	Real Time Simulation Dublin TMA2012 Phase 2 Implementation of a Point Merge System in Dublin TMA	EUROCONTROL

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TITLE:

REAL TIME SIMULATION DUBLIN TMA2012 PHASE 2
Implementation of a Point Merge System in Dublin TMA

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Abstract:

This document details the results and evaluation of a real-time simulation (RTS) based on the implementation of a Point Merge System in Dublin TMA. This activity was carried out in March 2010 at the EUROCONTROL Experimental Centre, in the framework of the Dublin TMA2012 project of the Irish Aviation Authority.

This simulation forms part of a series of validation and prototyping exercises aimed at investigating the operational feasibility, efficiency and benefits of solutions based on the use of Precision Area navigation (P-RNAV) route structure in TMA and the Point Merge System (PMS), with the main focus on arrival flows.

The analysis presented in the document addresses the impact of Point Merge on procedures and working methods, controller roles and human and system performances. It has shown that, provided the mitigations highlighted are satisfactorily addressed, TMA2012 Point Merge Operations can be implemented successfully and can provide the expected and significant benefits to the airlines using the Dublin TMA and enhancements to the services provided by the Irish Aviation Authority.

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EVOLUTION SHEET

Date	Change status	Changes	Version
11/06/10	First Draft		0.1
06/07/10	Second Draft	Conclusions and Recommendations added	0.2
01/10/10	Third Draft	Executive Summary and Acknowledgment added, general revision	0.3
08/10/10	Final	Annexes added, general revision	1

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EXECUTIVE SUMMARY

BACKGROUND

TMA2012 is a two part project, initiated to increase capacity within the Dublin TMA and to provide a more consistent and efficient service to airlines. Phase 1 of this project was successfully launched in May 2009 with the introduction of Precision Area Navigation (P-RNAV) SIDs and STARs and an enhanced airway structure to the North and West which included unidirectional routes and Approach Areas of Responsibility (AORs).

Phase 2 of TMA2012 involves the implementation of a Point Merge System in the Dublin TMA for RWYs 28, 10 and 16 along with agreements to provide more structured traffic delivery from adjacent air traffic control centres. In Dublin, in conjunction with the re-sectorisation of the airspace associated with the TMA2012 project, significant benefits to Dublin ATC, the Airport Authority and the airlines are expected to be achieved.

Point Merge is an innovative method of organising arriving traffic which has been developed for Dublin by the IAA with assistance from EUROCONTROL. It should be noted that Dublin is only one of the European TMAs, including Oslo, Rome and Paris, which are at an advanced stage of development of Point Merge. Furthermore, scoping of the potential for Point Merge is also being considered by a rapidly growing number of ANSPs, including NATS, Hungarocontrol and Belgocontrol.

The planned operational implementation date for this second phase of TMA2012 is 3rd May 2012 and in order to fully evaluate the benefits and potential disadvantages of the new initiatives a full-scale Real Time Simulation (RTS) was commissioned with the EUROCONTROL Experimental Centre and was conducted in early 2010.

The appended report gives full details of the activities carried out as components of the RTS, including extensive validation and Human Factors (HF) studies.

OBJECTIVES OF THE REAL-TIME SIMULATION (RTS)

General Objectives

- Evaluation of the feasibility and operability of the integrated operational concept applied to Dublin TMA local scenario;
- Appraisal of the ability to handle a 40% increase on current sector capacity limits with current staffing levels allowing for an efficiently balanced task allocation between the controllers throughout the TMA;
- Assessment of the efficiency, predictability and the environmental sustainability of the TMA operations achieved by enabling extensive use of aircraft Flight Management System (FMS) functionality and flight techniques;
- Assessment of the safety of the TMA2012 operational environment.

High Level Objectives

- Assessment of the impact of the Dublin TMA2012 scenario (simultaneous use of (P-RNAV) routes, Point Merge and Continuous Descent Operations (CDOs) in a suitable ATC manning configuration) to handle a 40% increase on current sector capacity limits (with current staffing levels) on:
    - o Human performance;
    - o System performance.
- Collating of information/data to supply Safety Case development;
- Initial investigation of implementation/benefits/limitations of an advanced arrival manager (AMAN) at Dublin.

Specific Low Level Objectives

- The assessment/development of:
    - Appropriate bases of controlled airspace on airways L975/L70;
    - New DUNLO SIDs and the associated routeings into the London FIR;
    - Free release of departures (jet SIDs);
    - R/T phraseology.

SIMULATION OPERATIONAL SETTING

The RTS simulated the proposed 'new' organisation of Dublin TMA operations and included the following elements:

- P-RNAV routeings (including SIDs and STARs);
- STARs based on Point Merge procedures for RWYs 28, 10 and 16;
- Re-organisation of North and South Area sectors involving a vertical level split between Lower and Upper sectors at FL125. (Note: In this scenario, Executive controllers are allocated to each of the four smaller sectors (Upper North, Lower North, Upper South and Upper North), rather than the Executive and Planner configuration for North and South sectors);
- Re-organisation of Approach which was sub-divided into two positions: Approach and Final Director;
- Mixed-mode operations to/from RWYs 28, 10 and 16;
- Traffic load levels representing a 40% increase on current sector capacity limits.

Traffic from Shannon, London, Manchester and Scottish ACCs was included in the scenarios to test the effect of the provision of a measured flow of aircraft into the Dublin arrival system.

SIMULATION CONDUCT

Ten controllers and two data assistants from DATCC participated in the RTS. The controllers were allocated to the measured positions and Tower and the two assistants manned the feed sectors. In addition to DATCC personnel, two controllers from NATS (Manchester and London sectors) participated in the simulation.

The RTS was conducted over five weeks in February-March 2010, and consisted of two weeks' training and three weeks of simulation exercises, with a break of one week between the training and the simulation.

The main objective of the training session was to enable the participants to build up sufficient knowledge of the different operational concept elements which were to be assessed during the simulation. This included an understanding of the enhanced P-RNAV SIDs and STARs for Dublin TMA, the TMA2012 Point Merge concept, procedures and the new working methods, which included the new Upper/Lower manning configuration for the area sectors and a new Traffic Manager role. The training modules which were developed by a member of the IAA TMA2012 project core team.

The three weeks' simulation consisted of two distinct phases:

- 'Measured' sessions from 1st to 16th March (main simulation);
- 'Exploratory' sessions from 17th to 19th March (including AMAN).

Measured Sessions

- Measured and scenario-based exercises were conducted based on four sessions per day.
- Each exercise included a 45 minute recording period for analytical purposes. In addition, exercises involved pre-briefing, warm-up and hand-over periods thereby extending each full exercise period to one hour or more.
- Each exercise was followed by a questionnaire.
- Group debriefings were held at the end of each morning and afternoon (i.e. after two consecutive exercises).
- The participants were finally asked to complete a final post-simulation questionnaire obtain further information on their perceptions with regards to the concepts, roles and working methods. A final debriefing on the measured session followed, to consolidate feedback obtained over the whole simulation period.

Exploratory Sessions

- A total of six exercises involving use of AMAN were conducted and, similar to the measured sessions, each exercise involved pre-briefing, warm-up and hand-over periods for a total scenario duration of one hour or more.
- An ad-hoc post-exercise questionnaire was given after each exercise to the Traffic Manager, to obtain feedback on AMAN usability.

RESULTS

Very comprehensive results to support the findings obtained from the simulation can be found in the main body of the report and, because of their necessarily detailed nature, it is not apposite to give an abridged version of them in this Summary.

CONCLUSIONS AND RECOMMENDATIONS

Again, more detailed conclusions and recommendations can be accessed in the report itself but the main conclusions are listed below.

Safety

- Overall, controllers felt that safety was at least maintained under TMA2012 Point Merge Operations compared to current operations. Furthermore, all controllers felt that Point Merge enabled them to safely and efficiently handle more traffic (40% traffic increase compared to current traffic levels).
- Non-nominal events, e.g. go-arounds, runway closure, were dealt with promptly and efficiently under TMA2012 Point Merge Operations and the associated manning configuration. As each sector controller had less communication tasks to perform they reported to have more time for conflict detection and resolution.

Capacity

- The analysis of the throughput at the runway showed that both the system and the controllers were able to deliver an increase of 40% traffic on current sector capacity limits. Measurements taken demonstrated it was possible to achieve up to 50 movements per hour and concurrently the controllers' workload was reported to be low.

Operational Feasibility

- The TMA2012 procedures (including Point Merge) were considered operationally feasible and acceptable

Efficiency and Predictability

- The use of open-loop vector instructions was significantly limited under TMA2012 Point Merge Operations. Moreover, reverting to vectoring when necessary was not seen as a problem by the controllers.
- The new procedures and working arrangements also meant that step descents (as in current operations) no longer became necessary in order to space and sequence the traffic.
- There was found to be a significant improvement in the quality of service to aircraft, in that FMS lateral navigation usage was very high (e.g. 85% of the arrivals never left the lateral mode) and their descent profile could be managed to perform a Continuous Descent Operation (CDO) from the level flown along the sequencing legs towards the ILS localiser.

Workload

- Workload was generally reported to be low with TMA2012 Point Merge Operations under nominal conditions for all measured positions and runway scenarios, despite the 40% traffic increase compared to current traffic levels. However, controllers in the Lower Areas sectors did report that workload could rapidly increase if it did become necessary to hold traffic.
- R/T usage was said to be significantly reduced under TMA2012 Point Merge Operations due to the adherence to standard trajectories (i.e. extensive use of LNAV mode), the implementation of CDO and the fact that, because of the associated re-sectorisation the number of aircraft on frequency at any one time was reduced.
- Co-ordination between adjacent sectors within the Dublin TMA was reduced and simplified due to the predictability of traffic flows under TMA2012 Point Merge Operations.

Situational Awareness

- Controllers felt that their awareness of the traffic situation within their own sector was better under TMA2012 Point Merge Operations than current day operations due to the predictability of traffic flows and the fact that they could set their radar displays at more appropriate ranges.
- Situational awareness of adjacent sectors was also reported to be high owing to the predictability of traffic flows in TMA2012 Point Merge Operations, but also because of the fact that the Upper & Lower tactical controllers in the same Area sectors and APP & FI are seated adjacent and work together as a team.

Traffic Manager Role and Responsibilities

- The role and tasks of the Traffic Manager were seen to be acceptable as well as essential to TMA2012 Point Merge Operations but it was emphasised that the Traffic Manager must work in close collaboration with the sector controllers in particular the Approach area sectors for the role to work successfully. However, all controllers felt that more work needs to be done in the future to further define the Traffic Manager's role and tasks.

Controllers' Acceptance

- Whilst all controllers accepted that TMA2012 Point Merge Operations enabled a more structured way of working with attendant low workload, there was some concern amongst the controllers that this could lead to the loss of their vectoring skills and might lead to less job satisfaction. However, there was also a feeling that giving a better and more efficient delivery of aircraft could actually provide an alternative way of achieving such satisfaction.

SPECIFIC RECOMMENDATIONS

Airspace Structure

- Three recommendations relating to the route structure and airspace configuration to further optimise TMA2012 Point Merge Operations in the Dublin TMA were proposed:
    - Increasing the length of the sequencing legs for RWY 28 in order to increase the leg capacity;
    - Lowering the base of controlled airspace on RWYs 10 and 16 to enable uninterrupted descent to the ILS from the sequencing legs;
    - Further evaluation of the DUNLO SID and INKUR non-jet SID for RWY 16 required.

Traffic Manager Role and Responsibilities

- The Traffic Manager role is pivotal to TMA2012 Point Merge Operations but needs further work, in particular with regards to task allocation. In particular, the allocation of the co-ordination tasks between the Traffic Manager and sector controllers needs to be further investigated, for example, the allocation of some tasks to the data assistant could be considered.
- The Traffic Manager role would benefit from additional information and or support tools as well as defined 'triggers' or 'rules of thumb' to enable him / her to make appropriate and timely decisions relating to the management of traffic flow. Evidence from the RTS Exploratory Sessions showed that, provided the output from the AMAN was consistent and accurate, there could be some benefit to the Traffic Manger in providing assistance as to when holding should be implemented
- Given the importance of the Traffic Manager role a specific training programme needs to be developed to ensure all Traffic Managers are proficient and competent.

Controller Working Procedures

- Procedures for holding aircraft need to be further developed, and to include a specific holding controller as in current day operations.
- Specific contingency procedures, namely sequencing leg run-offs, 'go-arounds', runway change, need to be further refined.
- Working procedures / practices within the Dublin TMA need to be standardised to ensure that all codes, markings & inputs used e.g. label markings have identical meaning for all controllers in all teams.

Operations Room Layout

- Adjacent 'inter-sector controllers' (i.e. Upper & Lower and Initial Approach and Final Director) to be seated beside each other in 'live' operations room to ensure situational awareness is maintained and to facilitate co-ordination and team-work.
- A dedicated CWP for the Traffic Manger should be positioned adjacent to the Approach sector to ensure and facilitate communication and collaborative working.

Training

- Adequate training is essential to ensure efficiency and safety levels in the Dublin TMA are maintained and, ideally, improved further. Therefore, all controllers must attend a complete and robust training programme prior to the implementation of TMA2012 Point Merge Operations. Training must be delivered using appropriately experienced instructors and the programme must include procedures under nominal condition, the contingency procedures for non-routine, unusual and non-nominal events, as well as the procedures for shift handover.
- Regular refresher training must be provided to ensure vectoring skills are maintained for current controllers. Furthermore, new recruits must be trained to work the traffic using vectoring before they become operational, as vectoring will still be required for certain runway configurations and under certain non-nominal or non-routine situations.

Shift Handover

- To ensure the outgoing controllers impart all the necessary information at the end of his / her shift to the incoming controller and / or to mitigate any negative affects of failure to impart the necessary information due to single person sectors, it is recommended that:
    - Checklists are developed and used to ensure all the necessary information is conveyed at shift handover.
    - All controllers are given training on the shift handover procedure.
    - Lower and Upper controllers manning the same Area sectors and the APP & FI do not change shift at the same time. This will ensure that there is always someone working in the adjacent sector that has a good picture of the traffic situation

SUMMARY STATEMENT

The Real-Time Simulation carried out in March 2010 has shown that, provided the mitigations highlighted in the Report are satisfactorily addressed, TMA2012 Point Merge Operations can be implemented successfully and can provide the expected and significant benefits to the airlines using the Dublin TMA and enhancements to the services provided by the Irish Aviation Authority.

ACKNOWLEDGEMENTS

EUROCONTROL would like to record its appreciation of the vigorous support given by the Irish Aviation Authority (IAA) and its staff for their part in the successful outcome of the TMA2012 Real-Time Simulation held during March 2010 at the Experimental Centre at Bretigny.

The TMA2012 Project Team and all of the participants at the simulation were enthusiastic throughout, and contributed fully and thoughtfully to detailed discussions and questionnaires aimed at evaluating the proposed enhancements to Dublin TMA operations.

The IAA Operational Staff taking part were:

Paul McCann (TMA2012 Project Leader), Gary Foran (Simulation Training Module Development and Delivery), Barry McCarthy, Barry Charles, Audrey Donnelly, Ronan Farrell, Barry Flynn, John Hand, John Kavanagh, Philip McDonnell, Michael McElwain, Gwen Morgan and Sandra Walshe,

In addition, and pivotal to the simulation was the construction of the comprehensive instrument flight procedures and which was the responsibility of Dermot McMahon (Senior Airspace/Flight Procedure Designer) of the IAA Operations Directorate.

Finally, the simulation could not have taken place without the whole-hearted management support and robust encouragement of David Usher (IAA General Manager DATCC), Kevin McGrath (IAA Operations Manager DATCC) and Ronnie Fallon (IAA Manager Airspace and Navigation).

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1. INTRODUCTION

1.1 Purpose of the Document

The purpose of this document is to present the results and findings of the full scale Real-Time Simulation (RTS) which was conducted in February / March 2010 at the EUROCONTROL Experimental Centre (EEC) as part of the Phase 2 TMA2012 project led by the Irish Aviation Authority (IAA).

The document forms the so-called Validation Report, which is the milestone of Step 4 of the EUROPEAN Operational Concept Validation Methodology (E-OCVM) (Ref. [1]), applied throughout the project.

The results and findings, contained in the Validation Report, are intended for use by the Dublin TMA2012 project leaders and involved stakeholders, who need support for decision making on:

- Further improvement of the concept of operation and;
- Subsequent validation activities in that area prior the implementation.

This document is available in particular to:

- The DATCC core team members;
- Representatives of the IAA management;
- Irish Safety Regulator representatives involved in the evaluation of the proposed changes;
- The EEC TMA2012 RTS project team members.

1.2 Structure of the Document

Apart from the present introduction section, the document is structured as follows:

- Sections 2 and 3 introduce respectively the scope of the Dublin TMA2012 RTS and the validation objectives;
- Sections 4 and 5 describe respectively the RTS setting and the experimental design;
- Section 6 presents the conduct of the RTS;
- Section 7 contains the results of the RTS;
- Section 8, finally, gives conclusions and recommendations.

Part of document, but separated by the main body, are a series of Annexes which further detail on RTS settings and findings.

1.3 Context of the Simulation

TMA 2012 is a two part project, initiated to increase capacity within the Dublin TMA and to provide a more consistent and efficient service to airlines. Phase 1 of this project was successfully launched in May 2009 with the introduction of Precision Area Navigation (P-RNAV) SIDs and STARs and an enhanced airway structure to the North and West which included unidirectional routes and Approach Areas of Responsibility (AORs).

Phase 2 of TMA 2012 involves the implementation of a Point Merge System in the Dublin TMA for RWYs 28, 10 and 16 along with agreements to provide more structured traffic delivery from adjacent air traffic control centres. In Dublin, in conjunction with the re-sectorisation of the airspace associated with the TMA2012 project, significant benefits to Dublin ATC, the Airport Authority and the airlines are expected to be achieved.

Point Merge is an innovative method of organising arriving traffic which has been developed for Dublin by the IAA with assistance from EUROCONTROL. It should be noted that Dublin is only one of the European TMAs, including Oslo, Rome and Paris, which are at an advanced stage of development of Point Merge. Furthermore, scoping of the potential for Point Merge is also being considered by a rapidly growing number of ANSPs, including NATS, Hungarocontrol and Belgocontrol.

The planned operational implementation date for Phase 2 of TMA2012 is 3rd May 2012 and in order to fully evaluate the benefits and potential disadvantages of the new initiatives a full-scale RTS was commissioned with the EUROCONTROL Experimental Centre and was conducted in February and March 2010.

The RTS followed on previous validation activities in less complex and exhaustive environments. These activities used the prototyping sessions approach and were conducted at DATCC between May and November 2009 (Ref. [3], [4]). The RTS built on results from the prototyping sessions and extended the scope of the operational scenario.

This more realistic human-in-the-loop (HITL) validation exercise, in a more representative and complete environment, allowed for comprehensive assessments on the operational feasibility, benefits and rooms of optimisation of the foreseen operational scenario for the Dublin TMA.

The appended report gives full details of the activities carried out as components of the RTS, including extensive validation and Human Factors (HF) studies.

2. OPERATIONAL CONTEXT

2.1 TMA2012 Concept Elements

2.1.1 Precision Area Navigation (P-RNAV)

Area navigation (RNAV) is a method of navigation which permits aircraft operation on any desired flight path without the necessity to fly point-to-point between ground-based navigational aids. Aircraft RNAV equipment automatically determines aircraft desired flight path by a series of waypoints held in a database.

In comparison to the Basic-RNAV (B-RNAV) procedures with cross-track accuracy of ±5nm suitable for en-route operations, the P-RNAV procedures provide an enhanced track keeping accuracy of ±1NM, which makes them suitable for use in terminal airspace.

By enabling all aircraft to fly accurate and predictable flight paths in the terminal area, operators are provided with the opportunity to employ flight management systems to the best advantage, as well as allowing the enhancement of the efficiency of Terminal Airspace usage.

An ECAC-wide mandate for the carriage of P-RNAV is not foreseen. However P-RNAV requirements for Terminal RNAV procedures are being introduced across the ECAC States, although some provision of conventional procedures is being made to continue to enable limited access to the airports in those areas.

2.1.2 Point Merge System (PMS)

The PMS is a P-RNAV application that has been developed by the EEC as an innovative technique aiming at improving and standardising terminal airspace operations (Ref. [9]).

The PMS procedure associates a dedicated route structure with a systemised operating method to integrate arrival flows with extensive use of RNAV while keeping aircraft on Flight Management System (FMS) lateral navigation mode. It thus enables an efficient use of FMS advanced functions and consequent optimisation of vertical profiles, making it possible to apply CDAs even under high traffic load. Open-loop radar vectoring is limited to the extent needed for recovering from non nominal situations.

The dedicated RNAV route structure relies on the following key elements: merge point and sequencing legs:

- A single point – denoted ‘merge point’, is used for traffic integration;
- Pre-defined legs – denoted ‘sequencing legs’, equidistant from the merge point, are dedicated to path stretching/shortening for each inbound flow.

The PMS operating method aims at integrating inbound flows, using this route structure, without normally relying on open loop vectors. It comprises the following main steps:

- Create the sequence order and inter-aircraft spacing. This is achieved by iteratively:
    - Leaving each aircraft fly along the sequencing leg as long as necessary for path stretching/shortening , and
    - Issuing a ‘Direct To’ instruction to the merge point when the appropriate spacing is reached with the preceding aircraft in the sequence (already on course to the merge point).
- Maintain the sequence order and inter-aircraft spacing. This is achieved through speed control after leaving the legs.

Upon leaving the sequencing legs following the 'Direct To' instruction, the descent profile can be optimised in the form of a CDA as the distance to go is then known by the FMS.

Considering a simple configuration involving the integration of two inbound flows, Figure 1 provides a typical example of PMS.

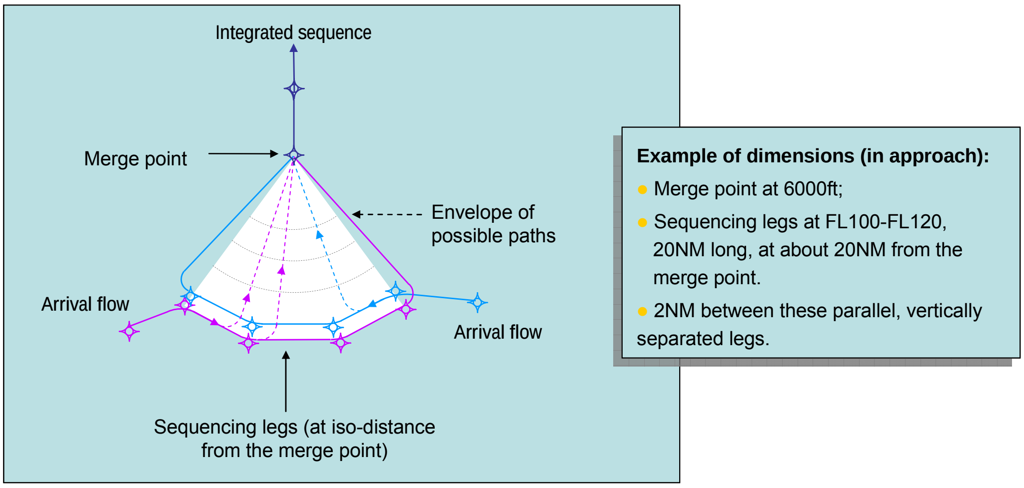

Figure 1. Example of Point Merge System

2.1.3 ATC Sectorisation (Manning configuration)

The solution includes the reorganisation of workload within the DATCC, and the re-definition of the current Dublin sectors. Although not an operational concept per se the change in sectorisation and manning configuration is essential to take advantage of the concept elements previously defined.

The current organisation of DATCC is as follows:

- The ACC airspace is divided into two sectors: North Area and South Area. Each sector is managed by an Executive Controller (EC) and a Planner Controller (PC);
- The Approach consists of one sector manned by one Approach controller who is responsible for all arrival aircraft delivered to him/her by the Area sectors until they are transferred to the tower control.

The TMA2012 scenario implies that:

- Both North and South Area are divided vertically into two sectors, with only the EC manning each of the four sectors;
- The Approach is divided into two positions with an Initial Approach (AP) controller and a Final Director (FI) controller:
    - o The AP controller is responsible for aircraft on the PMS sequencing legs;
    - o The FI controller is responsible for aircraft transferred from the AP until the aircraft reports 'established on the ILS localiser' where s/he transfers control to the tower.

Under PMS operations the current role of the Co-ordinator becomes more proactive and s/he takes on the responsibility for managing the strategic flow of traffic within the Dublin TMA. To reflect the additional responsibility assumed under PMS operations the role of the current Co-ordinator is renamed the Traffic Manager I.

It is presumed that no additional staff is required for the Dublin TMA2012 scenario compared to current day operations.

2.1.4 Continuous Descent Approach (CDA)

The objective of a CDA is to reduce aircraft noise, fuel burn and emissions by means of a continuous descent, so as to intercept the approach glide path at an appropriate height for the distance to touchdown.

A CDA is an aircraft operating technique in which an arriving aircraft descends from an optimal position with minimum thrust and avoids level flight to the extent permitted by the safe operation of the aircraft and compliance with published procedures and ATC instructions.

Keeping aircraft as high as possible for as long as possible can be more effective at reducing noise impact on the ground than Low-Power/Low Drag[1] (LP/LD) techniques alone.

CDA can be optimized within energy, speed and safety constraints by avoiding, as far as possible, unnecessary flap, air brake and engine thrust and avoiding early lowering of landing gear. Aircraft energy and speed management is therefore a critical factor in successful CDA implementation.

The proportion of aircraft achieving CDA will depend on local traffic conditions and local airspace characteristics, although a good success rate may be achieved in high traffic density situations. To support the success rate of CDAs in a high density environment, development and implementation of supporting planning and arrival tools, such as Advanced AMAN, may be necessary.

2.1.5 Arrival Manager (AMAN)

AMAN is a sequence planning and support tool for arriving traffic at a managed airport.

The objective of AMAN is to compute an optimal arrival sequence and to advise accordingly controllers to adjust flights in a manner ensuring a smooth flow of traffic entering the Approach. The final goal is to use the airport's capacity in the most efficient way.

The AMAN sequence computation is based on the following information:

- Flight plans from FDPS;
- Updated estimates from the FDPS/RDPS;
- Wind information in the TMA and on the ground;
- Runway acceptance rates (i.e. spacing on final approach).

Based on the above data AMAN:

- Sorts inbound flights by ETA and establishes the initial arrival sequence, based on the first-come, first-served rule;
- Optimises the arrival sequence and calculates Scheduled Time of Arrival (STA) at Feeder Fix (e.g. sequencing leg entry points) and at the runway;
- Generates and displays an arrival sequence at Feeder Fixes and RWYs with time and delay advisories for the controllers in order to meet and maintain the optimised arrival sequence;
- Supplies ACC and Approach controllers with control action to absorb the delays calculated.

AMAN automatically adapts the established inbound traffic sequence to the actual traffic evolution as well as to the controller decisions deemed necessary to meet exceptional cases (e.g. insertion of slots to comply with a temporary runway closure).

2.2 Interoperability of the Concept Elements and Expected Benefits

The joint use of P-RNAV, PMS, CDA and ATC system support tools (e.g. AMAN) in a suitable manning configuration is expected to form a cornerstone of ATM initiatives aimed at maximising the

[1] LP/LD is a noise abatement technique for arriving aircraft in which the pilot delays the extension of wing flaps and undercarriage until the final stages of the approach, subject to compliance with ATC speed control requirements and the safe operation of the aircraft.

efficiency of TMA operations and thereby providing economic, operational, capacity and environmental benefits to the aviation community.

3. AIMS AND OBJECTIVES OF THE SIMULATION

3.1 General Aim

Based on the stakeholder needs and the expectations of the project, the following objectives are set at project level (Ref. [2]):

- To assess the feasibility and operability of the integrated operational concept applied to Dublin TMA local scenario;
- To assess the ability to handle a 40% increase on current sector capacity limits with current staffing levels allowing for a fair task allocation between the controllers throughout the TMA;
- To assess the efficiency, predictability and the environmental sustainability of the TMA operations enabled by an extensive use of the FMS functionality and flight techniques;
- To assess the safety of the TMA operations.

3.2 RTS High Level Objectives

The RTS followed a series of prototyping sessions which aimed at developing procedures to go along with the new operational concept. The prototyping session approach appeared to be the most efficient way to gain immediate feedback from controllers in terms of acceptability and operational feasibility of different procedural options for P-RNAV routings, SIDs/STARs design as well as different manning configurations.

The most appropriate working arrangements were selected and procedures for both nominal and non-nominal situations developed and refined. The overall outcome was employed in the RTS to be extensively validated.

Therefore the main goal of the RTS was to enable controllers to work with the new operational concept in a realistic operational setting in order to assess the impact of the new working arrangements / procedures on human and system performances.

The objectives of the RTS were the following:

1) Assess the impact of the Dublin TMA2012 scenario (joint use of P-RNAV routes, PMS, CDA in a suitable ATC manning configuration) to handle a 40% increase on current sector capacity limits with current staffing levels) on:
    - o Human performance;
    - o System performance;
2) Collect information/data to feed other activities:
    - o Safety Case[2];
    - o Analytic Modelling[3];

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[2] Safety is considered a main focus area for the whole Dublin TMA2012 project. EUROCONTROL is producing a generic safety case for Point Merge but the IAA remains responsible for ensuring that the TMA 2012 project satisfies the safety requirements of the Irish Regulator.

[3] For Dublin TMA2012 project, individual flight elements (as outcome of the RTS) are input into programme software for assessment regarding flight profile, fuel usage and gaseous emissions. Numerical and graphical data can be combined to show comparisons between the current (or baseline) procedures and the new procedures. The data can then be used to evaluate the potential benefits of the new procedures and to help formulate alternative strategies to mitigate against any perceived disadvantages. The profile assessments provided can support environmental considerations regarding noise and the results from fuel burn module provide the basis for the production of CO2 emission data.

3) Investigate implementation/benefits/limitations of an advanced arrival manager (AMAN) at Dublin.

This description of the objectives clearly differentiates what could be assessed directly during the RTS (objective 1) from assessment/measurements requiring further activities (objective 2), where RTS provided assistance and data analysis to support their development, and from more exploring activities, where the RTS did not enable assessment, but rather provided conditions for controllers to be exposed to envisaged procedures and working methods (objective 3).

In addition there were a number of secondary objectives the RTS covered, although they were not clearly expressed in terms of validation objectives. These referred to the assessment/development of:

- Bases of controlled airspace on the L975/L70;
- New DUNLO SIDs and the associated routings through the London FIR;
- Free release of departures (jet SIDs);
- R/T phraseology;

With reference to objective 1 the following more specific validation objectives were set for the RTS:

- Human Performance:
  - H1. Acceptability and feasibility
  - H2. Roles and Tasks
  - H3. Workload
  - H4. Situation Awareness
- System Performance:
  - P1. Safety
  - P2. Capacity
  - P3. Efficiency
  - P4. Predictability

All the high level objectives concerned the assessment of the TMA2012 scenario in both nominal and non-nominal situations.

3.3 RTS Low Level Objectives

The high level validation objectives defined above were broken down into low level objectives. This process was done also taking into account the recommendations which were set in the HF Validation Plan (Ref. [3]). This plan suggested addressing the HF issues, identified by the HF Issues Analysis, in the various project validation activities. In particular it determined which among the HF issues were the most suitable to be addressed in a large scale RTS.

The Table 1 shows the list of low level objectives for the RTS. The low level objectives were even further formulated in detailed objectives, some of which were defined as a response to the identified HF issues.

The term “conditions” in the description of the low level objectives refers to experimental conditions as defined in section 5.3.

Table 1. Low Level Validation Objectives

High Level Objective	Low Level Objectives	Detailed Objectives	HF Issue (Ref. no)
HUMAN FACTORS Aspects			

High Level Objective	Low Level Objectives	Detailed Objectives	HF Issue (Ref. no)
H1. Acceptability, feasibility	H1.1 – Assess the feasibility and controllers' acceptance of the new manning configuration	H1.1.1 – Assess whether new manning configuration is acceptable to controllers.	SA2, WL1
		H1.1.2 – Assess whether new working arrangements / procedures are acceptable to controllers.	SA1, WL1
	H1.2 – Assess the feasibility and controllers' acceptance of the Point Merge System (PMS)	H1.2.1 – Assess whether controllers accept the change to a more systemised way of working.	AC3
		H1.2.2 – Assess whether controllers' procedures developed for PMS are acceptable / workable.	SA1, WL1, PR5
		H1.2.3 – Assess whether controllers' contingency procedures (i.e. procedures for unusual / non-nominal events) developed for PMS are acceptable / workable.	PR8
		H1.2.4 – Assess whether the more systematised way of working retains an acceptable level of flexibility.	
		H1.2.5 – Assess whether controllers' procedures developed for PMS are acceptable / usable in case of military airspace activation.	PR4
	H1.3 – Assess the proposed amendments to the procedures with the adjacent centres for effectiveness.	H1.3.1 – Assess acceptability of new working methods to adjacent ACCs.	PR4
H2. Roles and tasks	H2.1 – Assess the effect of the conditions on controllers' roles, responsibilities and task distribution	H2.1.1 – Assess whether roles and tasks of controllers are clearly defined.	RR6
		H2.1.2 – Assess whether role and tasks of Traffic Manager are clear and unambiguous.	RR1
		H2.1.3 – Assess whether the assigned tasks distribution between controllers is appropriate.	
		H2.1.4 – Assess whether the controllers find the new role of the Traffic Manager acceptable.	AC1
		H2.1.5 – Assess whether Traffic Manager role is acceptable in terms of tasks and responsibilities.	RR5
		H2.1.6 – Assess whether the Traffic Manager provides the required support / assistance to the controller with co-ordination.	RR3, RR4, TC1
		H2.1.7 – Assess whether co-ordinator / Traffic manager role supports controllers / new working methods.	RR4
H3. Workload	H3.1 – Assess the effect of the conditions on controller perceived workload.	H3.1.1 – Assess whether the introduction of PMS and new manning configurations is unacceptable in terms of controllers workload.	WL1, PR5
		H3.1.2 – Assess whether contingency procedures (i.e. procedures for unusual / non-nominal events) increase controllers workload to an unacceptable level.	PR8
		H3.1.3 – Assess whether co-ordinating between sectors within Dublin TMA in addition to tactical control tasks is too demanding for a single controller.	WL4

High Level Objective	Low Level Objectives	Detailed Objectives	HF Issue (Ref. no)
		H3.1.4 – Assess whether co-ordinating with adjacent ACCs in addition to tactical control tasks is too demanding.	WL4
		H3.1.5 – Assess whether under high workload conditions controller ability to handle unusual event is reduced as a result of PMS and manning configuration.	WL5
		H3.1.6 – Assess whether Traffic Manager role is acceptable in terms of workload.	RR5
	H3.2 – Assess the effect of the conditions on the task load (objective task demands).	H3.2.1 – Assess whether the task load balance between the Approach controller and the Final Director is acceptable.	
		H3.2.2 – Assess whether the task load balance between the Upper and Lower controllers is acceptable.	
H4. Situation awareness	H4.1 – Assess the effect of the conditions on controller perceived Situation Awareness (SA).	H4.1.1 – Assess whether new working arrangements / procedures have a negative impact on controller SA.	SA1
		H4.1.2 – Assess whether new manning configuration leads to inefficient monitoring and increases the possibility of missing critical events within the sector.	SA2
		H4.1.3 – Assess whether controllers SA in adjacent sectors is reduced.	SA3
		H4.1.4 – Assess whether controller SA is reduced as a result of delegation of responsibility for a/c descent to pilot under CDA.	AC2
		H4.1.5 – Assess whether the more systemised way of working with PMS has a negative effect on controller vigilance / SA.	AC3
PERFORMANCE Aspects			
P1. Safety	P1.1 – Assess the effect of the conditions on overall safety level.	P1.1.1 – Assess whether the new manning configuration is as safe as current operations	S1
		P1.1.2 – Assess whether PMS / new manning configuration is as safe as current operations.	
		P1.1.3 – Assess whether PMS / new manning configuration is as safe as current operations when a non-nominal / unusual event occurs.	S2
	P1.2 – Assess the effect of the conditions on human performance / □rror.	P1.2.1 – Assess whether new working arrangements / procedures increase potential for human error.	SA1, WL1, PR5, HE1, HE2
		P1.2.2 – Assess whether new manning configuration increases potential for human error.	SA2, WL1, HE1, HE2
		P1.2.3 – Assess whether the contingency procedures (i.e. procedures for unusual / non-nominal events) increase potential for human error.	PR8
		P1.2.4 – Assess whether the controllers are able to provide safe separation between arrivals.	

High Level Objective	Low Level Objectives	Detailed Objectives	HF Issue (Ref. no)
		P1.2.5 – Assess whether the controllers are able to provide safe separation between arrivals and departures.	
		P1.2.6 – Assess impact of new working arrangements / procedures on conflict resolution.	
P2. Capacity	P2.1 – Assess the effect of the conditions on the task load (objective task demands).		
	P2.2 – Assess the effect of the conditions on runway capacity.		
P3. Efficiency	P3.1 – Investigate the effect of the conditions on overall flight efficiency (lateral navigation mode and optimised vertical profiles).		
	P3.2 – Assess the effect of the conditions on ATC efficiency.	P3.2.1 – Assess whether the new working arrangements facilitate a consistent traffic delivery to the runway.	
		P3.2.2 – Assess whether the new working arrangements allow for equity in handling arrivals and departures.	
P4. Predictability	P4.1 – Assess the effect of the conditions on trajectory predictability for controllers.		

4. SIMULATION SETTING

4.1 Operational Context

All the detailed information is available in Ref. [6].

4.1.1 Simulation General Characteristics Based On New Airspace Organisation

The RTS simulated the new Dublin TMA operations, with implementation of the following new airspace organisation and elements:

- Enhanced airway structure to the North and West which included unidirectional routes;
- P-RNAV routings (including SIDs and STARs);
- STARs based on Point Merge procedures for RWYs 28, 10 and 16;
- Reorganisation of North and South Area sectors which involved a level split between Lower and Upper sectors at FL125;
- Reorganisation of the Approach which was divided into two positions: AP and FI;
- Mixed-mode operations to/from RWYs 28, 10 and 16;
- Traffic load levels representing a 40% increase on current sector capacity limits.

These characteristics were shared by all the experimental conditions described in section 5.3.

4.1.2 Simulation Area

The simulation area included:

- Dublin CTA at and below FL 245;
- Dublin CTR;
- Portions of Shannon UTA FL245 – FL660 and the Shannon CTA at and below FL245;
- Delegated airspace from LATCC, MACC and ScATCC to DATCC.

In order to feed traffic into the simulated measured sectors, parts of London FIR/UIR were included in the simulation area.

The following airports were simulated:

- Dublin EIDW
- Baldonnel EIME
- Weston EIWT

The following runway scenarios for EIDW were simulated (see maps in Annex B):

- RWY 28 Arrivals and Departures (with some jet departures from RWY 34 in the early morning peak rotation);
- RWY 10 Arrivals and Departures (with/without MOA4 activity);
- RWY 16 Arrivals and Departures.

All the SIDs and STARs were P-RNAV SIDs specifically prepared for the simulation by the IAA and EUROCONTROL to be compatible with P-RNAV and PMS operations implementation.

The reference route structure used during the simulation was ARN Version 6 effective from end 2008. The transition level was FL60.

The simulation area encompassed Temporary Segregated Areas (TSA). TSA included military restricted areas, military exercise and training areas and danger areas as defined in AIP Ireland.

Table 2. Temporary Segregated Areas (TSA)

Identification	Name	Vertical Limits	Lateral Limits
EIR15	Restricted Area 15	GND – 3000ft	As defined for RTS by IAA
EIR16	Restricted Area 16	GND – 4000ft	
EIR16A	Restricted Area 16A	GND – 4000ft	
R23	Circle inside EIR15	GND – 2000ft	
EID05	Glen of Imaal	GND – FL120	
MOA04	Military Operating Area 4	GND – FL150	

4.1.3 Measured and Feed Sectors

The simulation area was divided into measured and feed sectors. All measured sectors were manned by an EC only and equipped with one CWP. The following measured sectors were simulated:

Table 3. Simulated Measured Sectors

Name	Code	FIR/CTA	Vertical Limits	Number of CWP
Lower North	LN	Dublin CTA	SFC – FL125	1 (EC)
Upper North	UN		FL125 – FL245	1 (EC)
Lower South	LS		SFC – FL125	1 (EC)
Upper South	US		FL125 – FL245	1 (EC)
Initial Approach	AP		-	1 (EC)
Final Director	FI			1 (EC)
Traffic Manager	TM			1 (EC)
			Total CWP	**7**

The feed sectors represented the FIR/UIR, state and regional airports that interfaced with the measured sectors. The primary feed sector task was to respond to inbound co-ordination requests and to carry out orders using the console according to the co-ordination requests. Each feed sector was manned by one controller/assistant. The following feed sectors were simulated:

Table 4. Simulated Feed sectors

Name	Code	FIR/CTA	Number of CWP
Manchester	MN	MACC	1 (EC)
London	LD	LATCC	1 (EC)
Shannon / Scottish	SH	Shannon FIR/UIR ScATCC	1 (EC)
Tower	TR	Dublin CTR	1 (EC)

4.1.4 Meteorology

Different meteorological environments are simulated. Each meteorological environment is designed to reflect prevailing wind conditions for the active runway. Two different meteorological environments are finally defined for each runway.

The algorithm for wind introduces changes in the wind settings (speed and direction) with altitude.

The Figure 2 shows the surface wind settings tested, while Table 5 shows all the changes in speed and direction based on the altitude levels.

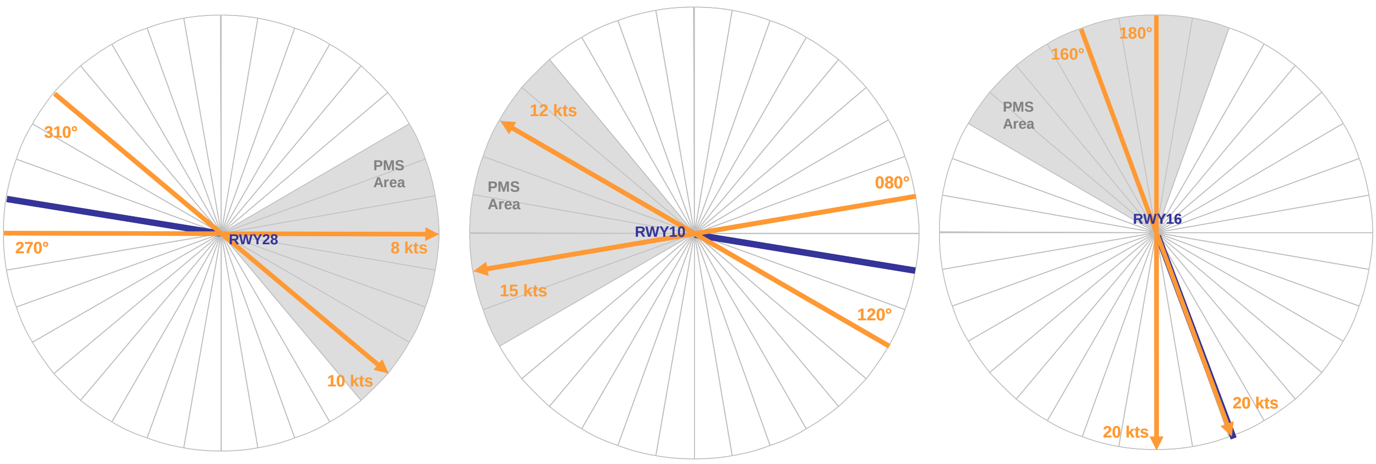

Figure 2. Meteorological conditions at surface

Table 5. Meteorological conditions per altitude

	Wind: Direction / Speed (Knots)					
	RWY 28		RWY 10		RWY 16	
Fligh Level	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
GRD - 2000'	270° / 8	310° / 10	080° / 15	120° / 12	180° / 20	160° / 20
2000' - 4000'	275° / 8	315° / 10	090° / 15	130° / 12	190° / 20	170° / 20
4000' - FL060	280° / 13	320° / 15	100° / 20	140° / 17	200° / 25	180° / 25
FL060 - FL080	285° / 18	325° / 20	110° / 25	150° / 22	210° / 30	190° / 30
FL080 - FL100	290° / 23	330° / 25	120° / 30	160° / 27	220° / 35	200° / 35
FL100 - FL120	295° / 28	335° / 30	130° / 35	170° / 32	230° / 40	210° / 40
FL120 - FL140	300° / 33	340° / 35	140° / 40	180° / 37	240° / 45	220° / 45
FL140 - FL160	305° / 38	345° / 40	150° / 45	190° / 42	250° / 50	230° / 50
FL160 - FL180	310° / 43	350° / 45	160° / 50	200° / 47	260° / 55	240° / 55
FL180 - FL200	315° / 48	350° / 50	170° / 55	210° / 52	270° / 60	250° / 60
FL200 - FL220	320° / 53	355° / 55	180° / 60	220° / 57	280° / 65	260° / 65
FL220 - FL240	325° / 58	360° / 60	190° / 65	230° / 62	290° / 70	270° / 70
FL240 - UNL	330° / 63	360° / 65	200° / 70	240° / 67	295° / 75	280° / 75

4.1.5 Traffic Scenarios

The traffic samples creation and preparation required close assistance from the DATCC core team and representatives from London and Manchester.

For the simulation, all aircraft were treated as MASPS compliant (RVSM separation). There was non-RVSM equipped aircraft in the simulation.

4.1.5.1 Simulation Traffic Samples

Two traffic samples were produced, based on typical 2008 morning (AM) and evening (PM) busy periods from Dublin TMA weekday operations provided by DATCC, and boosted to represent an increase of 40% on current sector capacity limits.

Each traffic sample was used to run two consecutive simulation exercises, with a duration of approximately one hour each.

Although all the traffic samples were similar in complexity they slightly differed in terms of the temporal distribution of the demand at EIDW. Adjustments were made to suit the simulation objectives.

Other minor differences among the traffic samples referred to the presence of:

- Non RNAV equipped traffic;
- VFR traffic;
- Weston and Baldonnel departures/arrivals.

4.1.5.2 Training Traffic Samples

Some training samples were produced to cater for initial training. These were developed from the main traffic samples, employed in the simulation, but were reduced by about 50% so as not to overload the controllers during the familiarisation and training phase.

4.1.6 ATC Procedures and Controller Tasks/Roles

The detailed description of the controller working procedures is provided in Ref [7].

Except as detailed in the Dublin TMA2012 Controller Working Procedures document, all ATC working procedures used during the simulation were in accordance with those defined in Dublin MATS Part 2 and current Letters of Agreement.

4.2 Technical Context

4.2.1 Controller Working Position

4.2.1.1 Radar HMI

The HMI used for the RTS was a replica of the HMI currently used at DATCC.

Each CWP was equipped with:

- A monitor, with a multi-window working environment;
- A keyboard;
- A three-button mouse;
- A digital voice communication system (Audio-LAN) with a headset, a loudspeaker, a footswitch and a panel-mounted push-to-talk facility;
- An ISA (Instantaneous Self-Assessment) subjective workload input device.

The HMI included the following safety nets:

- Short Term Conflict Alert (STCA);
- Area Proximity Warning (APW).

4.2.1.2 AMAN HMI

In addition all the measured sectors were equipped with an AMAN, display screen (separated from the radar screen). The AMAN HMI presented the timeline of STA with associated delay information.

The Traffic Manager could interact though the AMAN HMI to adjust parameters (e.g. spacing at final), to make changes in the sequence and to book time windows in the timeline (e.g. runway closure).

4.2.2 Simulation Room Layout

The layout of the operations room consisted of 11 CWPs as outlined in Annex C.

5. EXPERIMENTAL DESIGN

5.1 Main Variables

Early in the project, it was decided not to simulate a baseline replicating the current operational scenario. Therefore an experimental design which would allow for comparison between the baseline and the new operational scenario was not required. The design was built to present as many experimental conditions (or organisations) as possible and to expose the participating controllers to them. The main goal was to get the most comprehensive feedback from the participants to cover all the human performance related objectives. In addition the experimental design had to facilitate the collection of objective data to address a number of objectives linked to system performance aspects.

An experimental condition is defined as a combination of different experimental variables which constitute a particular operational scenario. The main experimental variables which were considered in the RTS are the following:

- Runway in use at EIDW;
- TSAs active;
- Non-nominal situations;
- Operating procedure for the release of departing traffic;
- AMAN.

The "levels" of these variables are described below.

5.1.1.1 Runway in use at EIDW

Three levels of this variable were employed during the simulation:

- RWY 28 and related SIDs and STARs;
- RWY 10 and related SIDs and STARs;
- RWY 16 and related SIDs and STARs.

More emphasis was given to RWYs 28 and 10 as these represent the runway configurations which currently are used the most (63% of 2008 movements concerned RWY 28, 30% RWY 10 and 6% RWY 16; RWY 34 is negligible with only 1% of the movements, so the decision was taken not to simulate it).

5.1.1.2 TSA active

Two levels of this variable were employed during the simulation:

- TSA1: R15 (to 3000ft), R16 (to 5000ft for EIME arrivals and departures) and D5 (to FL120);
- TSA2: R15 (to 3000ft), R16/MOA4 (to FL150) and D5 (to FL120).

The activation of R16/MOA4 up to FL150 greatly impacts operations when RWY 10 is in use. Therefore a different set of STARs was defined in this condition (PMS design was tailored to comply with the vertical restriction imposed by the military area activation). Otherwise the effect of R16/MOA4 is negligible for the other runway configurations.

5.1.1.3 Non-nominal situations

Focus of the RTS was on non-nominal / contingency situations and on the way controllers / working procedures dealt with them. With this regard the objective was also to use the results from the RTS as input to a Safety Case.

A number of non-nominal / contingency situations were simulated during the RTS. These were:

1. Runway closure

2. Missed approach
3. Sequencing leg run-off
4. Sequencing leg unavailability
5. Transition level (unusual)
6. Severe weather
7. Medical emergency
8. CWP failure
9. LAN failure

In addition a number of less invasive events were simulated to assess how the new concepts / working arrangements impacted on controllers' Situation Awareness (SA). These were:

10. Early turn to merge point
11. Early descent from sequencing legs
12. Level busts
13. Slow climbing departures
14. Departures on wrong SID

5.1.1.4 AMAN

Two levels of this variable were employed during the simulation:

- AMAN is not available to TM;
- AMAN supports TM's decision making.

5.1.1.5 Operating Procedure for Release of Departures

Two levels of this variable were employed during the simulation:

- Prior Permission Only – PPO (tower co-ordinates with the Lower controllers);
- Free Release of departures on jet SID.

The aim was to assess the acceptability of the free release procedure and measure the effect it had on controllers' workload and SA (mainly with regard to the Lower Sectors controllers).

5.2 Validation Exercises

The RTS constituted of two separate sessions: a measured and an exploratory session.

The measured session was to address the main validation objectives and made use of two categories of validation exercises: measured and scenario-based exercises.

The measured exercises allowed for human and system performance measurements, as they ran under standard conditions. The scenario-based exercises mainly focused on the assessment of human performance issues when contingency and non-nominal situations were in effect. Different contingency / non-nominal situations were usually grouped and simulated into one exercise to limit the total number of scenario-based exercises needed and to allow for repetitions of those situations deemed as the most critical/interesting for the Safety Case.

Some of the measured and scenario-based exercises hosted less intrusive events to assess controllers' SA. These were manufactured so as to minimise the impact they had on system performance but still to allow for significant measurements.

The exploratory session was to investigate the support of AMAN in the new operational scenario and made use of a limited number of validation exercises (exploratory) which ran under standard conditions only.

The assessment of the impact of AMAN on human and system performances was not within the scope of the RTS and therefore the experiment did not aim at an exhaustive analysis. The objective was rather to provide conditions for controllers to be exposed to envisage procedures and related working methods suitable to AMAN usage.

5.3 Experimental Conditions

An experimental condition is defined by a particular combination of experimental variables. In the context of the RTS, this definition applies principally for the measured exercises.

Seven experimental conditions (otherwise also known as Organisations) were simulated. These are represented in the figure hereafter:

Runway in Use		Miltary Configuration		Release of Departures
		TS1	TS2	
	28	X	-	PPO
		X	-	FR
	10	X	X	PPO
		X	X	FR
	16	X	-	PPO
		-	-	FR

Figure 3. Experimental Conditions in the RTS

5.4 Other Variables

Other variables were induced by the simulation characteristics. These were: the traffic samples and the meteorological characteristics.

The two traffic samples were similar in terms of load and complexity but they slightly vary with regard to the temporal distribution of demand at EIDW.

As far as possible the AM and PM traffic samples were alternatively used across the experimental conditions, in order to minimise the learning effect and to prevent the controllers from getting too familiar with the traffic scenarios. For the same purpose of maintaining controller interest, variations in each traffic sample were introduced by changing wind velocity and direction (depending on both traffic sample and runway in use).

Finally, with regard to scenario-based exercises only, a further variation was applied to some exercises by deactivating the D5 military area.

5.5 Measurements

5.5.1 Subjective Collection Methods and Tools

The Human Factors aspects were mainly assessed by subjective data, collected by means of post-exercise and post-simulation questionnaires, questions in interviews and de-briefings, and by means of observations during the exercises, gathering spontaneous controllers' comments.

5.5.2 Debriefings

Debriefings were conducted at the end of each simulation run (i.e. after two consecutive exercises) to enable participants to discuss their feeling regarding the feasibility and the acceptability of the concept, and evoke more specifically what they experienced during the run, (e.g. confirm appropriateness of procedures, discuss usability of the phraseology, describe problems or difficulties encountered).

In addition, two final debriefings took place at the end of the measured and exploratory parts of the simulation to collate participants' final feedback regarding the acceptability of the concept, improvements required and issues to investigate in further validation activities (e.g. prototyping sessions).

5.5.3 Interviews

During the RTS, semi-structured one to one interviews were conducted with each of the participants. The objective was get a more specific and precise feedback about the operability of the operational concepts and their working methods.

5.5.4 Questionnaires

The questionnaires prepared for the RTS are reported in Annex D. In particular two types of questionnaires were prepared:

5.5.4.1 Post-exercise Questionnaire

The aim of the Post-exercise questionnaire (completed by each measured controller at the end of each validation exercise) was to collect immediate feedback, with a specific focus on workload, situation awareness and acceptability of the concept and the induced new working method.

5.5.4.2 Post-simulation Questionnaire

At the end of the measured session of the RTS, a specific questionnaire was distributed to capture the global acceptability of the concept, the working methods and procedures.

5.5.5 Observations

Some elements of the experiment could not be recorded from the simulation platform and questionnaires feedback. Validation, HF and operational experts observed the conduct of the exercises and noted relevant events to be discussed later, during either collective debriefing or one to one interview. This assured a more complete analysis of each exercise.

5.5.6 Tools

Some specific tools were used to obtain data concerning workload and situation awareness.

5.5.6.1 Workload Assessment

Workload can be defined as the effect of task load on the controller and the degree to which s/he accepts it. In contrast to task load which reflects objective task demands, workload is influenced by the controller's internalised standards of performance, ability, and experience.

The specific tools that will be used are: Instantaneous Self-Assessment (ISA) and NASA Task Load Index (NASA-TLX).

<u>Instantaneous Self-Assessment (ISA)</u>

The Instantaneous Self-Assessment (ISA) technique is based on the use of a specific device, the ISA box. It requires the participants to rate their subjective experienced level of workload on a scale from 1 to 5. Measurements are taken every two minutes during a simulation run with a flashing red light indicating when an input has to be made. The level of workload is assessed by pressing one of the five numbered buttons which range from "Very Low" (1) to "Very High" (5).

With the ISA box, the controllers not only rate their level of workload but also their spare capacity in the different experimental conditions: the higher the perceived workload, the lower the information processing resources left available.

Table 6. ISA Rating Scale

Level	Workload	Spare Capacity	Description
5	Very High (VH)	None	Behind on tasks. Losing track of the full picture.
4	High (H)	Very Little	Non essential tasks suffering. Could not work at this level very long.
3	Normal (N)	Busy	All tasks well in hand. Busy but stimulating pace. Could keep going continuously at this level.
2	Low (L)	Ample	More than enough time for all tasks. Active on ATC task less than 50% of the time.
1	Very Low (VL)	Very Much	Nothing to do. Rather boring.

<u>NASA-Task Load IndeX (NASA-TLX) questionnaire</u>

The NASA-TLX questionnaire is a subjective workload assessment tool developed by NASA. Based on the premise that perceived workload is a combination of 6 factors, it derives an overall workload score from a multi-dimensional rating scale.

The NASA-TLX scale was included in the post-exercise questionnaire.

5.5.6.2 Situation Awareness Assessment

Situational awareness can be defined as the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.

The specific tool that was used is the Situation Awareness for SHAPE (SASHA) questionnaire.

<u>Situation Awareness for SHAPE (SASHA) questionnaire</u>

The SASHA questionnaire is a self-rating questionnaire for measuring Situation Awareness that has been developed by EUROCONTROL within the framework of the SHAPE project. It uses questions that focus on key elements of SA which controllers have identified themselves. The ratings are made on a 7-point rating scale.

The SASHA questions were included in the post-exercise questionnaire.

5.5.7 Objective Data Collection Methods and Tools

The Performance aspects were mainly assessed by objective data, collected by means of system recordings throughout the exercises. The recorded data concerned controller and pilot inputs, R/T and telephone communications, and aircraft navigation data.

The EUROCONTROL property MUDPIE analysis tool was used both to retrieve the recorded data (AIR, TELECOM, CWP and ISA) from the simulation platform and to deliver them in a format that could be used for data analysis and exploration.

The EUROCONTROL property Skyview2 tool was used to produce charts depicting 2D flown trajectories.

Specific analyses of the recorded data were performed for the assessment of Safety (measure of the Air Proximity Index to evaluate the degree of severity of losses of separation).

5.5.8 Summary of Measures Related to the Objectives

Links between the validation objectives, the measures/types of data to be obtained, and the tools and techniques used to collect them are reported in Annex E, as well as a detailed description of the objective metrics obtained through system in Annex F.

6. CONDUCT OF THE SIMULATION

6.1 Participants

Ten controllers and two data assistants from DATCC participated to the RTS. The controllers were allocated to the measured positions and TR; the two assistants manned the feed sectors.

Out of the DATCC controllers:

- Seven[4] were rated for both Area sectors and Approach positions;
- Three[5] were rated for Approach only (and tower).

In addition to DATCC personnel, two controllers from NATS participated to the first week of the simulation. These were allocated to MN and LD feed position. For the training beforehand, and for the successive weeks of the simulation, those two feed positions were managed, as already said, by the two DATCC data assistants.

The qualified experience of the ten controllers ranged from 6 to 30 years and was distributed as shown in Figure 4.

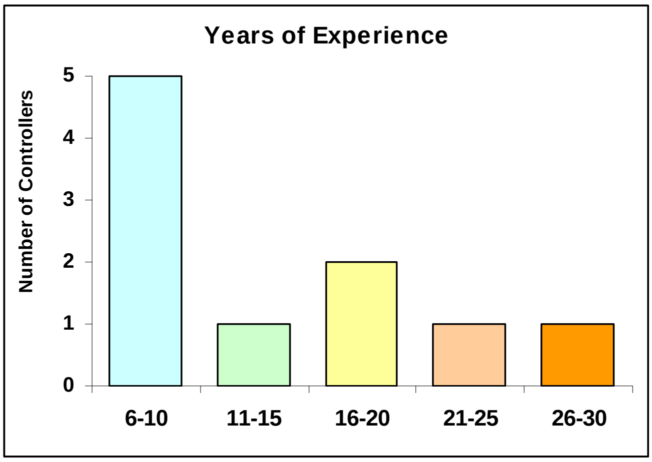

Figure 4. Experience Distribution of Participants

As illustrated in the Figure 5, different operational concept elements used in the simulation were not all equally familiar to the participants.

Four of the controllers had already participated in the first RTS which was held at the EEC site in early 2008 and so were very familiar with the PMS related working methods and procedures. The same controllers and four other had also taken part in some of the seven prototyping sessions which were held in the IAA in 2009.

Since the start of the project, all participants have had access to PMS publications in ATC magazines, the new SID/STAR charts and AIPs at the IAA over the last couple of years which has provided them with some knowledge of the different concept elements of PMS.

One of the controllers was familiar with the AMAN, having worked with the MAESTRO system in Dublin TMA.

[4] These seven controllers are denoted “A” to “G” in the simulation seating plan in section 6.3.
[5] These three controllers are denoted “H” to “J” in the simulation seating plan in section6.3.

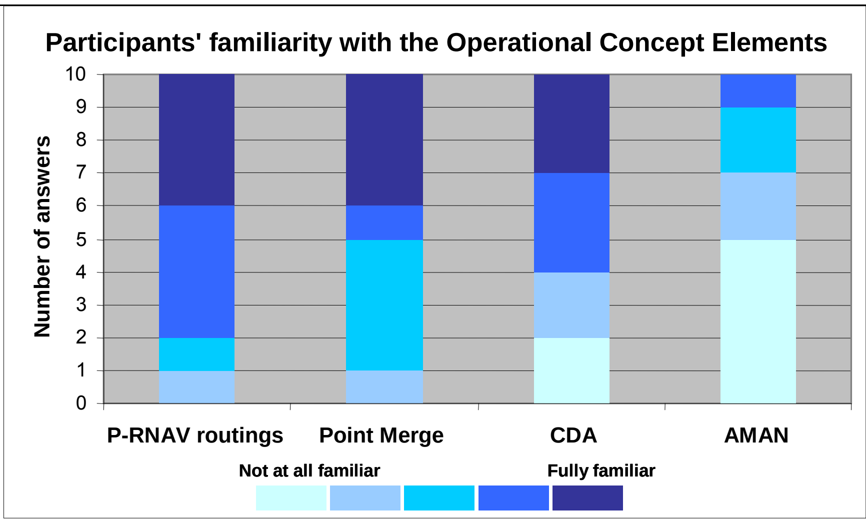

Figure 5. Level of Familiarity Participants with the Operational Concepts

6.2 Simulation Programme and Schedule

The RTS was conducted over five weeks in February-March 2010, and consisted of two weeks training and three weeks of simulation exercises, with a break of one week between the training and the simulation.

The training took place from Monday 8th to Friday 19th of February.

The simulation took place from Monday 1st to Friday 19th March.

6.2.1 Training

The main objective of the training session was to enable the 10 controllers and 2 assistants to build up sufficient knowledge of the different operational concept elements which were to be assessed during the simulation. This included an understanding of the enhanced P-RNAV SIDS and STARS for Dublin TMA, the PMS concept, procedures and the new working methods, which included the new Upper/Lower manning configuration for the area sectors and a new Traffic Manager role. In addition, the controllers were given a short briefing on the HMI functionalities as most of the same functionalities are currently used in Dublin TMA.

The training modules which were developed by a member of the IAA core team included the following elements:

- Several presentations which were aimed at covering the RTS objectives, content and organisation, the operational concept elements and the working procedures such as P-RNAV routings and procedures, Point Merge, CDA and the new manning procedures and the responsibilities and tasks of the new Traffic Manager role;
- A series of specific lectures on the procedures to be applied for each runway configuration;
- A series of specific lectures on the contingency procedures defined to deal with non-nominal events particularly: go-around; aircraft running off the sequencing legs; runway closure; holding;
- A series of 30 measured training runs, each lasting 45 minutes each. The ten controllers rotated over the measured positions so as to allow them to familiarise themselves with each controller working position at least twice. The first week contained a traffic sample of 50% to allow the controllers to familiarise themselves with their new environment, and in the second week, the traffic sample was increased to 100% to enable them to cope with higher traffic levels.

In addition the two weeks training programme also included:

- A series of short debriefing sessions were held at the end of several exercises over the two weeks in order to enable the controllers to provide their feedback. Due to time constraints, it was not possible to do so at the end of each exercise;
- Two day acceptance tests on platform functionalities and traffic scenarios to employ later in the simulation;
- A lecture by a former airline pilot, to allow the controllers to have crew's perspective on the PMS concept and CDA.

