. The results of PJ05 “Remote Tower for Multiple Airports” will serve as important references.

This potential regulatory activity could be captured by a new REG-XXX enabler, linked to SDM-0207.

PJ05 contribution to future standardisation and regulatory activities

PJ05 recommendation and results with respect to PJ.05-02 & PJ.05-03 will be exploited by future work of the EASA RMT.0624 as well as ICAO ATM Operational Panel (ATMOPSP) to update their existing guideline material.

PJ.05-05 “Advanced Automated MET System” should be properly integrated also in next phases of PJ.05 project.

EUROCAE WG100 instead does not specifically address single or multiple aerodrome remote control requirements, as it is considered that the requirements set forth by ED-240/ED-240A/ED-240B are applicable regardless of Single or Multiple mode of operation. PJ.05 baseline is Single Remote Tower wherefore requirements on optical systems remain unchanged.

3 Conclusion and Next Steps

3.1 Conclusions

After 13 validation exercises at different sites in different countries, with different validation platforms and prototypes, in different operational environments, with various aerodromes, tested with various R&D teams and ATCOs from many different ANSPs, it can be concluded that the PJ05 validation results are caused by a comprehensive technical and operational diversity, matching the real diversity rather well, and thus, inherent an excellent external validity.

Solution PJ.05-02 implemented and tested an improved HMI designs and new ATCO planning tools, which improved the ATCO's situation awareness. Thus, the ATCO was enabled to safely provide ATS up to three aerodromes simultaneously in the tested traffic scenarios, including degraded mode and emergency situations.

Solution PJ.05-03 tested procedures to split & merge aerodromes in between several MRTMs in a RTC enabling a flexible allocation of aerodromes within the RTC. This procedure is a great opportunity Multiple Remote Control offers for future remote control implementations: The ATCO's individual workload can perfectly be balanced to avoid over- and underload situation, to mitigate downgraded mode or even emergency situation. This procedure was very appreciated by the ATCOs.

Solution PJ.05-05 tested an advanced automated MET System technology which is an important enabler to automatically gain comprehensive weather information from the remote aerodromes.

One of the most conclusive and persuasive PJ05 results was that in all the different validations not only a single safety compromising situation has ever been reported, neither by the ATCO test subjects, nor by the ATCO expert observer, nor by the experimenter observer.

It can be concluded that a single ATCO providing air traffic service to more than one aerodrome simultaneously is a safe and feasible concept, prerequisite that the ATCO's workload and situation awareness are monitored and kept on reasonable levels.

PJ05 moved forward the maturity of Multiple Remote Tower concept and recommends a deployment of the concept.

3.2 Plan for next R&D phase (Next steps)

Solution PJ.05-02 - V3 maturity

Solution PJ.05-02 reached a V3 maturity and is ready for is ready for transitioning to industrialization and later deployment. However, there are recommendations to be considered during deployment. In particular specific details for system failure and back up as well as local procedures and harmonisation need to pay attention for like:

- Local procedures at the different aerodromes should be harmonised as much as possible

- Coordination needs with other sectors depending on APP/ACC sectors and airport coordination should be limited as far as possible by using of silent coordination through system support

- The procedures for degraded modes along with the minimum system performance should be considered locally as they are impacting required and possible mitigations.

The deployment needs a safety assessment on the chosen technical system for deployment. This to find proper mitigations for degradation, where a split in to single remote tower has the lowest impact on airport capacity and termination of service has the highest impact.

Solution PJ.05-03 – V2 maturity

Solution PJ.05-03, which reached a V2 maturity in PJ05, could prove that the supervisor planning tool can support flexible allocation of aerodromes and staff to MRTMs in a remote tower centre. Nevertheless further parameters need to be included in the planning tool at V3 level and the transparency of the workload calculation to the operator needs to be further investigated. The next R&D phase for reaching V3 maturity should focus on the following subjects in detail:

- More than three aerodromes and more than one MRTM are to be considered in the validation platforms in order to evaluate the operational feasibility and full benefit of a highly flexible allocation of aerodromes within an RTC.

- The supervisor role must be elaborated more thoroughly.

- For allocating airports and ATCOs to MRTMs, the supervisor planning tool should consider also ATCO endorsements, rostering plan, shift constraints, and airport opening hours.

- The workload calculation should be further investigated and the what-if functionality of the long term planning tool should be further elaborated. Operating the tool need to be intuitive.

- A more flexible allocation where a transferred aerodrome can take any position within the MRTM should be investigated.

- Phraseology with airport name added should be kept for V3 but it should be further investigated whether the airport name is required in all radio transmissions or mainly for the transmissions related to the runway (e.g. take-off and landing clearances) in order to reduce communication workload.

- Automation support using operational “events” should be further detailed allowing the ATCO to work in parallel with flight plans and the events.

