Final Project Report

Document information	
Project Title	Remotely Operated Tower Technology Enablers
Project Number	12.04.06
Project Manager	NATMIG
Deliverable Name	Final Project Report
Deliverable ID	D01
Edition	00.01.03
Template Version	03.00.00
Task contributors	
NATMIG, FREQUENTIS, NORACON	

Abstract

P12.04.06 evaluated remote tower technology enablers that would either contribute to the OI-steps or enhance the impact of the remote tower concept on the key performance areas. A series of prototypes were developed in the project and integrated into P12.04.07 and 12.04.08 remote tower platforms for validation by P06.09.03.

The project supported the three remote tower concepts and associated OI-steps of provision of ATS to a single aerodrome, remote tower technology used for contingency and provision of ATS to multiple aerodromes simultaneously.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
███████████████	Saab/NATMIG ██████████ ████████	2015-01-29

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
███████████████	Frequentis ████████	2015-04-07

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
███████████████	LFV/NORACON ██████ ████████	2015-04-30
███████████████	Saab/NATMIG ████████ █████	2015-05-01
███████████████	Saab/NATMIG ██████ ████	2015-01-27

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
███████████████	Saab/NATMIG ████ ████	2015-01-29
███████████████	Saab/NATMIG ████ ████	2015-01-29

Document History

Edition	Date	Status	Author	Justification
00.00.01	07/04/2015	Draft	██████	New Document
00.01.00	11/05/2015	Release	██████	Release issue
00.01.01	22/06/2015	Release	██████	Review updates
00.01.02	11/08/2015	Release	██████	Closure gate updates
00.01.03	29/01/2016	Release	██████	Closure gate updates

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

1 Final Project Report

1.1 Context

The purpose of P12.04.06 was to evaluate remote tower technologies within a total of eight pre-defined technology areas and to produce a series of prototypes to be integrated into P12.04.07 and P12.04.08 remote tower platforms. The reports and descriptions of the prototyped technologies are consolidated in the project technical feasibility report (ref [5]), Network Design report (ref [12]) and Voice and Data Distribution report (ref [7]).

P12.04.07 produced remote tower platforms for provision of ATS to a single aerodrome and multiple simultaneous aerodromes. P12.04.08 produced remote tower platforms for provision of ATS in contingency situations. P06.09.03 validated the platforms and produced the remote tower Operational Services and Environment Description (OSED).

1.2 Contribution to OI-steps and enablers

1.2.1 Deliverables and prototypes

The reports and descriptions of the prototyped technologies are consolidated in the project technical feasibility report [5]. Below is a brief description of the deliverables and the technologies:

Visual Reproduction:

- *Automatic Camera control*: Camera image pre- and post-processing was used to create an automatic algorithm that counteracts the camera shortcomings to create a high-quality, stable and uniform aerodrome panoramic view suitable for provision of ATS.

- *Infrared Vision*: Infrared vision allows the operator to visually observe aircrafts, vehicles, personnel and even wildlife in complete darkness. The technology has the potential to increase flight safety in low visibility scenarios.

- *High-definition cameras and displays*: As a part of the visual reproduction technology area, the project investigated new combinations of high-definition cameras, lenses and displays to provide a higher image resolution.

- *Panoramic view for multiple aerodromes*: The project investigated several possibilities for presenting a single operator with live video images from two or more aerodromes simultaneously.

Target Tracking:

The video image from the camera sensors was used by the project to extract moving objects. The information from all cameras was stitched together to create a 3D-mapping of the aerodrome with bearings to the objects extracted in the view. The information was fused with tracks from radar sources and presented together, heads-up on the panoramic view.

Target Analysis:

Building upon Target Tracking, Target Analysis aims to decrease the number on unwanted tracks in the extraction of moving objects in the video image by analysing characteristics, such as movement patterns, size, shape and colour, to categorize the movement as an aircraft, vehicle, tree, bird etc.