The training plan ran as follows:

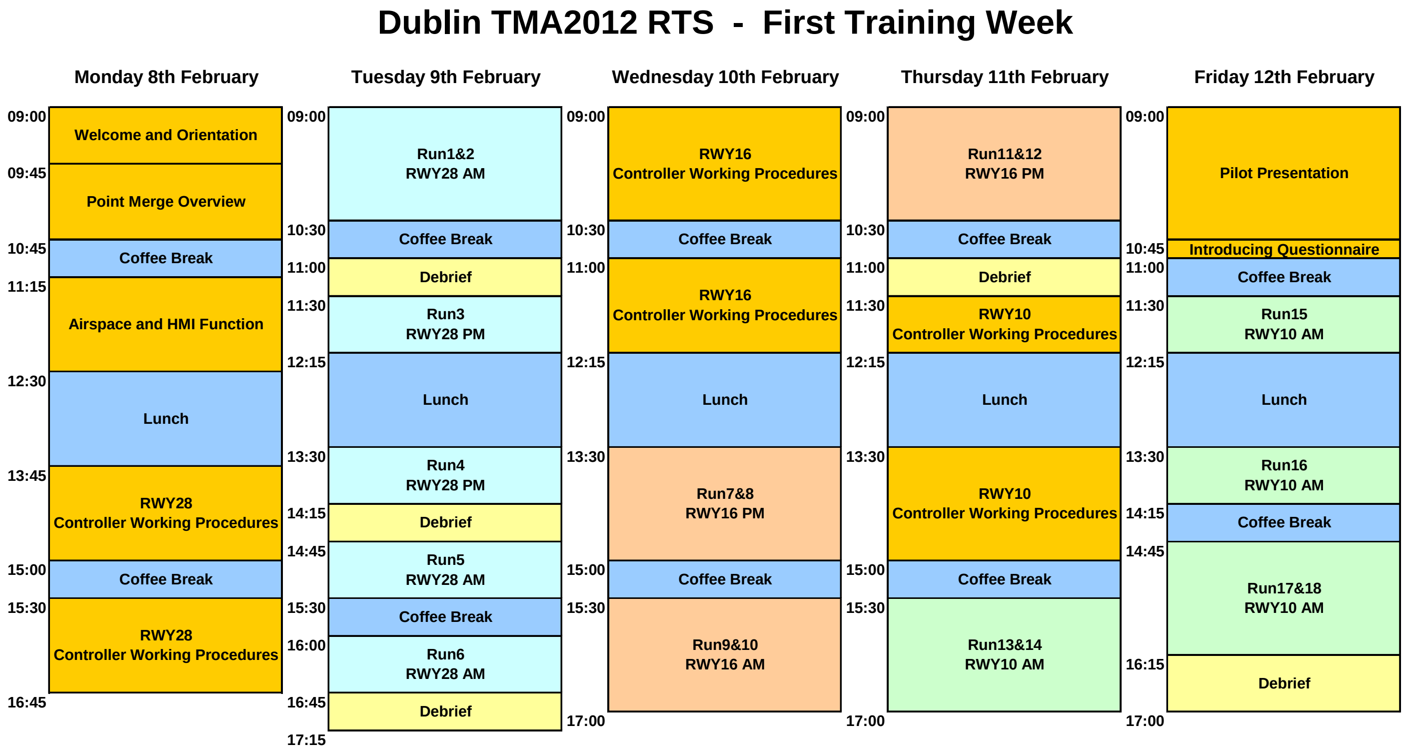

Figure 6. Training Plan (First week)

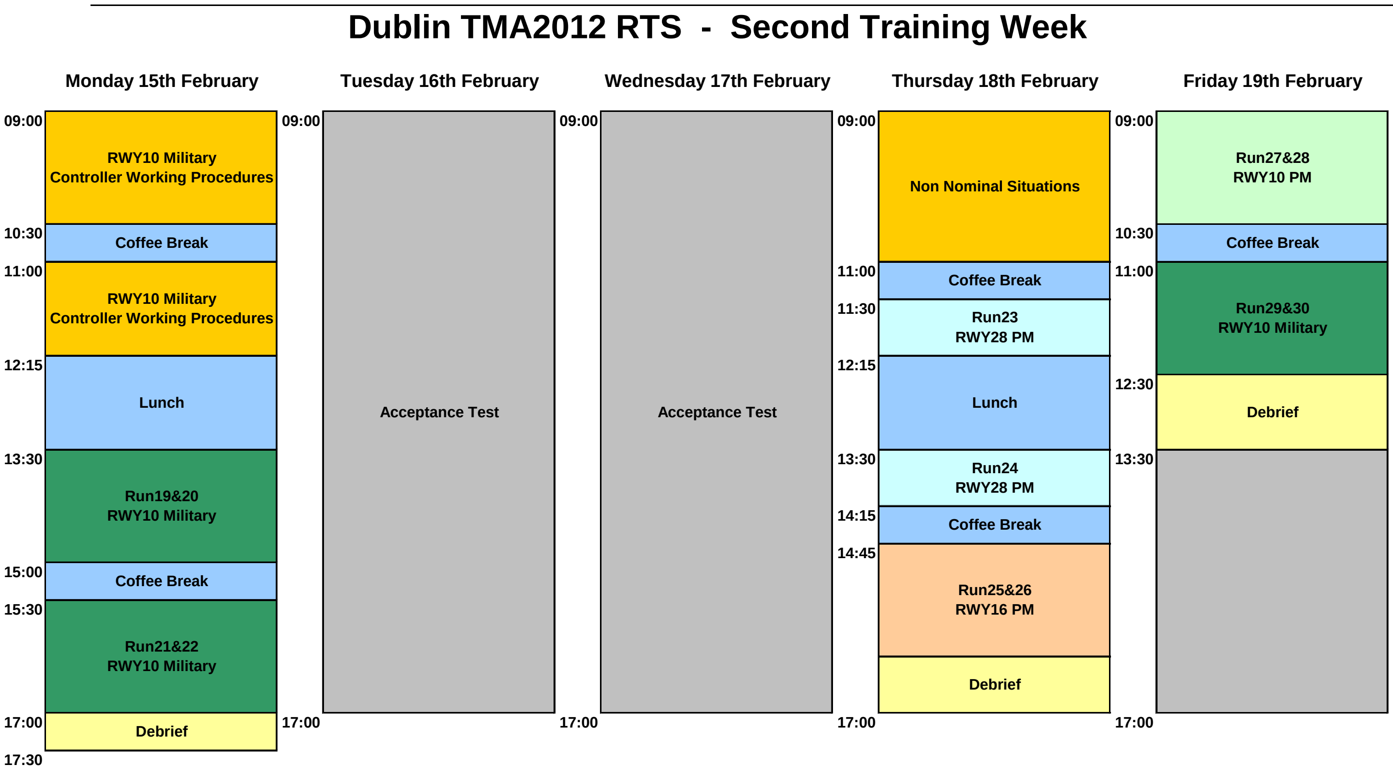

Figure 7. Training Plan (Second week)

After the two week training period, all ten controllers were satisfied with the presentations and either strongly agreed or agreed there was enough training to understand the concept of P-RNAV routings, the PMS concept and the new manning configuration. Despite that two controllers would have preferred to have more hands-on training to get familiar with the procedures.

Overall, the controllers were satisfied with the hand-on training sessions, with nine of the ten controllers reporting that that they had enough training to work with the PMS procedures and the new manning configuration.

Some of the controllers found at the beginning, that some of the procedures in dealing with non-nominal situations were quite complex and ''alien'' to them but as the training progressed, they began to understand them better.

While the majority of the controllers felt that they had enough training to fully understand and use the contingency procedures defined to deal with go-around, aircraft running off the sequencing legs, runway closure and holding, some controllers reported in the questionnaire that, due to lack of acceptance testing prior to the training and because this was carried out during the training, some valuable time was lost in getting more familiar with some of the contingency procedures for non-nominal situations. Some of the controllers who were already familiar with the PMS felt that they could have benefited from a few more training exercises with military active or weather conditions but found that that the training overall was sufficient and adequate for normal working procedures.

All ten controllers reported at times during that training that they experienced problems with slow reactions from pseudo-pilots on instructions given by them. This caused frustration for the controllers, particularly with procedures requiring rapid responses.

6.2.2 Simulation Exercises

The three weeks simulation consisted of two different sessions:

- A "Measured" session from Monday 1st to Tuesday 16th March, and
- An "Exploratory" session from Tuesday 16th to Friday 19th March.

6.2.2.1 Measured Session

Measured and scenario-based exercises were conducted based on 4 sessions per day. A total of 40 validation exercises was originally planned to run during the measured session period.

Each exercise included a 45 minute recording period for analytical purposes. In addition, exercises involved pre-briefing, warm-up and hand-over periods thereby extending each full exercise period to 1 hour or more.

Each exercise was followed by a post-exercise questionnaire.

Group debriefings were held at the end of each morning and afternoon (i.e. after two consecutive exercises).

The morning of the first day was dedicated to briefing the participating controllers on simulation objectives and validation aspects. A training refresh then followed.

Exercises started on the afternoon of the first day and were conducted until Monday 15th.

During the first three days only measured exercises were conducted and the three runway configuration (RWYs 28, 16 and 10) were presented successively in blocks of either four (RWYs 28 and 16) or two (RWY 10) exercises each. During the same period participants were given presentations to refresh on concepts and working procedures concerning the three conditions.

From Thursday 4th on, measured and scenario-based exercises were presented alternatively as were the different runway scenarios (RWYs 28, 10, 16, 10-Mil). On Friday 5th, the participating controllers were given refresher training on working procedures concerning RWY 10-Mil.

An increasing level of complexity was applied for the scenario-based exercises to allow participating controllers to gain experience. On Tuesday 9th a presentation was given to refresh on handling special non-nominal situations (e.g. runway closure, system failure).

The participants were finally asked to complete a final post-simulation questionnaire on the morning of Tuesday 16th, to obtain further information on their perceived benefits with regards to the concepts, roles and working methods. A final debriefing on the measured session followed, to consolidate feedback obtained during the two weeks using the questionnaires and the daily debriefings.

6.2.2.2 Exploratory Session

A total of six exploratory were presented during this period. Similar to the measured session each exercise involved pre-briefing, warm-up and hand-over periods for a total duration of 1 hour or more.

An ad-hoc post-exercise questionnaire was given after each exercise to the Traffic Manager, to obtain feedback on AMAN usability.

Group debriefings were held at the end of each morning and afternoon.

A final debriefing on the measured session took place on Thursday 18th March, to consolidate feedback obtained during the three days of exploratory exercises.

6.2.2.3 Simulation Plan

The original simulation plan (Ref. [8]) allowed for a number of spare sessions to replace lost exercises. These slots were used to replay the first exercises simulated with namely RWY 28 and RWY 10 in use. The decision was taken as traffic complexity / load issues affected the PM sample. It was necessary to correct the sample and then run again the concerned exercises.

The simulation plan is presented hereafter. The exercise code displayed in the following schedule is made up of an orderly group of characters (letters/numbers), as described below.

Table 7. Exercises Codes

Characters	Description
28 / 10 / 16	Represents the active runway.

AM or PM	Represents morning traffic or afternoon traffic.
M / S / E	Represents the type of exercise: ▪ Measured; ▪ Scenario-based; ▪ Exploratory;
Numbers 1 – 12	Progressive number to represent a simulation run.
(A) or (B)	Represents the separate validation exercises from a morning or afternoon simulation run.

Dublin TMA2012 RTS - First Week

Monday 1st March

Time	Activity
09:00	Welcome
09:15	Presentations (RTS Objectives & Validation)
10:30	Training refresh on RWY 28
10:30	Coffee Break
10:45	Training Hand-on Exercise
12:20	Lunch
13:30	Run1 28PMM1(A)
14:40	P-Ex Questionnaire
14:55	Coffee Break
15:10	Run2 28PMM1(B)
16:05	P-Ex Questionnaire
16:20	Run1&2 Debriefing
16:50	

Tuesday 2nd March

Time	Activity
09:00	Run3 28AMM2(A) Free Release
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run4 28AMM2(B) Free Release
11:35	P-Ex Questionnaire
11:50	Run3&4 Debriefing
12:20	Lunch
13:30	Training refresh on RWY 16
14:00	Run5 16PMM3(A)
15:10	P-Ex Questionnaire
15:25	Coffee Break
15:40	Run6 16PMM3(B)
16:35	P-Ex Questionnaire
16:50	Run5&6 Debriefing
17:20	

Wednesday 3rd March

Time	Activity
09:00	Run7 16AMM4(A)
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run8 16AMM4(B)
11:35	P-Ex Questionnaire
11:50	Run7&8 Debriefing
12:20	Lunch
13:30	Training refresh on RWY 10
14:00	Run9 10PMM5(A)
15:10	P-Ex Questionnaire
15:25	Coffee Break
15:40	Run10 10PMM5(B)
16:35	P-Ex Questionnaire
16:50	Run9&10 Debriefing
17:20	

Thursday 4th March

Time	Activity
09:00	Run11 28AMS1(A) Scenario-based
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run12 28AMS1(B) Scenario-based
11:35	P-Ex Questionnaire
11:50	Run11&12 Debriefing
12:20	Lunch
13:30	Run13 28PMS2(A) Scenario-based
14:40	P-Ex Questionnaire
14:55	Coffee Break
15:10	Run14 28PMS2(B) Scenario-based
16:05	P-Ex Questionnaire
16:20	Run13&14 Debriefing
16:50	

Friday 5th March

Time	Activity
09:00	Training refresh on RWY 10 + Mil
09:30	Run15 10AMM6(A)
10:40	P-Ex Questionnaire
10:55	Coffee Break
11:10	Run16 10AMM6(B)
12:05	P-Ex Questionnaire
12:20	Lunch
13:30	Run15&16 Debriefing
14:00	Run17 10AMM7(A) Free Release
15:10	P-Ex Questionnaire
15:25	Coffee Break
15:40	Run18 10AMM7(B) Free Release
16:35	P-Ex Questionnaire
16:50	Run17&18 Debriefing
17:20	

Figure 8. Simulation Plan (First week)

Dublin TMA2012 RTS - Second Week

Monday 8th March

Time	Activity
09:00	Run19 28AMS3(A) Scenario-based
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run20 28AMS3(B) Scenario-based
11:35	P-Ex Questionnaire
11:50	Run19&20 Debriefing
12:20	Lunch
13:30	Run21 10PMM8(A) Free Release
14:40	P-Ex Questionnaire
14:55	Coffee Break
15:10	Run22 10PMM8(B) Free Release
16:05	P-Ex Questionnaire
16:20	Run21&22 Debriefing
16:50	

Tuesday 9th March

Time	Activity
09:00	Run23 10AMM9(A) Free Release
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run24 10AMM9(B) Free Release
11:35	P-Ex Questionnaire
11:50	Run23&24 Debriefing
12:20	Lunch
13:30	Run1 (Replay) 28PMM1(A)
14:40	P-Ex Questionnaire
14:55	Coffee Break
15:10	Run2 (Replay) 28PMM1(B)
16:05	P-Ex Questionnaire
16:20	Run1&2 Debriefing
16:50	Buffer
17:00	

Wednesday 10th March

Time	Activity
09:00	Run25 10AMM10(A)
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run26 10AMM10(B)
11:35	P-Ex Questionnaire
11:50	Run25&26 Debriefing
12:20	Lunch
13:30	Briefing on RWY Closure and unusal situations
14:00	Run27 28PMS4(A) Scenario-based
15:10	P-Ex Questionnaire
15:25	Coffee Break
15:40	Run28 28PMS4(B) Scenario-based
16:35	P-Ex Questionnaire
16:50	Run27&28 Debriefing
17:20	

Thursday 11th March

Time	Activity
09:00	Run29 28AMM11(A)
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run30 28AMM11(B)
11:35	P-Ex Questionnaire
11:50	Run29&30 Debriefing
12:20	Lunch
13:30	Run31 16PMS5(A) Scenario-based
14:40	P-Ex Questionnaire
14:55	Coffee Break
15:10	Run32 16PMS5(B) Scenario-based
16:05	P-Ex Questionnaire
16:20	Run31&32 Debriefing
16:50	

Friday 12th March

Time	Activity
09:00	Run33 28AMS7(A) Scenario-based
10:10	P-Ex Questionnaire
10:25	Coffee Break
10:40	Run34 28AMS7(B) Scenario-based
11:35	P-Ex Questionnaire
11:50	Run33&34 Debriefing
12:20	Lunch
13:30	Run35 10PMS8(A) Scenario-based
14:40	P-Ex Questionnaire
14:55	Coffee Break
15:10	Run36 10PMS8(B) Scenario-based
16:05	P-Ex Questionnaire
16:20	Run35&36 Debriefing
16:50	

Figure 9. Simulation Plan (Second week)

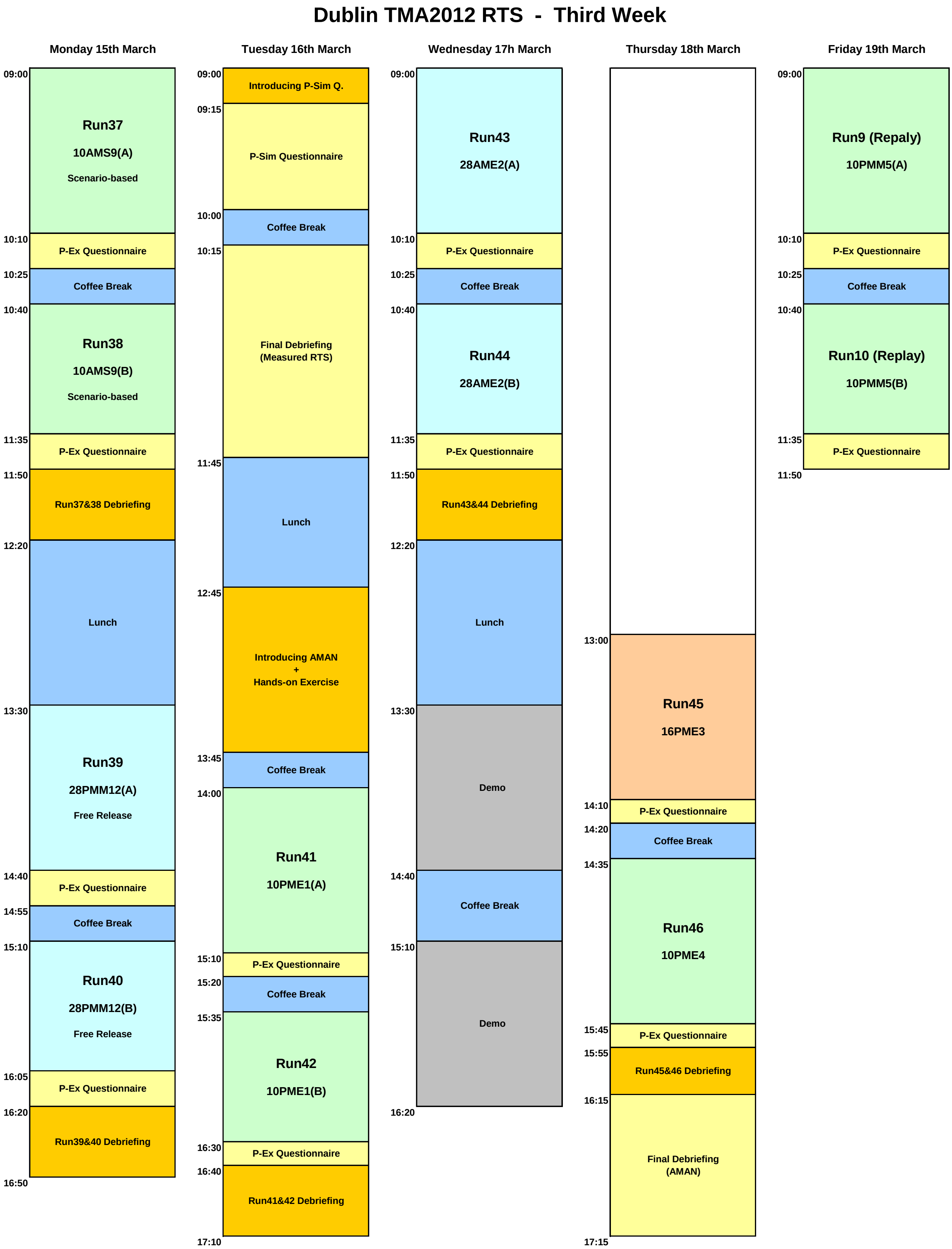

Figure 10 Simulation Plan (Third week)

All the details about the exercises, in terms of traffic samples used, meteorological conditions applied, and most importantly the descriptions of the non-nominal situations or other events simulated and the scenario-based exercises are reported in the Annex G.

6.3 Controller Seating Plan

The seating plan was designed to allow a maximum of controllers per sector/position in the different experimental conditions. For analysis purposes this facilitated more comprehensive measures and more balanced and informed feedback.

The seating plan was also designed to accommodate a number of constraints. These are:

- Controllers' rating (see section 6.1);
- Each simulation run allowed for running two simulation exercises. To minimise the effect of the handover the roster for the two exercises applied the following rules:
  - The same controller played the TM role;
  - The same pair of controllers was allocated to Upper/Lower sectors and they swapped positions.
- A number of measured exercises were used to assess the impact that the free release (of departing traffic) has on human performances. Same rosters (for Area sectors and Initial Approach) were repeated for the exercises with and without the free release procedure.

  RWY 10-Mil exercises did not accommodate this rule. The limited number of exercises made it preferable to allow as many controllers as possible in different positions to get more variety of feedback.

The controllers rotated over eight working positions, which included the measured sectors and the tower feed (TR).

The remaining feed sectors were normally manned by IAA data assistants. However during the first week of the simulation the London (LD) and Manchester (MN) feeds were manned by NATS controllers.

As there were ten controllers for eight working positions, two controllers were "spare" during each exercise and thus free to observe any of the positions/sectors.

When individual interviews were conducted (from the second week of simulation), the interviewee was chosen from the two spare controllers.

6.3.1 Training

The seating plan of the training session was the responsibility of the DATCC core team. The plan was designed to accommodate some of the rules above where possible.

6.3.2 Simulation Exercises

In these tables, each controller is denoted by a letter, A to J. Data assistants are denoted by X and Y.

Table 8. Seating Plan for the measured session

	Measured Positions							Feed			
	UN	LN	US	LS	AP	FI	TM	TR	MN	LD	SH
Run1	B	F	E	C	D	H	A	J	NATS	NATS	Y
Run2	F	B	C	E	H	I	A	D	NATS	NATS	X
Run3	E	A	B	D	F	J	C	I	NATS	NATS	Y
Run4	A	E	D	B	J	H	C	F	NATS	NATS	X
Run5	G	D	E	F	A	J	B	H	NATS	NATS	Y
Run6	D	G	F	E	I	C	B	J	NATS	NATS	X
Run7	B	E	D	C	J	I	F	H	NATS	NATS	Y
Run8	E	B	C	D	G	A	F	J	NATS	NATS	X
Run9	F	C	A	E	I	B	D	H	NATS	NATS	Y
Run10	C	F	E	A	H	J	D	I	NATS	NATS	X
Run11	D	A	B	G	C	I	E	H	NATS	NATS	Y
Run12	A	D	G	B	J	F	E	I	NATS	NATS	X
Run13	C	D	F	A	B	H	G	I	NATS	NATS	Y
Run14	D	C	A	F	E	I	G	J	NATS	NATS	X
Run15	E	B	F	D	H	I	C	J	NATS	NATS	Y
Run16	B	E	D	F	J	A	C	H	NATS	NATS	X
Run17	B	C	E	D	A	I	F	J	NATS	NATS	Y
Run18	C	B	D	E	J	A	F	I	NATS	NATS	X
Run19	A	G	C	B	H	F	E	D	X		Y
Run20	G	A	B	C	I	D	E	J	Y		X
Run21	F	C	A	E	I	B	D	H	X		Y
Run22	C	F	E	A	H	J	D	I	Y		X
Run23	F	D	A	C	E	J	B	H	X		Y
Run24	D	F	C	A	I	H	B	J	Y		X
Run25	B	C	E	D	A	H	F	I	X		Y
Run26	C	B	D	E	J	I	F	H	Y		X
Run27	B	E	C	F	I	H	A	D	X		Y
Run28	E	B	F	C	H	J	A	I	Y		X
Run29	E	A	B	D	F	J	C	I	X		Y
Run30	A	E	D	B	J	H	C	F	Y		X
Run31	A	E	F	B	C	H	G	J	X		Y
Run32	E	A	B	F	H	D	G	I	Y		X
Run33	C	D	A	E	J	I	B	F	X		Y
Run34	D	C	E	A	H	G	B	J	Y		X
Run35	A	F	B	D	J	I	E	H	X		Y
Run36	F	A	D	B	G	C	E	I	Y		X
Run37	D	C	A	F	B	E	G	J	X		Y
Run38	C	D	F	A	I	J	G	H	Y		X
Run39	B	F	E	C	D	H	A	J	X		Y
Run40	F	B	C	E	H	I	A	D	Y		X

Table 9. Seating Plan for the exploratory session

	Measured Positions							Feed			
	UN	LN	US	LS	AP	FI	TM	TR	MN	LD	SH
Run41	D	B	A	F	I	H	C	J	X		Y
Run42	B	D	F	A	H	J	C	I	Y		X
Run43	E	A	B	D	J	I	F	H	X		Y
Run44	A	E	D	B	I	H	F	J	Y		X
Run45	F	D	A	C	H	J	E	I	X		X
Run46	C	A	E	F	J	I	D	H	Y		X

6.4 RTS Caveats and Limitations

6.4.1 Reference Scenario

The main limitation of the RTS concerned the lack of a baseline replicating the current operational scenario; hence the assessment of the impact of the new working arrangements / procedures on system performance was heavily limited in the experiment.

Other or more detailed aspects of system performance, which would require a comparison with a baseline to clearly identify potential benefits of the new procedures, need additional activities to be carried on. The RTS could ‘only’ facilitate the collection of information/data to feed these further activities.

However the TMA2012 project in general and the RTS in particular incorporate results of previous studies and experiments conducted over the last few years. In particular, in early 2008, a simulation was conducted as part of the Mid-Term Concept Validation (MTV) Cycle 0 studies related to the management of flows in the TMA, leading up to Episode 3 Cycle 1 validation activities of the SESAR proposed solutions for the execution phase of the airport and TMA operations (Ref. [10], [11])

The main aim of that simulation was to investigate the feasibility of using an RNAV route structure in TMA with the application of a specific P-RNAV procedure for arrivals. As it was not possible to obtain resources including controllers from the main partners in Episode 3, and the IAA was planning to redesign its Dublin TMA airspace, it was agreed to conduct this simulation also to address the IAA objectives. Therefore the simulation employed the Dublin TMA operational scenario and controllers from DATCC participated to it.

In that simulation a baseline replicating the current Dublin TMA operational scenario was compared to new proposals of airspace redesign (including P-RNAV procedures, PMS and new manning configuration). The simulation confirmed that single person operations, coupled with P-RNAV procedures and implementation of PMS would be able to accommodate the expected increased traffic demand, and by enabling aircraft to perform CDA, PMS has the potential to enable significant environmental benefits and fuel savings to be achieved (Ref. [12]).

Therefore previous studies had already ‘proved’ that the implementation of P-RNAV procedures in the Dublin TMA along with PMS and new manning configuration (single person operations) would bring benefits in terms of system performances against the today situation. In addition these benefits could be measured through direct comparison between current and new operational scenarios.

Even though the 2008 simulation did not employ the exact scenario of the present RTS, it was assumed that the majority of the achieved results would still be applicable to the refined operational scenario.

6.4.2 Experimental Conditions

The amount of conditions which had to be simulated, limited the number of exercises in each condition. Therefore the participating controllers could not be all exposed to all the conditions the RTS featured.

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7. RESULTS

The results presented in this section are based on controller ratings and feedback obtained from the ISA, post exercise and post simulation questionnaires, individual interviews and group debriefs as well as recorded system performance data.

As mentioned previously, in order to achieve the primary objectives of the RTS two main types of exercises were used in the simulation: measured and scenario- based exercises:

- The measured exercises were based on nominal conditions with the aim to gain controller feedback and system performance data to assess both the feasibility and acceptability of PMS operations to the Dublin TMA controllers as well as in terms of the system performance. As there was no baseline or control condition used in the simulation no objective comparisons to today's operations are presented hereafter (see also section 6.4.1). The findings from questionnaire ratings obtained are based on absolute measures and only descriptive statistics, namely the means and standard deviations, are used to analyse and interpret the data obtained.
- The scenario based exercises were used to investigate the feasibility and acceptability of the PMS concept under non-nominal events. Again the data / ratings obtained are used as absolute measures. In addition, as the number of times each non-nominal event could be simulated was limited, no in-depth statistical analysis could be performed on the questionnaire ratings and system performance data obtained. Thus, the data and feedback obtained each non-nominal event simulated is analysed on a case by case basis.

It should be noted that only an extract of the results obtained are presented in this chapter, in order to highlight the main findings from the real time simulation. A complete and more detailed set of the results obtained from the questionnaires can be found in Annex H. A summarised version of the recorded interview notes can be found in Annex I.

Finally, initial feedback from the controllers regarding the usability and suitability of AMAN as a tool to support PMS operations in the Dublin TMA are reported in Annex A.

7.1 Nominal Conditions

This section describes the results obtained for the measured exercises that were used to assess PMS under nominal conditions. Only the results obtained for the Area and Approach positions are presented in this section. The findings relating to the Traffic Manager role are reported later on in section 7.3.

7.1.1 Feasibility and Acceptance of TMA2012

Feasibility addresses the workability of the assessed aspect (concept, procedures, methods, tools, etc.) in the operational environment. Acceptability refers to the suitability and usability of the tool, of a working method, procedures etc. (i.e. it is easy to do, to understand etc.) The term operability is also used to designate feasibility and acceptability in the operational context. Acceptability and feasibility are closely linked to the controllers' perception of workload and situation awareness which will be addressed in following sections.

Acceptance and feasibility of the PMS and associated manning configuration were investigated using controller feedback from the post simulation questionnaire, individual interviews and group debriefings.

7.1.1.1 Feasibility and Controllers' Acceptance of PMS

The results from the post simulation questionnaire relating to the feasibility and acceptability of PMS operations were overall very positive. All controllers participating in the RTS either agreed or strongly agreed that the working methods proposed for Dublin TMA in 2012 (i.e. PMS plus the new manning configuration) were easier to apply than in current operations and that handling arrivals using PMS is easier than vectoring aircraft. All controllers also reported that reverting to vectoring when necessary was not an issue during the simulation.

Overall controllers agreed that the procedures for the Upper and Lower Area controllers, Approach and Final Director controllers were clearly defined and workable (only one controller of the ten stated that he neither agreed nor disagreed that the procedures for the Approach sectors were workable).

The level of flexibility with the PMS in terms of optimising the traffic sequence was also overall considered acceptable by the controllers. In fact, the Approach controllers considered that it was even easier to make certain changes in the sequence of aircraft under PMS than under current day operations.

When asked whether ‘Applying PMS is less stimulating than radar vectoring the aircraft’, half the controllers agreed and half disagreed with this statement. One of the controllers that agreed added that ‘Because of the consistent nature of the tasks and procedures I can see controllers becoming bored more quickly, having less satisfaction and stimulation from their work’. However, the controllers that disagreed all felt that although their job would change under PMS, controllers would still gain satisfaction from their work, for example one controller stated ’…(PMS) is still stimulating in itself. Consistently providing 3/5NM spacing is a difficult task given weather / wind / aircraft types in Dublin TMA and is rewarding in itself’. One controller commented that he felt that not vectoring traffic would not impact controller job satisfaction in itself but perhaps the lack of autonomy and decision making due to the Traffic Manager being more responsible and taking away some of the control decision-making from controllers (i.e. both Area and Approach) could affect job satisfaction.

Three of the Dublin Approach controllers also commented that although using 3NM separation on Final was workable, it could not be sustained for a long period of time as it required a lot of concentration and was very intense. As one controller commented, ‘I agree with 3NM separation but as a Final controller it would be quite hard to sit in this position for a prolonged period of time as it is quite intense and draining. Also if tower have departures they will not be happy with lengthened periods of 3NM between arrivals.’ However it should be noted that this issue is not a direct consequence of PMS, as it is the case also in current day operations where 3NM happens to be applied even though the level of traffic worked is 40% less than that worked by the controllers in the RTS.

However, overall feedback from the questionnaires and controller interviews and debriefs showed that controllers liked and were positive about the Point Merge System and were impressed about the amount of traffic that they felt could be safely handled with such a system in place.

In addition, controllers recommended a number of improvements to optimise PMS operations in the Dublin TMA, these included:

- Lowering the base of controlled airspace in the west and north of the Dublin control zone to facilitate approach operations when RWY 10 or RWY 16 is active;
- Increasing the length of the sequencing legs for RWY 28 in order to increase the capacity of the legs;
- Further evaluation of the DUNLO SID and INKUR non-jet SIDs for RWY 16 in future prototyping sessions.

7.1.1.2 Feasibility and Controllers’ Acceptance of New Manning Configuration

The findings from the post simulation questionnaire showed that all the controllers that had worked the Area positions either agreed or strongly agreed that the manning configuration is workable in the Dublin North and South Area sectors. The feedback gained from the interviews and group debrief sessions supported this as all the controllers reportedly found the new manning configuration under PMS where each Upper and Lower Area sector is manned by a single tactical controller to be acceptable. As one controller stated ‘Single person sectors work everywhere else so there is no reason why they shouldn’t work here in Dublin’. Although controllers agreed that under single person operations the tactical controller loses an extra ‘pair of eyes and ears’ that act as a backup, the controllers participating in the simulation also commented that they didn’t really consider this to be a problem as under the new manning configuration each tactical controller was now responsible for half the volume of airspace compared to current operations. This meant that the tactical controllers’ task load per sector was reduced compared to current operations, both in terms of the number of aircraft within the sector at any one time and the amount of R/T communication. Furthermore, all the Area controllers stated that although the Upper and Lower Area controllers are each responsible for the aircraft in their own sector they still continued to work very closely together as a team. Observations made during the simulation support this as the Upper and Lower controllers were seen to be continuously communicating and co-ordinating with each other, pointing out potential events and advising each other of ways to deal with and resolve an event.

The controllers working the Approach and Final Director positions also found the new manning configuration for Approach control acceptable. However, it was pointed out by several controllers that if it was quiet and traffic demands were not so high it may become ‘quite mundane' having two controllers working the approach. Therefore it was suggested that under low traffic conditions the two sectors could be collapsed into one.

7.1.1.3 Perceived Benefits and Limitations of TMA2012

The participants were asked in the post simulation questionnaire to generally describe the foreseen benefits and limitations of the TMA2012 operational scenario, not only in relation to controllers' acceptability but in a broader sense.

The majority of the controllers answered that the new operational scenario would bring numerous major benefits to the whole ATM system, whereas it would only have a few minor limitations/ (Figure 11).

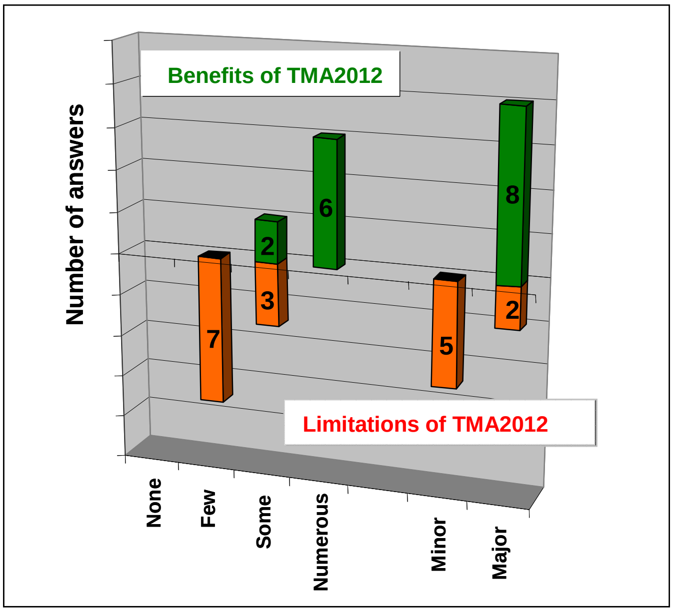

Figure 11. Benefits and Limitations of TMA2012

In relation to the previous question the controllers were asked to list the three benefits and three limitations of TMA2012 they deemed as the most relevant.

All responses (controllers' quotes) can be found in Annex H. In this section only the results of the cluster analysis are presented. The listed clusters cover the majority of the responses given.

The benefits of TMA2012 can be clustered into five performance areas, which are:

- Environment sustainability;
- Airspace capacity;
- ATC efficiency;
- Controllers' workload;
- Predictability.

A major benefit for the participants was the impact the new operational concept would have on flight efficiency which in turn facilitates more environmentally sustainable operations. Specifically, the implementation of CDA would increase fuel efficiency and provide knock-on environmental benefits in terms of condensed noise contours and reduced noxious emissions.

The systemised nature of the PMS working method determines the way controllers handle the traffic, i.e. adherence to the standard procedures and less likelihood of ad-hoc controlling. This would generate an increase in the throughput of the Dublin TMA assuring at the same time a much improved and more consistent ATC service.

The adherence to a more systemised way to handle traffic and the new working arrangements (e.g. split of the Area sectors into two executive controllers) would reduce the workload the controllers experience in their current system.

The respect of the standard procedures would facilitate the predictability of the traffic. Both controllers and pilots would therefore profit from enhanced situation awareness.

The limitations of TMA2012 can be clustered into three main areas, which are:

- Training;
- External factors;
- Job satisfaction.

Training was reported as an important issue in the implementation of TMA2012. The controllers stressed two important issues with regards to conduct appropriate training programme.

Firstly, PMS was seen as a major change in working method. The effectiveness and efficiency of PMS was considered highly dependant on the performance of the various actors (controllers and most importantly Traffic Manager). If training is not delivered in a comprehensive manner, the new working method will not realise the full expectation of the anticipated potential benefits.

Secondly, PMS was associated with the loss of vectoring skills. The new working method relies on adherence to the procedures thereby avoiding the use of open-loop instructions in so far as possible. However, controllers would still be required to vector aircraft under certain conditions and therefore, would require a suitable refresher training programme to ensure they retain their vectoring skills.

Controllers anticipated that training requirements would be considerable and they feared that management might not release enough resources to meet their training needs.

PMS was seen as highly dependant on external factors, such as meteorological conditions and facilities. Severe weather conditions could cause disruption in the applicability of PMS.

Finally, the easiness in using PMS was perceived by some controllers as a 'downgrade' of their role, as if the new working method would no longer require high level skills. The less demanding working method was associated with the possibility to lose part of that job satisfaction which the controllers want to preserve.

7.1.1.4 Synthesis of Acceptance

- PMS operations considered to be easier to apply than current operations using vectoring;
- PMS working procedures for all positions under all runway scenarios investigated considered workable and acceptable. Three recommendations to further optimise PMS operations were made:
    - Increase sequencing leg length of RWY 28;
    - Lower the base on control for RWYs 10 and 16;
    - Further evaluation of the DUNLO SID and INKUR non-jet SIDs for RWY 16 in future prototyping sessions;
- The new manning configuration for the Area sectors is considered workable and acceptable. Having single person sectors was not considered to be a problem for several reasons:
    - The Upper and Lower controllers in the same Area sectors work together as a team supporting and co-ordinating with each other as necessary;

- o Each sector controller is working a smaller range (i.e. half the current volume of airspace) and hence has fewer number of aircraft on frequency at any one time;
- o The Traffic Manager is present to provide support if necessary;

- The manning configuration for the Approach under PMS is considered workable and acceptable. As with the Upper and Lower controllers in the Area sectors the Initial and Final Approach controllers work closely together as a team. However, under low traffic demands the Initial Approach and Final director positions could combined and manned by one Approach controller;
- Although there may be a potential reduction in job satisfaction because of the ease of the PMS working method, its thought satisfaction can still gained in achieving the tasks more efficiently (e.g. appropriate delivery conditions, consistent spacing, etc.);
- The more systemised way of working under PMS is still seen to allow for an acceptable level of flexibility.

7.1.2 Roles and Tasks

The roles and tasks of the Area and Approach controller were assessed in terms of their appropriateness and acceptability by use of post exercise and post simulation questionnaires, observations, individual interviews and group debriefs as well as system recorded data where possible.

Detailed results obtained from the post-exercise and post-simulation questionnaires relating to working methods, roles and tasks can be found in Annex H.

7.1.2.1 Task Distribution

7.1.2.1.1 Recorded Data

One of the aims of the introduction of PMS was to simplify the controllers' work by introducing a more systematic way of working compared to current operations.

The controllers were required to maintain a/c on the appropriate SIDs and STARs as far as possible. Hence, the use of vectoring was no longer considered as the primary tool to use to space and sequence the traffic. Spacing between aircraft had to be achieved primarily through the use of speed control. Moreover the PMS working method relied on the implementation of continuous descent profiles, as opposed to the current step descents.

The respective usage of level, speed, heading and direct instructions was analysed as a function of the concerning sector and the experimental condition. It should be noted that results from previous simulation showed that PMS operations considerably reduced the requirement for heading and level instructions leading to a significant decrease in the total number of ATC instructions issued (Ref. [12]).

The repartition of manoeuvre instructions gives an objective assessment of the controllers' activity over traffic in terms of number of instructions and respective roles. The results displayed in Figure 12 and Figure 13 refer to the mean number of instructions each sectors[6] gave within the exercise measured period (45 minutes). The figures are further broken down into the four different experimental conditions.

The Area sectors issued approximately 200 manoeuvre instructions on average during 45 minutes. 60% of these instructions were given by the Lower controllers, the remaining 40% by the Upper controllers. Instructions were mainly for level (56%) and speed (24%). Heading instructions represented only 6% of the total.

[6] As far as the Area sectors are concerned the diagrams show the instructions given to all traffic types.

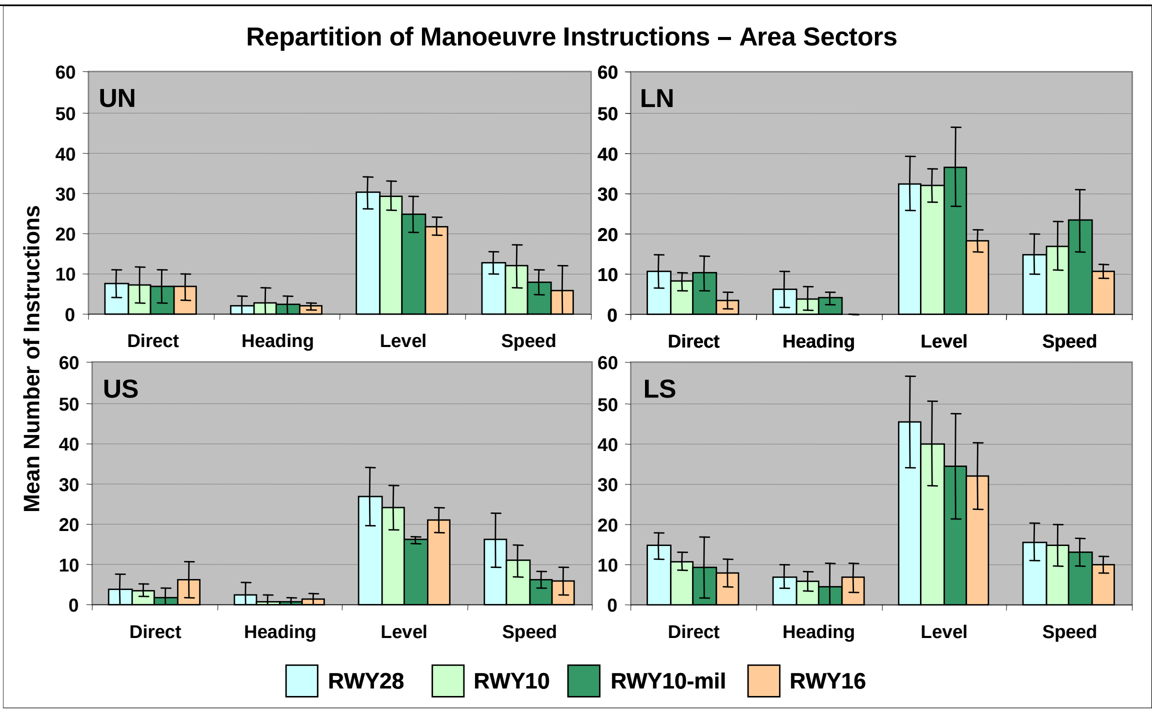

Figure 12. Manoeuvre Instructions at the Area Sectors

The Approach sectors issued 150 manoeuvre instructions on average during 45 minutes. Instructions were evenly distributed between the Initial Approach controller and the Final Director. Instructions were mainly for speed (53%) and level (29%). Heading instructions represented only 1% of the total.

The Final Director essentially gave speed orders (72% of the FI total), whereas the Initial Approach equally handled level, speed and direct orders (respectively 34%, 34% and 31% of the AP total).

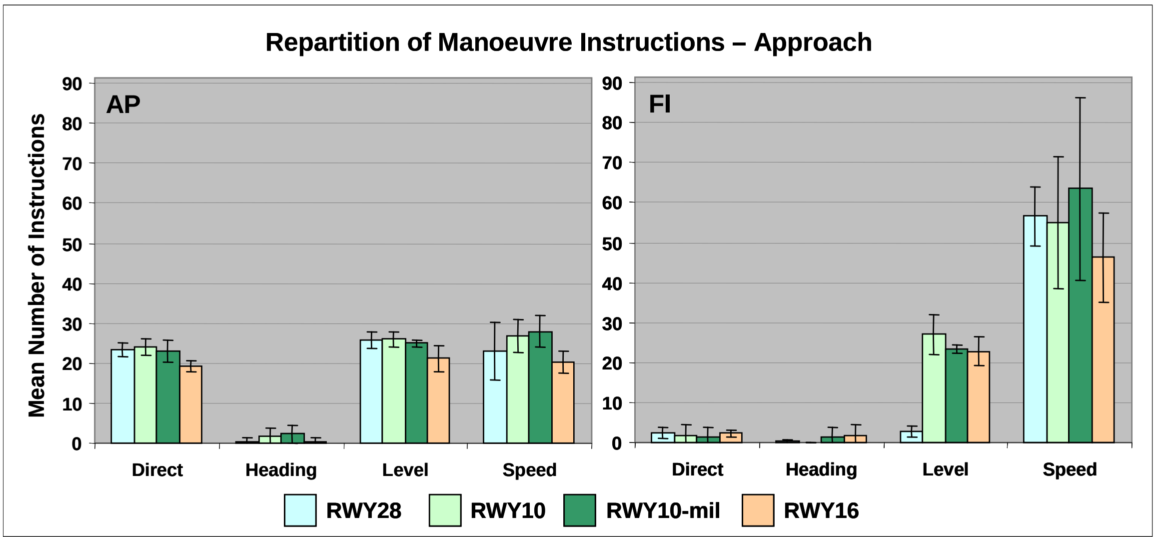

Figure 13. Manoeuvre Instructions at the Approach

7.1.2.1.2 Subjective Feedback

All but one of the seven controllers that worked the Area positions felt that the task distribution between the Upper and Lower sector area controllers was appropriate (the one controller was undecided). Although, there was consensus opinion that under PMS the Upper sector positions had less workload than the Lower sector positions especially in busy periods. Several of the controllers commented that the Lower control position was more demanding because the Lower controller had to ensure that all aircraft reached a specific level, speed and spacing before handing over the aircraft to Approach. In addition the Lower controllers were also mainly responsible for resolving conflicts

However, although the Lower controllers had a slightly greater amount of workload than the Upper controllers the distribution of tasks and workload was judged to be much more balanced than under the current traditional Executive and Planning controller manning configuration. As one controller commented 'In the simulation the task load distribution (between the Upper and Lower controllers) was about 40/60…it is far better than the current 90/10 split with Executive / Planner'.

It should also be noted that as the simulation progressed and the controllers became more familiar and comfortable with the procedures, the roles of the Upper and Lower controllers evolved. The Upper controller started to take on more of a proactive role for example, s/he would point out potential situations/events to the Lower controller and where possible advise on how to best deal with the situation. It was also noted that the Upper controller was co-ordinating more with the Traffic Manager than the Lower controller. This was seen by the controllers as a natural evolution of the Upper controller role as he had more time to point things out to the Traffic Manager and discuss possible strategies than the Lower controller. The Upper controller would then communicate this to the Lower controller when an opportune moment arose. Furthermore the Upper controller would adapt his working method depending on the situation, for example if the Upper controller saw the Lower controller was busy and he was not he would tell the Lower controller to transfer a departing aircraft over to him early etc. By the end of the simulation the Upper and Lower controllers working the same area sector were observed to work very much as a team and there was constant communication and co-ordination between the two. In the debriefs and interviews the controllers confirmed this and said that this team work and constant co-ordination and support was essential and emphasised the importance of the Upper and Lower controllers being seated adjacent to each other in the control room.

All ten controllers stated that the task distribution between the Approach controller and the Final Director was appropriate. Although as mentioned previously, several controller pointed out that with the current traffic levels the Approach and Final Director positions could perhaps be combined and manned by one controller.

7.1.2.2 Communication and Co-ordination

An advantage noted by the controllers of having two Executive controllers manning the same volume of airspace compared to the traditional Executive and Planning controller set up is that each tactical controller is responsible for half the current volume of airspace and each has his own R/T communication system which means that the amount of R/T is reduced. Furthermore, as heading instructions are rarely necessary under PMS this also contributes to a significant reduction in R/T[7]. Most of the controllers also commented that the amount of co-ordination and communication between adjacent sectors appeared to be reduced under PMS compared to current day operations. This was supported by the fact that the majority (seven of the ten) of controllers agreed with the statement in the post simulation questionnaire that 'the more systematic nature of PMS reduced co-ordination workload' and disagreed with the statement 'handling co-ordination with adjacent sectors within the Dublin TMA is more difficult with the new manning configuration than the current manning configuration. As one controller stated 'communication is reduced as everyone knows what to expect as the procedures define how aircraft has to be delivered to each sector in terms of speed, level and spacing, hence communication between adjacent sectors is usually relatively short and simple.'

Handling co-ordination with adjacent centres was also seen to be easier with the new manning configuration by four of the seven controllers although two of the seven felt that co-ordination with adjacent centres was further complicated under PMS due to having to go through the traffic manager.

Co-ordination between the Approach and Final Director was reported to be very easy and straightforward and worked well because they were seated next to each other. It was also noted that the amount of co-ordination the Approach controller required with Area control was reduced under PMS operations as again the Lower Area controllers had to ensure that traffic was delivered to the PMS sequencing legs in accordance with the procedures. This was seen as a positive by the Approach controllers as under current operations the 'aircraft can arrive from more or less anywhere in the Dublin TMA.'

[7] The 2008 simulation measured that in the PMS conditions the R/T load was reduced from 55% to 33% for the Approach an Final sectors when was compared to the reference today scenario (Ref. [12]).

7.1.2.3 Monitoring and Conflict Detection & Resolution

In the post simulation questionnaire the majority of controllers (8 out of 10) agreed that the monitoring of aircraft sequence required less effort under PMS compared to the current operations. The reason for this was said to be due to the increased predictability resulting from PMS operations as aircraft are required to adhere more to specific routes (i.e. SIDs, STARS and sequencing legs). A couple of the controllers added that there may be some concerns that the job is becoming more simplified.

Monitoring the traffic situation and identifying critical events was reported to be no more difficult under the new manning configuration compared to the current Dublin TMA manning configuration. As one controller commented ‘As all traffic are following the same route you are less like to lose track of any item of traffic’.

7.1.2.4 Vectoring Aircraft

Several controllers mentioned in the interviews that it was easier to identify when they needed to issue instructions, such as to turn aircraft onto the Final, to ensure the required spacing was achieved under PMS compared to current operations. Furthermore although all controllers reported that reverting to vectoring when necessary was not an issue during the simulation, they did express a concern that if PMS was introduced some controllers may have trouble reverting to vectoring. This was thought to be an especially prevalent issue with regards to future new recruits that would never have used vectoring as a standard working method. Hence ensuring vectoring skills are acquired and maintained through training and regular refresher training even if PMS is introduced was seen as essential by all controllers.

7.1.2.5 Holding

All controllers but one considered the procedures for holding under PMS to be workable and suitable. The one controller that felt that the holding procedures were not suitable or workable stated the reason for his response was because one controller should not manage a hold using the Traffic Management List and handle departures and en-route traffic. When questioned about the need for a separate holding controller in the interviews and debriefs all the controllers fully agreed that when holding aircraft the workload of the Lower controller escalated and that a separate holding controller was essential when the number of aircraft in the hold exceeded a certain number (e.g. two or three).

One suggestion made by a controller to help temporarily ease the workload of the Lower controller when holding aircraft was necessary was for the Lower controller to hold the aircraft higher up so as to force the stack into the Upper controllers airspace so that the upper controller could take on the responsibility for some of the holding aircraft. This would help relieve the Lower controller’s workload to a degree although it must be noted that it was also agreed that this could not replace a holding controller but may be a useful tactic to employ if necessary.

7.1.2.6 Flight Information Service (FIS)

As highlighted in the task analysis, the allocation of the Flight Information Service tasks had not been considered in the development of concept of operations for the Dublin TMA 2012 scenario. When questioned, all controllers agreed there was an obligation for the Dublin TMA to provide a Fight Information Service. The controllers also agreed that the Area controllers should not be responsible for this task as it would be too much for them to do in addition to the tasks they were already assigned under PMS. Thus a separate Flight Information Service desk manned by a qualified controller was seen as necessary. There was concern expressed by a couple of controllers that as the Upper controller was the least busy position in the Area sectors, responsibility for the Flight Information Service would fall onto them. This was not seen as a feasible solution as the Upper controller responsible for the FIS would not have the capacity to provide the FIS to aircraft in both Area sectors. One suggestion for a potential solution was to have a countrywide Flight Information Service desk as they currently have in the UK.

7.1.2.7 Shift Handover

The task analysis also highlighted the fact that under the new manning configuration there was no-one to act as a ‘back stop’ in case the outgoing controller failed to convey all the necessary information to the incoming controller starting his/her shift. When questioned during the interviews controllers did not perceive this as a major problem, controllers felt that as PMS increased the predictability of the traffic in the Dublin TMA, it would be easier for incoming controllers to get a good understanding of the traffic situation. In addition, it was agreed that several mitigation actions should be implemented to facilitate the transfer of information to incoming controllers and also reduce the impact if all the necessary information is not provided. The mitigations included:

- Checklists to help ensure all the necessary information is conveyed at shift handover;
- Training on the handover procedure;
- Ensure that the Upper and Lower controllers for each Area sector and Approach controller and Final Director do not change shift simultaneously, so as to ensure there is always someone working in the adjacent sector that has a good understanding of the current traffic situation and who can convey necessary information to the incoming controller if required;
- Standardised working methods within the Dublin TMA so that all codes and inputs such as label markings have the same meaning for all controllers.

7.1.2.8 Synthesis of Roles and Tasks

- Task distribution between the Upper and Lower controllers in the Area sectors is seen as acceptable. Although the Lower controller role is considered more demanding than the Upper controller role the task distribution between the Upper and Lower controllers is seen as much more balanced than the current task distribution between Executive and Planning controllers (i.e. task distribution estimated by controllers to be 40:60 for the Upper and Lower controller respectively compared to 90:10 for the Executive and Planner controller under current operations);
- Task distribution between the Initial Approach and Final Director considered appropriate;
- As each Area sector controller is responsible for half the current volume of airspace & heading instructions are no longer necessary under PMS operations, R/T is said to be reduced for the sector controllers;
- Co-ordination between adjacent sectors is said to be reduced and simplified due to heading instructions no longer being necessary under PMS, the systematic nature of PMS and ops room seating arrangement where adjacent sectors working the same areas are seated adjacent;
- Opinions about co-ordination with adjacent centres mixed. Half the controllers believe co-ordination to be easier under PMS. Half the controllers felt that co-ordination with adjacent centres is further complicated under PMS due to having to go through the Traffic Manager. Allocation of co-ordination tasks to be investigated in future activities;
- Monitoring of aircraft sequence & traffic situation and identifying conflicts considered to be just as easy if not easier due to the predictability of traffic flows under PMS operations;
- Reverting to vectoring when necessary was not considered a problem during the simulation. However, refresher training and training new recruits on vectoring seen as essential to ensure the skills are maintained;
- Overall the procedures for holding aircraft seen as workable and suitable but more work needed to refine and better define the holding procedures;
- Dublin TMA is obliged to provide a Flight Information Service. Allocation of the Flight Information Service tasks must be considered in future;
- Shift handover not considered to be issue for the single person Area sectors as long as the recommended mitigations (described in 7.1.2.7) are implemented.

7.1.3 Workload

Controller's perceived workload for each exercise was assessed using ISA and the NASA-TLX. In addition, controllers were asked to rate their level of workload compared to current day operations. To obtain more in-depth understanding of the workload experienced under PMS further subjective feedback on controllers' workload was also obtained from debriefing sessions held over the course of the simulation and from individual semi-structured interviews held with the controllers during the second week of the simulation. System performance data was used to determine the task load for each sector during an exercise. The workload results for each of the measures obtained are described below.

7.1.3.1 ISA Workload Ratings

The Instantaneous Self-Assessment (ISA) technique allows continuous assessment of controllers' subjective perceived workload through periodic self-rating using a specific device, the ISA box.

The ISA box equipped, with five buttons labelled 1 (Very Low), 2 (Low), 3 (Normal), 4 (High), 5 (Very High), was available on each measured controller position. Prompted by a flashing red light during 30 seconds, the controllers were required to periodically rate their subjective experienced level of workload by pressing the corresponding button. The activation parameter of the red light was set for every 2 minutes; therefore 23 inputs were performed by each controller during the measured period of 45 minutes. As the Traffic Manager was expected to walk around the ops room to co-ordinate with the other controllers, the concerning working position was not equipped with the ISA device. Hence the ISA assessment does not cover the Traffic Manager role.

The continuous assessment during the exercises allows identification of workload variations throughout the runs, and completes the global ISA workload assessment figures and post-run workload assessment obtained through questionnaire ratings (NASA-TLX).

The global ISA figures (Figure 14) show that despite the fact that traffic levels were set at 40% above current sector capacity limits, most of the time all positions recorded normal, low or very low levels of workload.

Workload was well balanced between the Initial Approach controller (AP) and the Final Director (FI), who generally experienced slightly higher workload levels than the Area sector controllers.

Workload ratings for Lower and Upper positions are 'numerically' closer than anticipated by the participants during debriefing sessions, during which they foresaw a 60% and 40% split against respectively Lower and Upper. If the ISA scores were averaged on a continuous interval from 1 (Very Low) to 5 (Very High), a 52% and 48% workload repartition would be obtained.

Globally workload was rated higher at Area South positions.

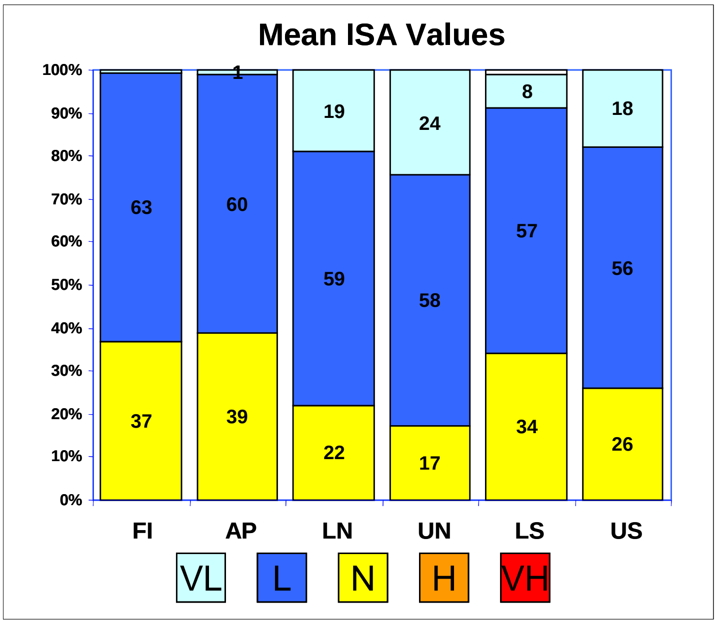

Figure 14. Global ISA Workload Ratings

The ISA ratings are further broken down to show results as far as the different simulated conditions are concerned (Figure 15).

The highest workload levels (albeit within the normal range) were rated at the approach positions (both AP and FI) with RWY 28. The Initial Approach controller, except for RWY 16, perceived the related position as barely more demanding than the Final position.

The lowest workload levels were rated at the Area North positions on RWY 16. Area North positions, except for RWY 10, were generally less demanding than Area South positions.

When R16/MOA4 up to FL150 was active with RWY 10 in use, an increase in Area South workload ratings was recorded. Nevertheless the workload never went up to high levels.

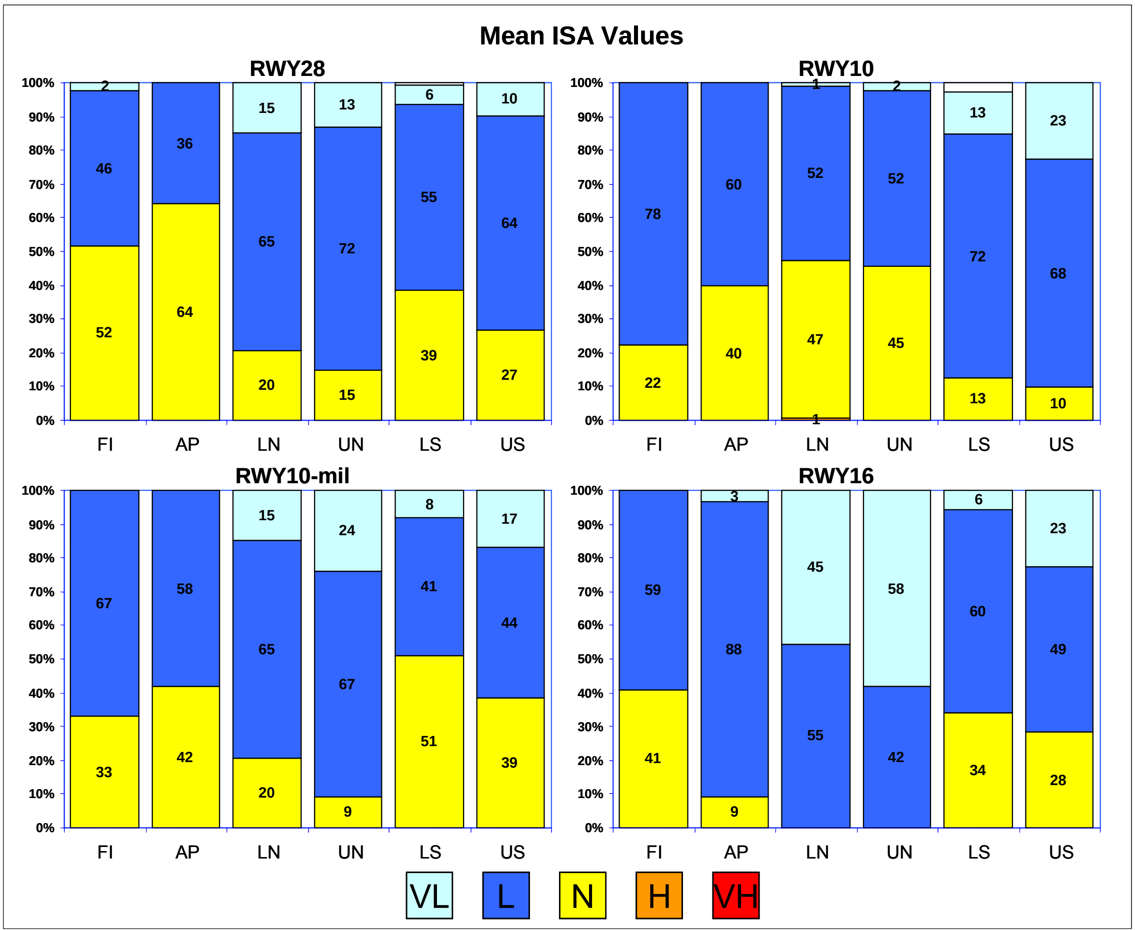

Figure 15. ISA Workload Ratings at different RWY

Previous experience with the ISA ratings within the scope of real-time simulations run at the EEC showed that “High” or “Very High” ISA scores for more than 40% of an exercise lead to a likely rejection of the tested condition by the controllers. Clearly this is not the case as far as the Dublin TMA2012 scenario is concerned as high ISA scores were only recorded for 1% of the time.

