Demonstration Report

Document information	
Project Title	Remote Towers
Project Number	LSD 02.04
Project Manager	Irish Aviation Authority
Deliverable Name	Remote Towers Demonstration Report
Edition	00.02.00
Template version	01.00.00
Task contributors	
IAA, SAAB, daa, Stobart Air.	

Abstract

This document contains the report of LSD 02.04 which consisted of fifty live trial exercises involving the of the provision of ATS (Air Movements Control and Surface Movements Control) for Cork and Shannon airports from a Remote Tower Centre at Dublin ATS Unit. Various scenarios were selected to reflect representative IFR and VFR traffic at Cork and Shannon airports during low movement rates building incrementally to 'in sequence' and 'simultaneous' aircraft operations. Demonstration results focused on human performance, safety, capacity and cost efficiency in order to provide proof of concept for Remote Tower services provision for multiple airports (OFA06.03.01).

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
[redacted]/IAA	[redacted]	05/09/2016
[redacted]/IAA		05/09/2016

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
[redacted]/IAA	[redacted]	06/09/2016
[redacted]/IAA		26/09/2016
[redacted]/IAA		26/09/2016
[redacted]/IAA		26/09/2016
[redacted]/IAA		26/09/2016
[redacted]/daa		14/10/2016
[redacted] Stobart Air		20/10/2016

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
[redacted]	[redacted]	19/10/2016

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
[redacted]/IAA	[redacted]	29/09/2016

Rejected By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
None	N/A	N/A

Rational for rejection
None.

Document History

Edition	Date	Status	Author	Justification
00.0.01	06/09/2016	First Draft	[redacted]	Version for review by project personnel
00.00.02	13/09/2016	Updated following review		Version following project personnel comments
00.01.00	29/09/2016	Further updates		Version for submission to SJU
00.02.00	24/10/2016	Final Edition		Updated following SJU comments on Ed 00.01.00

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Executive summary

The Remote Towers project (LSD.02.04), sponsored by the ATM Operations and Strategy Division of the Irish Aviation Authority (IAA) and the SESAR JU, involved the provision of aerodrome control service (air movements control and surface movements control) including alerting service for Cork and Shannon airports from a Remote Tower Centre (RTC) at Dublin Air Traffic Services Unit which is located in excess of 100 nautical miles from both Cork and Shannon airports. Cork airport is a H24 international airport facilitating the domestic and European market with aircraft up to medium weight category such as Boeing 737 and Airbus 320. Total movements in 2013 were 42,000. Shannon is a H24 international airport serving the domestic, European and American markets with 24,000 movements in 2013. Cork and Shannon airports have Control Zones with Class 'C' airspace, full radar service and connectivity to the en-route network. Neither airport has surface movements radar.

The remote tower ATS were provided 'in sequence' and 'simultaneously' for both airports during periods of low traffic density. Out the Window visualisation supported by radar, electronic flight strips and the existing data and communications network provided the necessary environment for the provision of ATS. The project was supported by a safety case which was accepted by the NSA for Ireland. Fifty live trial exercises involving up 500 aircraft were conducted between June and September 2016 building incrementally from single airport remote ATS to 'in sequence' and 'simultaneous' provision of ATS at Cork and Shannon airports from the RTC at Dublin.

A consortium was established to ensure all aspects of relevant aviation activity was represented in the project. The IAA ANSP as sponsor and project coordinator is the ANS provider for Dublin, Cork and Shannon airports; the Dublin Airport Authority (DAA) as the airport operator for Cork Airport and Stobart Air, an international commuter airline. The Shannon Airport Authority (SAA) was involved as a stakeholder.

A Demonstration Plan was prepared to describe how the live trial exercises would be organised, conducted, supervised, and assessed focused on safety, capacity, cost efficiency and human performance. A summary of the main conclusions and recommendations is as follows:

Safety: The live trial exercises demonstrated that the ATS provided by the RTC for a single airport and two medium airports by a single Controller with 'in sequence' and 'simultaneous' aircraft operation was at least as safe as the ATS provided by the Local Towers at Cork and Shannon aerodromes. There was no ATS safety occurrence report nor did any operational safety issue arise during the conduct of the fifty live trial exercises. The project considers this objective was achieved.

Capacity: The live trial exercises demonstrated that Aerodrome Control Service could be provided by the RTC for Cork and Shannon in single airport or multiple airport modes by one Controller 'in sequence' during periods of low aircraft movements. Aerodrome Control service for 'Simultaneous' aircraft operation was possible during these periods but spacing would be required when the arrival/departure times at the two airports coincided.

Cost efficiency: The Demonstration provided confirmation that a multiple remote tower solution provided the potential for more cost effective deployment of human resources during periods of low aircraft movements, particularly when combined with other initiatives such as the centralisation of Approach Control Service and for contingency purposes.

Human performance: MRTO (Multiple Remote Tower Operation) is the future for safety and capacity of air traffic control at small/medium airports. However, there was a trend of increasing mental demand, physical demand, temporal demand, effort and frustration on multiple remote tower operations compared to local tower operations across all the trials based on NASA-TLX. There is a requirement to address the issue of Controllers' perceived workload for performing multiple remote tower operations either by training, staffing, designing new standard operating procedures or interface design, as workload can negatively affect a Controller's performance and increase the potential for error.

The validation of Human-Computer Interaction for multiple remote tower operations based on Controllers' visual parameters reveals that they estimate distance of aircraft and maintain situation awareness in multiple remote tower operations while tracking fast moving targets on the screens of

the Out The Window (OTW) view and radar display. Further development of the OTW view could contribute to a reduced Controller workload.

1 Introduction

1.1 Purpose of the document

This document provides the Demonstration Report for the SESAR sponsored Remote Towers Project, LSD 02.04 – Operational Focus Area (OFA) 06.03.01. which was conducted by the ANSP of the Irish Aviation Authority during summer 2016. It describes how fifty live trial demonstrations were organised by providing a description of the context of the demonstrations, the project management employed, the overall approach to the live trial exercises and the implementation of solutions. It also contains the results, conclusions and recommendations arising from LSD 02.04 which was conducted in accordance with the Demonstration Plan Edition 00.03.00. Second Review, dated 28/04/2016 [Ref1].

1.2 Intended readership

The following entities comprise the target audience which would be expected to have an interest in reading this Demonstration Report:

The LSD 02.04 Consortium (IAA, daa, Stobart air)

Airport Operators in Ireland and internationally as they may be interested in deploying a remote tower solution at their airports in the future;

Airspace Users as the customers of both the airport operators and the ANS providers will be interested in safety and efficiency of aircraft operations;

The Department of Transport, Tourism and Sport of the Irish Government as the entity responsible for deciding aviation policy in Ireland and other aviation policy making bodies in Europe and beyond;

Air Navigation Services Providers who may be considering the remote tower solution for single and/or multiple airports;

Other LSD remote tower projects such as RACOON and RTO;

National Supervisory Authorities and Competent Authorities which conduct supervision of changes to ATM systems and the introduction of new systems;

EASA Rulemaking to support further development of requirements for remote tower operations;

SESAR P06.09.03; Remote and Virtual TWR;

SESAR P12.04.06; Remotely Operated TWR for Multiple Controlled Airports;

SESAR P12.04.08; Remotely Operated Tower Technology for Contingency;

SESAR 2020 PJ05; Remote Towers for Multiple Airports;

SESAR 2020 PJ29; Remote Tower Control;

EUROCAE to support the development of standards/specifications for remote tower operations.

EUROCONTROL for all aspects of remote tower operations and in particular human factors and human performance;

The Social Partners/Representative Associations as entities involved in and affected by the deployment of remote tower operations.

1.3 Structure of the document

This Demonstration report begins with an authoring and approval page, table of contents and executive summary. Thereafter it is divided into eight sections with subsections as appropriate to elaborate on constituent parts of the section title:

1. **Introduction** stating the purpose and scope of the document;

2. **Context of Demonstrations** describes the purpose and scope of the live trial demonstration;
3. **Project Management describes** the how LSD 02.04 was managed in accordance with the Demonstration Plan and changes that were necessary in the light of experience gained;
4. **Execution of Demonstration Exercises** summarises exercise preparation, environment and methodology for measurement of metrics and indicators;
5. **Exercise Results** provides a summary of results compared to the success criteria as described in the Demonstration Plan;
6. **Demonstration Exercises Reports** outlines the results of each exercise or batch of exercises as the case may be;
7. **Summary of the Communication Activities** describes the Demonstration's communications activities/achievements/plans;
8. **Next Steps** describes the intentions of the project sponsor with regard to deployment of the remote towers solution;
9. **References** contain a list of documents which may be referenced in this Demonstration Report;
10. **Annex 1** LSD 02 04 IAA Remote Tower Trial Exercise Results contains a detailed description of each exercise;
11. **Annex 2** LSD 02 04 IAA Remote Tower Human Performance Report contains a report on the human performance/factors aspects of LSD 02.04;
12. **Annex 3** LSD 02 04 IAA Remote Tower System Operational Evaluation contains a report on the operational aspects of the remote towers systems.

1.4 Glossary of terms

Aerodrome Control Service is the air traffic control (ATC) service provided by the Air Traffic Control Officer (ATCO) at and in the vicinity of an aerodrome.

Air Movements Control (AMC) is the air traffic control service provided to aircraft in the vicinity of an aerodrome and to aircraft, vehicles and personnel on the runway in use.

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

Approach Control Service is the air traffic control service provided to arriving and departing traffic before and after control has been transferred by Aerodrome Control. In certain cases, approach control service may be combined with aerodrome control service.

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

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

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

Remote Tower Module (RTM) is the term for the complete module including both the CWP(s) and the Visual Reproduction display screens. The RTM enables the remote tower operator to maintain a view over the aerodrome including the manoeuvring area and surfaces as stipulated in applicable

regulations or agreed procedures. The RTM may be used to provide an ATS to single or multiple aerodromes or during contingency.

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

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

Surface Movement Control (SMC) is the air traffic control service provided to aircraft, vehicles and personnel on the manoeuvring area of an aerodrome excluding the runway in use. In certain cases, the SMC controller may provide an advisory service to aircraft on the aerodrome apron.

1.5 Acronyms and Terminology

Term	Definition
AMC	Air Movements Control
APP	Approach Control
ATM	Air Traffic Management
daa	Dublin Airport Authority
DOD	Detailed Operational Description
E-ATMS	European Air Traffic Management System
EFS	Electronic Flight Strip System
E-OCVM	European Operational Concept Validation Methodology
FAT	Factory Acceptance Test
FIS	Flight Information Service
FTO	Flight Training Operations
GAT	General Air Traffic
HMI	Human Machine Interface
IAA	Irish Aviation Authority
IFR	Instrument Flight Rules
LSD	Large Scale Demonstration
LVP	Low Visibility Procedures
MASO	Multiple Airport Simultaneous Operations
MET	Meteorological Services

Term	Definition
NSA	National Supervisory Authority
OFA	Operational Focus Areas
OSED	Operational Services and Environment Description
OTW	Out The Window
PTT	Push To Talk button
PTZ Camera	Pan Tilt Zoom Camera
RACOON	Remote Airport Concept of Operation
RCT	Remote Contingency Tower
RDP display	Radar Data Processing display (the radar screen in the RTC)
RFFS	Rescue and Firefighting Services
RTC	Remote Tower Centre
RTM	Remote Tower Module
RTO	Remote Tower Operations
RVP	Reduced Visibility Procedures
RWY	Runway
SAA	Shannon Airport Authority
SAR	Search and Rescue
SAT	Site Acceptance Test
SESAR	Single European Sky ATM Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SMC	Surface Movement Control

2 Context of the Demonstrations

This Large Scale Demonstration involved the provision of aerodrome control service (air movements control and surface movements control) and flight information service for Cork and Shannon airports from a Remote Tower Centre (RTC) located at Dublin Air Traffic Services Unit. LSD 02.04 was co-sponsored by the SESARJU and is known as LSD 02.04. The Remote Tower equipment supplier was SAAB.

It is important in the context of the demonstrations to define what is meant by 'in sequence' and 'simultaneous' arrivals and departures when providing ATS to multiple airports from an RTC. The following definitions applied in the case of LSD 02.04.

In sequence: Where the spacing between two aircraft arriving or departing at Cork and Shannon airports is equal to or more than that which would be required if the two aircraft were landing or departing at the same airport.

Simultaneous: Where the spacing between two aircraft arriving or departing at Cork and Shannon airports is less than that which would be required if the two aircraft were landing or departing at the same airport.

2.1 Scope of the demonstration and complementarity with the SESAR Programme

The remote tower services were provided in sequence or simultaneously for both Cork and Shannon airports during periods of low traffic density building on the SESAR solution package for remote tower for a single airport and multiple airports. Out the window visualisation supported by radar and electronic strip technology and the existing data and communications network (enhanced as necessary) provided the necessary environment for the provision of ATS remotely and without degradation. Regulatory approval for the conduct of the demonstration was achieved by submission of a safety case which was accepted by Ireland's NSA. The standard four-part safety case approach was used and full account was taken of SESAR publications related to remote towers Project 6.9.3.

Fifty live trial demonstration exercises were conducted between 27th June and 8th September involving up to 500 aircraft flying under IFR and VFR (commercial air transport, general aviation and flight training organisation (FTO) flights) building incrementally to the provision of aerodrome control service to 'in sequence' and 'simultaneous' arrivals and departures at Cork and Shannon airports. The services provided by the RTC were shadowed by the local Towers.

The concept of operation (Con-Ops) for the conduct of the live trials was provision of ATS as described above from the RTC in Dublin with the local towers at Cork and Shannon shadowing with an immediate intervention capability. The RTC contained two panoramic OTW displays (each with two CWPs) and two airports could be displayed on one 14 screen display with a number of screens assigned to each airport depending on the operational scenario to be trialled. Therefore, one ATCO could provide services for both Cork and Shannon using one OTW display. An Electronic Strip System and a feed from the radar system was provided to the ATCO.

The Demonstration Plan [Ref 1] describes how the 50 live trial exercises were divided into three batches (5,15,30) and how the trials built from extremely low traffic to increased traffic in an iterative and progressive manner with a comprehensive review of each live trial exercise before proceeding to the next. The Demonstration Plan also specified the success criteria for each live trial exercise.

The objective of the first batch of five exercises was to familiarise operational and technical ATS with the procedures to be used and the environment in which they were operating. These exercises introduced Surface Movements Control (SMC) at each airport from an early stage moving incrementally to the inclusion of Air Movements Control (AMC) with naturally occurring or managed spacing (in sequence) between arrivals and/or departures. Normal airport activity reflected all aspects of vehicular movements on the manoeuvring area.

The second batch of fifteen exercises included both SMC and AMC with incrementally increasing movements mixing arrivals and departures at both Cork and Shannon airports. Flexibility in the timing

of exercises was applied to maximise the variability of scenarios to be used with regard to runway in use, type of approach (instrument or visual). During this phase the simultaneous scenario (Cork and Shannon) was introduced with low traffic movements.

A further 30 exercises were conducted building on the experience gained from previous exercises and increased traffic as appropriate in the sequenced and simultaneous scenarios.

This report will contribute to the objectives for in sequence and simultaneous remote provision of ATS for multiple aerodromes as outlined in the Operational Improvement Step (OIS) SDM-0205 linked to SESAR Work Package (WP) 06.09.03 of the EU ATM Master Plan. This activity falls under SESAR Operational Step 3 (ATM Service Level 4), the timeline for which is outlined in Fig 2.1 below.

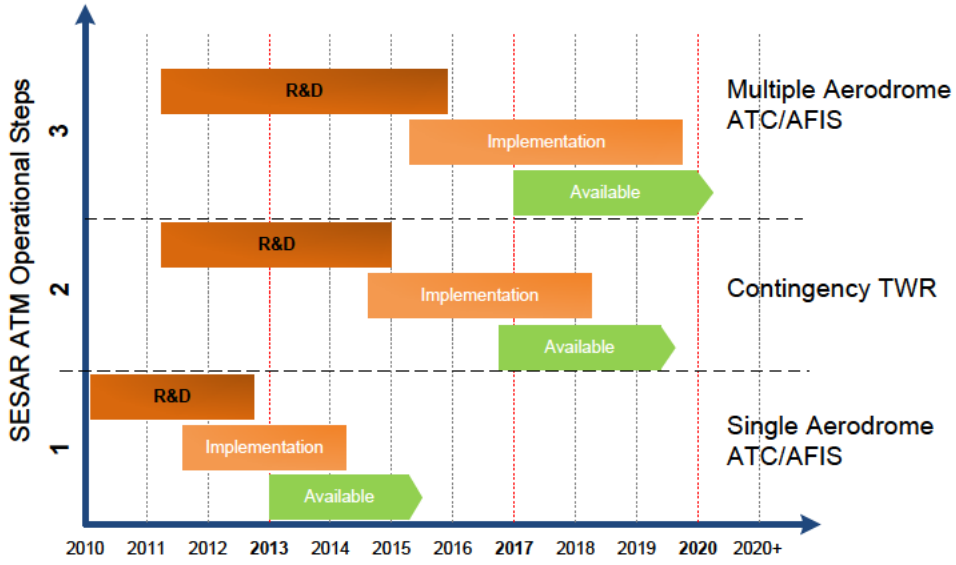

Figure 2.1 – SESAR ATM Operational Step Timeline

The results of LSD 02.04 are expected to contribute to SDM-0201-Single Remote Tower, SDM-0205-Multiple Remote Towers, solution PJ.05-02 of SDM-0207 (Remotely Provided Air Traffic Service for Multiple Aerodromes as referenced in SESAR 2020 multi-annual work programme), SDM-0204-Contingency and Project 12.4.7- Remotely Operated Tower for Multiple Controlled Airports and the SESAR Solution #52 Remotely Provided Air Traffic Services for Two Low Density Aerodromes (OI SDM 02.05) under OFA 06.03.01.

The following tables are extracted from the Demonstration Plan and formed the basis for the planning of the exercises. Section 4.3 'Deviations from the Demonstration Plan' outlines where the project deviated from the exercises as initially proposed below.

Demonstration Exercise ID and Title	**EXE-02.04-D-001 to EXE-02.04-D-005**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning
High-level description of the Concept of Operations	For these 5 exercises only the SMC will be handled by the Remote Tower. The AMC will continue to be provided by the Cork & Shannon Towers.

Applicable Operational Context	• Cork & Shannon airport • Mainly SMC (Surface Movements OPS) • General Vehicle activity around the airfield • General Aircraft Movement around the ground areas normally controlled by the SMC • Emergency Vehicle Airfield OPS
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 5 live trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

Demonstration Exercise ID and Title	**EXE-02.04-D-006 to EXE-02.04-D-010**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning
High-level description of the Concept of Operations	These 5 exercises will introduce aircraft in the air at one airport controlled by AMC at the RTC. In addition, the SMC for both airports will also be handled by the Remote Tower. The AMC will be provided by the RTC for one airport only and the other AMC will remain with the other airport. The SMC will control the surface traffic at both airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) controlled by RTC • Aircraft controlled by AMC at the RTC for a single airport

Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on capacity or traffic that can be handled in this mode.
Number of flight trials	At least 5 live trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

Demonstration Exercise ID and Title	**EXE-02.04-D-011 to EXE-02.04-D-015**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning • Initial measurements for "In Sequence" Operations
High-level description of the Concept of Operations	These 5 exercises will introduce aircraft in the air controlled by AMC at the RTC for the two airports. The AMC will be provided by the RTC for both airports. The SMC will control the ground traffic at both airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic i.e. <3 aircraft for both airports.
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on capacity or traffic that can be handled in this mode.