- ATCOs reported that the main challenge was to set up the mental picture for the three aerodromes in parallel. All the ATCOs reported a huge training effect after providing ATS in the simulations for about 2 days. Therefore, more time for training before the actual validations is to be planned for.

Solution PJ.05-05 – TRL4 maturity

PJ.05-05 Advanced Automated MET System reached TRL4 maturity and has shown great potential, because utilization of Remote Observer (semi-automated mode of the system) had significantly

superior statistic results in comparison to common automatic AWOS system used at the airports. Although in fully automated mode there are some limitations to deal with and results are not so significantly better compared to current state of art AWOS system, there is also potential for improvements in next R&D phases. Specifically when taking into account that currently deployed systems are mature technologies, performing very poorly in inhomogeneous weather conditions and their development and improvement is rather slow.

One of the elements for further research would be ability of MET observer to handle provisioning of remote MET service simultaneously for more than one aerodrome from a central MET office. The validation of this option is expected to be performed in TRL6 hand in hand with conducting safety assessment of whole concept, since it was not conducted in TRL4 due to capacity constraints.

4 References

4.1 External References

[1] SESAR2020, Final Project Report Template (01.00.00) (1.0), 11102, 01.00.00, 07.08.2019

[2] ATM Masterplan 2015, 17 Jul 17

[3] SESAR2020, Maturity Report 2018, 11105, 08 Jul 19

[4] SESAR2020, Maturity Report 2018 Executive Summary , 11104, 08 Jul 19

[5] EASA, Guidance Material on remote aerodrome air traffic services, Issue 2, 2019

[6] EASA, AMC & GM to Part ATCO, Issue 1, Amendment 2 (Executive Director Decision 2019/004/R), 2019,

[7] EUROCAE, ED-240A MINIMUM AVIATION SYSTEM PERFORMANCE SPECIFICATION FOR REMOTE TOWER OPTICAL SYSTEMS, 2018

[8] ICAO, Document 4444 “Procedures For Air Navigation Services - Air Traffic Management”, Sixteenth Edition, 2016 (Amendment 8, 08 November 2018)

[9] ICAO, Document 9426 “Air Traffic Services Planning Manual”, 1st Edition, December 1992

4.2 “PJ 05 Remote Tower” Deliverables

[10]PJ05 Remote Tower	D1.1 - Project Management Plan	D1.1	15.05.2017
[11]PJ05 Remote Tower	D1.2 - Final Project Report	D1.2	this deliver.
[12]PJ05 Remote Tower	D1.3 - Quarterly Progress Report 1	D1.3	09.05.2017
[13]PJ05 Remote Tower	D1.4 - Quarterly Progress Report 2	D1.4	06.11.2017
[14]PJ05 Remote Tower	D1.5 - Quarterly Progress Report 3	D1.5	06.11.2017
[15]PJ05 Remote Tower	D1.6 - Quarterly Progress Report 4	D1.6	17.02.2018
[16]PJ05 Remote Tower	D1.7 - Quarterly Progress Report 5	D1.7	03.05.2018
[17]PJ05 Remote Tower	D1.8 - Quarterly Progress Report 6	D1.8	13.07.2018
[18]PJ05 Remote Tower	D1.9 - Quarterly Progress Report 7	D1.9	22.10.2018
[19]PJ05 Remote Tower	D1.10 - Quarterly Progress Report 8	D1.10	28.01.2019
[20]PJ05 Remote Tower	D1.11 - Quarterly Progress Report 9	D1.11	17.04.2019