7.1.3.2 NASA-TLX Ratings

The results obtained were used as absolute measures. Any scores from the NASA-TLX over 7 (on the scale of 1-10) were considered to indicate high workload and potentially unacceptable (with the exception of ‘performance’ where a high score is generally considered positive).

The ratings obtained for each of the six dimensions in the NASA-TLX questionnaire were used to obtain an overall workload score for each exercise. The mean overall workload scores together with the standard deviation were then calculated for each sector position for each of the four scenarios assessed in the RTS. The results are depicted in the graph below (Figure 16). More detailed results including the mean rating obtained for each of the six NASA TLX dimensions (i.e. mental demand, physical demand, temporal demand, performance, effort and frustration) are provided in Annex H.

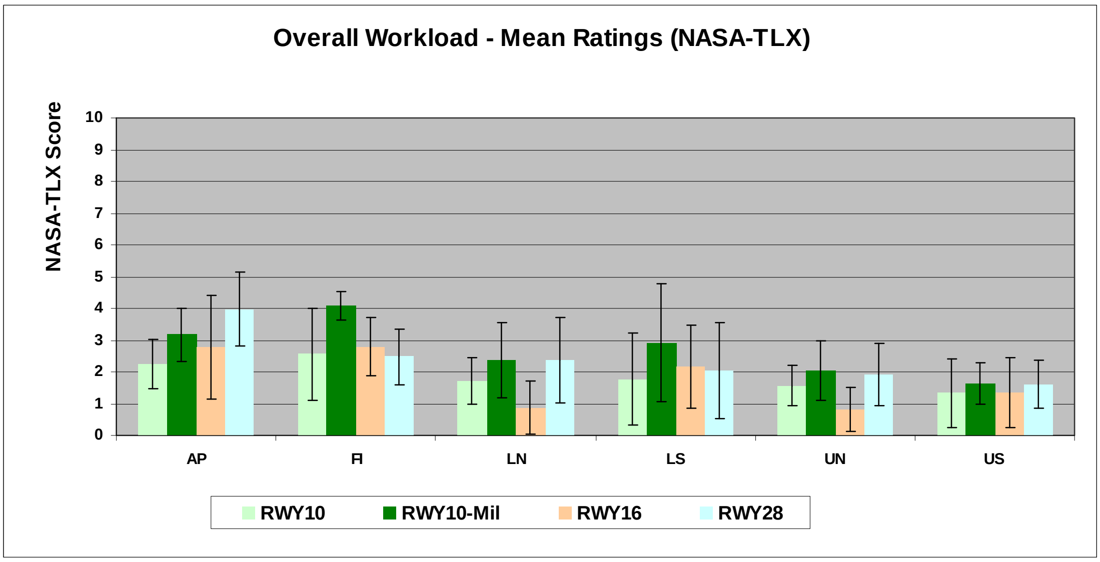

Figure 16. Global NASA TLX Score

In the measured exercises, the overall workload in all sectors and for all four runway scenarios was globally rated low. As can be seen from figure above, on a scale of 1 (extremely low) to 10 (extremely high) the mean value for overall workload did not exceed five in all sectors. All ten controllers reported their performance during the measured exercises to be high, the mean value obtained was above 7.0 (on a scale of 1-Exremely poor, to 10-Extremely good) for all sector positions and runway scenarios simulated (see graph in Annex H for details). All controllers felt that the workload in the simulation was manageable especially given the amount of traffic they were required to work, for example one controller commented 'workload much more manageable… (under PMS)… if I had the same quantity of traffic with the current set up I would not be able to safely handle that amount of traffic.'

The mean overall scores indicate that workload is generally lowest in the Upper sectors, with the mean overall workload score not exceeding two, for all four runway scenarios. The workload in the Lower sectors was generally considered more demanding but again was still low with the mean overall workload score not exceeding 3.0 for any of the runway scenarios investigated. Controllers commented that the workload in the Lower sectors was generally more demanding than the Upper sectors because there was a certain time pressure as they had to ensure that aircraft achieved the required speed, level and spacing before they were handed over to Approach. Upper controllers found that they had more periods of low workload and less time pressure as they just had to pre-sequence and descend the aircraft before delivering them to the Lower controllers.

In the Lower sectors, the overall workload with PMS was generally considered higher for the Lower South controller than for Lower North controller particularly when RWY 16 was in use (mean=2.2, SD=1.30 for LS and mean= 0.9, SD=0.85 for LN). However, it should be noted that controller workload was perceived as very low (below 1.0) for both UN and LN when RWY 16 was in use.

There was a significant increase in reported frustration levels for the Lower South controller when RWY 10 was in use with the military active (mean=compared with SD=2.4 with RWY 10 mil) compared to other Area sector ratings for all other runway scenarios. Piloting errors were given as the reason for the increased level of frustration experienced in the LS position under this runway scenario.

The overall workload scores show that the Approach controller and Final Director generally experienced higher workload levels than the Area sector controllers. The controllers felt the overall level of workload for both the Approach and Final positions was acceptable and remained at a constant low level (the mean overall workload scores for both Approach positions did not exceed 4.5 for any of the four runway scenarios). With the systemised nature of PMS, all controllers found they were able to handle larger volumes of traffic in finals with greater accuracy than the current vectoring methods.

One interesting observation to note is that for the Approach position when RWY 28 is in use (is active), the level of effort and temporal demand required to carry out the tasks was rated as medium (mean value of 5.8 for effort and 5.3 for temporal demand) compared to the other sectors where mean values did not exceed 3.5 for effort or 3.1 for temporal demand (see graph in Annex H). All Approach controllers commented that the workload was found to be more demanding on RWY 28 due to the shorter capacity on the sequencing legs, especially with strong wind conditions.

It should also be pointed out that the mean ratings for Effort were high for the Final approach position when RWY 10 is in use with the military active (mean Effort rating for RWY 10-mil = 7.3). The reason given for this high effort rating was that task demands were very high and 3NM separation was used extensively. Pilot communication errors during the military active exercises also contributed to the relatively high effort recorded. The controllers that worked the Final Director position all mentioned during the interviews and debriefs that working with 3NM separation on the Finals was demanding and required a lot of effort and concentration and that prolonged use of 3nm spacing should be managed carefully in order to avoid controller fatigue.

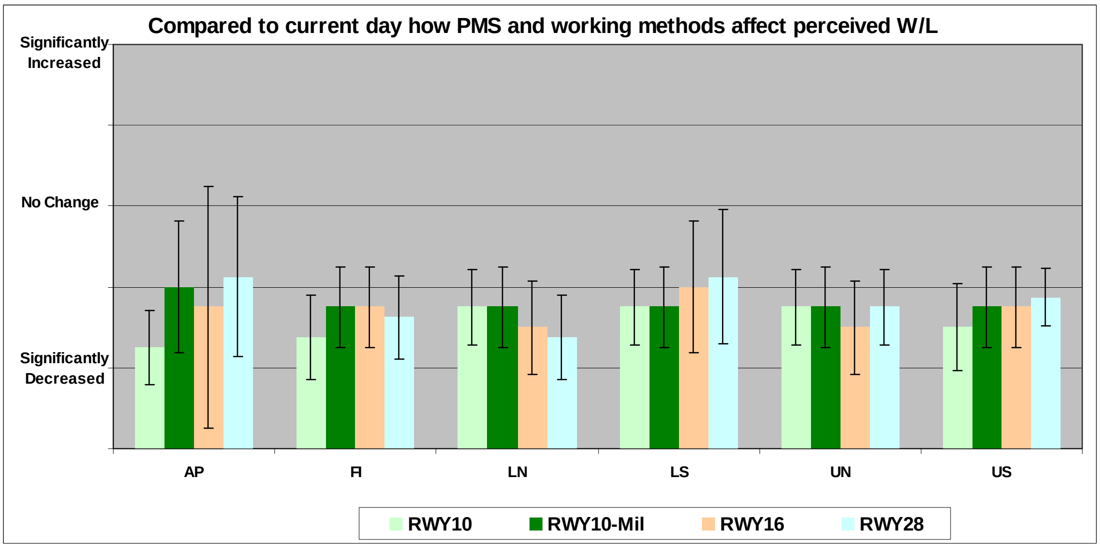

Figure 17. Perceived Workload under PMS compared to current day operations

The controllers were also asked to rate their level of workload perceived with PMS compared to their current day situation (Figure 17). For all the measured runs, all ten controllers rated that the workload experienced under PMS (with a 40% traffic increase) had decreased compared to current operations. All the controllers found that compared to the current Executive/Planner configuration where the planner does mostly planning and little tactical control, PMS allows both upper and lower to do both tactical and planning control.

In normal conditions in the Area sectors, the controllers found that the general distribution of workload between the lower and upper sectors was approximately 60/40 which they considered provided a more balanced split than the perceived workload in the current Executive/Planner configuration. All ten controllers agreed that PMS enabled a more even distribution of workload, more tactical control of aircraft for both the upper and lower sectors, and this in turn allowed for the effective and efficient management of both arriving and departing traffic.

One of the main challenges considered by the Lower controllers was the monitoring of aircraft entering and exiting the hold while simultaneously dealing with departing aircraft and overflights. In managing the holds, the controllers had to monitor the TML lists which they felt was time consuming and demanding where in current operations, this task would normally be carried out by the planner controller or hold controller[8]. All the controllers felt that for this problem one potential solution would be to put a Holder Controller in place when the holds exceeded two or three aircraft.

However, as previously mentioned in the roles/tasks section, as the simulation progressed, the role of the Upper Controller evolved and teamwork enhanced as the Upper Controller, after consultation,

[8] Note that in current operations a holding controller is available for the busiest hold. However, it was agreed that the hold controller position would not be included in the simulation.

was able to adjust their work accordingly and relieve some the workload of the Lower controller by holding on to aircraft longer or dealing with identified departure aircraft. This took some of the pressure off the Lower controller in order to allow him to concentrate on setting up the most appropriate sequence.

7.1.3.3 Task Load

System performance data was used to determine task load for each measured position with the exception of the Traffic Manager.

The measurements that were taken to elicit indications on the controllers' task load are namely the number of aircraft on any one frequency and the percentage of time each controller spent on frequency.

7.1.3.3.1 Number of A/C on Frequency

The number of aircraft on frequency is measured by the mean number of aircraft which were on a controller's frequency at same time. The display of the results is against a continuous timeline which corresponds to the duration of the exercise measured period (45 minutes).

The analysis was done for each traffic sample and for each experimental condition, in order to reflect the differences in traffic distribution that each exercise was characterised by. The complete results can be found in Annex J. In this section only the global results are presented.

The global results (Figure 18) are representative of an ideal exercise which is the 'average' of the whole set of the measured exercises. This means that the differences in traffic distribution related to the different samples can not be inferred from this display. Therefore the original peaks and troughs got stretched and outer values downsized.

The analysis of the global results mainly shows that:

- The repartition of traffic among the Area sectors was more balanced than it was perceived and reported by the controllers, although characterised by a high variability;
- In Approach the Final Director managed a consistent number of aircraft and s/he was slightly more loaded than the Initial Approach controller.

In the Area sectors the traffic load was generally not high. On a time basis the number of aircraft on frequency spreads from 2 to 4 aircraft.

On average, in Area North the Lower controller managed 2.6 aircraft and the Upper 3.2. Similar values, but these recordings were inverted in Area South, where the Lower controller managed 3.2 aircraft and Upper 2.9.

These values mirror the situation the controllers mainly experienced , i.e. the new manning configuration leads to the executive controllers working half the current volume of airspace hence the number of aircraft on frequency at anyone time is significantly reduced.

The pressure on the Approach in terms of traffic load was higher than in the Area sectors. On a time basis the number of aircraft on frequency spreads from 3 to 5 aircraft.

On average, the Initial Approach controller managed 3.7 aircraft, whereas the Final Director 4.7.

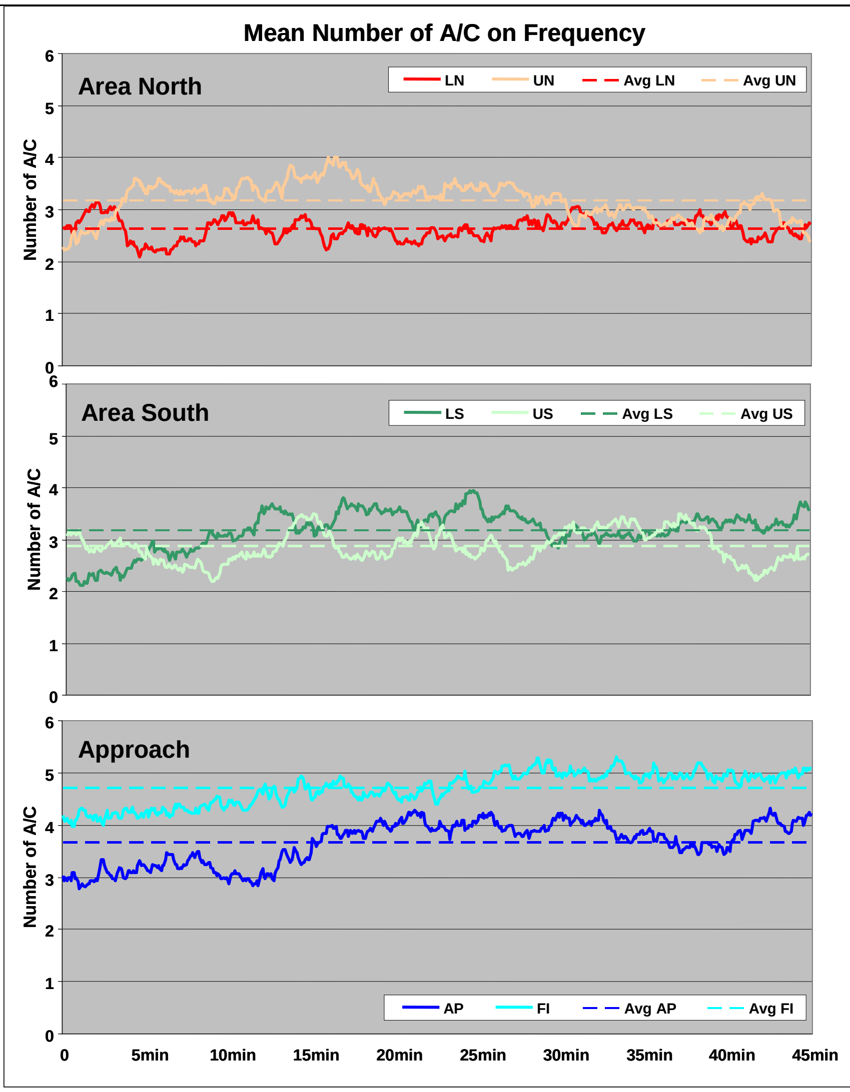

Figure 18. Number of A/C on frequency

7.1.3.3.2 R/T Task Load

The R/T task load is measured by frequency occupancy that corresponds to the percentage of time a controller spends on frequency to handle aircraft, issuing instructions and receiving read-back/requests from the pilots.

Note that telephone communications are not included in this analysis. Most of the co-ordination among positions occurred verbally as facilitated by the appropriate operations room layout. Hence the figures shown by the telephone analysis do not entirely represent the concerned controllers' task load.

The analysis of the frequency occupancy sectors confirms the controllers' perception that the R/T load was not demanding in the TMA2012 scenario (Figure 19) and shows results which are consistent with the sectors traffic load reported in the section above.

The average value of frequency occupancy is about 25.7%. Considering the standard deviation the complete set of values spreads from 18.6% in LN to 34.2 % in LS.

As for the Approach the frequency was slightly more loaded in the AP (27 ± 2.6%) than in the FI (24.5 ± 3.3%). Overall the values are consistent and subject to less variability than in the Area sectors.

As for the Area sectors the analysis shows opposite trends based on the side considered. While at Area North the frequency was more loaded in the Upper (26 ± 4.4%) than in the Lower (23.5 ± 5%), in the Area South the analysis proves the opposite trend with the Lower more loaded than the Upper (respectively 28.3 ± 5.9% against 24.8 ± 4.6%).

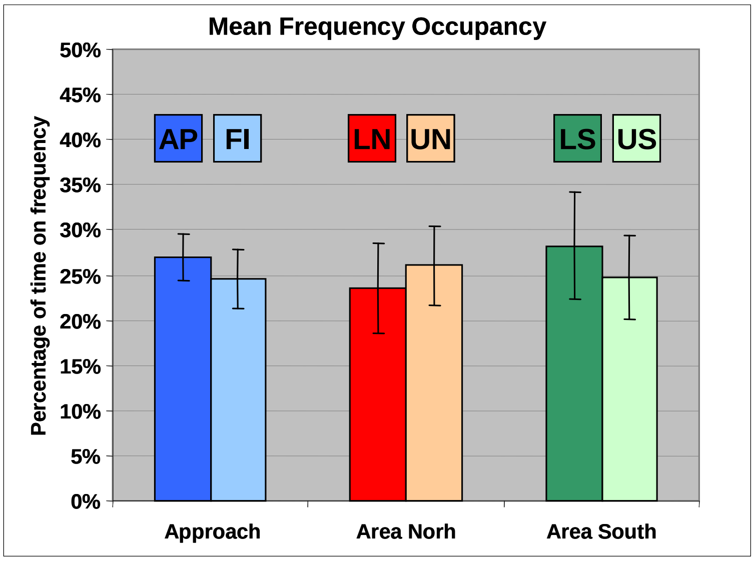

Figure 19. Mean Frequency Occupancy

The frequency occupancy values are further broken down to show results as far as the different simulated conditions are concerned (Figure 20).

The runway related results are in line with the global result and the trends are still confirmed.

Considering variability the highest mean frequency occupancy levels concern LS on RWY 28 (37.1%), whereas the lowest ones concern LN on RWY 16 (14.9%).

A great variability affected results at LS on RWY 10 with the activation of R16/MOA4 up to FL150, with the frequency occupancy spreading from 16% to 35.6%.

The task load was evenly distributed between the two Approach positions over all the conditions, except for RWY 28 where AP was a 5% more loaded.

The mean values recorded at AP were generally more consistent than those related to FI, which are subject to more standard deviation. The frequency occupancy at FI spreads from 20.8% (RWY 16) to 31.6% (RWY 10 with the activation of R16/MOA4 up to FL150).

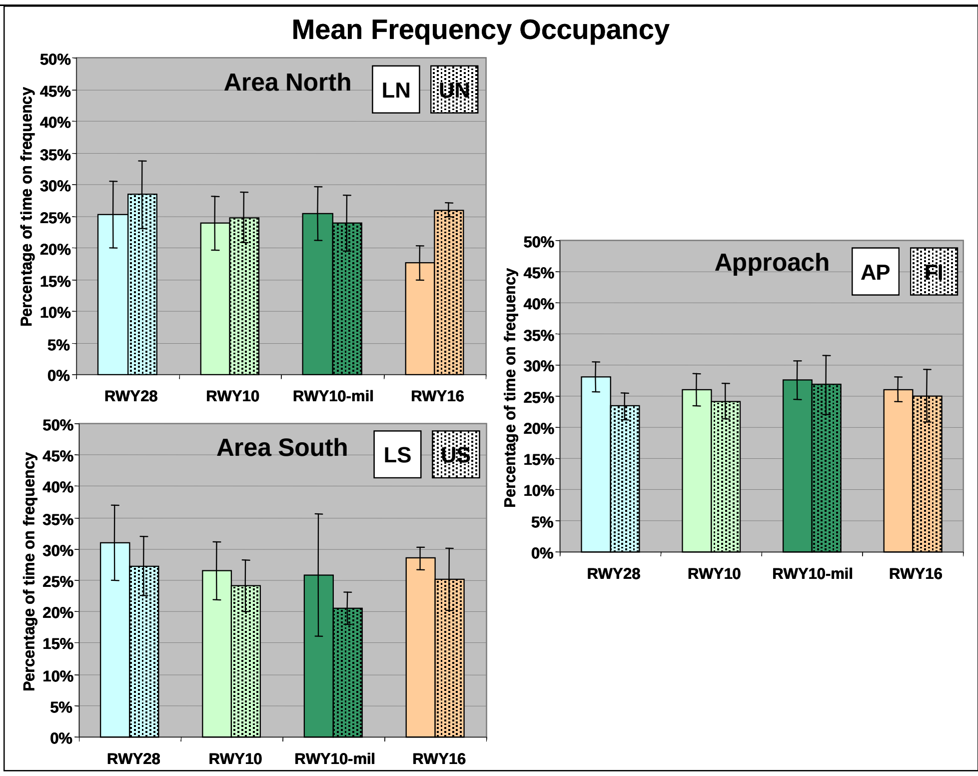

Figure 20. Mean Frequency Occupancy at different RWY

7.1.3.4 Synthesis of Workload

- In summary, with PMS the overall workload was considered to be low in all sectors and for all runway scenarios. Although, the Approach controllers workload was found to be more demanding on RWY 28 under strong wind conditions due to the sequencing legs being shorter, hence having less capacity compared to the sequencing legs for RWYs 10 and 16;
- Controllers felt that PMS and the associated manning configuration significantly reduces the amount of R/T as:
    - No heading instructions are being given under PMS;
    - Each Area sector controller works half the current volume of airspace hence the number of aircraft on frequency at anyone time is reduced;
    - Extensive use of lateral navigation mode and continuous descent approach (CDA);

  This has the advantage of allowing the controllers to concentrate on other tasks, e.g. conflict detection and resolution, etc.
- A higher workload was perceived in the lower sectors compared to the upper sectors (workload distribution between Lower and Upper controller was estimated by controllers to be about 60:40 respectively). However, the controllers all agreed that PMS and the associated manning configuration led to a more even distribution of workload compared to the current Executive/Planner configuration (where workload distribution was estimated to be 90:10 respectively). In the Upper and Lower sectors, controllers found it more satisfying to have a better balance of tactical controlling and conflict detection and resolution compared to today where the Executive does the tactical work and the Planner's role mainly involves monitoring the traffic situation;
- The Lower controllers' workload was said to increase when they had to manage the holds while dealing simultaneously with other aircraft. However as the roles evolved, the Upper controller relieved some of the work of the Lower controller by holding on to aircraft longer or dealing with identified departure aircraft.

7.1.4 Situation Awareness

Controllers' situation awareness (SA) during each exercise was assessed using the EUROCONTROL (EC) SASHA questionnaire. In addition controllers were asked to rate, as far as possible, their level of situation awareness compared to current day operations. Certain events e.g. level busts and SID deviations, were also incorporated into the measured exercises and controllers responses to these events were observed in order to obtain a more objective measure of controller's SA for each exercise. In order to gain a more in-depth understanding of the controllers situation awareness under PMS further subjective feedback was obtained from debriefing sessions held over the course of the simulation and from individual semi-structured interviews held with the controllers during the second week of the simulation. Only an extract of the results obtained relating to SA are described in this section, more detailed results are provided in Annex H.

7.1.4.1 SASHA Ratings

An overall indication of controllers overall SA is determined by calculating a mean score from the ratings obtained for each of six dimensions included in the SASHA questionnaire that are believed to contribute to ATCO SA. Each of the six dimensions can be rated on a 7 point rating scale from 0 to 6 (inclusive) An overall SA score of 4 or below obtained was considered to indicate that SA had been somewhat degraded during an exercise and was a potential issue.

The following graph (Figure 21) depicts the means obtained for the overall SA scores obtained for each position and each runway scenario while the standard deviation is represented by the line bars.

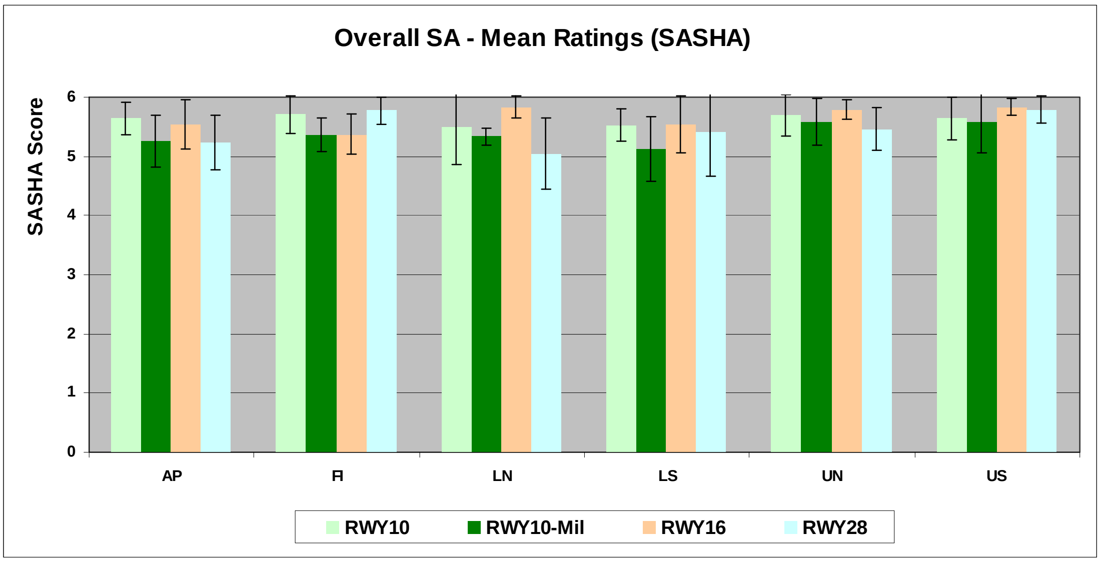

Figure 21. Overall Situation Awareness Mean ratings

It is clear from the results that the overall level of situation awareness was high for all controller positions in all runway scenarios. All ten controllers stated that they either 'often' or 'always' were able to anticipate the traffic evolution which allowed them to plan and organise their work without any difficulties.

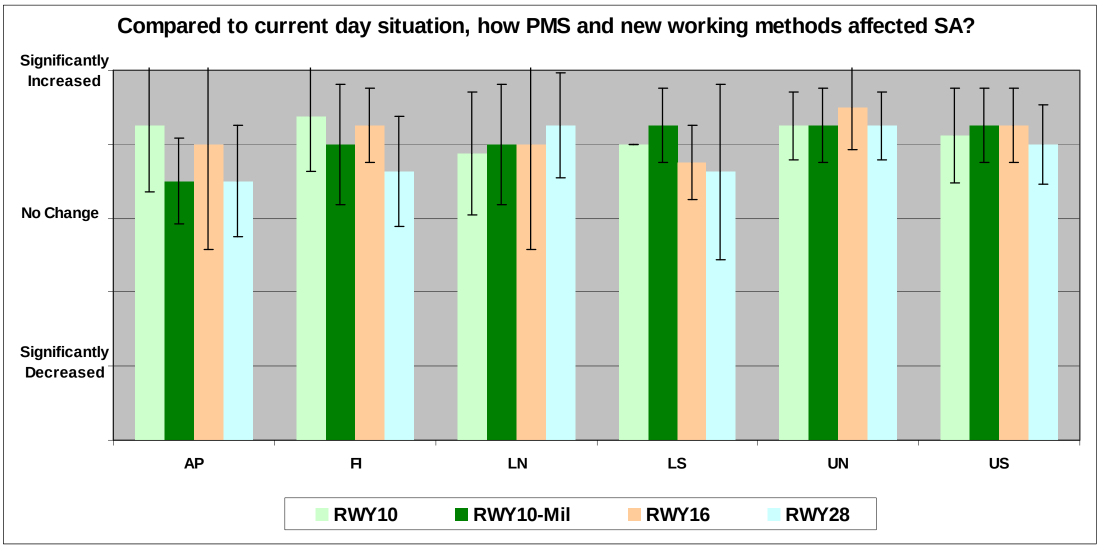

Figure 22. Perceived Situation Awareness under PMS compared to current day operations

In the post-exercise questionnaire, the controllers were asked to rate on a five point scale from significantly decreased to significantly increased how they found their SA with PMS compared to current day operations. As can be seen in the above Figure 22, the global level of SA with PMS compared to current day operations was rated between no change to significantly increased for all sectors over the four runway scenarios. Almost all the controllers felt that the increased predictability of PMS allowed them to better anticipate the traffic evolution thereby enhancing their SA which made operations easier than the current day vectoring of aircraft. The fact that under PMS and the new manning configuration each tactical controller is responsible for half the volume of airspace compared to current day operations, this allowed the controllers to work at a much smaller range and this was also said to help enhance controller SA within their sector.

The findings from the post simulation questionnaire support the post exercise questionnaire results. For example, none of the controllers agreed with the statement in the post simulation questionnaire that 'under the new manning configuration I felt I had less awareness of the traffic situation inside my sector compared to the current manning configuration. All controllers commented that as they were working on a smaller range their situation awareness within their sector of responsibility was enhanced. The controllers also found that having Upper and Lower controllers plus the Approach and Final Controllers sitting beside each other enabled them to have a good picture of what was happening in the sector beside them.

However, none of the controllers disagreed with the statement that 'under the new PMS manning configuration I had less awareness of the traffic situation outside my sector compared to current operations'. In the debriefs and interviews all controllers commented that that they had limited situation awareness of non-adjacent sectors. However, when questioned, all the controllers with the exception of one stated that this was not really an issue as under PMS there was no real need to know what was going on in the other sectors and if there was, the Traffic Manager would inform you. For example as one controller said, 'With the new manning configuration you do not need to know what is happening else where. If you need to know the Traffic Manage will tell you'. Another controller commented 'with PMS controller situation awareness is confined into what the controller needs to work'.

Of the ten controllers only one controller agreed with the statement in the post simulation questionnaire that the transfer of responsibility for descent initiation to the pilot reduces overall SA.

As mentioned previously, one of the major challenges for the Lower controllers was in situations where the holding of aircraft became necessary. They felt that focussing their attention on aircraft entering and exiting the holds sometimes caused controller delays in reacting to other aircraft such as departing traffic, and overflights. The controllers believed that having a holding controller in place when the holds exceeded more than two or three aircraft would help them allow them to better monitor and react to other aircraft in their sector.

7.1.4.2 Outcomes of Situation Awareness Events

As mentioned a series of events were scripted into certain scenarios to assess how PMS and the new working arrangements impacted on controllers situation awareness. The events included early turn to merge point, early descent from sequencing legs, level busts, slow climbing departures and departures on wrong SID. One of the main aims was to assess using a more objective measure than controller feedback whether PMS and the new manning configuration could lead to inefficient monitoring and increase the possibility of missing critical events.

From the observations made during each exercise, it appeared that all the controllers were able to detect and resolve the scripted events in a timely manner with no problems what-so-ever, even when traffic demands were high.

7.1.4.3 Synthesis of Situation Awareness

- With PMS, overall situation awareness was rated as high in all conditions and over all runway scenarios. All ten controllers reported that the systemised method of PMS increased their SA compared to current day operations and enable them to either very often (5) or always (6) anticipate the traffic evolution;
- PMS and the associated manning configuration did not appear to affect controllers ability to detect critical events. The scripted events inserted into the exercises to obtain a more objective measure of situation awareness were all identified and handled appropriately by the controllers in all sectors and runway scenarios, even when work demands were high;
- Under PMS and the associated manning configuration, the controllers are responsible for half the volume of airspace compared to current day operations. The controllers found that working out a smaller range enhanced their situation awareness within their sector;
- The more ordered and predictable flow of traffic resulting from PMS operations was also said to contribute to controllers' improved awareness of the traffic situation within their sector;
- Situation awareness in adjacent sectors was also reported to be good. This was again said to be due to the predictability of traffic under PMS, as well as adjacent sector controllers working together as a team. Controllers highlighted the importance of the Operations room layout in order to ensure that controllers have a good awareness of what is happening in the adjacent sector;
- The limited situation awareness of non-adjacent sectors was not considered as an issue, as the Traffic Manager had the global picture and provided them with the required information when necessary.

7.1.5 Safety

Safety under nominal conditions was assessed during the simulation through observations made during the measured exercises, together with feedback from controllers via the post exercise and post simulation questionnaires as well as the individual interviews and group debriefs.

In addition, system data were analysed and losses of separation identified to provide a quantitative and deeper safety assessment.

7.1.5.1 Impact on Perceived Safety Levels and Human Performance

Overall the controllers agreed that safety was at least maintained, if not enhanced under PMS compared to current operations (9 out of 10 controllers agreed or strongly agreed that safety is at least maintained under PMS operations compared to current operations and 5 out of 10 either 'agreed' or 'strongly agreed' that under PMS safety was enhanced, whilst 3 neither agreed or disagreed with the latter statement).

Controllers also agreed that PMS allowed controllers to safety handle more traffic (8 out of 10). The main reason given for this was said to be due to the fact that PMS increases the predictability of traffic and this helps to increase their situation awareness within their sector which in turn helps to ensure safety is at least maintained compared to current operations with higher traffic demands.

One controller that believed safety was increased under PMS commented 'Overall with PMS situation awareness is greatly increased and maintained even with an increase in traffic flow. This must increase safety.' Of the controllers who felt that safety neither increased or decreased under PMS compared to current operations one commented, 'I don't necessarily think that PMS makes the overall system safer but I do believe it allows controllers to handle more traffic while still maintaining at least the same safety as current system with less traffic going through the system'.

The one controller who reportedly found that safety under PMS was somewhat degraded stated that he felt that 'under PMS the controllers global situation awareness in the Dublin TMA was reduced and this could impact safety.' When questioned about this in the interviews and debriefs, although the other controllers agreed their global situation awareness of what was happening in the Dublin TMA was somewhat less under PMS compared to current operations they did not feel this had any safety implications as they felt they had the necessary situation awareness they required to do their job. Moreover, if they needed to have a more global view of what was happening in the Dublin TMA, the Traffic Manager would provide them with the required information when necessary (see section 7.1.4 for more details).

The majority of controllers (seven of the ten) agreed that the new manning configuration enhances safety; one controller stated that 'working off a lower range is very beneficial as you have a better SA within your sector, therefore safety should be increased'. The seating arrangement in the operations room was also said to be an important factor that helped to contribute to safety, as the fact that controllers in adjacent sectors are seated next to each other (i.e. Upper and Lower controllers in Area plus the Initial Approach and Final Director) helped to ensure that the controllers have a good picture of what is happening in the adjacent sector as well as enabling them to work together as a team, co-ordinating and supporting each other, when necessary. However, two controllers disagreed with the statement that the new manning configuration enhances safety, as they felt that not having a controller to delegate responsibility for holding aircraft was an issue. When questioned, the other controllers agreed that an additional holding controller was required when the number of the aircraft in the hold exceeded a certain number (three was given as a ball part figure).

None of the controllers agreed that it is more difficult to monitor the traffic situation and identify critical events within the sector under the new manning configuration compared to the current manning configuration. As one Approach controller commented 'as all traffic is following the same route you are less likely to lose track of any item of traffic', other controllers commented that as mentioned before as they were working out of a lower range 'it was easier to monitor and identify critical events under PMS'.

7.1.5.2 Safety Concerns and Potential for Human Error

Several concerns were expressed by controllers relating to safety and the potential for error under PMS operations. However, for each concern, recommendations for potential mitigation were also identified:

- One of the main concerns which was expressed by controllers throughout the simulation was the impact of holding aircraft on the Lower Area controllers. The majority of controllers that worked the Area positions felt that when the number of aircraft in the hold exceeded 2 or 3 their workload escalated, and as they had to monitor the holding aircraft using the Traffic Management List their attention was diverted away from the radar screen. They also commented that focussing their attention on the holds sometimes caused delays in reacting to other aircraft such as departing traffic, and over-flights. There was an overall consensus among the controllers that being responsible for the holding aircraft plus dealing with over-flights, departing aircraft and sequencing arriving traffic was at times too much and that a separate holding controller should be available when the number of aircraft in the hold exceeded a certain number. Therefore it was recommended that the holding procedures under PMS need be further developed;
- Several controllers expressed some concern that under PMS there are many aircraft on the same level and converging aircraft are no longer vertically separated as in current day operations and this could be a problem if things went wrong, especially with the sheer volume of aircraft in a relatively small area of air space, particularly when using 3NM separation. Although this was not found to be a major issue during the simulations, it was questioned

whether it could be an issue in the real world with live traffic. However, it should be noted that the Generic Safety Case for PMS operations concludes that at a generic level PMS operations are as safe as current day operations. It was also pointed out that controllers can still revert to vectoring and can use vertical separation if necessary;

- Controllers also mentioned that a potential safety concern was that aircraft were levelled off on the inner sequencing leg at the same level as the aircraft holding in the South (this may be further evaluated in future validation activities);
- The Approach controllers working the Final Approach commented that working with 3NM separation was very tiring as it required a high level of concentration. Thus it was agreed that prolonged use of 3NM spacing on the Final Approach needs to be carefully managed to prevent controller fatigue[9];
- Loss of vectoring skills was also a concern expressed by the controllers which could have safety implications, as controllers would still be required to vector aircraft when necessary and particularly under certain non-nominal conditions when workload and stress levels are often high. Therefore, regular refresher training was seen as essential in order to ensure controllers retain their vectoring skills. It was also stressed that new recruits should be trained on both PMS and vectoring to ensure they also are familiar and comfortable vectoring aircraft under such conditions;
- Robust and sufficient training on PMS was seen as essential prior to the implementation of PMS Training to ensure safe operations. As one controller stated 'One thing related to safety and efficiency is that all controllers must be fully trained before PMS operations introduced – it's a major change in working method so needs more than just two weeks training before hand'. It was also added that the training for PMS must be delivered using appropriate resources.

7.1.5.3 Recorded Data

In addition to controllers' feedback and Human Error analysis, losses of separation were analysed to provide a quantitative and deeper safety assessment.

For this purpose, the API (Aircraft Proximity Index) metric was used as a measure of the severity of an incident (loss of separation). Three degrees of severity of an incident, namely minor, serious and very serious, were defined in terms of the maximum value of the API during a loss of separation (see Annex F).

Out of 40 exercises (i.e. 30 hours of simulation), only one serious loss of separation was recorded. It involved an arrival on the VATRY STAR and a departure on the PESIT SID while RWY 10 was in use. The conflict occurred when both the aircraft were under the responsibility of the Lower South controller. The separation went down to 1.1NM and 300ft between the STAR segment DOWNS-CAMEL. The departure at that time was levelled-of at FL120 while the arrival was descending after leaving FL130 as cleared, by LS him/herself, to reach FL70 at the sequencing leg entry point MARTO (see Figure 23).

[9] This is also a runway management issue as prolonged usage of 3NM separation on approach removes any possibility for the Tower to release departures – many of which may be subject to departure slot restrictions. In addition, ramp congestion can be severely impacted by departure queues, particularly when RWY 28 is in use.

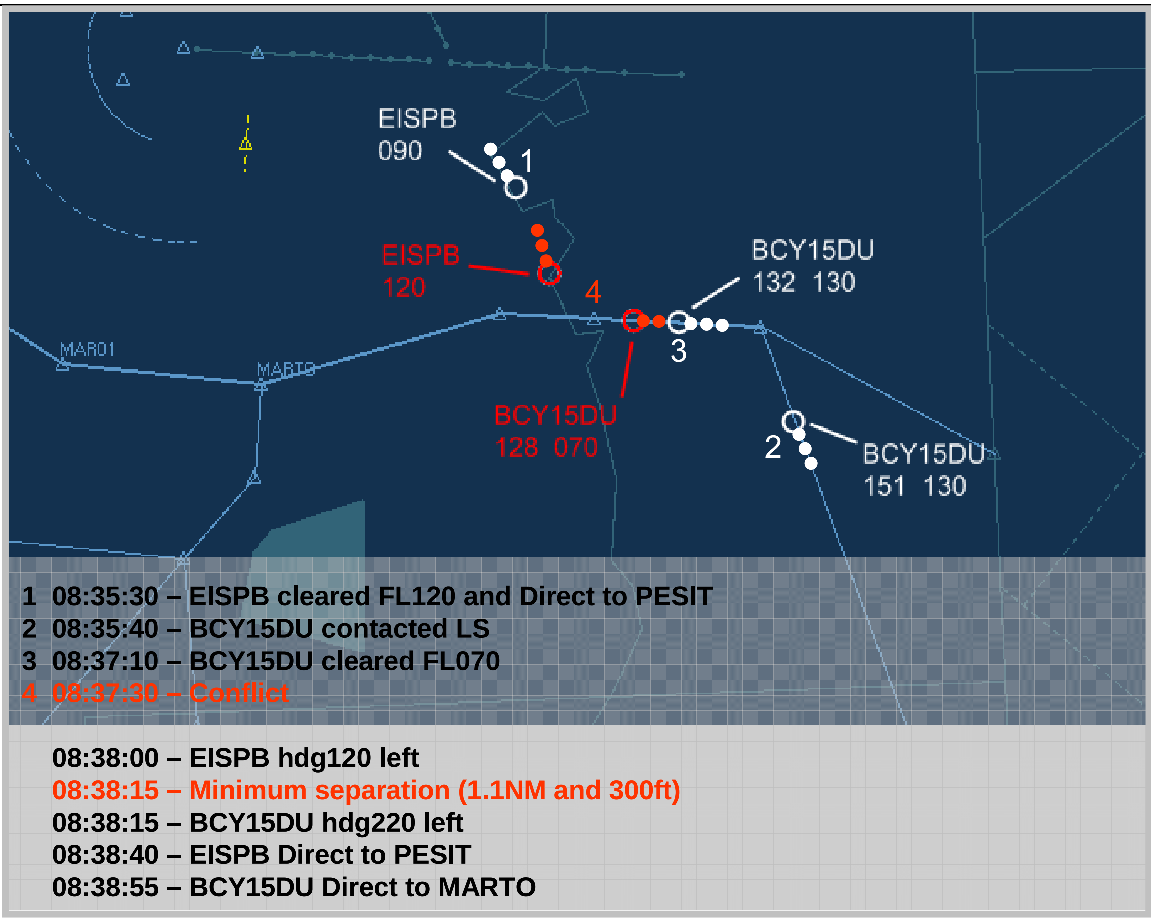

Figure 23. Loss of Separation Storyboard

Apart from that, three other minor losses of separation occurred. The first one was the result of an intentional scenario aimed at assessing controllers' situation awareness in the new managing configuration with RWY 16 in use. The scenario simulated a climbing aircraft level bust. The concerning aircraft (on PESIT SID), although correctly cleared to FL120 to keep the vertical separation with an arrival (on LIPGO STAR), broke the cleared level. Although promptly spotted and vectored by the controller (LS) the separation went down to 2.4NM and 500ft.

The second loss of separation was recorded while RWY 28 was in use and involved a climbing aircraft on the SUROX SID and an overflight cruising at FL110. The separation went down to 2.5NM and 700ft when both the aircraft where on the Lower North controller' frequency.

Finally the third case concerned more closely the PMS as the loss of separation concerned two aircraft which were flying the sequencing legs on opposite direction. The runway in use was RWY 10 and the R16/MOA4 was active up to FL150. The minor conflict occurred between MAR04 and MAR05 when the aircraft on the inner leg started the descent just after the turn towards the merge point. It lost separation with the parallel aircraft on the outer leg. The minimum separation recorded between the two aircraft was 2.5NM and 800ft.

7.1.5.4 Synthesis of Safety

- Overall the controllers felt that safety was at least maintained, if not enhanced under PMS compared to current operations;
- Controllers also agreed that PMS allowed controllers to safety handle more traffic. The main reason given for this was said to be due to the fact that PMS increases the predictability of traffic and this helps to increase their situation awareness within their sector which in turn helps to ensure safety;
- The majority of controllers felt that the new manning configuration actually enhanced safety. The main reason given for this was that controllers are working off a lower range and working half the volume of airspace which gave them better situation awareness within their sector.

Seating arrangement in the operations room was also said to be an important factor that helped to contribute to safety, as the fact that controllers in adjacent sectors are seated next to each other (i.e. Upper and Lower controllers in Area plus the Initial Approach and Final Director) helped to ensure that the controllers have a good picture of what is happening in the adjacent sector as well as enable them to work together as a team, co-ordinating and supporting each other, when necessary;

- As global picture is provided by the Traffic Manager, the controllers generally felt that their limited situation awareness was not an issue;
- A few safety concerns were raised by the controllers during the simulation. However, for each concern raised recommendations for potential mitigation were also identified (see section 7.1.5.2).

7.1.6 Capacity

7.1.6.1 Subjective Feedback

The simulation gave subjective evidence that the controllers were able to manage a traffic demand higher than the current one with no particular concerns in terms of workload in most of the circumstances.

PMS, new standard procedures and working arrangements worked suitably and consequently downsized the requirement for controllers' tactical interventions and the need of coordination between sectors and positions. The reduced workload (with regard to PMS and new standard procedures, the participants agreed that one of the main benefits the new concept would bring is the reduction of radio communications) is then expected to result in an increase of controllers' time availability.

This meant that the controllers could spend more time on other tasks in the simulation, such as conflict detection and resolution.

7.1.6.2 Throughput

The analysis of the throughput at runway gives an indication of the capability to accommodate high load of traffic which were designed to represent an increase of 40% on current sector capacity limits.

Figure 24 displays the average values of throughput with regard to the four runway scenarios simulated and shows the repartition between arrivals and departures which landed and took-off within the measured period (45 minutes). Variability in throughput over the measured exercises is shown by means of standard deviation of the values.

Even though differently distributed between arrivals and departures, the average throughput recorded for both RWY 28 and RWY 10 is consistent and of about 37 aircraft per 45 minutes.

The activation of R16/MOA4 up to FL150 with RWY 10 active did not have a major impact on the delivery of arrivals at the runway if compared with the nominal condition (average of 21.3 against 21.8). The overall average throughput was 35 aircraft per 45 minutes.

The throughput slightly dropped when RWY 16 was used because of the smaller number of arrivals which could be delivered to the runway (when RWY 16 is active the minimum spacing on final approach is 5NM). In this condition the overall average throughput was 33.5 aircraft per 45 minutes.

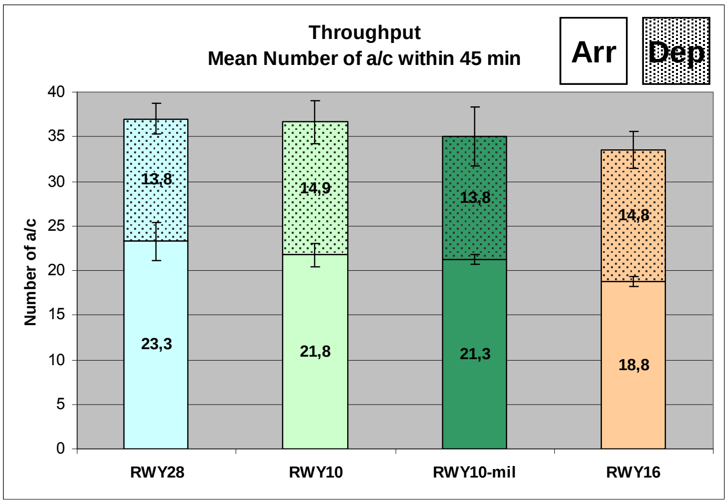

Figure 24. Mean Throughput

The table hereafter lists the detailed results in terms of throughput achieved over all the measured exercises. The information contained in each row refer to the actual number of operations recorded within the measured time, the mean time and the maximum time between two operations, the actual total throughput and the total throughput projected to one hour. Finally for each runway scenario the table displays the mean value of the one hour projected throughput (along with standard deviation).

Considering the four runway scenarios the throughput values spread from 45 to 50 aircraft per one hour.

There were a number of exercises were departures were excessively delayed on the ground by the Tower to accommodate busy arrival flows with 3NM spacing between aircraft (e.g. Ex 23, Ex 01, Ex 09). The maximum time recorded between two successive departures was in the region of 15-20 minutes. As mentioned before, this raises issues with regards to runway efficiency.

Table 10. Throughput per Run

		Arrivals			Departures			TOTAL	
RWY	Ex	Actual Num	MTBA	MaxTBA	Actual Num	MTBD	MaxTBD	Actual Num	1h Projection
RWY28	Ex 01	20	00:02:14	00:08:10	11	00:04:01	00:17:10	31	41,7
	Ex 02	24	00:01:50	00:02:25	14	00:03:16	00:09:30	38	52,1
	Ex 03	23	00:01:58	00:02:30	16	00:02:54	00:06:35	39	52,1
	Ex 04	25	00:01:49	00:02:35	14	00:03:12	00:04:45	39	52,8
	Ex 29	22	00:02:00	00:03:15	16	00:02:52	00:13:10	38	51,7
	Ex 30	26	00:01:44	00:02:25	13	00:03:38	00:10:15	39	51,1
	Ex 39	21	00:02:09	00:04:20	14	00:02:48	00:04:25	35	46,1
	Ex 40	25	00:01:47	00:02:35	12	00:03:35	00:09:10	37	50,8
								Mean	49,8
								StDev	3,88
RWY10	Ex 09	20	00:02:11	00:03:20	14	00:03:22	00:16:10	34	45,5
	Ex 10	24	00:01:50	00:02:35	14	00:02:52	00:08:25	38	52,9
	Ex 17	23	00:02:01	00:03:45	12	00:02:50	00:05:20	35	46,4
	Ex 18	21	00:02:07	00:02:35	18	00:02:32	00:05:50	39	53,0
	Ex 21	21	00:02:05	00:03:10	12	00:03:58	00:13:20	33	43,4
	Ex 22	22	00:02:01	00:02:45	18	00:02:33	00:05:00	40	54,0
	Ex 25	22	00:02:05	00:02:50	16	00:02:48	00:06:45	38	51,1
	Ex 26	21	00:02:06	00:02:40	15	00:03:01	00:06:15	36	48,4
								Mean	49,3
								StDev	3,96
RWY10-mil	Ex 15	21	00:02:04	00:02:45	18	00:02:28	00:03:35	39	53,8
	Ex 16	21	00:02:13	00:03:20	13	00:03:24	00:08:10	34	45,0
	Ex 23	21	00:02:03	00:02:45	10	00:04:51	00:20:55	31	41,6
	Ex 24	22	00:02:08	00:02:50	14	00:03:00	00:05:15	36	47,1
								Mean	46,9
								StDev	5,16
RWY16	Ex 05	19	00:02:28	00:03:20	13	00:03:32	00:08:00	32	42,1
	Ex 06	19	00:02:16	00:03:30	17	00:02:43	00:06:45	36	48,8
	Ex 07	18	00:02:29	00:03:20	13	00:03:18	00:05:15	31	43,0
	Ex 08	19	00:02:17	00:03:55	16	00:02:54	00:05:20	35	47,3
								Mean	45,3
								StDev	3,21

7.1.6.3 Synthesis of Capacity

- The simulation with the series of measured exercises provided trends on the reduction in controller task load achieved by a reduced requirement for controller tactical interventions. This reduced workload might provide a potential for capacity increase (but it has to be proven that freed resources can be used for capacity);
- The simulation gave subjective and quantitative evidences that the controllers were able to manage a traffic demand higher than the current (represent an increase of 40% on current sector capacity limits);
- The activation of MOA4 with RWY 10 in use did not disrupt the system in terms of its capability to deliver high traffic load;
- Concerns arose on the prolonged period departures held at ground in some circumstances.

7.1.7 Efficiency and Predictability

In this section, efficiency and predictability are addressed from both an ATC and flight perspective in terms of quality of service and flight efficiency.

7.1.7.1 Subjective Feedback

In the post simulation questionnaire nine of the ten controllers agreed (one abstained) with the statement that PMS is more efficient for ATC than the current vectoring working method.

Eight controllers agreed that the level of flexibility with PMS is acceptable concerning the optimisation of the traffic sequence, and two controllers abstained.‘

Only one controller disagreed with the statement that PMS facilitates a consistent delivery to the runway.

All but one of the controllers either ‘agreed’ or ‘strongly agreed’ that the systematic nature of PMS increases trajectory predictability. As mentioned previously this predictability was said by the controllers to have a positive affect on controller situation awareness and hence safety.

7.1.7.2 Spacing Accuracy – Inter Aircraft Spacing

One of the main tasks of the Final Director was the application of speed control in order to achieve the required sequence and spacing.

The predicted spacing at touchdown was determined by the Traffic Manager. FI was generally tasked to achieve 5NM. In case of streams of arrivals, the TM could temporary allow for 3NM spacing in order to reduce ‘pressure’ on the sequencing legs and avoid run-off situations. When RWY 16 was active, the required spacing was always 5NM.

The accuracy achieved in providing the required spacing could not be suitably assessed for three main reasons:

- With the exception of RWY 16, the required spacing was not consistent throughout the exercise. The TM requirements evolved in accordance with the traffic situation;
- The simulator assigned default speeds to aircraft after stabilisation on the ILS. In some cases the speed profile calculated by the simulator was not deemed to be realistic and adversely impacted on the spacing management of following traffic;
- The traffic samples were designed to allow for peaks and troughs in the arriving flows. As a result the inter aircraft spacing distribution was subject to significant variability (in the upper bound).

For these reasons, the analysis of the inter aircraft spacing (Figure 25) is purely descriptive and no definitive conclusions can be inferred. Nevertheless, some considerations can be still done. These are:

- The small standard deviation values obtained in each condition (1NM on average) shows a regular sequence of traffic along the axis towards the runways;

- 96% of the traffic achieved at least 3NM spacing at touchdown with RWY 28 and RWY 10;
- The impact of the activation of R16/MOA4 up to FL150 (RWY 10) was very limited on the sequence of traffic, as differences in the distribution of achieved spacing were almost negligible;
- The achieved spacing for RWY 16 was often below 5NM although the requirement did not allow for it (values less than 5NM were recorded for 57% of the occurrences; only 1% of the occurrences was below 3NM).

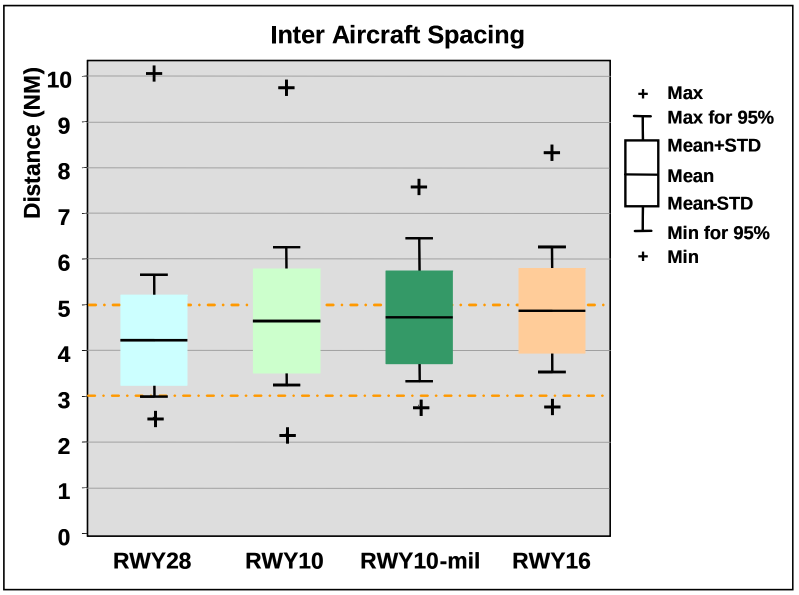

Figure 25. Inter Aircraft Spacing Mean

7.1.7.3 Distribution of Manoeuvre Instructions per Aircraft

According to previous results, there was a perceived reduction in the number of instructions given compared to the current situation. The adherence to the SIDs and STARs procedures and to the PMS working method made the use of vectoring very limited and the use of step descents (especially in approach) not necessary to space and sequence the traffic. The arrivals were mainly managed through speed control.

The distribution of manoeuvres was also assessed in terms of instructions received per aircraft. The results (Figure 26) provide indications on the mean reparation of the different instructions per aircraft and on the differences among the four experimental conditions.

In general, arrival aircraft received approximately 10 instructions in the TMA. 46% of these instructions were for speed, 39% for levels and 13% for Direct-To orders. Headings instructions were rarely issued, i.e. less than the 2% of all instructions received by aircraft.

Departures received 4 instructions on average in the TMA. 58% of these were for levels and 24% for Direct-To orders. The remainder were equally divided between speed and heading instructions.

The runway in use had a minor impact on the instructions received per aircraft. The results, which are quite homogenous among the different conditions, confirm that:

- With RWYs 10 and 16, a two-steps descent was applied in the approach to cope with the vertical limits of the base of controlled airspace. Therefore the arrivals received one level order more than with RWY 28;
- The activation of R16/MOA4 up to FL150 when RWY 10 was active only resulted in a small increase in the number of instructions received by arrivals and departures. This was due to of a slight increase in the number of speed orders issued.

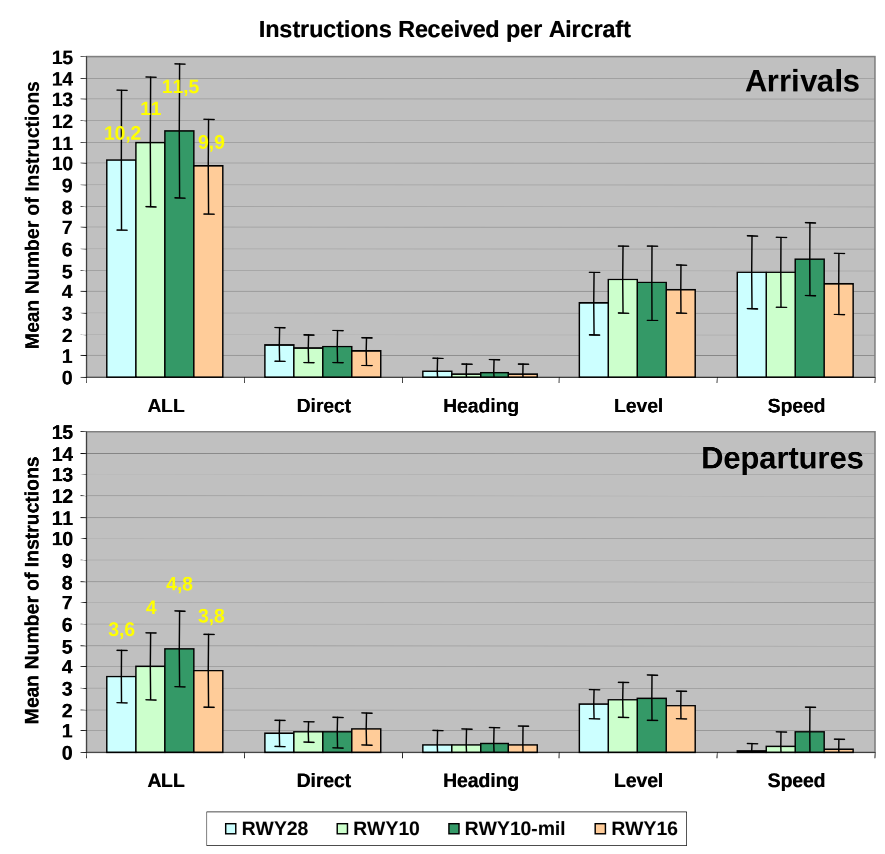

Figure 26. Mean Number of Instructions Per Aircraft within Dublin TMA

7.1.7.4 Flown Trajectories

For each exercise the aircraft trajectories were looked at. In the absence of advanced metrics such as “trajectory containment”, these trajectories provide a support for a subjective analysis. Typically these trajectories illustrate:

- The usability of the legs;
- The containment of trajectories;
- The frequency and location of occurrence of deviation from the standard trajectories.

Figure 27 shows examples of trajectories flown by arrivals (only). These examples are representative of what happened throughout the simulation in the four different experimental conditions.

As a general result, the track dispersion is contained in the approach within the fan shaped by the PMS structure. Upstream, in the Area sector, the tracks rarely deviate from the standard trajectories, if we exclude holding patterns at the sequencing legs entries.

The usability of the sequencing legs greatly depended on the runway in use.

With RWY 28 the aircraft often flew over the very last part of the sequencing legs (hence trajectories are more concentrated at the extremes of the fan in the figure below). The capacity of the sequencing legs for RWY 28 was questioned by the participants in case of intense traffic load. Handling peak of arrivals often resulted in holding at RONNY/SHEEP to decrease the pressure on the sequencing legs. Sequencing leg run-off occurred more frequently in RWY 28.

With RWYs and 16 the trajectories are more dispersed throughout the length of the sequencing legs. The greater capacity provided by the longer sequencing legs (compared to RWY 28) allowed controllers to better optimise the management of peak traffic. Therefore, the use of holding was less frequent with these runways in use (extremely rare in the case of RWY 16).

When RWY 16 was in use, the minimum required inter aircraft spacing on final approach was 5NM. Nevertheless the PMS structure proved to be more than capable of processing high loads of traffic which profited from the longer sequence legs available.

The activation of R16/MOA4 up to FL150 with RWY 10 in use reduced the length and consequently the capacity of the inner sequencing leg (the red one). This had an impact on the flow integration strategy to build the final sequence. In this case, the Initial Approach controllers adopted the natural order (based on the 'first come, first served' principle). Feeling the pressure of the more constrained inner leg, the controllers generally gave priority for the turn-to the merge point to the southbound aircraft and let the northbound ones run longer on the outer leg (the green one). That is why, in the figure below, the green trajectories are more concentrated at the extreme of the fan in RWY 10-mil than they are in RWY 10[10].

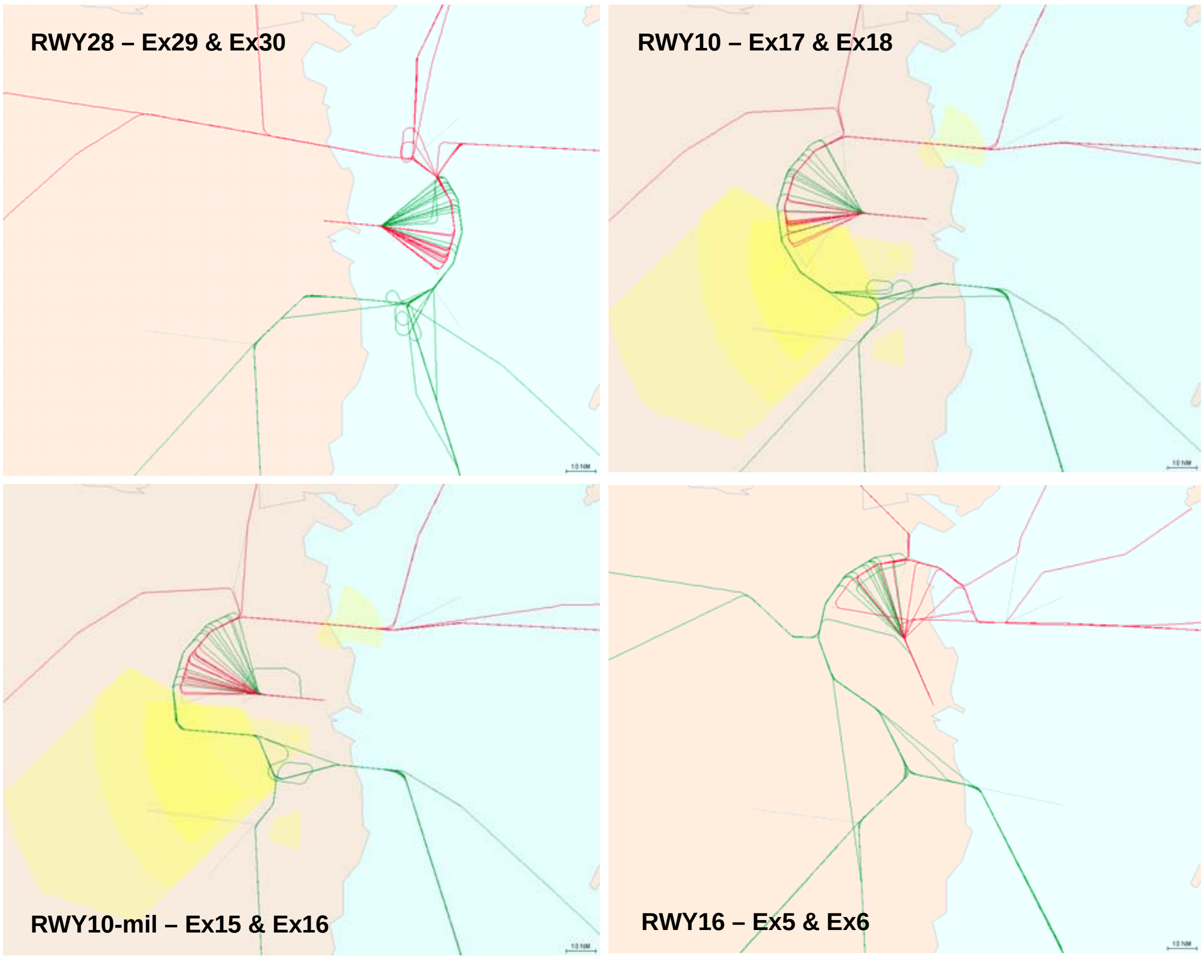

Figure 27. Examples of Trajectories Flown by Arrivals

The diagrams in Figure 28 display the spatial location of the 'Direct-To merge point' instructions throughout the measured exercises in the different experimental conditions[11]. The following considerations can be made:

- With RWY 28 the location of the instructions is concentrated towards the last third of both the sequencing legs length; there are many sequencing legs run-off occurrences (or generally cases the Direct-to instructions was given when the aircraft run out of sequencing leg);
- With RWY 10 the location of the instructions is concentrated at half way on the inner sequencing leg (red one) and between the second and last third of the outer sequencing legs length (green one); the number of sequencing legs run-off occurrences is almost negligible and concern the inner leg which is significantly shorter than the outer one;

[10] The 2D trajectories shown for RWY 10 and RWY 10-mil were recorded during measured exercises which made use of the same traffic sample.