Number of flight trials	At least 5 trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

Demonstration Exercise ID and Title	**EXE-02.04-D-016 to EXE-02.04-D-020**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning • Measurements for "In Sequence" Operations continue. • Initial measurements for "Simultaneous" Operations
High-level description of the Concept of Operations	These 5 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic i.e. <3 aircraft for both airports. • Perform initial analysis on other influencing factors such as Daylight & poor weather conditions.
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on capacity or traffic that can be handled in this mode.
Number of flight trials	At least 5 trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09

OFA addressed	OFA 06.03.01

Demonstration Exercise ID and Title	**EXE-02.04-D-021 to EXE-02.04-D-030**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • Measurements for "In Sequence" Operations continue. • Measurements for "Simultaneous" Operations continues • The main objective will be to explore the influencing factors on the limits of simultaneous operations.
High-level description of the Concept of Operations	These 10 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic. • Perform initial analysis on other influencing factors such as daylight & poor weather conditions. • Simultaneous Operations consisting of Arrivals followed by Departures and also Departures followed by Departures or Arrivals.
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on capacity or traffic that can be handled in this mode.
Number of flight trials	At least 10 trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

Demonstration Exercise ID and Title	EXE-02.04-D-031 to EXE-02.04-D-040
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • Measurements for "In Sequence" Operations continue. • Measurements for "Simultaneous" Operations continue. • The main objective will be to continue to explore the minimum required spacing between two arrivals.
High-level description of the Concept of Operations	These 10 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic. • Perform continued analysis on other influencing factors such as Daylight & poor weather conditions. • Simultaneous Operations consisting of Arrivals to both airports.
Expected results per KPA	**Safety**: No degradation in Safety levels. **Human Performance**: No negative impact on Controller workload. **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs. **Capacity**: No negative impact on capacity or traffic that can be handled in this mode.
Number of flight trials	At least 10 trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

Demonstration Exercise ID and Title	EXE-02.04-D-041 to EXE-02.04-D-050
Leading organization	Irish Aviation Authority

Demonstration exercise objectives	The High level objective is to verify: • That Tower ATC Operations of both AMC and SMC can be controlled by a Single ATCO from an RTC. When required it can be supplemented by assigning a dedicated SMC at the RTC.
High-level description of the Concept of Operations	These 10 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports by a single ATCO. The exercises will be standard Operations for both Towers (light traffic) controlled by the RTC.
Applicable Operational Context	• Cork & Shannon airport. • All SMC (Surface Movements OPS). • All Aircraft controlled by AMC at the RTC for both airports with the workload limitation closely monitored. • Perform continued analysis on other influencing factors such as Daylight & poor weather conditions.
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on capacity or traffic that can be handled in this mode.
Number of flight trials	At least 10 trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

Table 1: Exercises overview

3 Programme management

The Remote Towers LSD 02.04 was conducted in accordance with the Demonstration Plan [Ref1] with the following variations.

The Demonstration Plan indicated that after exercise eleven, Cork and Shannon combined SMC would be provided from one CWP on an RTM and Cork and Shannon combined AMC from the other CWP on the same RTM. It became clear that this combination was not feasible during moderately busy aircraft movements due to the excessive SMC-AMC co-ordination that was required and was therefore not continued in succeeding exercises. Consequently, for the scenarios to be trialled in this group of exercises, priority was given to combined AMC with the local towers retaining control of SMC.

The Demonstration Plan specified what personnel should be present in the RTC during the live trial exercises and provided for an IAA ATM Operations Support Group representative and an ATM Operations Lead Role. The project team considered that these roles could be combined in circumstances where it was reasonable and practical to do so. This variation was accepted by the Regulator by means of an amendment to the safety case.

3.1 Organisation

The LSD 02.04 Organisational Structure is represented in fig 3.1 hereunder.

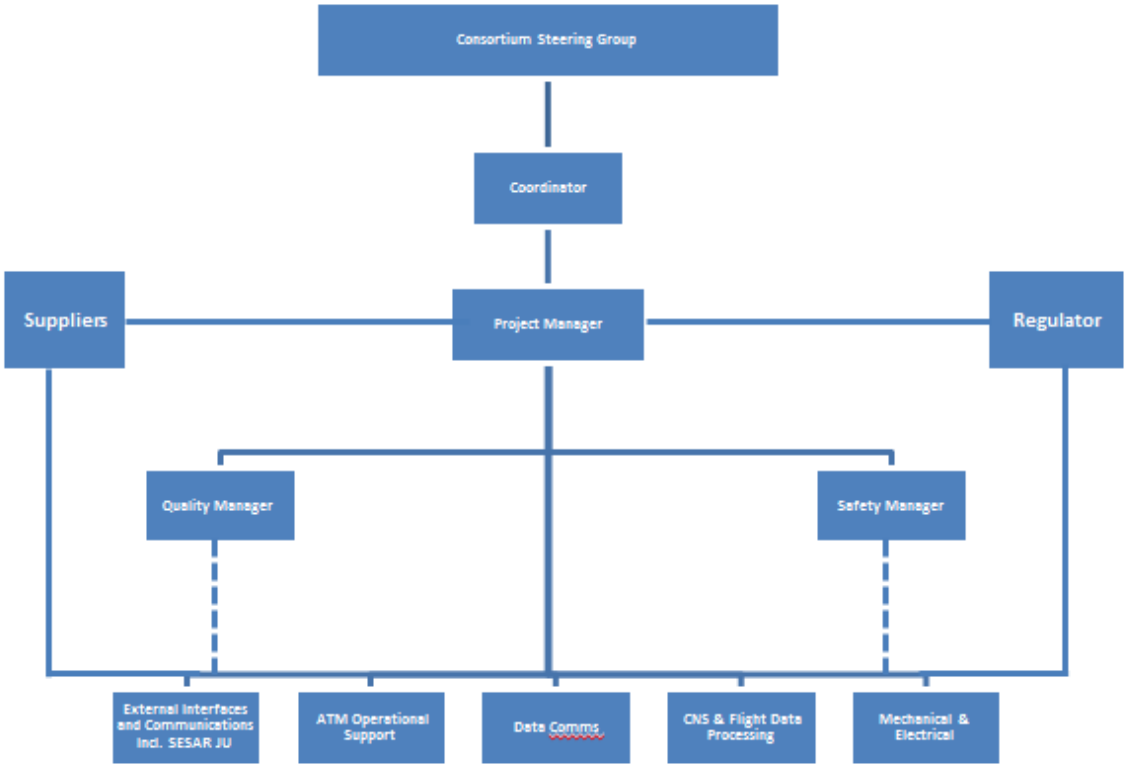

Figure 3.1 – Project work and Organisational breakdown structure

Other stakeholders are identified as the entities involved in the provision of ATS and airport operations at Cork and Shannon airports, SAAB the suppliers of the Remote Tower equipment and electronic strip system, aircraft operators of all categories which avail of the services provided, the IAA's Safety Regulation Division as the competent authority and NSA for the safety regulation of civil

aviation in Ireland, social partners and representative associations, SESARJU and ICAO via EUROCAE.

3.2 Work Breakdown Structure

A Work Breakdown Structure is provided within Appendix A.

3.3 Deliverables

Deliverable name	Date
Demonstration Report	30/09/2016
Final Cost Statement	30/09/2016

3.4 Risk Management

As described in the Demonstration Plan, the project risk management process was used to assist early detection of a problem issue that may have impacted the project as well as describing and tracking a process for the mitigation of the identified risk. This section describes the project approach for dealing with all recognised risks that have a certain probability and impact to the project.

This table has been updated with a post-trial opinion on the risks identified at the beginning of the project. All project risks were closely controlled and were closed with no adverse impact on the project.

Risk Id	Risk description	Probability assessment (Low/Medium/ High/Very high)	Severity Assessment (Low/Medium/ High/Very high)	Mitigation actions	Opinion on the Risk status post-trial completion
RSK-02-04-001	A RTC Live Trial Safety Case will be produced for the Irish Regulator to approve in advance of the trial. The risk is that the approval is not given in due time or not at all for the live trials to commence.	Low	Very High	Project Safety Plan to be commenced immediately Project Safety Plan to be presented early to the IAA internal Safety teams Project Safety Plan to be presented early to the NSA	To list this Risk as a "Very High" impact in advance was correct. The IAA could not have performed any trial without NSA approval. The mitigations that the IAA put in place worked very well and NSA approval was achieved in advance and the trials were completed.
RSK-02-04-002	The equipment required to be installed at the Local Tower (Cameras etc) and also the equipment required at the	Medium	Very High	The Call for tender for the systems has been issued All of the potential suppliers have	To list this Risk as a Medium likelihood in the timeframe that was available to the project team was correct but with regular meetings with the supplier and regular project

	RTC (screens etc) is not ready in due time or not at all for the live trials to commence.			already performed a site visit All of the potential suppliers have been made aware of the timescales 28/04/2016: Risk Status Closed because the equipment will be ready.	Coordination meetings the equipment was ready on time.
RSK-02-04-003	The GND-GND communications and the GND-AIR communications that is required for the trial to commence) is not ready in due time for the live trials to commence.	Low	Very High	The IAA Communications team have already commenced project planning and task identification 28/04/2016: Risk Status Closed because the equipment will be ready.	To list this Risk as a Low likelihood in the timeframe that was available to the project team was probably not correct because there was a significant amount of work was required to ensure the Comms worked correctly. However, regular meetings with the Comms team and regular project Coordination meetings ensured the Comms equipment was ready on time.
RSK-02-04-004	The EFS Flight Data system is not ready in due time for the live trials to commence.	Medium	Medium	The Call for tender for the systems has been issued All of the potential suppliers have already performed a site visit All of the potential suppliers have been made aware of the timescales 28/04/2016: Risk Status Closed because the	To list this Risk as a Medium likelihood in the timeframe that was available to the project team was correct but regular meetings with our supplier and regular project Coordination meetings ensured the equipment was ready on time.

				equipment will be ready.	
RSK-02-04-005	Difficulty in having the correct traffic flow into Cork and Shannon in order to demonstrate the exercise requirements	Low	High	We have commenced high level discussions on how we plan to run the exercises to ensure that when the traffic presents itself in the correct configuration that the Live trial team will be ready to take the opportunity to perform the exercise. 28/04/2016 The status of this Risk is still Open however we believe that can will find the correct scenarios.	This was one of the more challenging aspects of the trial. However, by using the Eurocontrol CHMI the project team was in a position to target the periods when the traffic would most likely allow Remote Tower Operations. The project team became more experienced as the trials progressed and managed to complete the trials while never exceeding the capacity of what a Controller in the RTC could safely manage.
RSK-02-04-006	The Project Plan is not understood by all project staff.	Low	Medium	Following the creation of this Demonstration Plan the Project team will provide information to the wider project team 28/04/2016 Risk status Closed. A dedicated project team has been working on the project. The dual Rate ATCOs have been identified and are currently working on RTM procedures. The dual Rate ATCOS will be	The project team was relatively small and were all project team members were fully involved in the lead up to the trial commencement and therefore this Risk did not materialise.

				released from Operational Roster to the project for the duration of the trials.	
RSK-02-04-007	Project changes are handled informally	Low	Medium	The Change Control process is contained in the project sponsor's procedures and will be applied. 28/04/2016 Risk status Closed. The project team are very familiar with IAA system change control processes.	Project changes were kept to an absolute minimum and changes were accommodated only where absolutely necessary. Consequently no issues arose it this area.
RSK-02-04-008	Project members are assigned to new tasks.	Low	High	The project team will have senior management approval for the prioritisation of the project including assignment of required resources. 28/04/2016 Risk status Closed. A dedicated project team has been working on the project. The dual Rate ATCOs have been identified and are currently working on RTM procedures. The dual Rate ATCOS will be released from Operational Roster to the	At no stage during the project were the core project team staff assigned to another project to the detriment of the Remote Tower project.

				project for the duration of the trials.	
RSK-02-04-009	Supplier equipment does not interface with existing technology	Low	High	The compatibility of supplier equipment with existing and/or enhanced infrastructure will be addressed in the supplier tender process. Interface Control Documents shall be issued. This risk shall be monitored carefully during the installation phase. 28/04/2016 The system supplier has had no issues connecting to existing IAA systems.	The system supplier accommodated the interface with existing IAA equipment as required and consequently no issues arose.
RSK-02-04-010	Performance measures are difficult to quantify	Low	Medium	Performance measures will be documented in a manner which is clear and concise.	As can be seen in this document the Conclusions reached demonstrate the quality of the trials conducted.
RSK-02-04-011	Timelines for project milestones are not maintained	Low	High	A detailed project schedule will be produced. The project will be managed and implemented by experienced staff with a proven track record in 'on time' project delivery.	Close project team cooperation with the system supplier resulted in the trials commencing just 2 weeks after the time which was planned 12 months previously. The trials were completed within the planned timeframe. For a project of its size this was a significant achievement.
RSK-02-	Human and/or budgetary	Low	High	The Project Manager has	At no stage during the project were the core

04-012	resources are not properly controlled.			extensive experience in human resources management and budget management. 28/04/2016 Risk status Closed. A dedicated project team has been working on the project. The dual Rate ATCOs have been identified and are currently working on RTM procedures. The dual Rate ATCOS will be released from Operational Roster to the project for the duration of the trials.	project team staff assigned to another project to the detriment of the Remote Tower project and no budgetary impediments arose.

4 Execution of Demonstration Exercises

4.1 Exercises Preparation

4.1.1 Description of the Systems

4.1.1.1 Description of the Visual Systems

Shannon & Cork Remote Tower Sites:

Shannon and Cork Airports have the SAAB Remote Tower POD Installed.

The Shannon Cameras are located between the existing ATC Tower and the Runway and are at a Camera height of 20.615m. The viewing angle is similar to the local Shannon Tower but it is not as high as the local tower.

The Cork Cameras are located behind the existing ATC Tower slightly further away from the runway than the local Tower. The Camera height is 26.615m and provides for the same viewing aspect as the local Tower. The height of the camera mast exceeds that of the local Cork Tower.

Cork Camera Installation

The Remote Tower Centre is equipped with two opposite facing Remote Tower Modules comprising of 15 screens in each (14 active & 1 spare). Each of the modules is equipped with the SAAB EFS & radar data display which is used only as a distance to touchdown indicator and not to provide a radar service. Each of the modules accommodates two Controller positions i.e. SMC & AMC.

The picture below shows Module “A” with Shannon on the left (10 screens) and Cork in CAT11 conditions on the right (4 screens).

Camera System	The out the window (OTW) visualisation is made up of 14+1 full HD LED displays in a 220 degree configuration. 14 displays are normally used to present the images from the 14 cameras, while the last display is a stand-by unit in the event of equipment failure. The displays match the camera resolution of 1920x1080 pixels, and have a refresh rate of at least 60Hz. The displays are mounted in portrait mode to match the portrait-mounted cameras.
PTZ Camera	The PTZ camera function provides the capability to mimic regular binoculars. PTZ cameras are controlled from RTC and include features for: · On/off selection; · Up to 30 times zoom (optical); · 90 degrees up and 80 degrees down tilt; · Panning 360 degrees; · Selecting pre-defined positions; · Selecting pre-defined sweeps.
IR (Infra-Red) Camera	The IR camera enables the ATCO to see objects during darkness or low visibility. 14 IR cameras are placed in an array on the roof of the camera housing. The cameras cover 360 degrees.
FDP (Flight data processing) System	The Flight Data Processing (FDP) includes the display of messages accessed by a pull down display on top of the visualisation display. SIGMETS;NOTAMS; TAFS;MET Reports; Flight Plan info.
EFS (Electronic Flight Strip) System	Each ATCO position is equipped with an EFS system which is divided into two parts; one for Shannon and one for Cork.
OTW Map Overlays	The overlays can be used to outline the runway(s), taxiways, buildings or other terrain features;

	Runway ends and taxiways can be marked with ID to facilitate the ATCO in a multiple airport exercise scenario; The airport name as well as cardinal directions can also be marked out.
RDP (Radar Data Processing)	Each ATCO position contains one screen for display presentation which can be divided into two parts, one for Shannon and one for Cork.
Airport Sound	This function refers to the capture and reproduction of the aerodrome's background sounds at the CWP. It is aimed at further improving the ATCO's situational awareness by combining visual presentation and local ambient sound.
Moving Object Target Tracking	The visual target tracking feature enabled the automatic visual tracking of moving objects such as movements on the manoeuvring area and in the air, with an aim of improving situational awareness.
Radar Target Tracking	The radar target tracking presents information from the radar display as an overlay in the visual presentation, linked with the visual tracking if available. This enables the aircraft to be tracked with a label attached providing radar information including call sign and altitude.
Signal Light Gun	The signal light gun is co-locater with the PTZ and is capable of producing the appropriate visual signals.

4.1.1.2 Description of the Communication Systems

Due to the fact that the operation of the Remote Tower Centre was for a trial period only and at all times during the trial the Local Tower was fully staffed with ATC staff ready to re-assume control, it was decided to reduce the complexity and data line costs to provide a single non redundant video data line and a connection to the A channel radios only for voice communications. Obviously stand-alone operations, fully redundant systems and data lines would be an absolute requirement.

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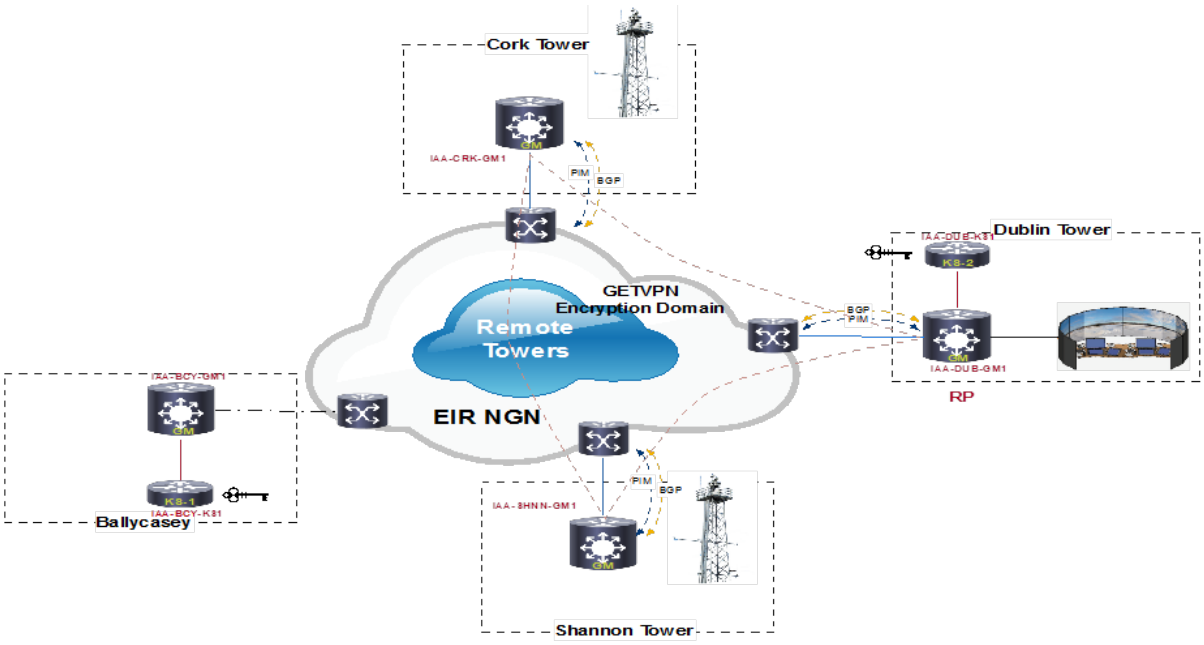
4.1.1.3 Video Data Communications:

For the Video Data Communications link the project used secure L3 IP private MPLS connections from a trusted Telecom provider network. Each link from the Remote Tower site has a dedicated 250MB IP link with real-time CoS (Class of service). Due to the sensitivity of information exchanged between IAA sites, all traffic must be protected by IPsec which is a framework of open standards that provides data confidentiality, data integrity and data authentication between participating peers at the IP layer. Data protection is based on next generation encryption algorithms using VRF (Virtual Routing and Forwarding) and KeyShare architecture. Encryption is implemented end to end on IAA owned and housed equipment. NGE offers the best standards that one can implement today to meet the security and scalability requirements for years to come and to interoperate with the cryptography likely be deployed in the future.