Interaction Technologies:

- *Eye-tracking*: Traditional input devices such as joysticks and computer mice might not be optimal for interaction over a large number of panoramic displays. The project investigated new promising technologies within the area of eye-tracking and tried to adapt the technology for remote tower purposes.

- *Controller working position HMI layout for multiple aerodromes*: The multiple remote tower concepts allow a single controller to provide ATS to multiple aerodromes simultaneously. One

of the main issues within the area of interaction technologies is to define how a controller will interact with multiple aerodromes. P12.04.06 supported P12.04.07 in identifying different options for HMI layouts.

Camera positioning:

The project investigated placement of additional cameras for hot-spot monitoring and gap filling. The image was incorporated in the panoramic view for increased situational awareness.

Technical supervision:

The collection and presentation of health and status of the remote tower system differs from traditional air traffic management systems in the sense that some of the system components reside at the airport and some reside at the remote tower centre. P12.04.06 investigated the options for centralised monitoring that would fit the remote tower concept.

Network Design:

The remote tower concept relies heavily on the actual network performance and properties. The project produced a report with recommendations of Network Design for layer 2 and 3 of the OSI reference model.

Voice and Data Distribution:

The provision of remote tower services requires a lot of information – voice and data – to be transported from the remote airport to the remote tower centre, and vice versa. The project produced a report that describes the available protocols for layer 4-7 of the OSI model to support the remote tower concept.

1.2.2 Contributors

NATMIG consortium member Saab was project manager of P12.04.06. Saab also produced a series of prototypes in the areas of Visual Reproduction, Target Tracking, Target Analysis, Interaction Technologies, Camera Positioning and Technical Supervision that were later integrated into the remote tower platforms in P12.04.07 and P12.04.08.

Frequentis produced a series of more in-depth reports in the areas of Network Design, Voice and Data Distribution, Target Tracking and Analysis, and Interaction Technologies.

NORACON consortium members LFV, EANS and Avinor contributed with operational expertise during the technical feasibility studies, with reviews of reports and with planning and feedback for upcoming prototype development.

1.2.3 Validations

The prototypes were integrated into the remote tower platforms of P12.04.07 and P12.04.08, validated by P06.09.03. The P12.04.06 prototypes were validated as a part of the platforms.

P12.04.07 produced three remote tower platforms for remote provision of ATS to a single aerodrome:

- **VP-056**: Provision of ATC to a single aerodrome.
- **VP-057**: Provision of ATC to a single aerodrome.
- **VP-058**: Provision of AFIS to a single aerodrome.

The platforms consisted of a controller working position with all the ATM systems and other capabilities found in an ordinary control tower. The aerodrome view was shown on a panoramic view of displays and the binoculars in the tower were replaced by a manoeuvrable pan-tilt-zoom camera. P12.04.06 extended the platform with functionalities such as infrared vision, additional camera viewpoints, tracking of moving objects in the video image (fused with radar data and presented on top of the video in the panoramic view).

Figure 1 depicts the platform used for validating remote provision of AFIS to Værøy Heliport from Bodø remote tower centre:

Figure 1 – Image from the platform validated in VP-058 for remote provision of AFIS to Værøy Heliport from Bodø remote tower centre

P12.04.07 also produced three remote tower platforms for remote provision of ATS to multiple aerodromes simultaneously:

- **VP-060**: Simulation of multiple simultaneous aerodromes.

- **VP-061**: Provision of ATC to two simultaneous aerodromes.

- **VP-063**: Provision of AFIS to two simultaneous aerodromes.

The controller working positon provided ATM systems for all aerodromes and the panoramic view incorporated live video image from up to three aerodromes simultaneously.

P12.04.08 produced two platforms validated by P06.09.03 for remote provision of ATC for an aerodrome in contingency situations:

- **VP-059**: Provision of ATS in a contingency situation

- **VP-062**: Provision of ATS in a contingency situation

The setup of the platform was similar to the single remote tower validations, but with more matured functionality. One of the main validation goals was to get an indication of the airport capacity using remote tower technology.