[11] The difference in the number of the georeferenced instructions among the conditions, is after the difference in the number of measured exercises run for each condition. Eight exercises run under RWY 28 and RWY 10, whereas only four exercises were conducted with RWY10-mil and RWY 16.

- With RWY 10 and the R16/MOA4 up to FL150 active the location of the instructions is pushed towards the last part of the sequencing legs length; sequencing legs run-off occurrences are anyway contained and concern slightly more the inner and much shorter leg;
- With RWY 16 the location of the instructions is spread more equally on the sequencing legs length; sequencing legs run-off occurrences are almost negligible.

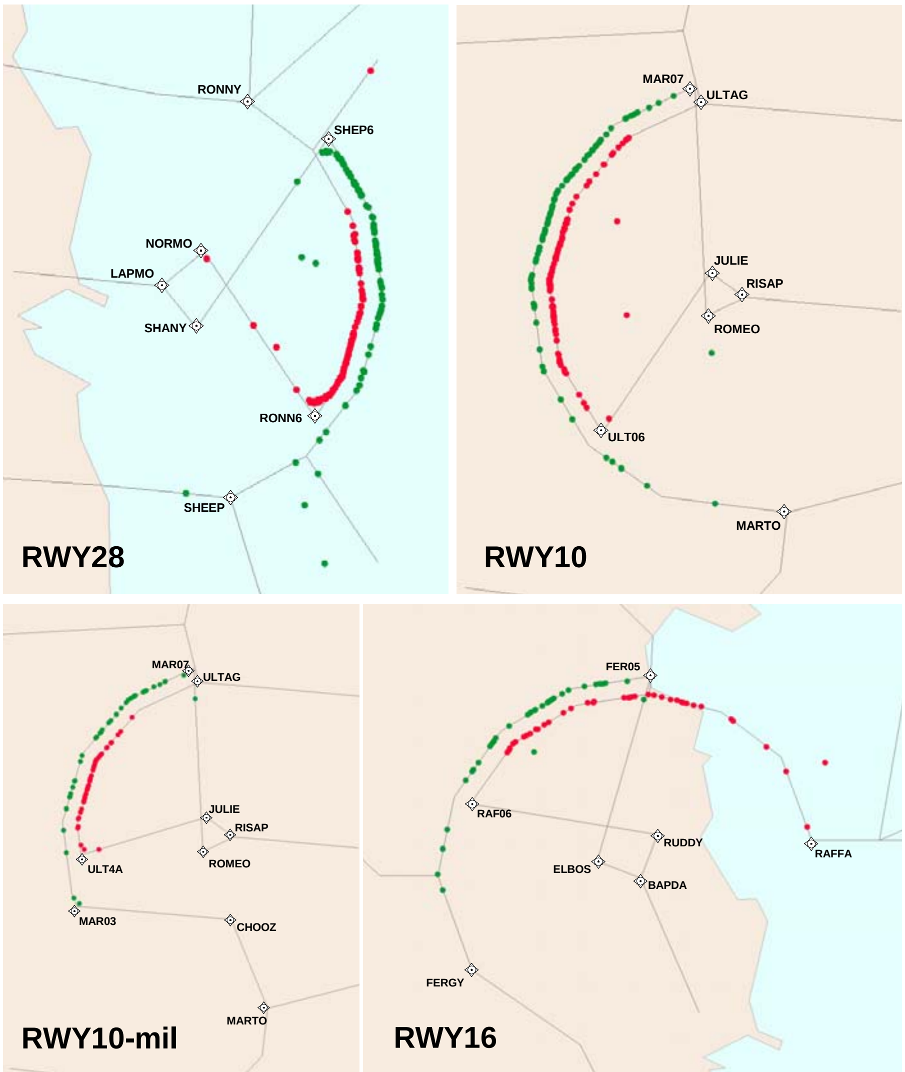

Figure 28. Distribution of Direct-To Merge Point Instructions

7.1.7.5 Descent Profiles

The vertical profile of each aircraft was analysed. In addition to the full display of all aircraft profiles per exercise, an average distribution was calculated per runway scenario. The results are displayed through the mean descent profiles flown by all the concerned arrivals at North (red curve) and South (green curve) and their dispersion (Figure 29).

In all runway scenarios and for both North and South flows, the descent profiles were characterised by a similar pattern. Aircraft started to descend and kept a regular descent down to the sequencing leg entry points (or some miles before) where they levelled off and kept the level before being directed to the merge point. A continuous descent was then flown until the final approach point (at 3000ft) where the curves stop in the diagrams.

This gave flight crew the opportunity to perform a Continuous Descent Approach (CDA) thereby better managing their descent from the level flown along the sequencing legs towards the localiser, which should provide environmental benefits in terms of reduced noise, emissions and fuel consumption.

In accordance with the agreed operating procedures, when RWYs and 16 were active controllers could not clear the flight crew to perform a CDA from the sequencing leg to the localiser, because of the base of control airspace limits. Therefore, the Initial Approach controller descended the aircraft to A5000ft after the direct-to instruction and the Final Director, subject to the base of control airspace constraints, further descended the aircraft to A300ft (in case R16/MAO4 was active, the FI had also to ensure that the aircraft did not descend below A5000ft until clear of the lateral limits of the military area). Despite this, the resulting mean descent profiles for RWYs 10 and 16 appear to be continuous.
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The descent profiles concerning RWY 16 are characterised by a more continuous trend, the decrease of the inclination (because of the levelling off on the sequencing legs) looks smoother. This would indicate the sequencing legs were less flown when RWY 16 as was already demonstrated in the previous paragraph.

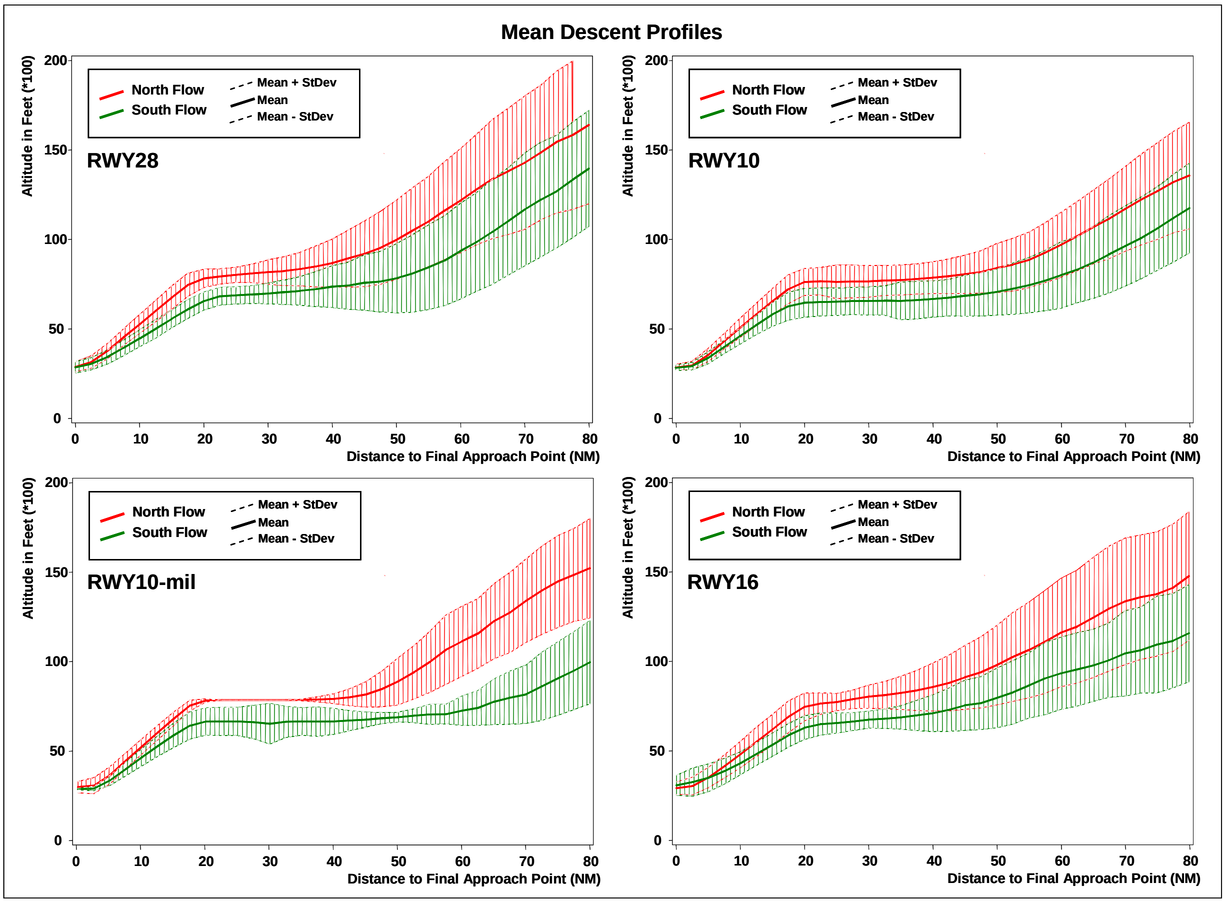

Figure 29. Mean Descent Profiles in TMA

Departures vertical profiles were analysed as well. The analysis showed that some aircraft were levelled-off for 1 to 2 NM before transfer to the Upper sectors. The controllers usually stopped the climb (at FL120) to keep vertical separation with arrival flows on standard trajectories, but in several circumstances a continuous climbing profile was possible.

7.1.7.6 Use of Lateral Navigation Mode

The use of the PMS method facilitated the adherence to standard trajectories[12] in the Dublin TMA. In addition to the benefits for the controllers, standard trajectories also represent potential advantages for pilots, in providing a better anticipation/knowledge of future positions/path throughout their route.

This section aims at quantifying how much/long aircraft were on lateral navigation mode (LNAV) compared to open loop vectors (heading).

Two measurements were taken, that are respectively the percentage of aircraft which adhered to the lateral mode all the flight time and, for those aircraft which deviated from the standard trajectories,

[12] The standard trajectory includes the use of sequencing legs.

the percentage of time spent on lateral mode. The flight time was defined as the interval given by the difference between the time the aircraft was assumed by any of the Upper sectors and the time the aircraft reached the final approach point. It was considered that aircraft left the lateral managed mode when receiving a heading instruction (or a “continue heading”) and went back on lateral mode after a direct, when they were held or when they were established on the localiser.

The result of the analysis (Figure 30) proves that 85% of arrivals adhered to the lateral mode throughout the flight time, and that overall 99% of the flight time was spent in lateral mode. Moreover the arrivals which received heading instructions (15% of the total) left the lateral mode only for 10% of their flight time.

The results are further broken down into the four different conditions to show differences caused by the particular runway usage.

The highest percentages of aircraft which left lateral mode were recorded with RWY 28 in use and with RWY 10 when R16/MOA4 up to FL150 was active. In these two conditions some 20% of the total number of arrivals received heading instructions. Nevertheless the interval of time the aircraft spent in open-loop mode was limited to the 7-9% of their overall flight time.

With RWYs 10 and 16 in use the percentage of aircraft leaving lateral mode for a short time was 10% of the total. As for RWY 10, the concerning aircraft left the standard trajectories for a small interval of their flight time (7%). As for RWY 16 the equivalent percentage is considerably higher than the trend (27%). This result is because of one flight item[13] which was vectored almost throughout the TMA. If we discard this outlier the percentage drops to 12%.

In summary these results demonstrate that the PMS method significantly improves the quality of service to aircraft in that their FMS lateral navigation usage was considerably high. The majority of the arrivals (85%) never left the lateral mode.

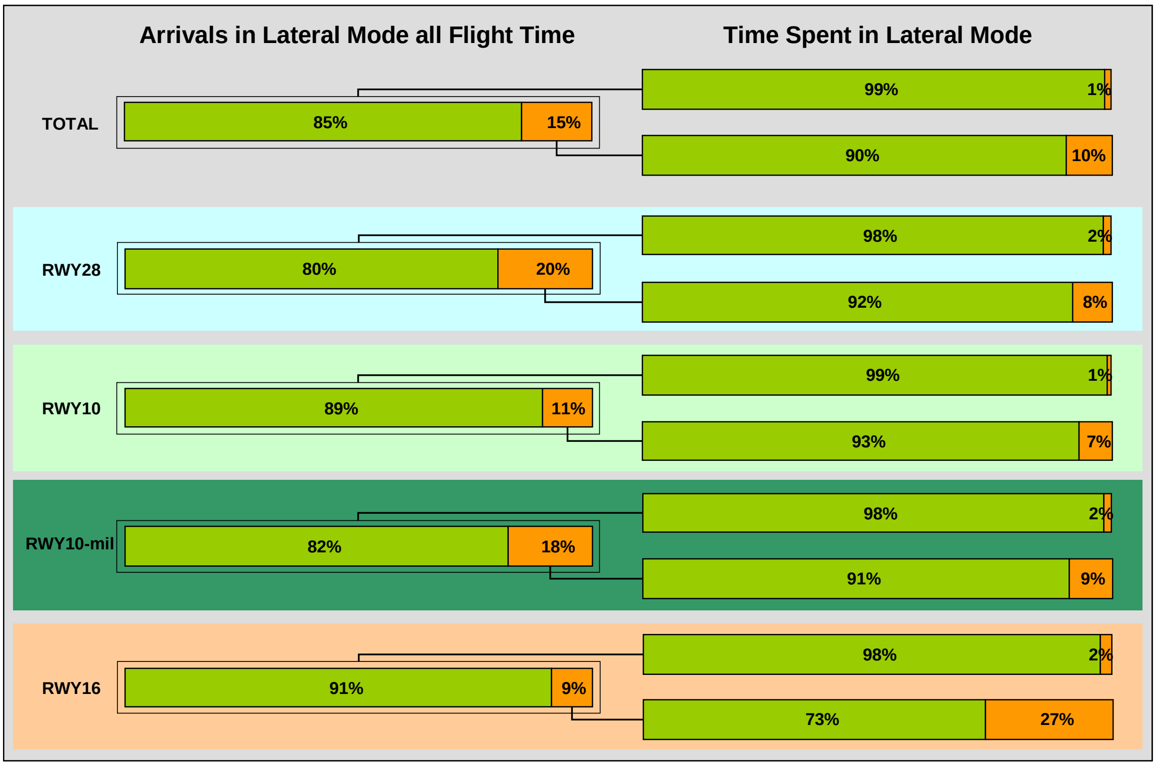

Figure 30. Arrivals and Time Spent in Lateral Mode

Measurements were taken for departures also. The flight time for departures was defined as the interval given by the difference between the time the aircraft took-off and the time the aircraft was transferred to an adjacent centre. The analysis shows that:

- 92% of the total flight time was spent in lateral mode;
- 76% of the departures adhered to the lateral mode throughout their flight time.

[13] BCY125G (Exercise 5).

These results show a reasonably high level of adherence to the standard trajectories, albeit with a slightly higher usage of vectoring than for arrivals

In general, the controllers did not deviate arrivals from the P-RNAV procedure track. When they did it (e.g. trajectory shortcuts), the track adjustments changed the profile and thus no longer assured the respect of the defined vertical windows (for arrival/departure separation). In these cases, the controllers' preference for ensuring flow separation and avoidance of potential conflicts was to issue a heading instruction to the departing aircraft.

7.1.7.7 Number of Holding Aircraft and Time Spent in Hold

Holding was necessary when the path stretching offered by the sequencing legs was not sufficient and further delay actions had to be taken[14].

The analysis of the mean number of holding aircraft and mean time spent within a hold per exercise shows a clear impact of the runway in use (Figure 31).

Over the eight exercises performed with RWY 28 active, 50 aircraft (average 6.3) were held. This result backs up the concern about the sequencing leg capacity on RWY 28. Approximately 60% of those aircraft were held at the SHEEP hold.

Over the eight exercises performed with RWY 10 active, 21 aircraft (average 2.6) were held. Holding was evenly distributed between the ULTAG and MARTO holds.

Over the four exercises performed with RWY 10 in use and R16/MOA4 active, five aircraft (average 1.3) mainly at ULTAG.

Finally, over the four measured exercises performed with RWY 16, only one aircraft was held.

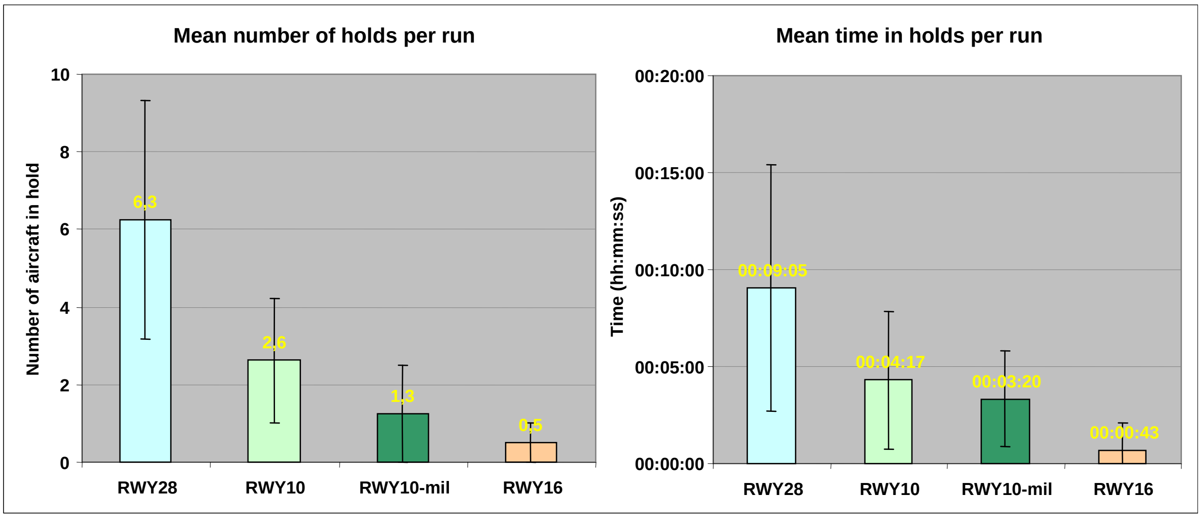

Figure 31. Mean Number and Time Spent in Hold per Run

7.1.7.8 Synthesis of Efficiency and Predictability

- The PMS and the new working arrangements were more efficient for ATC than the current vectoring working method; the quality of service was deemed as better because of the standardised procedures and consistent controllers' performance;
- The adherence to the standard made the use of vectoring very limited and the use of step descents (especially in the approach) not necessary to space and sequence the traffic. The arrivals were mainly handled through speed control;
- Hence there was a perceived reduction in the number of instructions given compared to current operations; the results demonstrated a significant improvement in the quality of service to aircraft in that their FMS lateral navigation usage was considerably high. The majority of the arrivals (85%) never left the lateral mode;

[14] Holding was counted as being flown in lateral managed mode.

- The systemised procedures increased predictability for controllers and pilots, it was easier for the controllers to check whether the traffic were on the standard trajectories as the tracks dispersion was generally very contained. This predictability was said by the controllers to have a positive affect on controller situation awareness and hence safety;
- In the Approach, the respect of the procedures gave flight crews the opportunity to perform a Continuous Descent Approach (CDA) thereby better managing their descent from the level flown along the sequencing legs towards the localiser;
- While it was not possible within the simulation to carry out a detailed study, the new working arrangements are believed to have a positive impact on environmental sustainability. Containment of trajectory dispersions and improved flight profiles both have potential for reducing fuel burn, noxious emissions and noise; note that further evaluation of these criteria will be carried out prior to implementation.
- Holding was still necessary when the path stretching offered by the sequencing legs was not sufficient (particularly when RWY 28 was active);
- Generally a consistent spacing was provided by FI to TWR.

7.2 Non-nominal Conditions

The contingency working procedures designed to deal with non-nominal situations and unusual events under PMS were assessed in a series of scenario based exercises. The ‘scenario’ based exercises featured a number of selected non-nominal events with the primary events investigated being system failures, ‘runway closure’, ‘sequencing leg run-offs’ and ‘go arounds’. Other scenarios also assessed during the RTS were unusual transitional levels, severe weather and medical emergencies. The contingency working procedures were assessed in terms of acceptability, and in term of how they impacted on controllers’ workload and situation awareness.

As with the measured exercises a variety of different techniques were used to obtain the required data. Controller reactions to the non-nominal events were observed and subjective feed-back was obtained from the controllers using the ISA (workload), NASA TLX (workload) and the SASHA (SA) questionnaires as well as a question in the post-exercise questionnaire relating to the ease / difficulty that controllers had in dealing with non-nominal and unplanned events. Controllers’ comments and feedback were also collected during the debriefing sessions and individual interviews. Again, the rating scores obtained from the ISA, NASA-TLX and SASHA are used as absolute measures.

7.2.1 General

As can be seen from Figure 32 the results from the post exercise questionnaires indicate that, generally, controllers found it either ‘very easy’ or ‘easy’ to deal with all the non-nominal or unplanned events simulated during the scenario exercises. The controllers found the contingency procedures for the main non-nominal events tested in the RTS more ‘rigid’ than current day procedures which meant that they were adhered to in an appropriate way without being left open to interpretation. This was seen as positive. However, controllers did state that how they work the traffic under non-nominal conditions very much depends on the situation and in the real world most controllers would ‘work it dynamically’. It was agreed that a set of procedures for selected non-nominal situations had to be defined. One suggestion made by the controllers was for more than one set of procedures for each of the main non-nominal events to be developed. This would allow a certain degree of flexibility depending on the traffic situation. It was also recommended that the number of different procedures for each non-nominal event should be limited to a maximum of three to avoid confusion.

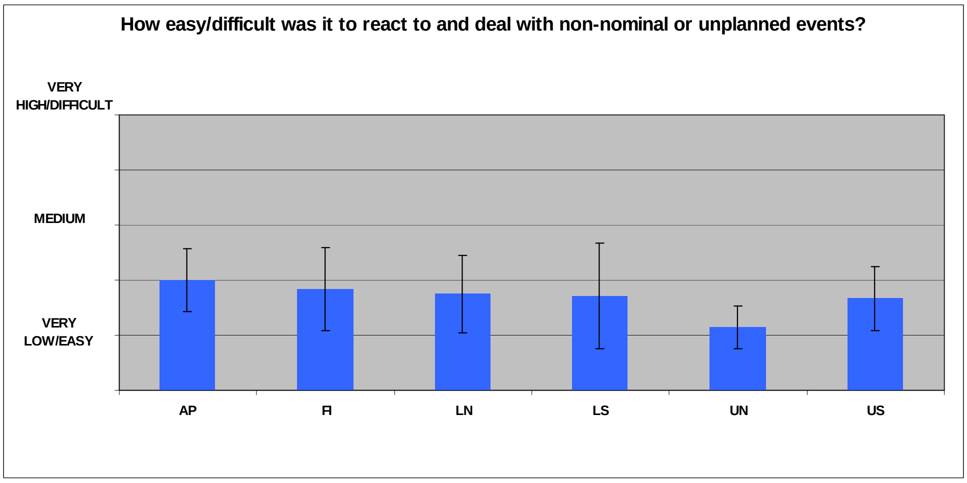

Figure 32. Post Exercise Question on non-nominal or unplanned events

7.2.2 Sequencing Legs Run-off

During the simulation a total of four run-off scenarios were planned during the exercises to assess whether the contingency procedures developed were acceptable to controllers and to assess the controllers' ability to handle these unusual events. In addition to the planned sequencing leg run-off scenarios, additional non-scripted sequencing leg run-offs occurred during other exercises during the simulation which gave the opportunity to gain further feedback on the contingency procedures for this type of non-nominal event.

It was considered that the event would have the most impact on Approach and Final Director sectors as a run-off required reverting to vectoring. As all aircraft in the lower sectors are sent to the holds during sequencing leg runoffs the upstream controllers in the Lower sectors are also affected to some degree.

7.2.2.1 Acceptability and Workload

All the controllers considered that the procedures worked well and ran very smoothly during all the exercises except one. In that particular exercise the controller attributed the high workload experienced to the high mental demand required when dealing with aircraft in the holds while trying to manage the Traffic Management List (TML). Piloting errors resulting in aircraft not complying with the controllers' instructions further contributed to the high workload he experienced during the scenario.

7.2.2.2 Situation Awareness

The contingency procedures for sequencing leg run-offs did not have a major impact on controllers SA. In one of the exercises the Lower North controller found that holding traffic using the TML diverted his attention and this detracted from his overall SA.

7.2.3 Go-around

During the simulation, a series of eight go around scenarios were planned in the non-nominal exercises for RWYs 10, 16 and 28 in order to assess the effect of the procedures in place to deal with such an event. It was considered that the go-around would have the greatest impact on the Approach and Final Controllers.

7.2.3.1 Acceptability and Workload

All the controllers reported that the contingency procedures for 'go-arounds' were suitable and hence appropriate. The mean results obtained in the NASA TLX for the eight exercises which had go around event show overall demand on workload did not exceed a mean score of five out of a maximum of ten.

The Approach and Final controllers did not experience any problems in dealing with go-around situations. However, it was reported that a high amount of coordination was created between the Approach and Final Controllers as the Approach Controller had now to coordinate the required headings with the Final Controller and agree when the go-around aircraft around could be fitted into the sequence. The controllers felt that with PMS, having Approach and Finals seated next to each other and working together made it very manageable, whereas some of the controllers were in doubt as to how this would work in the current day situation with only one controller

7.2.3.2 Situation Awareness

It was considered that the contingency procedures developed for a 'go-around' did not have a major effect on controller situation awareness. All controllers rated their situation awareness above four (on a scale of zero to six) which signifies that they were ''more often'' to ''always'' ahead of the traffic and able to predict the evolution of the traffic. According to all the Approach and Final controllers, with PMS, focussing on a smaller area and the predictably of the aircraft tracks made it easier than in their current system.

7.2.4 Runway Closure

Three runway closures were simulated to assess the impact of the designed procedures for this event.

7.2.4.1 Acceptability and Workload

All the controllers felt that the contingency procedures designed for runway closure were suitable and acceptable. One Approach controller commented ''because PMS procedures are rigid when the runway is closed, everything ran smoothly and the situation was always in positive control''.

There was no major impact of the procedures on controllers' perceived workload. The overall workload from NASA TLX did not exceed 4.7. However, the Final Controller position was considered to be the most demanding in terms of the effort required in taking aircraft from the holds and issuing time-critical instructions in order to get them onto finals with the required spacing once the runway was re-opened.

In the upstream sectors, the main workload for the sector controllers involved informing other centres of the runway closures and organising the arrival traffic to enter the holds and none of the Upper and Lower controllers felt that this extra workload required was significant.

The analysis of the ISA ratings (Figure 33) also show the workload remained acceptable both during the runway closure period and afterwards when the runway availability went back to normality. The ISA values reported were not really affected by the simulated scenario.

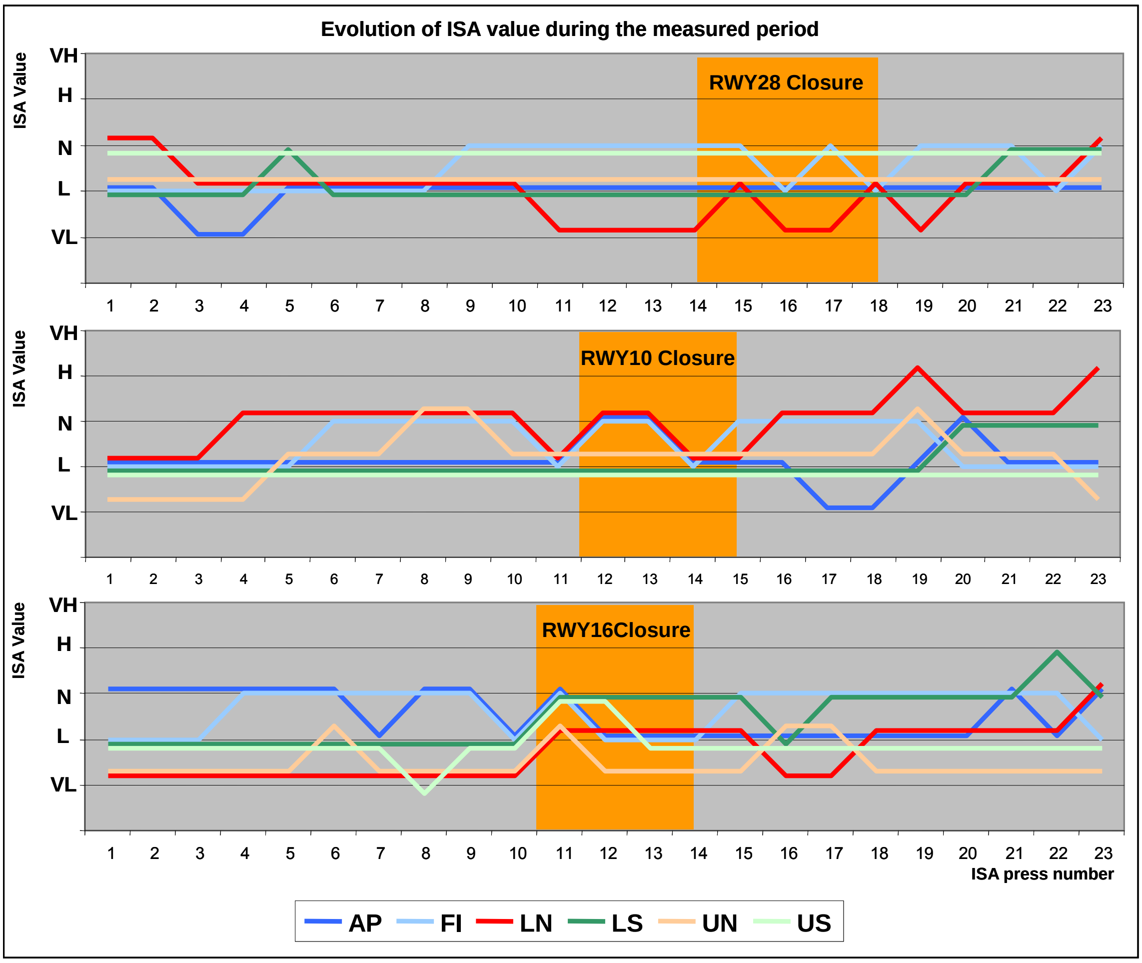

Figure 33. Evolution of ISA during RWY Closure

7.2.4.2 Situation Awareness

Overall, in the runway closure scenarios, none of the controllers felt that this event had any major impact on their situation awareness. The average controller rating scores obtained for SA was above 4.3 (on scale of 0 to 6). All controllers reported being able to maintain an overall picture of their traffic situation, even when the runway was re-opened.

7.2.5 System Failures

In current day operations, if there is system failure such as a LAN or CWP failure the Executive controller has the support of the Planner controller. The Planner controller not only acts as a second pair of eyes and ears but is also there to support the Executive by performing delegated tasks. With PMS and the new manning configuration each Area sector is split in two (an Upper and Lower sector) and controlled by one tactical controller. Hence it was considered particularly important to assess the controllers' ability to handle system failures such as LAN and CWP failure and see how they would recover from such an event with the new manning configuration. The contingency procedures for system failure were the same as current day procedures.

7.2.5.1 LAN Failure

7.2.5.1.1 Acceptability and Workload

The overall ratings of the controllers in the Post Exercise NASA TLX questionnaire did not indicate a major impact of LAN failure on the controllers' perceived workload. The mean rating for overall workload demand for all positions, except the Upper South, did not exceed 6 on a scale of one to ten. The controller in the Upper South sector reported an increase in effort and frustration due to 'the tedious method of identifying and tagging the aircrafts call sign''. However, the workload was said to only increase for a short period during the event.

According to the Final Approach Controllers, the procedures for LAN failure did not have a major impact on their perceived workload. Although it should also be noted that there were only a couple of aircraft on frequency when the LAN failure occurred.

The analysis of the ISA ratings (Figure 34) confirms that the LAN failure had a significant impact on the controller in the Upper South sector. S/he reported 'High' values to three successive ISA interrogations counting from the failure start. The controller in the Lower South sector experienced a high workload only for a short period, after that his/her workload went back to 'Low' level. The rest of the controllers were not significantly impacted by the failure in terms of their workload, which remained confined between 'Low' and 'Normal' levels.

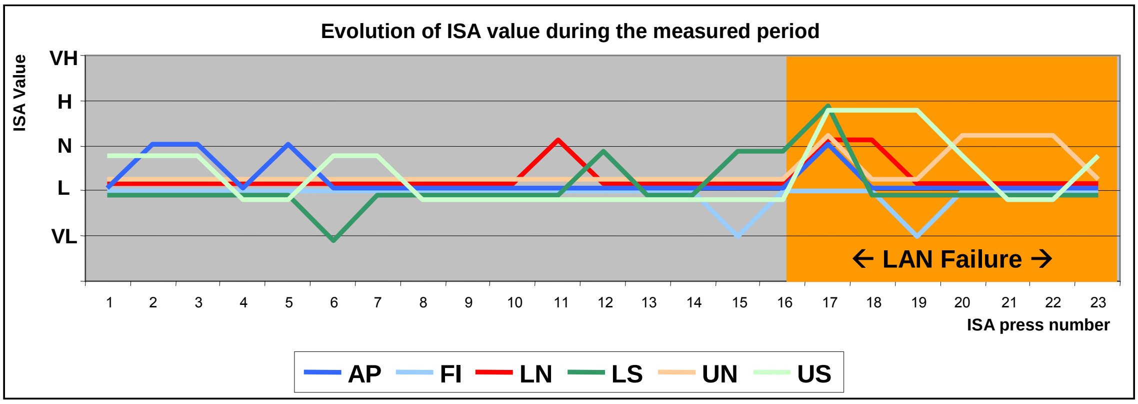

Figure 34. Evolution of ISA during LAN failure

7.2.5.1.2 Situation Awareness

The ratings obtained from the SASHA questionnaire over the whole exercise show that LAN failure did not have a negative effect on controllers overall perceived situation awareness. The average score rated by the controller was 5 (out of a maximum of 6). Even though the controllers reported that they were surprised by an event which they were not expecting, they were ''more often'' to ''always'' ahead of the traffic and able to predict the evolution of the traffic.

The Approach controller commented that with PMS because the aircraft are on the sequencing legs, the controllers had a better picture of the location of the aircraft and where the next aircraft would be coming from and this made it easier for them to apply the squawk-ident technique.

7.2.5.2 CWP Failure

7.2.5.2.1 Acceptability and Workload

The controllers considered that with PMS the procedures designed for the failure of a controller working position did not have an effect on their perceived workload. In addition, they did feel that there was extra workload involved in recovering from such a failure.

7.2.5.2.2 Situation Awareness

It was observed that the Lower sector controller who had experienced the CWP failure handled the situation with ease. In the SASHA questionnaire for SA, the mean score obtained for overall SA rated by the Lower Controllers was 5.8 out of a maximum score of 6. When the event took place, there was no problem as the Upper controller had already worked the arriving traffic and had already built up a very good picture of the traffic situation in both the Upper and Lower Area sectors. As a result, the two controllers were able to work easily together as a team to determine the best strategy. The Lower controller found that Traffic Manager also facilitated the coordination between the other sectors both during the event and in the recovery from the CWP failure.

7.2.6 Other Non-nominal / Contingency Situations

All controllers but one agreed that under the new manning configuration they were able to handle all unusual events without any problems even under high workload conditions. Four of the controllers disagreed that handling critical events, such as a level bust, is more difficult with the new manning configuration whilst five of the controllers reported to 'neither agree' or disagree' and only one 'strongly agreed' with the statement. The controllers that tended to disagree that it was more difficult to handle critical events with the new manning configuration stated that because they were using a smaller range in each sector, critical events were often easier to spot and as under PMS you have more predictability in terms of what the traffic is going to do it is also easier to manage. However, the controllers that neither 'agree or disagree' with the statement commented that they could not give a definitive answer as it really depended on the situation.

Only one of the ten controllers found it more difficult to handle unusual and critical events without any problems. Those controllers that reported to find it easier to handle unusual and /or critical events under PMS once again said it was mainly due to the enhanced situation awareness resulting from the smaller range used in each sector. One controller added that as 'you are handling less traffic at any one time which allows you to spend more time monitoring the traffic you have'. Half of the controllers felt that dealing with critical events, such as a level bust under PMS, really depended on the situation, so it was difficult to give a definitive answer to this question.

Some concerns by Approach and Final controllers were expressed in the debriefs regarding the free-vectoring of aircraft coming out of the holds during the recovery process of non-nominal situations. It was found that extra workload for the Approach controller was induced in having to ex-hold the traffic to put it on vectors while advising the appropriate sector or Traffic Manager of cleared levels. Some of the controllers also considered that this procedure restricted efficiency and predictability for aircraft as when exiting the holds, aircraft were subsequently loosing track miles before being given headings and in reality this would cause more fuel burn for the aircraft. Some controllers suggested that more appropriate recovery strategy would have been to get aircraft back into the traffic flow by putting them on the sequencing legs or even giving them 'Direct to the IAF.

7.2.7 Synthesis of Non-Nominal Events Results

- The controllers dealt with the system failures i.e. LAN failure and CWP failure, very smoothly and without any problems under the new manning configuration;
- Controllers were able to able to handle all unusual events without any problems even under high workload conditions under the manning configuration;
- The contingency procedures developed for the main non-nominal events tested e.g. sequencing leg run-offs, runway closure and 'Go around' procedures were generally seen as suitable and hence acceptable by the majority of the controllers;
- However, there was also a general consensus that although the procedures for the non-nominal events tested were suitable there was still some work to do and they need to be further refined;
- To provide some degree of flexibility it was suggested that more than one set of procedures for each of the main non-nominal events t be developed. The number of different procedures for each non-nominal event should be limited to a maximum of three to avoid confusion;
- Thus it was recommended that more prototyping sessions are required to further refine the non-nominal procedures under the PMS.

7.3 Traffic Manager

The role of the Traffic Manager was assessed in terms of acceptability, perceived workload and situation awareness using a bespoke post-exercise questionnaire, the post-simulation questionnaire and through the group debriefs and individual interviews. All of the seven controllers who were Area rated were rotated around this position over the course of the simulation.

7.3.1 Acceptability / Role and Tasks

The results obtained regarding the Traffic Manager role and procedures were mixed. All controllers felt that the role of the Traffic Manager was essential in order to optimise operations under PMS.

The controllers that assumed the role of Traffic Manager commented that as the simulation progressed, the role and tasks of the Traffic Manager became clearer and better defined. However, they also felt that the role was still evolving and there was still some work to do. A couple controllers expressed concern that the Traffic Manager was responsible for too many tasks which may become unmanageable under busy conditions. It was suggested that some of the tasks such as certain co-ordination / communication tasks could be performed either by the sector controller (e.g. co-ordination with adjacent sectors) or the Data Assistant (receiving / filtering incoming calls from Baldonnel and Weston). A couple of controllers also commented that some controllers may not like having some of their responsibility taken away and being given to the Traffic Manager. As a result of this concern, all controllers agreed that the Traffic Manger role must be accompanied by a specific training course and the Traffic Manager role should ideally be a rated position.

Most of the controllers (four of the seven) agreed with the statements in the post simulation questionnaire that the procedures for the Traffic Manager were clearly defined and workable. However, when questioned, all controllers felt that the Traffic Manager procedures needed some extra work and fine tuning.

Working in close co-ordination with the Area and in particular, the Approach controllers together with advanced planning and early decisions were seen as key to the role of the Traffic Manager to ensure the flow of traffic was optimised in the Dublin TMA. Feedback from the controllers resulted in them generating several recommendations relating to the Traffic Manager role:

- Suitable decision aids or support tools could be beneficial to help the Traffic Manager make certain tactical decisions, for example when to hold aircraft or reduce spacing on final from 5NM to 3NM. AMAN was investigated as a potential support tool for the Traffic Manager and although was perceived as being useful it was felt it could be further development to better support PMS operations;
- Rules of thumb' or identifiable triggers needed to be defined to further help the Traffic Manager make tactical decisions relating to the traffic flow;
- The Traffic Manager should have his/her own controller working position in the Ops room. The CWP should have a separate screen so that the Traffic Manager can easily identify the status of each aircraft i.e. departures, arrivals, over-flights etc.;
- Although the Traffic Manager is in charge of defining the traffic flow strategy, s/he must consult the Approach controller and the Approach must agree to the decisions being made before the Traffic Manager implements them. As a result it was recommended that the Traffic Manger CWP should be adjacent to the Approach sectors;
- The Traffic Manager should have an associated rating given the importance of the role under PMS;
- In general, all controllers felt that the Traffic Manager role and associated tasks and procedures needed to be refined and re-visited in future prototyping sessions.

7.3.2 Workload

As can be seen in Figure 35, out of 24 measured exercises, the controllers agreed that the workload of the Traffic Manager was manageable for all but one exercise. The controllers also felt that as the simulation progressed and they became more familiar and comfortable with the procedures, the role of the Traffic Manager evolved and the workload experienced became more manageable. Under nominal conditions, Traffic Managers felt they were able to communicate and co-ordinate easily with the Area controllers, in particular the Upper sector controllers, to help formulate plans to deal with identified issues and ensure the traffic flow in the Dublin TMA was optimised. In parallel, the Traffic manager worked together with the Approach controllers to determine what actions had to be taken to ensure the traffic on the sequencing legs was kept efficient and manageable. As one controller stated, 'I was able to be proactive in guiding the sector controllers as to my requirements for arriving?'.

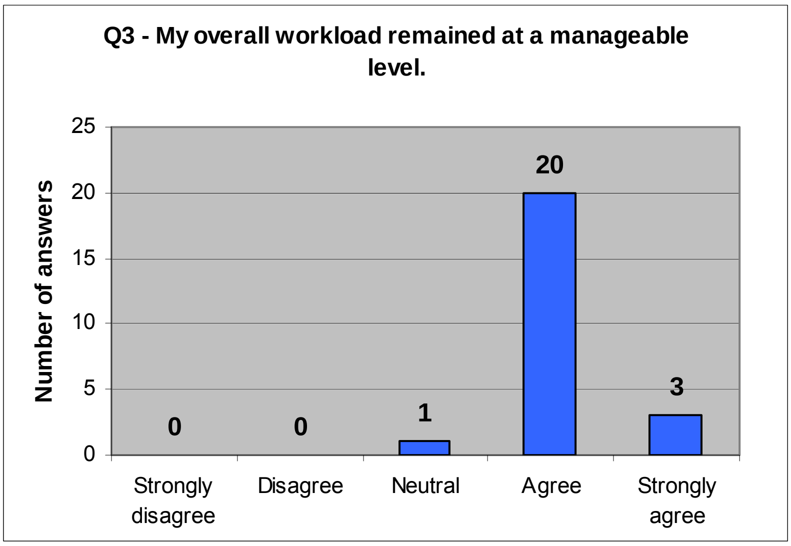

Figure 35. Traffic Manager Workload

7.3.3 Situation Awareness

In order for the Traffic Manager to develop the appropriate strategy to optimise flow of traffic within the Dublin TMA the Traffic Manger must have a good global picture of the current and near future traffic situation. The results from the post-exercise questionnaire indicated that, in general, the Traffic Manager was able to maintain an overall picture of the traffic situation in the Dublin TMA (see Figure 36 below). Similarly all responses given showed that controllers agreed that they were ahead of the traffic and able to predict the evolution of the traffic except for one who disagreed and one who neither agreed nor disagreed.

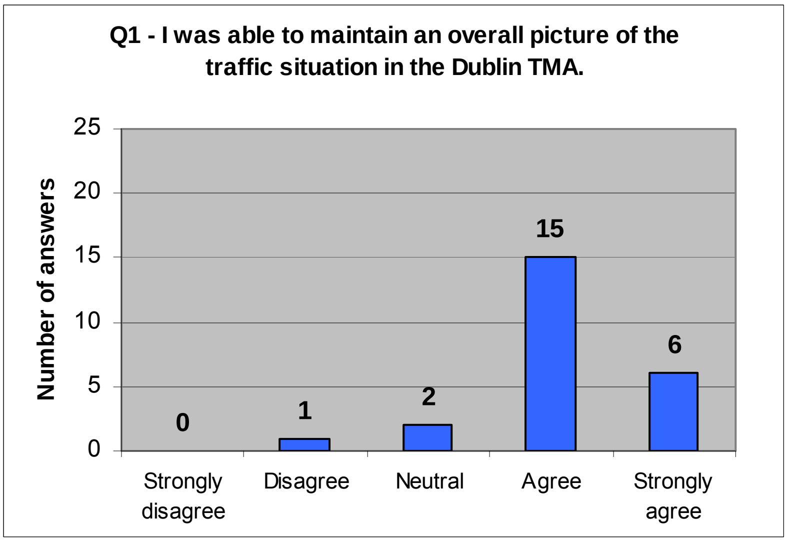

Figure 36. Traffic Manager Situation Awareness

When questioned, the controller that reportedly was unable to maintain a global picture of the traffic situation in the Dublin TMA in one of the exercises, said that he had a good global picture of the traffic situation in the Dublin TMA for most of the exercise. However, at one point during the exercise he had to leave his position to co-ordinate with the Area sectors. By the time he resumed his position at his CWP, he had lost the picture of the traffic situation in the Approach sectors and an aircraft had over-ran the sequencing leg. As a result of this incident he felt that the amount of time the Traffic Manager spent away from his CWP co-ordinating with the Area sectors should be minimised. He suggested that some of the co-ordination tasks could be performed by the Area Sector controllers themselves and perhaps co-ordination with Area sectors could be performed by intercom.

7.3.4 Synthesis of Results for Traffic Manager

- The role of the Traffic Manager was essential in order to optimise operations under PMS, although the role and associated tasks and procedures were seen as workable they were still evolving and needed to be refined in future prototyping sessions;
- Overall workload for the Traffic Manager was considered to be manageable. Although there was a slight concern that the Traffic Manager was responsible for too many tasks which may become too demanding under busy conditions. It was suggested that some of the tasks such as certain co-ordination / communication tasks could be allocated to either the sector controllers or data assistant;
- The Traffic Manager generally had good situation awareness, and felt he was able to maintain a good overall picture of the current and future traffic situation in the Dublin TMA;
- Working in close co-ordination with the Area and in particular, the Approach controllers together with advanced planning and early decisions were seen as key elements in optimising the performance of the Traffic Manager;
- The Traffic Managers needed additional support tools or decision aids and rules of thumb or triggers to help them make the right tactical decisions and the right time, e.g., when to open holds, reduce separation on finals to 3NM;
- Given the important role of the Traffic Manager appropriate training is essential and should be a rated position.

7.4 Military and Adjacent Centres Acceptance of TMA2012

7.4.1 Military

The two military representatives that attended the RTS found the proposed procedures for the Dublin TMA 2012 acceptable and commented they were please to see that their requirements had been considered and incorporated into the concept of operations.

However, they did express a concern that they would not be communicating and co-ordinating directly with the sector controllers and would have to go through the traffic manager.

7.4.2 Adjacent Centres

The representatives from the three adjacent air traffic control centres, Manchester, London and Shannon, that attended the RTS all found the procedures proposed for the Dublin TMA 2012 acceptable and feasible.

7.5 Secondary Objectives

The RTS had a number of secondary objectives which concerned other operational improvements/changes that the organisation could benefit from. These included the assessment/development of:

- Free release of departures (jet SIDs);
- New bases of controlled airspace on the L975/L70;
- New DUNLO SIDs and the associated routings through the London FIR;
- R/T phraseology.

The present report gives the findings as far as the implementation of free release procedures for departures is concerned. The other operational objectives could not be exhaustively addressed during the RTS and a decision was taken to investigate them in other validation activities (i.e. prototyping sessions) which are planned for the second semester of 2010 at DATCC facilities.

7.5.1 Departure Procedures

Two operating procedures for the release of departing traffic were simulated during the RTS:

- Prior Permission Only – PPO (tower co-ordinates with the Lower controllers);
- Free Release of departures on jet SID.

The aim was to assess the acceptability of the free release procedure and measure the effect it had on Lower sectors controllers' workload and situation awareness.

A set of measured exercises (with RWYs 28 and 10) was repeated twice to expose the same group of controllers to the two procedures. As all the other experimental variables were kept the same it was assumed that changes recorded, essentially through the questionnaires, in the situation awareness and workload indicators would be attributed to the procedure itself.

As already seen, controllers' situation awareness and workload were assessed using respectively the SASHA and the NASA-TLX questionnaires after each exercise. The overall scores were averaged over the two Lower sectors in the two different conditions. The results are presented in Figure 37.

No difference in either of the indicators was found, surprisingly enough the SASHA and NASA-TLX scores ended up being exactly the same. Hence there was no need to run statistical tests to check for significance in potential differences which were expected.

Based on this analysis the free release of departures did not have an impact on the Lower controllers' situation awareness. No degradation could be recorded. Similarly the workload stayed the same. Despite the impact the release procedure has on the number of calls from Tower to Lower sectors (Figure 38), freeing the controllers of part of these co-ordination tasks did not lead to a decrease in their workload perception.

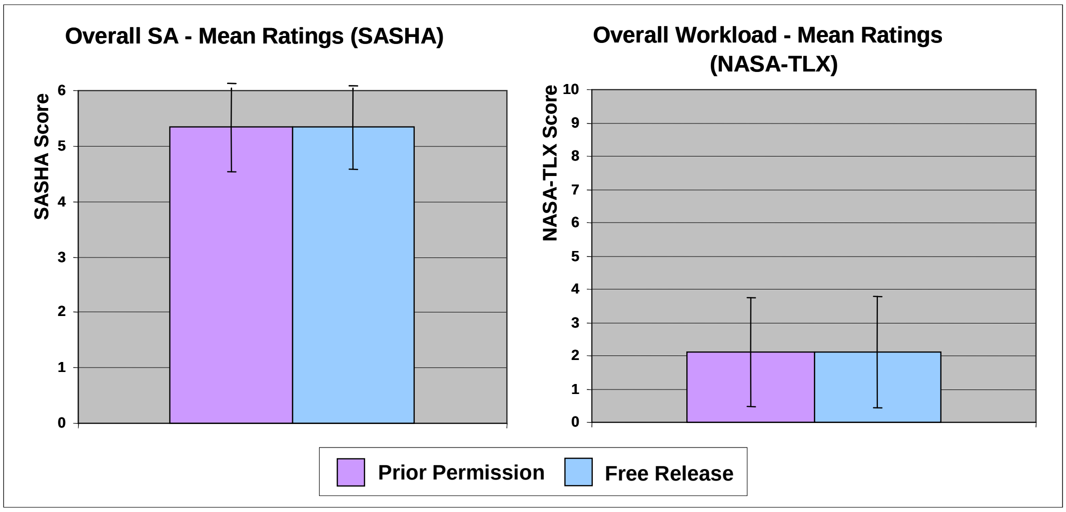

Figure 37. Departure Procedures: Overall SA and Workload of Lower Sectors

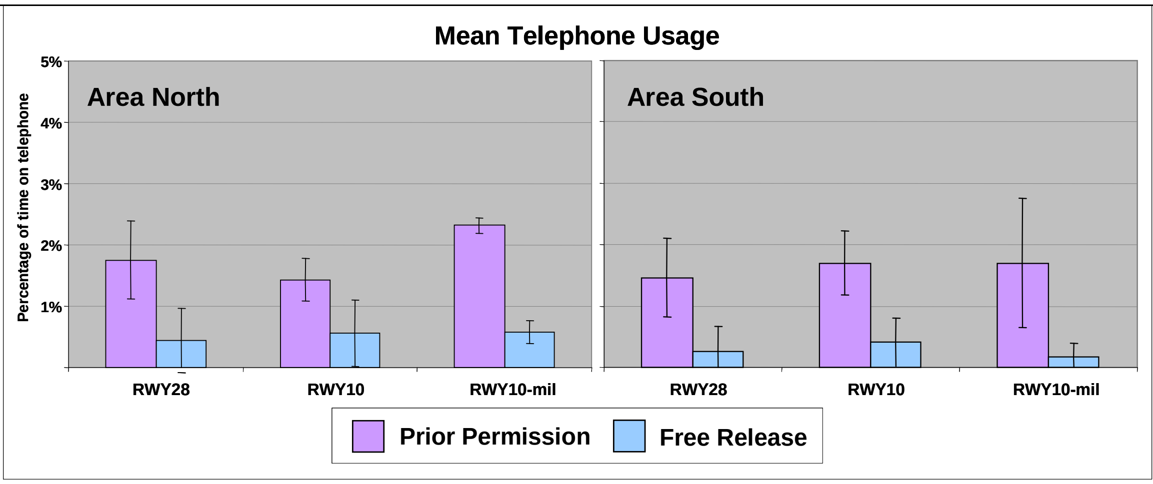

Figure 38. Departure Procedures: Telephone Usage of Lower Sectors

Controllers expressed their satisfaction during the debriefs at the reduction of co-ordination that the free release procedure introduced. However they would still need information presented by the current system ACEMAX, which was not featured in the simulation platform.

They also agreed on the decision to limit the procedure to the jets. As far as departures from RWY 34 were concerned, the controllers doubted that the free release could be applied, but this was only a judgement based on personal experience which would need to be confirmed (or contradicted) in an ad-hoc study.

In synthesis the controllers did not recognise any obvious disadvantages of applying free release procedure, even though bringing it into operation would mean well drawn up / clarification of the Tower procedures and responsibilities. Tower controllers shall know about a/c performances (e.g. rate of climb), WV category etc, and time based departure release shall necessarily have to be looked at. Therefore the implementation of free release would require time in order to properly define the procedures for Tower and TMA and assure that the concerned actors will be give appropriate training. Eventually the implementation of free release will also be advantageous for Tower controllers as it saves them time with regards to telephone and intercom operations.

8. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are designed to provide a conclusive summary to the analysis of the RTS results.

8.1 Conclusions

8.1.1 Operational Feasibility and Controllers Acceptance

- PMS procedures under nominal conditions were considered operationally feasible and acceptable. Controllers considered that the new PMS procedures were easy to use / apply and allowed for a greater volume of traffic to be handled safely. Although, holding procedures need to be further developed.
- Some controllers expressed concern that the ease of the PMS working method may lead to controllers becoming less skilled and this may negatively impact job satisfaction. However, most of the controllers felt that satisfaction can be gained in achieving more efficiently the tasks (e.g. appropriate delivery conditions, consistent spacing, etc)
- Contingency procedures developed for certain non-nominal situations were considered acceptable and workable but some need to be further refined in future prototyping sessions. Controllers also felt that more than one contingency procedure per identified scenario was necessary to allow for flexibility.

- Controllers were able to handle all unusual events simulated under high workload conditions (+40% of current traffic levels) without any problems under PMS and the associated manning configuration.
- Changes in delivery procedures for aircraft entering Dublin TMA developed were considered acceptable by the adjacent centre representatives, i.e. Shannon, Manchester, London, Weston and Baldonnel.

8.1.2 Controller Roles and Tasks

- R/T was said to be significantly reduced under PMS due to the adherence to standard trajectories (i.e. extensive use of LNAV mode), the implementation of CDA and the fact that the number of aircraft on frequency at the same time was reduced, .
- The use of open-loop instructions was limited under PMS. Reverting to vectoring when necessary was not seen as a problem by the controllers.
- Co-ordination between adjacent sectors within the Dublin TMA was reduced and simplified due to the predictability of traffic flows under PMS. The Operations room layout and seating arrangements were said to be an essential factor that facilitated communication and co-ordination.
- Due to the predictability of traffic flows and the fact that the number of communication tasks was reduced, monitoring of aircraft sequence and traffic situation as well as conflict detection and resolution, was considered by the controllers, to be just as easy if not easier under PMS.
- Dublin TMA is obliged to provide the Flight Information Service (FIS), provision of such a service under PMS in terms of who is allocated responsibility of the FIS tasks needs to be considered in future.
- Shift handover under single person operations (SPO) was not felt to be an issue as long as the recommendations to prevent and / or mitigate any potential negative impacts were implemented (see recommendations relating to shift handover in section 8.2.7).

8.1.3 Traffic Manger Role and Tasks

- The role and tasks of the traffic manager were mostly seen to be acceptable and essential under PMS but it was emphasised that the traffic manager must work in close collaboration with the sector controllers in particular the Approach area sectors for the role to work successfully. However, all controllers felt that more work needs to be done in the future to further define the traffic manager's role and tasks.
- As the traffic manager is responsible for determining the traffic flow strategy s/he must have a good global awareness of the traffic situation within the Dublin TMA. Therefore the traffic manager requires his / her own CWP and the radar display on the traffic manager's CWP must display aircraft status so that s/he can easily identify arriving, departing and over-flight aircraft. In addition, the traffic manager role would benefit from having additional information & decision aids as well as defined 'triggers' or 'rules of thumb' to support his/her work.
- In the RTS, the Traffic Manager was responsible for co-ordination with adjacent centres. Some controllers felt that allocating such tasks to the TM was beneficial as it helped to reduce their task load and workload others felt that it further complicated co-ordination. Allocation of the co-ordination tasks needs to be further assessed in future prototyping sessions.

8.1.4 Workload

- Workload was generally reported to be low with PMS under nominal conditions for all measured positions and runway scenarios, despite the 40% traffic increase compared to current traffic levels. However, controllers in the Lower Areas sectors did report that workload could rapidly increase when holding aircraft.

- Controllers felt that workload was slightly greater in the Lower sectors compared to the Upper sectors. However, workload and task distribution was reported to be much more balanced for the Area sector controllers under PMS operations compared to current operations. Task distribution was estimated to be split about 40:60 between the Upper and Lower controllers under PMS compared to an estimated 90:10 between the Executive and Planning controllers under current operations. Furthermore, the controllers found it satisfying that both Upper and Lower controllers assumed tactical control of aircraft.
- The workload and task distribution between the Initial Approach and Final Director was also seen to be appropriate. Although it was mentioned that under low traffic conditions there may not be enough work for two controllers so there should be the possibility to collapse the two sectors into one.

8.1.5 Situation Awareness

- Controllers felt that their awareness of the traffic situation within their own sector was better under PMS than current day operations due to the predictability of traffic flows and the fact that they could work at lower ranges.
- Situation awareness of adjacent sectors was also reported to be high due to the predictability of traffic flows under PMS, but also due to the fact that the Upper & Lower tactical controllers in the same Area sectors and APP & FI are seated adjacent and work together as a team.
- The controllers found that situation awareness was relatively limited for non-adjacent sectors but this was not considered as an issue as the traffic manager provides them with the required information when, and if, necessary.

8.1.6 Safety

- Overall controllers felt that safety was at least maintained under PMS compared to current operations. Furthermore, all controllers felt that PMS enabled them to safety and efficiently handle more traffic (40% traffic increase compared to current traffic levels).
- All unusual events, e.g. pilot errors, simulated were dealt with promptly and efficiently under PMS and the associated manning configuration. As each sector controller had less communication tasks to perform they reported to have more time for conflict detection and resolution.
- The system failures simulated in the RTS (i.e. CWP failure and LANS failure) were handled efficiently and smoothly, without any problems under the new single person sector manning configuration. The predictability of the traffic together with the fact that the adjacent sector controllers worked together as team were said to contribute to the ease with which the system failures were effectively handled.
- No human errors specific to PMS and the associated manning configuration were reported by the controllers nor observed during the RTS. However, low workload could be a potential issue as it could lead to boredom and lack of vigilance. The traffic manager must monitor controller workload, fatigue and performance to ensure the appropriate strategies / actions are implemented when necessary, for example, band-boxing adjacent sectors when workload is very low etc., to ensure PMS operations are optimised in the Dublin TMA.

8.1.7 Capacity

- The analysis of the throughput at the runway showed that both the system and the controllers were capable to deliver high load of traffic which represented an increase of 40% on current sector capacity limits. Measurements taken demonstrated it was possible to achieve up to 50 movements per hour and concurrently the controllers' workload was reported to be low.

- On some occasions and in order to accommodate the stream of arrivals, were a prolonged use of 3NM spacing was carried out which resulted in departures excessively held at ground. This raises concerns in terms of efficient use of runway capacity.
- Military activity with RWY 10 in use did not affect the system in terms of its capability to deliver high traffic load with the impact on the runway throughput being almost negligible.

8.1.8 Efficiency and Predictability

- The new procedures and working arrangements meant that the use of open-loop instructions and step descents became no longer necessary in order to space and sequence the traffic as in the current operations.
- There was found to be a significant improvement in the quality of service to aircraft, in that, their FMS lateral navigation usage was considerably high (e.g. 85% of the arrivals never left the lateral mode) and their descent profile could be managed to perform a CDA from the level flown along the sequencing legs towards the localizer.
- The use of holdings was still necessary when the path stretching offered by the sequencing legs was not enough and further delay actions had to be put in place. This is particularly the case when RWY 28 was active.
- The systemised procedures increased predictability for controllers, as a result it was easier for the controllers to check whether the traffic were on the standard trajectories as the tracks dispersion was generally very contained.
- The systemised procedures are believed to have a positive impact on the environmental sustainability. Containment of trajectories dispersion and improved flight profiles both have the potential for reducing fuel burn, noxious emissions and noise.

8.2 Recommendations

8.2.1 PMS Route structure and airspace configuration

Three recommendations relating to the Route structure and airspace configuration to further optimise PMS operations in the Dublin TMA were proposed:

- Increase the length of the sequencing legs for RWY 28 in order to increase the capacity;
- Lower the base of control on RWYs 10 and 16;
- Further evaluation of the DUNLO SID and INKUR non-jet SID for RWY 16 in future prototyping session required.

8.2.2 Controller roles and tasks

- Allocation of Flight Information Service (FIS) tasks to be addressed in future activities. Feedback from the RTS suggests that a separate FIS desk is necessary.
- Future prototyping sessions should investigate the feasibility of the sector controllers performing certain co-ordination tasks allocated to the traffic manager in the RTS.

8.2.3 Traffic manager role and tasks

- The traffic manager role is essential under PMS but needs further work, in particular with regards to task allocation. Future prototyping sessions to further develop and assess the traffic manager role, tasks and procedures are necessary. In particular, the allocation of the co-ordination tasks between the traffic manager and sector controllers' needs to be further investigated in future prototyping activities. Furthermore, the allocation of such tasks to the data assistant should be considered.