4.1.1.4 Voice Communications:

Each of the four CWPs in the Remote Tower Centre was equipped with a Schmid VCCS communications panel which was used for both GND<>AIR and GND<>GND communications. Each of the four units was configured with the necessary Shannon & Cork frequencies as well as Shannon and Cork intercom direct dial buttons. This configuration of the communications system enabled the project team to be flexible during the trial in relation to which function was performed from which position.

4.1.2 Description of the Training

A training needs analysis was conducted for the three Cork and Shannon rated controllers involved in the live trial exercises and in accordance with the guidance material contained in EU Regulation 340/2015 an individual training plan was developed for each. Training was conducted and completed prior to the commencement of LSD 02.04.

4.1.3 Description of the Procedure development

In advance of LSD 02.04 a review of the Cork and Shannon ATS procedures was conducted to identify any incompatibility with the application of the procedures in the RTC systems and equipment environment. Procedures were then developed as Temporary Work Instructions (TWI) to provide for

any incompatibilities identified between Local Tower and Remote Tower operations. In the event six TWIs were produced. There was no amendment required to the application in the RTC of the ATS procedures in force at the local towers with one exception whereby, during the conduct of the live trial exercises it was decided to develop a specific procedure for helicopters arriving at Shannon from the south. This was to compensate for the inability to clearly identify on the OTW view the precise helicopter set down location.

4.1.4 Description of the Safety Case development

The Safety Case for LSD 02.04 followed the standard four-part safety case approach beginning with the production of a Safety Plan (using the SESAR template) outlining the safety case activities to be conducted for the entire Remote Tower System (people, procedures, equipment), the specific deliverables applicable thereto and the timescale for their submission to the NSA.

This was followed by the production of a functional hazard analysis which formed the basis for the setting of safety objectives and requirements for the system. A preliminary system safety assessment document was then developed leading to a final system safety assessment. Each deliverable was submitted to the NSA as it reached maturity. A hazard log was also developed which remained open for the duration of LSD 02.04 so that any previously unidentified hazards could be recorded and mitigated appropriately. Following exchanges via an NSA Comments Response Document and meetings with the Project, the NSA issued its acceptance of the safety case signifying approval to proceed with the first fifteen exercises as outlined in the Demonstration Plan. The project provided a report to the NSA on progress after ten exercises and having reviewed this report and an updated safety case the NSA issued acceptance to proceed with exercises 16 to 30. A further update to the safety case as exercise 15 approached led to NSA acceptance to proceed with exercises 31 to 50. This arrangement was in line with the Demonstration Plan which provided for concurrent signoff of safety deliverables at key milestones thereby causing no delay to the demonstration schedule.

4.2 Exercises Execution

The following table details the actual exercise schedule as conducted. As detailed below in section 4.2.1, at the start of each day there were a number of tasks to be conducted prior to performing one of the exercises. On occasion due to weather or traffic complexity at one of the Local Towers it was not possible for the RTC to take control. However, as can be seen below the project team, on occasion, completed and debriefed four exercises in one day.

Exercise ID	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date	Actual Exercise start analysis date	Actual Exercise end date
EXE-02.04-D-001	N/A	28/06/2016	28/06/2016	28/06/2016	20/09/2016
EXE-02.04-D-002	N/A	29/06/2016	29/06/2016	29/06/2016	20/09/2016
EXE-02.04-D-003	N/A	29/06/2016	29/06/2016	29/06/2016	20/09/2016
EXE-02.04-D-004	N/A	29/06/2016	29/06/2016	29/06/2016	20/09/2016
EXE-02.04-D-005	N/A	30/06/2016	30/06/2016	30/06/2016	20/09/2016
EXE-02.04-D-006	N/A	01/07/2016	01/07/2016	01/07/2016	20/09/2016
EXE-02.04-D-007	N/A	03/08/2016	03/08/2016	03/08/2016	20/09/2016
EXE-02.04-D-008	N/A	04/08/2016	04/08/2016	04/08/2016	20/09/2016
EXE-02.04-D-009	N/A	04/08/2016	04/08/2016	04/08/2016	20/09/2016
EXE-02.04-D-010	N/A	05/08/2016	05/08/2016	05/08/2016	20/09/2016
EXE-02.04-D-011	N/A	10/08/2016	10/08/2016	10/08/2016	20/09/2016

Exercise ID	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date	Actual Exercise start analysis date	Actual Exercise end date
EXE-02.04-D-012	N/A	10/08/2016	10/08/2016	10/08/2016	20/09/2016
EXE-02.04-D-013	N/A	10/08/2016	10/08/2016	10/08/2016	20/09/2016
EXE-02.04-D-014	N/A	11/08/2016	11/08/2016	11/08/2016	20/09/2016
EXE-02.04-D-015	N/A	11/08/2016	11/08/2016	11/08/2016	20/09/2016
EXE-02.04-D-016	N/A	12/08/2016	12/08/2016	12/08/2016	20/09/2016
EXE-02.04-D-017	N/A	15/08/2016	15/08/2016	15/08/2016	20/09/2016
EXE-02.04-D-018	N/A	16/08/2016	16/08/2016	16/08/2016	20/09/2016
EXE-02.04-D-019	N/A	16/08/2016	16/08/2016	16/08/2016	20/09/2016
EXE-02.04-D-020	N/A	17/08/2016	17/08/2016	17/08/2016	20/09/2016
EXE-02.04-D-021	N/A	17/08/2016	17/08/2016	17/08/2016	20/09/2016
EXE-02.04-D-022	N/A	18/08/2016	18/08/2016	18/08/2016	20/09/2016
EXE-02.04-D-023	N/A	18/08/2016	18/08/2016	18/08/2016	20/09/2016
EXE-02.04-D-024	N/A	18/08/2016	18/08/2016	18/08/2016	20/09/2016
EXE-02.04-D-025	N/A	18/08/2016	18/08/2016	18/08/2016	20/09/2016
EXE-02.04-D-026	N/A	22.08.2016	22.08.2016	22.08.2016	20/09/2016
EXE-02.04-D-027	N/A	23.08.2016	23.08.2016	23.08.2016	20/09/2016
EXE-02.04-D-028	N/A	29.08.2016	29.08.2016	29.08.2016	20/09/2016
EXE-02.04-D-029	N/A	29.08.2016	29.08.2016	29.08.2016	20/09/2016
EXE-02.04-D-030	N/A	30/08/2016	30/08/2016	30/08/2016	20/09/2016
EXE-02.04-D-031	N/A	30/08/2016	30/08/2016	30/08/2016	20/09/2016
EXE-02.04-D-032	N/A	30/08/2016	30/08/2016	30/08/2016	20/09/2016
EXE-02.04-D-033	N/A	31/08/2016	31/08/2016	31/08/2016	20/09/2016
EXE-02.04-D-034	N/A	31/08/2016	31/08/2016	31/08/2016	20/09/2016
EXE-02.04-D-035	N/A	31/08/2016	31/08/2016	31/08/2016	20/09/2016
EXE-02.04-D-036	N/A	01/09/2016	01/09/2016	01/09/2016	20/09/2016
EXE-02.04-D-037	N/A	01/09/2016	01/09/2016	01/09/2016	20/09/2016
EXE-02.04-D-038	N/A	05/09/2016	05/09/2016	05/09/2016	20/09/2016
EXE-02.04-D-039	N/A	05/09/2016	05/09/2016	05/09/2016	20/09/2016
EXE-02.04-D-040	N/A	05/09/2016	05/09/2016	05/09/2016	20/09/2016
EXE-02.04-D-041	N/A	05/09/2016	05/09/2016	05/09/2016	20/09/2016
EXE-02.04-D-042	N/A	06/09/2016	06/09/2016	06/09/2016	20/09/2016
EXE-02.04-D-043	N/A	06/09/2016	06/09/2016	06/09/2016	20/09/2016
EXE-02.04-D-044	N/A	07/09/2016	07/09/2016	07/09/2016	20/09/2016
EXE-02.04-D-045	N/A	07/09/2016	07/09/2016	07/09/2016	20/09/2016
EXE-02.04-D-046	N/A	07/09/2016	07/09/2016	07/09/2016	20/09/2016
EXE-02.04-D-047	N/A	08/09/2016	08/09/2016	08/09/2016	20/09/2016
EXE-02.04-D-048	N/A	08/09/2016	08/09/2016	08/09/2016	20/09/2016
EXE-02.04-D-049	N/A	08/09/2016	08/09/2016	08/09/2016	20/09/2016
EXE-02.04-D-050	N/A	08/09/2016	08/09/2016	08/09/2016	20/09/2016

Table 2: Exercises execution/analysis dates

4.2.1 Exercise daily execution

Each day the project team assembled and performed the following tasks:

- Systems check both from a Technical and Operational point of view;
- Coordination with the Local Towers for briefing on the planned activities and obtain initial feedback on any local issues that could impact the planned exercises;
- Analysis of the scheduled traffic into both airports using the EUROCONTROL CHMI tool.
- Analysis of any weather issues that may impact the planned exercises;
- Decide on the targeted times for the RTC to take control depending on the predicted sequence of traffic and the objectives for the upcoming exercise(s).

4.3 Deviations from the planned activities

In the Demonstration plan it was stated from exercise 11 onwards the AMC & SMC would be controlled from the RTC.

After the initial exercises it was concluded:

- all four roles could only be worked by a single Controller late in the evening when the workload was light;
- it was not practical for one Controller to Control the two AMC Positions while another RTC Controller Controlled the two SMC positions. This would have led to a significant amount of cross Coordination i.e. the RTC SNN AMC Controller would have to brief the RTC SNN SMC Controller on relevant information while at the same time also briefing on RTC CRK SMC relevant information;
- a more efficient arrangement for future RTC operations with two Controllers would be for each to provide AMC & SMC for a single airport thus eliminating any need for cross over coordination between the two RTC Controllers.

Given that this was a large scale demonstration of remotely provided air traffic service for multiple aerodromes the project team decided to leave the SMC in the Local Tower and assume control of two AMC positions in a single RTC position for the majority of the exercises.

This enabled us to trial the optimum number of aircraft that an AMC could manage in the ‘in sequence’ and ‘simultaneous’ scenarios without the additional workload of SMC.

5 Exercises Results

5.1 Summary of Exercises Results

5.1.1 Analysis of Objective/Success criterion for Batch 1 - Exercise 1 to Exercise 5

General Objectives which will be examined in part					
	OBJ-0204-001	To demonstrate the state of readiness of the remote tower concept for industrialisation and subsequent deployment.	The equipment, procedures and people elements of the remote tower system have been measured and analysed in relation to their state of readiness for deployment.	The procedures defined for Shannon and Cork SMC control were sufficient. The system was suitable for Shannon and Cork SMC operation.	OK
	OBJ-0204-006	To evaluate the human performance/factors element from the ATCO's and other human actors perspective in a sequenced or simultaneous scenario.	Human performance and human factors have been measured and assessed for 'in sequence' and 'simultaneous' scenarios	There were two minor HF issues: 1. A different method of monitoring Shannon AMC operation had to be used when only SMC was being controlled because normally the SMC is located very close to the AMC in the Local Tower whereas when one of the Roles was in the RTC the only method of monitoring was to select the AMC frequency in monitor mode on a nearby COMPAD in the RTC. 2. The other minor issue was the Controller, on one occasion, made an incorrect selection of a button on the COMPAD. 3. The Mouse pointer in the Out of the Window view is a shared mouse pointer which, from time to time, resulted in one Controller waiting for the other to manoeuvre the	OK

				Zoom Camera. However, with practice during the trials the Controllers became adept at co-ordinating the use of the mouse.	
	OBJ-0204-009	To measure the contribution provided to the remote tower operations by the implementation of Electronic Flight Strips (EFS).	The contribution of the EFS system to safety performance and efficiency levels was measured and assessed.	The EFS performed very well and the controllers are getting efficient in its operation.	OK
	OBJ-0204-010	To assess the findings of the demonstration exercises in order to optimise collaborative airports operations management at Cork and Shannon aerodromes in terms of scheduling, push-back, taxi out etc.	The interface between the RTC (one ATS unit) and the two airport operators have been measured and assessed to identify opportunities for efficiencies in operations.	Because we only took Shannon and Cork SMC it was better to have all airport interaction routed via the local tower to ensure that there was no confusion created with the airport authority units. Therefore, this Objective is not applicable in this Batch due to the fact that multiple airport was not performed.	NOK
	OBJ-0204-013	To support the proof of concept and demonstrate the state of readiness of the remote tower initiative for industrialisation in the case of ATS provision for multiple airports	An assessment of the live trial demonstrations to support the proof of concept and readiness for industrialisation of remote towers for multiple airports has been conducted and	CRK and Shannon SMC only therefore no assessment of multiple airport was possible in this batch of exercises. In these exercises the main focus was that the RTC took control of the SMC at both airports. Each airport SMC control was performed by a dedicated Controller in the RTC. There was no impact to service observed when SMC was performed from the RTC compared to SMC being operated from the Local Tower.	NOK

			assessed as positive.		
Batch 1 dedicated Objectives					
	OBJ-0204-014	To establish that the RTC visualisation functionality (availability, reliability, maintainability) is adequate and stable.	The functionality of the RTC visualisation availability, reliability and maintainability has been assessed as adequate and stable.	The remote tower equipment was suitable for Cork and Shannon SMC operations.	OK
	OBJ-0204-015	To confirm ground/ground and ground/air VHF communication adequate.	The communications system availability, reliability and maintainability have been assessed as adequate for Operations.	The GND<>GND and GND<>AIR communications worked well but it is difficult to have multiple frequencies being monitored in the same room.	OK for the trial, but further work needs to be done in any future Remote Tower Multiple Operations to determine on how best to set up COMMS.
	OBJ-0204-016	To confirm operational procedures for the	The operational procedures for the	The operational procedures for the provision of SMC for vehicles/persons	OK

		SMC for vehicles/persons are appropriate.	provision of SMC for vehicles/persons have been assessed as suitable for the provision of SMC ATS	have been assessed as suitable for the provision of SMC ATS	
	OBJ-0204-017	To confirm operational procedures for the provision of SMC for aircraft have been assessed for adequacy.	The operational procedures for the provision of SMC for aircraft have been assessed as suitable for the provision of SMC ATS	The operational procedures for the provision of SMC for aircraft have been assessed as suitable for the provision of SMC ATS	OK
	OBJ-0204-018	To evaluate coordination procedures with airport stakeholders, the parent area control centre and external agencies (MET, AIS, CFMU, IFPS, SAR and Security etc.).	Coordination procedures with airport stakeholders, the parent area control centre and external agencies (MET, AIS, CFMU, IFPS, SAR and Security etc.) have been assessed for adequacy.	There were a low number of calls with the airport authority for stand allocation and this worked OK.	OK
	OBJ-0204-019	To evaluate the human performance/factor elements of the ATC and technical support personnel.	The human performance/factor elements of the ATC and technical support personnel have been assessed and any reasons for negative impacts detailed for further examination.	As mentioned above in a Local Tower the AMC and SMC can easily monitor each other's activities whereas in this exercise it was more difficult. This presented a change in the working relationship between the SMC and AMC in terms of more intercom work was required. More evaluation required on this impact if this was to become the normal situation.	OK

	OBJ-0204-020	To identify shortcomings and limitations	Any shortcomings and limitations have been identified and assessed and detailed for further examination.	As mentioned above in a local Tower the AMC and SMC can easily monitor each other's activities whereas in this exercise it was more difficult. This presented a change in the working relationship between the SMC and AMC in terms of more intercom work was required. It is unlikely that in a future operation the AMC and SMC would be permanently in a different location. However more evaluation would be required on this impact if this was to become the normal situation.	OK
	OBJ-0204-021	To identify corrective actions required before the next exercise	Corrective actions necessary for continuation of live trial exercises have been identified and assessed.	None at this stage	OK
	OBJ-0204-022	To gather data for analysis, the communication plan and reporting to the project team, the Consortium and the SESAR JU	Appropriate data has been gathered for analysis, communication and reporting.	This Report	OK

Table 3: Summary of Demonstration Batch 1 Exercises Results

5.1.2 Analysis of Objective/Success criterion for Batch 2 - Exercise 6 to Exercise 20

Exercise ID	Trial Objective ID	Objective	Success Criterion	Exercise Results	Status
General Objectives which will be examined in part					
	OBJ-0204-001	To demonstrate the state of readiness of the remote tower	The equipment, procedures and people elements of	Equipment: The suitability of the equipment has been assessed during exercise 6 to 20 and there has been a number of comments. These are captured in the LSD 02 04 IAA Remote Tower System	OK

		concept for industrialisation and subsequent deployment.	the remote tower system have been measured and analysed in relation to their state of readiness for deployment.	Operational Evaluation document as Annex 3 to this report. Procedures: The suitability of the Procedures has been assessed during exercise 6 to 20 and there was only one slight procedure change recommended after exercise 9. People: No additional comments at this stage	
	OBJ-0204-002	To demonstrate that the full range of ATS as provided from on-site control towers can be provided without degradation from the RTC	The tasks and duties of the ATCO providing services from the RTC have been measured and assessed in line with the developed procedures to ensure that there was no degradation of service when providing a service from the RTC.	As discussed in the exercises 6 to 20 there are obvious differences between the Local Tower Operation and the R.T.C Operation. This mainly relates to the fact that the view from the Local Tower is better than the RTC. Some examples of this are: In exercise 15 there is a discussion about the difficulty in seeing smaller aircraft. In exercise 16 there is a discussion about rapid climbing aircraft In exercise 17 there is a discussion about challenging lighting conditions. All of the above can be mitigated by a combination of experience of RTC Operation, changes to Operating methods/procedures however in some cases there may have to be a change to how the service operates.	The status is OK for this objective because the full range of ATS as provided from on-site control towers was provided without degradation to the service provided from the RTC however the Controller had on occasion to perform extra tasks such as use the PTZ to see certain objects.
	OBJ-0204-003	To evaluate various aircraft movement rates in order to establish the optimum number consistent with a safe and effective service for a remote tower – multiple airports scenario.	The level of safe and effective provision of services to multiple airports under varying traffic levels has been measured and assessed to establish the optimum number of aircraft movements..	From exercise 12 onwards we begin to get a picture of the workload increase required to manage a MULTI RTC environment. The project team have a good system in place for monitoring workload and a decision process in place to decide or not to continue in MULTI Operation or Split into separate airport control. However, at this stage it is very difficult to actually put an exact figure or establish the “optimum” number of movements because it very much depends on the type of movement. e.g. A regular scheduled IFR aircraft will be relatively straight forward to handle whereas a Solo student VFR pilot in the circuit will be totally unpredictable in the workload increase to the Controller.	OK