[21]PJ05 Remote Tower	D1.12 - Quarterly Progress Report 10	D1.12	12.07.2019
[22]PJ05 Remote Tower	D2.1 - Solution PJ.05-02: V2 Data Pack	D2.1	14.02.2019
[23]PJ05 Remote Tower	D2.1.001 - OSED PJ05-02 V2 initial	D2.1.001	07.07.2017
[24]PJ05 Remote Tower	D2.1.002 - OSED PJ05-02 V2 final	D2.1.002	29.06.2018
[25]PJ05 Remote Tower	D2.1.003 - VALP PJ05-02 V2 initial	D2.1.003	30.09.2017
[26]PJ05 Remote Tower	D2.1.004 - VALR PJ05-02 V2 final	D2.1.004	24.05.2018
[27]PJ05 Remote Tower	D2.1.005 - TS PJ05-02 V2 initial	D2.1.005	29.09.2017
[28]PJ05 Remote Tower	D2.1.006 - TS PJ05-02 V2 final	D2.1.006	29.06.2018
[29]PJ05 Remote Tower	D2.1.007 - PJ.05-02: CBA (V2)	D2.1.007	02.07.2018
[30]PJ05 Remote Tower	D2.1.008 - AN - EXE-05.02-V2-2.1 - ON (B4)	D2.1.008	05.04.2018
[31]PJ05 Remote Tower	D2.1.009 - AN - EXE-05.02-V2-2.2 - COOPANS	D2.1.009	27.03.2018
[32]PJ05 Remote Tower	D2.1.010 - AN - EXE-05.02-V2-2.3 - INDRA	D2.1.010	05.04.2018
[33]PJ05 Remote Tower	D2.1.011 - AN - EXE-05.02-V2-2.4 - HC	D2.1.011	15.12.2017
[34]PJ05 Remote Tower	D2.2 - Solution PJ.05-02: V3 Data Pack	D2.2	28.11.2019
[35]PJ05 Remote Tower	D2.2.001 - OSED PJ05-02 V3 final	D2.2.001	01.08.2019
[36]PJ05 Remote Tower	D2.2.002 - VALP PJ05-02 V3 final	D2.2.002	01.10.2018
[37]PJ05 Remote Tower	D2.2.003 - VALR PJ05-02 V3 final	D2.2.003	03.07.2019
[38]PJ05 Remote Tower	D2.2.004 - TS PJ05-02 V3 final	D2.2.004	01.08.2019
[39]PJ05 Remote Tower	D2.2.005 - PJ.05-02: CBA (V3)	D2.2.005	31.07.2019
[40]PJ05 Remote Tower	D2.2.006 - AN - EXE-05.02-V3-2.2 - COOPANS	D2.2.006	24.01.2019
[41]PJ05 Remote Tower	D2.2.007 - AN - EXE-05.02-V3-2.3 - INDRA	D2.2.007	15.03.2019
[42]PJ05 Remote Tower	D2.2.008 - AN - EXE-05.02-V3-2.4 - HC	D2.2.008	19.12.2018
[43]PJ05 Remote Tower	D2.2.009 - AN - EXE-05.02-V3-2.5 - ENAV	D2.2.009	05.02.2019
[44]PJ05 Remote Tower	D3.1 - Solution PJ.05-03: V2 Data Pack	D3.1	28.11.2019

[45]PJ05 Remote Tower	D3.1.001 - OSED PJ05-03 V2 initial	D3.1.001	07.07.2017
[46]PJ05 Remote Tower	D3.1.002 - OSED PJ05-03 V2 interim	D3.1.002	23.07.2018
[47]PJ05 Remote Tower	D3.1.003 - OSED PJ05-03 V2 final	D3.1.003	01.08.2019
[48]PJ05 Remote Tower	D3.1.004 - VALP PJ05-03 V2 initial	D3.1.004	28.09.2018
[49]PJ05 Remote Tower	D3.1.005 - VALP PJ05-03 V2 final	D3.1.005	28.09.2018
[50]PJ05 Remote Tower	D3.1.007 - VALR PJ05-03 V2 final	D3.1.007	24.07.2019
[51]PJ05 Remote Tower	D3.1.008 - TS PJ05-03 V2 initial	D3.1.008	29.09.2017
[52]PJ05 Remote Tower	D3.1.009 - TS PJ05-03 V2 interim	D3.1.009	23.07.2018
[53]PJ05 Remote Tower	D3.1.010 - TS PJ05-03 V2 final	D3.1.010	02.08.2019
[54]PJ05 Remote Tower	D3.1.011 - PJ.05-03: CBA (V2)	D3.1.011	02.08.2019
[55]PJ05 Remote Tower 19.12.2018	D3.1.012 - AN - EXE-05.03-V2-3.1 - ON (B4)	D3.1.012	
[56]PJ05 Remote Tower 24.01.2019	D3.1.013 - AN - EXE-05.03-V2-3.2 - COOPANS	D3.1.013	
[57]PJ05 Remote Tower 15.03.2019	D3.1.014 - AN - EXE-05.03-V2-3.3 - INDRA	D3.1.014	
[58]PJ05 Remote Tower	D3.1.016 - AN - EXE-05.03-V2-3.5 - DFS	D3.1.016	25.01.2019
[59]PJ05 Remote Tower	D3.1.100 - VALP PJ05-03 Roadmap	D3.1.100	02.08.2019
[60]PJ05 Remote Tower	D4.1 - H - Requirement No. 1	D4.1	17.10.2017
[61]PJ05 Remote Tower	D4.2 - POPD - Requirement No. 2	D4.2	17.10.2017
[62]PJ05 Remote Tower	D4.3 - NEC - Requirement No. 3	D4.3	17.10.2017
[63]PJ05 Remote Tower	D4.4 - Requirement No. 4	D4.4	17.10.2017
[64]PJ05 Remote Tower	D5.1 - Solution PJ.05-05: TRL4 Data Pack	D5.1	04.11.2019
[65]PJ05 Remote Tower	D5.1.001 - TS PJ05-05 TRL4 interim	D5.1.001	31.01.2018
[66]PJ05 Remote Tower	D5.1.002 - TS PJ05-05 TRL4 final	D5.1.002	15.05.2019
[67]PJ05 Remote Tower	D5.1.003 - TVALP PJ05-05 TRL4 initial	D5.1.003	12.03.2018
[68]PJ05 Remote Tower	D5.1.004 - TVALP PJ05-05 TRL4 final	D5.1.004	04.05.2018
[69]PJ05 Remote Tower	D5.1.005 - TVALR PJ05-05 TRL4 final	D5.1.005	25.02.2019