- The traffic manager has a good global picture of the traffic situation and is responsible for determining the strategic flow of traffic with the Dublin TMA. Therefore, the traffic manager is responsible for informing controllers of relevant events in non-adjacent sectors when, and if, such events have an impact on their tasks in any way.
- The traffic manager role would benefit from additional information and or support tools as well as defined ‘triggers’ or ‘rules of thumb’ to enable him /her to make appropriate and timely decisions relating to the management of traffic flow. More work needs to be done in future prototyping sessions to determine exactly what information and tools the traffic manager requires, as well as to identify specific and reliable ‘triggers’ or ‘rules of thumb’.

8.2.4 Procedures

- Procedures for holding aircraft need to be further developed, and to include a specific holding controller as in current day operations.
- Specific contingency procedures, namely sequencing leg runoffs, ‘go-arounds’, runway closure, need to be further refined in future prototyping sessions.
- More than one contingency procedure for each type of event identified should be developed in future prototyping sessions to allow for flexibility. The number of procedures per event should be limited to a maximum of three to avoid confusion.
- Dublin airport operations need to be consulted in future activities to ensure spacing on final are suitable and feasible.

8.2.5 Operations room layout

- Consideration needs to be given to the seating arrangement and layout of the operations room to ensure that controller situation awareness, communication and team work is optimised with the TMA. A couple of requirements were already identified from the RTS are:
- Adjacent ‘inter-sector controllers’ (i.e. Upper & Lower and Initial Approach and Final Director) to be seated beside each other in operations room to ensure SA is maintained and to facilitate co-ordination and team-work
- The traffic manager requires his/her own CWP which should be positioned adjacent to the Approach sector to ensure and facilitate communication and collaborative working.

8.2.6 Training

- Adequate training is essential to ensure efficiency and safety levels are maintained and ideally optimised in the Dublin TMA. Therefore, all controllers must attend a complete and robust training programme prior to the implementation of PMS. Training must be delivered using qualified instructors. The PMS training programme must include training on PMS procedures under nominal condition, the contingency procedures for non-routine, unusual and non-nominal events, as well as the procedures for shift handover.
- Regular refresher training must be provided to ensure vectoring skills are maintained for current controllers is essential. Furthermore, new recruits must be trained to work the traffic using vectoring before they become operational, as vectoring will still be required for certain runway configurations and under certain non-nominal or non-routine situations.
- Given the importance of the traffic manager role a specific training programme needs to be developed to ensure all traffic managers are proficient and competent. Furthermore, it is recommended that the traffic manager role should be a rated position to ensure the traffic manager role is respected and a particular standard of performance has to be achieved before a controller can assume the role.

8.2.7 Shift handover

To ensure the outgoing controllers impart all the necessary information at the end of his / her shift to the incoming controller and / or to mitigate any negative affects of failure to impart the necessary information due to single person sectors, it is recommended that:

- Checklists are developed and used to ensure all the necessary information is conveyed at shift handover.
- All controllers are given training on the shift handover procedure.
- Lower and Upper controllers manning the same Area sectors and the APP & FI do not change shift at the same time. This will ensure that there is always someone working in the adjacent sector that has a good picture of the traffic situation and who can convey the required information to the controllers just starting his/her shift if necessary.
- Standardised working procedures / practices within the Dublin TMA so that all codes, markings & inputs used e.g. label markings have the same meaning to all controllers in all teams.

9. ACRONYMS AND ABBREVIATIONS

Abbreviations and Acronyms List	
ACC	Area Control Centre
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
AOR	Area of Responsibility
AP	Initial Approach
APW	Area Proximity Warning
ARN	ATS Route Network
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATS	Air Traffic Services
B-RNAV	Basic Area Navigation
CDA	Continuous Descent Approach
CDO	Continuous Descent Operations
CWP	Controlling Working Position
DATCC	Dublin Air Traffic Control Centre
EC	Executive Controller
ECAC	European Civil Aviation Conference Strategy (France)
EEC	EUROCONTROL Experimental Centre
EIDW	Dublin International Airport
EIME	Baldonnel Military Airport
EIWT	Weston Executive Airport
E-OCVM	European Operational Concept Validation Methodology
ESCAPE	EUROCONTROL Simulation Capabilities and Platform for Experimentation
ETA	Estimated Time of Arrival
EUROCONTROL	European Organisation for the Safety of Air Navigation
FDPS	Flight Data Processing System
FI	Final Director
FIR	Flight Information Region
FL	Flight Level
FMS	Flight Management System
HF	Human Factor
HITL	Human-In-The-Loop
HMI	Human Machine Interface
IAA	Irish Aviation Authority
IAC	Irish Air Corps
ILS	Instrument Landing System
ISA	Instantaneous Self-Assessment
KPA	Key Performance Area
LAN	Local Area Network
LATCC	London Air Traffic Control Centre
LN	Lower North
LP/LD	Low Power / Low Drag
LS	Lower South
MACC	Manchester Area Control Centre
MASPS	Minimum Aviation System Performance Standards
MATS	Manual of Air Traffic Services

Abbreviations and Acronyms List	
MUDPIE	Multiple User Data Processing Interactive Environment
NATS	National Air Traffic Services (United Kingdom)
P-RNAV	Precision Area Navigation
PC	Planner Controller
PMS	Point Merge System
PPO	Prior Permission Only
RDPS	Radar Data Processing System
RNAV	Area Navigation
RTS	Real Time Simulation
RVSM	Reduced Vertical Separation Minimum
RWY	Runway
SA	Situation Awareness
SAAM	System for Assignment and Analysis at a Macroscopic level
ScATCC	Scottish Air Traffic Control Centre
SID	Standard Instrument Departure Route(s)
SPO	Single Person Operations
STA	Scheduled Time of Arrival
STCA	Short-Term Conflict Alert
STAR	Standard Arrival Route(s)
TM	Traffic Manager
TMA	Terminal Manoeuvring Area
TR	Tower
TSA	Temporary Segregated Area
UIR	Upper (flight) Information Region
UN	Upper North
US	Upper South

10. REFERENCE DOCUMENTS

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ANNEXES

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ANNEX A AMAN

A.1 Objective

One of the secondary objectives of the Real Time Simulation was to gain initial feedback from the controllers regarding the usability and suitability of AMAN as a tool to support PMS operations in the Dublin TMA.

A.2 Method

The last six exercises of the simulation were dedicated to investigate the utility, usability and suitability of AMAN as a potential tool to support PMS operations in the Dublin TMA. During these six exercises only subjective data was obtained i.e. no system performance data was collected. Although it was envisaged that the AMAN would be used mainly by the Traffic Manager all the Area sector CWPs were equipped with an AMAN to investigate whether the Area controllers would gain any benefit from AMAN.

Four of seven the Area rated controllers assumed the role of the Traffic Manager in the six AMAN exercises, and as previously controllers were rotated around the various positions in the Dublin TMA.

Controllers were observed during the exercises. In addition, feedback from the Traffic Managers was gained using a post exercise questionnaire based on SATI, a generic EUROCONTROL SHAPE questionnaire that had been developed specifically to assess the controller trust in new automation and tools, which includes questions relating to utility, reliability, accuracy and timeliness of information etc.. The observations and feedback from the post exercise questionnaires were then used as an input for discussion in the group debriefing held at the end of the six AMAN exercises.

A.3 Controller Feedback

A.3.1 AMAN and the Traffic Manager role

Initial feedback regarding AMAN indicated that controllers that assumed the role of Traffic Manager during the six AMAN exercises all felt that the AMAN was useful for the Traffic Manager role. The controllers all agreed that although the AMAN did not change the decisions made by the Traffic Managers with regards to delay tactics, e.g. opening holds, reducing final separations from 5NM to 3NM it did help to ‘flag up’ potential traffic situations earlier and so in turn help the Traffic Managers to make decisions relating to traffic flow management earlier.

The controllers all mentioned that they used AMAN to make tactical flow decisions to regulate the traffic flow when the traffic demands were relatively high. When traffic demands were low no such decisions were necessary so AMAN was not used. Further more, there were times when the Traffic Manager became too busy and did not have the time to use AMAN, such as under non-nominal conditions.

Some initial recommendations were made by the controllers regarding the AMAN HMI and functionality, see below list. However, it should be noted that all controllers stated that they needed more experience working in the role of Traffic Manager and more experience working with AMAN to make more informed recommendations and better define AMAN requirements to support PMS operations.

- AMAN should have the facility to adjust the separation in accordance with what is being used , for example in the AMAN exercises the AMAN did not update accurately when using 3NM on Final Approach as it could only use 5NM;
- The AMAN HMI needs to be more intuitive. All controllers complained that when using the information displayed on the AMAN they had to interpret too much of the displayed data and that takes time, and hence made it more difficult to use;
- One suggestion was for there to be an indication on the HMI to inform the Traffic Manager when an aircraft needs to hold;

- The contrast between background and text on the AMAN HMI needs to be increased as it was difficult at times to see information displayed;
- The AMAN should display distance to flight leg as well as the time;
- There should be the facility to input projected routings and easily see the impact on time to sequencing leg etc. (apparently the AMAN in Dublin has this functionality);
- One suggestion to ensure continuity between screens was that when an aircraft on the radar is highlighted it should also be highlighted on AMAN;
- All controllers agreed that as well as further developing the AMAN to support PMS operations more rules of thumb need to be developed to help the controller make the most appropriate and timely decisions regarding flow control tactics.

A.3.2: AMAN and the sector controllers

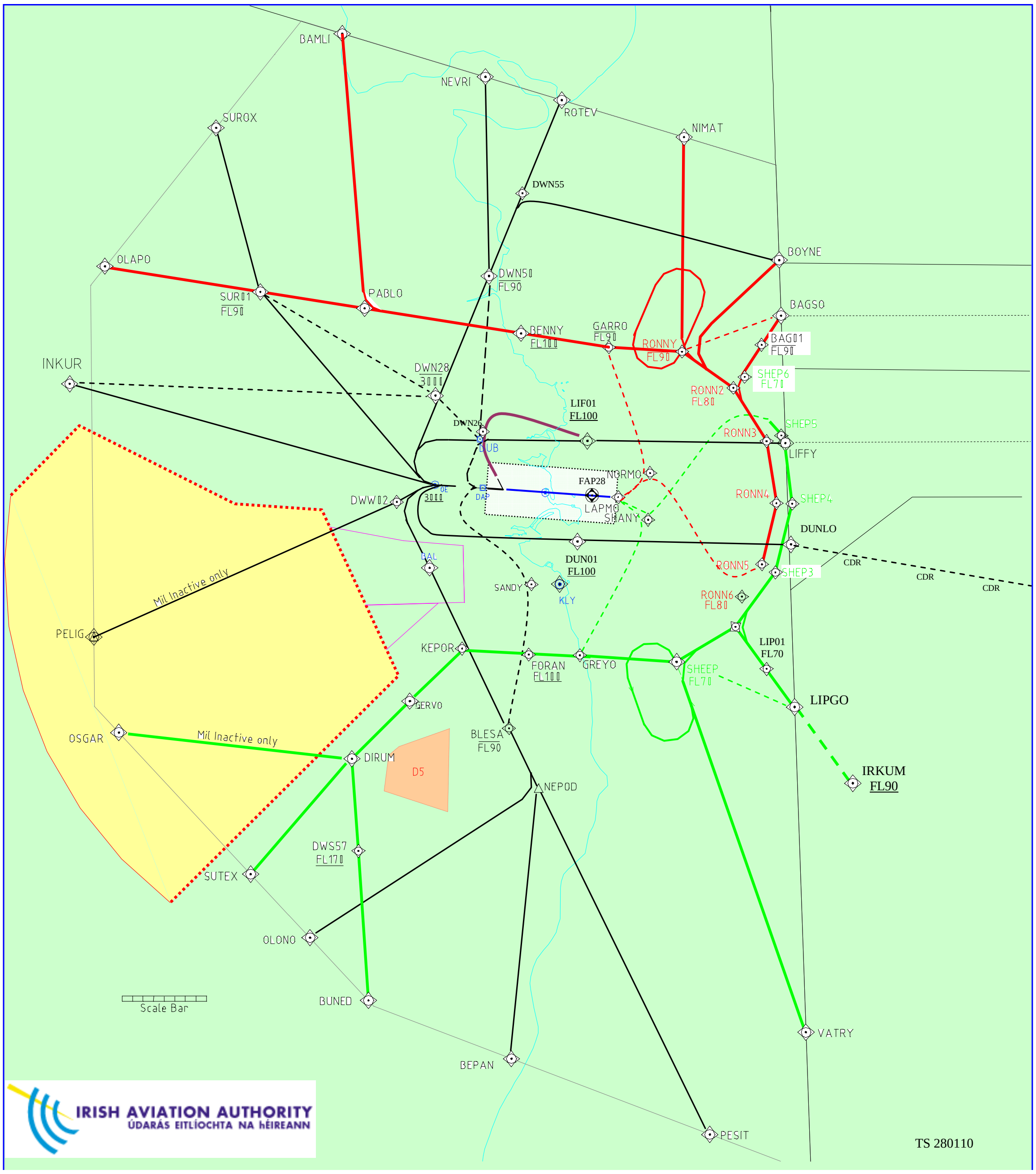
Overall controllers felt that AMAN should not be used by the Area or Approach sector controllers. The Area controllers that used AMAN said that although it gave them a larger range and helped them to confirm the feasibility of certain tactical decisions such as taking shortcuts before consulting the Traffic Manager, it should not and would not be used to make control decisions. It was also commented that when they were busy, they disregarded AMAN.

Furthermore, all the controllers commented that the AMAN HMI was not intuitive and that you could not quickly extract the required information but you had to translate the information displayed on the AMAN HMI. As this takes time and takes the controllers attention away from the radar screen, it was considered to be a potential safety issue.

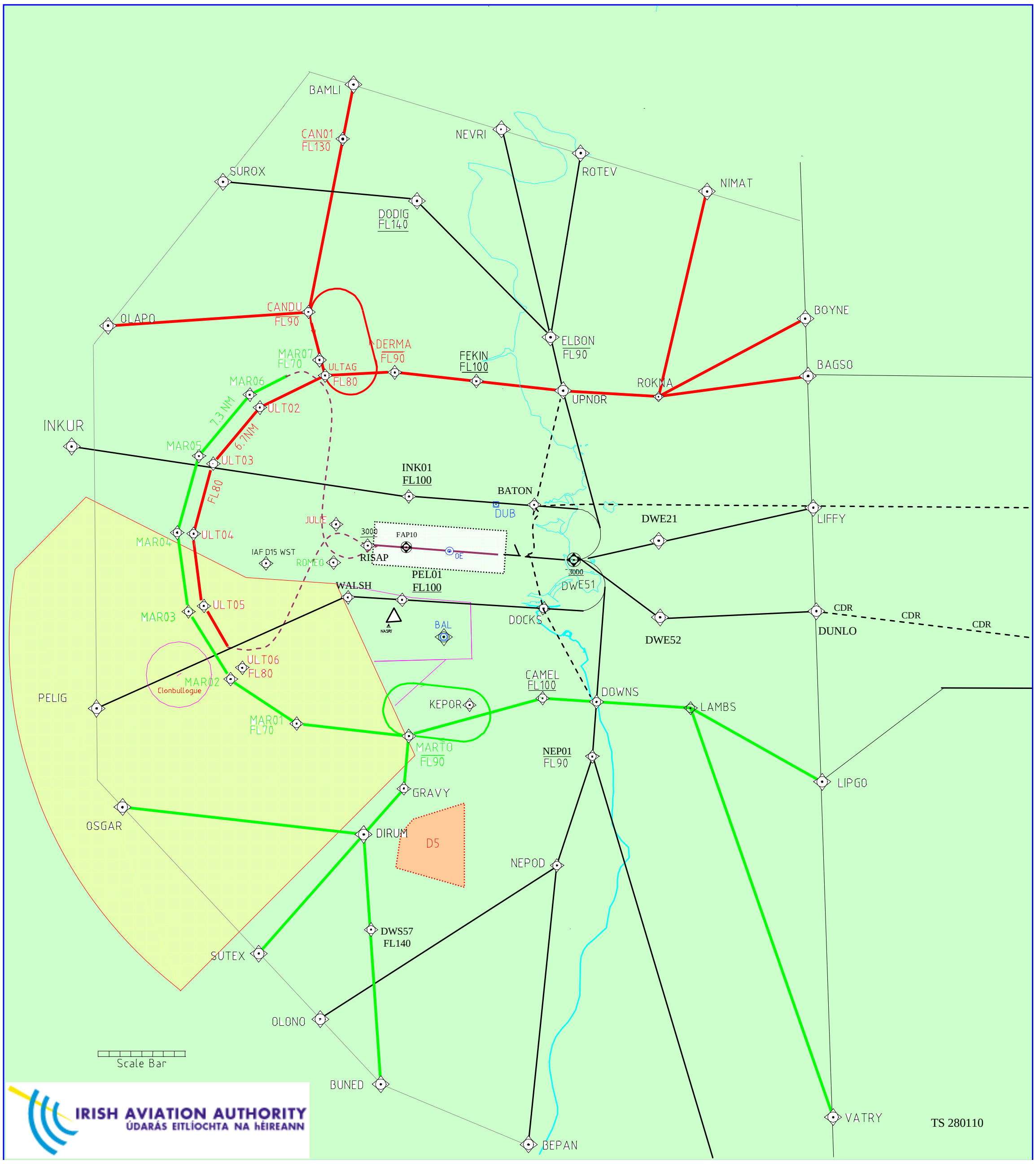
None of the Approach controllers used the information displayed on AMAN during any of the six exercises.

ANNEX B AIRSPACE MAPS

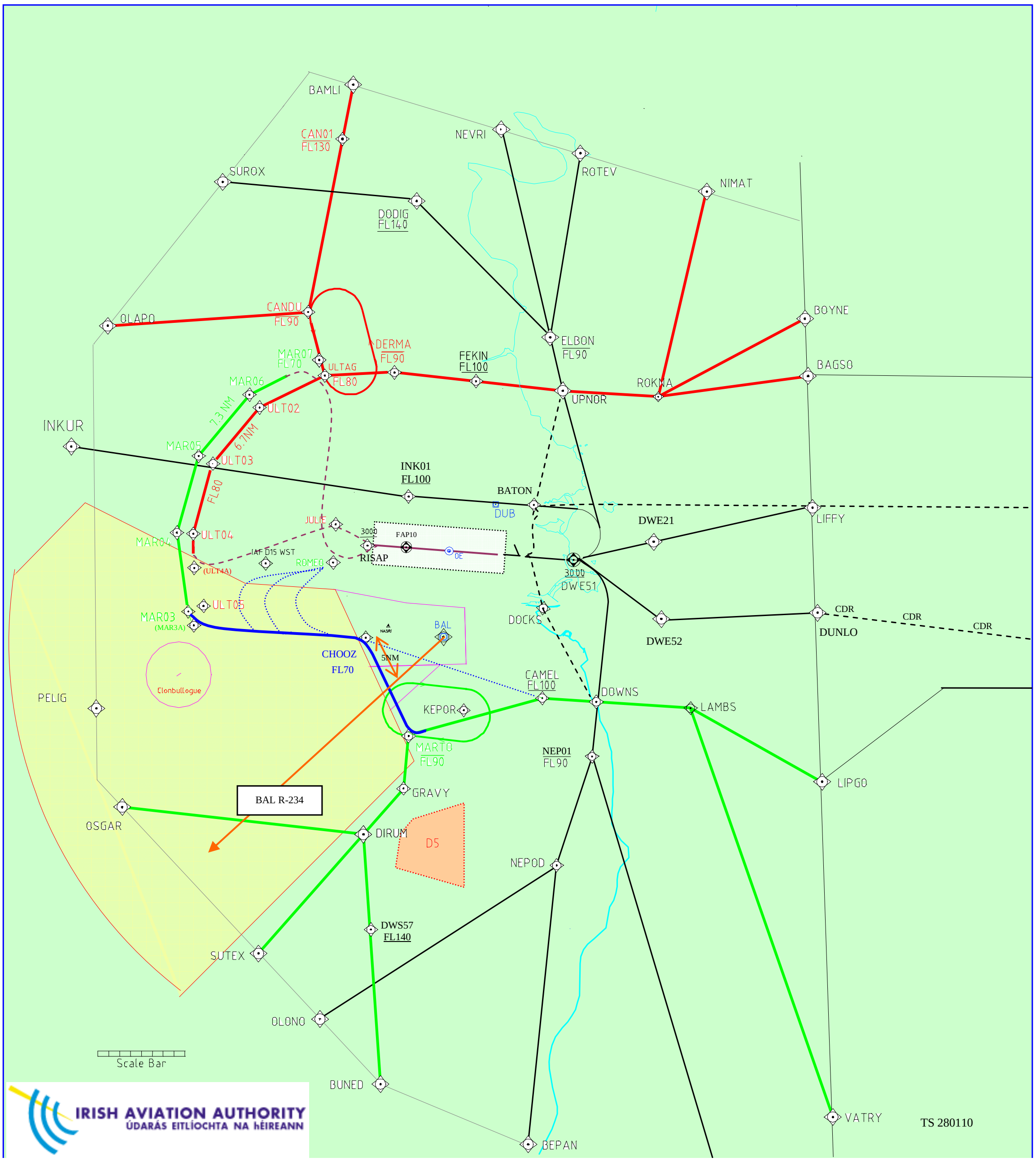
B.1 EIDW RWY 28 Arrivals (Point Merge) and Departures



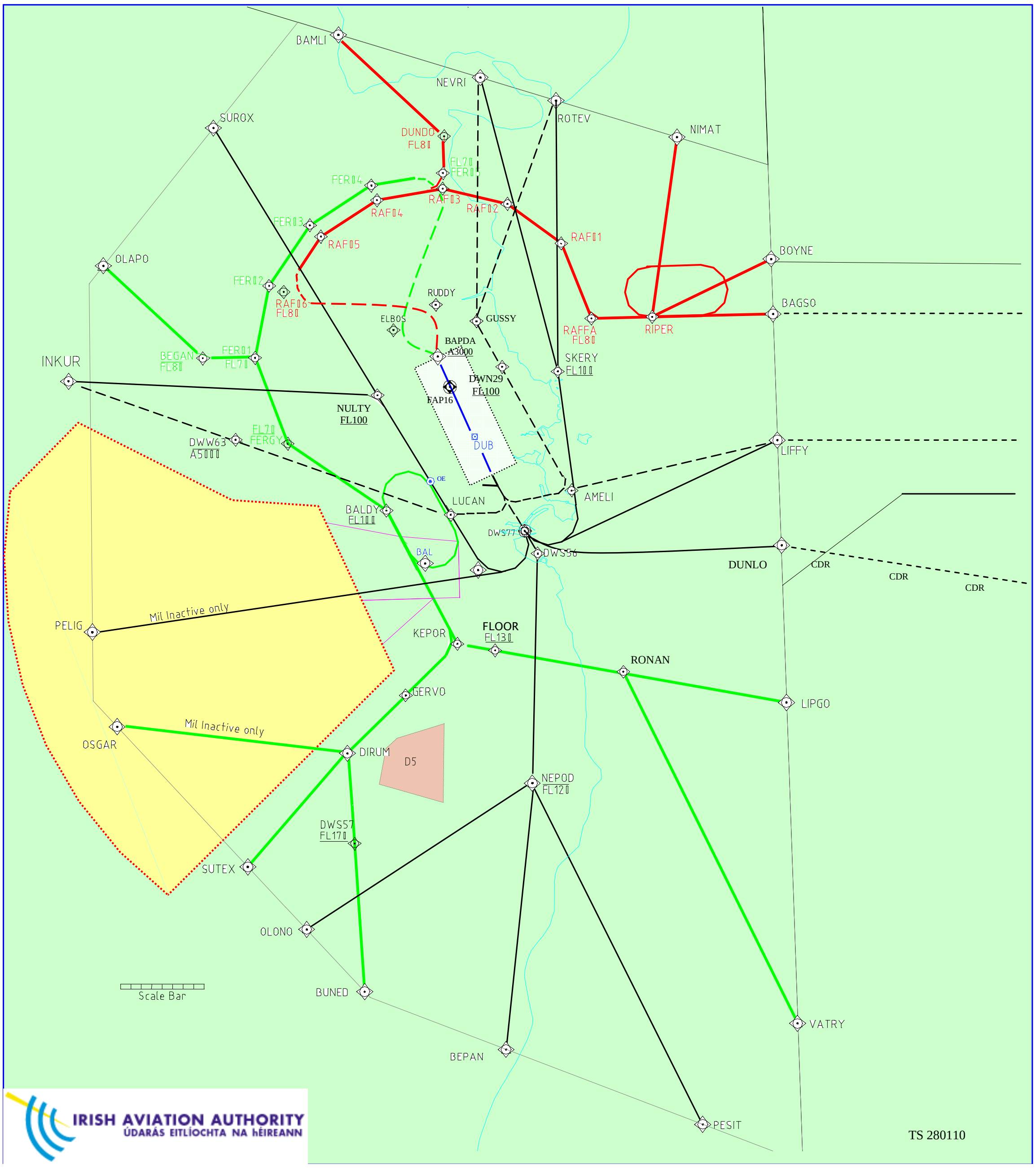
B.2 EIDW RWY 10 Arrivals (Point Merge) and Departures (military not active)



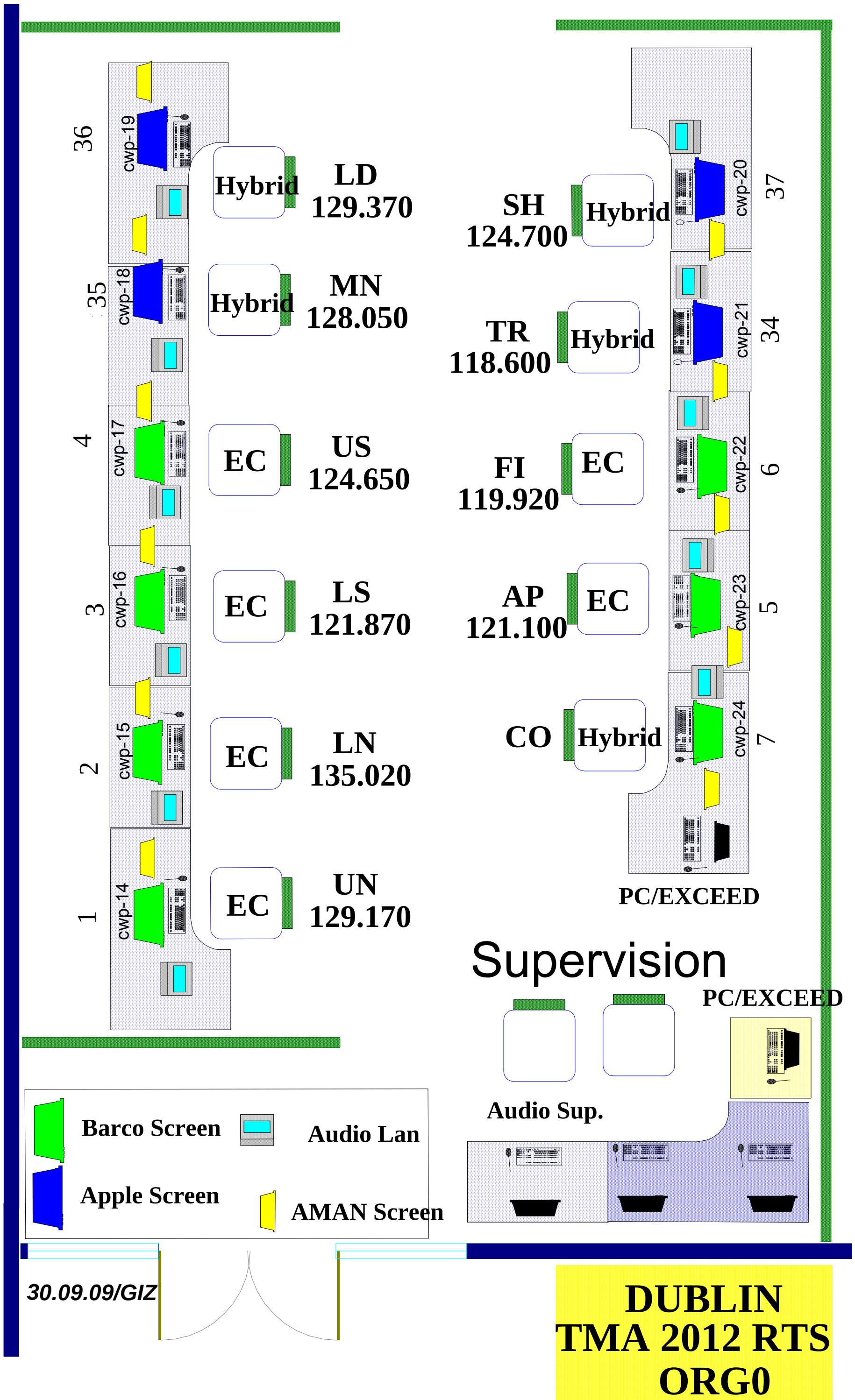
B.3 EIDW RWY 10 Arrivals (Point Merge) and Departures (military active)



B.4 EIDW RWY 16 Arrivals (Point Merge) and Departures



ANNEX C SIMULATION ROOM LAYOUT



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ANNEX D QUESTIONNAIRES

D.1 Post-exercise Questionnaire

Purpose of this questionnaire

The purpose of this questionnaire is to collect information both about the working methods and your perception of your workload, situation awareness and other factors that could affect, in a positive or negative way, your overall performance in the last exercise you performed. Please note all information collected in this questionnaire will remain **anonymous.**

Method to fill it

Please complete this questionnaire by putting a cross in the box ☐ that corresponds to your answer for the exercise run that you have just completed. If you make a mistake, please fill the box in completely and put a cross in the correct box. (This is an example of a crossed box ☒ and this is an example of a filled-in box ■).

If you need help, please, ask the analysis team representatives (Marie, Stefano or Cath).

Date:	ATCO ID:	Sector:	Run no:

Thank you very much for your co-operation and contribution!

Working Methods

1. How easy/difficult was it to apply procedures in the last run?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
2. What was the level of coordination with the upstream sector in the last run?	☐ Very low	☐ Low	☐ Medium	☐ High	☐ Very high
3. How easy/difficult was it to coordinate with the upstream sector in the last run?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
4. What was the level of coordination with the downstream sector in the last run?	☐ Very low	☐ Low	☐ Medium	☐ High	☐ Very high
5. How easy/difficult was it for you to coordinate with the downstream sector in the last run?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
6. What was the level of coordination with the traffic manager in the last run?	☐ Very low	☐ Low	☐ Medium	☐ High	☐ Very high
7. How easy / difficult was it to coordinate with the traffic manager in the last run?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
8. How easy/difficult was it for you to sequence the traffic and/or monitor the sequence order and aircraft spacing during the last run?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
9. How easy/difficult was it for you to maintain standard separations between aircraft during the last run?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
10. How easy / difficult was it for you to react to and deal with non-nominal or unplanned events in the last run? (*if applicable*)	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
11. As executive controller in a single sector how easy/difficult did you find it to detect conflicts?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult
12. As executive controller in a single sector how easy/difficult was it for you to plan the resolution of conflicts?	☐ Very easy	☐ Easy	☐ Medium	☐ Difficult	☐ Very difficult

Please provide any further comments regarding **Working Methods** in the box below:

Situation Awareness

	0	1	2	3	4	5	6
13. Did you have the feeling that you were ahead of the traffic, able to predict the evolution of the traffic?	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
14. Did you have the feeling that you were able to plan and organize your work as you wanted?	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
15. Have you been surprised by an event that you were not expecting (like an aircraft call)?	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
16. Did you have the feeling of starting to focus too much on a single problem and/or area of the sector?	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
17. Did you forget something important (like transfer an aircraft on time or communicate a change to an adjacent sector)?	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
18. Did you have any difficulty in finding an item of information?	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always

19. Compared to your current day situation, how do you think PMS and the new working methods affected your situation awareness?	☐ Significantly decreased	☐ Decreased	☐ No change	☐ Increased	☐ Significantly increased

Please provide any further comments regarding **Situation Awareness** in the box below:

Workload

	0	1	2	3	4	5	6	7	8	9	10
20. What was your level of **Mental Demand** during the last run? How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex?	☐ Extremely low	☐	☐	☐	☐	☐ Medium	☐	☐	☐	☐	☐ Extremely high
21. What was your level of **Physical Demand** during the last run?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	Extremely low / Medium / Extremely high
22. What was your level of **Temporal Demand** during the last run? How much time pressure did you feel due to the rate or pace at which the task or task elements occurred? Was the pace slow and leisurely or rapid and frantic?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Extremely low / Medium / Extremely high
23. What was your level of **Performance** during the last run? How successful do you think you were in accomplishing the goals of the task? How satisfied were you with your performance in accomplishing these goals?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Extremely poor / Medium / Extremely good
24. What was your level of **Effort** during the last run? How hard did you have to work to accomplish your level of performance?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Extremely low / Medium / Extremely high
25. What was your level of **Frustration** during the last run? How insecure, discouraged, irritated, stressed, and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Extremely low / Medium / Extremely high

26. Compared to your current day situation, how do you think PMS and the new working methods affected your perceived workload?	☐ **Significantly decreased**	☐ Decreased	☐ **No change**	☐ Increased	☐ **Significantly increased**

Please provide any further comments regarding **Workload** in the box below:

Safety

27. Do you have any concerns regarding safety in the previous run? If so, please describe the situation(s) that occurred in the simulation or that might have occurred in the simulation or the real world. How was it detected and recovered? What factors contributed to that occurrence? What could have made it worse?

Non-nominal Situations *(if applicable)*

28. How suitable was the contingency/non-nominal procedure you tested during the run?	☐ Not at all suitable	☐	☐ Quite suitable	☐	☐ Perfectly suitable

If your answer was equal or less than "Quite suitable", in your opinion what needs to be improved?

Once again thank you for taking the time to complete the questionnaire!

D.2 Post-Exercise Questionnaire for Traffic Manager

Purpose of this questionnaire

The purpose of this questionnaire is to gather information on the role of the Traffic Manager in relation to PMS and the new working methods. Your feedback will be helpful in ensuring that the role, tasks and responsibilities are suitably defined for PMS. Please note all information collected in this questionnaire will remain **anonymous.**

Method to fill it

For some questions, you will have to put a cross in the box ☐ that corresponds to your answer for the exercise run that you have just completed. If you make a mistake, please fill the box in completely and put a cross in the correct box. (This is an example of a crossed box ☒ and this is an example of a filled-in box ■).

When answering the questions, please compare, as far as is possible, the new proposed working methods to your current day working methods.

If you need help, please, ask the analysis team representatives (Marie, Stefano or Cath).

Date:	ATCO ID:	Run no:

Thank you very much for your co-operation and contribution!

Situation Awareness

	☐ Strongly Disagree	☐ Disagree	☐ Neither agree or disagree	☐ Agree	☐ Strongly Agree
1. I was able to maintain an overall picture of the traffic situation in the Dublin TMA.	☐	☐	☐	☐	☐
Please explain your answer:					
2. I was ahead of the traffic, able to predict the evolution of the traffic.	☐	☐	☐	☐	☐
Please explain your answer:					

Workload

	☐ Strongly Disagree	☐ Disagree	☐ Neither agree or disagree	☐ Agree	☐ Strongly Agree
3. My overall workload remained at a manageable level.	☐	☐	☐	☐	☐

Please explain your answer:

4. The workload involved in dealing with non-nominal situations remained at a manageable level.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**
Please explain your answer:					

Working Methods

5. I was able to coordinate efficiently and effectively with adjacent centres.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**
Please explain your answer:					
6. I was able to coordinate efficiently and effectively with the Upper sector controllers in the Dublin TMA.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**
Please explain your answer:					

7. I was able to coordinate efficiently and effectively with the Lower sector controllers in the Dublin TMA.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**

Please explain your answer:

8. I was able to coordinate efficiently and effectively with the Approach and Final Director controllers in the Dublin TMA.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**

Please explain your answers:

Tasks and Responsibilities

9. In my opinion, the roles and responsibilities defined for the traffic manager are clearly defined.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**

Please explain your answer:

10. In my opinion, the tasks and responsibilities defined for the traffic manager are workable for Dublin TMA.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**

Please explain your answer:

11. I felt I was able to fully support the controllers in their tasks.	☐ **Strongly Disagree**	☐ Disagree	☐ **Neither agree or disagree**	☐ Agree	☐ **Strongly Agree**

Please explain your answer:

12. I was able to develop the appropriate strategy without any difficulty to manage the traffic into and out of Dublin TMA particularly to:	**Strongly Disagree**	Disagree	**Neither agree or disagree**	Agree	**Strongly Agree**
(a) Decide/Approve the sequencing leg levels.	☐	☐	☐	☐	☐
(b) Decide when holding is to be initiated.	☐	☐	☐	☐	☐
(c) Ensure the minimum aircraft-to-aircraft spacing is used on final approach.	☐	☐	☐	☐	☐
(d) Coordinate Baldonnel and Weston arrivals.	☐	☐	☐	☐	☐

Please explain your answer:

13. I was able to ensure the implementation of the appropriate strategy without any difficulty to manage the traffic into and out of Dublin TMA particularly to:	**Strongly Disagree**	Disagree	**Neither agree or disagree**	Agree	**Strongly Agree**
(a) Decide/Approve the sequencing leg levels.	☐	☐	☐	☐	☐
(b) Decide when holding is to be initiated.	☐	☐	☐	☐	☐
(c) Ensure the minimum aircraft-to-aircraft spacing is used on final approach.	☐	☐	☐	☐	☐
(d) Coordinate Baldonnel and Weston arrivals.	☐	☐	☐	☐	☐

Please explain your answer:

Once again thank you for taking the time to complete the questionnaire!

D.3 AMAN Post-exercise Questionnaire

Purpose of this questionnaire

The purpose of this questionnaire is to collect information about the usefulness of AMAN. Please note all information collected in this questionnaire will remain **anonymous.**

Method to fill it

Please complete this questionnaire by putting a cross in the box ☐ that corresponds to your answer for the exercise run that you have just completed. If you make a mistake, please fill the box in completely and put a cross in the correct box. (This is an example of a crossed box ☒ and this is an example of a filled-in box ■).

If you need help, please, ask the analysis team representatives (Marie, Stefano or Cath).

Date:	**ATCO ID:**	**Sector:**	**Run no:**

Thank you very much for your co-operation and contribution!

In the previous working period, I felt that…

14. … the AMAN was useful	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
15. …the information provided by AMAN was reliable	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
16. …the information presented on AMAN was accurate and timely	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
17. …the information presented on the AMAN was understandable	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
18. …the AMAN worked robustly (in difficult situations, with invalid inputs, etc)	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always

19. …I was comfortable and confident using the AMAN	☐	☐	☐	☐	☐	☐	☐

	Never	Seldom	Sometimes	Often	More often	Very often	Always
20. …I was able to incorporate the information provided by AMAN into my control actions	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always
21. …AMAN enabled me to better anticipate traffic	☐ Never	☐ Seldom	☐ Sometimes	☐ Often	☐ More often	☐ Very often	☐ Always

22. …I would like more / different information from AMAN	☐ Yes	☐ No	☐ Don't know

If you answered 'yes' to question 9 elaborate your answer here:

Please provide any further comments you may have in the box below:

Once again thank you for taking the time to complete the questionnaire!

D.4 Post-Simulation Questionnaire

Purpose of this questionnaire

The purpose of this questionnaire is to collect information about your working experience and your perception of the: Point Merge (PM) method; Continuous Descent Approach (CDA); the new manning configuration (i.e. Single Person Operations (SPO)) and sector configuration; and the respective working methods **compared to, as far as possible, your current working methods in the real world**. Please note all information collected in this questionnaire will remain anonymous.

Method to fill it

For some questions, you will have to put a cross in the box ☐ that corresponds to your answer for the exercise run that you have just completed. If you make a mistake, please fill the box in completely and put a cross in the correct box. (This is an example of a crossed box ☒ and this is an example of a filled-in box ■).

When answering the questions, please compare, as far as is possible, the new proposed working methods to your current day working methods.

If you need help, please, ask the analysis team representatives (Marie, Stefano or Cath).

Controller ID:

Thank you very much for your co-operation and contribution!

Point Merge (PM)

To what extent do you agree with the following statements? As far as is possible, please compare to current working methods.

Acceptability	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable

Acceptability	**Strongly disagree**	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**	**Not applicable**
1. The TMA 2012 is easier to apply than current working method.	❑	❑	❑	❑	❑	❑
2. Handling arrivals using PMS is easier to apply than the current working method.	❑	❑	❑	❑	❑	❑
3. Reverting to radar vectoring when necessary was not an issue.	❑	❑	❑	❑	❑	❑
4. The PMS is more efficient for ATC than the current working method.	❑	❑	❑	❑	❑	❑
5. The controller working procedures of the Upper and Lower sector are clearly defined.	❑	❑	❑	❑	❑	❑
6. The controller working procedures of the Upper and Lower sector controllers are workable.	❑	❑	❑	❑	❑	❑
7. The controller working procedures of the Approach Controller are clearly defined.	❑	❑	❑	❑	❑	❑
8. The controller working procedures of the Approach controller are workable	❑	❑	❑	❑	❑	❑
9. The controller working procedures of the Final Director are clearly defined.	❑	❑	❑	❑	❑	❑
10. The controller working procedures of the Final Director are workable.	❑	❑	❑	❑	❑	❑
11. The controller working procedures of the Traffic manager are clearly defined.	❑	❑	❑	❑	❑	❑
12. The controller working procedures of the Traffic manager are workable.	❑	❑	❑	❑	❑	❑
13. The go-around procedures designed PMS are suitable.	❑	❑	❑	❑	❑	❑
14. The holding procedures designed for PMS are suitable.	❑	❑	❑	❑	❑	❑
15. The runway closure procedures designed for PMS are suitable.	❑	❑	❑	❑	❑	❑
16. The run-off sequencing leg procedures designed for PMS are suitable.	❑	❑	❑	❑	❑	❑

Workload	**Strongly disagree**	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**	**Not applicable**
17. The monitoring of the aircraft sequence requires less effort with the PMS compared with the current working method.	❑	❑	❑	❑	❑	❑
18. The more systematic nature of PMS reduces co-ordination workload.	❑	❑	❑	❑	❑	❑
19. The impact of military airspace activation is more difficult with PMS than with current day military activation.	❑	❑	❑	❑	❑	❑

Feasibility	**Strongly disagree**	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**	**Not applicable**
20. The level of flexibility with PMS is acceptable concerning the optimization of	❑	❑	❑	❑	❑	❑

Feasibility	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
the sequence.						

Roles and Tasks	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
21. The task distribution between the Approach controller and the Final Director is appropriate.	❑	❑	❑	❑	❑	❑
22. The task distribution between the controllers in the Upper and Lower sectors is appropriate.	❑	❑	❑	❑	❑	❑

Predictability	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
23. The more systematic nature of PMS increases trajectory predictability.	❑	❑	❑	❑	❑	❑

Quality of Service	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
24. The PMS facilitates a consistent traffic delivery to the runway.	❑	❑	❑	❑	❑	❑

Job Satisfaction	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
25. Applying the PMS is less stimulating than radar vectoring the aircraft.	❑	❑	❑	❑	❑	❑

Safety	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
26. With PMS, safety is at least maintained.	❑	❑	❑	❑	❑	❑
27. With PMS, safety is enhanced.	❑	❑	❑	❑	❑	❑
28. The PMS enables you to safely handle more traffic.	❑	❑	❑	❑	❑	❑

Situation Awareness (SA)	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
29. The transfer of responsibility for descent initiation to the pilot reduces overall SA.	❑	❑	❑	❑	❑	❑

30. If you wish so, please, elaborate any of your previous answers (use the question #):

New manning configuration and sector configuration

To what extent do you agree with the following statements? As far as is possible, please compare to current working methods.

Acceptability	**Strongly disagree**	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**	**Not applicable**
31. The new manning configuration is workable in Dublin Upper North and South sectors.	❑	❑	❑	❑	❑	❑
32. With the new manning configuration I felt I was able to handle all unusual events without any problems even under high	❑	❑	❑	❑	❑	❑

Acceptability	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
workload conditions.						

Safety	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
33. Handling critical events (i.e. level bust) is more difficult with the new manning configuration.	❑	❑	❑	❑	❑	❑
34. The new manning configuration enhances safety.	❑	❑	❑	❑	❑	❑
35. With the new manning configuration it is more difficult to monitor the traffic situation and identify critical events within the sector compared to the current manning configuration.	❑	❑	❑	❑	❑	❑

Situation Awareness (SA)	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
36. With the new manning configuration I felt I had less awareness of the traffic situation inside my sector compared to the current manning configuration.	❑	❑	❑	❑	❑	❑
37. With the new manning configuration I felt I had less awareness of the traffic situation outside my sector compared to the current manning configuration.	❑	❑	❑	❑	❑	❑

Roles, Tasks and Responsibilities	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Not applicable
38. Handling coordination with adjacent sectors within the Dublin TMA is more difficult with the new manning configuration than with the current manning configuration.	❑	❑	❑	❑	❑	❑
39. Handling coordination with adjacent centres is more difficult with the new manning configuration than with the current manning configuration.	❑	❑	❑	❑	❑	❑
40. The Traffic Manager helped me to co-ordinate efficiently and effectively with adjacent sectors and centres.	❑	❑	❑	❑	❑	❑
41. The role of the Traffic Manager was beneficial as he supported me in my tasks.	❑	❑	❑	❑	❑	❑
42. The procedures for holding were workable.	❑	❑	❑	❑	❑	❑

43. If you wish so, please, elaborate any of your previous answers (use the question #):

44. Do you have any additional comments/suggestions about the working methods in the different conditions?

Safety

45. Overall, compared to today, how would you rate the level of safety?	☐ **Very much degraded**	☐ Quite degraded	☐ **Same**	☐ Quite improved	☐ **Very much improved**

Please comments:

46. Do you think that unusual events like: ac picking up instruction for other ac (callsign confusion), non compliance with level, a heading/Direct To or speed clearance, can be detected and solved with the same efficiency as in the current configuration for?

Point Merge	❑ Yes	❑ No
New manning configuration?	❑ Yes	❑ No

47. If No, please explain why?

48. Do you have any other concerns regarding the safety of the Point Merge System?

❑ Yes ❑ No

49. If Yes, please describe them below. Any suggestion for possible mitigation is welcome.

50. Do you have any concerns regarding the safety of the new manning configuration?

❑ Yes ❑ No

51. If Yes, please describe them below. Any suggestion for possible mitigation is welcome.

and finally…….

	None	Few	Some	Many
52. Overall, how would you describe the foreseen benefits of TMA 2012 for the whole ATM system (ATCo, pilots, airlines…)?	☐	☐	☐	☐
		Minor	Major	
		☐	☐	
Please list 3 of them:				

1.

2.

3.

	None	Few	Some	Many
53. Overall, how would you describe the foreseen limitations of TMA 2012 for the whole ATM system (ATCo, pilots, airlines…)?	☐	☐	☐	☐
		Minor	Major	
		☐	☐	

Please list 3 of them:

1.

2.

3.

And for the very last time
Thank you very much for your feedback!

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ANNEX E VALIDATION OBJECTIVES VS MEASURES AND TOOLS

High Level Objective	Low Level Objectives	Detailed Objectives	Tools/Techniques	Measures
HUMAN FACTORS Aspects				
H1. Acceptability, feasibility	H1.1 - Assess the feasibility and controllers' acceptance of the new manning configuration	H1.1.1 - Assess whether new manning configuration is acceptable to controllers.	Post-sim questionnaire Debriefing Individual interview	Questionnaire ratings Controller feedback
		H1.1.2 - Assess whether new working arrangements / procedures are acceptable to controllers.	Post-sim questionnaire Debriefing Individual interview	Questionnaire ratings Controller feedback
	H1.2 - Assess the feasibility and controllers' acceptance of the Point Merge System (PMS)	H1.2.1 - Assess whether controllers accept the change to a more systemised way of working.	Post-sim questionnaire Individual interview	Questionnaire ratings Controller feedback
		H1.2.2 - Assess whether controllers' procedures developed for PMS are acceptable / workable.	Post-ex questionnaire Post-sim questionnaire Debriefing Individual interview System performance data	Questionnaire ratings Controller Feedback Repartition of manoeuvre instructions Density of manoeuvre instructions Flown trajectories
		H1.2.3 - Assess whether controllers' contingency procedures (i.e. procedures for unusual / non-nominal events) developed for PMS are acceptable / workable.	Post-exe questionnaire Post-sim Questionnaire Debriefing Individual interview System performance data	Questionnaire ratings Controller Feedback Repartition of manoeuvre instructions Density of manoeuvre instructions Flown trajectories
		H1.2.4 - Assess whether the more systematised way of working retains an	Post-sim questionnaire	Questionnaire ratings

High Level Objective	Low Level Objectives	Detailed Objectives	Tools/Techniques	Measures
		acceptable level of flexibility.		
		H1.2.5 - Assess whether controllers' procedures developed for PMS are acceptable / usable in case of military airspace activation.	Post-sim questionnaire Debriefings ISA System performance data	Questionnaire ratings Controller feedback ISA workload ratings Frequency occupancy Telephone usage Repartition of manoeuvre instructions APW
	H1.3 - Assess the proposed amendments to the procedures with the adjacent centres for effectiveness.	H1.3.1 - Assess acceptability of new working methods to adjacent ACCs.	Debriefing	Controller feedback from adjacent ACCs
H2. Roles and tasks	H2.1 - Assess the effect of the conditions on controllers' roles, responsibilities and task distribution	H2.1.1 - Assess whether roles and tasks of controllers are clearly defined.	Post-sim questionnaire	Questionnaire ratings
		H2.1.2 - Assess whether role and tasks of Traffic Manager are clear and unambiguous.	Post-ex questionnaire(TM) Individual interviews	Controller ratings Controller feedback
		H2.1.3 - Assess whether the assigned tasks distribution between controllers is appropriate.	Post-sim questionnaire System performance data	Controller feedback Repartition of manoeuvre instructions
		H2.1.4 - Assess whether the controllers find the new role of the Traffic Manager acceptable.	Post-sim questionnaire Debriefing Individual interview	Questionnaire ratings Controller feedback
		H2.1.5 - Assess whether Traffic Manager role is acceptable in terms of tasks and responsibilities.	Post-ex questionnaire(TM) Post-sim questionnaire Individual interviews	Questionnaire ratings

High Level Objective	Low Level Objectives	Detailed Objectives	Tools/Techniques	Measures
		H2.1.6 - Assess whether the Traffic Manager provides the required support / assistance to the controller with co-ordination.	Post-ex questionnaire Post-sim questionnaire Debriefing Individual interview	Questionnaire ratings Controller feedback
		H2.1.7 - Assess whether co-ordinator / Traffic manager role supports controllers / new working methods.	Post-ex questionnaire Post-sim questionnaire Debriefing Individual interview	Questionnaire ratings Controller feedback
H3. Workload	H3.1 - Assess the effect of the conditions on controller perceived workload.	H3.1.1 - Assess whether the introduction of PMS and new manning configurations is unacceptable in terms of controllers workload.	Post-ex questionnaire Post-sim questionnaire ISA	Questionnaire ratings NASA –TLX ratings ISA workload ratings
		H3.1.2 - Assess whether contingency procedures (i.e. procedures for unusual / non-nominal events) increase controllers workload to an unacceptable level.	Post- ex questionnaire Post-sim questionnaire ISA Debriefing	Questionnaire ratings Controller feedback ISA workload ratings
		H3.1.3 - Assess whether co-ordinating between sectors within Dublin TMA in addition to tactical control tasks is too demanding for a single controller.	Post –ex questionnaire Post-sim questionnaire Individual interview Debriefing	Questionnaire ratings Controller feedback
		H3.1.4 - Assess whether co-ordinating with adjacent ACCs in addition to tactical control tasks is too demanding.	Post- ex questionnaire Post-sim questionnaire Debriefing	Questionnaire ratings Controller feedback
		H3.1.5 - Assess whether under high workload conditions controller ability to handle unusual event is reduced as a result of PMS and	Post-ex questionnaire Post-sim questionnaire	Questionnaire ratings

High Level Objective	Low Level Objectives	Detailed Objectives	Tools/Techniques	Measures
		manning configuration.	Individual interview	
		H3.1.6 - Assess whether Traffic Manager role is acceptable in terms of workload.	Post-ex questionnaire Post-sim questionnaire Individual interview	Questionnaire ratings Controller feedback
	H3.2 - Assess the effect of the conditions on the task load (objective task demands).	H3.2.1 - Assess whether the task load balance between the Approach controller and the Final Director is acceptable.	Post-sim questionnaire System performance data	Questionnaire ratings Frequency occupancy Telephone usage Repartition of manoeuvre instructions
		H3.2.2 - Assess whether the task load balance between the Upper and Lower controllers is acceptable.	Post-sim questionnaire System performance data	Questionnaire ratings Frequency occupancy Telephone usage Repartition of manoeuvre instructions
H4. Situation awareness	H4.1 - Assess the effect of the conditions on controller perceived Situation Awareness (SA).	H4.1.1 - Assess whether new working arrangements / procedures have a negative impact on controller SA.	Post-ex questionnaire Post-sim questionnaire Individual interview	Questionnaire ratings (SASHA) Controller feedback
		H4.1.2 - Assess whether new manning configuration leads to inefficient monitoring and increases the possibility of missing critical events within the sector.	Post-sim questionnaire Introduction of intrusive event	Questionnaire ratings (SASHA) Controller identification of intrusive event (observation)
		H4.1.3 - Assess whether controllers SA in adjacent sectors is reduced.	Debriefing	Controller feedback
		H4.1.4 - Assess whether controller SA is reduced as a result of delegation of responsibility for a/c descent to pilot under CDA.	Post-sim questionnaire	Questionnaire ratings

High Level Objective	Low Level Objectives	Detailed Objectives	Tools/Techniques	Measures
		H4.1.5 - Assess whether the more systemised way of working with PMS has a negative effect on controller vigilance / SA.	Post-ex questionnaire Individual interview	Questionnaire ratings (SASHA)
PERFORMANCE Aspects				
P1. Safety	P1.1 - Assess the effect of the conditions on overall safety level.	P1.1.1 - Assess whether the new manning configuration is as safe as current operations	Post-ex questionnaire Post-sim questionnaire Debriefing Individual Interviews	Questionnaire ratings PEQ safety related questions PSQ safety related questions Controller feedback
		P1.1.2 - Assess whether PMS / new manning configuration is as safe as current operations.	Post-ex questionnaire Post-sim questionnaire Individual interviews	Questionnaire ratings PEQ safety related questions PSQ safety related questions Controller feedback
		P1.1.3 - Assess whether PMS / new manning configuration is as safe as current operations when a non-nominal / unusual event occurs.	Post-ex questionnaire Post-sim questionnaire Debriefing Individual interviews	Questionnaire ratings PEQ safety related questions PSQ safety related questions Controller feedback
	P1.2 - Assess the effect of the conditions on human performance / errror.	P1.2.1 - Assess whether new working arrangements / procedures increase potential for human error.	Post-ex questionnaire Post-sim questionnaire Debriefing Observations	Questionnaire ratings (SAHSA) PEQ safety related questions PSQ safety related questions Controller feedback No. of human errors
		P1.2.2 - Assess whether new manning configuration increases potential for human error.	Post-ex questionnaire Post-sim questionnaire Debriefing Observations	Questionnaire ratings Safety related questions Controller feedback

High Level Objective	Low Level Objectives	Detailed Objectives	Tools/Techniques	Measures
		P1.2.3 - Assess whether the contingency procedures (i.e. procedures for unusual / non-nominal events) increase potential for human error.	Post-ex questionnaire Post-sim questionnaire Debriefing Observations	Questionnaire ratings PEQ safety related questions PSQ safety related questions Controller feedback
		P1.2.4 - Assess whether the controllers are able to provide safe separation between arrivals.	Post-ex questionnaire Post-sim questionnaire System performance data	Questionnaire ratings No. of losses of separation STCA
		P1.2.5 - Assess whether the controllers are able to provide safe separation between arrivals and departures.	System performance data	No. of losses of separation STCA
		P1.2.6 - Assess impact of new working arrangements / procedures on conflict resolution.	Post-ex questionnaire	Questionnaire ratings
P2. Capacity	P2.1 - Assess the effect of the conditions on the task load (objective task demands).		System performance data	Frequency occupancy Telephone usage Repartition of manoeuvre instructions
	P2.2 - Assess the effect of the conditions on runway capacity.		System performance data	Throughput at FAF Runway Throughput
P3. Efficiency	P3.1 - Investigate the effect of the conditions on overall flight efficiency (lateral navigation mode and optimised vertical profiles).		System performance data	Distribution of instructions per a/c Use of LNAV mode No of a/c sent to hold Time spent in hold Vertical profiles Level off Flown trajectories

High Level Objective	Low Level Objectives	Detailed Objectives	Tools/Techniques	Measures
	P3.2 - Assess the effect of the conditions on ATC efficiency.	P3.2.1 - Assess whether the new working arrangements facilitate a consistent traffic delivery to the runway.	Post-sim questionnaire System performance data	Controller ratings Inter aircraft spacing
		P3.2.2 - Assess whether the new working arrangements allow for equity in handling arrivals and departures.	System performance data	Level off Flown trajectories
P4. Predictability	P4.1 - Assess the effect of the conditions on trajectory predictability for controllers.		Post-ex questionnaire System performance data	Controller ratings Use of LNAV mode Flown trajectories

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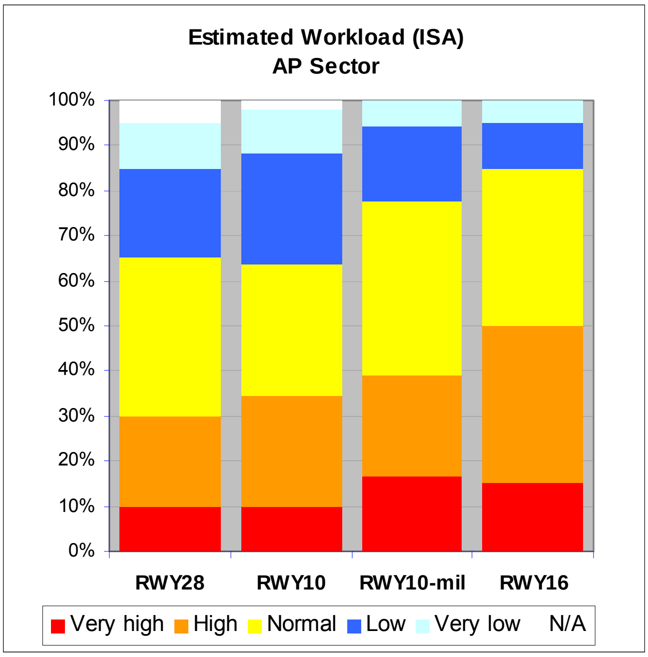
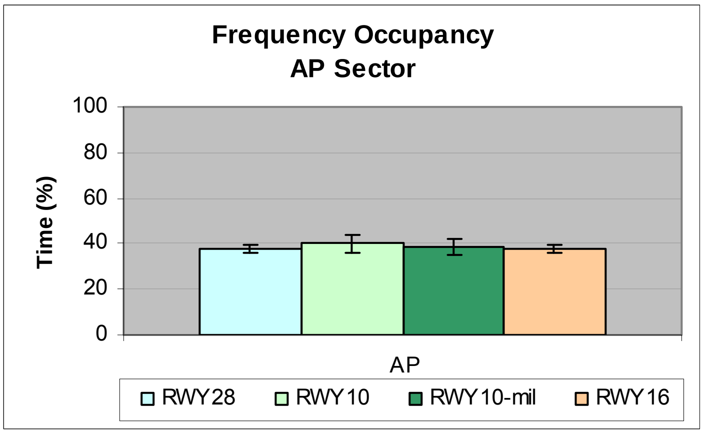
ANNEX F LIST OF METRICS

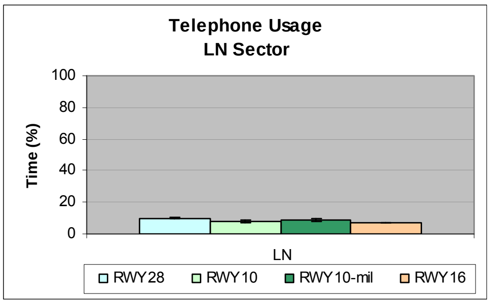
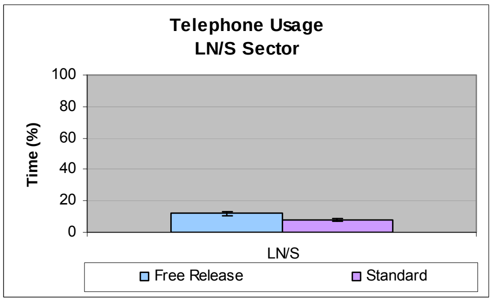
F.1 ISA Workload ratings

Objective	Provide indication on the controller perceived workload level (ISA ratings) in each Organisation.
Description	Shows the % of each level of perceived workload as rated by the controller during the runs.
Measured positions	All
Recorded data	ISA ratings (ISA box): 5 values (very high, high, normal, low, very low) + no answer.
Data sample	NA
Results, analysis	Pos/Run: % of each rating value Pos/Org[1,2,3]a and Org4: % of each rating value Lower/Org[x]a and Org[x]b: % of each rating value Significance test: comparison Release Lower/Org(5-6).
Format	• Graphics: Pos/Run The 6 measured sectors presented on the same graphic • Graphics: Pos/ Org[1,2,3]a and Org4 The 4 Orgs presented on the same graphic. One graphic per position. • Graphics: Org[x]a and Org[x]b The 2 Orgs presented on the same graphic. One graphic, lower north and south are grouped. Information displayed on the graphics as presented in the examples below (% of each rating). 

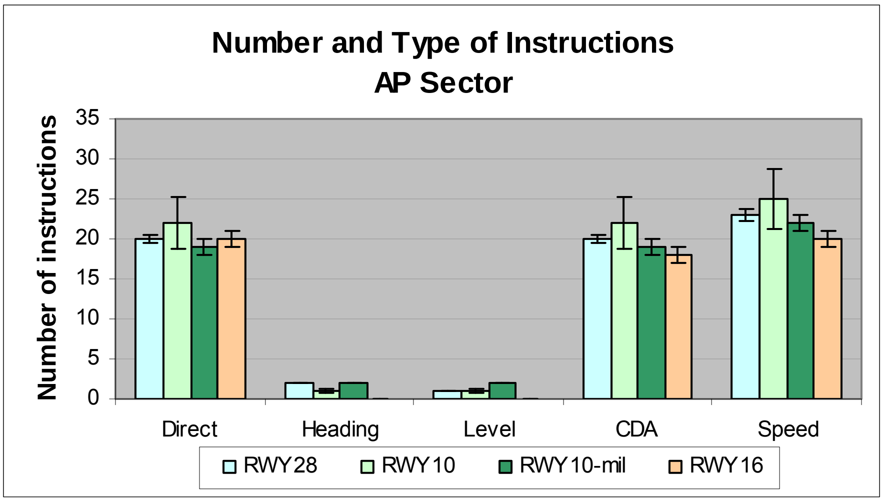
F.2 Frequency occupancy

Objective	Assess the controllers' communication load in terms of R/T usage. This provides an indication of controllers' workload considered as a capacity and safety indicator.
Description	Show the frequency load in terms of percentage use of R/T (incoming + outgoing communication), corresponding to the time spent on the frequency compared to the total analysis period.
Measured positions	All
Recorded data	All instructions given via R/T
Data sample	NA
Results, analysis	Pos/Run: % frequency occupancy Pos/ Org[1,2,3]a and Org4: mean % + standard deviation
Format	• Tables: all data (including total number and duration per sector) • Graphics: Pos/ Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic for each position. Each position on a separate graphic. Information displayed on the graphics as presented in the example below (SD representation). 