Table 1 shows in which of the P06.09.03 validation exercises the technologies produced by P12.04.06 were included:

Developed prototypes		Projects, concepts and validation exercises							
		P12.04.07						P12.04.08	
		Single			Multiple			Contingency	
Technology Areas	Prototypes	056 ATC	057 ATC	058 AFIS	060 SIM	061 ATC	063 AFIS	059 ATC	062 ATC
Visual Reproduction	Automatic Camera Control	✓	✓	✓		✓	✓		
	Infrared Imaging	✓	✓	✓			✓	✓	✓
	High definition cameras and displays		✓	✓		✓	✓	✓	✓
	Panoramic view for multiple aerodromes				✓	✓	✓		
Target Tracking / Target Analysis	Target Tracking & Analysis[1]	✓	✓	✓	✓	✓	✓	✓	✓
Interaction Technologies	Eye-tracking[2]								
	Multiple Remote Tower working position HMI layout				✓	✓	✓		
Camera Positioning	Camera Positioning		✓					✓	✓
Technical Supervision	Technical Supervision[3]	✓							

Table 1 – validated technologies

P12.04.06 was closed prior to P12.04.07 and P12.04.08 as the development of remote tower platforms is completed and the last P06.09.03 validation exercise has been conducted. The findings in the validations are used as input for requirements and recommendations in the remote tower technical specifications (ref [14]). The finalization of the remote tower technical specifications is carried out by P12.04.07 and P12.04.08, using the validation results together with the P12.04.06 reports (ref [5][7][12]) describing the technologies in more detail.

---

[1] Target Tracking and Target Analysis were actually different tasks with separate deliverables, but in practise they built upon each other and are for purposes of this report counted as a single prototype.
[2] Eye-tracking never reached prototype stage. More elaboration on the reasons can be found in chapter 1.3.4.
[3] The technical supervision prototype was discontinued after the first validation. More elaboration on the reasons can be found in chapter 1.3.4.

1.2.4 OI-steps

The main purpose of the prototypes has been to either enable one or more of the OI-steps (ref [19]) to be achieved, or to enhance the key performance area impact of the remote tower concept. The project and its prototypes contributed to the OI-steps listed below:

- **SDM-0201**: Remotely provided air traffic service for a single aerodrome. The OI-step has been developed to a V3 maturity level [9].

- **SDM-0204**: Remotely provided air traffic service in contingency situations at aerodromes. The maturity of this OI-step has not yet been concluded. However, a V3 maturity level is suggested in the preliminary validation report [10].

- **SDM-0205**: Remotely provided air traffic service for multiple aerodromes. The maturity of this OI-step has not yet been concluded. However, a V3 maturity level has is suggested in the preliminary validation report [11].

1.2.5 Enablers

The contribution by P12.04.06 to the OI-steps was achieved through contribution to enablers. The bullets below provide a short description of each of the enablers contributed to by P12.04.06:

- **AERODROME-ATC-51**: Provide a remote tower controller working position that in a contingency situation hosts the operator - no longer be located at the local Tower.

- **AERODROME -ATC-52**: Provide a remote tower controller working position with visual reproduction of both the remote aerodrome view and other sensor data.

- **AERODROME -ATC-53**: Provide a remote tower controller working position enhanced with additional sensors and information for low visibility conditions.

- **AERODROME -ATC-54**: Provide a remote tower controller working position that enables a single operator to provide ATS to multiple aerodromes simultaneously, or in sequence.

Below is an overview of how the different technology areas targeted the enablers:

The prototypes within the area of Visual Reproduction include image enhancements, infrared technologies for increased visibility in darkness and visual reproduction of multiple aerodromes in one controller working position. These prototypes addressed the AERODROME-ATC-51, 52, 53 and 54 enablers.

The prototypes within the area of Target Tracking presented surveillance data and tracking data extracted from the aerodrome video cameras heads-up in the aerodrome view for increased situational awareness. These prototypes addressed the AERODROME-ATC-52 and 54 enablers.