				At this stage we are confident that with processes in place to collapse and de-collapse positions to share the workload between a number of Controllers Multiple airport Control is possible notwithstanding the comment above OBJ-0204-002 relating to the potential impact to service in some cases	
	OBJ-0204-004	To assess the service efficiency in terms of capacity/delay in the provision of ATS from the RTC.	In addition to on site monitoring, aircraft operator views as to service level efficiency have been obtained and assessed as positive.	During exercises 6 to 20 we have seen in a number of cases where the level of service provided to Vehicles is not the same and a Vehicle will almost always get a lower priority than an aircraft. On one occasion there was a slight delay to an aircraft at one airport due to work on-going in the other airport.	OK
	OBJ-0204-006	To evaluate the human performance/factors element from the ATCO's and other human actors perspective in a sequenced or simultaneous scenario.	Human performance and human factors have been measured and assessed for 'in sequence' and 'simultaneous' scenarios	As we progress through the exercises we can see the Controllers are conscious of the fact that due to Multiple tasks having to be done at the same time that the level of service is not the same as in the Local Tower and this adds to the pressure on the RTC ATCO. The main reason for this is that the Controller knows that if he was just performing a task for a single airport that e.g. this Vehicle would not have been delayed but because he was engaged in another task for the other airport he is delaying something in the other airport. This is alien to the Controller because they would be used to very rarely having to delay replying to a Vehicle when Operating in the Local Tower.	OK
	OBJ-0204-008	To assess the results of the demonstration exercises with respect to sequencing and metering to support 'in sequence' and/or 'simultaneous' operations.	The application of sequencing and metering processes as applied to two airports was measured and assessed.	This aspect is one of the aspects of the exercises so far that was most interesting. The project team are formulating good opinions on the impact of in sequence and simultaneous. In these series of exercises, we had a number of exercises with good examples of "in sequence" such as Ex 14 & 16 and also some good examples of aircraft departing in one airport and an arrival <1 Min later in the other airport such as Ex 15 & 17. In addition we also has exercise 18 which demonstrated where it was not possible to merge due to too many predicted simultaneous operations/tasks.	OK
	OBJ-0204-009	To measure the contribution provided to the remote tower	The contribution of the EFS system to safety performance	The EFS performed very well and the controllers are getting efficient in its operation. However, in exercise 10 there was a comment that in a Multi Airport set up the EFS has to be split between the two	OK

		operations by the implementation of Electronic Flight Strips (EFS).	and efficiency levels was measured and assessed.	airports and therefore there is only room for 15 fully displayed strips per airport. Most of the time that will be OK but on occasion it may not. The main conclusion about the EFS contribution this far is that, once the EFS is kept up to date with the latest aircraft & vehicle picture it is a fantastic tool with measureable safety benefits that the current paper strips don't provide.	
	OBJ-0204-010	To assess the findings of the demonstration exercises in order to optimise collaborative airports operations management at Cork and Shannon aerodromes in terms of scheduling, push-back, taxi out etc.	The interface between the RTC (one ATS unit) and the two airport operators have been measured and assessed to identify opportunities for efficiencies in operations.	For simplicity and to ensure there was no confusion for the airport agencies and the Shannon ACC, all telephone interaction with the airport agencies and the Shannon ACC was conducted via the Local Tower Controllers. However, even though this aspect was not performed, it is anticipated that there would be almost zero difference in the interaction between an RTC and airport operators and the Local Tower and airport operators because it is all interactions are performed by telephone and consequently no difference would be experienced.	NOK
	OBJ-0204-013	To support the proof of concept and demonstrate the state of readiness of the remote tower initiative for industrialisation in the case of ATS provision for multiple airports	An assessment of the live trial demonstrations to support the proof of concept and readiness for industrialisation of remote towers for multiple airports has been conducted and assessed as positive.	As can be seen in exercise 6 to 20 there are times when it is possible to conduct the provision of ATS in a Multiple airport scenario from an RTC, however there are also time due to traffic where that is just not possible. Nevertheless, these exercises have shown that a single Controller can provide ATS services to more than one airport at the same time, using the equipment installed and the procedures that were developed.	OK
Batch 2 dedicated Objectives					
	OBJ-0204-023	To demonstrate that that the current range of ATS (ATC service, flight information service and alerting service) can be	The provision the current range of ATC service, flight information service and alerting service from the RTC for in	There were no aspects of ATS provision that could not be conducted from the RTC during these exercises. However, as stated above and described in the exercise results there are times when a Controller is providing a service to one airport (Vehicle or aircraft) when the other airport (Vehicle or aircraft)	OK

		provided from the RTC for in sequence operation without degradation.	sequence operation has been assessed to confirm no degradation of service.	will have to wait for service. This is not directly a limitation of the Equipment/People /Procedures in a Multi Airport mode, it is simply a fact that one Controller cannot talk to two aircraft/Vehicles at the same time.	
	OBJ-0204-024	To measure the optimum movement rate for Cork and Shannon aerodromes in the case of in sequence ATS provision from the RTC	The optimum movement rate for Cork and Shannon aerodromes in the case of in sequence ATS provision from the RTC has been measured.	During this batch of exercises from 6 to 20 there were a number of good examples of “in sequence” aircraft operation such as ex 14 & 16. In addition to the pair of aircraft involved in the “in sequence movements there are a number of other tasks the Controllers could conduct such a vehicle management or a limited amount of VFR traffic. But the experience so far is that e.g. in sequence departures or arrivals at two different airports with no other traffic involved is actually easier than two aircraft departing or arriving at the same airport because the two aircraft can work independently of each other and are not competing for the same runway or taxiways. The only additional task in this scenario is that two runways must be checked for obstacles instead of one runway.	OK
	OBJ-0204-025	To assess the service efficiency aspect of ATS provision from the RTC for in sequence operation.	The service efficiency aspect of ATS provision from the RTC for in sequence ATS provision has been assessed.	The service efficiency really depends on what else the Controller is doing at the time. As stated above if there are only two aircraft in sequence and nothing else, it would be very efficiently done by one Controller, however if that single Controller is performing other tasks because he is one his own then there could be a degradation of service resulting is less efficiency for one of the two aircraft.	OK
	OBJ-0204-026	To identify areas for optimised collaborative airport operation at Cork and Shannon aerodromes for in sequence and simultaneous operation.	The interface between the RTC (one ATS unit) and the two airport operators have been measured and assessed to identify opportunities for efficiencies in airport operations in the case of in sequence and simultaneous	What we have learned so far in exercise 6 to 20 is that in order to optimise Controller time and spread the workload evenly and to avoid peaks and troughs in Controller workload due to airport operations, it is possible that in a future RTC operation there may be a requirement for more coordination between the airport operations units. For example, if both airports continue to operate totally independently without Cooperation/Coordination then a single Controller would be handling a Runway Patrol or a Field Lighting Check at both airports at the same time whereas in any future RTC Operations it may be a better management of Controller workload that these checks would be Coordinated between the two airports	OK

			ATS provision.	and the task staggered so that they do not occur at the same time.	

Table 4: Summary of Demonstration Batch 2 Exercises Results

5.1.3 Analysis of Objective/Success criterion for Batch 3 - Exercise 21 to Exercise 50

Exercise ID	Trial Objective ID	Objective	Success Criterion	Exercise Results	Status
General Objectives which will be examined in part					
	OBJ-0204-001	To demonstrate the state of readiness of the remote tower concept for industrialisation and	The equipment, procedures and people elements of the remote tower system have been	Equipment: The suitability of the equipment has been assessed during exercise 21 to 50 and there has been a number of comments in relation to the system which are captured in the LSD 02 04 IAA Remote Tower System Operational Evaluation document as Annex 3 to this report. Procedures: The suitability of the procedures has been assessed during	OK

		subsequent deployment.	measured and analysed in relation to their state of readiness for deployment.	exercise 21 to 50 and there was no addition procedure change required however potential changes were discussed to operating methods in any future RTC environment such as better cooperation between airports involved in a Multiple Tower Operation whereby vehicle activity is coordinated so as to manage the workload of the RTC Controller. People: No additional comments at this stage	
	OBJ-0204-002	To demonstrate that the full range of ATS as provided from on-site control towers can be provided without degradation from the RTC	The tasks and duties of the ATCO providing services from the RTC have been measured and assessed in line with the developed procedures to ensure that there was no degradation of service when providing a service from the RTC.	As discussed in the exercises 6 to 20 and also in 21 to 50 there are obvious differences between the Local Tower operation and the RTC operation. This mainly relates to the fact that the view from the Local Tower is better than the RTC. In addition to that which was reported in the Batch 2 Objectives, it was also noted in the Batch 3 exercises that as the Controller workload increased and more frequently simultaneous requests were made to the single Controller there was no alternative but for some items to get a delayed response from the Controller. As the Controllers because more experienced with the RTC operation they became better at anticipating and manipulating tasks which mitigated to some extend potential delays in replying to requests for service, however as stated before in some cases there would have to be a degradation to the existing Local Tower service that is provided because in a Multiple Tower environment one single Controller cannot provide what it takes two Controllers to do today. However, despite what is stated above some of the degradation to the service can be mitigated by a combination of experience of RTC Operation and changes to operating methods/procedures. However in some cases there may have to be a change to how the service operates.	OK
	OBJ-0204-003	To evaluate various aircraft movement rates in order to establish the optimum number consistent with a safe and effective service for a remote tower – multiple airports scenario.	The level of safe and effective provision of services to multiple airports under varying traffic levels has been measured and assessed to establish the optimum number of	As stated above in the Batch 2 summary and similarly to what was experienced from exercise 12 to 20, from exercise 30 to 50 we begin to get a picture of the workload increase required to manage a multiple aerodrome environment. In addition to what we learned in Batch 2 in relation to workload management we also noted in later exercises in Batch 3 the impact of environmental factors such as high winds and night operations. As stated also in Batch 2 at this stage it is very difficult to actually put an	OK

			aircraft movements.	exact figure or establish the “optimum” number of movements because it very much depends on the type of movement. e.g. A regular scheduled IFR aircraft will be relatively straight forward to handle whereas a Solo student VFR pilot in the circuit will be totally unpredictable in the workload increase to the Controller. The workload issue is also very much dependant on the setup of the RTC in terms of what Roles the single Controller is assigned. i.e. dual AMC or dual AMC/SMC Roles. The project team will need more time to discuss the merits of all of the combinations of Roles to determine the optimum set up.	
	OBJ-0204-004	To assess the service efficiency in terms of capacity/delay in the provision of ATS from the RTC.	In addition to on site monitoring, aircraft operator views as to service level efficiency have been obtained and assessed as positive.	Similarly, to Batch 2, when there is a conflict in terms of tasks to be done the Controller will determine the order in which the tasks will be performed. This is standard practise for a Controller in any Role, ranging from an en-route Controller to a Local Tower Controller. i.e. Tasks are analysed, prioritised and carried out with the least priority item experiencing a perceived different level of service compared to what they might be used to in a Local Tower set up.	OK
	OBJ-0204-005	To assess cost efficiency of the provision of ATS for multiple airports from the RTC	The cost efficiency of the provision of services from the RTC vis-à-vis Cork and Shannon local towers has been measured and assessed.	It is the opinion of the Project team that RTC Operations do not reduce workload on a Controller, if anything there is actually a marginal increase in workload. This means that if during certain hours in the current Local Towers the two Controllers are busy then this will directly translate to two busy Controllers in the RTC. However, there were also relatively quiet times during the trials when a single RTC Controller was performing the tasks of two Controllers in the Local Tower. This resulted in a moderately busy RTC Controller compared to a Local Controller with a relatively light workload. This would imply that there are cost efficiencies to be gained. Significant work would have to be done to analyse typical traffic patterns before a shift schedule could be designed so as to ensure that a single Controller operated RTC would have, at all times, a manageable workload.	OK
	OBJ-0204-006	To evaluate the human performance/factors	Human performance and human factors	A human performance/human factors report has been compiled by Dr Wen Chin Li of Cranfield University on the Large Scale Demonstration and in	OK

		element from the ATCO's and other human actors perspective in a sequenced or simultaneous scenario.	have been measured and assessed for 'in sequence' and 'simultaneous' scenarios	summary it states; *"MRTO is the future for safety and capacity of air traffic control of small airport. However, there is a trend of increasing mental demand, physical demand, temporal demand, effort, and frustration on multiple remote tower operations compared to local tower operations across all the trials based on NASA-TLX. There is a raising need for dealing with ATCO's perceived workload for performing multiple remote tower operations either by training, staffing, designing new SOPs or interface design, as workload can negatively affect ATCOs' performance and increase the error of operation.* "	
	OBJ-0204-007	To evaluate the human performance/factors element from the ATCO's and other human actors perspective in a sequenced or simultaneous scenario.	Human performance and human factors have been measured and assessed for 'in sequence' and 'simultaneous' scenarios	A human performance/human factors report has been compiled by Dr Wen Chin Li of Cranfield University on the Large Scale Demonstration. As part of that report, there were 3 scenarios which were broken down by 5 domain experts based on the principles of HTA for multiple remote tower operations. The step by step of operations for multiple remote tower research include the human-computer interaction on Electronic Flight Strip (EFS), Out of the Window (OTW), Radar Data Processing (RDP), and Information Data Processing (IDP). These 3 scenarios comprised by Scenario 1: Simultaneously Landing on EINN and EICK (figure 1); Scenario 2: Simultaneously Landing on EINN and Departing EICK (figure 2); and Scenario 3: Simultaneously Landing on EINN and Departing plus Circuit on EICK (figure 3). See the report for the results.	OK
	OBJ-0204-008	To assess the results of the demonstration exercises with respect to sequencing and metering to support 'in sequence' and/or 'simultaneous' operations.	The application of sequencing and metering processes as applied to two airports was measured and assessed.	As outlined in Batch 3 the project team have gained a very good understanding of what is possible in a Multiple airport 'in sequence' and/or 'simultaneous' aircraft operations. These findings are in the summary of the trials.	OK
	OBJ-0204-011	To assess the suitability of remote tower operations at Cork and Shannon in	The suitability of remote tower operations at Cork and Shannon in the	During the trials there was limited opportunity to study this aspect of possible future Multiple RTC Operations, however, as stated above in OBJ-0204-008 the project team has initial proposals for the handling of in sequence' and/or 'simultaneous' aircraft operations which would have a direct impact on how	OK

		the context of centralisation of approach radar service for these airports.	context of centralisation of approach radar service for these airports has been assessed.	approach services are currently operated. The changes required to approach control service would not be significant but a certain amount of training would be required so that the Approach Controller who would normally be delivering aircraft in sequence to a single airport may in the future have to make some adjustments to facilitate aircraft movements at another airport.	
	OBJ-0204-012	To contribute to the case for deployment of remote towers for Cork and Shannon airports.	The contribution of the live trial demonstrations to the deployment of remote towers for Cork and Shannon airports has been assessed as positive.	This LSD 50 trials is only the initial step towards any possible future deployment of Remote Towers for Cork and Shannon. There is still significant amount of work to complete a full analysis for any future deployment, however, the Results of the trials show that it is possible to provide ATS for two Local Towers from an RTC based in a remote location.	OK
	OBJ-0204-013	To support the proof of concept and demonstrate the state of readiness of the remote tower initiative for industrialisation in the case of ATS provision for multiple airports	An assessment of the live trial demonstrations to support the proof of concept and readiness for industrialisation of remote towers for multiple airports has been conducted and assessed as positive.	The document “LSD 02 04 IAA Remote Tower System Operational Evaluation” (Annex 3 to this report) provides the project teams full assessment of the state of readiness of the systems provided for the provision of ATS provision for multiple airports. The document lists a number of suggestions for changes to systems which should be considered in advance of any potential future deployment.	OK
Batch 3 dedicated Objectives					
	OBJ-0204-027	To demonstrate that that the current range of ATS (ATC service, flight information service and alerting service) can be provided from the RTC for simultaneous operation without degradation.	The provision the current range of ATC service, flight information service and alerting service from the RTC for simultaneous operation has been assessed to confirm no degradation of	The provision the current range of ATC service, flight information service and alerting service from the RTC for simultaneous operation has been assessed and as stated above on a number of occasions, simultaneous operations of aircraft is possible in a multiple airport RTC environment but on occasion there may be a delay to a vehicle or aircraft that would not occur to the same extent in the Local Tower Operations.	OK

			service.		
	OBJ-0204-028	To measure the optimum movement rate for Cork and Shannon aerodromes in the case of simultaneous ATS provision from the RTC.	The optimum movement rate for Cork and Shannon aerodromes in the case of simultaneous operation ATS provision from the RTC has been measured	As stated above at this stage it is very difficult to actually put an exact figure or establish the “optimum” number of movements because it very much depends on the type of movement. e.g. A regular scheduled IFR aircraft will be relatively straight-forward whereas a solo student VFR pilot in the circuit will constitute an unpredictable increase in Controller workload. At this stage we are confident that with processes in place to collapse and de-collapse positions to share the workload between a number of Controllers Multiple airport Control is possible notwithstanding the comment above OBJ-0204-002 relating to the potential impact to service in some cases	OK
	OBJ-0204-029	To assess the service efficiency aspect of ATS provision from the RTC for simultaneous operation.	The service efficiency aspect of ATS provision from the RTC for simultaneous ATS provision has been assessed.	These trials show that on occasion some aircraft and/or vehicles can experience some slight delays. These trials show that it is possible for a single Controller to perform the tasks of two Controllers under certain workload conditions. A further detailed analysis would have to be conducted to determine if any future operation of a multiple aerodrome RTC operation would be in overall terms more efficient than the current situation from the point of view of airport operations, aircraft operations and ATS operations.	OK
	OBJ-0204-030	To identify areas for optimised collaborative airport operation at Cork and Shannon aerodromes for simultaneous operation.	The interface between the RTC (one ATS unit) and the two airport operators have been measured and assessed to identify opportunities for efficiencies in airport operations in the case of simultaneous ATS provision.	Nothing further to add to what was stated in OBJ-0204-026 above. What we have learned so far in exercise 6 to 50 is that in order to optimise Controller time and spread the workload evenly and to avoid peaks and troughs in Controller workload due to Airport Operations, it is possible that in a future RTC Operation that they may have to be more Coordination between the Airport Operations units who are being provided with ATS Service from an RTC. For example, if both airports continue to operate totally independently without Cooperation/Coordination then it is possible that a single Controller would be handling a runway patrol or a field lighting check at both airports at the same time whereas in any future RTC Operations inter airport coordination would manage the timing of these activities so that they are staggered.	OK

Table 5: Summary of Demonstration Batch 3 Exercises Results

5.2 Summary of Assumptions

The following are the Demonstration Assumptions for the conduction of the demonstration exercises as outline in the Demonstration Plan. The assumptions listed outline the key items which in advance of the trials were assumed necessary for the trials to be run successfully.

The project has added a column to the right of the table to provide an opinion following completion of the live trials.

Identifier	Title	Type of Assumption	Description	Justification	Flight Phase	KPA Impacted	Source	Value(s)	Owner	Impact on Assessment**	Opinion post trial completion.
ASS-02-04-001	NSA Approval	Live Trial Enabler	A RTC Live Trial Safety Case will be produced for the Irish Regulator to approve in advance of the trial	Approval is require prior to performing the Trials	All	Safety	Project Team		IAA	H	To list this as a Live trial enabler with "H" impact in advance was correct. The IAA could not have performed any trial without NSA approval. NSA approval was achieved in advance and the trials were completed.
ASS-02-04-002	Remote Tower Video Equipment	Live Trial Enabler	The equipment required to be installed at the Local Tower (Cameras etc) and also the equipment required at the RTC (screens etc)	The video image of the Airport is essential for the exercises to commence.	All	Safety Capacity	Project Team		IAA	H	To list this as a Live trial enabler with "H" impact in advance was correct. The IAA could not have performed any trial without Remote Tower Video Equipment. The equipment was installed and site accepted in advance of the trials and performed very well during the trials.