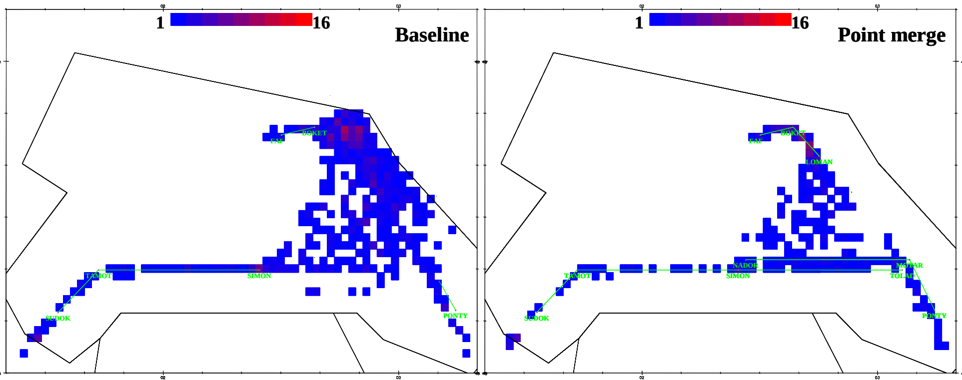
F.3 Telephone usage

Objective	Provide the telephone communications load of each sector for each organisation. Provide indication on the co-ordination task load between controllers.
Description	Shows the telephone usage, for each measured position in each organisation, expressed in percentage of the total time of analysis period. In addition: provides the total number and duration of messages.
Measured positions	All
Recorded data	All telephone communications
Data sample	NA
Results, analysis	Pos/Run: % telephone occupancy Pos/Org Org[1,2,3]a and Org4: mean % + standard deviation Lower/Org[x]a and Org[x]b: mean % + standard deviation Significance test: comparison Release Lower/Org[x]a and Org[x]b.
Format	• Tables: all data (including total number, duration, outgoing and incoming call sector per sector) • Graphics: Pos/Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic. One graphic per position. • Graphics: Lower/Org[x]a and Org[x]b The 2 Orgs presented on the same graphic. One graphic, lower north and south are grouped. Information displayed on the graphics as presented in the example below (SD representation).  

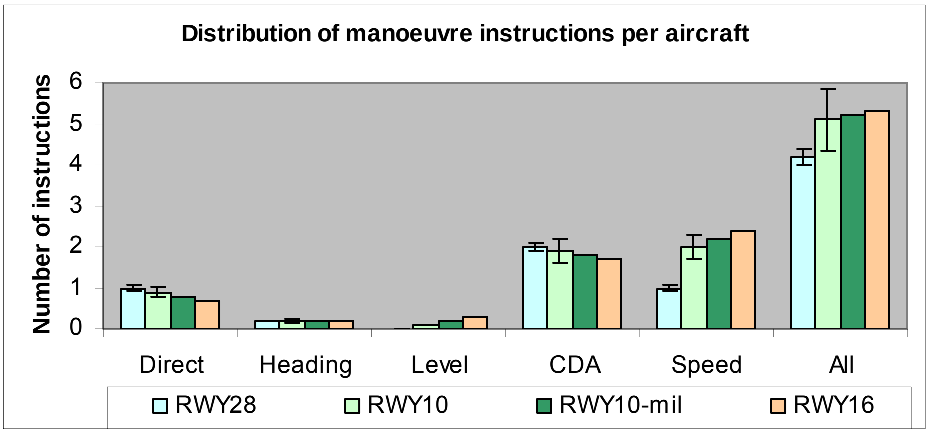
F.4 Repartition of manoeuvre instructions

Objective	Indicate the number and type of instructions and show impact of the organisations on the controllers' workload considered as a capacity and safety indicator, as well as on their working practices considered as an indicator of operability.
Description	Show the number and type of instructions issued by each sector in each organisation.
Measured positions	All
Recorded data	Direct, Heading, Level, CDA and Speed instructions.
Data sample	Data sample all1
Results, analysis	Pos/Run: total number of each instruction Pos/Org[1,2,3]a and Org4: mean + standard deviation (for each instruction)
Format	• Tables: all data. • Graphics:Pos/ Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic. Each position on a separate graphic. Instructions presented separately for each Org. Information displayed on the graphics as presented in the example below. 

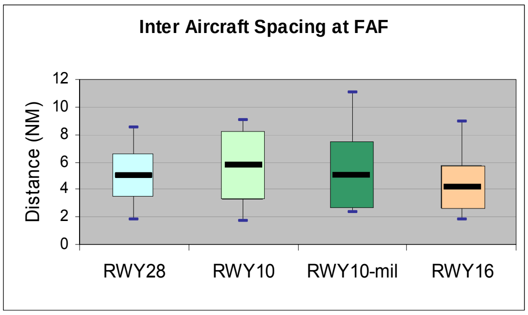
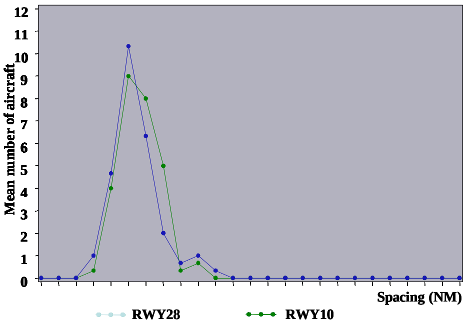
F.5 Density of manoeuvre instructions

Objective	Reflect a possible change in the location and density of instructions that have been issued to all aircraft, between organisations.
Description	Shows the number of instructions issued in each organisation, per square airspace unit (the size of the square is a **parameter**).
Measured positions	All
Recorded data	Direct, Heading, Level, CDA and Speed instructions.
Data sample	Data sample arr4
Results, analysis	Run: - all instructions - only Direct to Point Merge / ‘shortcut’ point Org[1,2,3]a and Org4: - all instructions - only Direct to Point Merge / ‘shortcut’ point
Format	• Tables: all data. • Graphics: Run. Separate graphic for each run. • Graphics: Org[1,2,3]a and Org4. Separate graphic for each of the 4 Orgs. Information displayed on the graphics as presented in the example below (example refers to a different simulation). Scale presenting the colour coding, function of number of instructions issued per square airspace unit. 

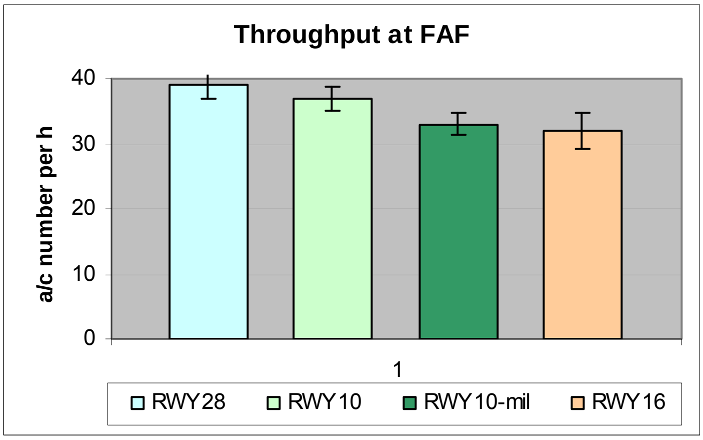
F.6 Distribution of manoeuvre instructions per aircraft

Objective	Provide an indication of quality of service from users' perspective. Also reflect a possible change in the number of instructions received by each aircraft, between organisations.
Description	Shows the number of each type of instruction received by each aircraft in each Organisation.
Measured positions	All
Recorded data	Direct, Heading, Level, CDA and Speed instructions.
Data sample	Data sample arr1 Data sample dep1
Results, analysis	Run: mean + standard deviation (for each instruction + for all instructions) Org[1,2,3]a and Org4: mean + standard deviation (for each instruction + for all instructions)
Format	• Tables: all data. • Graphics: Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic. Instructions presented separately for each Org + addition of "all instructions". Information displayed on the graphics as presented in the example below (SD). 

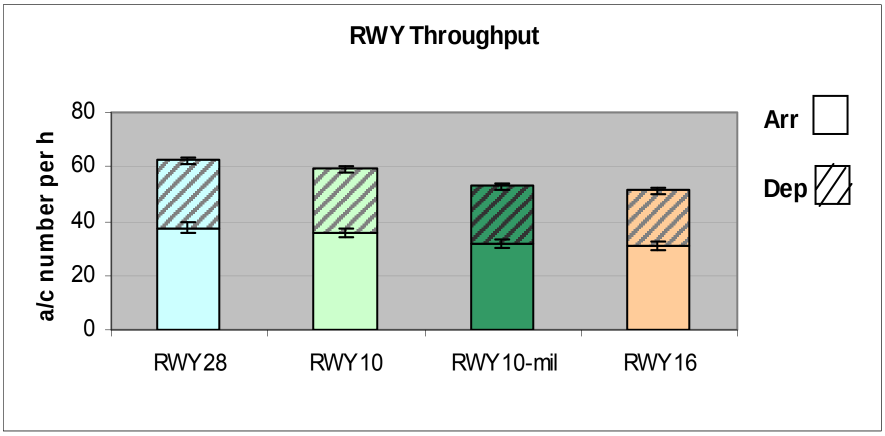
F.7 Inter aircraft spacing

Objective	Provide a measure of accuracy of spacing achieved over the FAF (and at the threshold), reflecting an optimisation of the runway throughput, and an indication of quality of service from users' perspective.
Description	Show the mean inter aircraft spacing in distance achieved over a reference point (FAF and threshold) in each experimental condition. Inter aircraft spacing in NM: distance between two aircraft in direct sequence, when the first aircraft reaches the FAF (and the threshold). In addition the achieved spacing should be normalised according to the aircraft turbulence category: for a Medium aircraft following a Heavy one, the achieved spacing should be multiplied by 0.75.
Measured positions	NA
Recorded data	Inter aircraft spacing in NM: distance between two aircraft in direct sequence, when the first aircraft reaches the FAF (and the threshold).
Data sample	Data sample arr2 Data sample arr3
Results, analysis	Run: mean + standard deviation + 95% + Min + Max values Org[1,2,3]a and Org4: mean + standard deviation + 95% + Min + Max values
Format	• Tables: all data • Graphics: Org[1,2,3]a and Org4. 1 graphic presenting the mean spacing, 1 graphic presenting the distribution of the spacing. The 4 Orgs presented on the same graphic. Information displayed on the graphics as presented in the examples below (SD representation, number of aircraft that have reached the FAF).  

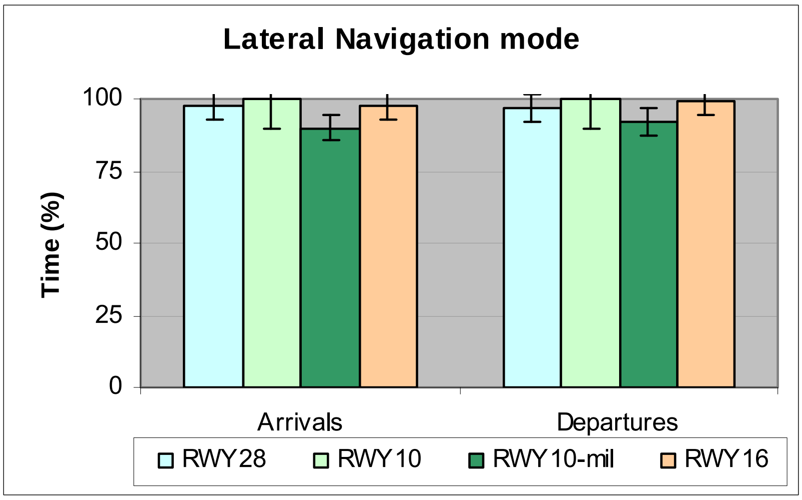
F.8 Throughput at the FAF

Objective	Provide an indication of throughput in each organisation and indicate a possible impact of the experimental conditions on the quality of service (and possibly on the capacity).
Description	Show the number of aircraft that fly over a reference point (FAF) per hour (as the analysis period is 45 minutes long, the actual observation needs to be normalised to 1 hour).
Measured positions	All
Recorded data	Time stamp of aircraft over the FAF.
Data sample	Data sample arr2 Data sample arr3
Results, analysis	Pos/Run: total number (normalised to 1 hour) Pos/Org[1,2,3]a and Org4: mean + standard deviation
Format	• Tables: all data • Graphics: Pos/Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic. Information displayed on the graphics as presented in the example below (SD representation). 

F.9 Runway Throughput

Objective	Provide an indication of throughput in each organisation and indicate a possible impact of the experimental conditions on the quality of service (and possibly on the capacity).
Description	Show the number of aircraft that land and takeoff at a given runway per hour (as the analysis period is 45 minutes long, the actual observation needs to be normalised to 1 hour).
Measured positions	All
Recorded data	Time stamp of aircraft.
Data sample	Data sample arr3 Data sample dep2
Results, analysis	Pos/Run: total number (normalised to 1 hour) Pos/Org[1,2,3]a and Org4: mean + standard deviation
Format	• Tables: all data • Graphics: Pos/Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic. Information displayed on the graphics as presented in the example below (SD representation). 

F.10 Use of lateral navigation mode

Objective	Quantify the use of the FMS lateral navigation mode (LNAV) in each Organisation.
Description	Shows the time spent in lateral navigation mode in each Organisation, expressed as a percentage of the total time of the analysis period (env. 60 minutes). The navigation mode is determined as follows: by default aircraft enter the measured airspace in LNAV. The LNAV mode is terminated if the aircraft receives a heading or a heading instruction. The LNAV mode is restarted: • if the aircraft receives a Direct to instruction. • on ILS intercept.
Measured positions	NA
Recorded data	Time spent in lateral navigation mode
Data sample	Data sample arr1 Data sample dep1
Results, analysis	Run: mean % + standard deviation Org[1,2,3]a and Org4: mean % + standard deviation
Format	• Tables: all data • Graphics: Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic. Arrivals and departures presented separately for each Org. Information displayed on the graphics as presented in the examples below (SD representation). 

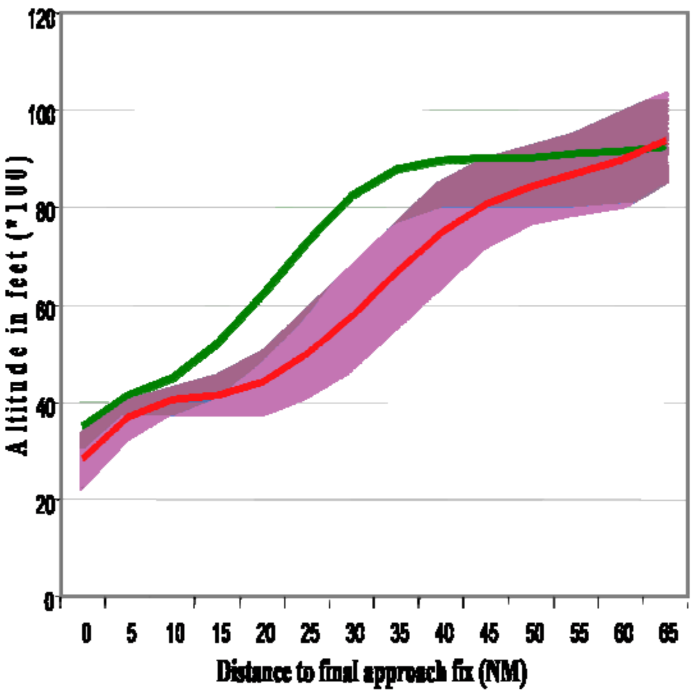
F.11 Number of aircraft sent to a hold

Objective	Provide the number of aircraft sent to a hold in each Organisation.
Description	As above.
Measured positions	NA
Recorded Data	Number of aircraft in a hold
Data sample	Data sample arr1
Results, analysis	Run: number of aircraft
Format	• Tables: all data.

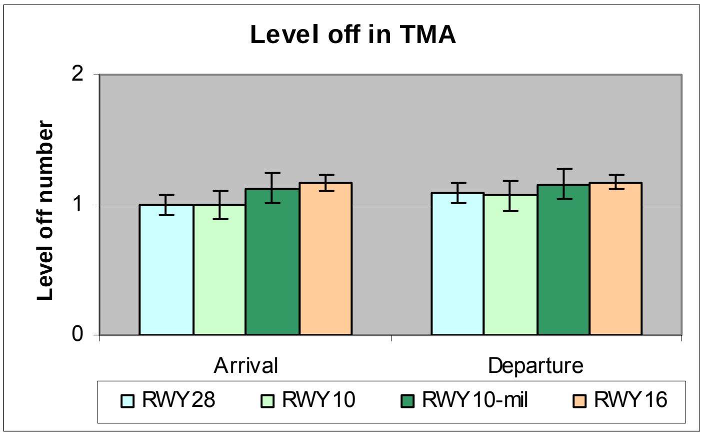
F.12 Time spent in hold

Objective	Provide the total time spent by aircraft in holds in each Organisation.
Description	As above.
Measured positions	NA
Recorded data	Holding time
Data sample	Data sample arr1
Results, analysis	Run: total time
Format	• Tables: all data.

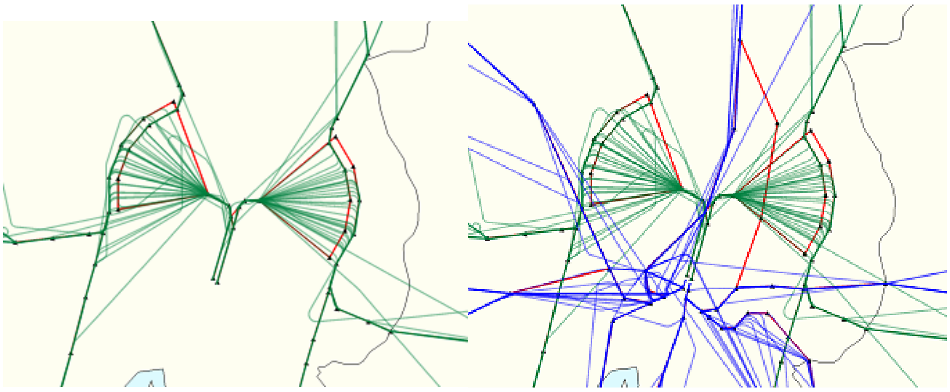
F.13 Vertical profiles

Objective	Provide the aircraft descent profile through the measured airspace in each organisation to indicate potential flight efficiency and environmental impact.
Description	For each run, the altitude in feet is displayed as a function of distance to FAF in NM. (Ideally, the distance to FAF should be calculated with the use of trajectories to exactly reflect the distance to go.
Measured positions	NA
Recorded data	Aircraft vertical profiles
Data sample	Data sample arr1.
Results, analysis	Run: mean vertical profile + SD Org[1,2,3]a and Org4: mean vertical profile + SD
Format	• Tables: all data. • Graphics: Run. The profiles on red and green legs on the same graphic. • Graphics: Org[1,2,3]a and Org4. Separate graphic for each of the 4 Orgs. The profiles on red and green legs on the same graphic. Information displayed on the graphics as presented in the example below. 

F.14 Level off

Objective	Provide an indication of flight efficiency in the TMA, as well as feasibility of the CDA (from TOD down to the FAF) and CCD from take off to en-route.
Description	Show the number of times an aircraft levels off in the approach and climb phase.
Measured positions	All
Recorded data	Aircraft vertical profiles Aircraft vertical profiles
Data sample	Data sample arr1 Data sample dep1
Results, analysis	Pos/Run: mean + standard deviation Pos/Org[1,2,3]a and Org4: mean + standard deviation
Format	• Tables: all data. • Graphics: Pos/Org[1,2,3]a and Org4. The 4 Orgs presented on the same graphic. Arrivals and departures presented separately for each Org. Information displayed on the graphics as presented in the example below (SD representation). 

F.15 Flown trajectories

Objective	Provide an indication of the containment of the trajectories dispersion.
Description	Provide the aircraft 2D trajectory representation through the measured airspace, with the route structure on background. 2D trajectories of arrival flows should be displayed on the same graph using 2 different colour codes to differentiate the flows on different sequencing legs (red and green legs).
Measured positions	NA
Recorded data	Aircraft trajectories through the measured sectors.
Data sample	Data sample arr1 Data sample dep1
Results, analysis	Run: all trajectories
Format	• Graphics: Run. 1 graphic presenting 2D trajectories of arrival flows. 1 graphic presenting 2D trajectories of arrival and departure flows. Investigate the possibility of using SAAM (see examples below) 

F.16 Number and severity of losses of separation

Objective	Provide indication on the number and severity of losses of separation.
Description	The loss of separation occurs if : • Vertical separation < 1000 ft • Horizontal separation : < 3 NM in TMA; < 5 NM outside TMA **<u>Severity</u>** The API (Aircraft Proximity Index) metric will be used as a measure of "safety". The API provides a measure of the severity of an incident. If • V_{sep} is the vertical separation minimum standard (in feet) • H_{sep} is the horizontal separation minimum standard (in nautical miles) • D_V is the actual vertical separation (in feet) of a pair of aircraft, and • D_H is the actual horizontal separation (in nautical miles) of the same pair of aircraft then if $D_V \leq V_{sep}$ and, simultaneously, if $D_H \leq H_{sep}$ then the value of the API, I_{API}, is given by $$I_{API} = \frac{(V_{sep} - D_V)^2 * (H_{sep} - D_H)^2 * 100}{(V_{sep}^2 * H_{sep}^2)}$$ The possible values that the API can have ranges from 0 if there is no loss of separation between the two aircraft concerned up to 100 if there is a collision between the two aircraft concerned. Three degrees of severity of an incident, namely minor, serious and very serious, can be defined in terms of the maximum value of the API during a loss of separation. These three degrees can be defined as follows: I_{API} — **Severity** $0 \leq I_{API} < 6.25$ — Minor $6.25 \leq I_{API} < 31.36$ — Serious $31.36 \leq I_{API}$ — Very Serious
Measured positions	NA
Recorded data	See Description above
Data sample	Data sample all1
Results, analysis	Run: number and severity (separate for TMA and outside TMA)
Format	• Tables: all data per run (for each loss: actual separation and calculated severity, concerned position, type of conflict)

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ANNEX G EXERCISE CARDS

<table>
<tr><td rowspan="7">Ex 1</td><td colspan="3">Code Name: 28PMM1(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: PM</td><td>Wind: 310° / 10 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 2</td><td colspan="3">Code Name: 28PMM1(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: PM</td><td>Wind: 310° / 10 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 3</td><td colspan="3">Code Name: 28AMM2(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: AM</td><td>Wind: 270° / 8 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures:
1. Free release of departing traffic on the jet SIDs.</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 4</td><td colspan="3">Code Name: 28AMM2(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: AM</td><td>Wind: 270° / 8 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C flying out on wrong PESIT SID (taking the non-jet SID with early turn).
Concerned Sector: Lower/Upper South (L/US).</td></tr>
<tr><td colspan="3">Procedures:
1. Free release of departing a/c on the jet SIDs.</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 5</td><td colspan="3">Code Name: 16PMM3(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY16</td><td>Traffic Sample: PM</td><td>Wind: 160° / 20 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Low performance a/c on INKUR/SUROX SID (not making the level at NULTY).
Concerned Sector: Lower South (LS) and Initial Approach (AP).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 6</td><td colspan="3">Code Name: 16PMM3(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY16</td><td>Traffic Sample: PM</td><td>Wind: 160° / 20 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 7</td><td colspan="3">Code Name: 16AMM4(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY16</td><td>Traffic Sample: AM</td><td>Wind: 180° / 20 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 8</td><td colspan="3">Code Name: 16AMM4(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY16</td><td>Traffic Sample: AM</td><td>Wind: 180° / 20 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C level bust on PESIT/BEPAN SID (scenario decided dynamically). Concerned Sector: Lower/Upper South (L/US).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 9</td><td colspan="3">Code Name: 10PMM5(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C flying out on wrong BEPAN/PESIT SID (taking a non-jet SID with early turn).
Concerned Sector: Lower/Upper South (L/US).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 10</td><td colspan="3">Code Name: 10PMM5(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="2">Ex 11</td><td>Code Name: 10AMS1(A)</td></tr>
<tr><td>Type: Scenario-based Exercise</td></tr>
</table>

<table>
<tr><td rowspan="5"></td><td>Runway in use: RWY10</td><td>Traffic Sample: AM</td><td>Wind: 080° / 15 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C level bust on ROTEV SID (scenario decided dynamically).
Concerned Sector: Lower/Upper North (L/UN).
2. Medical emergency for heart attack (while a/c on sequencing leg) – priority landing.
Concerned Sector: Initial Approach (AP).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 12</td><td colspan="3">Code Name: 10AMS1(B)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: AM</td><td>Wind: 080° / 15 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Early descent to point merge (a/c descend to 5000 immediately after turn to PM, whilst it was not cleared).
Concerned Sector: Initial Approach (AP) / Final Director (FI).
2. Severe weather on ROKNA-UPNOR (Ex time: from 09:10 to 09:20 – end of exercise).
Concerned Sector: Lower/Upper North (L/UN).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 13</td><td colspan="3">Code Name: 28PMS2(A)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: PM</td><td>Wind: 310° / 10 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Medical emergency for heart attack (while a/c on Upper frequency) – priority landing.
Concerned Sector: Upper/Lower North (U/LN) & Initial Approach (AP).
2. Early turn to merge point (two a/c turn simultaneously because of similar c/s).
Concerned Sector: Initial Approach (AP) / Final Director (FI).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 14</td><td colspan="3">Code Name: 28PMS2(B)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: PM</td><td>Wind: 310° / 10 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Go around procedure (one).
Concerned Sector: Initial Approach (AP) / Final Director (FI).
2. Low performance a/c on LIFFY SID (not making the level).
Concerned Sector: Lower North (UN) and Initial Approach (AP).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

Ex 15	Code Name: 10AMM6(A)

	Type: **Measured** Exercise		
	Runway in use: RWY10	Traffic Sample: AM	Wind: 080° / 15 kts
	Military Areas active: 1. R15 (to 3000ft) 2. R16/MOA4 (to FL150) 3. D5 (cross FL130 or above)		
	Non-nominal / SA events: -		
	Procedures: -		
	Notes: 1. NATS controllers man London (LD) and Manchester (MN) feeds.		

Ex 16	Code Name: 10AMM6(B)		
	Type: **Measured** Exercise		
	Runway in use: RWY10	Traffic Sample: AM	Wind: 080° / 15 kts
	Military Areas active: 1. R15 (to 3000ft) 2. R16/MOA4 (to FL150) 3. D5 (cross FL130 or above)		
	Non-nominal / SA events: -		
	Procedures: -		
	Notes: 1. NATS controllers man London (LD) and Manchester (MN) feeds.		

<table>
<tr><td rowspan="7">Ex 17</td><td colspan="3">Code Name: 10AMM7(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: AM</td><td>Wind: 080° / 15 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C level bust on ROTEV/SUROX SID (scenario decided dynamically). Concerned Sector: Lower/Upper North (L/UN).</td></tr>
<tr><td colspan="3">Procedures:
1. Free release of departing traffic on the jet SIDs.</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 18</td><td colspan="3">Code Name: 10AMM7(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: AM</td><td>Wind: 080° / 15 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures:
1. Free release of departing traffic on the jet SIDs.</td></tr>
<tr><td colspan="3">Notes:
1. NATS controllers man London (LD) and Manchester (MN) feeds.</td></tr>
</table>

<table>
<tr><td rowspan="2">Ex 19</td><td>Code Name: 28AMS3(A)</td></tr>
<tr><td>Type: Scenario-based Exercise</td></tr>
</table>

	Runway in use: RWY28	Traffic Sample: AM	Wind: 270° / 8 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)		
	Non-nominal / SA events: 1. Go around procedure (two). Concerned Sector: Initial Approach (AP) / Final Director (FI). 2. Sequencing leg run-off procedure. Concerned Sector: Initial Approach (AP) / Final Director (FI).		
	Procedures: -		
	Notes: -		

Ex 20	Code Name: 28AMS3(B)		
	Type: **Scenario-based** Exercise		
	Runway in use: RWY28	Traffic Sample: AM	Wind: 270° / 8 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr) 2. D5 (cross FL130 or above)		
	Non-nominal / SA events: 1. Medical emergency for heart attack (while a/c on sequencing leg) – priority landing. Concerned Sector: Initial Approach (AP). 2. A/C flying out on wrong PESIT SID (taking the non-jet SID with early turn). Concerned Sector: Lower/Upper South (L/US). 3. A/C level bust on sequencing leg entry (traffic to RONNY descending at FL70). Concerned Sector: Lower North (LN) and Initial Approach (AP).		
	Procedures: -		
	Notes: -		

<table>
<tr><td rowspan="7">Ex 21</td><td colspan="3">Code Name: 10PMM8(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C flying out on wrong BEPAN/PESIT SID (taking a non-jet SID with early turn).
Concerned Sector: Lower/Upper South (L/US).</td></tr>
<tr><td colspan="3">Procedures:
1. Free release of departing traffic on the jet SIDs.</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 22</td><td colspan="3">Code Name: 10PMM8(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures:
1. Free release of departing traffic on the jet SIDs.</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

Ex 23	Code Name: 10AMM9(A)		
	Type: **Measured** Exercise		
	Runway in use: RWY10	Traffic Sample: AM	Wind: 080° / 15 kts
	Military Areas active: 4. R15 (to 3000ft) 5. R16/MOA4 (to FL150) 1. D5 (cross FL130 or above)		
	Non-nominal / SA events: -		
	Procedures: 1. Free release of departing traffic on the jet SIDs.		
	Notes: -		

Ex 24	Code Name: 10AMM9(B)		
	Type: **Measured** Exercise		
	Runway in use: RWY10	Traffic Sample: AM	Wind: 080° / 15 kts
	Military Areas active: 6. R15 (to 3000ft) 7. R16/MOA4 (to FL150) 1. D5 (cross FL130 or above)		
	Non-nominal / SA events: -		
	Procedures: 1. Free release of departing traffic on the jet SIDs.		
	Notes: -		

<table>
<tr><td rowspan="7">Ex 25</td><td colspan="3">Code Name: 10AMM10(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: AM</td><td>Wind: 080° / 15 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C level bust on ROTEV/SUROX SID (scenario decided dynamically). Concerned Sector: Lower/Upper North (L/UN).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 26</td><td colspan="3">Code Name: 10AMM10(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: AM</td><td>Wind: 080° / 15 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 27</td><td colspan="3">Code Name: 28PMS4(A)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: PM (red.)</td><td>Wind: 160° / 20 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Runway closure and re-opening (Ex Time: from 17:45 to 17:50).
Concerned Sector: All.</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. 75% traffic load.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 28</td><td colspan="3">Code Name: 28PMS4(B)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: PM (red.)</td><td>Wind: 160° / 20 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. LAN failure (Ex Time: From 18:45 to 18:55 – end of exercise).
Concerned Sector: All.
2. A/C level bust on sequencing leg entry (traffic to RONNY descending at FL70 during the LAN failure).
Concerned Sector: Lower North (LN) and Initial Approach (AP).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. 75% traffic load.</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 29</td><td colspan="3">Code Name: 28AMM11(A)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: AM</td><td>Wind: 270° / 8 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 30</td><td colspan="3">Code Name: 28AMM11(B)</td></tr>
<tr><td colspan="3">Type: Measured Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: AM</td><td>Wind: 270° / 8 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:

1. A/C flying out on wrong PESIT SID (taking a non-jet SID with early turn).
Concerned Sector: Lower/Upper South (L/US).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

Ex 31	Code Name: 16PMS5(A)		
	Type: **Scenario-based** Exercise		
	Runway in use: RWY16	Traffic Sample: PM	Wind: 160° / 20 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr) 2. D5 (cross FL130 or above)		
	Non-nominal / SA events: 1. A/C level bust on INKUR non-jet SID (going through 4000ft). Concerned Sector: Lower/Upper South (L/US). 2. Sequencing leg run-off procedure. Concerned Sector: Initial Approach (AP) / Final Director (FI).		
	Procedures: -		
	Notes: -		

Ex 32	Code Name: 16PMS5(B)		
	Type: **Scenario-based** Exercise		
	Runway in use: RWY16	Traffic Sample: PM (red.)	Wind: 160° / 20 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)		
	Non-nominal / SA events: 1. Go around procedure (two). Concerned Sector: Initial Approach (AP) / Final Director (FI). 2. Runway closure and re-opening (Ex Time: from 18:35 to 18:40). Concerned Sector: All.		
	Procedures: -		
	Notes: 1. 75% traffic load.		

<table>
<tr><td rowspan="7">Ex 33</td><td colspan="3">Code Name: 28AMS6(A)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: AM</td><td>Wind: 270° / 8 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Sequencing leg run-off procedure.
Concerned Sector: Initial Approach (AP) / Final Director (FI).
2. CWP failure: LN CWP goes off (Ex Time: from 08:00 to 08:03).
Concerned Sector: Lower/Upper North (L/UN).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 34</td><td colspan="3">Code Name: 28AMS6(B)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY28</td><td>Traffic Sample: AM</td><td>Wind: 270° / 8 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Severe weather on VATRY-SHEEP (during the whole measured period).
Concerned Sector: Lower/Upper South (L/US).
2. Go around procedure (two).
Concerned Sector: Initial Approach (AP) / Final Director (FI).
3. Sequencing legs unavailability due to weather (Ex Time: from 09:10 to 09:20 – end of the exercise).
Concerned Sector: All</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
<tr><td>Ex 35</td><td colspan="3">Code Name: 10PMS7(A)</td></tr>
</table>

<table>
<tr><td rowspan="6"></td><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM (red.)</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. Go around procedure (two).
Concerned Sector: Initial Approach (AP) / Final Director (FI).
2. Runway closure and re-opening (Ex Time: from 17:45 to 17:50).
Concerned Sector: All.</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes:
1. 75% traffic load.</td></tr>
</table>

<table>
<tr><td rowspan="8">Ex 36</td><td colspan="3">Code Name: 10PMS7(B)</td></tr>
<tr><td colspan="3">Type: Scenario-based Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events:
1. A/C flying out on wrong NEVRI/ROTEV SID (taking the non-jet SID with early turn).
Concerned Sector: Lower/Upper North (L/UN).
2. Medical emergency for heart attack (while a/c on Upper frequency) – priority landing.
Concerned Sector: Upper/Lower South (U/LS) & Initial Approach (AP).
3. Sequencing leg run-off procedure.
Concerned Sector: Initial Approach (AP) / Final Director (FI).</td></tr>
<tr><td colspan="3">Procedures: -</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

Ex 37	Code Name: 10AMS8(A)		
	Type: **Scenario-based** Exercise		
	Runway in use: RWY10	Traffic Sample: AM	Wind: 080° / 15 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)		
	Non-nominal / SA events: 1. Unusual transition level (QNH<950; TL75) Concerned Sector: All. 2. Low performance a/c on INKUR SID not making the level. Concerned Sector: Lower/Upper North (L/UN). 3. Go around procedure (two). Concerned Sector: Initial Approach (AP) / Final Director (FI).		
	Procedures: -		
	Notes: -		

Ex 38	Code Name: 10AMS8(B)		
	Type: **Scenario-based** Exercise		
	Runway in use: RWY10	Traffic Sample: AM	Wind: 080° / 15 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)		
	Non-nominal / SA events: 1. A/C level bust on sequencing leg entry (traffic to ULTAG descending at FL70). Concerned Sector: Lower North (LN) and Initial Approach (AP). 2. Sequencing legs unavailability due to weather (Ex Time: from 09:10 to 09:20 – end of the exercise).. Concerned Sector: All		
	Procedures: -		
	Notes: -		

Ex 39	Code Name: 28PMM12(A)

	Type: **Measured** Exercise
	Runway in use: RWY28 | Traffic Sample: PM | Wind: 310° / 10 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr) 2. D5 (cross FL130 or above)
	Non-nominal / SA events: -
	Procedures: 1. Free release of departing a/c on the jet SIDs.
	Notes: -

Ex 40	Code Name: 28PMM12(B)
	Type: **Measured** Exercise
	Runway in use: RWY28 | Traffic Sample: PM | Wind: 310° / 10 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr) 2. D5 (cross FL130 or above)
	Non-nominal / SA events: -
	Procedures: 1. Free release of departing a/c on the jet SIDs.
	Notes: -

<table>
<tr><td rowspan="7">Ex 41</td><td colspan="3">Code Name: 10PME1(A)</td></tr>
<tr><td colspan="3">Type: Exploratory Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures:
1. Traffic Manager supported by AMAN.</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 42</td><td colspan="3">Code Name: 10PME1(B)</td></tr>
<tr><td colspan="3">Type: Exploratory Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: PM</td><td>Wind: 120° / 12 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures:
1. Traffic Manager supported by AMAN.</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

Ex 43	Code Name: 28AME2(A)		
	Type: **Exploratory** Exercise		
	Runway in use: RWY28	Traffic Sample: AM	Wind: 270° / 8 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr) 2. D5 (cross FL130 or above)		
	Non-nominal / SA events: -		
	Procedures: 1. Traffic Manager supported by AMAN.		
	Notes: -		

Ex 44	Code Name: 28AME2(B)		
	Type: **Exploratory** Exercise		
	Runway in use: RWY28	Traffic Sample: AM	Wind: 270° / 8 kts
	Military Areas active: 1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr) 2. D5 (cross FL130 or above)		
	Non-nominal / SA events: -		
	Procedures: 1. Traffic Manager supported by AMAN.		
	Notes: -		

<table>
<tr><td rowspan="7">Ex 45</td><td colspan="3">Code Name: 16PME3</td></tr>
<tr><td colspan="3">Type: Exploratory Exercise</td></tr>
<tr><td>Runway in use: RWY16</td><td>Traffic Sample: PM</td><td>Wind: 160° / 20 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft) / R16 (to 5000ft for BAL dep/arr)
2. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures:
1. Traffic Manager supported by AMAN.</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

<table>
<tr><td rowspan="7">Ex 46</td><td colspan="3">Code Name: 10AME4</td></tr>
<tr><td colspan="3">Type: Exploratory Exercise</td></tr>
<tr><td>Runway in use: RWY10</td><td>Traffic Sample: AM</td><td>Wind: 080° / 15 kts</td></tr>
<tr><td colspan="3">Military Areas active:
1. R15 (to 3000ft)
2. R16/MOA4 (to FL250)
3. D5 (cross FL130 or above)</td></tr>
<tr><td colspan="3">Non-nominal / SA events: -</td></tr>
<tr><td colspan="3">Procedures:
1. Traffic Manager supported by AMAN.</td></tr>
<tr><td colspan="3">Notes: -</td></tr>
</table>

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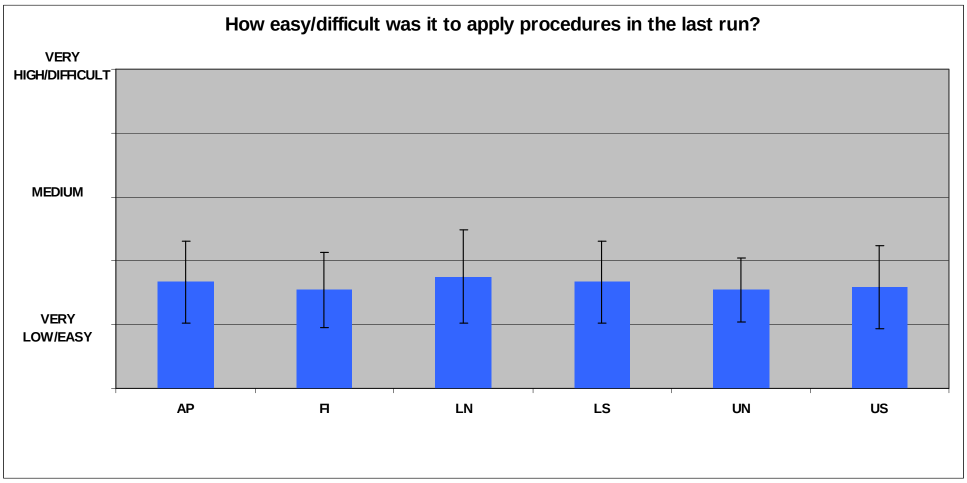
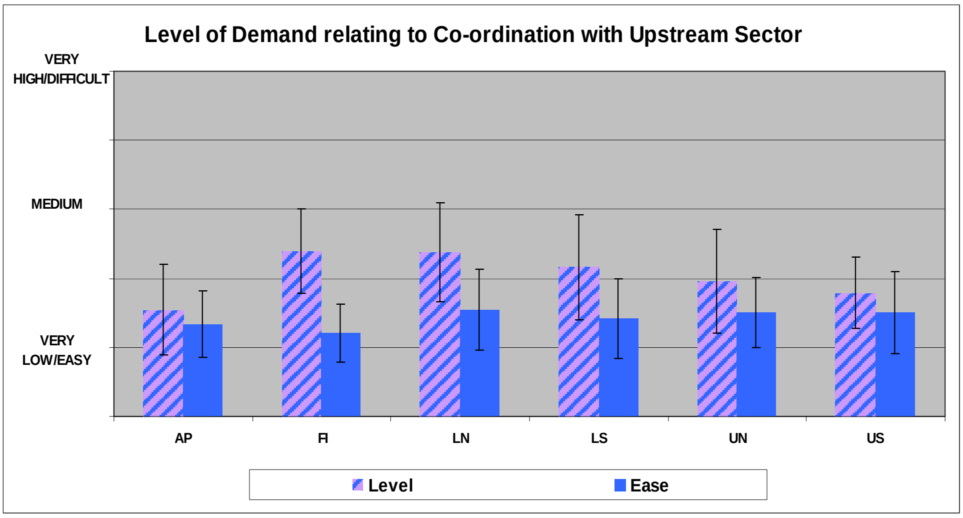
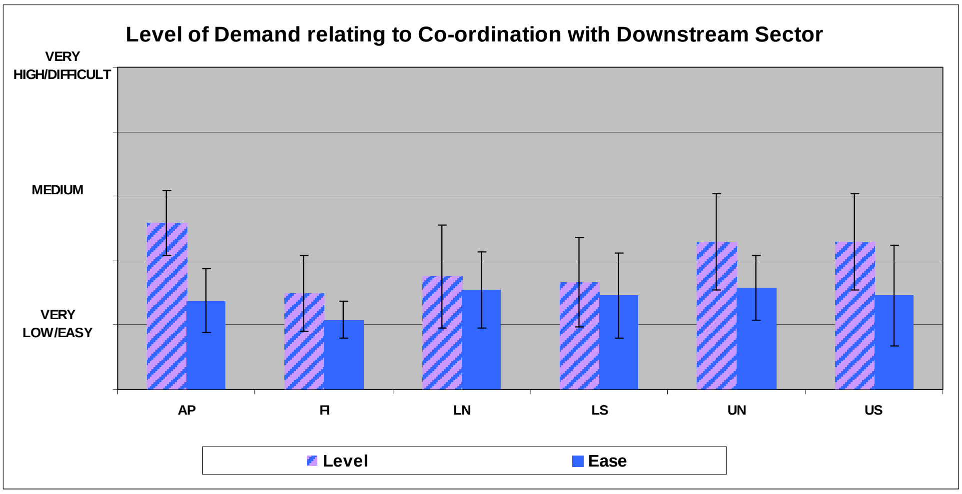
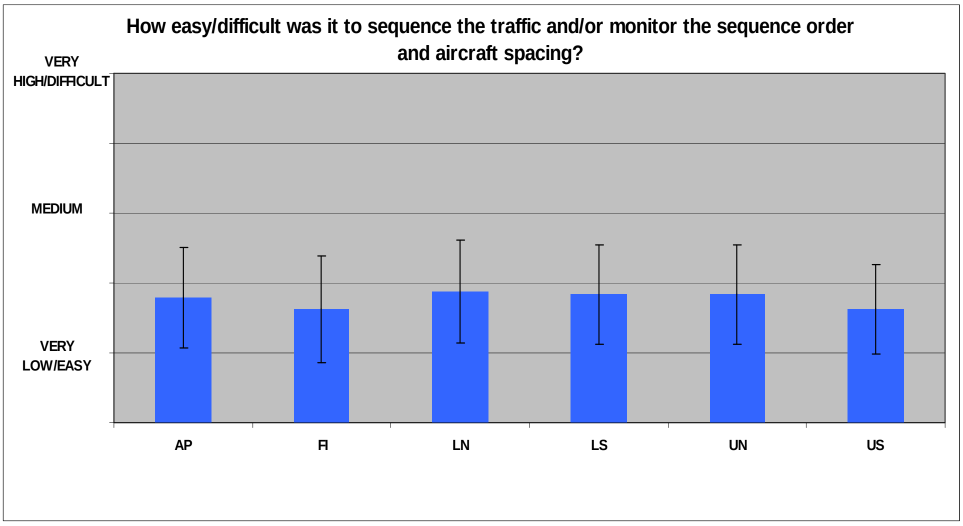
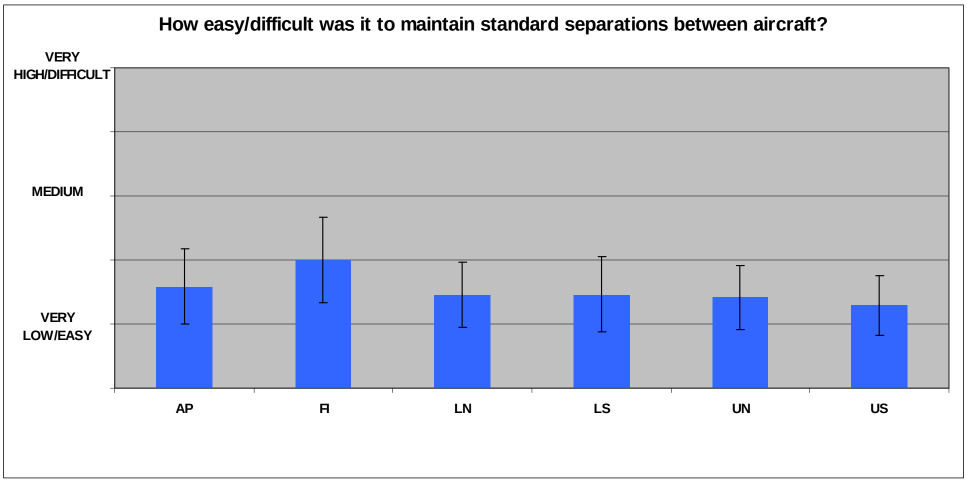
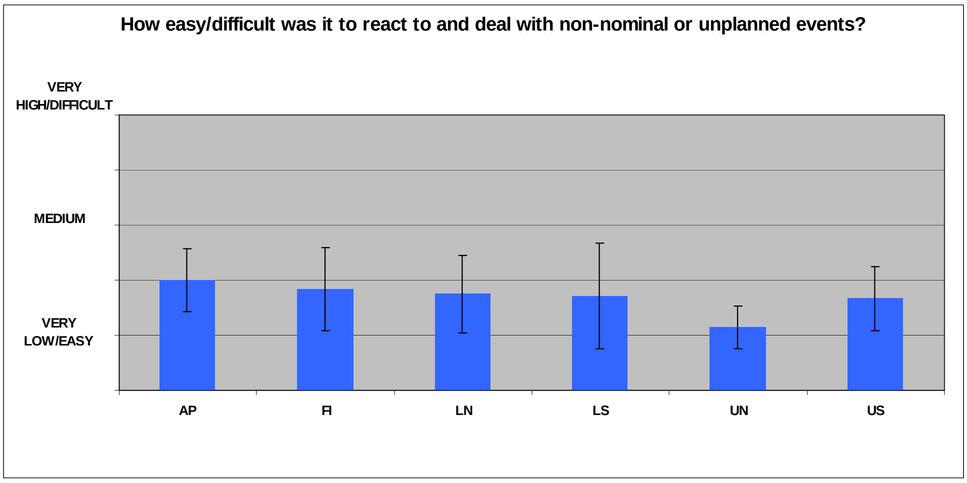
ANNEX H QUESTIONNAIRE RESULTS

H.1 Post-Exercise Questionnaire Results

QUESTIONS	RATINGS & COMMENTS
WORKING METHODS	
Q1: How easy/difficult was it to apply procedures in the last run?	
Q2: What was the level of coordination with the upstream sector in the last run?	
Q3: How easy/difficult was it to coordinate with the upstream sector in the last run?	
Q4: What was the level of coordination with the downstream sector in the last run?	
Q5: How easy/difficult was it for you to coordinate with the downstream sector in the last run?	
Q6: What was the level of coordination with the Traffic Manager in	

<table>
<tr><th>QUESTIONS</th><th>RATINGS & COMMENTS</th></tr>
<tr><td>the last run?</td><td></td></tr>
<tr><td>Q7: How easy/difficult was it to coordinate with the traffic manager in the last run?</td><td></td></tr>
<tr><td>Q8: How easy/difficult was it for you to sequence the traffic and/or monitor the sequence order and aircraft spacing during the last run?</td><td>
</td></tr>
<tr><td>Q9: How easy/difficult was it for you to maintain standard separations between aircraft during the last run?</td><td>
</td></tr>
<tr><td>Q10: How easy/difficult was it for you to react to and deal with non-nominal or unplanned events in the last run?</td><td>
</td></tr>
<tr><td>Q11: As executive controller in a single sector how</td><td></td></tr>
</table>

QUESTIONS	RATINGS & COMMENTS
easy/difficult was it for you to plan the resolution of conflicts?	
Q12: As executive controller in a single sector how easy/difficult was it for you to plan the resolution of conflicts?	
Please provide any	**RWY 28**

<table>
<tr><th>QUESTIONS</th><th>RATINGS & COMMENTS</th></tr>
<tr><td>further comments regarding working methods</td><td>
AP

Good coordination with both down stream sector and TM which was important because of large volume of traffic.
Wind was very strong from north with a/c on red leg for 2.45 mins. Only with a speed of 210kts. This led to constant changing of 3 to 5 miles for TWR etc and coordination with FI and TM.
The unplanned item was REA22N turning left at ULTAG towards another a/c. I instructed the REA22N to turn right but it was slow to react, that made it more difficult to handle but it was still ok.
The wind at the higher levels plays a major factor and I felt I was fighting against it the whole time. Hard to keep the 5nm for prolonged periods.

FI

Thought everything went very smoothly
Q9: I rated medium as there was a fair few heavy items and I didn’t always provide the correct separation with traffic following.
Q11 and Q12: workload associated with step descent due to bases of controlled airspace took attention away from spacing on finals
A little difficult to coordinate at end of exercise with upstream sector due to workload increase because of traffic having to be vectored.

UN

Was unclear at one stage about who was holding and for how long
There were a lot of overflights that were in conflict but it was easy to sort out.
The TM must tell both upper and lower of any strategy e.g. holding. At times I was a bit unsure of the plan.

LN

Re Q10, EIN 357 took a wrong turn which required remedial action to avoid a conflict with traffic working UN CTLR.
Needed some coordination but easy to coordinate.
Several times in exercise we went from holding to normal ops and back. This process hugely increases workload and frustration.
All difficulties caused by poor piloting throughout run, very frustrating and it did affect the efficiency of the sector to a great extent.
Q10: An a/c on the leg turned back towards ULTAG conflicting with the next to go onto the leg. I though this was driver error and felt I was a bit slow to deal with the situation.

US

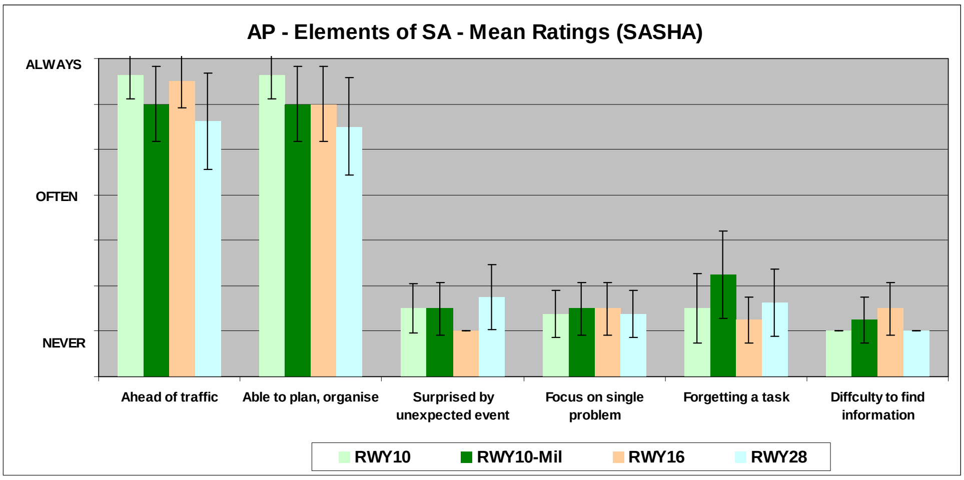
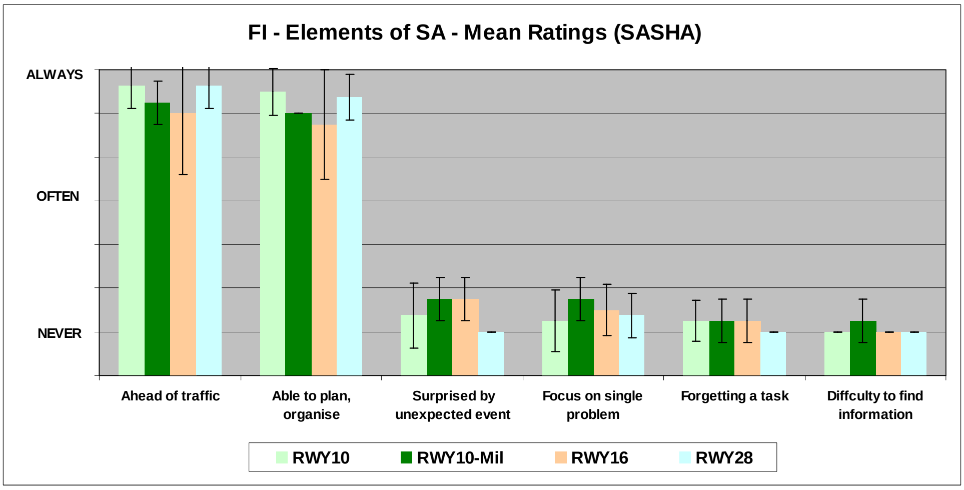
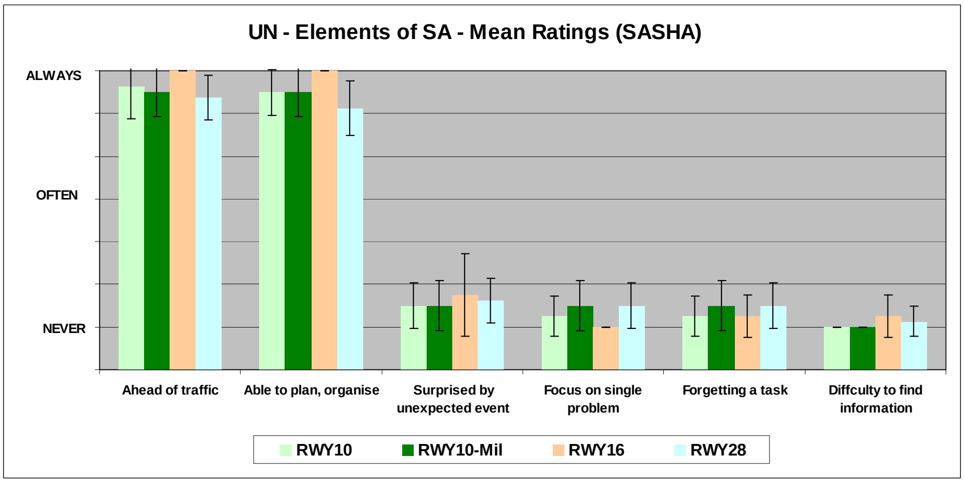
Q1 Due to holding there was less opportunity to apply the usual coordination with LS
Coordination was good and easy to do.

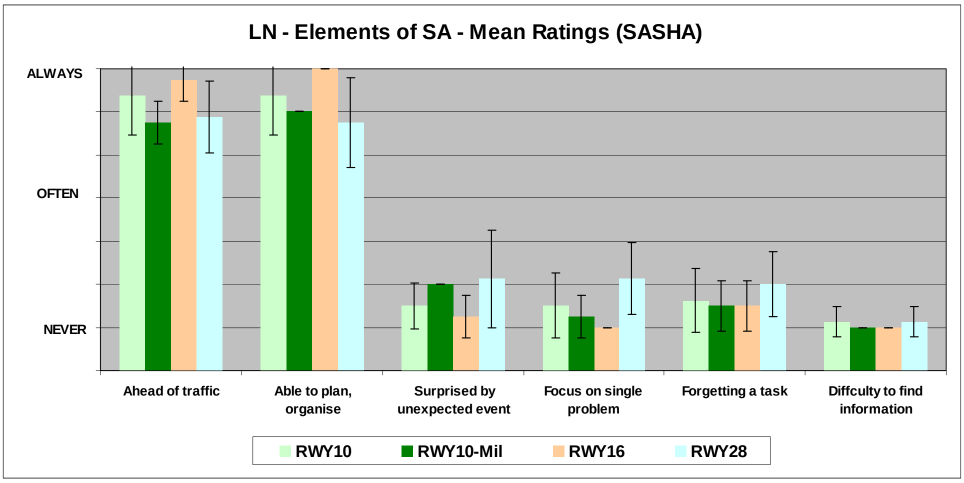
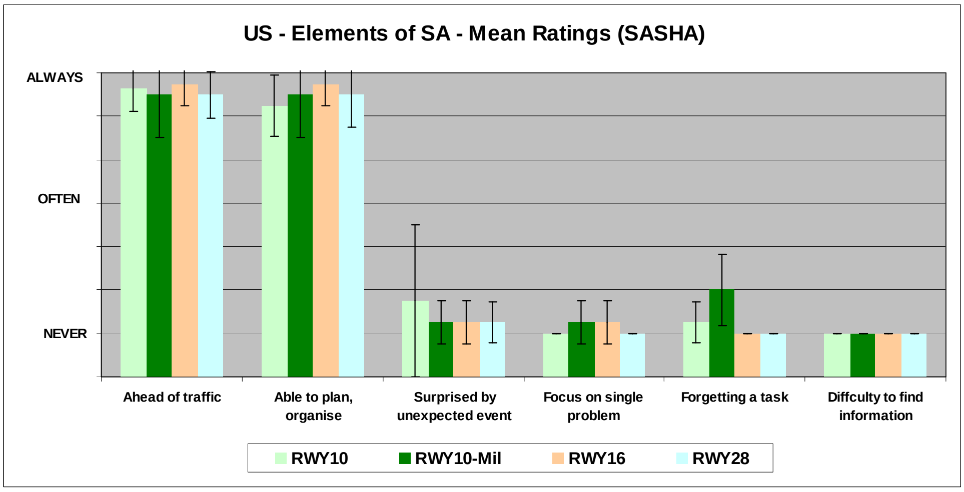
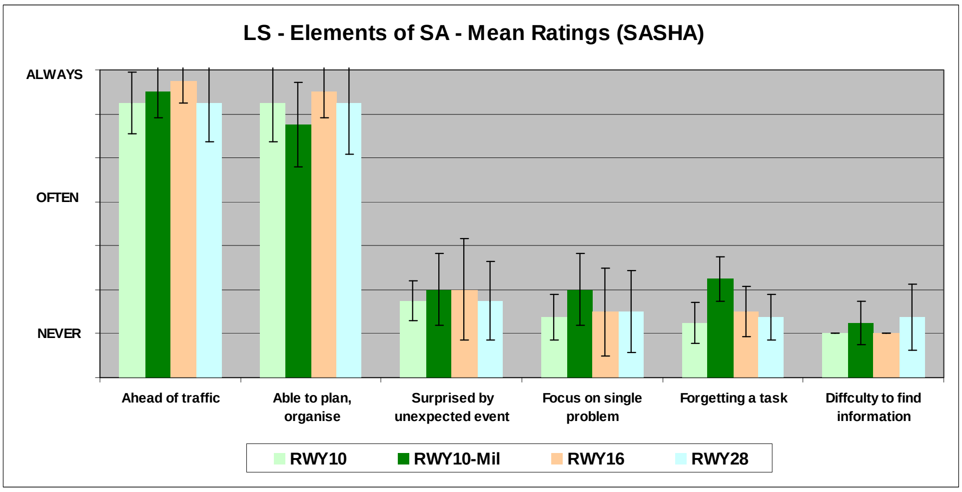
LS

Q10: I noticed that the CLF9 was turning early but was aware that no arrival traffic were close enough to be affected and was happy to leave the CLF9 on the heading he was on.
Q1: A bit frustrated with constantly having to call the TM. Q2: Not knowing or able to call the shots re the sequence.
Very easy to coordinate. You always know that the downstream sector requires.
Didn’t have to worry about streaming traffic until they left the hold.
Q6: There was a good bit of coordination with the TM but I did have time to do so. Q10: I noticed the jet dep turning early and resolved with a heading.