The research and prototyping within the area of Interaction Technologies included input devices (such as eye-tracking). These prototypes addressed the AERODROME-ATC-51 and 54 enablers.

1.3 Project achievements

1.3.1 Results

The main achievement of P12.04.06 is to have contributed to the single remote tower concept being proven feasible in SESAR [9]. P12.04.06 has also contributed to the contingency and multiple remote tower concepts. They are not yet concluded, but preliminary reports indicate that they are also feasible [10][16].

During the course of the project, technologies within eight technology areas were evaluated (please refer to **Error! Reference source not found.**). A series of prototypes within these technology areas w ere developed and evolved in maturity during re-iterations of R&D. The prototypes were integrated into P12.04.07 and P12.04.08 remote tower platforms and validated in a total of eight remote tower validations [9][10][11]. Table 1 shows the relation between the prototypes and the validation exercises in which they were validated, totalling at 34 validation instances. The validations answered important R&D questions, summarized in chapter 1.3.2 of this report.

A technical feasibility study report (ref [5]) was released by the project, containing descriptions of all the validated technologies that were developed by the project, and the conclusions and recommendations for each technology.

The project also produced more in-depth stand-alone reports on remote tower Network Design (ref [12]) and Voice & Data Distribution (ref [7]).

All prototypes reached a maturity[4] of V3 with the exceptions of the Technical Supervision prototype, which reached a V2 maturity, and the eye-tracking prototype (within the Interaction Technologies area), which reached a V1 maturity.

1.3.2 R&D questions answered

Through the integration of the technologies into P12.04.07 and P12.04.08 platforms, and through the validation of the platforms in P06.09.03, this project contributed to findings connected to the technologies that serve as input both inside and outside SESAR. Listed below are some of the questions answered through P12.04.06 contribution:

- P12.04.06 contributed to the visual reproduction of the remote tower, introducing (among other things) for the first time high-definition LCD displays and high definition cameras for the remote tower panoramic view, as opposed to the projected image used previously. The contribution to the visual reproduction helped to answer a series of R&D questions [9][10][16]:
  - o The displays were found to be superior in terms of the crispness and resolution and were also validated in standard office environments. Unlike the projected image, which required dimmed lights, it was found to not cause strain in the eyes.
  - o Different camera image resolutions were tested (between ~32 to ~42 pixels per degree) and from the validation results it is possible to conclude that the recommended resolution for provision of ATS is in the proximity of 40-42 pixels per degree.
  - o Different vertical coverages was tested (between ~20 to ~45 degrees total vertical coverage) and while the requirement is aerodrome dependent and dependent on the placement of the camera mast, the validations still gave important indications of the required vertical coverage for certain traffic patterns.
  - o Different frame rates was tested (16, 20, 24, 30 frames per second) and the validations made important findings on the general perception of the image in different settings, and on the perception/detection of acceleration and retardation of moving objects. From the test in can be concluded that a frame rate of approximately 24-30 frames per second is recommended for provision of ATS.

- Long-wave infrared imaging can be used in complete darkness to verify the positioning of aircrafts, vehicles and personnel on the manoeuvring area, to detect wildlife on the ground as well as in the air. It was also found to be useful in weather observation during darkness [9].

- Target tracking and analysis increases the situational awareness of the operator by displaying frequently accessed surveillance information heads-up in the panoramic view. Preliminary results also indicate that the effect is even larger when providing ATS to multiple aerodromes simultaneously, possible even becoming a future requirement for provision of ATS to more than one aerodrome [16].

- Alternative camera placements does not only have the potential to offer more superior views of airfield hotspots but can also provide a much better view in low visibility scenarios, such as fog or darkness, thanks to the reduced distance between the camera sensor and point of interest [9][10][16].

- Camera image pre- and post-processing (in terms of contrast adjustments and contrast alignments) is required (and sufficient) to counteract shortcomings in camera technology in order to produce an image quality required for the provision of ATS [9][10][16].

---

[4] The maturity levels targeted by SESAR are defined in the E-OCVM (ref [17]).