ASS-02-04-003	RTC Comms (GND-GND)	Live Trial Enabler	The GND-GND communications between the RTC and the local tower as well as the Comms between the RTC and adjacent agencies that is required	Ground-Ground Communications between the RTC and adjacent agencies as well as the Local Tower is essential for the exercises to commence.	All	Safety Capacity	Project Team		IAA	H	To list this as a Live trial enabler with "H" impact in advance was correct. The IAA could not have performed any trial without RTC Comms (GND-GND). However, the essential element for these trials was connectivity with the Local Tower for coordination of handover. In a full RTC Operation this would become less essential and connectivity with surrounding ATC sectors more essential.
ASS-02-04-004	RTC Comms (Main GND-AIR)	Live Trial Enabler	The Main GND-AIR communications that are available to the Local Towers is required in the Local Tower.	The Control of aircraft cannot commence without the Main Communication Frequencies being available in the RTC	All	Safety Capacity	Project Team		IAA	H	To list this as a Live trial enabler with "H" impact in advance was correct. The IAA could not have performed any trial without RTC Comms (Main GND-AIR). However, it was very interesting to observe the difficulties surrounding 4 active frequencies and two monitored frequencies being handled by a single Controller.
ASS-02-04-005	RTC Comms (back-up GND-AIR)	Live Trial desirable	The back-up GND-AIR communications that are available to the Local Towers is ideally required in	The Control of aircraft can commence without the Back-up Communication Frequencies being available in the RTC on	All	Safety Capacity	Project Team		IAA	M	The IAA made the decision in order to simplify the installation in the RTC because it was only a trial to conduct the trial without backup Communications. During the trial we never experienced a situation where we had to hand back control

			the Local Tower.	the basis that the Local Tower is Operating in "Hot Standby" mode							due to a Comms issue. For full RTC operation, back-up Comms would be listed as "an enabler" and "H" but not for a trial where we had adequate procedures in place for the Local Tower to re-assume control in the event of an issue with the main Comms.
ASS-02-04-006	Other General Tower Equipment	Live Trial desirable	Other standard Tower Equipment such as: Field Lighting panel, ILS Monitor & Switching, ALDIS Lamp	The aim will be that these equipment will be installed in the RTC in advance of the trial commencement however in the event that they are not due to time constraint the trials can commence on the basis that the Local Tower will operate/monitor the equipment	All	N/A	Project Team		IAA	M	The IAA made the decision in order to simplify the installation in the RTC because it was a trial, not to remote control of other standard tower equipment (airport assests) such as: field lighting panel, ILS monitor & switching. This function remained, by procedure, with the Local Tower and that decision did not cause any issues during the trials. For full RTC operation, this equipment and more would be listed as "an enabler" and "H". In addition, in the Demo Plan Wind display (ANEMO) was not listed here. During discussions with the Controllers the Wind display was listed as an enabler and "H" for the trials for AMC Control but only in conditions where frequent wind was required to be passed to

											aircraft. In light winds we could have managed by having the wind relayed via an intercom to the Local Tower. Nevertheless, it was decided to install the wind display form Cork & Shannon in advance of the trials and in hindsight that was a good decision. The Wind displays worked very well during the trials. In particular Ex 48 with a gusting 28Kts cross wind situation.
ASS-02-04-007	Remote Tower EFS Flight Data	Live Trial desirable	The display of Flight data on the Electronic Strip system	The project includes the installation of an EFS in the RTC. In the event that this does not occur in due time for trial commencement, the existing paper strip operation will enable the trials to continue	Capacity	N/A	Project Team		IAA	L	The EFS was listed as “desirable” and “L” in the DEMO plan. Post the trials that is still a correct assessment because we could have used Paper Flight strips, however the EFS was installed on time and was an excellent addition for the Controllers. In future single RTC Operations it would not be listed as essential but if performing RTC Operations whereby roles are combined and there is switching of RTMs etc, a tool such as an EFS which automatically delivers up to date flight data information depending on the role selected, reduces workload on Controllers, helps avoid confusion and therefore becomes an important feature of an RTC.
ASS-	ATC	Live Trial	The ATC	Without the	Saf	N/A	Project		IAA	H	To list this as a Live trial

02-04-008	Procedures	Enabler	procedures required to enable the live Trial to commence	agreed and approved ATC procedures the Live Trials cannot commence	ety		Team				enabler with “H” impact in advance was correct. No ATS service can be delivered without supporting procedures and NSA approval would not have been given without approved procedures. In addition, the supporting procedures were also essential for Controller briefing in advance of any trials being conducted.

Table 4: Demonstration Assumptions

5.2.1 Results per KPA

See the Conclusions and Recommendations section.

N/A			

5.2.2 Impact on Safety, Capacity and Human Factors

5.2.2.1 Impact on Safety

In setting out the governing principles for the LSD 02.04 IAA Remote Tower Trials Safety Case the IAA listed as a fundamental principle the maintenance of at least the same level of safe ATS provision from the RTC at the Dublin ATS Unit as is currently provided by the local Towers at Cork and Shannon ATS Units. The safety case provided the evidence, arguments and assumptions to support this principle. During the trials the Controllers and the RTC project team were governed by the same safety management policy, principles and procedures that exist in the Local Towers or indeed any of the IAA's operational ATS units. There was no occasion during the conduct of LSD 02.04 where there was a reduction in safety barriers which was not anticipated or provided for during the Safety Case development and update.

The project team can conclude therefore that there was no adverse impact on safety while conducting the Remote Tower Trials from the RTC and conditions for the grant of project acceptance by the NSA were successfully maintained.

5.2.2.2 Impact on Capacity

In advance of commencing the Remote Tower trials from the RTC in Dublin it was agreed between the Remote Tower Project team and the Operational units that the trials should be, as far as possible, invisible to the airport operators. Similarly, there would be little or no change to, or deviation from the air traffic services that the aircraft operators would normally experience when these services were provided from the Local Towers. As described in Section 4.2.1 - Exercise Daily Execution - the project team performed advance analysis to ensure that the RTC Operations would not impact capacity while services were provided from the RTC. In addition, when the RTC had control of the Shannon & Cork AMC positions, predicted traffic was monitored to determine if the two AMC positions could be merged. On occasion when the two AMC positions were merged and Controlled by a single Controller it was necessary to un-merge the responsibilities to ensure that we did not overload the Controller and consequently impact safety and/or capacity.

However even with the protections outlined above there were a number of occasions where there was a delayed response (< 60 seconds) to a vehicle and two occasions where an aircraft was slightly delayed because the Controller was dealing with traffic at the other aerodrome.

The comments on capacity for the Remote Tower trials are contained in the Chapter 6 of this document.

5.2.2.3 Impact on Human Factors

In advance of the trials the Controllers received training on the RTC Procedures and Equipment, part of which included a number of hours training on the Human Factors issues they were likely to encounter during the conduct of the trials. This training is documented in the training documentation which was submitted to and approved by the NSA.

During the trials a number of human factor issues were encountered, most of which were anticipated (e.g. the operation of new equipment and associated HMI) and some which were not anticipated such as the level of noise in the RTC when a single Controller was operating four frequencies and monitoring an additional two frequencies.

The detail of the Human factors issues listed above as well as other Human Factor issues encountered are outlined in Section 6 of this document while the formal Human Factors report prepared by Dr Wen Chin Li is a separate document as Annex 2 to this report.

5.2.3 Description of assessment methodology

The core project team of the Remote Tower Project which consisted of Project Manager, an ATM Specialist and two appropriately rated Controllers were present for each of the fifty live trials.

During the trials the following type of activities took place:

- Recording of over the shoulder observations;
- Recording of aircraft involved in the trial;
- Recording of Controller comments during the exercise;
- A number of exercises were observed and recorded by Dr Wen Chin Li Human Factors expert whose report is contained in a separate document as Annex 2 to this report.

Following each exercise, a debrief took place using the pre-formatted exercise results document which recorded items such as:

- Exercise date and time;
- Tower Roles assumed in the RTC;
- Exercise participants;
- Weather at both airports;
- Aircraft involved in each exercise and, where appropriate, the timing (to the second) of events to record what actions a Controller was conducting during each minute, in particular when in a multiple aerodrome exercise;
- General comments from the Controllers and a record of the debrief observations;
- Aircraft involved in the exercise as well as recording notes on non-normal aircraft movements e.g. simulated engine failure or Touch & Go etc.;
- Completing the initial assessment of the controller impression of various aspects such as procedures, systems, workload etc.;
- Compiling Unexpected Behaviour/Results;
- Compiling the Conclusions and Recommendations.

After each Batch of exercises, the Objectives and Success criteria were examined and the status was updated before moving on to the next batch of exercises. This report is a synopsis of the exercise results document, with Chapter 5 containing a synopsis of the overall trial and Chapter 6 containing a synopsis per batch of exercises. For the detail of each exercise and to follow the progression and development of the project conclusions, the exercise results document (Annex 1) should be consulted.

5.2.4 Results impacting regulation and standardisation initiatives

From a regulatory perspective to findings of LSD 02.04 could contribute to EASA rulemaking activity for single and multiple airport remote tower operation in order to further develop EASA Decision 2015/014/R 3 July 2015 on the Implementation of the Remote Tower Concept for single mode of operation [Ref 9] particularly with regard to system safety and controller licensing.

In the case of standardisation, LSD 02.04 could inform EUROCAE WG 100 in developing standards for remote towers systems for single and multiple modes of operation for adoption by ICAO as standards and recommended practices.

5.3 Analysis of Exercises Results

See Annex 1 - LSD 02 04 IAA Remote Tower Trial Exercise Results

5.3.1 Unexpected Behaviours/Results

The Following are the main Unexpected Behaviour/Results synopsised from Chapter 6 which contains the main Unexpected Behaviour/Results per Batch of exercises.

5.3.1.1 Depth perception on OTW.

- It was felt that while depth perception was possible in the RTC, it was easier to judge the position of an aircraft in relation to another aircraft from the local tower than the RTC. It was agreed that where there were more than two aircraft in the vicinity of an airport, Controller knowledge of aircraft size was advantageous in determining which aircraft was closer e.g. a medium size aircraft 5 DME from an airport may be represented on the OTW view as being the same size as a small aircraft closer to the airport.

- The height and location of the RTC cameras, compared to the location and height of the Local Tower, particularly in Shannon where the cameras are lower than the Local Tower, made difficult to clearly differentiate between traffic on Taxiway C and D2.

5.3.1.2 Difference in the OTW view compared to the Local Tower

- The Out of the Window view displays objects at a smaller size compared to the object size when viewed from the Local Tower, this results in it being difficult to see smaller objects far away from the camera. Therefore, the PTZ camera is important for monitoring Airport Hotspots. For areas of the airfield >1.5KM from the cameras continuous use of the PTZ is required to get a clear view of the area. This PTZ operation increases workload on the Controller, a workload which does not exist in the Local Tower to the same extent. i.e. PTZ is used more frequently than binoculars.
- In order to try to mitigate and reduce this workload in future RTC operations, the IAA will discuss system changes with the supplier that could reduce this workload on PTZ manipulation such as:
  - Automatic PTZ tracking of certain Objects as determined by the Controller;
  - Explore HMI adjustments to the PTZ manipulation;
  - Hotspot Cameras set up on targeted distant areas of the airfield displayed permanently on separate displays;

The changes suggested above could be part or all of the solution.

5.3.1.3 Communication and Frequency monitoring

When a single Controller is responsible for four tower Roles AMC/SMC in two airports, there is a requirement to actively use four frequencies in addition to monitoring two separate approach unit frequencies (for situational awareness). Consequently, there is an increased likelihood of the Controller missing a transmission by an aircraft or vehicle. The totality of the organisation communications in an RTC needs to be explored further.

5.4 Confidence in Results of Demonstration Exercises

5.4.1 Quality of Demonstration Exercises Results

The Quality of the exercise results in LSD 02.04 can be categorised as high due to the high quality of the:

- Remote Tower System installation;
- Communication systems;
- Project planning;
- Training & procedures development;
- Tailored and incremental Batch objectives and scenarios which were suitable for the phase of the project;
- Methodical documenting of traffic and comments during the exercises;
- Project related SESAR documents which provided valuable preparatory information.

5.4.2 Significance of Demonstration Exercises Results

The operational significance of the demonstration results was assured because the traffic samples that were used and the scenarios trialled consisted of the actual summertime aircraft operation and vehicular activity at Cork and Shannon airports without restriction or alteration. Therefore, the live trial exercises were totally representative of real-time ATS provision during low to medium traffic density and complexity and were more than adequate to provide valid measurements against objectives. In addition, documented exercise results recording aircraft movements and the timing of Controller actions enabled the Project team to verify incrementally how remotely provided air traffic service for multiple aerodromes could be conducted and identify limiting circumstances.

5.4.3 Conclusions and recommendations

The general conclusions and recommendations of LSD 02.04 are as follows:

Safety: The live trial exercises demonstrated that the ATS provided by the RTC for a single airport and two medium airports by a single Controller with ‘in sequence’ and ‘simultaneous’ aircraft operation was at least as safe as the ATS provided by the Local Towers at Cork and Shannon aerodromes. There was no ATS safety occurrence report nor did any operational safety issue arise during the conduct of the fifty live trial exercises. The project considers this objective was achieved.

Capacity: The live trial exercises demonstrated that Aerodrome Control Service could be provided by the RTC for Cork and Shannon in single airport or multiple airport modes by one Controller ‘in sequence’ during periods of low aircraft movements. Aerodrome Control service for ‘Simultaneous’ aircraft operation was possible during these periods but spacing would be required when the arrival/departure times at the two airports coincided.

Cost efficiency: The Demonstration provided confirmation that a multiple remote tower solution provided the potential for more cost effective deployment of human resources during periods of low aircraft movements, particularly when combined with other initiatives such as the centralisation of Approach Control Service and for contingency purposes.

Human performance: MRTO (Multiple Remote Tower Operation) is the future for safety and capacity of air traffic control at small/medium airports. However, there is a trend of increasing mental demand, physical demand, temporal demand, effort, and frustration on multiple remote tower operations compared to local tower operations across all the trials based on NASA-TLX. There is a requirement to address the issue of Controllers’ perceived workload for performing multiple remote tower operations either by training, staffing, designing new standard operating procedures or interface design, as workload can negatively affect a Controller’s performance and increase the potential for error.

The validation of Human-Computer Interaction for multiple remote tower operations based on Controllers' visual parameters reveals that they estimate distance of aircraft and maintain situation awareness in multiple remote tower operations while tracking fast moving targets on the screens of the OTW view and radar display. Further development of the Out the Window view could contribute to a reduced Controller workload.

5.4.3.1 Multiple Airport Simultaneous Aircraft Operations

The following are the conclusions on what the IAA believes is possible in relation to the simultaneous aircraft operation at two airports in a Remote Tower environment and under what environmental conditions we would advocate that in sequence aircraft operations would be preferable to simultaneous operations.

- In a Multiple Airport Simultaneous Operations (MASO) environment, with **two simultaneous departures at two different airports**, with a single RTC controller, it would be better to add more time between the two cleared for take-off instructions so that the Controller can monitor the roll and initial rotation before clearing the second aircraft for take-off.

- In a Multiple Airport Operations (MASO) environment, **with one arrival at one airport followed by a departure at the other airport**, ideally the landing aircraft should be steady on the Runway i.e. that the Controller is satisfied that the aircraft can continue safely on the ground, before clearance for take-off is given to another aircraft at the other aerodrome.

- In a Multiple Airport Simultaneous Operations (MASO) environment and **with one departure at one airport followed by an arrival at the other airport**, ideally time should be allowed between the cleared for take-off instruction so that the Controller can monitor the roll and initial departure of the departing aircraft before the arrival aircraft is 1NM from touchdown at the other aerodrome.

- In a Multiple Airport Simultaneous Operations (MASO) environment and **with two simultaneous arrivals into two different airports** ideally the first landing aircraft should be steady on the Runway before the second arrival aircraft is 1NM from touchdown at the other aerodrome. Meeting this guideline has been identified as difficult and it could be the case that this guideline would not be accomplished due to the varying speeds of the two aircraft on final approach. Any such recommendation when implemented in the future would be supported by an additional caveat which should give the Controller the authority to exercise professional judgement with regard to the issuance of a landing clearance to the second arriving aircraft.

- **In Multiple Airport Simultaneous Operations (MASO)** the influencing factors such as night operations, poor visibility, or high cross wind conditions would advocate that in sequence aircraft operations would be preferable to simultaneous operations. This recommendation should be reviewed as more experience is gained.

5.4.3.2 Remote Tower Single Airport Operations

While the IAA project was primarily focussed on multiple airport operations there were a number of occasions during the trial where single airport operations was conducted before merging to multiple airport operations. From this experience of single airport operations, we can conclude that due to the fact that there is increased workload in a remote tower mainly due to the difference in the out of the window view there would be times when operating a single airport for Shannon or Cork may not be possible without impacting the level of service that is delivered today from the Local Tower.

In general, scheduled IFR traffic are naturally spaced due to the radar separation applied in the upstream approach sector. This natural spacing of the IFR scheduled traffic would protect the Remote Tower from work overload. The main concern is the activity of non-scheduled VFR traffic which is unpredictable and more difficult to manage due to the increased difficulty in seeing the smaller aircraft in the Remote Tower OTW. This leads us to conclude that without a change to the flexibility that currently exists for the VFR aircraft using in particular Cork airport, even single airport Control would be difficult from the Remote Tower at certain times.

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6 Demonstration Exercises reports

6.1 Demonstration Exercise #1 to 5 - Batch 1 Report

The following section is the summary of the exercises in Batch 1. As outlined in the demonstration plan, Batch 1 is comprised of exercise 1 to 5.

6.1.1 Exercise Scope

As outlined in Section 2 of this document the following table gives an overview of the plan, objectives and CONOPS for these exercises.