[70]	PJ05 Remote Tower 10.08.2018	D5.1.006 - AN - EXE-05.05-TRL4-5.1 - LPS	D5.1.006
[71]	PJ05 Remote Tower	D5.1.007 - PJ.05-05: CBA (TRL4)	D5.1.007 30.04.2019
[72]	PJ05 Remote Tower	D5.1.008 - TVALP PJ05-05 TRL6 interim	D5.1.008 30.04.2019

4.3 Project Communication and Dissemination papers

[1] Hagl, M., Friedrich, M., Jakobi, J., Schier-Morgenthal, S., & Stockdale, C. (2019). *Impact of Simultaneous Movements on the Perception of Safety, Workload and Task Difficulty in a Multiple Remote Tower Environment*. Paper presented at the 2019 IEEE Aerospace Conference, Mountain View, Montana.

[2] Friedrich, M., Hamann, A., & Jakobi, J. (2020). *An eye catcher in the ATC domain: Influence of Multiple Remote Tower Operations on distribution of eye movements*. Paper presented at the 2020 IEEE Aerospace Conference, Mountain View, Montana.

[3] Hamann, A. et al (2020). *Assessment of human performance in a Multiple Remote Tower Environment with flexible allocation of aerodromes*. Paper in preparation for the ICRAT 2020, Florida, USA.

Appendix A Glossary of Terms, Acronyms and Terminology

A.1 Glossary of terms

Term	Definition	Source of the definition
ATS (Air Traffic Service)	A generic term meaning variously, Flight Information Service (FIS), Alerting Service (ALRS) and Air Traffic Control Service (ATC) (area control service, approach control service or aerodrome control service). In this document, when the term ATS is used, it is usually referring to TWR or AFIS.	ICAO, Annex 11
Aerodrome ATS	Aerodrome ATS means air traffic service for aerodrome traffic, in the form of 'aerodrome control service (ATC) or 'aerodrome flight information service' (AFIS).	EASA
Aerodrome Control Service (TWR)	The air traffic control (ATC) service provided by the Air Traffic Control Officer (ATCO) for aerodrome traffic. Air traffic control service is a service provided for the purpose of: • preventing collisions: • between aircraft, and • on the manoeuvring area between aircraft and obstructions; and • expediting and maintaining an orderly flow of air traffic.	ICAO, Annex 11
APP (Approach control service)	**APP** (Approach control service) is the service for Arrival and Departing traffic (before and after they will be/have been under the TWR control. APP is provided by a single ATCO for one or more airports, either separate or in combination with TWR (TWR & APP from the Tower).	ICAO
Conventional Tower	Conventional Tower means a facility located at an aerodrome from which aerodrome ATS is provided principally through direct out-of-the-window observation of the aerodrome and its vicinity.	EASA
Multiple mode of operation	Multiple mode of operation means the provision of ATS from one remote tower/remote tower module for two or more aerodromes at the same time (i.e. simultaneously).	EASA
Multiple Remote	Multiple Remote Tower Module (MRTM) is a term	PJ.05 definition

Tower Module (MRTM)	used by project PJ.05 and in this document to specifically indicate a Remote Tower Module (RTM) which enables the possibility to provide ATS to two or more aerodromes at the same time (i.e. simultaneously).	
Out-of-the-window (OTW) view'	'Out-of-the-window (OTW) view means a view of the area of responsibility of the aerodrome ATS unit from a conventional tower, obtained via direct visual observation.	EASA
Remote Tower	Remote Tower means a geographically independent facility from which aerodrome ATS is provided principally through indirect observation of the aerodrome and its vicinity, by means of a visual surveillance system. (It is to be seen as a generic term, equivalent in level to a conventional tower).	EASA
Remote Tower Centre (RTC)	A Remote Tower Centre (RTC) means a facility housing one or more remote tower modules.	EASA
Remote Tower Module (RTM)	Remote Tower Module (RTM) means a combination of systems and constituents from where remote aerodrome ATS can be provided, including one or more ATCO/AFISO workstation(s) and the visual presentation. (It can be compared with the tower cabin of an aerodrome conventional tower.)	EASA
Simultaneous movements	Simultaneous movements are all aircraft and vehicle movements under the control of the ATCO or on the frequency at the same time.	PJ.05 definition
Single mode of operation	Single mode of operation means the provision of ATS from one remote tower/remote tower module for one aerodrome at a time.	EASA
Technical Enablers	Technical Enablers refer to additional features and functions within a single or a multiple module that enable the provision of ATS using the concept. These technical features will assist in the areas of visualisation and operational performance. Further information on the requirement status of the Technical Enablers is given within this document.	
Visual Presentation	Visual Presentation means a view of the area(s) of responsibility of the aerodrome ATS unit, provided by a visual display.	EASA