1.3.3 Contribution to ATM performance targets

The main contribution of the remote tower concept is to the cost effectiveness Key Performance Area (KPA) [6]. The productivity of the operator is a major input to the cost effectiveness. The remote tower concept increases the operator productivity by allowing a single operator to provide ATS to more than one aerodrome either simultaneously or by switching between them on demand. In addition, the concept enables increased cost effectiveness through knock-on effects such as more efficient staffing and training through centralization of personnel [8].

P12.04.06 contributed to the overall concept of remote tower with enablers in the areas of visual reproduction and interaction technologies, aiming at producing an aerodrome view of sufficient quality for provision of ATS and ways of interacting with the system that reduces the operator work load and increases the productivity. The network design and voice and data distribution reports are also important input for the future enabling of the concept, taking bandwidth constraints and quality of service into consideration.

Technologies within the areas of target tracking, camera positioning and infrared technologies all aimed at increasing the operator productivity by providing an increased situational awareness. Target tracking provides a heads-up information source used by the operator to form a quick awareness of the traffic situation. Infrared technologies allow the operator to visually observe the aerodrome in darkness, to quickly verify the position of aircrafts, vehicles and personnel, and to perform runway checks without sending airport personnel. Camera positioning gives the operator the optimal visual surveillance capabilities for decision making and collision avoidance, providing views of the airfield hot-spots at closer range, better angles and from areas distant or blocked from the panorama viewpoint.

P12.04.06 also contributed directly and indirectly to the KPA of safety. By integrating infrared technology into the remote tower platform we allow the operator to form safe decisions with more visual confirmation in darkness than previously available [16]. In addition to confirming the position of objects in the aerodrome, the infrared image allows the operator to get visual confirmation on weather data, such as storm fronts. For similar reasons, the additional viewpoints provided by the camera positioning will provide the operator with additional visual confirmation of events on the manoeuvring area and thereby contribute to safe decision making [16].

The indirect contribution to safety is achieved through a reduction of head-down time. The validations indicated the target tracking increased the operator situational awareness without moving the attention away from the aerodrome view [9][10][16]. The technology also opens up for future safety-nets such as runway incursion warnings and trespassing on the manoeuvring area etc.

For more information on additional impacts on the KPAs specific to each technology, please refer to ref [5].

1.3.4 Evolvement of scope

P12.04.06, as a project, was constructed to be flexible due to fact that the remote tower concept was fairly uncharted territory at the start of the project and it was hard to foresee the progress between validations. The project was heavily dependent on the outcome of the technical feasibility studies conducted in the project (where expert panels judged and made recommendations for potential technologies evaluated for research and development), and on the validation reports produced by P06.09.03. The following was the major deviations from the initial scope:

- Technical supervision was the only technology which required non-operational personnel to validate. Also, a remote tower implementation project running in parallel with SESAR implemented the same concept for technical supervision[5]. Due to these factors, a re-iteration of the technical supervision for validation purposes was no longer requested by P12.04.07 [15][14].

- Eye-tracking is a fairly new technology that uses cameras to track the movement of the human eye to determine where the user is looking. The consumer products were evaluated

---

[5] Operational implementation of remote tower in Sundsvall and Örnsköldsvik, Sweden, acquired by LFV in 2011.

by P12.04.06 but found to be inapplicable to a panoramic view -which was a base requirement for remote tower applications. The R&D versions were too expensive to evaluate further in the project, they were not intended for the consumer market, and possibly (for the time being) too expensive considering that cost effectiveness is the main key performance area of the remote tower concept. The technology was therefore not taken to a prototype level and was discontinued in P12.04.06.

- Among the advanced features in the second remote tower validation (VP-057), target tracking was the most well received and the results strongly indicated that the technology had a positive effect on the operators' situational awareness, and among the comments were indications that the tool made the operators more confident in the remote tower system [9]. However, most of the validations also indicated a need to increase the reliability of the target tracking functionality, reducing the number of unwanted tracks and unexpected behaviour. More effort than originally expected was therefore allocated towards improvement of the tracking functionality to fully investigate its impact on the ability to provide ATS.