Demonstration Exercise ID and Title	**EXE-02.04-D-001 to EXE-02.04-D-005**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning
High-level description of the Concept of Operations	For these 5 exercises only the SMC will be handled by the Remote Tower. The AMC will continue to be provided by the Cork & Shannon Towers.
Applicable Operational Context	• Cork & Shannon airport • Mainly SMC (Surface Movements OPS) • General Vehicle activity around the airfield • General Aircraft Movement around the ground areas normally controlled by the SMC • Emergency Vehicle Airfield OPS
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 5 live trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

6.1.2 Conduct of Demonstration Exercise EXE-02.04-D-001 to EXE-02.04-D-005

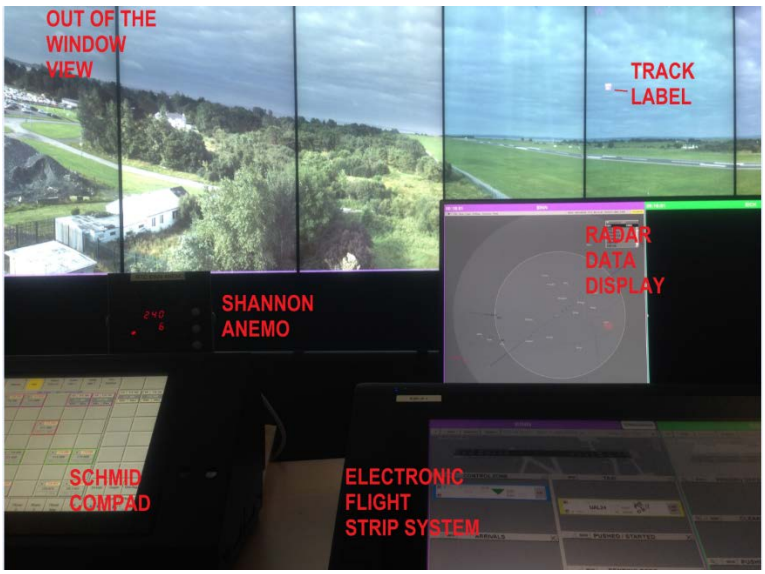
6.1.2.1 Exercise Preparation

As described in 4.2.1

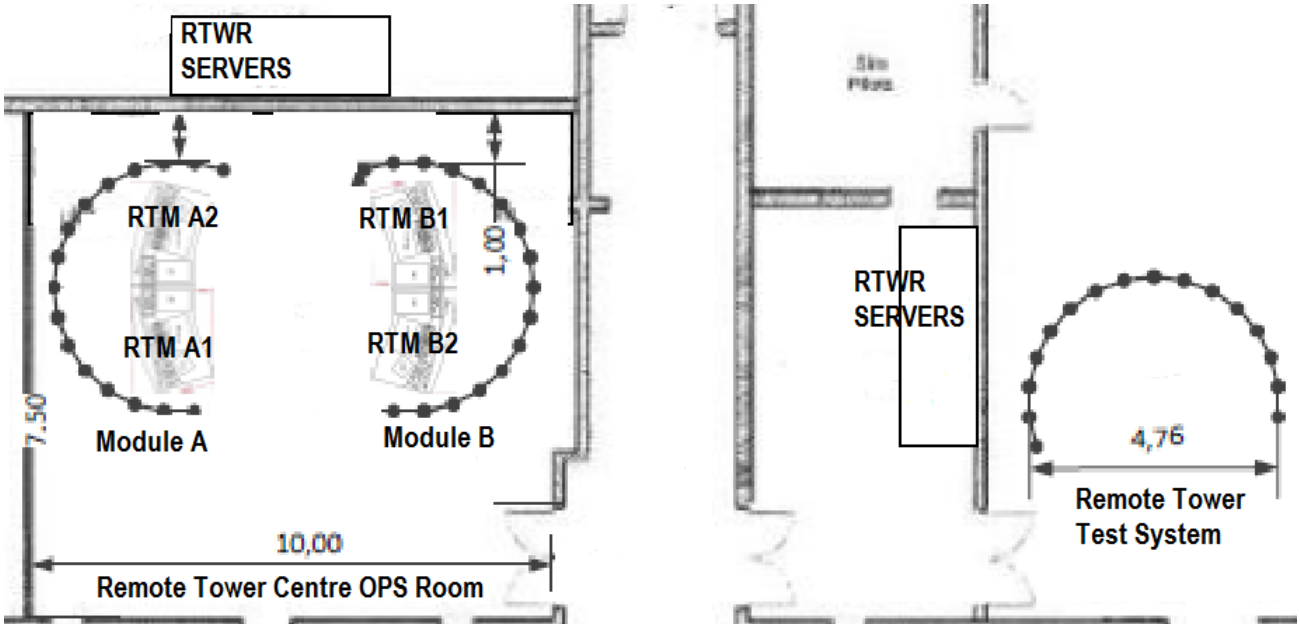
Each day the project team assembled and performed the following tasks:

- Systems check both from a Technical and Operational point of view;
- Coordination with the Local Towers to brief them on the planned activities and get initial feedback from them on any Local issues that may impact the trials;
- Analysis of the scheduled traffic into both airports using the EUROCONTROL CHMI tool;
- Analysis of any weather issues that may impact the trial;
- Decide on the targeted times to take control depending on the predicted sequence of traffic and the objectives for the upcoming exercise;

  The picture below shows the equipment that makes up one working position of a Remote Tower Module. The Remote Tower Module is comprised of two identical Controllerworking positions.



Remote Tower single working position.



Remote Tower Centre OPS Room and Test & Validation Room.

The RTC contained two identical remote Tower Modules, each with two identical working positions.

Each Remote Tower Module is comprised of 15 screens. 14 screens for the Out of the Window view at any one time and one spare screen.

All of the Remote Tower Trials were conducted in the Remote Tower Centre OPS Room. None of the trials were conducted on the test system.

Depending on what airport the Controller was responsible for the screen configuration was changed to suit the scenario for that exercise and could be dynamically changed during the exercise.

The following are typical screen configurations:

- 14 Screens used for Shannon displaying 14 cameras for a single airport with one camera view per screen;
- 14 Screens used for Cork displaying 14 cameras for a single airport with one camera view per screen;
- Screens used for Shannon displaying 14 cameras on 7 screens and 7 screens used for Cork displaying 14 Cameras on 7 screens;
- 11 screens used for Shannon displaying 11 Cameras on 11 screens and 3 screens used for Cork displaying 6 cameras on 3 screens.

6.1.2.2 Exercise execution

Once the exercise was prepared as outline above and the target time Role and time to take control was identified, the final preparations for exercise start was conducted as per the RTC Procedures for the trial namely:

- LSD 02 04 IAA_TWI_ATC Procedures for Local Tower (AMC_SMC) ATCOs during Remote Tower Trials EINN Rev 1
- LSD 02 04 IAA_TWI_ATC Procedures for Local Tower (AMC_SMC) ATCOs during Remote Tower Trials EICK Rev 0

Extract from the RTC Tower procedures:

20 minutes before transfer of Control

- *Cross check information on Local Tower strips against information on electronic strips at Remote Tower. This will be initiated through a phone call from the Remote Tower. If Local workload permits a cross check of the stand allocations, transponder codes and any upcoming training details should be included.*

  10 Minutes before transfer of Control
- *When Local workload permits commence detailed handover of position(s) to Remote Tower ATCO in accordance with current handover procedures including current weather data, airfield lighting status and nav-aid status.*

  1 minute before transfer of Control
- *Deselect Frequency Transmission on COMPAD in the Local Tower and temporarily operate on Radio Backup System in the Local Tower. This is to avoid simultaneous transmissions from two locations on a single transmitter which may cause transmitter failure.*

  At transfer of Control
- *When Handover is complete confirm transfer of control to the Remote Tower using the following phraseology.*
- *Local Tower Controller says - "Remote Tower you have Control"*
- *Remote Tower Controller says - "Roger I have Control"*
- ***From this point on the responsibility for the provision of ATS rests solely with the Remote Tower Controller who has assumed control of the position(s) which will remain with the Remote Tower Controller until transfer of control back to the Local Tower Controller has been completed***
- *Local Tower Controller shall advise Approach of position(s) transferred to Remote Tower*

Each exercise was run only once. The following are the list of exercises in Batch 1.

The first batch of 5 five demonstrations objective was to familiarise operational and technical ATS and airport personnel with the procedures to be used and the environment in which they will be operating.

Exercise Id	*Exercise Description*
001	SHANNON SMC only in Module RTM-A1
002	CORK SMC only in Module RTM-A2
003	Control of SNN SMC in RTM-A1 & Cork SMC in RTM-A2
004	Cork SMC first then SNN SMC combined on a single position
005	Cork SMC in RTWR A2 SNN SMC in RTWR 1 with different screen configuration to exercise 003

6.1.2.3 Deviation from the planned activities

In Batch 1 there was no deviation from the planned activities.

6.1.3 Exercise Results

6.1.3.1 Summary of Exercise Results

In order to gain an understanding of the results of Batch 1 exercises the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.1.3.1.1 Results per KPA

In order to gain an understanding of the results of Batch 1 exercises the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.1.3.1.2 Results impacting regulation and standardisation initiatives

In order to gain an understanding of the results of Batch 1 exercises the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.1.3.1.3 Unexpected Behaviours/Results

The following are the main Unexpected Behaviours/Results for Batch 1.

- In order to follow the necessary inter-station (RTC and Local Towers) co-ordination procedures, the increased co-ordination with the Local Tower during these exercises increased Controller workload at the RTC.

- The frequent use of the PTZ added to that Controller's workload. The Out of the Window view displays objects at a smaller size compared to the object size when viewed from the Local Tower, this makes it difficult to see smaller objects far away from the Camera. Therefore, the PTZ zoom Camera is important for monitoring Airport Hotspots. For areas of the airfield >1.5KM from the Cameras continuous use of the PTZ is required to get a clear view of the area. This PTZ Operation increases workload on the Controller and is a workload which does not exist in the Local Tower to the same extent. i.e. PTZ is required for use more than Binoculars. Suggestions to improve/ mitigate against this issue are listed in 5.3.1.2

6.1.3.1.4 Quality of Demonstration Results

The Quality of the exercise results in Batch 1 is can be categorised as high due to the high quality of the:

- Remote Tower System installation;
- The Communication systems;
- The project planning;
- The training & procedures development;
- The tailored Batch 1 objectives and scenarios were suitable for the phase of the project.

6.1.3.1.5 Significance of Demonstration Results

The Operational significance of the demonstration results can be assumed due to the traffic that presented itself during the Batch 1 was representative of the typical traffic appropriate for the objectives that were to be met for Batch 1.

6.1.4 Conclusions and recommendations

After the initial exercises and discussions with the project team, it was obvious that all four roles (2xAMC and 2XSMC) could only be carried out by a single Controller late in the evening when the traffic and workload was light. In addition, it was not feasible for one RTC Controller to Control the two AMC positions while another RTC Controller Controlled the two SMC positions as this would involve a significant amount of cross Coordination i.e. The RTC SNN AMC Controller would have to brief the RTC SNN SMC Controller on relevant information while at the same time also briefing him on RTC CRK SMC relevant information. It would be more efficient in future exercises when two Controllers were available for each to assume Control of AMC & SMC for a single airport thus eliminating any need for cross coordination between the two RTC Controllers. Due to the fact that this was a trial focusing on Multiple Airport Control, it was decided for the majority of exercises to leave the SMC in the Local Tower and assume Control of two AMC positions in a single RTC CWP for the majority of the exercises.

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6.2 Demonstration Exercise # 6 to 20 - Batch 2 Report

The following section is the summary of the exercises in Batch 2. As outlined in the demonstration plan, Batch 2 is comprised of exercise 6 to 20.

6.2.1 Exercise Scope

As outlined in Section 2 of this document the following table gives an overview of the plan, objectives and CONOPS for these exercises.

Demonstration Exercise ID and Title	**EXE-02.04-D-006 to EXE-02.04-D-010**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning
High-level description of the Concept of Operations	These 5 exercises will introduce aircraft in the air at one Airport controlled by AMC at the RTC. In addition the SMC control for both airports will also be handled by the Remote Tower. The AMC will be done by the RTC for one airport only and the other AMC will remain with the other airport. The SMC will control the ground traffic at both airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) controlled by RTC • Aircraft controlled by AMC at the RTC for a single airport
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 5 live trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01
Demonstration Exercise ID and Title	EXE-02.04-D-011 to EXE-02.04-D-015
Leading organization	Irish Aviation Authority

Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning • Initial measurements for "In Sequence" Operations
High-level description of the Concept of Operations	These 5 exercises will introduce aircraft in the air controlled by AMC at the RTC for the two airports. The AMC will be done by the RTC for both airports. The SMC will control the ground traffic at both airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic i.e. <3 aircraft for both airports.
Expected results per KPA	Safety: No degradation in Safety levels Human Performance: No negative impact on Controller workload Cost efficiency: Document initial results for a single ATCO performing the task which today is performed by two ATCOs Capacity: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 5 trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01
Demonstration Exercise ID and Title	EXE-02.04-D-016 to EXE-02.04-D-020
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • System Capability & Suitability • Operational CONOPS & Procedures Fine Tuning • Measurements for "In Sequence" Operations continue. • Initial measurements for "Simultaneous" Operations
High-level description of the Concept of Operations	These 5 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports. The
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic i.e. <3 aircraft for both airports. • Perform initial analysis on other influencing

	factors such as Daylight & poor weather conditions.
Expected results per KPA	Safety: No degradation in Safety levels Human Performance: No negative impact on Controller workload Cost efficiency: Document initial results for a single ATCO performing the task which today is performed by two ATCOs Capacity: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 5 trials in these exercises
Related projects in the SESAR Programme	P06.09.03 P12.04.06 P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

6.2.2 Conduct of Demonstration Exercise EXE-02.04-D-006 to EXE-02.04-D-020

6.2.2.1 Exercise Preparation

In Batch 2 the configuration and exercise preparation was identical to Batch 1 as described in 6.1.2.1.

6.2.2.2 Exercise execution

In Batch 2 the exercise detailed planning and execution was identical to Batch 1 as described in 6.1.2.1.

Each exercise was run only once. The following are the list of exercises in Batch 2.

The next 15 exercises included both SMC and AMC with incrementally increasing movements mixing arrivals and departures.

Exercise Id	*Exercise Description*
006	Control of SNN SMC in RTM-A1 & Cork SMC in RTM-A2
007	Control of SNN SMC & SNN AMC from a single position in RTM-A1. No Cork Positions.
008	Control of SNN AMC & SNN SMC in RTM-A1 and Cork SMC in RTM-A2
009	Continuation of exercise 08. Hand back CRK and split SNN SMC onto RTM-A2
010	Control of SMC & AMC from a single position RTM-A1. During the exercise the combined position got busy so we split the combined AMC/SMC single Operation into AMC on one position RTM-A1 and SMC on a separate position RTM-A2.
011	Control of SNN AMC in RTM-A1. Cork AMC in RTM-A2
012	Merge SNN AMC and Cork AMC in RTM-A2 This exercise is a continuation of exercise 11 whereby we kept control of both SNN & CRK AMC Roles but merged them onto a

	single position thereby making this exercise the first time Multiple AMC Control was performed from a single Remote Tower position.
013	Control of SNN AMC in RTM-A1 and CRK AMC in RTM-A2 The plan is to merge the two positions as soon as traffic allows
014	Control of SNN AMC in RTM-A1. Cork AMC in RTM-A2.
015	Control of SNN AMC in RTM-A1. CRK AMC in RTM-A2 Later SNN and CRK AMC combined in RTM-A2
016	Control of SNN AMC RTM-A1 CRK AMC RTM-A2 Later SNN & CRK AMC combined in RTM-A1
017	Control of SNN AMC in RTM-A1. CRK AMC in RTM-A2 Later SNN & CRK AMC combined in RTM-A2
018	Control of SNN AMC in RTM-A1. CRK AMC in RTM-A2. Due to traffic complexity it was not possible to merge.
019	Control of SNN & CRK AMC combined in RTM-A2
020	Control of SHA AMC in RTM-A1. No Control of CRK AMC due to Low visibility in Cork which needed to be discussed before actively Controlling in these conditions. Instead we performed passive Shadow OPS of CRK AMC to gain experience of Operating in Low Visibility.

6.2.2.3 Deviation from the planned activities

As outlined in 4.3 of this document in the Demonstration plan it was stated from exercise 11 onwards the AMC & SMC would be controlled from the RTC.

After the initial few exercises it was concluded:

- all four Roles could only be carried out by a single Controller late in the evening when the workload was light.
- It was not practical for one Controller to Control the two AMC Positions while another RTC Controller Controlled the two SMC positions. This would have led to a significant amount of cross Coordination i.e. The RTC SNN AMC Controller would have to brief the RTC SNN SMC Controller on relevant information while at the same time also briefing him on RTC CRK SMC relevant information.
- It would be more efficient in a future RTC operations with two Controllers on duty for each to assume Control of AMC & SMC for a single airport thus eliminating any need for cross over Coordination between the two RTC Controllers.

Due to the fact that this was a trial for Multiple Airport Control it was decided to leave the SMC in the Local Tower and assume Control of two AMC positions in a single RTC position for the majority of the exercises.

This enabled us to test the in sequence and simultaneous aircraft traffic that an AMC could handle without the additional workload of ground traffic.

6.2.3 Exercise Results

6.2.3.1 Summary of Exercise Results

In order to gain an understanding of the results of Batch 2 exercises the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.2.3.1.1 Results per KPA

In order to gain an understanding of the results of Batch 2 exercises the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.2.3.1.2 Results impacting regulation and standardisation initiatives

In order to gain an understanding of the results of Batch 2 exercises the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.2.3.1.3 Unexpected Behaviours/Results

The following are the main Unexpected Behaviours/Results for Batch 2.

- This was the first time AMC from both Local Towers were controlled at the same time which meant that in the RTC there were 6 frequencies being monitored i.e. 2 x AMC, 2 x SMC and 2 x APP.
    - *Note: The monitoring of the appropriate Approach (APP) frequency by AMC assists in maintaining situational awareness. In local towers the Approach Radar position is co-located therefore monitoring of this frequency is not necessary. The noise level of monitored frequencies is something that needs to be observed in future exercises.*
- Similarly, when both AMC positions were operated by a single controller in the RTC, all intercom calls were received in one position which greatly added to Controller workload.
- PTZ is important for monitoring Airport Hotspots, continuous use of which increases workload. PTZ issues:
    - When two Controllers were working in the RTC, as AMC or SMC Controllers, at times both controllers required the use of the PTZ. However simultaneous interaction with another different PTZ was not possible due to the current system design and created a situation where one controller did not have use of a PTZ;
    - When winds were >15kts, especially at Shannon, the PTZ had a difficulty auto-focusing when utilising high magnification;

- The interaction with the Out The Window (OTW) and the Radar data display (RDP) is conducted from the same mouse device, which sometimes can be hard to find as the mouse device is used on those two sub-systems and their associated screens.

6.2.3.1.4 Quality of Demonstration Results

The Quality of the exercise results in Batch 2 is can be categorised as high due to the high quality of the:

- Remote Tower System installation;
- The Communication systems;
- The project planning;
- The training & procedures development;
- The tailored Batch 2 objectives and scenarios were suitable for the phase of the project.
- The methodical documenting of traffic and comments during the exercises.

6.2.3.1.5 Significance of Demonstration Results

The Operational significance of the demonstration results can be assumed due to the traffic that presented itself during the Batch 2 was representative of the typical traffic appropriate for the objectives that were to be met for Batch 2. In addition, documented exercise results recording the actual traffic including the flight timing and the timing of Controller actions enabled the Project team to prove that Multiple Remote Tower Operations is possible and in what circumstances.

6.2.4 Conclusions and recommendations

6.2.4.1 Capacity

- While there were a number of comments during the debrief of these exercises in relation to workload impacts, *the control of a single Local Tower with both SMC and AMC positions* from an RTC was possible for the levels of traffic in the exercise scenario;

- The addition of the second Tower (Cork SMC on a separate position but from the same module) had little impact on the Shannon SMC/AMC Operation apart from some increased noise due to monitoring Cork frequencies. *The control of a single Local Tower with both SMC and AMC positions and a second single SMC position* was possible for the levels of traffic to be managed;

- *The control of multiple local Towers (AMC positions only)* was sometimes not possible for the levels of traffic to be managed.

  Some capacity examples

  - In one exercise with two VFR aircraft in the circuit in Cork, once the Local Tower was reduced to a single person operation the RTC was unable to combine Cork AMC with Shannon AMC. However, the RTC AMC Cork Controller was able to manage the VFR circuit traffic that was on the AMC frequency;

  - In one exercise it was not possible to merge the AMC for the two airports due to a number of training aircraft. Without the training aircraft SNN & CRK AMC positions

could have been merged but it would have been likely that some traffic would have been delayed;

- In another exercise the 'in sequence' presentation of traffic posed no problems for the Controller workload when controlling both Cork and Shannon AMC position. In advance of the positions being combined there were seven scheduled arrivals to the two airports in addition to a number of VFR aircraft. This initially made the workload too high to combine the two AMC Roles;

- In one exercise it was again demonstrated that two 'in sequence' arrival flights into the two airports were manageable but it was recorded that there could be times that items are delayed in one airport due to work on-going in another airport. In that particular exercise two vehicles were delayed. The Controller managed his workload in the exercise and was able to prioritise which work had to be done and which work could wait.