Visual Surveillance System	Visual Surveillance System means of a number of integrated elements, normally consisting of optical sensor(s), data transmission links, data processing systems and situation displays providing an electronic visual presentation of traffic and any other information necessary to maintain situational awareness at an aerodrome and its vicinity. **Note:** EUROCAE ED-240/ED-240A is using the term 'remote tower optical system' for the same.	ICAO, Doc 4444 EASA

Table 6: Glossary of Terms

A.2 Acronyms and Terminology

Term	Definition
ACC	Area Control Centre
AD	Aerodrome
AFIS	Aerodrome Flight Information Service
AFISO	Aerodrome Flight Information Service Officer
AGL	Aerodrome Ground Lighting
AIM	Aeronautical Information Management
AIP	Aeronautical Information Publication
ANSP	Air Navigation Service Provider
APP	Approach Control
APT	Airport
ARR	Arrival
ATCC	Air Traffic Control Centre
ATCO	Air Traffic Control Officer
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATS	Air Traffic Service
CNS	Communication Navigation and Surveillance

CWP	Controller Working Position
DEP	Departure
EASA	European Aviation Safety Agency
EATMA	European ATM Architecture
EFS	Electronic Flight Strip system
E-ATMS	European Air Traffic Management System
E-OCVM	European Operational Concept Validation Methodology
HDD	Heads-Down Display
HUD	Heads-Up Display
HPAR	Human Performance Assessment Report
IBP	Industrial Based Platform
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INTEROP	Interoperability Requirements
IRS	Interface Requirements Specification
KPA	Key Performance Area
KPI	Key Performance Indicator
LVO	Low Visibility Operations
LVP	Low Visibility Procedures
MET	Meteorology, meteorological
MRTM	Multiple Remote Tower Module
OI	Operational Improvement
OSED	Operational Service and Environment Definition
OTW	Out-The-Window
PAR	Performance Assessment Report
PTZ	Pan-Tilt-Zoom
RPAS	Remotely Piloted Aircraft Systems

RTC	Remote Tower Centre
RTM	Remote Tower Module
RTO	Remote Tower Operations
RVR	Runway Visual Range
RTC SUP	RTC supervisor
RWY	Runway
SA	Situational Awareness
SAR	Safety Assessment Report
SecAR	Security Assessment Report
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPR	Safety and Performance Requirements
SUT	System Under Test
SWIM	System Wide Information Model
TRL	Technology Readiness Level
TS	Technical Specification
TSD	Traffic Situation Display
TWY	Taxiway
UC	Use Case
VALP	Validation Plan
VALR	Validation Report
VALS	Validation Strategy
VCS	Voice Communications System
VFR	Visual Flight Rules
VMC	Visual Metrological Conditions
WL	Workload

Table 7: Acronyms and technology

Appendix B Final Project maturity self-assessment

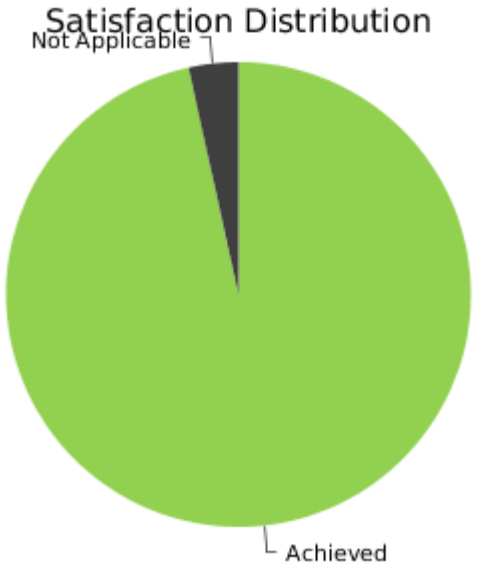
B.1 V3 Gate for Solution PJ05-02 - MAT

B.1.1 Maturity assessment

Identification	
Name	V3 Gate for Solution PJ05-02 - MAT
Space	PJ05 Remote Tower
Maturity gate	V3 Gate for Solution PJ05-02
Link to Solution	PJ.05-02
V-Level / TRL	V3
Assessor	Marcus Filipp
Date of assessment	July 2019
Comments	-
Approved by SJU	No
Reviewers	
SJU PM	
PJ19	