1.4 Key Deliverables

The key deliverables to prove the concepts of remote ATS provision, provision to multiple aerodromes and the use of remote tower technology for contingency purposes, are the prototypes delivered to P12.04.07 and P12.04.08 and validated by P06.09.03.

The Technical Feasibility Report (D15, ref [5]) describes all the technologies developed by P12.04.06. For the technologies that were prototyped, the report also includes a brief description of their progression and a summarizing extract of the validation results concerning each prototype.

The prototypes were also complemented by more in-depth reports on some of the remote tower topics. While some of these have been consolidated into D15 (such as the Target Tracking and Analysis), the Network Design and Voice and Data Distribution report (D14 and D18 respectively, ref [7] and ref [12]) are covered in stand-alone reports.

1.5 Contribution to the development of standards

1.5.1 Contribution within SESAR

P12.04.06 has contributed to the production of functional requirements in the P06.09.03 OSED through participation in a series of P06.09.03 workshops. The requirements are later broken down in the remote tower technical specifications produced by P12.04.07 and P12.04.08. As an input for the technical specifications, P12.04.06 has also, in close coordination with those projects, contributed to the creation of technical requirements specific to the prototypes developed in P12.04.06.

The technical feasibility study produced in P12.04.06 contributes to the remote tower specifications. It provides more detailed descriptions of specific topics within the area of remote tower that can be incorporated into, paraphrased or referenced to in the technical specifications.

1.5.2 Contribution to EUROCAE

The project has (together with WP06.09.03 and WP12.04.07) verified and validated a series of parameters concerning the aerodrome panoramic view captured by video cameras (listed in chapter 1.3.2). The output of the verifications and validations have indicated important threshold values for these parameters as well as documented potential negative effects on the ability to provide ATS as an effect of too low values. This output has been used as input by EUROCAE WG-100 (Remote & Virtual Tower) in its work to produce a Minimum Aviation System Performance Specification (MASPS) for Remote and Virtual Towers Visual Surveillance Systems [4].

1.6 Recommendations

The validation reports produced by P06.09.03 (ref [9][10][11]) provide detailed recommendations for further development and deployment. The recommendations regarding the technical enablers are summarized here.

No conclusive indications were given regarding which of the features developed by P12.04.06, P12.04.07 and P12.04.08 should be required in a base configuration of a remote tower platform, and which should be considered recommended or optional. However, the validation results do indicate that the technical enablers in general had a positive impact on human performance, level of service, safety and the overall ability of the ATCO/AFISO to perform the necessary tasks [11].

The list of technologies covered by P12.04.06 is not exhaustive and we can recommend further research and development in the area of remote tower. Particularly technologies associated with the features unique to the remote tower, such as the panoramic view and the pan-tilt-zoom camera. Validations indicated that technologies that created more heads-up time helped the operators to gain situational awareness, especially when providing ATS to multiple aerodromes.

Large scale remote tower operation was not covered by P12.04.06. A remote tower centre providing ATS to a large number of airports, with a flexible and dynamic allocation of airports connected to different remote tower modules will have a major impact on the cost reduction of the remote tower concept. There will be a need for technology enablers in the area of effective planning tools in both short term and long term all managed by a supervisor role, as described in the OSED (ref [8]).

The remote tower technology enablers have been validated on small- and medium-sized airports. There might be a need to adapt some of the technologies to meet the capacity needs at bigger airports.

We recommend that the remote tower technology enablers are not only considered in remote tower operations, but for traditional operations in the tower as well. The validation results indicate that some of the technologies (infrared image being one good example) increases the situational awareness and safety beyond traditional operations. There might be other remote tower technologies that are equally suited for traditional control towers, with or without adaptation.