- There may be times when operation from the RTC would result in a more restricted operation compared to Local Tower operations, due to low cloud impacting the cameras and not impacting the Local Tower. In the case of Cork which is 502 feet AMSL, low cloud can result in the visibility from the Local Tower being better than the camera view as the camera installation is higher than the Local Tower. As a result, LVP may be invoked by the RTC when it would not be necessary at the Local Tower. It is difficult to determine a statistical value for the times when the cameras would be in cloud and the Local Tower not in cloud because cloud base by its very nature is not a single value but more a value which can change continually and quickly. To demonstrate this point, in one 20 minute period when the RTC had not yet assumed control there was almost zero visibility of the Runway at 11:25, full visibility of the runway at 11:35 and almost zero visibility of the Runway at 11:45;

- For future exercises, workload capacity must be monitored to ensure that unplanned pop up aircraft such as the SAR Helicopter can be accommodated without delay.

6.2.4.2 Systems

- There was recognition of the capability of the RTC systems to combine and split roles easily and quickly in order to adapt to changing in workload situations;

- System interaction with the OTW and the RDP via the mouse control was generally good. However, in order for the mouse pointer to stand out easily on the OTW:

  - the appearance of the mouse cross-hair could be enhanced;

  - a default resting position on the OTW to which the mouse reverts if not used could be incorporated. This is particularly relevant as the OTW and RDP share the same mouse device and this functionality would facilitate the Controller locating the mouse pointer;

- Discussion is required on the design, use and the operation of the PTZ function as it is an essential feature for RTC operations;

- Monitoring of vehicles and small aircraft at a distant point on the aerodrome requires regular manipulation of PTZ adding to controller workload;

- The Controller reported little difficulty in adapting to a 360 Degree circuit in the OTW view;

- It was observed that it was easier to monitor light aircraft on those approaches closer to the camera mast, e.g. a PA23 was easier to see landing on runway 06 in Shannon which is proximate to the cameras, however it was difficult to ascertain on the OTW view, without using the PTZ, when this aircraft had vacated onto taxiway 'C' at the 24 end of the runway, which is over 1.8 Km away from the cameras;

- Object Tracking on the OTW view worked well for SMC operations but also in the case of two helicopters operating in the vicinity of Shannon airport allowing the Controller to maintain situational awareness and to easily re-locate them on the OTW view while monitoring other IFR traffic approached for landing. However, it does need improvement, in particular Vehicles and small aircraft on a Runway and taxiway at a long distance e.g. Threshold Runway 24 Shannon quite often do not show up. In particular, if the object is not moving for a while the box disappears. A possible improvement could be that if an object is detected as moving onto a Runway that the box would remain around the object even if stationary for a period of time.

6.3 Demonstration Exercise # 21 to 30 - Batch 3a Report

As outlined in the demonstration plan, Batch 3 is comprised of exercise 21 to 50. The following section is the summary of the first 10 exercises in Batch 3.

6.3.1 Exercise Scope

As outlined in Section 2 of this document the following table gives an overview of the plan, objectives and CONOPS for these exercises.

Demonstration Exercise ID and Title	**EXE-02.04-D-021 to EXE-02.04-D-030**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • Measurements for "In Sequence" Operations continue. • Measurements for "Simultaneous" Operations continues • The main objective will be to explore the influencing factors on the limits of simultaneous operations.
High-level description of the Concept of Operations	These 10 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic. • Perform initial analysis on other influencing factors such as daylight & poor weather conditions. • Simultaneous Operations consisting of Arrivals followed by Departures and also Departures followed by Departures or Arrivals.
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 10 trials in these exercises
Related projects in the SESAR	P06.09.03 P12.04.06

Programme	P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

6.3.2 Conduct of Demonstration Exercise EXE-02.04-D-021 to EXE-02.04-D-030

6.3.2.1 Exercise Preparation

In Batch 3 the configuration and exercise preparation was identical to Batch 1 as described in 6.1.2.1.

6.3.2.2 Exercise execution

In Batch 3 the exercise detailed planning and execution was identical to Batch 1 as described in 6.1.2.1.

Each exercise was run only once. The following are the list of the first 10 exercises in Batch 3.

These 10 exercises continued to control air and ground operations from the RTC for the two airports with the purpose of measuring "In Sequence" and "Simultaneous" aircraft operations.

Exercise Id	*Exercise Description*
021	Control of SNN AMC in RTM-A1. CRK AMC in RTM-A2 initially then later in the exercise SNN & CRK AMC combined in RTM-A2
022	Control of SNN AMC in RTM-A1 CRK AMC in RTM-A2 initially then later in the exercise SNN & CRK AMC combined in RTM-A2
023	Control of SNN & CRK AMC combined in RTMA1
024	Control of SNN AMC in RTM-A1 CRK AMC in RTM-A2 Later SNN & CRK AMC combined in RTM-A2
025	Continuation of exercise 024. Control of SNN & CRK AMC combined in RTM-A2
026	Control of SNN AMC in RTM-A1 CRK AMC in RTM-A2 initially then later in the exercise SNN & CRK AMC combined in RTM-A2
027	Control of SNN AMC in RTM-A1 CRK AMC in RTM-A2 initially then later in the exercise SNN & CRK AMC combined in RTM-A2
028	Control of SNN & CRK AMC combined in RTM-A2
029	Control of SNN & CRK AMC combined in RTM-A2
030	Control of SNN & CRK AMC combined in RTM-A2

6.3.2.3 Deviation from the planned activities

As outlined in 4.3 of this document in the Demonstration plan it was stated from exercise 11 onwards the AMC & SMC would be controlled from the RTC.

After the initial few exercises it was concluded:

- all four Roles could only be worked by a single Controller late in the evening when the workload was light.

– it equally made no sense for one Controller to Control the two AMC Positions while another RTC Controller Controlled the two SMC positions. This would have led to a significant amount of cross Coordination i.e. The RTC SNN AMC Controller would have to brief the RTC SNN SMC Controller on relevant information while at the same time also briefing him on RTC CRK SMC relevant information.

– It would be more efficient in a future RTC Operations with two Controllers on duty for each to assume control of AMC & SMC for a single airport thus eliminating any need for cross over Coordination between the two RTC Controllers.

Due to the fact that this was a trial for Multiple Airport Control we therefore decided for the majority of exercises to leave the SMC in the Local Tower and assume Control of two AMC positions in a single RTC position for the majority of the exercises.

This enabled us to test the in sequence and simultaneous aircraft traffic that an AMC could handle without the additional workload of ground traffic.

6.3.3 Exercise Results

6.3.3.1 Summary of Exercise Results

In order to gain an understanding of the results for the first 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below
- Review the Conclusions & Recommendations section below
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.3.3.1.1 Results per KPA

In order to gain an understanding of the results for the first 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below
- Review the Conclusions & Recommendations section below
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.3.3.1.2 Results impacting regulation and standardisation initiatives

In order to gain an understanding of the results for the first 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below
- Review the Conclusions & Recommendations section below
- For more detail review the LSD 02 04 IAA Remote Tower Trial exercise results document (Annex 1) which contains details of each exercise.

6.3.3.1.3 Unexpected Behaviours/Results

The following are the main Unexpected Behaviours/Results for the first 10 exercises in Batch 3.

Depth perception on OTW.

- It was felt that while depth perception was possible in the RTC, it was easier to judge the position of an aircraft in relation to another aircraft from the local tower than the RTC. It was agreed that where there were more than two aircraft in the vicinity of an

airport, Controller knowledge of aircraft size was advantageous in determining which aircraft was closer e.g. a medium size aircraft 5 DME from an airport may be represented on the OTW view as being the same size as a small aircraft closer to the airport;

- There was some difficulty in establishing from the OTW whether VFR aircraft had passed each other, the controller being reliant on reports from pilots to confirm this. Therefore, in any future RTC environments additional procedures/practises may have to be developed to support this issue;

- The height and location of the RTC cameras, compared to the location and height of the Local Tower, particularly in Shannon where the cameras are lower than the Local Tower, made difficult to clearly differentiate between traffic on Taxiway C and D2.

6.3.3.1.4 Quality of Demonstration Results

The Quality of the exercise results in Batch 3 is can be categorised as high due to the high quality of the:

- Remote Tower System installation;
- The Communication systems;
- The project planning;
- The training & procedures development;
- The tailored Batch 3 objectives and scenarios were suitable for the phase of the project;
- The methodical documenting of traffic and comments during the exercises.

6.3.3.1.5 Significance of Demonstration Results

The Operational significance of the demonstration results can be assumed due to the traffic that presented itself during the Batch 3 was representative of the typical traffic appropriate for the objectives that were to be met for Batch 3. In addition, documented exercise results recording the actual traffic including the flight timing and the timing of Controller actions enable the Project team to prove that Multiple Remote Tower Operations is possible and in what circumstances.

6.3.4 Conclusions and recommendations

The general conclusions and recommendations of LSD 02.04 are as follow:

6.3.4.1 CONOPS

- In a Multiple Airport Simultaneous Operations (MASO) environment, with **two simultaneous departures at two different airports**, with a single RTC controller, it would be better to add more time between the two cleared for take-off instructions so that the Controller can monitor the roll and initial rotation before clearing the second aircraft for take-off.

- In a Multiple Airport Operations (MASO) environment, **with one arrival at one airport followed by a departure at the other airport**, ideally the landing aircraft

should be steady on the Runway i.e. that the Controller is satisfied that the aircraft can continue safely on the ground, before clearance for take-off is given to another aircraft in the other aerodrome;

- In a Multiple Airport Simultaneous Operations (MASO) environment **with one departure at one airport followed by an arrival at the other airport**, ideally time should be allowed after the cleared for take-off instruction so that the Controller can monitor the roll and initial rotation of the departing aircraft before the arrival aircraft is 2NM from touchdown at the other aerodrome;

- In a Multiple Airport Simultaneous Operations (MASO) environment and **with training traffic performing a simulated engine failure at one airport**, it is recommended that a clearance for take-off to an aircraft in the other airport would not be given until the aircraft performing the simulated engine failure reported that the aircraft had recovered from the simulated engine failure, or that the request for a simulated engine failure after take-off would be deferred until there was no critical phase movement at the other airport;

- In a Multiple Airport Simultaneous Operations (MASO) environment **with two simultaneous arrivals into two different airports**, some spacing should exist between them, perhaps around 2NM between the landing aircraft and the aircraft on approach at the second airport. However, due to the unpredictability of speeds at the final stages of approach this is not a final conclusion and was further explored in subsequent exercises.

- Controllers can apply delay techniques, in particular when there is a departure involved, in order to provide “in sequence” operations so as to avoid unnecessary “simultaneous” arrivals/departures at different airports;

- Generally, traffic is naturally spaced and is manageable but on occasion there is the possibility that traffic in one airport experiences a slight delay while the Controller is controlling traffic at the other airport. As experience was gained Controllers were more at ease utilising delay tactics to assist in this spacing with minimal or insignificant delay to aircraft.

6.3.4.2 Capacity

- The unpredictable nature of the training aircraft made the decision to merge and split SNN & CRK AMC difficult. (There is a busy Flight Training Operation at Cork). Therefore, in any future RTC Operation which required the possibility to merge AMC Roles, a mechanism to determine the future workload of non-scheduled training traffic would have to be examined;

- There is a discussion required around the impact on workload of maintaining visual contact with smaller items of traffic in the circuit in an RTC system environment. There is a possibility that some of this workload increase could be reduced with a combination of:

    - more experience with this type of traffic in RTC operation;
    - Additional system capabilities, such as:
        - automatic PTZ tracking;
        - a second PTZ view;
        - fixed PTZ cameras on critical areas;
        - improved Object and Radar Tracking;
        - greater ease in locating the mouse cursor.

- There were a number of factors causing a feeling of increased workload in the RTC compared to the Local Tower such as:

    - Difference in O.T.W. view compared to the local tower;

    - Requirement for P.T.Z. to see smaller aircraft and to check that the runway thresholds were clear; in particular thresholds a long distance from the camera;

    - The edge lights on one Runway close to the threshold, appeared to pulsate when PTZ was auto-focusing, this looking similar to a vehicle beacon which can be disconcerting for a controller, who then had to use the PTZ to ensure that the runway was clear;

    - The communications HMI with Shannon on one COMPAD unit and Cork on the other COMPAD unit as well as monitoring the approach frequencies in the background;

    - Additional controller thinking time is being used due to a conscious effort to say the correct airport, runway and frequency when communicating with items at both airports.

6.3.4.3 Systems

- VFR circuit traffic is more difficult to monitor than in the local tower and the availability of information from the radar display was an important support to the controller in managing their integration with IFR arrivals and departures.

6.4 Demonstration Exercise # 31 to 40 - Batch 3b Report

As outlined in the demonstration plan, Batch 3 is comprised of exercise 21 to 50. The following section is the summary of the second 10 exercises in Batch 3.

6.4.1 Exercise Scope

As outlined in Section 2 of this document the following table gives an overview of the plan, objectives and CONOPS for these exercises.

Demonstration Exercise ID and Title	**EXE-02.04-D-031 to EXE-02.04-D-040**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • Measurements for "In Sequence" Operations continue. • Measurements for "Simultaneous" Operations continues • The main objective will be to continue to explore the minimum required spacing between two arrivals.
High-level description of the Concept of Operations	These 10 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports in light traffic. • Perform continued analysis on other influencing factors such as Daylight & poor weather conditions. • Simultaneous Operations consisting of Arrivals to both airports.
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 10 trials in these exercises
Related projects in the SESAR	P06.09.03 P12.04.06

Programme	P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

6.4.2 Conduct of Demonstration Exercise EXE-02.04-D-031 to EXE-02.04-D-040

6.4.2.1 Exercise Preparation

In Batch 3 the configuration and exercise preparation was identical to Batch 1 as described in 6.1.2.1.

6.4.2.2 Exercise execution

In Batch 3 the exercise detailed planning and execution was identical to Batch 1 as described in 6.1.2.1.

Each exercise was run only once. The following are the list of the second 10 exercises in Batch 3.

These 10 exercises continued to manage AMC and SMC from the RTC for the two airports with one Controller for the purpose of measuring "In Sequence" and "Simultaneous" aircraft operations. Reduced Visibility Procedures (RVP) scenarios and twilight conditions were trialled in this Batch.

Exercise Id	*Exercise Description*
031	Control of SNN & CRK AMC combined in RTM-A2
032	Control of SNN & CRK AMC combined in RTM-A1 Control of SNN & CRK SMC combined in RTM-A2 initially then later in the exercise Control of SNN & CRK AMC & SMC combined in RTM-A2
033	Control of SNN AMC in RTM-A1. CRK AMC in RTM-A2 initially then later in the exercise SNN and CRK AMC combined in RTM-A2
034	Control of SNN & CRK AMC combined in RTM-A2
035	Control of SNN AMC in RTM-A1 CRK AMC in RTM-A2 initially then later in the exercise SNN & CRK AMC combined in RTM-A2
036	Control of SNN AMC& SMC in RTM-B2 Control of CRK AMC& SMC in RTM-A2
037	Control of SNN & CRK AMC & SMC combined in RTM-A2
038	Control of SNN AMC in RTM-A1 Control of SNN SMC in RTM-A2 The objective of the next series of exercises is to follow the progression of workload through periods of the day starting with 2 Controllers at one airport and in the next exercise moving to 1 Controller per airport.
039	Control of SNN AMC& SMC in RTM-B2 Control of CRK AMC& SMC in RTM-A2
040	Control of SNN & CRK AMC & SMC combined in RTM-A2

6.4.2.3 Deviation from the planned activities

As outlined in 4.3 of this document in the Demonstration plan it was stated from exercise 11 onwards the AMC & SMC would be controlled from the RTC.

After the initial few exercises it was concluded:

- all four Roles could only be worked by a single Controller late in the evening when the workload was light.
- It was not practical for one Controller to Control the two AMC Positions while another RTC Controller Controlled the two SMC positions. This would have led to a significant amount of cross Coordination i.e. The RTC SNN AMC Controller would have to brief the RTC SNN SMC Controller on relevant information while at the same time also briefing him on RTC CRK SMC relevant information.
- It would be more efficient in a future RTC Operations with two Controllers on duty then they would each assume Control on AMC & SMC for a single airport thus eliminating any need for cross over Coordination between the two RTC Controllers.

Due to the fact that this was a trial for Multiple Airport Control we therefore decided for the majority of exercises to leave the SMC in the Local Tower and assume Control of two AMC positions in a single RTC position for the majority of the exercises.

This enabled us to test the in sequence and simultaneous aircraft traffic that an AMC could manage without the additional workload of ground traffic.

6.4.3 Exercise Results

6.4.3.1 Summary of Exercise Results

In order to gain an understanding of the results for the second 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- and for more detail review LSD 02 04 IAA Remote Tower Trial exercise results document which contains the detail of each exercise.

6.4.3.1.1 Results per KPA

In order to gain an understanding of the results for the second 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- and for more detail review LSD 02 04 IAA Remote Tower Trial exercise results document which contains the detail of each exercise.

6.4.3.1.2 Results impacting regulation and standardisation initiatives

In order to gain an understanding of the results for the second 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- and for more detail review LSD 02 04 IAA Remote Tower Trial exercise results document which contains the detail of each exercise.

6.4.3.1.3 Unexpected Behaviours/Results

The following are the main Unexpected Behaviours/Results for the second 10 exercises in Batch 3.

- There was an example of an aircraft being replied to on the incorrect frequency, i.e. an aircraft calling Shannon was answered on a Cork frequency. The ATCO perceived this as being partly due to the fact that the aircraft in Shannon was observed on a screen to the right of the controller, a screen which previously had been dedicated to Cork, but due to its configuration at the particular time was displaying Shannon. The controller then pressed the corresponding PTT switch in his right hand, transmitting the reply on Cork frequency;

- On one occasion the position of bird activity at in Cork was more difficult to establish from the RTC than from the Local Tower. It was difficult to ascertain if the birds were to the left of RWY 07 or over the threshold RWY 07;

- The label on the RDP display in the RTC is different to what the Controller sees in his Local Tower and on one occasion he misjudged the speed of an arrival aircraft. This resulted in a slight delay to lining up a departing aircraft;

- IR (infra-red) functionality, as available in the RTC, did not appear to offer any additional capacity to monitor the movement of traffic in Cork airport during Low/Reduced Visibility Operations;

- The OTW view performed well in twilight conditions.

6.4.3.1.4 Quality of Demonstration Results

The Quality of the exercise results in Batch 3 is can be categorised as high due to the high quality of the:

- Remote Tower System installation;
- The Communication systems;
- The project planning;
- The training & procedures development;
- The tailored Batch 3 objectives and scenarios were suitable for the phase of the project;
- The methodical documenting of traffic and comments during the exercises.

6.4.3.1.5 Significance of Demonstration Results

The Operational significance of the demonstration results can be assumed due to the traffic that presented itself during the Batch 3 was representative of the typical traffic appropriate for the objectives that were to be met for Batch 3. In addition, documented exercise results recording the actual traffic including the flight timing and the timing of Controller actions enable the Project team to prove that Multiple Remote Tower Operations is possible and in what circumstances.