PJ20	
PJ22	
Airspace User	

B.1.2 Satisfaction distribution



B.1.3 Assessed maturity per thread

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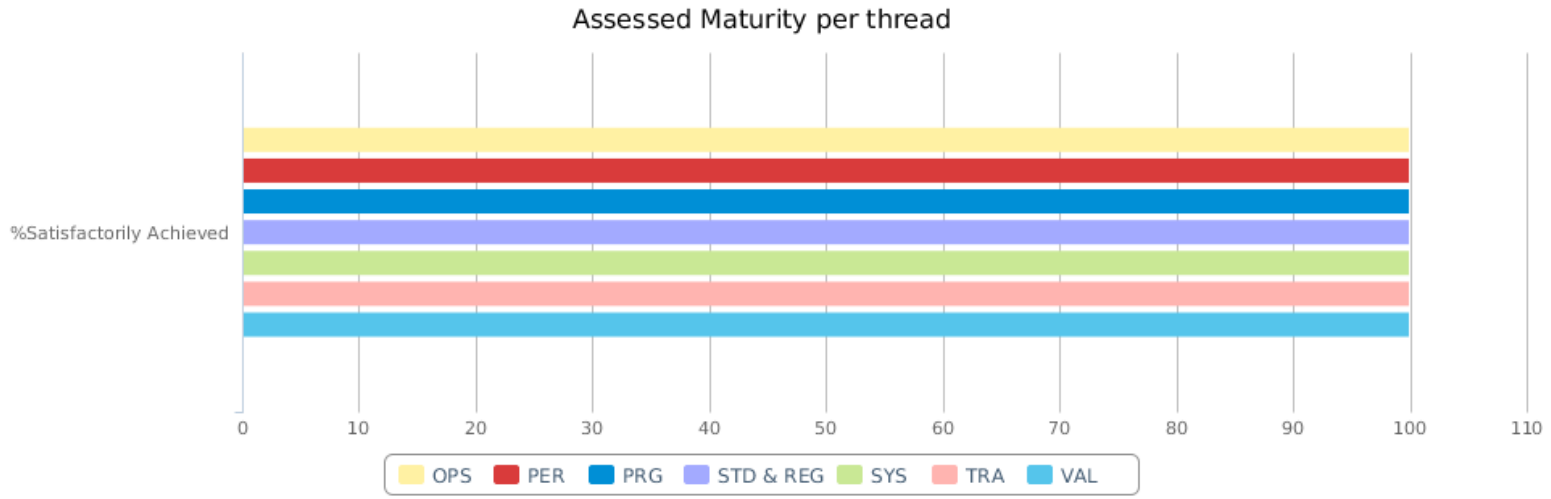

B.1.4 Assessed maturity

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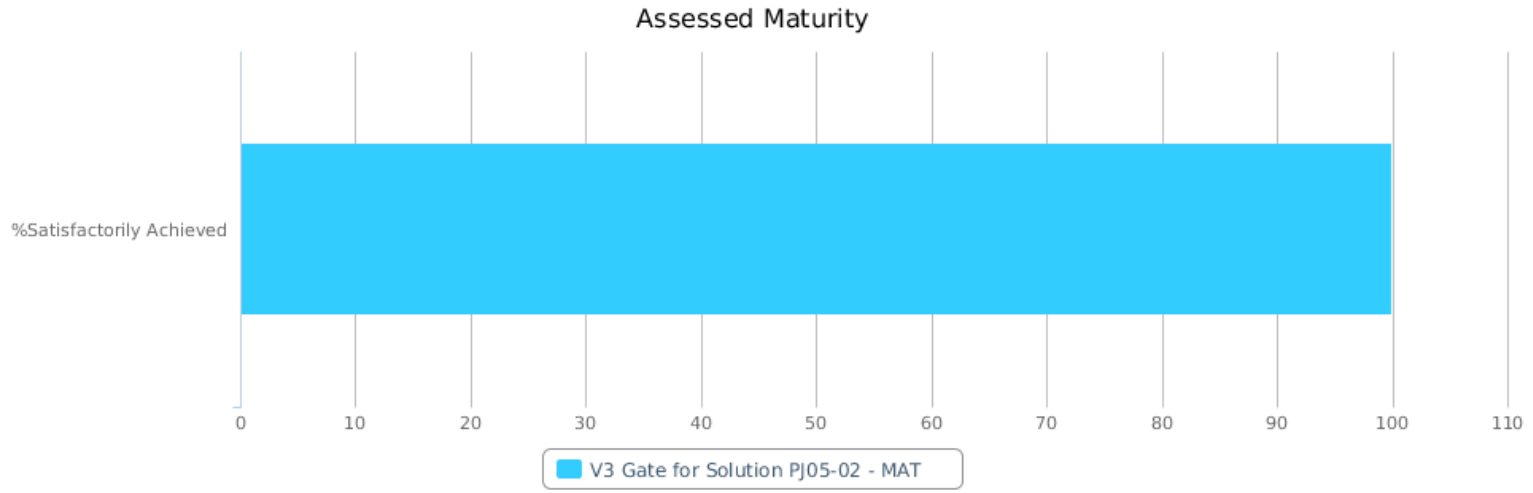