</td></tr>
<tr><td></td><td>RWY 10</td></tr>
</table>

QUESTIONS	RATINGS & COMMENTS
	FI - Q9; System problems at start with a/c speeds, which lessened as I issued 180/160kts to subsequent traffic. Should also note that with many a/c I issued descent clearance to A3000 based on their position and profile to issue step descent would have increased my workload. **US** - Very little coordination. Helps a lot when person in your sector is on the same wave length. **LS** - No problems. Not much coordination.
	RWY 10 - mil
	AP - Didn't spot that one of the a/c was a heavy jet so set up the sequence for 3nm on finals which then caused a go-around. - Good coordination made it easy. **FI** - Standard separation was easy but I didn't notice a heavy jet. I had to break off the following a/c. **UN** - I noticed workload increased when a no of overflights entered the system, which will be reflected by the no of 'fair' selections made on ISA. **LN** - Low slow overflyer. While in yr sector you will use reminders to highlight him – but you may use these tools for other traffic and when you clear them it will also clear it from the overflight. Removing a safety net. - Moderate traffic, plenty of time to coordinate. **LS** - Q9, 10, 11, 12 a few pilot errors led to increases in difficulty of the run – it was easier to see conflicts due to lower range. - I would prefer not to have to ask TM for permission to short-cut if separation with preceding traffic does not go below 8nm. - Good co-ordination and TM made it very simple - I don't think allowing the sector to take shortcuts without consulting with the TM reduces coordination. I was a bit confused sometimes about who was allowed to take a shortcut and who wasn't.
	RWY 16
	FI - Procedures stated 3/5nm on finals but we were then told that we could not use 3nm, led to a little confusion and had to work hard to regain 5nm between a/c on finals. **AP** - Needed some coordination but very easy to coordinate. **US** - There was a lot of clutter in the area of PMS legs. Overflight a/c could be obscured and forgotten.
SASHA (SITUATION AWARENESS ASSESSMENT)	

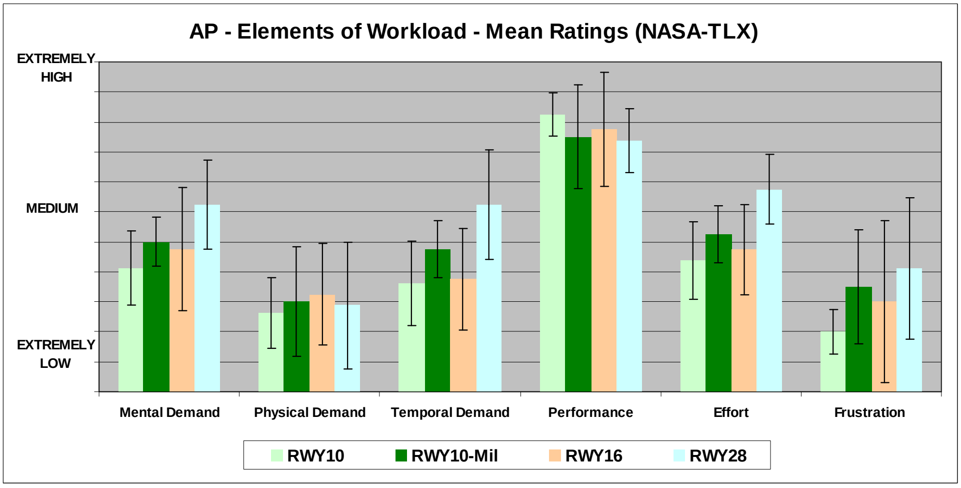
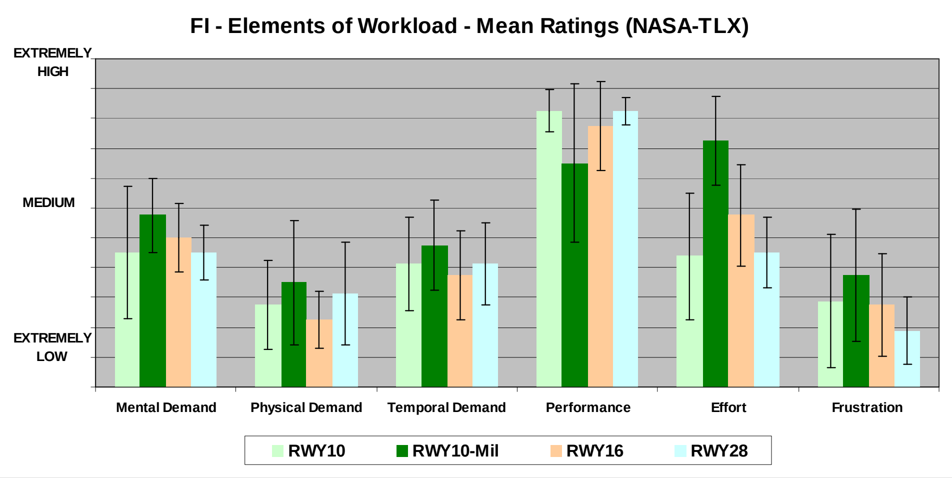
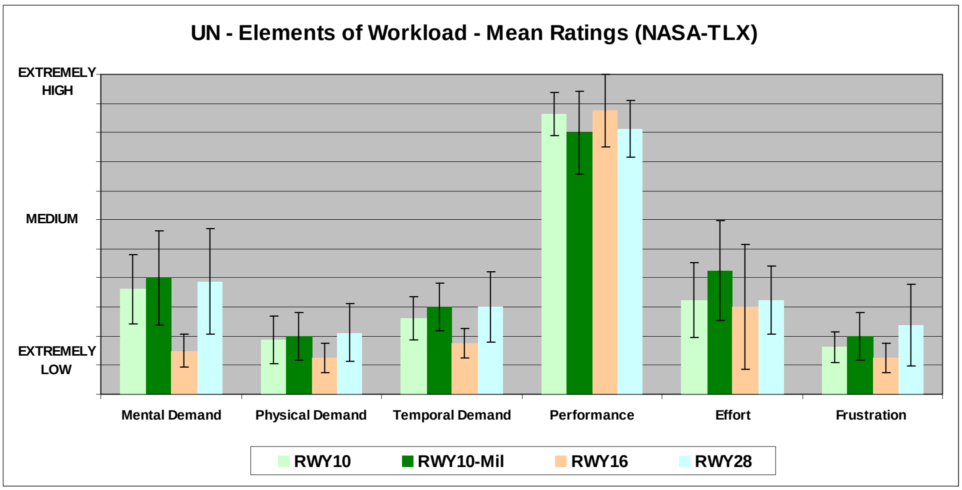
QUESTIONS	RATINGS & COMMENTS
Q 13: Did you have the feeling that you were ahead of the traffic, able to predict the evolution of the traffic? **Q14: Did you have the feeling that you were able to plan and organise your work as you wanted?** **Q15: Have you been surprised by an event that you were not expecting (like an aircraft call)?** **Q16: Did you have the feeling of starting to focus too much on a single problem and/or area of the sector?** **Q17: Did you forget something important (like transfer an aircraft on time or communicate a change to an adjacent sector)?** **Q18: Did you have any difficulty in finding an item of information?**	  

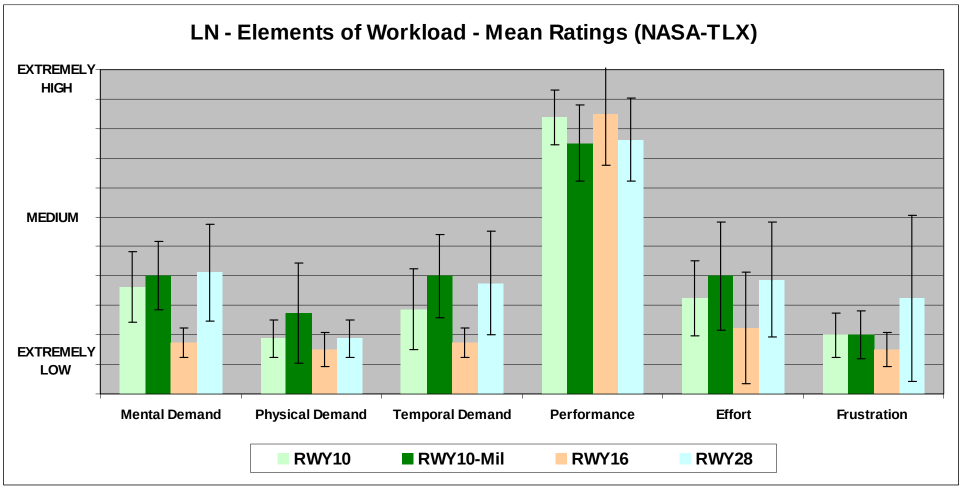
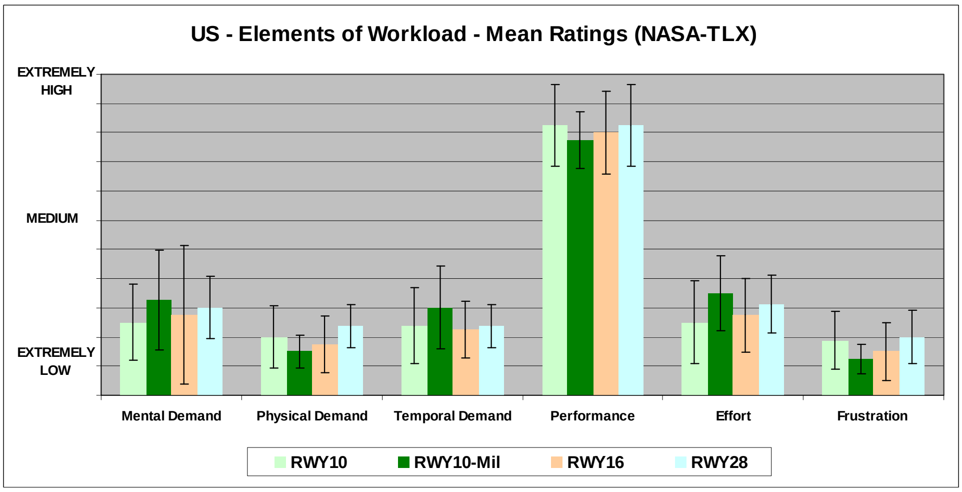
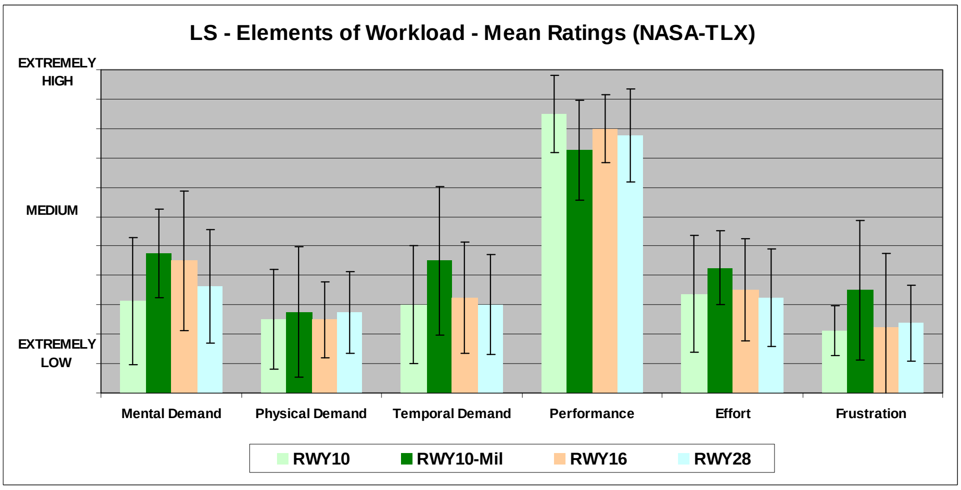
QUESTIONS	RATINGS & COMMENTS
	  
Please provide any	**RWY 28**

QUESTIONS	RATINGS & COMMENTS
further comments regarding SA.	**AP** - Standard speed of incoming a/c plus known range of traffic on seq. legs make this position much easier. **FI** - Had to keep an extra watch for wake turbulence particularly for mediums following heavies. - As traffic became more busy 3nm separation was used a lot and I think in reality the tower would require more gaps but I was unable to provide due to heavy constant sequencing. - Worked a lot of traffic but seemed to have plenty of time to deal with it. **UN** - When traffic was light, a/c would have been vectored straight in the PMS. When busy it would have been clear to hold – so real difference found in working in this sector. - I forgot to transfer 2 labels to FI. - Less traffic and more time to watch the bigger picture. **LN** - Re 15-17: I had to take action to resolve a situation, as a result I allowed a departure level off at 3000 ft even though there were no safety implications - During holding, I forgot about departures. There were not many deps at that time so I was not focused on that area. - LN is a small sector so easy to maintain SA. **US** - Q19: Due to w/l associated to holding in LS, while was aware of what was going on I found it difficult at times to coordinate with the LS so had to resort to less efficient solutions to traffic problems. - There was a lot of clutter as my departures crossed the sequence legs. - Having less tasks to do helps maintain good SA. - I had so much spare time I was able to help my lower sector with his traffic. **LS** - As I have a much smaller airspace its easier to see the picture in one glance - I feel that I'm just concentrating purely on my sector and not looking at other sectors at all.
	RWY 10
	AP - A number of a/c came on with level separation which forced me into turning 2nd a/c before the leading a/c which changed my initial plan for sequence. - Q19: Hare to compare as we don't work with these levels of traffic. More structured allowing for more SA. - I had plenty of time to look at what was coming. **FI** - Q15: Some problems caused by inconsistent aircraft performed in one way while the same type with the same instructions performed another way - SA was sometimes hampered because I had to focus on speeds inside 4nm. Those speeds were not consistent. - A departure called and should have called LS. Forgot to transfer on a/c to FI. - Some speed problems with the system were unexpected. **LN** - Towards the end of the exercise I tried to call a sequence without involving the Tm. I feel I may have allowed myself to make that decision because I was working so routinely up to then. This emphasises the importance of the lower controller talking to the TM. **US** - I was finding it difficult to be aware of what was happening in other sectors and approach and because of that I found it sometimes difficult to plan arrivals. - Q17: Forgot overflight from north and then transferred on wrong frequency. - Q17: Forgot to transfer overfliying traffic to upper north. **LS** - Had no problems even when holding. - One a/c was given to me outside my range. It surprised me. - I forgot to transfer an arrival but it was at the start of the sim when I had no traffic! Q15:Ex1: A/c from south sector mistakenly headed for a dep in north sector.

QUESTIONS	RATINGS & COMMENTS
	South sector controller highlighted the situation. I took avoiding action to the left and situation solved.
	RWY 10 - mil
	AP - Twice when I called a/c to turn to the merge point the pilot said they did not have them on frequency. Odd because I was sure I received an initial call in from them! - EIN151 called but wasn't in my sector and it was a little distracting trying to find out which sector it needed to be transferred to. Forgot to transfer some a/c to finals, but this did not cause problems. - Q15: Upstream sector wasn't transferring labels before a/c called. Q16: When holding I was looking at the TML verses the radar for deps. **FI** - Giving 3nm continuously on finals needs full concentration and over extended periods of time it feels a little like tunnel vision. - No change in SA compared to today but I would be less aware of what is taking place beyond the sequencing legs. **UN** - Lots of time to monitor the bigger picture. But caution if you're too quiet you can become lax. - Q16 while I didn't loose focus of the bigger picture I did have to work harder to ensure that I maintained the picture during the overflight phase. - One a/c cleared to Julie continued on same track after Julie instead of turning for RISAP which was unexpected but easily solved. **LN** - Small range means you loose out on the bigger picture. **US** - Standards sequence legs increase awareness of traffic in your sector. - Once or twice my attention was turned to the a/c speed on final more than I would normally be especially during 3nm. **LS** - SA increased but over focussed in my own sector - Due to uncertainty about the availability of shortcuts, I couldn't plan like normal, but it was still fine.
	RWY 16

QUESTIONS	RATINGS & COMMENTS
	AP - Very good SA no problems. - Ex7: In this exercise PMS allowed more time for SA. - I was concentrating on my own traffic, and traffic in unconcerned label colour fades out of my SA. I needed continually refocus my mind to the unconcerned traffic. **FI** - Final working EIWT approaches is not appropriate - Ex7: 1 traffic item couldn't reduce speed so that took a little more attention than normal. **UN** - I concentrated solely on my sector and the downstream, I was not aware of the traffic in APP, FI or LS. - Traffic not busy on north south – low w/l so high SA. **LN** - LN is a small sector so easy in this run to maintain SA. - Concentrating on my sector, I was not aware of how my traffic would integrate into the overall arriving traffic from US and LS. **US** - I had so much spare time I was able to help my lower sector with his traffic. **LS** - Same level of awareness as current day. You disregard unconcerned a/c at times. - Ex8: A planned level bust event has been spotted but probably a little bit late. The reaction has been as if was a sim glitch/pilot error.
NASA TLX (WORKLOAD ASSESSMENT)	

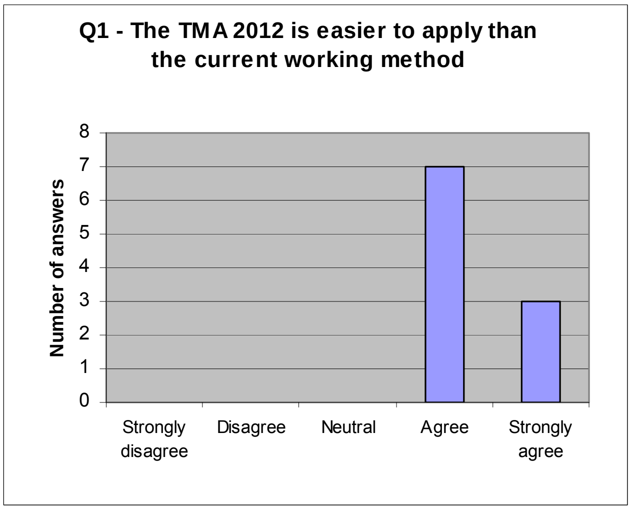
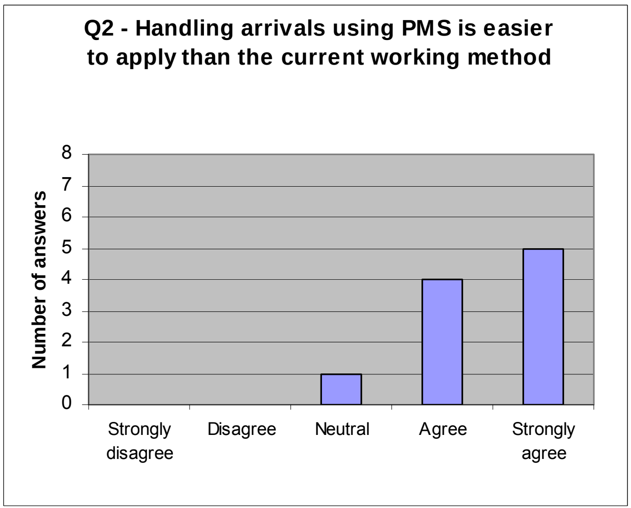
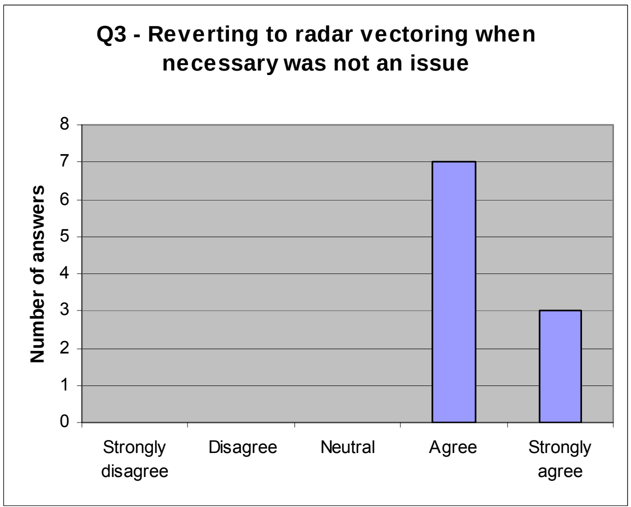
QUESTIONS	RATINGS & COMMENTS
Q20-25: During the last run, what was your level of: - **Mental Demand** - **Physical demand** - **Temporal Demand** - **Performance** - **Effort** - **Frustration**	  

QUESTIONS	RATINGS & COMMENTS
	  
Please provide any	**RWY 28**

QUESTIONS	RATINGS & COMMENTS
further comments regarding workload.	**AP** - I felt I was constantly trying to slow traffic to stop falling off sequence legs especially on red leg it would have been easier to go I into the holds. Do think wind and length of legs for RWY 28 affected this. - As Approach I would have liked to have input in discussions to hold and the rate at which traffic joins the sequencing leg. - Frustrated due to the strong winds from the north and the sequence legs are very short so you feel like you're running out of space much quicker. - Heavy volume of traffic but PMS makes it seem like a loss less. **FI** - Extra workload required to provide separation behind heavy a/c - It didn't feel like I worked a lot of traffic as everything was straightforward. - To free vector the same amount of traffic would have required a lot more effort and mental demand. **UN** - Even though I was moving more traffic, I had more time to observe the whole picture. - During short periods, workload was high but very manageable. **US** - Problems caused by holding reduced efficiency throughput. - W/L was very low as coordination with LS was very easy. - When holding, I felt the lower controller had more of the W/L than I had. **LS** - The small airspace meant less work. Less involvement in calling the shots i.e whether a/c hld or not. Repeated the clicks to get the level to accept the cleared FL. - Was having to switch from TML to holding area – departures to crosses constantly.
	RWY 10
	AP - Difficult to compare as don't work with same level of traffic. Again more structured therefore w/l decreased particularly in r/t. - Only 2-3 transmissions per a/c makes it very easy. - Exercise seems a bit too busy to be realistic. A/c running off the legs caused extra work which could have been prevented by holding earlier. In reality flow control would be used. Could not handle that amount of traffic using current procedures. **FI** - A lot of traffic ran off the sequencing legs towards the end of the exercise and therefore I had to resort to vectoring. Workload increased very rapidly. - Workload increased because of speed inside 4nm. - This was a very busy exercise with a high level of traffic and a higher workload in finals due to runway in use with extra descent with current traffic levels that would have been much easier to work. **UN** - The mental and temporal demand with such traffic in own current system would be much greater. **LN** - This level of traffic would be very difficult t o cope with in our own Dublin set-up. - There was a rare occasion when I found PMS increased workload because of difficulty changing to and from holding situations. **US** - Workload was constant but low. - Evenly shared workload at times between upper and lower. - Some a/c speeds were way below causing me extra workload **LS** - Constant issues with wrong callsigns, read-backs from pilots cause my frustration levels to increase dramatically. Constantly having to call the TM over, not his fault, he was busy. Inputs in labels - Low workload because of the sector.

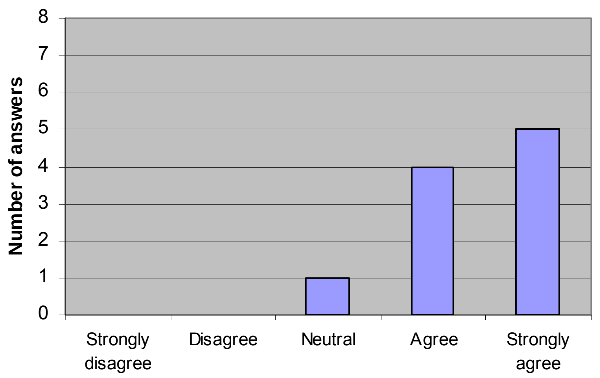
QUESTIONS	RATINGS & COMMENTS
	RWY 10 - mil
	AP - Frustrated with pilots not turning when expected. With shorter leg I felt pressure with north side traffic. Had to work harder to keep spacing. **FI** - W/L was quite high with a lot of arrivals having 3nm spacing between them so a lot of speed control was used which can get very intense. **UN** - I was quieter and had little mentally or physically to do. - The w/l in UN/US compared to LN/LS is much less. **LN** - Less traffic – less workload and r/t. **US** - W/L split between high and low is probably more 70/30. **LS** - W/L was low but mistakes from pilots increased everything else.
	RWY 16
	AP - I was feeling insecure because of my lack of familiarity with procedures and what happens next. I was feeling uncertain about BAL and Weston arrival and what would happen next because I had not seen it before. Time and practice should make a difference. **UN** - I felt myself regularly very quiet with little or nothing to do. **US** - For the level of traffic we moved I felt like it was a quiet day. - Workload is heavily biased towards the lower sector. Therefore US is very undemanding in this exercise. **LS** - Weston EIWT/EIME departures and arrivals quite difficult when RWY 16 active. - Still same level of w/l with arr/dep crosses – will I climb, will I not, will I turn, will I not?

H.2 Post-Simulation Questionnaire Results

QUESTIONS / RATINGS	COMMENTS
POINT MERGE	
	- No comments
	- No comments
	- No comments

<table>
<tr><th>QUESTIONS / RATINGS</th><th>COMMENTS</th></tr>
<tr><td>

Q4 - The PMS is more efficient for ATC than the current working method



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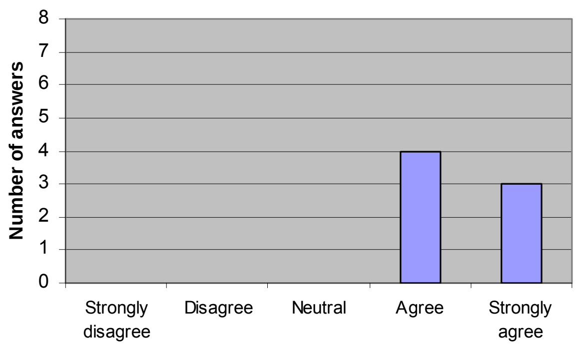
Q5 - Thecontroller workiing procedures for the Lower and Upper sector are clearly defined



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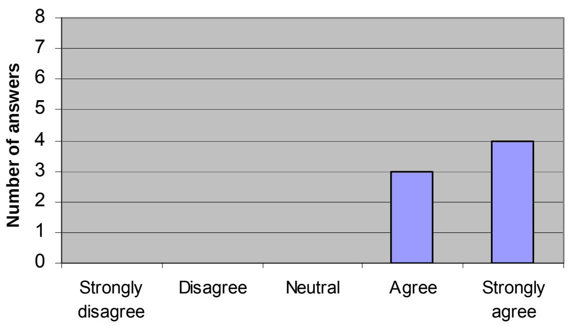
<tr><td>

Q6 - The controller working procedures for the Lower and Upper sector controllers are workable



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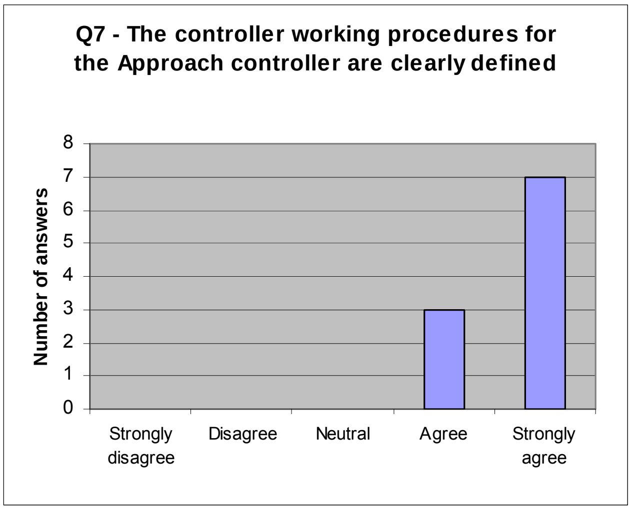
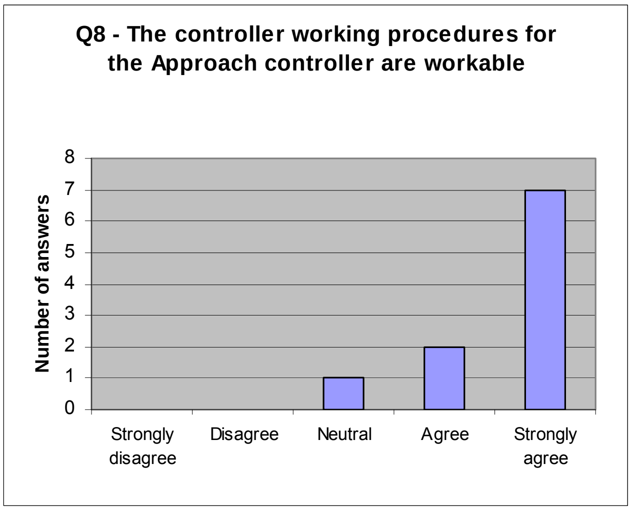
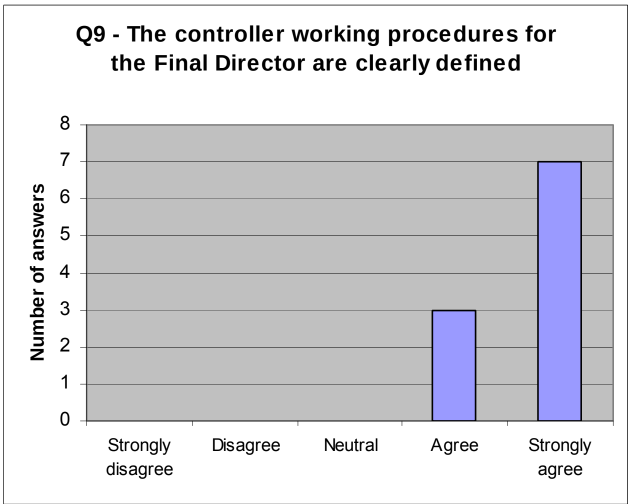
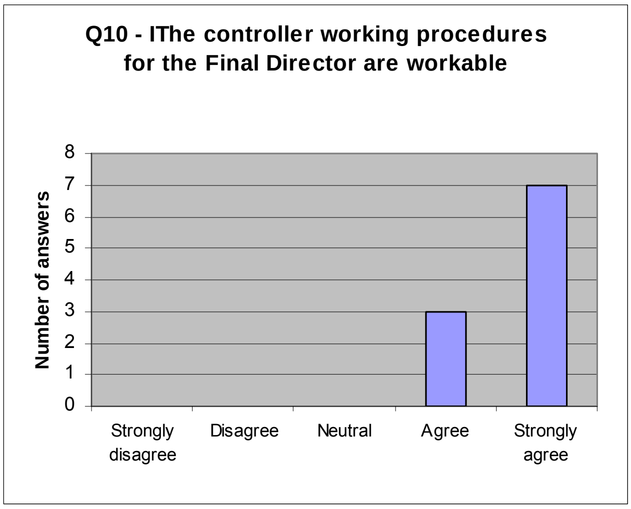
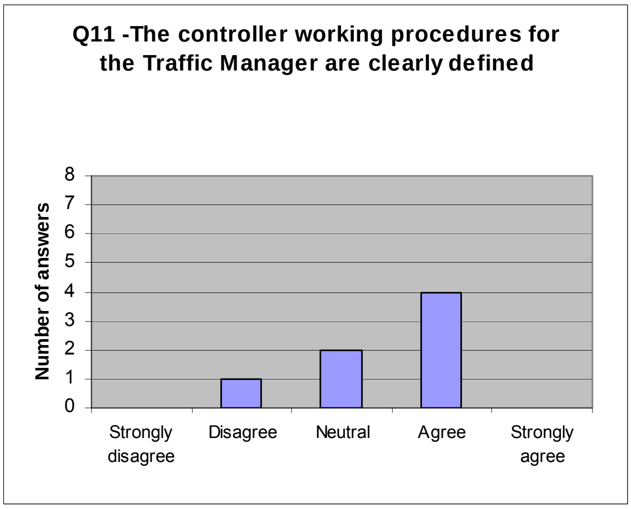
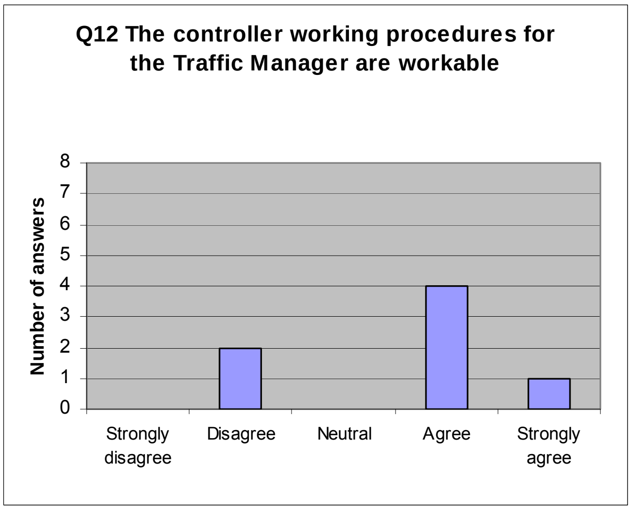
QUESTIONS / RATINGS	COMMENTS
	- No comments
	- No comments
	- No comments

QUESTIONS / RATINGS	COMMENTS
	- No comments
	- **ATCO A** – The controller working procedures for the TM need some fine-tuning but I think we have sorted most of the tasks. - **ATCO D** – Feel that TM role is not fully defined.
	- No comments

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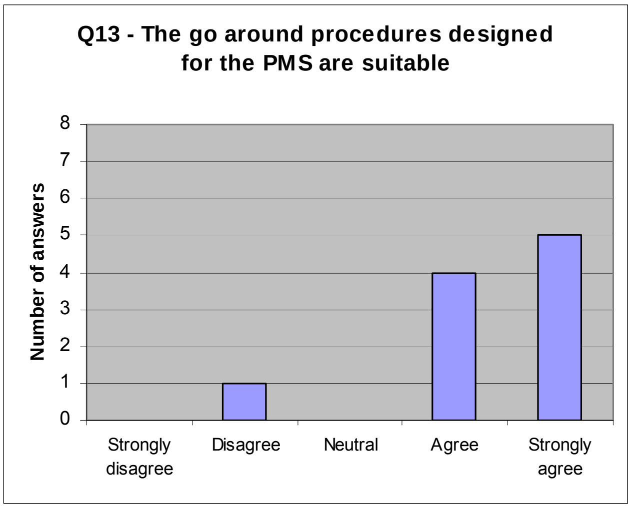
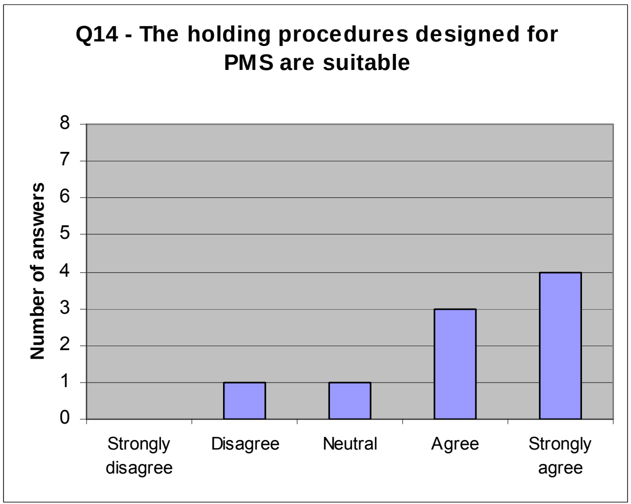
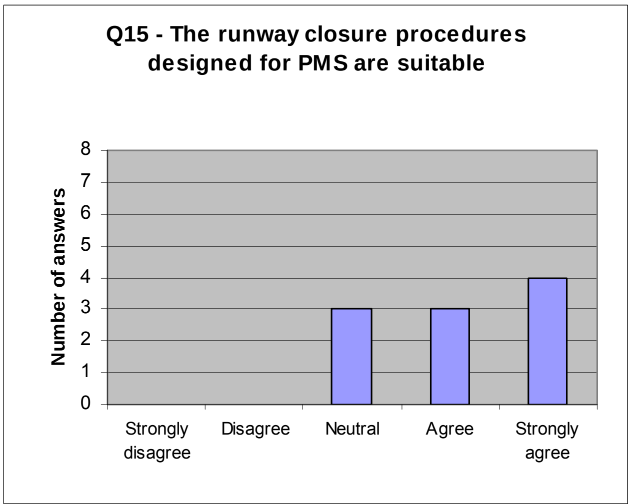
<tr><td>
</td><td>- No comments</td></tr>
<tr><td>
</td><td>- ATCO A – We need to look at holding controller procedures.
- ATCO D – I believe holding procedures for RWY closure could be developed. Where should a/c on leg be held? Think this should be examined on its own.</td></tr>
<tr><td>
</td><td>- No comments</td></tr>
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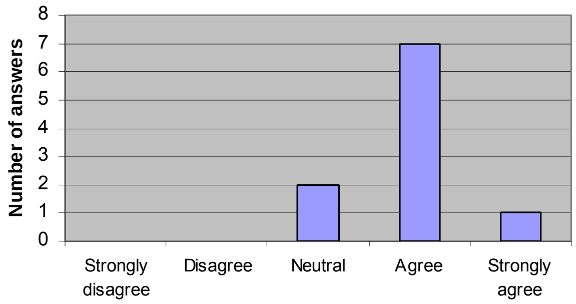
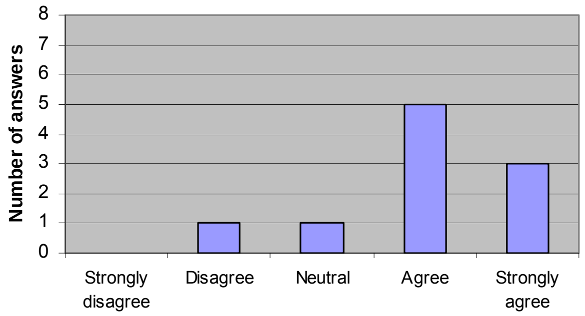
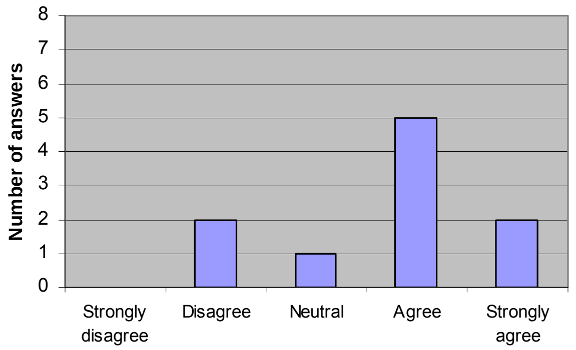
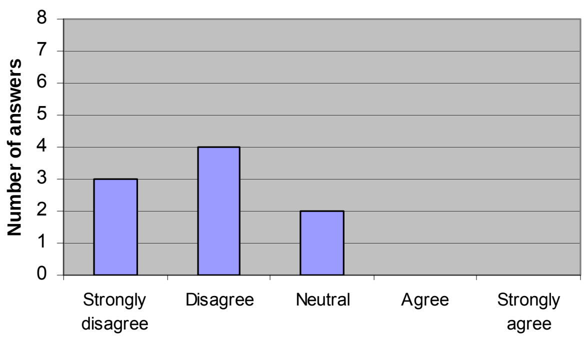
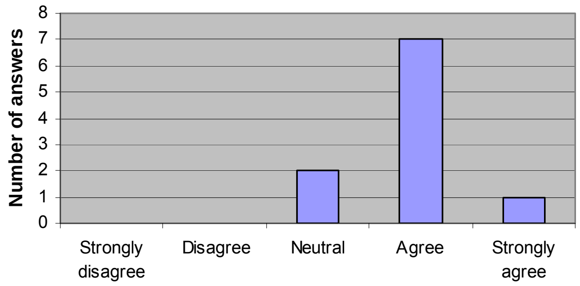
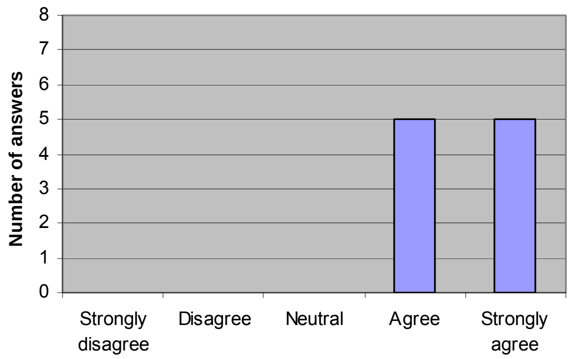
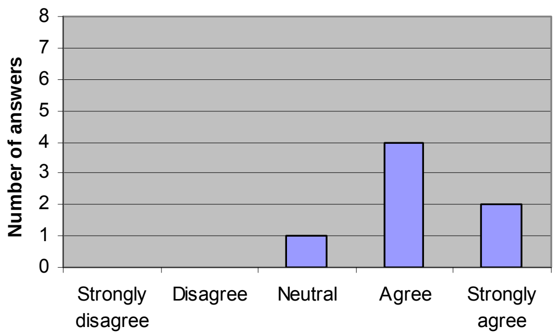
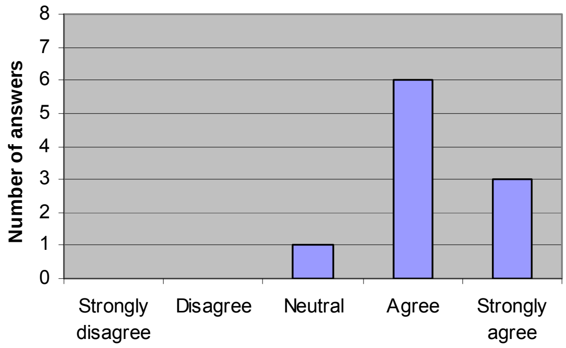
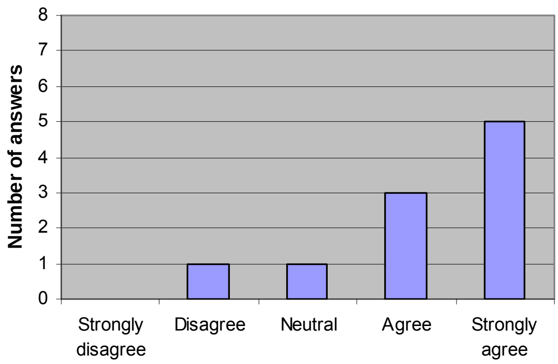
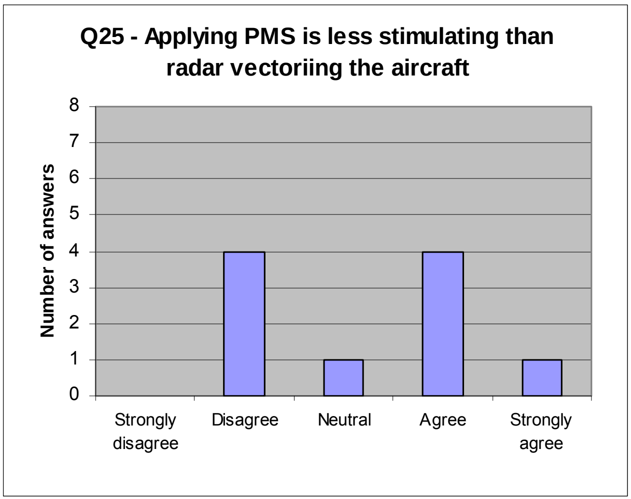
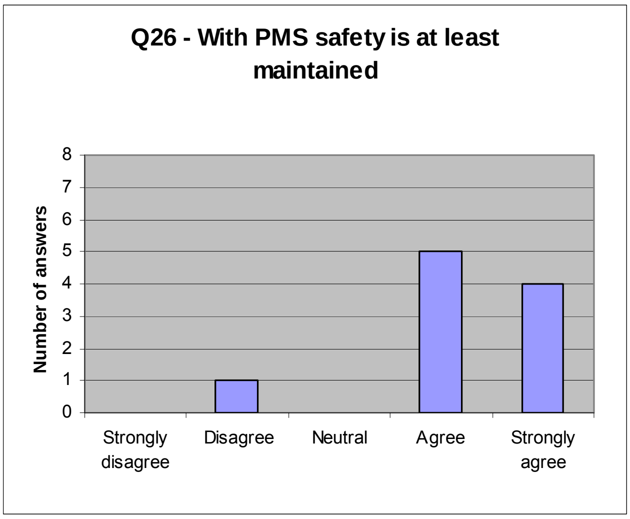
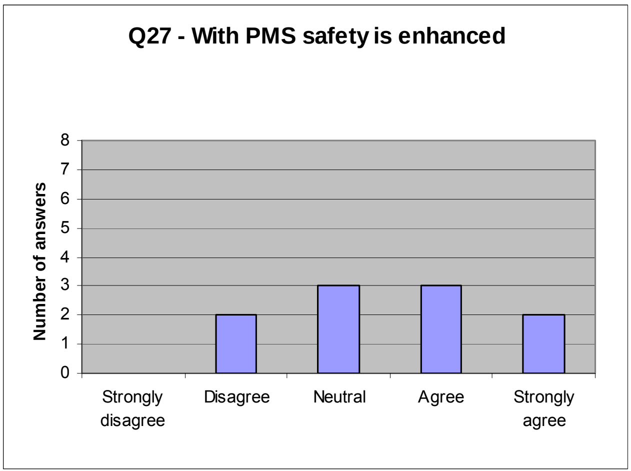
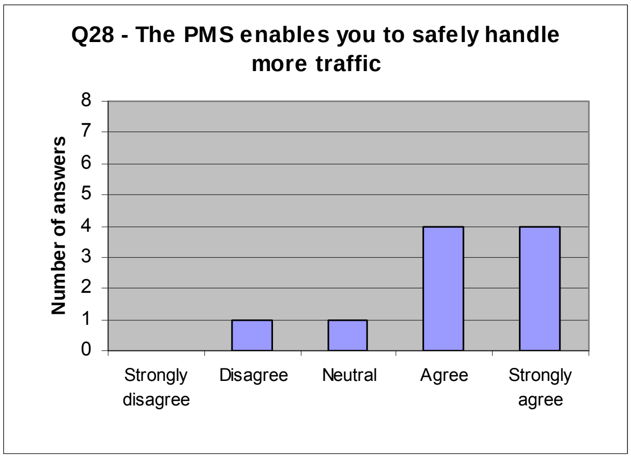
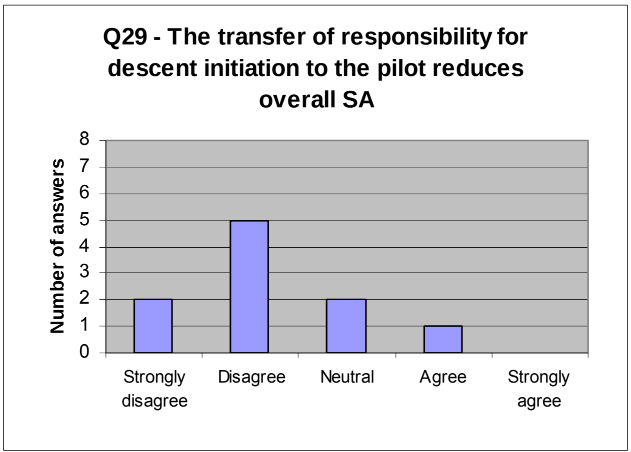
<table>
<tr><th>QUESTIONS / RATINGS</th><th>COMMENTS</th></tr>
<tr><td>Q16 - The sequencing leg run-off procedures designed for PMS are suitable

</td><td>- ATCO A – Seq. Leg run off needs to be nailed down – most controllers work it dynamically which is fine but we also need a solid procedure.</td></tr>
<tr><td>Q17 - The monitoring of aircraft sequence required less effort with PMS compared to the current working method

</td><td>- ATCO H – App monitors sequence currently but rarely changes it. The same for PM although if App wanted to change the sequence I believe it easier to do under PMS.</td></tr>
<tr><td>Q18- The more systematic nature of PMS reduced co-ordination workload

</td><td>- ATCO D – A lot of co-ordination inter-sector but as per my questionnaires (post exercise) very easy.</td></tr>
</table>

QUESTIONS / RATINGS	COMMENTS
Q19 - The impact of military airspace activation is more difficult with PMS than current day military activation 	- **ATCO A** – We never assessed the impact of changing from RWY with no mil to RWY 10 with mil.
Q20 - The level of flexibility with PMS is acceptable concerning the optimisation of the sequence 	- No comments
Q21 - The task distribution between the Approach controller and the Final Director is appropriate 	- No comments

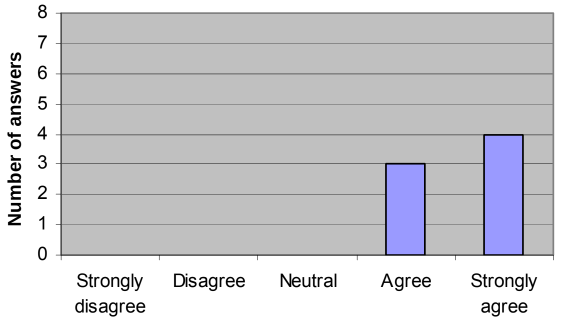
QUESTIONS / RATINGS	COMMENTS
Q22- The task distribution between controller in the Upper and Lower sectors is appropriate 	- **ATCO A** – In the sim the task distribution was about 60/40. In reality I think it will even out more as the Upper will have more co-ordination with adjacent sectors. Either way it is far better then the current 90/10 split with EC/PC. - **ATCO D** – I believe good majority of WL taken by Lower controllers.
Q23 - The more systematic nature of PMS increases trajectory predictibility 	- No comments
Q24 - The PMS facilitates a consistent delivery to runway 	- **ATCO I** – PMS helps the controller provide a consistent traffic delivery but it is still up to the controller on the day to deliver it. Some will some wont.

QUESTIONS / RATINGS	COMMENTS
 	- **ATCO A** – There is still satisfaction in achieving what is required for PM to work. - **ATCO B** – The use of PMS does involve a new skill set but is still stimulating in itself. Consistently providing 3/5NM spacing is a difficult task given weather/wind/a/c types in Dublin TMA, and is rewarding when achieved. - **ATCO C** – Because of the consistent nature of the tasks and procedures I can see controllers becoming bored more quickly than at present, also less satisfaction and stimulation from their work.
 	- No comments
 	- **ATCO C** – Overall with PMS SA is greatly increased and maintained event with an increase in traffic flow. This must increase safety. - **ATCO E** – I don't see any overall safety enhancements in Area. But in Approach you could argue that a/c are all doing the same thing therefore increasing safety. You're still just as likely to though to lose lateral separation when using 3NM spacing or vertical if traffic descends early on the leg. - **ATCO H** – I don't necessarily think PMS makes the overall system safer but I do believe it allows controllers to handle more traffic while still maintaining at least the same safety as current system with less traffic going through the system.

QUESTIONS / RATINGS	COMMENTS
	- **ATCO H** – As Q27. - **ATCO I** – I feel some controllers have a comfort zone of how many a/c they are comfortable with. No matter how good PMS is they won't leave that comfort zone. Maybe with proper training it might help.
	- **ATCO B** – I do not believe this to be an issue in cases where separation may be a concern then positive control should be applied e.g. 'descend now' or 'level by' instructions. - **ATCO E** – We currently allow pilots to initiate their own descents. - **ATCO J** – With regard to the CDA of the a/c most a/c will begin to descend at around the same time and because separation has already been achieved and maintained laterally on the sequencing legs SA is not affected.
Q30. - Please elaborate any of your previous answers to Q1-29 here:	- **ATCO F** – My answers are generally positive. My negative answers concerned the role of the TM. I believe the responsibility and tasks assigned to the TM are too many and in certain circumstances could become unworkable.
NEW MANNING AND SECTOR CONFIGURATION	

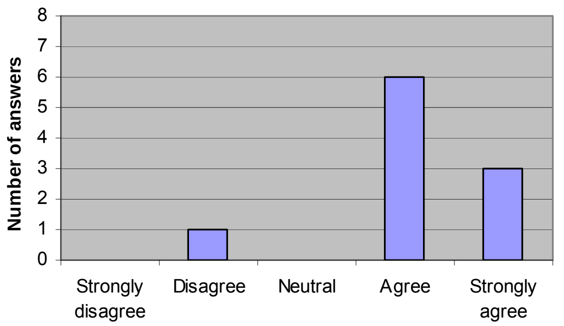
QUESTIONS / RATINGS	COMMENTS

Q31 - The new manning configuration is workable in Dublin Upper North and South sectors



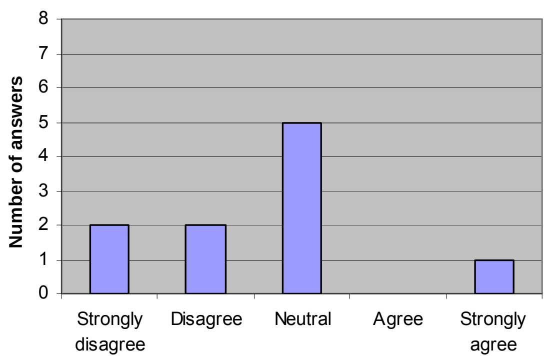
- No comments

Q32 - With the new manning configuration I felt I was able to handle all unusual events without any problems even under high workload conditions

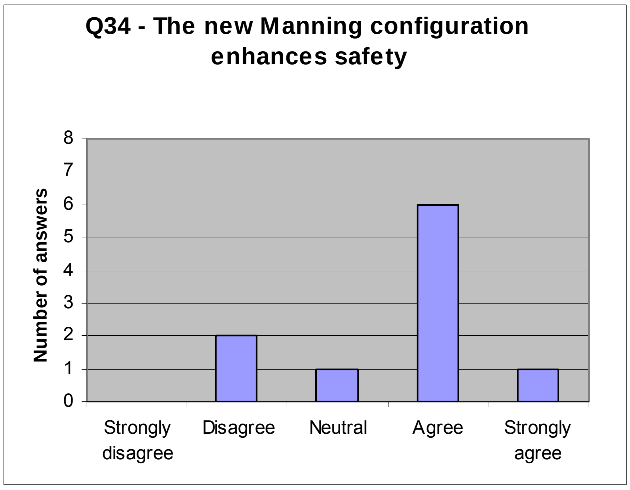
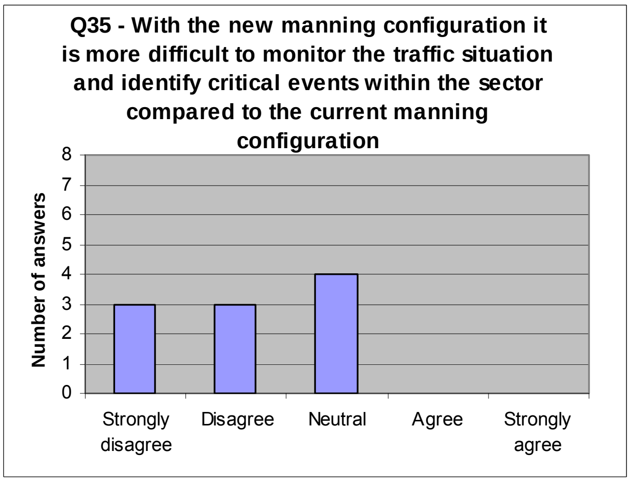
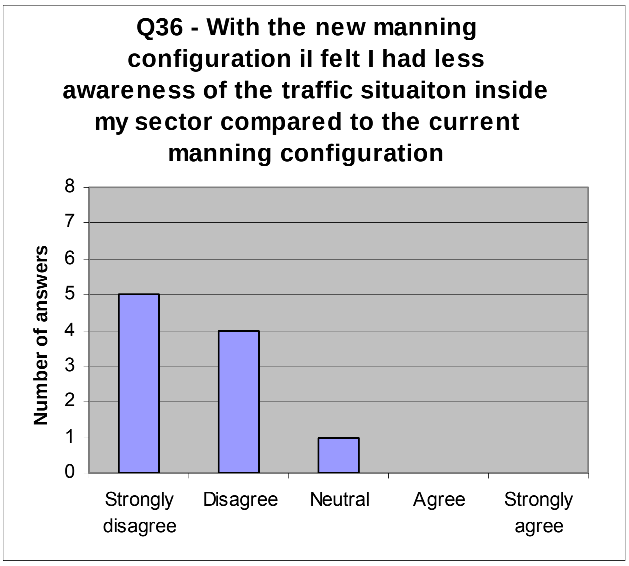


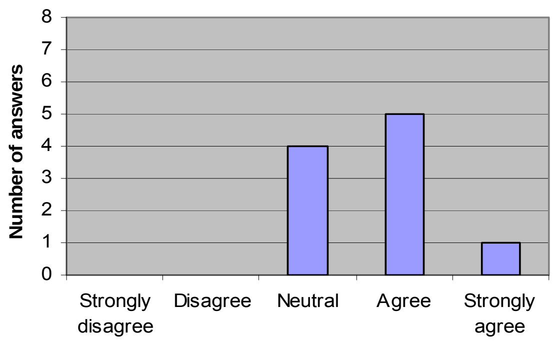
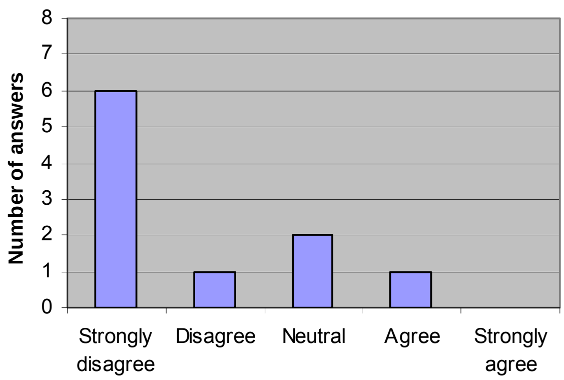
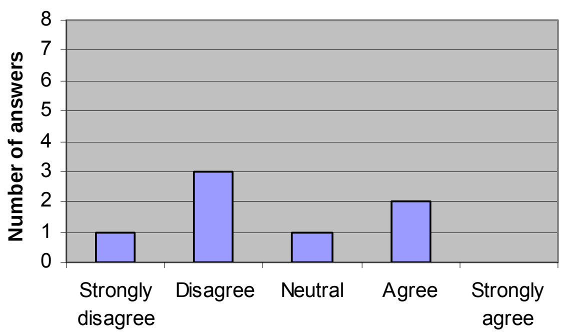
- No comments

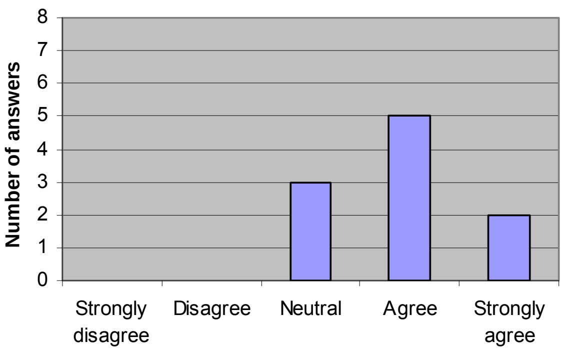
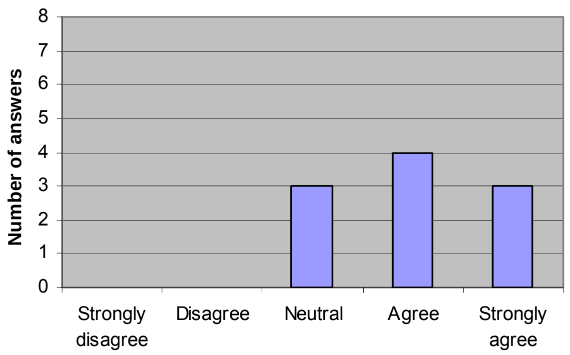
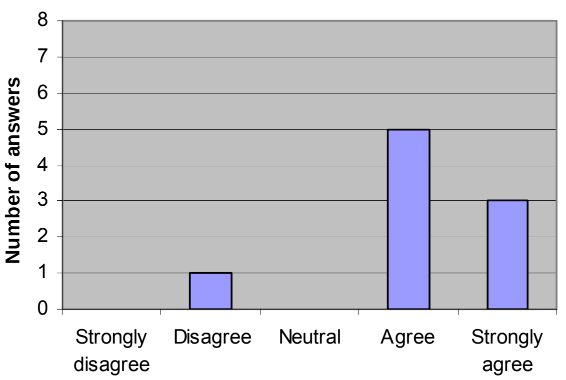
Q33 - Handling critical events (e.g. level bust) is more difficult with the new manning configuration



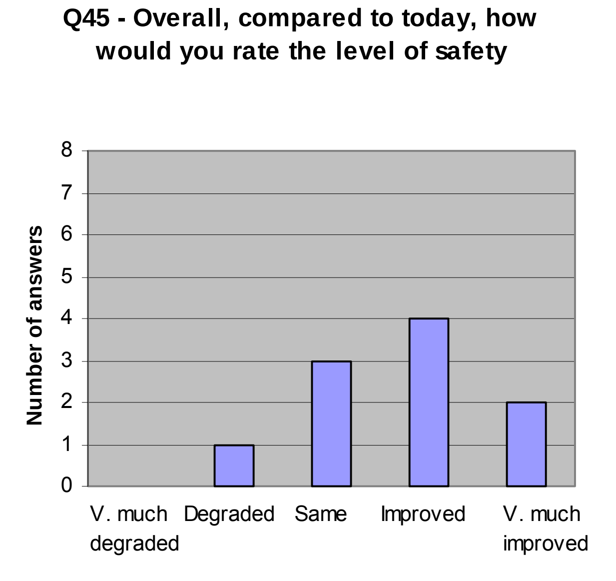
- **ATCO D** – As previous Qs it is often easier to spot a level bust due to smaller scale used in each sector.
- **ATCO H** – Level bust, it really depends where it happens. I believe within your sector (i.e. APP or FI) it would be spotted immediately but I don't think I would necessarily notice what was happening outside of the APP sectors. Again a level bust on the sequencing legs is far more critical, depending on what other traffic is on the legs than a level bust that takes place away from other traffic. This is why for Q34 and Q33 I can neither agree nor disagree because it depends on the situation.

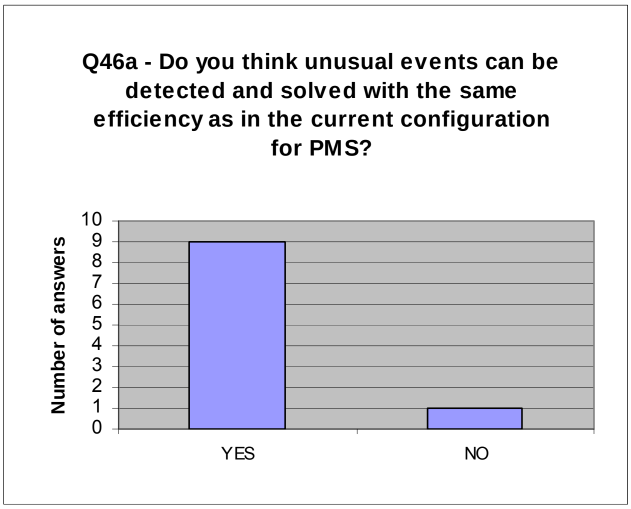
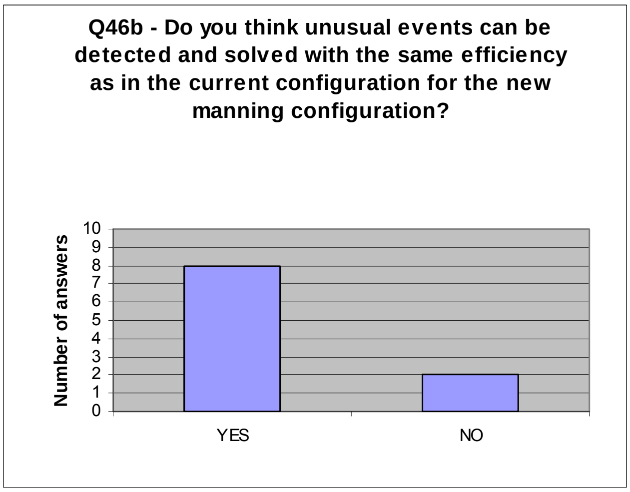
QUESTIONS / RATINGS	COMMENTS
	- **ATCO A** – It enhances safety as all sectors have a designated airspace and designated procedures. You know what is expected of you and you know what everyone is doing. Lower working off a small range is very beneficial. - **ATCO I** – Only slightly agree. PMS increases SA therefore safety should be increased.
	- **ATCO H** – I strongly disagree because we now have two people looking at APP sector currently we only have one. Also all traffic is following the same route so you are less likely to lose track of any item of traffic.
	- No comments

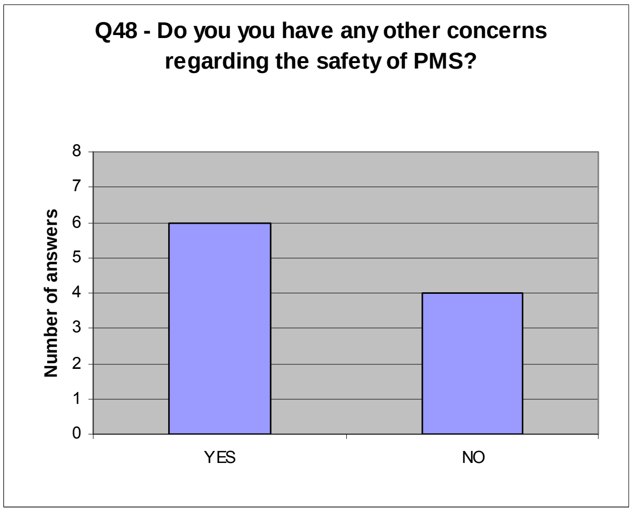
QUESTIONS / RATINGS	COMMENTS
Q37 - With the new manning configuration I felt I had less awareness of the traffic situation outside my sector compared to the current manning configuration 	- **ATCO A** – With the new manning configuration you don't need to know what is happening elsewhere. If you need to know the TM will tell you. - **ATCO B** – In some circumstances I had little idea what was going on in certain sectors e.g. in Lower North I was unaware of Upper South. While this is true it had no impact on my role and is worth asking why I would need to know about such traffic in the first place. I was more aware of other sectors that could have an impact on my own in the above example that would be APP, UN and LS. - **ATCO C** – I had awareness of the traffic situation in the other half of my sector whether Upper or Lower. I had very little to nil awareness of what was transpiring in the opposite sector whether North or South. - **ATCO I** – With SA I still found myself scanning outside my area the same as in current day. Which is more often than not.
Q38 - Handling co-ordination with adjacent sectors within the Dublin TMA is more difficult with the new manning configuration than with the current manning configuration 	- **ATCO A** – Co-ordination is much easier with the new layout.
Q39 - Handling co-ordination with adjacent centres is more difficult with the new manning configuration than with the current manning configuration 	- **ATCO E** – While on the phone no-one is listening to the frequency may be missing an important transmission. Some phone calls can take over a minute currently.