The target tracking was among one of the most well received technical enablers, especially when providing ATS to multiple aerodromes simultaneously and in low visibility. Tracking had a positive impact the situational awareness by providing the operators with the traffic situation heads-up in the panoramic view. We can recommend that target tracking is further investigated in the following areas:

- The ability to use the tracking data as input to create safety-nets, such as detection of runway incursion and trespassing onto the manoeuvring area.

- The possibility to utilize the information in separation of aircrafts. How can the data from the camera sensors and/or data from other surveillance sources be used for separation in the panoramic view, and what requirements would apply?

- Air traffic control is a new ground for this previously established technology. Since the aerodrome environment is relatively static and many of the scenarios in air traffic control are predictable, it is reasonable to believe that the general tracking functionality can be further improved and adapted to fit the need of the controllers.

P12.04.06 did not reach an expected V3 maturity for the application of eye-tracking technology used as an input device for the remote tower panoramic view. We still believe that eye-tracking have a potential edge over traditional input devices in terms of ease of use and ability to complete tasks in a timely fashion. The available eye-tracking products and research and development platforms were limited at the time of evaluation in P12.04.06, but as they become more mature and more cost efficient we recommend that their applicability to the remote tower concept is further investigated.

For future research and development we also recommend technology enablers for a large scale remote tower solution. A remote Tower Centre providing remote tower services to a large number of airports, with a flexible and dynamic allocation of airports connected to different remote tower modules over time will have a major impact on the cost reduction of the remote tower concept. There will be a need for effective planning tools in both short term and long term all managed by a supervisor role, as described in the OSED (ref [8]). This could also include a remote tower centre to remote tower centre coupling, transferring responsibility of an aerodrome between centres.

The next step for the remote tower technologies developed by P12.04.06 is the Large Scale Demonstrations of the remote tower concept, carried out in Sweden, Ireland and Germany during 2015 and 2016 [18].

2   References

[1] [SESAR Programme Management Plan, Edition 03.00.01](#)

[2] [European ATM Master Plan, Edition 2](#)

[3] Multilateral Framework Agreement ("MFA") signed between the SJU, EUROCONTROL and its 15 selected members on August 11, 2009, amended on 14 June 2010, 19 October 2010 and 2 July 2012

[4] EUROCAE, Initial TERMS OF REFERENCE – REFERENCE N°TOR WG-(100/RevN°0), 2014-04-02.

[5] P12.04.06, technical Feasibility Report, D15, edition 02.01.00, 2015-04-24.

[6] European Commission, http://ec.europa.eu/research/transport/projects/items/art_en.htm, 2012-02-20

[7] P12.04.06 Voice and Data Distribution, D18, edition 01.02.00, 201-06-08

[8] P06.09.03, OSED, D98, edition 00.05.03, 2015-01-02

[9] P06.09.03, Remotely Provided Air Traffic Services for Single Aerodrome VALR, D08, edition 00.05.02, 2014-05-01

[10] P06.09.03, Contingency TWR trial 1 & 2 VALR, D12, edition 00.02.01, 2015-04-27

[11] P06.09.03, Remotely Provided Air Traffic Services for Two Low Density Aerodromes VALR, D13, edition 00.03.00, 2015-04-15

[12] P12.04.06 Network Design V3, D14, edition 01.02.00, 2015-06-05

[13] http://saabgroup.com/Media/news-press/news/2015-04/sweden-first-in-the-world-with-remotely-operated-air-traffic-management/, 2015-06-17

[14] P12.04.07 and P12.04.08, consolidated remote tower technical specifications, D06, 2014-11-12

[15] P12.0.06, Change request 1816, 2014-04-02

[16] P06.09.03, Remotely Provided Air Traffic Services for Multiple Aerodromes Validation Report, D11, edition 00.02.02, 2015-02-26

[17] E-OCVM (European Operational Concept Validation Methodology), Version 3.0, Volume I, February 2010, EUROCONTROL

[18] http://www.sesarju.eu/newsroom/programme-highlights/launch-large-scale-demos, 2015-08-11

[19] SESAR project B.01, Integrated Roadmap Dataset, DS14, 2015-06-30

-END OF DOCUMENT-