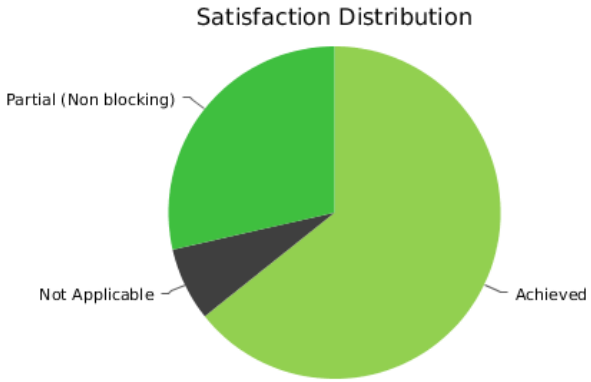
B.2 V2 Gate for Solution PJ05-03 - MAT

B.2.1 Maturity assessment

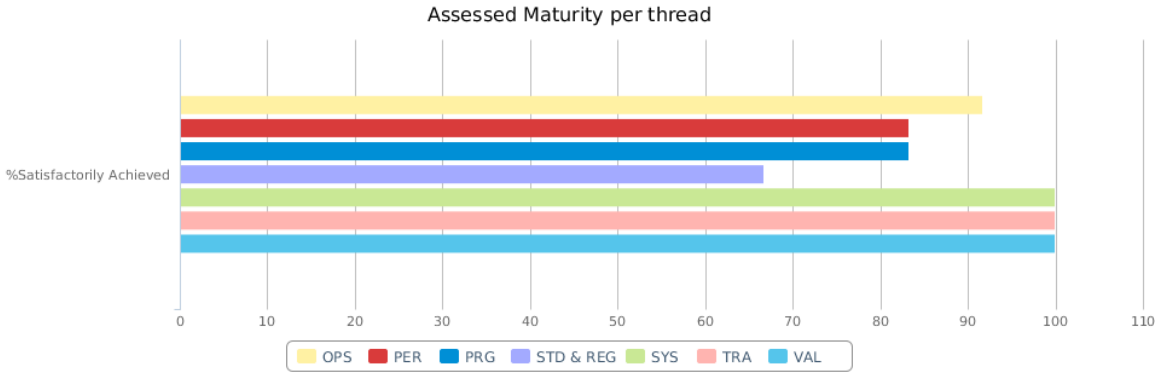
Identification	
Name	**V2 Gate for Solution PJ05-03 - MAT**
Space	**PJ05 Remote Tower**
Maturity gate	**V2 Gate for Solution PJ05-03**

Link to Solution	**PJ.05-03**
V-Level / TRL	**V2**
Assessor	**Rainer Kaufhold**
Date of assessment	**July 2019**
Comments	**-**
Approved by SJU	**No**
Reviewers	
SJU PM	
PJ19	
PJ20	
PJ22	
Airspace User	