6.4.4 Conclusions and recommendations

6.4.4.1 CONOPS

- *(Updated Conclusion/Recommendation)* In a Multiple Airport Simultaneous Operations (MASO) environment and **with two simultaneous arrivals into two**

different airports, following this batch of exercises it was concluded that ideally the first landing aircraft should be steady on the runway before the second arrival aircraft is 1NM from touchdown at the other aerodrome. Management of the arrivals to meet this guideline will be difficult, therefore in the event that this guideline cannot be achieved it is suggested that the Controller will use best judgement to allow the second aircraft to continue to land, or to initiate a go-around;

- *(Updated Conclusion/Recommendation)* In a Multiple Airport Simultaneous Operations (MASO) environment **with one departure at one airport followed by an arrival at the other airport**, ideally time should be allowed after the cleared for take-off instruction so that the Controller can monitor the roll and initial rotation of the departing aircraft before the arrival aircraft is 1NM from touchdown at the other aerodrome;

- Applicability of Reduced Separation rules in the vicinity of an aerodrome for VFR traffic can be a useful tool in a RTC environment. However, caution has to be exercised when providing ATS to Students pilots and solo Students;

- Changes in certain local procedures (e.g. use of a single frequency for AMC & SMC when both positions are amalgamated in the Local Tower, rather than two frequencies as it is currently the case) would decrease the controller's workload and free up frequency talk time in a RTC environment. Any such change would have to go through the SMS process for changes to the ATM system;

- There are certain procedures related to R/T (radio telephony) where improvements could be obtained in order to minimise R/T occupancy by aircraft or vehicles. (e.g. "monitor the frequency "instructions) for the purpose of achieving more positive R/T control particularly in a Remote Tower environment.

6.4.4.2 Capacity

- Without the complication and added workload of VFR aircraft the RTC Controller can handle the same traffic as the Local Tower. However, as stated previously there is added workload in the RTC due to the view not being the same as the Local Tower. In general, this workload increase can be taken on-board by the RTC Controller but further work is required to fully assess the limitations of the RTC Controller in capacity terms;

- In a particular exercise of this Batch the workload was similar to the Local Tower and the view was that a merge during that period with Cork Tower activities was not possible. If there were additional VFR aircraft, it would have been more difficult and there would have been additional workload associated with PTZ operation;

- In any future RTC environment, merging two AMC positions will most likely involve having the control of the SMC positions as well. This will have a positive effect in that the Controller can streamline the departure traffic, making it easier to manage the workload but a negative effect of all of the additional SMC tasks;

- In twilight conditions there would be no need to adjust or increase the spacing between simultaneous aircraft movements at Cork and Shannon. It is noted that this

also depends on the weather at the time because obviously in poor weather conditions twilight does not last long until there is complete darkness.

6.4.4.3 Systems

- Full transfer of both working positions from Module B to Module A, including handover to a colleague, operating as Cork AMC and SMC on this Module, was initiated. It took 25 seconds for the OTW on Module A to fully display Shannon airport; within 60 seconds the EFS for Shannon on Module A could be interacted with and after 90 seconds the Radar Data display for Shannon was useable on Module A and a single controller had control of all four positions (AMC & SMC Cork and Shannon) on Module A. This was a very positive result which demonstrated the systems capability to merge positions and airports as workload decreases.

6.4.4.4 Human Factors

- In this Batch of exercises, it was clear that Controllers were getting more familiar with the equipment and routine tasks;
- Controllers feel more comfortable handling simultaneous non-complex traffic scenarios with the application of ATC time management techniques when required;
- Discussion was required as to how long a single Controller could manage and operate the four selected frequencies 2xSMC & 2xAMC and monitor both approach frequencies without experiencing mental fatigue;
- Discussion in detail was required as to what level of complexity would be acceptable, from a human factors point of view, in a multiple airport scenario. The initial approach, based on the observed exercises, would dictate that air and ground traffic must be light and complexity low in order to assume all four roles AMC & SMC Cork and AMC & SMC Shannon in one;
- For that aforementioned purpose: Could complexity been measured in terms of items of traffic in both airports, or in terms of “number of conflicts’’ between the two airports to ascertain and lay down operational limits for one single Controller managing AMC & SMC in two airports? These aspects will have to be looked at later in these trials or in future studies.

6.5 Demonstration Exercise # 41 to 50 - Batch 3c Report

As outlined in the demonstration plan, Batch 3 is comprised of exercise 21 to 50. The following section is the summary of the final 10 exercises in Batch 3.

6.5.1 Exercise Scope

As outlined in Section 2 of this document the following table gives an overview of the plan, objectives and CONOPS for these exercises.

Demonstration Exercise ID and Title	**EXE-02.04-D-041 to EXE-02.04-D-050**
Leading organization	Irish Aviation Authority
Demonstration exercise objectives	The High level objective is to verify: • That Tower ATC Operations of both AMC and SMC can be controlled by a Single ATCO from an RTC. When required it can be supplemented by assigning a dedicated SMC at the RTC.
High-level description of the Concept of Operations	These 10 exercises will continue to handle Air and Ground Operations controlled by the RTC for the two airports by a single ATCO. The exercises will basically will be standard Operations for both Towers (light traffic) controlled by the RTC.
Applicable Operational Context	• Cork & Shannon airport • All SMC (Surface Movements OPS) • All Aircraft controlled by AMC at the RTC for both airports with the workload limitation closely monitored. • Perform continued analysis on other influencing factors such as Daylight & poor weather conditions.
Expected results per KPA	**Safety**: No degradation in Safety levels **Human Performance**: No negative impact on Controller workload **Cost efficiency**: Document initial results for a single ATCO performing the task which today is performed by two ATCOs **Capacity**: No negative impact on Capacity or traffic that can be handled in this mode.
Number of flight trials	At least 10 trials in these exercises
Related projects in the SESAR	P06.09.03 P12.04.06

Programme	P12.04.07 P12.04.08 P12.04.09
OFA addressed	OFA 06.03.01

6.5.2 Conduct of Demonstration Exercise EXE-02.04-D-041 to EXE-02.04-D-050

6.5.2.1 Exercise Preparation

In Batch 3 the configuration and exercise preparation was identical to Batch 1 as described in 6.1.2.1.

6.5.2.2 Exercise execution

In Batch 3 the exercise detailed planning and execution was identical to Batch 1 as described in 6.1.2.1.

Each exercise was run only once. The following are the list of the final 10 exercises in Batch 3.

These 10 exercises continued with the management of SMC and AMC controlled by the RTC for the two airports by a single ATCO with the purpose of measuring "In Sequence" and "Simultaneous" operations. Low Visibility Procedures (LVP) scenarios and twilight and darkness conditions were trialled in this Batch.

Exercise Id	*Exercise Description*
041	Control of SNN & CRK AMC & SMC combined in RTM-A2
042	Control of CRK SMC in RTM-A1 & CRK AMC in RTM-A2
043	Control of SNN SMC in RTM-A1 SNN AMC in RTM-A2
044	Control of SNN and CRK AMC combined in RTM-A2
045	Control of SNN and CRK AMC combined in RTM-A2
046	Continuation of Ex.45 Control of SNN and CRK AMC combined in RTM-A2
047	Control of SNN and CRK AMC combined in RTM-A2
048	Control of SNN and CRK AMC combined in RTM-A2
049	Control of SNN AMC on RTA 1 and CRK AMC combined in RTM-A2 initially then later in the exercise Control of SNN & CRK AMC & SMC combined in RTM-A2
050	Control of SNN & CRK AMC & SMC combined in RTM-A2

6.5.2.3 Deviation from the planned activities

As outlined in 4.3 of this document in the Demonstration plan it was stated from exercise 11 onwards the AMC & SMC would be controlled from the RTC.

After the initial few exercises it was concluded:

- all four Roles could only be worked by a single Controller late in the evening when the workload was light;
- it was not practical for one Controller to Control the two AMC Positions while another RTC Controller Controlled the two SMC positions. This would have led to a significant

amount of cross Coordination i.e. The RTC SNN AMC Controller would have to brief the RTC SNN SMC Controller on relevant information while at the same time also briefing him on RTC CRK SMC relevant information;

– It would be more efficient in a future RTC Operations with two Controllers on duty for each to assume Control on AMC & SMC for a single airport thus eliminating any need for cross over Coordination between the two RTC Controllers.

Due to the fact that this was a trial for Multiple Airport Control we therefore decided for the majority of exercises to leave the SMC in the Local Tower and assume Control of two AMC positions in a single RTC position for the majority of the exercises.

This enabled us to test the in sequence and simultaneous aircraft traffic that an AMC could handle without the additional workload of ground traffic.

6.5.3 Exercise Results

6.5.3.1 Summary of Exercise Results

In order to gain an understanding of the results for the final 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- and for more detail review LSD 02 04 IAA Remote Tower Trial exercise results document which contains the detail of each exercise.

6.5.3.1.1 Results per KPA

In order to gain an understanding of the results for the final 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- and for more detail review LSD 02 04 IAA Remote Tower Trial exercise results document which contains the detail of each exercise.

6.5.3.1.2 Results impacting regulation and standardisation initiatives

In order to gain an understanding of the results for the final 10 exercises of Batch 3 the reader should:

- Review the Unexpected Behaviours/Results below;
- Review the Conclusions & Recommendations section below;
- and for more detail review LSD 02 04 IAA Remote Tower Trial exercise results document which contains the detail of each exercise.

6.5.3.1.3 Unexpected Behaviours/Results

The following are the main Unexpected Behaviours/Results for the final 10 exercises in Batch 3.

- In the RTC, fast climbing traffic departing Shannon runway 24 disappeared out of the OTW view, faster than it would in the local tower, before re-appearing as it moved away from the RTC cameras. This could slightly delay the issuing of a take-off clearance or a go-around clearance to a subsequent flight at Shannon, when compared to the Local Tower, until the RTC Controller is satisfied the departure is clear;

- An aircraft making an approach in darkness to one of the airports flew low level along the RWY before initiating a Go-Around. From the RTC it was difficult to determine if the aircraft had landed however in the local tower the consensus was that it could be seen that the aircraft had not touched down. The aircraft then performed a go-around;

- The object tracking was less useful in darkness than in daylight due to the proliferation of ambient light surrounding the airports at night

6.5.3.1.4 Quality of Demonstration Results

The Quality of the exercise results in Batch 3 is can be categorised as high due to the high quality of the:

- Remote Tower System installation;
- The Communication systems;
- The project planning;
- The training & procedures development;
- The tailored Batch 3 objectives and scenarios were suitable for the phase of the project;
- The methodical documenting of traffic and comments during the exercises.

6.5.3.1.5 Significance of Demonstration Results

The Operational significance of the demonstration results can be assumed due to the traffic that presented itself during the Batch 3 was representative of the typical traffic appropriate for the objectives that were to be met for Batch 3. In addition, documented exercise results recording the actual traffic including the flight timing and the timing of Controller actions enable the Project team to prove that Multiple Remote Tower Operations is possible and in what circumstances.

6.5.4 Conclusions and recommendations

6.5.4.1 CONOPS

- *(Updated Conclusion/Recommendation):* When in a Multiple Airport Simultaneous Operations (MASO) environment and **with two simultaneous arrivals into two different airports** ideally the first landing aircraft should be steady on the Runway before the second arrival aircraft is 1NM from touchdown at the other aerodrome. Meeting this guideline has been identified as difficult and it could happen that this guideline could not be accomplished due to varying speeds on final approach of the two aircraft. Any such recommendation when implemented in the future would be supported by an additional caveat such which should give the Controller the authority to exercise professional judgement with regard to the issuance of a landing clearance to the arriving aircraft;

  In this regard Controller will use a number of factors in deciding if second aircraft can to continue to land, such as:
  - Is the arrival Runway clear of obstructions;
  - Prevailing weather;
  - Complexity of the workload.

- **In Multiple Airport Simultaneous Operations (MASO)** the influencing factors such as night operations, poor visibility, or high cross wind conditions would advocate that

in sequence aircraft operations would be preferable to simultaneous operations. This recommendation should be reviewed as more experience is gained;

- In darkness, in order to ascertain the position of aircraft and vehicles, Controllers must rely most of the time on the aircraft and vehicle lights on the OTW, or on position reports from pilots/drivers. This would be the case in the Local Tower at one of the airports for certain portions of the movement area and when using a particular runway;

- Certain working practices at various airports may need to be reviewed in light of RTC operations, such as;

    - Field Lighting inspection being carried out at de-conflicting times of the day for each of the airports involved;
    - Possibility of renaming airport vehicles at both airports to avoid confusion.

6.5.4.2 Capacity

- Low visibility results in additional workload due to:

    - The Controller needs to be cognizant of the different procedures applicable to different airports;
    - Difficult to see items on the airfield on the OTW view;
    - When runways at different airports are occupied/blocked at the same time it could potentially happen that when one RWY is vacated the controller could make an incorrect electronic flight strip input and unblock the RWY at the incorrect airport.

6.5.4.3 Systems

- During Low Visibility Procedures (LVP) or Reduced Visibility Procedures (RVP) the view depicted in the RTC by the OTW is not as good when compared to the Local Tower. This could have an impact on operations in that it could cause the application of LVP earlier than would be the case at the Local Tower. In one of the airports this is compounded by the RTC Camera sitting higher (26m) than the Local Tower (approx. 15m) and more distant from the runway and other parts of the manoeuvring area. As a result, less traffic would be facilitated compared to the Local Tower;

- Compensating features for LVP/RVP, such as the Infrared cameras, need to be improved before they can be considered for use as an acceptable means of compliance with LVP/RVP procedures;

- Importance of camera mast placement is acknowledged. Any ANSP considering RTC operations should devote considerable time to this decision;

- Twilight is considered one of the best times in the RTC and would have no impact on simultaneous aircraft operation because:

- Aircraft lights are easier to see;
- Normally there is little or no VFR traffic;
- There is good visibility in the OTW of runways, taxiways and movement area in general;

- The use of overlays on the OTW outlining the runways at night is very useful as at night there are no visual references to differentiate between Cork and Shannon;

- When operating the RTC in darkness, an overlay mark determining when an aircraft is clear of a runway would be useful;

- The use of the PTZ to ascertain if there is precipitation at the aerodrome when operating in darkness may be required.

6.5.4.4 Human Factors

- Workload management in the provision of ATS for two Towers is a new task for Controllers and practice is required to even out the workload by distributing tasks that can be distributed;

- Controllers must be alert to the possibility of call sign similarity with aircraft on different airports;

- Heads Down discussion:

  "Is there more heads down time in the RTC compared to the local tower?"

  - In general, the answer was that the operation of paper strips in the local tower took approximately the same amount of time as the EFS;

  - There are some additional tasks on the EFS such as vehicle management but likewise the paper strips have to be placed in the plastic holders and removed from the plastic holders so it balances out.

  The conclusion of the project team was that there is not more heads down time in the RTC operation.

- From a Human Factors perspective, the rules governing the display of the anemometers may need to be reconsidered if the same module is used for single and multiple airports operations (whereby the anemometers for both airports displayed in the same module could potentially lead to confusion when switching from multiple to single airports operations in that same module).

  - It took a high level of concentration to watch both wind displays and ensure a mistake was not made by giving the wrong wind to the wrong pilot.

7 Summary of the Communication Activities

Following completion of the fifty live trial exercises which made up LSD 02.04, the main communications vehicle for publication of information is the IAA website and the primary means used is the posting of video material. A previous video showing the RTC and local tower installations with voiceover explaining the remote towers project has received in excess 2700 views on utube. During the demonstration period familiarisation visits to the RTC by the FAA representatives involved in NextGen and airline pilots from Irish airlines and this is continuing. From an internal perspective, articles are being prepared for publication in the IAA quarterly magazine. In addition, the project sponsor's public relations communication process is being used to inform and update external targeted stakeholders on the successful completion of the live trial demonstration. This activity is ongoing pending a decision by the IAA on deployment. Following expressions of interest from a number of organisations, Open Days in the RTC are planned for 8th and 9th November 2016. At time of writing stakeholders from the following countries are expected to attend: Denmark, Germany, Hungary, Poland, Sweden and the UK. In addition, invitations have issued to Irish airlines, ANSPs, airport operators, SAAB and officials from Department of Transport, Tourism & Sport of the Irish Government as the IAA's sponsor department. The Minister, accompanied by the Chief Executive of the IAA visited the RTC on 18th October 2016.

The main milestones and targeted dates for the post-trials communications are as follows:

	Communication Milestone	Target date
1	Successful Completion of demonstration exercises	September 2016
2	Final report on demonstration exercises	September 2016
3	Open Days in the RTC	November 2016

The following conduits through which the key messages can be routed are being utilised:

- CANSO;
- IAA Website;
- IAA Quarterly Magazine;
- Press Releases/Videos;
- IAA Customer Care Programme;
- Staff Representative Groups Joint Consultation Forum;
- IAA industry consultation groups such as the Flight Operations Consultation Group (FOCG);
- Airports Council International (ACI);
- SJU website and monthly e-news.

The project sponsor is engaged in the following partnerships which are being included in the communications plan:

- Borealis (alliance among the north-west European ANSPs);
- COOPANs (international partnership between the ANSPs of Austria, Croatia, Denmark, Ireland and Sweden and system supplier, Thales);
- Entry Point North (one of the largest global ATS training academies);
- Iceland/Ireland (alliance for the provision of HF radio in the north Atlantic region).

Vireo recordings of the November Open Days are being arranged in addition to articles for corporate and aviation magazines, IAA annual reports, fact sheets and flyers for aviation trade events, seminars and meetings. The SESARJU is being consulted with regard to the project's communications activities.

8 Next Steps

The next steps for the IAA with regard to the Remote Tower project is to review the content of this report with the various IAA Directorates such as the:

- Operations Directorate;
- Technology Directorate;
- Human Resources Directorate;

The purpose of this review is to determine how Remote Tower technology can contribute to the provision of ATS at aerodromes where the IAA is responsible for the provision of terminal services.

In parallel with this activity the Remote Tower project team will continue to work with the system supplier to complete post demonstration activities and discuss potential improvements of the system for future deployment.

9 References

9.1 Applicable Documents

[1] Demonstration Plan LSD 02.04 Edition 00.03.00;

[2] EUROCONTROL ATM Lexicon; https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR

[3] Annex 1 LSD 02 04 IAA Remote Tower Trial Exercise Results;

[4] Annex 2 LSD 02 04 IAA Remote Tower Human Performance Report;

[5] Annex 3 LSD 02 04 IAA Remote Tower System Operational Evaluation;

9.2 Reference Documents

The following documents provide input/guidance/further information/other:

[1] ATM Master Plan https://www.atmmasterplan.eu

[2] P 06.09.03 & P06.08.04 D35 OSED & SPR for remote provision of ATS to Aerodromes;

[3] P 12.04.07 D 07 Remote Tower Technical Specification;

[4] P 06.09.03 D32 Safety Assessment Report for Multiple Remote Towers;

[5] P06.03.01 D28 remotely provided ATS for two low density Aerodromes Appendix F (HF);

[6] D02/04 OSED for Remote Provision of ATS to Aerodromes, including functional specification;

[7] SESAR Solution Package - Remote provision of ATS to a single Aerodrome (Safety Assessment Report, Human Performance Report and Validation Report);

[8] SESAR Solution Package - Remote Tower for two low density aerodromes;

[9] EASA Decision 2015/014/R 3 July 2015 on the Implementation of the Remote Tower Concept for single mode of operation.

[10]SJU Communication Guidelines;

[11]Demonstration Design

[12] SESAR Communication Plan

Appendix A - WBS

		Days 2016	Days 2015	Days 2014
Preparation	Manager 1	40	20	0
Preparation	Manager 2	15	15	0
Delivery	ATCO 1	119	48	0
Preparation	ENG 1	32	15	0
Preparation	ENG 2	22	15	0
Preparation	ENG 3	71	8	0
Preparation	ENG 4	28	12	0
Preparation	Manager 3	99	97	28
Preparation	ENG 5	40	10	0
Preparation	Safety Manager	52	10	0
Preparation	ENG 6	45	8	0
Delivery	ATCO 2	32	0	0
Preparation	Safety Consultant	94	0	21
Preparation	ENG 7	77	33	0
Delivery	ATCO 3	93	24	0
Delivery	ATCO 4	54	0	0
Preparation	ENG 8	28	0	0
	Total	941	314	48
	Years	4.7	1.6	0.2

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