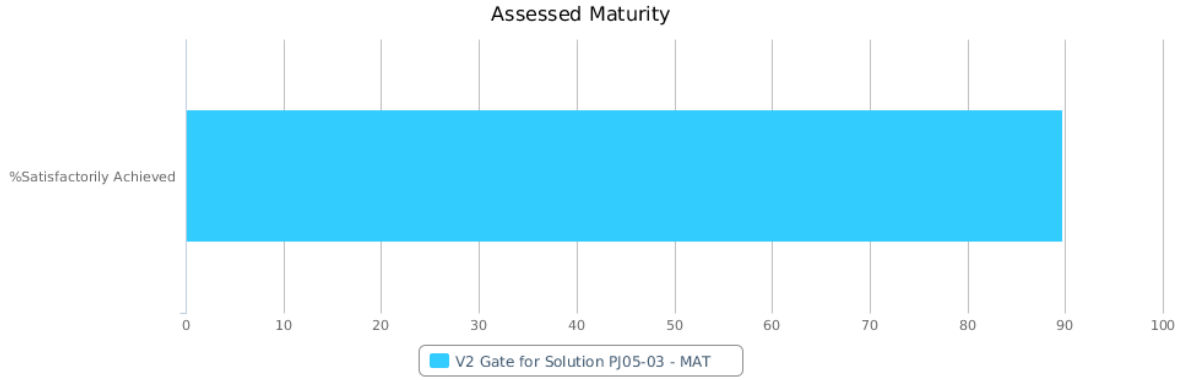
B.2.2 Satisfaction distribution



B.2.3 Assessed maturity per thread



B.2.4 Assessed maturity



Maturity Assessment Criteria

B.3 TRL4 Gate for Solution PJ05-05 – MAT

B.3.1 Maturity assessment

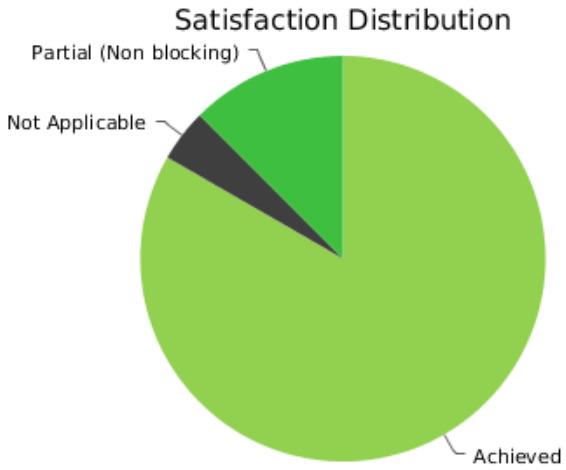
Identification	
Name	TRL4 Gate for Solution PJ05-05 - MAT
Space	PJ05 Remote Tower
Maturity gate	TRL4 Gate for Solution PJ05-05
Link to Solution	PJ.05-05
V-Level / TRL	TRL4
Assessor	Priboj, Ondrej
Date of assessment	16 Oct 19
Comments	-
Approved by SJU	No
Reviewers	
SJU PM	
PJ19	

PJ20	
PJ22	
Airspace User	

B.3.2 Satisfaction distribution

Satisfaction Distribution

Wed, 16 Oct 2019 13:03:21 +0200



B.3.3 Assessed maturity per thread

Assessed Maturity per thread

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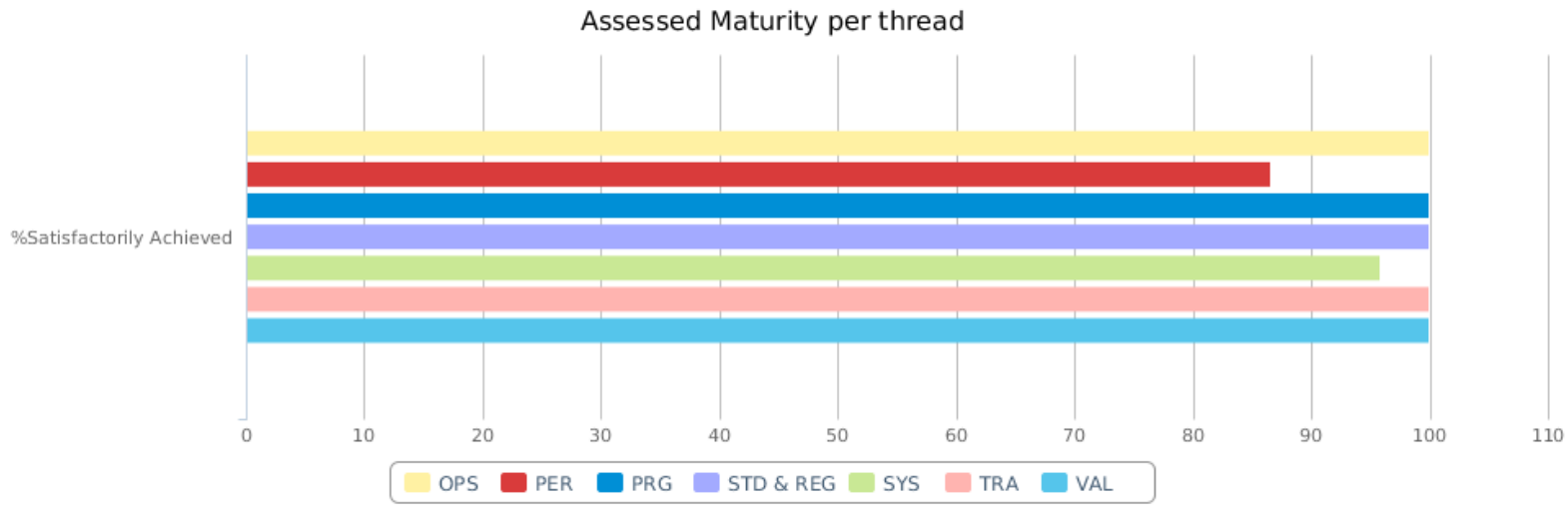

B.3.4 Assessed maturity

Assessed Maturity

Wed, 16 Oct 2019 13:03:21 +0200