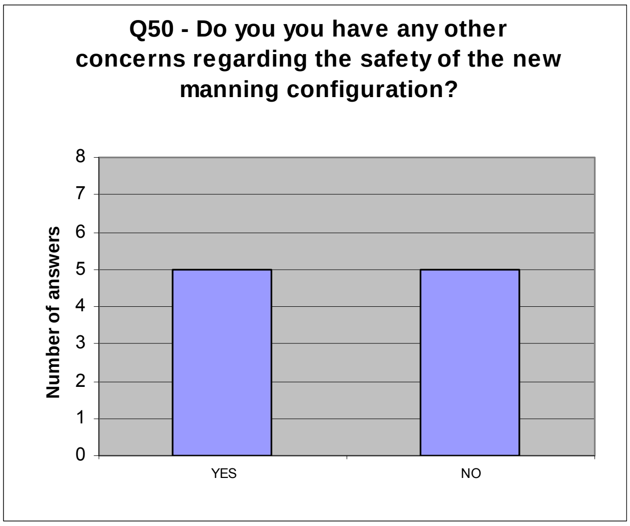
QUESTIONS / RATINGS	COMMENTS
Q40 - The Traffic Manager helped me to co-ordinate efficiently and effectively with adjacent sectors and centres  	- **ATCO C** – I co-ordinated with other sectors and centres myself. TM did co-ordinate departures and arrivals with Baldonnel and Weston.
Q41 - The role of the Traffic Manager was beneficial as he supported me in my tasks more than the co-ordinator does with the current manning configuration  	- **ATCO C** – Difficult to compare TM in new and old scenario. He was essential in providing solutions to sequence problems when 8miles separation was not achievable. In our present working methods the TM would be less involved in deciding sequence of traffic.
Q42 - The procedures for holding were workable  	- **ATCO A** – Again we need to look at a holding controller. - **ATCO F** – All through the simulation I have expressed reservations as to whether one controller should manage a hold using TML and handle departures and en-route traffic .
Q43 – Please elaborate any of your previous answers to Q31-42 below.	- **ATCO F** – One advantage of the old system was that co-ordination within a sector was generally done by the Planner this not distracting the Executive controller from other tasks. The argument against this is that the

QUESTIONS / RATINGS	COMMENTS
	controllers in single sectors have less to do in PMS. - **ATCO J** – I definitely think safety is enhanced by PMS because the procedures are so well defined that if something outside of these occurs it is very easily spotted. - I only experienced holding at the merge point holds and thought these worked extremely well as it gives more SA to pilots and they are much close to touchdown than if they are held at the start of the seq. legs.
Q44 – Additional comments / suggestions about working methods in the different conditions	- **ATCO A** – Overall the new manning configuration is far superior to the current one and PM only enhances that superiority. Very clear and definite procedures must be produced and adhered to in order for this to work. The TM must be a rated position and they should have authority. - **ATCO D** – Work has to be done on the role of the TM, the training involved & due to the nature of the position it should involve passing a minimum standard. TM important also as controllers will have to change mindset and allow an individual to make some controlling decisions for them. - **ATCO F** – Continuing from Q43. I think a holding controller should always be available when more than 2 or 3 a/c is being held. - I also think the TM should operate from a work station equipped with an active screen and generally do co-ordination by phone, intercom. This would give TM the opportunity to prioritise his work. - **ATCO G** – I would have preferred a consistency in working procedures throughout the RTS. All be it if they didn't work optimally rather than amendments being made and re-made e.g. sequencing leg runoffs. - **ATCO J** – I think that 3NM separation on finals should not be abused as a way of cleaning a mess that happened further back on the seq. legs. I agree with 3NM separation but as a FI controller it would be quite hard to sit in this position for a prolonged period of time as it is quite intense and draining. Also if tower have departures they will not be happy with lengthened periods of 3NM between arrivals.
SAFETY	

QUESTIONS / RATINGS	COMMENTS
	- No comments
Q45b –Comments to 45.	- **ATCO A** – WL is significantly decreased so this gives more time for monitoring and checking. There is also more planning time as the controller knows exactly what has to be achieved. The current working methods lead to ad hoc working practices. The new working methods have a definite structure which can enhance safety. - **ATCO B** – Re. the PMS element, the predictable trajectories provide more certainty regarding a/c flight patterns and the reduction in descent clearances means there is less chance of a level bust or an incorrect descent clearance issued by APP. Leaving FI to apply speed control enables consistent application of 3NM spacing with less chance of loss of separation on finals. - The new manning configuration in Area balances WL and allows much more time and attention for each controller to notice and react to any safety issues. - **ATCO D** – Lower range means greater concentration on a/c – although one man positions I feel each sector will work as team looking out for each other (i.e. Lower and Upper). - Feel procedures such as run offs, rwy closures etc. should be developed more. - **ATCO E** – No change. As most of the SIDs /STARs in the new procedures match current ones crossing points are the same. In Approach you have traffic pretty much flying the same as current traffic does, i.e. daisy chain. But new system allows a higher volume of traffic to be handled. - More label clutter in the Approach sector close to the airfield. - **ATCO F** – This is not a negative comment but I consider the level of safety now (in the current system) to be high. - **ATCO G** – SA of traffic in TMA is degraded. - **ATCO H** – I don't believe the PMS system necessarily enhances safety in APP and FI but it definitely does not reduce it either! PMS does allow controller to handle a lot more traffic than currently without reducing safety. Does this mean that it is safer or just more efficient whilst not degrading safety?! This WL is not handled by two controllers (APP and FI) currently one controller in

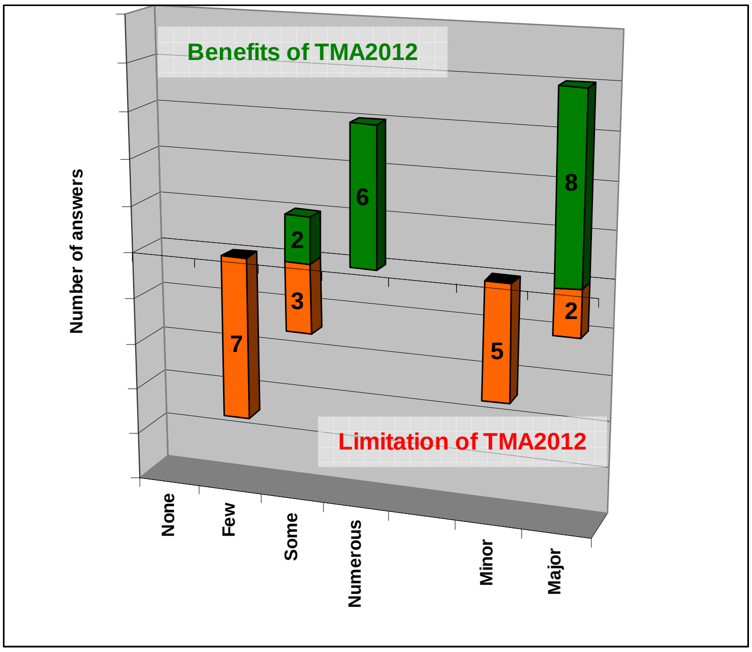
QUESTIONS / RATINGS	COMMENTS
	APP could not safely handle this much traffic. Traffic would just go to the hold to be vectored when sole controller able to. - **ATCO I** – A/c doing what you expect. Though SA increased therefore safety increased. - **ATCO J** – I today's environment there are too many variables between all the teams. It doesn't mean that its not a safe environment but I think that PMS regulate safety because if PMS procedures are followed strictly throughout all teams there is definitely less chance for confusion to occur.
	- No comments
	- No comments
Q47 – If responded 'No' to Q46 please explain.	- **ATCO E** – You're handling less traffic at any one time which allows you to spend more time monitoring the traffic you have. - **ATCO F** – I'm assuming that lack of second pair of eyes in a sector will be compensated for by the WL being shared - **ATCO G** – A number of occurrences of a/c transferred between sectors when the a/c made unforeseen or were non compliant with previous ATC sector clearances. - **ATCO H** – Note again if sequence legs full and one a/c

QUESTIONS / RATINGS	COMMENTS
	descends it is critical to solve immediately but I do believe it would be spotted immediately and solved efficiently. - **ATCO J** – PM – Less chance of a/c taking wrong heading as less headings being given. - New manning configuration – arguments for and against this. More of an equal split of traffic between sectors in PMS therefore potentially making it easier for errors to be noticed however, in current environment there are 2 people sitting in the Area sectors so there are more sets of eyes and ears available to spot errors. - Splitting APP into 2 sectors in PMS makes unusual incidents easier to spot.
	- No comments
Q49 – If responded 'yes' to Q48 please describe them.	- **ATCO A** – In the first exercise where I was in Lower I lost some SA when holding. I was busy working the hold ad departures. This didn't occur in later sims but I think that was because when holding we were normally on 3NM separation and there were no departures. - Twice after a handover 2 arrivals entered the hold when they should have been cleared to continue on the seq. leg. The traffic behind had been cleared to the same level. Avoiding action had to be taken in one of the instances as the traffic in the hold had been transferred to Approach. - **ATCO B** – Training resources must be prioritised before implementation, it is essential that staff is fully trained and comfortable with the new system for it to work well and safely. Consideration should be given to making training courses a rating where a pass standard must be met. - Once implemented standards must be enforced rigorously. If people start to adopt their own procedures which are contrary to those published then problems will arise. This may mean changes to the current UCE process. - **ATCO D** – Some concerns when things go wrong about fact that many a/c will be at same level. Although in simulation this was not a major issue I would wonder with live traffic. - **ATCO E** – When holding as the Lower controller I felt at times I had too much to do (i.e. control the hold, departures, Weston departures and crosses. - If I got sucked into one area it might be to the detriment

QUESTIONS / RATINGS	COMMENTS
	of another area. - What happens if one airline or pilot decides he is not flying a CDA and descends early on the leg. - **ATCO F** – I would like to express one reservation. The efficiency of the PMS is such that in certain circumstances using 3NM separation a large number of a/c will be delivered into a small volume of airspace. (i.e. on finals and inside sequencing legs). While the procedures for non-nominal events (e.g. rwy closure, weather avoidance have been well formulated) I would worry about the ability and skill of individual controllers to apply them. - **ATCO G** – 1. CDA vis a vis ATC requirement to descend / climb a/c to ensure separation. 2. Reduction to 3nm occurred on a number of occasions when it was not intended / planned, 3. Incorporation of holding controllers into the system, 4. Use of 5NM on FI, this is not a separation standard between arriving and departing traffic. I am not convinced it is a suitable spacing for day to day operations. - **ATCO I** – My one main concern is training. Proper training has to be delivered with proper instructors and resources. Proper time must be given to the training and possibly the introduction of a PAA MARK. - PMS might reduce controller radar vectoring skills particularly in APP and FI. Possibly introduce simulated radar vectoring exercises one a year.
	- No comments
Q51 – Do you have any concerns regarding the safety of the new manning configuration?	- **ATCO A** – See first point above. - **ATCO E** – No extra set of eyes and ears on the sector. Watching and listening for an error or deviation. Especially when distracted by co-ordination on phone or in the centre. - **ATCO F** – My comment in Q47 applied here. - **ATCO G** – 1. Potential for loss of separation between a/c descending to the same level for Seq. Leg entry join ad one a/c making an unintentional hold turning back at the succeeding a/c. In addition this occurring at point o transfer of the No1 between sectors. 2. Boredom, lack of stimulation in Upper sectors, leading to loss of SA and separation. - **ATCO J** – See Q47.

BENFITS AND LIMITATIONS OF TMA2012

Q52, Q53 – Overall, how would you describe the foreseen benefits and limitations of TMA2012 for the whole ATM system?



	Benefits	Limitations
ATCO A	Fuel savings to airlines.	Weather. Its Ireland. Its wind and wet in the summer. Long periods of high winds causing havoc with speeds on legs for sequencing.
	Increase in throughput of traffic handled by the centre.	Poor controllers will handle less traffic just to feel comfortable and not run into issues like overworking themselves. Causing delays.
	Reduction in R/T time for volume of traffic,	What happens if the ILS is unavailable or in

	allowing more efficient handling of the traffic (i.e. descents and speed instructions given on time)	Low visibility?
ATCO B	ATCOs – Standardised system for delivery of a/c – at DUB we provide a very inconsistent service.	ATCOs – Minor loss of vectoring skills.
	Airlines – to follow on from above we would now provide a consistent service.	-
	CDAs – Efficiency, less fuel burn so better for airlines and environment.	-
ATCO C	Consistent spacing on Final Approach to Tower.	Loss of controller vectoring skills.
	Fuel saving to airlines because of CDA.	Less job satisfaction possibly for some controllers.
	Environmental advantages: less noise pollution, less use of fossil fuel.	More aircraft having to level off until clear of arrival tracks.
ATCO D	Large reduction in workload for ATCOs.	Training – TM must be rated. The overall training required for all positions will be huge.
	Better predictability + delivery of traffic.	Pilot adherence – This, I think, will be unlike most services provided so I hope pilots will follow the instructions.
	Better working practices + enhanced safety.	Safety Case – Historically our company has been reluctant to go to SPO.
ATCO E	Safety – Rigid procedures adhered to all the time enhances safety.	ATCOs – Feeling like some of our radar skills have been lost (e.g. vectoring).
	Efficiency – A regulated flow of traffic but still being able to move more traffic than current procedures allow for is god for both airlines and ATCOs	-
	-	-
ATCO F	Reduced workload for controllers, therefore increased capacity for Dublin airspace in future.	Possibly less responsibility for sector controllers, therefore less job satisfaction.
	Less fuel burn, emissions, therefore beneficial to environment.	Workload of TM (in addition to responsibility too great, leading to under-performance and not getting most out of system.
	Standard procedures, therefore less likelihood of ad-hoc controlling.	De-skilling of controllers (e.g. lack of vectoring practice) could cause problems when PMS not available (e.g. RWY34 active).
ATCO G	Increased situation awareness.	Possibility of controllers losing vectoring skills.
	Increased fuel efficiency.	Possibility of management not devoting resources to training.
	Decreased workload.	Lack of a parallel runway at Dublin.
ATCO H	CDA (pilots, airlines).	Loss of situation awareness (ATC).
	Some ATC predictability (ATC, pilots).	Loss of some control to cockpit (CDA).
	Structured airspace (ATC, pilots).	Loss of ATC predictability for level crosses, due CDA descents (ATC).
		Long time at low level on the sequencing leg, particularly when needing to use 5000ft due transition level greater than 70.
ATCO I	New airspace configuration balances TMA workload.	Unfamiliarity with airspace and procedures for pilots who do not fly regularly into Dublin.
	CDA to airlines saving fuel.	Inability of adjacent centres (particularly London/Manchester east of BAGSO) to provide traffic streamed may cause Dublin some problems.
	Improved delivery of aircraft to runway.	Importance of APP segments may mean we penalize non-Dublin traffic (e.g. low level overflight).

ATCO J	Much increased efficiency (can handle more traffic than current system).	Weather can cause disruption and even shut down completely the PMS.
	Much increased predictability for pilots and airlines.	Loss of vectoring skills for controllers which could then be a safety issue if PMS not available.
	Reduced workload for APP. PMS is a lot less tiring than free vectoring a lot of traffic.	Very dependent on excellent traffic management and constant flow without overloading sequencing legs.

ANNEX I INTERVIEWS NOTES

As a complement to the debriefing sessions and in order to obtain more specific and individual feedback about the operability of the operational concept and its working methods, interviews of about 20 minutes were conducted during the second week of the simulation with each of the measured controllers by the members of the validation team.

The interviews were semi-structured, which means that although specific questions were directed as to how the controllers perceived certain elements of the PMS (see the set of interview questions for consideration below), the controllers were also free to provide any further feedback they considered worthwhile regarding the PMS.

Furthermore, as not all the controllers who participated in the simulation have area ratings and therefore did not sit in the area positions during the simulation, the questions asked of them were mainly focussed on Approach and Final positions.

A summarised version of the recorded interview notes can be found in this annex.

Interview Questions for consideration

- With regards to your working methods, how do you compare the PMS with your current way of working? for example,
    - Do you find a significant change in the tasks you have to do?(if possible explain impact for different positions)
    - Have you more or less monitoring?
    - Are you able to perform other tasks as well as applying point merge?
    - Does point merge make your job easier or difficult in any way?
- Overall, how do you find your workload levels in PMS as compared to current working methods – has is increased or decreased – what do you think are the reasons for this?
- With PMS, do you find it difficult to handle have an unusual event under high workload conditions?
- Are the new controllers working procedures for PMS sufficient?
- How do you find the working procedures for unusual events/non nominal events – do they work for you?
- Do you have any problems with the Upper and Lower manning configuration?
    - Does it affect your situation awareness?
    - Are the coordinating tasks combined with tactical tasks too demanding?
    - In your opinion, is it something that would be easily accepted into Dublin TMA?
- As an executive, controller, do you feel the traffic manager provides the right assistance to support you in your tasks? Do you think there is a need for a traffic manager role?
- If you have had the opportunity to be traffic manager, do you think the tasks and responsibilities given to you are sufficient and adequate? - is the workload manageable?

I.1 Controller A

PMS – Benefits and Limitations

According to the controller, one of the major advantages of the PMS is that not only does it provide benefits to the controller but the predictability of the system also provides benefits for airlines. The controller who also participated in the previous RTS 2008 feels even more positive about the PMS, especially now that the appropriate procedures have been put in place to deal with unusual situations. He found that the procedures were picked up and received very well by the controllers which he finds encouraging. Moreover, while the procedures are more rigid than current day methods, they leave nothing open to interpretation and can be therefore adhered to in an appropriate way.

Although with the current traffic situation, PMS may not be very useful, when traffic eventually picks, the PMS is a good step forward for the future.

With regards to acceptance in Dublin, he mentioned that there may be reluctance in controllers changing to a new way of working.

Upper/Lower Manning Configuration

Workload

In the area sectors the controller estimated that the workload split is about 60/40 but this varies. While in the simulation the lower sectors seem to have more workload, in reality the upper sectors haves to deal with adjacent sectors which have not been simulated and this may balance out the workload between upper/lower. However, overall the controller felt that the workload remained quite low for both upper and lower controllers.

Situation Awareness of Area sectors

Because it is the TM's role to have the overall picture of what's going on in north and south sector and to inform the other controllers, the controller felt that it was not the area controllers concern to need to know what was going on in the other sectors.

When asked about the handover of the area position with the new manning configuration, the controller didn't think that there were any issues related to this. This is currently done with the Approach position in Dublin TMA.

Holding

One of the major issues for the controller is the holding procedures. In one of the exercises he reported having missed a departure because he was dealing with holding traffic. According to him this is one of the areas where having a planner controller as a fall-back procedure comes into play and could have safety implications. As a possible solution he mentioned maybe having two holding controllers available, depending on staffing and if traffic went up to a level where PM was constantly being used.

Traffic Manager

The controller believes that as the simulation progressed, the role of the Traffic Manager evolved. He felt that it was more efficient to have the responsibility of ensuring that the traffic flows correctly with one person instead of everyone doing their own thing.

If something goes wrong for example too much traffic coming on to the legs, he found that it is easy to recover and although workload goes up, this is not to a huge extent. The most challenging for the TM is ensuring the smooth flow of traffic onto the legs. According to him, the other tasks are the usual basic tasks. As an area or approach controller he found that found that coordination with TM was simple and easy to understand.

In his opinion, if training is done correctly and a few tools are looked such as a mechanism for counting aircraft, the job is very feasible. He believes that is also imperative to have a suitable mechanism to allow the TM to decide the appropriate time to open the holds such as a reliable AMAN system.

In, in Dublin the TM would need to be a rated position it is a different type of role to the normal tactical controller.

Having a data assistant could be beneficial – if the tasks are laid out properly.

Overall potential issues with PMS

The controller reported that the runway 28 sequencing legs were an issue particularly when the wind condition was introduced need to be longer.

The 3 mile separation has a huge impact on the tower so they would need to be kept in the loop. However he finds it is easier to do point merge on dep/arr to get a 5 mile gap than vectoring.

VFR traffic, especially in runway 10, the whole base of controlled airspace needs to be looked at. It is usually the South sector which deals with it and it can be quite busy.

Although approach and Finals works very well, the controller finds he is sometimes bored in approach and this may have an impact on vigilance – on a couple of occasions he forgot to watch altitudes on some VFR a/c going to the West.

I.2 Controller B

PMS – Benefits and Limitations

Overall very positive about PMS operations think they are a very good thing. Certainly using current day working methods / procedures would not be able to handle the same quantity of traffic.

Major change in working method must listen to the TM and accept that he has a high level strategy that they must adhere to. If not it wont work.

APP and FI Ok but would like to have another go. It takes some time to get used to tweaking traffic to get 3NM or 5 NM exactly and achieve it easily. Perhaps when implemented should be careful not to swap controller positions too much i.e. mixing Area with APP sectors need to keep APP on APP do they fine tune spacing as it takes some time to get used to. Therefore could do by the day the changes i.e. one day APP sectors another day Area.

Upper/Lower Manning Configuration

Workload

Workload distribution under PMS is much more even between Upper and Lower. In current system the Planning controller does very little distribution of WL between EC and PC is 85%:15%. Whereas under current system it is more 55%:45%. So workload much more manageable if had the same quantity of traffic with current set up would not be able to handle it.

Situation Awareness

Not aware of what is going on in the South when working the North and vice versa – but do not need to be as TM will know and on that basis defined a strategy.

Working procedures

Lots of crossing a/a at sector boundary (Upper and Lower) so the scenarios are a bit artificial, and manufactured for the RTS that would not happen to same degree in real life.

Traffic Manager

TM role is workable, no real difficulties noted but the procedures need to be clarified more. The key is advanced planning and informing controllers of what is likely to happen. But perhaps there is a bit of co-ordination overkill – too much co-ordination going on. It may not be necessary to co-ordinate per a/c but let the TM give blanket instructions e.g. you can give shortcuts instead of defining short cur required for each a/c. Perhaps some task could be handed back to sector controllers e.g. Weston a/c. TM does not need to do this s/he could receive a call then hand it to the appropriate sector for them to deal with instead of doing it him/her self. Or let the sector deal with it directly.

TM needs to focus on APP, FI and also co-ordinate most with Lower controllers

In terms of information a segregated HMI is needed so that TM know which a/c are departures, arrivals etc. Clear rules of thumb needed to help make decisions such as when to open holds.

People must listen to the TM – need more experience and TM role to become more stable and clear

Safety issues

No real safety problems although the big issue is base of control. The only real solution for this is to have the Base of control lowered – this must be sorted out.

Other thing is related to safety and efficiency before PMS operations introduced all controllers must be fully trained – it's a major change in working method so need more than just two weeks training before hand. Some people will not be motivated and will not want to use it but they must be familiar and comfortable using PMS operations and not revert to vectoring or putting a/c in holds as that will have efficiency and perhaps safety implications.

Shift handover

Check list are a good idea – also ensuing Upper and lower controller do not change shift simultaneously is another thing that should be ensured – in fact this is the procedure that happens today, EC and PC are not allowed to change shift at same time.

Another thing that could help is that each team even controller uses different marks and highlights on labels to dignify different things – therefore a controller may not know what highlighted text symbolises – therefore one way to ensure everyone know the meaning of different symbols/ highlights is to standardise meaning for such think. Same with the strips everyone uses there own symbols etc. to indicate something if this was standardised then all controllers would know what symbol signifies.

Data Assistant

Data Assistant could definitely help out and do some extra tasks. If does FIS needs to be fully trained and also be in addition to a Data assistant as the DA could not do both at the same time – in that case would have 2 DA working one on FIS another doing DA work. DA already does a lot in terms of preparing flight strips, could do this and expand their role slightly.

VFR needs a separate desk – needs to be open at all times if DA is responsible for this then need another DA doing DA tasks. There is only 1 DA per shift currently available.

I.3 Controller C

PMS – Benefits and Limitations

The controller finds that with PMS you can handle a lot of traffic safely because of its predictability compared to current situation. Speed control is a huge element and it seems to deliver a more consistent spacing to the tower. He feels very positive about PMS, and especially the amount of traffic that can safely go through the system. Compared to current day situation, it seems to be much easier to deal with issues like runway closure etc, LAN failure etc. With PMS the sequencing legs and merge points allow controllers to deal with a/c with at least 8 miles between them so there is more time to deal with conflicts, compared with the current situation where a/c are streaming towards a holding pattern leaves you less time and increased workload in order to the 1000ft between a/c coming into the holds.

Upper/Lower Manning Configuration

Workload

The controller believes that with the current exec/planner configuration, there is an uneven distribution of workload. The executive controller can devolve responsibility of the hold to the planner but this is not always the best way as it involves crossing of transmissions. Currently in Dublin TMA, most executive controllers prefer to work the hold themselves and will just ask the planner to confirm the availability of levels. As a planner, it is difficult to keep a high attention level when there is not a lot of traffic in the sector.

With PMS, The controller agreed the upper sector position has less workload than the lower controller, especially in busy periods. He estimates the workload at a ratio of 60/40 with PMS, when there is no holding involved and nothing unusual is happening and there is a normal amount of traffic. Because the lower controller has the a/c longer, s/he has to work them to get them on the sequencing leg whereas the upper controller only has to descend them and send them to the lower controller.

Situation Awareness

The controller believes that with PMS it is not necessary to see what’s happening in the other sectors. He found this strange at the beginning but as he became more familiar with the system he found that easier working from a smaller range allows you to concentrate on your own sector.

On several occasions the controller experienced problems with label clutter when dealing with overflying aircraft especially in the upper north position. Although he never forgot that they were there, he had to actively look for them and this could cause problems for SA if the sector had been very busy.

Approach and Final

The controller feels that the present day situation involves “free-vectoring aircraft all over the sky”. Because of the systemised nature of PMS, reverting to vectoring may happen only to recover a 2 or three miles so he finds it very easy to manage.

However he finds that in the final approach, ensuring that a/c speeds are maintained is so critical that focussing too long on the screen causes eye fatigue. If implemented there would have to be a time limit on doing this task.

The controller believes that VFR traffic are a problem with PMS would have to have a FIS for the core hours of the day.

Traffic Manager

In current Dublin TMA operations, the coordinator only intervenes when necessary. It is the area controllers who decide on the sequencing of aircraft. With the PMS, it is the TM who decides what's going on. The controller feels that the procedures are well laid out. However, he feels that there is a lot of responsibility to get it right and other controllers have to have the confidence that the TM is not going to overload them.

In the first exercises of the simulation the controller found that holding was an issue – with time and more experience the upper and lower controllers can now tell the TM the situation. The controller highlighted the importance of having a trigger to allow the TM to make the decision on holding and stressed it as ''a safe option'' to enable the TM to decide holding at an early stage in order to avoid any difficulties later on.

Training

The controller expressed his concern at the current lack of TRM courses in place at the IAA and stresses that they need to get away from familiarisation courses and concentrate on putting more strategic plan in place for training for PMS, particularly for lower sectors and approach.

I.4 Controller D

Working methods

Overall I like the concept. The RTS has definitely shown that you can push a lot of traffic through the system safety using PMS.

The working method is changing significantly with PMS, I enjoy vectoring the a/ c but you need a change in mindset, at the end of the day the aim of our job is to provide a safe and efficient flow of traffic. No concerns really about the introduction of PMS, and perhaps becoming deskilled. Perhaps for those people that really enjoy vectoring they may miss vectoring and wont like so much sticking to STARS but the aim is to make your job easier so why not.

Over the RTS the concept has impressed me. PMS is a huge difference and will take some people quite awhile to get there head around the whole thing – training is essential

Upper controller has time to point things out to Lower. Lower and Upper should work as a team, find that you are talking to the constantly.

Workload

The WL is manageable. Needed to get used to the procedures, it took a couple of weeks, i.e. training and the first couple of days but now there are no problems working with PMS.

The Lower area sector controller does a lot more work than the Upper. But the work is still manageable for the Lower and upper because working at such short ranges. But compared to current operations the work is easier. However, Upper controller and Lower controller work as a team, talking together all the time and co-ordinating.

WL for APP and FI is manageable – after a week everyone was very familiar with the procedures and they worked well in the exercises.

Situation Awareness

With PMS you do find that you concentrate a lot of more in your own sector. Have a great SA of what's going on in own sector, but SA of what's going on in other sectors i.e. overall SA, is reduced. Not really a problem but this is where the role of the TM comes in greatly. Currently in Dublin we not really use the co-ordinator role

Working procedures

For non-nominal situations – still some work to do with the procedures- it is not 100% proofed yet. With the sequencing leg run offs the more experience you have the easier they become.

Non-nominal of blocked runway worked well. I need to see more non-nominal situations before I can fully comment.

Each position seems to be well manageable. It took people about a week to become really familiar with procedures but now it works well.

Traffic Manger

The role of the TM is not yet full defined, it is evolving over the simulation and will continue to evolve, I think as people become more experienced doing it. I feel the role should have a rating to ensure that people are well trained and achieve a certain level of performance. It is a very important role, especially with regards to SA of whole sector therefore you need someone you can trust and hence ensure they have the necessary qualifications to do the job. I think everyone here things that the role of TM needs a rating associated with it. It needs to be a trained position separate from a sector controller.

The issues of delegating some responsibility to the TM for deciding strategy and way to handle traffic is not a problem if that person is qualified but I would not trust someone who had not been properly trained – I would have a huge issue with it.

Data Assistant

Need to have a separate FIS suit. The person who has the least amount of workload in the Dublin TMA under PMS is the Upper controller. But I do not think the Upper controller should be responsible for VFR traffic this will be too much. Lower cannot do it either as they have too much work. There needs to be a solution. I think a DA could do it but they need to be qualified and again they would need the appropriate training.

Safety

When at the end of a sequencing leg and you go to opposite hold you will have a/c on the same level, here you need to be mindful, in current day we are used to stacking a/c so you have the level separation but here you are using longitudinal separation so it's a big change. I wonder if it will get through a safety case.

It may be difficult to get the fact that you are working more with longitudinal separation instead of using levels to ensure separation to get through safety case you could have 5 a/c in close proximity at same level, but operationally it is not a problem. But if it does go wrong it could be an issue.

Other

With the RTS there are too many inbounds and then no departures for 15 – 20 minutes – this is a bit unrealistic and wouldn't / couldn't happen in real life.

Training is massive and a real issue currently in the IAA. As current training is inadequate, its not invested in even refresher straining seems to have been sacrificed. There has been not TRM training since 2001 and TRM is really important in PMS due to the change in way of working where you become more a team working the traffic led by the TM.

Way to many inbounds in RTS – it's a bit unrealistic. Also need a few more departures – again to make it realistic.

I.5 Controller E

PMS – Benefits and Limitations

The controller found that PMS is a much better system than what is currently in Dublin today. For the volume of traffic that was being handled in the simulation, he feels that the overall workload stayed at a relatively low level. However, with the current low volume of traffic at the moment he is not sure if the system would work in Dublin as there would not be enough traffic to fill the sequencing legs. Today, 75% of all traffic in Dublin is getting direct to LATMO because Dublin airspace is so quiet.

Upper/Lower Manning Configuration

The controller considers the new manning configuration as an improvement to the current Executive/Planner configuration. According to him, with the new configuration the executive can now make his/her own decisions.

Workload

He feels that the workload is sufficiently split between upper/lower to allow him enough time to listen to what is happening on frequency and watch and double-check where as the current environment you only have half the time to do a quick sweep of the entire sector.

However, one drawback he found is that while operating as a lower controller and having as many as four aircraft in the hold caused the workload to increase significantly. The holding procedures need to be clearer. Or alternatively, the need to have a holder controller may be justified, as for the lower controller – having to manage TML list and control aircraft can be a problem.

Co-ordination

Certainly the loss of second pair of eyes along with second pair of ears is a disadvantage – for example transmissions can be easily missed where all the coordination with Shannon, London, Manchester, Scottish has to be done by the upper controller where transmissions can take up to one minute to do. Having a second person beside him who also knows the strategy is a support, particularly with regard to coordination which allows him to continue with his tactical tasks.

The controller does not feel that delegating the responsibility for coordinating with adjacent centres is a good idea – it should stay with the sector controller and anyhow a data assistant would need a radar rating.

Situation Awareness

When in the upper sector, the controller reported that you can see north, lower and approach. However in the lower sector, the controller might be able to see some of the upper ctrl airspace but not all and you cannot see at all what's happening in the other sector.

With the PMS, an approach controller cannot see the flow of traffic coming to her/him. He feels that having a view of this traffic would allow him to better plan his strategy regarding getting the 3 or 5 mile separation. The final controller does not see what's going on beyond the legs. All he sees is a/c coming on to the legs. It is not really important for him to see beyond this.

Traffic Manager

The controller interviewed believes that traffic manager has a lot of tasks to carry out and in busy periods the job could become unmanageable. For example, dealing with one phone call while an extra a/c goes on to the legs and facing into a run off situation could create a considerable increase in workload, stress and frustration in a short time.

Piling too many tasks and responsibilities on to one person could become an issue.

One of the possible solutions should be perhaps to take a few tasks of the TM and this would relieve the feeling of huge responsibilities the TM has somewhat. He also proposed having an automatic a/c count figure for traffic in the airspace in the TM display could help the TM decide at an early stage on the best strategy to take. solution. Because of six areas to cover, this display would allow the traffic manager to quickly decide on the best strategy to take – such as the visual display of how much traffic in the sector.

The MAESTRO system which is currently in Dublin is not accurate and the size of Dublin TMA with the close proximity of Manchester and Scotland and Shannon does not allow them to have the aircraft long enough but an improved and efficient system might help them to decide when holding is required.

Approach/Final

Job Satisfaction

The controller found that when busy, workload remains at a normal level in approach and final, however, when quiet he finds it quite tedious. However if you achieve the 3 miles or the 5 mile gap on the legs, controllers feel this is job well-done and there is a certain job satisfaction which ensues.

He finds with the new procedures that you can find flexibility in the rules and work within the rules – this makes working more dynamically ensures efficiency at the same time.

Training

When asked about the training required for PMS the controller believes that the required amount of training for approach, area and traffic manager should be at least, at least 4 or 5 weeks.

Particularly in an emergency situation, vectoring is a skill which could be lost over time and this would have to be covered in refresher training.

I.6 Controller F

Working methods

PMS concept is workable with the co-operation of adjacent centres. If we had FABs it would be perfectly workable. With PMS you need a bigger lead in but in the future it shouldn't be a problem with FABs.

Happy working the Area sectors without a planner. When holding its difficult would like a holding a controller as its not sustainable to work hold, departure and arrivals at same time.

Workload

PMS does reduce WL. I also like the environmental aspect. I worry that the WL for the TM may be too high and there is perhaps a little bit too much responsibility being taken from the sector controllers. I am worried about APP not being given responsibility for their WL, they should have a say in the amount of traffic going on the seq. legs. The TM and APP must work together in a two way relation and APP should have the right to decide on the flow rate onto the sequencing legs – it should be a collusion between TM and APP. The WL distribution and responsibilities given to the Upper and Lower sectors is OK.

The Lower sector definitely has more WL than the Upper sector but it's an improvement to current days operations. Perhaps to make the distribution of WL more even between the Upper and Lower the Upper controller should assume responsibility for crossing traffic. Currently the Lower does it because they are working on a Lower range but it could be delegated to the Upper controller.

Situation Awareness

Overall SA for the sector controllers has decreased. However, the controllers SA within their sector is increased they have less SA of the global situation. But again the TM has the global view; perhaps this puts too much responsibility on the TM especially if an unusual situation occurs. For example, it happened yesterday when was the TM there was a Baldonnel and Weston departure at the same time looking for a climb out by the time I dealt with it and informed the other controllers a lot had happened in APP and a/c fell off the sequencing leg. I think Baldonnel departures should go straight through to sector and not the TM but not sure others will agree.

Working procedures

The Upper controller should assume responsibility for crossing traffic. Currently the Lower does it because they are working on a Lower range but it could be delegated to the Upper controller to relieve some of the Lower controllers' workload. Upper and Lower controllers still need to work like a team as PC and EC currently do – in fact this is how the roles have evolved over the simulation.

I am comfortable working a single sector. Although a holding controller is needed. It is not sustainable for the Area sector controllers to be responsible for arriving traffic, departures, over-flights and holding a/c – it is too much – under current day when I am working the PC looks after a/c when they are in the hold or there is a separate holding controller.

In the last week, I felt very comfortable with the controller working procedures, the first week I need the procedures next to me so I could look up stuff if necessary.

Traffic Manger

I am concerned that too many tasks are being put on the TM – some of the tasks should be offloaded from the TM, e.g. sector controllers should be able to take short cuts – perhaps the use of blankets instructions are a better alternative than instructions i.e. TM advising per aircraft. I am worried that APP is not being able to determine his/her WL is and the TM must work with the APP to decide on actions, it must be two way relationship.

Perhaps there is too much responsibility on the TM especially if an unusual situation occurs. For example, it happened yesterday when was the TM there was a Baldonnel and Weston arrival at the same time by the time I dealt with it an informed the other controllers a lot had happened in APP and a/c fell off the sequencing leg. I think that Baldonnel should ring directly the sector, and not the TM.

TM has a lot of co-ordination to do. He also has to go around the room a lot and so may not be there to support the APP when needed. TM should work from a workstation near / next to APP and could communicate with other sectors by intercom, so that TM does not have to walk around room and perhaps miss something or shout across the room. The TM must have a screen that depicts the different status of the a/c i.e. arrivals, departures, over-flights in all sector (and not 'unconcerned' as the current co-ordinator has). The HMI that has been developed for the TM position (during the RTS that shows the number of a/c per sector) is not so useful as the number of a/c per sector would jump for example jumped from 12 to 20 in one go need something more than that.

Data Assistant

The DA giving clearances to Baldonnel and Weston departures may be more trouble than its worth in terms of Industrial relations, i.e. unions, money etc.

For the Flight Information Service – the DA will not do it as it is a controllers job, again there will be Industrial relation issues – I have no good ideas on that. A permanent FIS suite would be good but it depends on the demand from VFR traffic. If there is not much demand it will fall on the Upper controller to be responsible for the FIS, it is not the best solution but it will happen anyway. Not sure a countrywide FIS is feasible – it may be too big an area for one person to be responsible on a busy summer day.

Safety

I am fairly happy with the procedures for the non-nominal situations e.g. rwy closures although some procedures do need to be refined.

I am a bit concerned just about the number of a/c there are in a smaller volume of space, i.e. by the level of traffic we think we can accept, especially if a non-nominal situation occur, e.g. a runway closure. In the RTS the number of a/c that were being handled was very large but perhaps this is increasing sector capacity too much.

Performing in the Area sector and looking after en-route and holding traffic is not sustainable – need to have a separate holding controller. Also as mentioned the Upper controller can take on responsibility for en-route traffic.

Other

As mentioned there is a worry about losing vectoring skill. Everyone will still have to be trained on vectoring as it is still needed in non-nominal situations. People may lose vectoring skill. Further RWY 34 is used perhaps 2 days per year and will not have PMS and so vectoring will still be required for RWY 34.

Job satisfaction relating to the vectoring skills is not so much a problem as there will probably be new challenges – so we will have to wait and see. But perhaps the lack of decision making i.e. the TM being more responsible and taking away some of the decision making from controllers (Area and APP) may affect job satisfaction as they may feel less important.

Shift change is not a huge problem as long as handover is not simultaneous. SPS work everywhere else not reason why they shouldn’t work here in Dublin.

I.7 Controller G

Benefits and Limitations

The controller found that the method involved a different way of controlling aircraft. He believes that it is a more structured way of delivering traffic to the runway. It successfully achieves linear holds, predictability, CDAs for the a/c less fuel burn etc. when compared to holding.

He also believes it is positive that control is now moving from the ATC to the pilot in order to allow him/her manage the a/c profile. There is a shift of control from the executive controller to the Traffic Manager and this means less r/t workload involved. However, he feels that this may not work for Dublin TMA because of the physical dimensions of the airspace.

Upper/Lower Configuration

The controller found that being responsible for a certain level of traffic in a sector rather than having two people where one controller is not involved enough is a better way of working. When the workload and flow of the sector is regulated you don’t need the ‘second pair of eyes’ pertaining to the work. However, as a sector controller, SA of the whole airspace is lost. The controller feels therefore that the option of integrating a holder controller within the configuration needs to be looked.

Traffic Manager

The controller believes that the traffic manager role is not evolved enough and not sure that the controllers really know what is expected of them – “who controls, who is in control – how is that shared”? He feels there is an issue with the fact that that if there is a loss of separation, who really bears the responsibility for this if a tactical controller is acting on the suggestions of the TM. There is also the issue of how a controller interprets a decision of the traffic manager. He stressed that the procedures need to be clearly defined. He thinks that an ideal way is that traffic is delivered traffic to the runway and knows exactly where to commence top of descent to arrive at the runway without any ATC interference. For this an efficient arrival manager tool which would allow the predication of this and inform the a/c of the delay they need to absorb either prior to departure or en-route would assure the a/c of a straight in all the time.

TM needs clear-cut strategies to handle the traffic as s/he doesn't really have the time to discuss the strategy with the executive controller.

During the simulation the tool provided to give a representation of the arriving traffic arrivals in the sectors gives a good indication of when sectors are going to be busy but doesn't allow you to know when approach has reached the capacity and unless you look at the radar screen you cannot determine this. The AMAN should allow controllers to view the traffic at an early stage to let them know when to introduce the holding position or to go to 3nm and it would provide better methodology for issuing traffic into the TMA but this is still in the early stages. Because of the small TMA, you need to effect change early on in the flight and this is something that doesn't currently exist – this is done by telephone coordination. In the long term Dublin TMA needs a technology shift in terms of a metered system such as of an arrival manager which is more sophisticated and homed to support controller decisions that provides relevant information to the controller and not just something that has to be interpreted.

Workload

The PMS decreases the workload of the Approach Controller.

The workload is more evenly distributed overall, but it escalates considerably in certain situations. That might be a factor of the new procedures and the new way of doing things which eventually would decrease with experience.

I.8 Controller H

Benefits/Limitations of PMS

From an approach and final perspective, the controller believes the system would work in Dublin TMA as it requires mainly monitoring of speeds. This is a different skill which makes the job easier and pilots know where they are as the aircraft are not being vectored all over the sky. According to the controller, it would work well in the current environment as the aircraft could 'Direct To' the merge point which would make it even more efficient with the evening rush of traffic.

From the controller's perspective, the area sectors in Dublin are already quite systemised as controllers automatically send traffic into the holds.

The controller found that there was at times during the simulation an over ambitious amount of traffic given and that it was far from reality. In PMS controllers are more restricted when it comes to giving the spacing required. In reality when an aircraft reaches six miles in final, it has 5 miles on touchdown. With the PMS, she considers that a/c should be given 8 miles to approach to achieve the required spacing for finals.

Situation Awareness

The controller found that the SA of working the aircraft is high – in fact there is no change from the current environment. The difference is that in today's environment in approach, the controller takes a look at areas sector to get a picture of what's going on before the aircraft are handed over, whereas with PMS, the aircraft are handed over coming on to the legs with the appropriate separation so the approach controller doesn't have to make his/her own judgement until later on – for the approach controller SA is confined into what the controller needs to work.

Coordination Approach and Finals

The controller feels that coordination works well between approach and finals, however in reality, these would be merged together – this would also avoid the boredom factor of each position having little to do. However, the controller believes that the positions should be kept separate when busy especially when traffic comes to 3nm spacing.

Traffic Manager

According to the controller, it is essential that a TM can do the job well especially if traffic levels are high as a lot of people are dependent on his/her decision making and coordination strategies.

In order to relieve some of the tasks of the TM, staffing issues would have to be considered in Dublin. Certain tasks such as receiving the call from Westin or Baldonnel and for flight information could be handed over to the Data Assistant but this would require a second data assistant to cope with the other tasks which have to be done.

Impact of PMS on Tower

The controller feels that the tower would be impacted with PMS especially in busy periods. When provided with standard continuous gap, this is manageable. However the fact that when approach is busy and controllers go to 3nm until traffic calms down means that does not always have the stands to hold all the arriving aircraft..

Procedures for non-nominal situations

The controller found that the procedures in place for non-nominal situations work well especially those defined for runway closure.

The LAN failure procedures work well. The approach controller has the squawk sign and just has to re-identify the a/c and call-sign tag it. However, the controller felt that the LAN failures occurred when most of the traffic was with the area controllers so it may have been busier so less easier, especially for the lower controllers to deal with this.

I.9 Controller I

Working methods

APP certainly easier and it is more simplified but there is still work involved can have job satisfaction by seeing if can consistently achieve required separation, problem solving is reduced / simpler whether this will affect my job satisfaction or become boring in the future I cannot say. But, even with PMS there is still work involved and there is satisfaction in trying to achieve 3 or 5 NM consistently.

Less co-ordination with Area sector is a good thing, and as said a proactive controller will scan out to see what is going on elsewhere. But when you are busy there is little co-ordination anyway (currently).

Workload

Workload definitely decreases. Timing on when and where to turn a/c onto Final much easier. Problem solving under PMS is easier. Do worry a bit that the job is becoming more simplified and controllers may become over reliant so they may find that when an unusual situation arises such in bad weather and they have to use vectoring it is not so easy. However, controllers must just have extra time on the simulator to make sure the vectoring skills are maintained.

Situation Awareness

Situation awareness definitely increased because a/c are following a specific path, makes traffic more predictable and easier to check if they are on the correct path so have more time to scan the screen. More predictable know where a/c are coming from. Also a lot of the guess work or timing of when to turn a/c is easier - have a better idea of when to turn a/c.

Low and slow a/c over-flight has been sited as a concern by BA is this an issue do you think – For me I don't think so as I have noticed it on the runs. No co-ordination with Area was not an issue for me and did not seem to affect my SA or performance.

No real issues with the over-flights – if there are low and slow aircraft we have to work them if they come in our sector but there are not many – not experienced this is the RTS. However, a good controller does zoom out to see what is happening elsewhere when they have time.

Working procedures

In the RTS exercises you need 2 controllers because of the quantity of traffic, if it was quiet then one would do and this would be an interesting and perhaps give more job satisfaction. It is acceptable to have just one controller working APP and FI if traffic levels are not so high and it is more or less what AP does today when getting a/c out of hold.

Working procedures for non-nominal see OK.

Task allocation

Need 2 controllers on APP with the exercise and amount of traffic there is currently. If its quiet possibly do not need 2 controllers there. One person doing APP and FI is doable if traffic is much lower.

Traffic Manger

TM role has evolved over the training and RTS. There is a lot of co-ordination with the TM but it is good – he is like a helping hand and its good to have someone to discuss options with- it's a good valid second opinion. About delegation of responsibility and loss of control over what is going on in sector – no TM would even put a controller in a position he does not feel comfortable, and the APP and FI still have a voice. APP and FI must say if he is not happy with a decision made by the TM – and most TNM will respect that. In the RTS the APP and Tm are on the same wavelength so no difference there.

Clearances for Weston and Baldonnel should be done by DA – this would relieve TM of the task. So DA would give clearance then hand over strip to TM or sector (depending on procedures), the DA would inform them that Baldonnel or Weston would call them in 5 minutes for a climb out clearance and they would give the a/c the climb out. But it would save TM doing this task.

Data Assistant

Currently APP has little dealings with the DA – only if VFR flights form the UK call your frequency instead of the FUS frequency. DA would support APP in that instance getting squawk and giving any information required to him.

In current situation with current traffic demands a separate FIS suite is not really required. But the question is who would work it - no-one is really available. Perhaps the least busy is the Upper sector but the Upper sector cannot manage a/c on other side as well as on own side i.e. Upper North being responsible for a/c in the South. DA could do it but still need to have another DA doing current tasks. It would not have to be a permanent thing just during certain hours.

One option is to have a countrywide FIS suite that is done in Dublin or Shannon.

DA could give clearance for Baldonnel departures and print out required strips (not the climb out- that has to be given by TM or sector controller).

Safety

Training – proper resources should be given to training. Dublin is re-known for not putting the resources into training. In fact this is a problem within IAA for all sorts of training including refresher training – given TRM training in 2001 two years after joining the IAA and nothing since. Also a pass rate / criteria level of performance for TM must be defined before person can be assigned responsibility for the position. PMS is a whole new way of working you have longitudinal separation instead of lateral separation (with 1000ft separation), and you give continuous descents and normally have stepped descents – so training is important. Also need to ensure that the instructors are properly trained and qualified.

Also have not yet seen a Weston arrival with an aircraft near – would like to see this scenario. Have had a Weston arriving on the South but it was clear of any other a/c so ran smoothly. Would like to see Weston arrival when a/c turning off legs is nearer and in more of a potential conflict position (3 or 4nm away) - perhaps in a prototyping.

I.10 Controller J

Working methods

I think PMS is good. PMS operations regulates job, and results in a better flow of traffic. Both controllers and pilots know better what is coming. It may become less satisfying but I don't think you can stand in the way if its to make things easier and safer.

PMS brings better procedures and that improves safety and predictability. With PMS procedures must be rigidly followed and that's good as currently there are several different ways the procedures may be implemented so everyone does things slightly differently, there are too many variations.

Under current system Area can transfer traffic to you that isn't clear of departure traffic and you will have to co-ordinate with each other but under PMS you do not have that so there is less co-ordination like at. But less co-ordination is a good thing, as frequency is free. I am fully aware of what is happening in FI and we need to sit together to co-ordinate but co-ordination between APP and FI is very easy, I can see how busy they are.

Workload

PMS is less taxing on the brain that's sure but I don't think it's a reason not to implement it. Its true that PMS reduces the mental demand – I like working APP and my current job but PMS is a step in the right direction. If you are a controller vectoring will always be with you – need to be trained on it first.

With PMS if the traffic is quiet perhaps it will become more mundane. Could collapse sectors (APP and FI-and there should be not problems with APP doing both taking a/c off the sequencing leg and ensuring the required spacing is required before handing over to tower).

Situation Awareness

You definitely have more SA with PMS operations in APP and FI. I know exactly where the a/c are coming from. In current operations they could come from any number of places, there are too many variations in how the traffic can be delivered. It depends on the team and how the team work but all teams should work the same, procedures should be standardised.

Non-nominal events in APP and FI went well – you need to have procedures. A set of options of procedures for different situations would be good as you do have to adapt, and how you resolve a situation depends on the traffic situation. So you need procedures but you also need to be able to deal with them dynamically.

In APP less aware of what is going on upstream with PMS operations but from APP and FI point of view you don't even have to worry about what is going on as you know where they will deliver traffic you don't even have to deal with departures unless they do something funny.

Working procedures

The procedures seem to work, they are quite straight forward. Procedures for APP are clear. Very easy to co-ordinate between FI and APP as long as they are seated next to each other.

For TM and non-nominal events they need to be fine tuned to be fully effective. And need dynamicity for non-nominals – you need a number of options (but not too many) because again how you resolve depends on the traffic situation at the time.

Traffic Manger

I have had no problems with the TM it is quite straight forward. No conflict of responsibility with TM in RTS anyway. It may arise with some other people. From an APP perspective the TM role works well.

I think the role of TM is just a question of familiarity need different rules or thumb to help them make decisions but they need to get used to role.

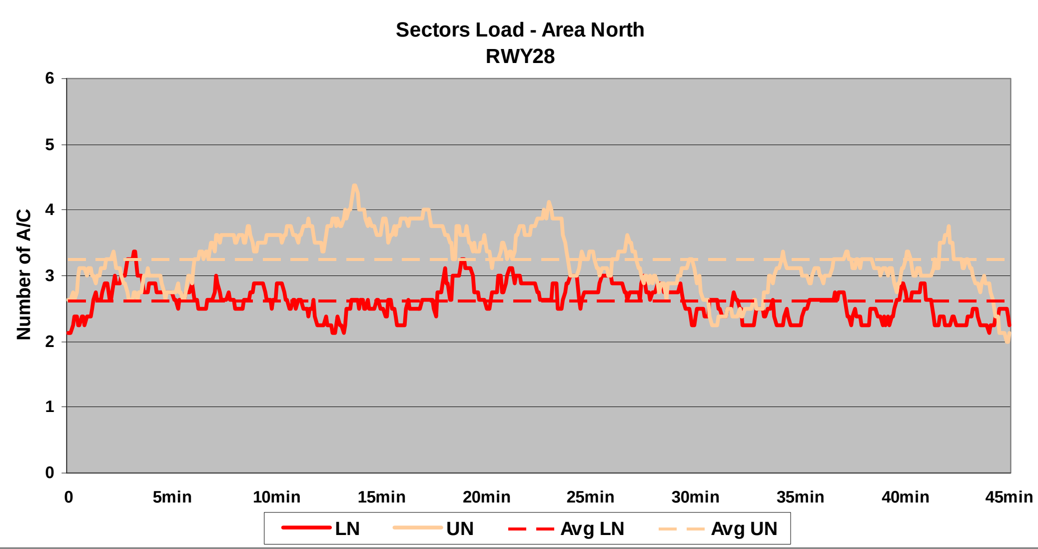
Data Assistant

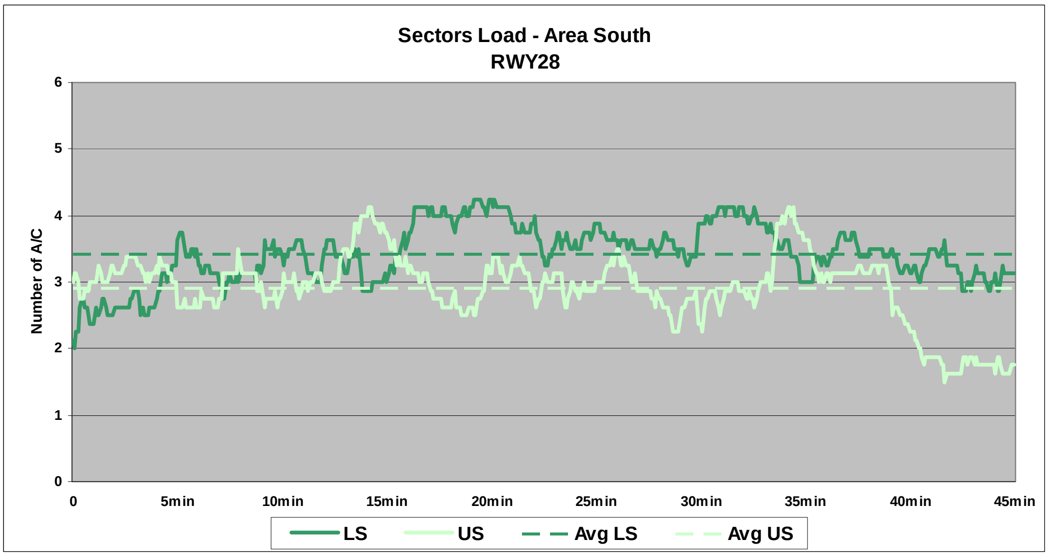
In current day DA supports the APP with VFR flights if they are not correlated, they can then correlate and prepare a flight plan and a flight plan strip. DA supports APP less than Area. DA can also ring estimates if outbound / departing sector to Shannon. So DA can do that anyway today no reason why they can't do it under PMS operations

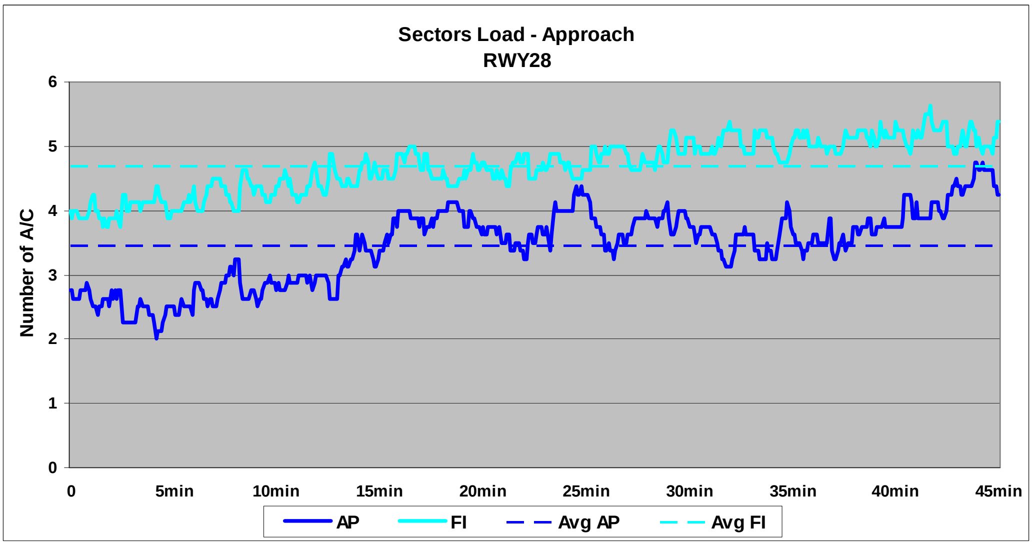
Safety

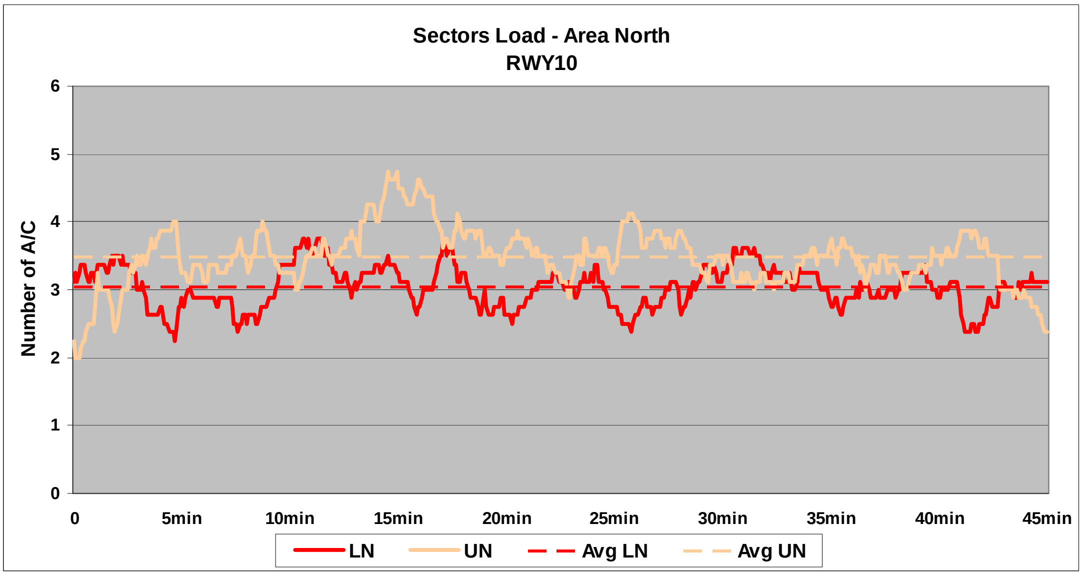
PMS improves safety due to the increase in predictability. Also you have standard procedures currently there are so many procedures that people so ore or less what they want. Having standardised procedures where everyone is doing the same thing and knows what to expect it is safer.

ANNEX J NUMBER OF A/C ON FREQUENCY









Sectors Load - Area North
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Number of A/C
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5
4
3
2
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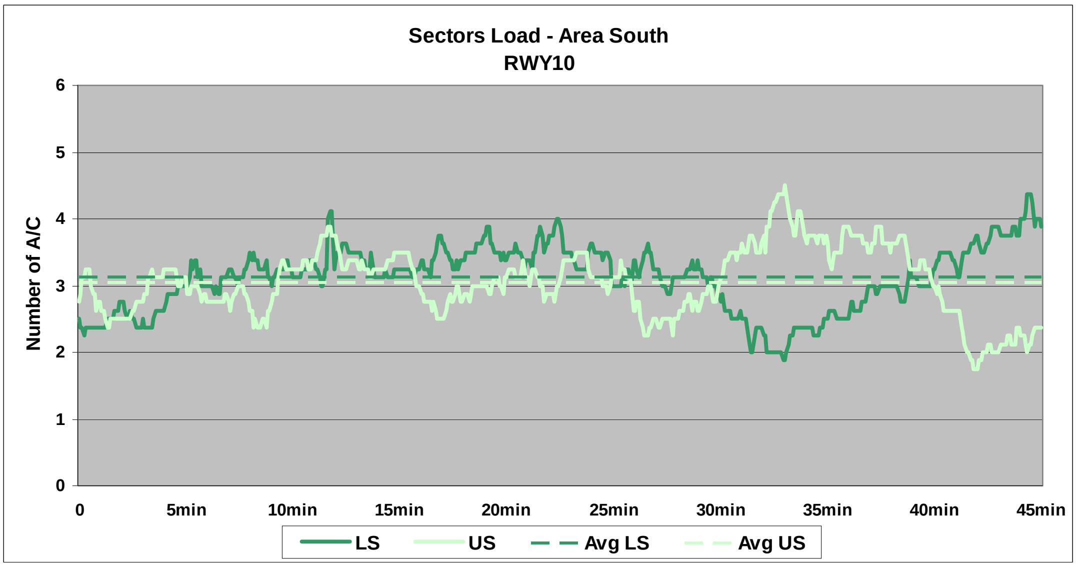
10min
15min
20min
25min
30min
35min
40min
45min
LN
UN
Avg LN
Avg UN



Sectors Load - Area South
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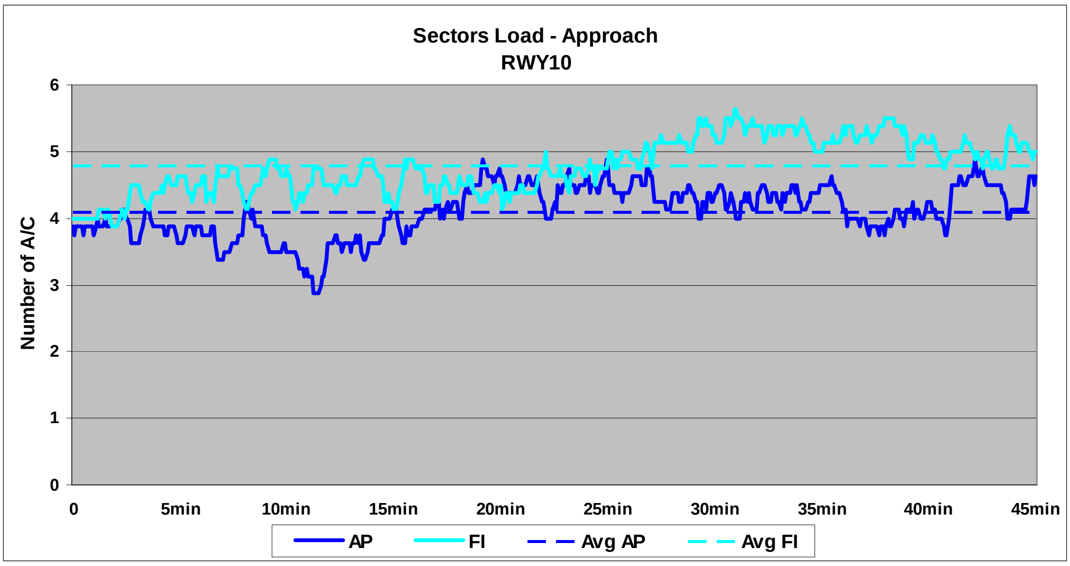
4
3
2
1
0
0
5min
10min
15min
20min
25min
30min
35min
40min
45min
LS
US
Avg LS
Avg US



Sectors Load - Approach
RWY10
Number of A/C
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5
4
3
2
1
0
0
5min
10min
15min
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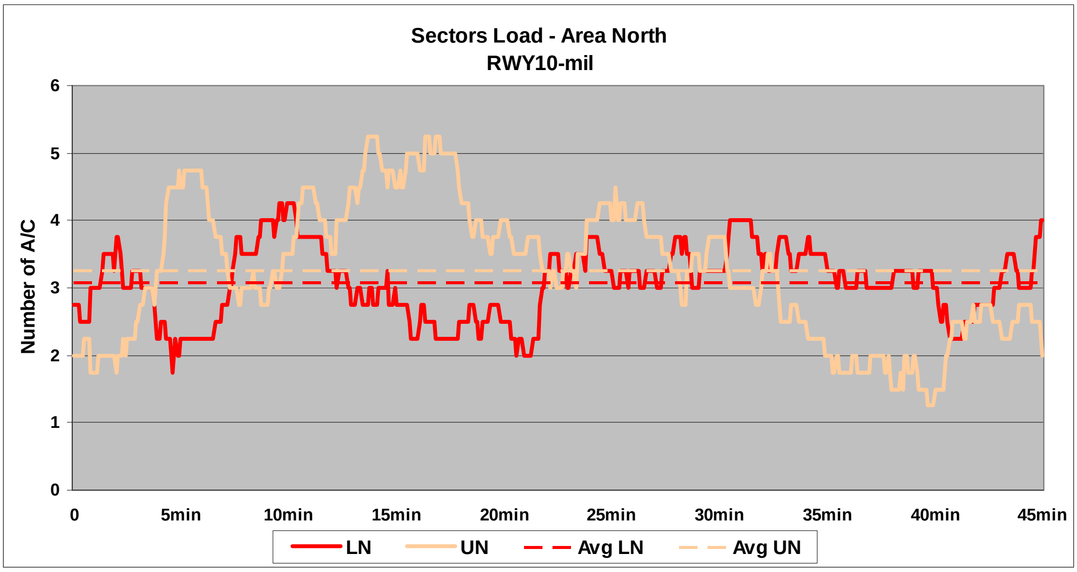
40min
45min
AP
FI
Avg AP
Avg FI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RWY10-mil
Number of A/C
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2
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4
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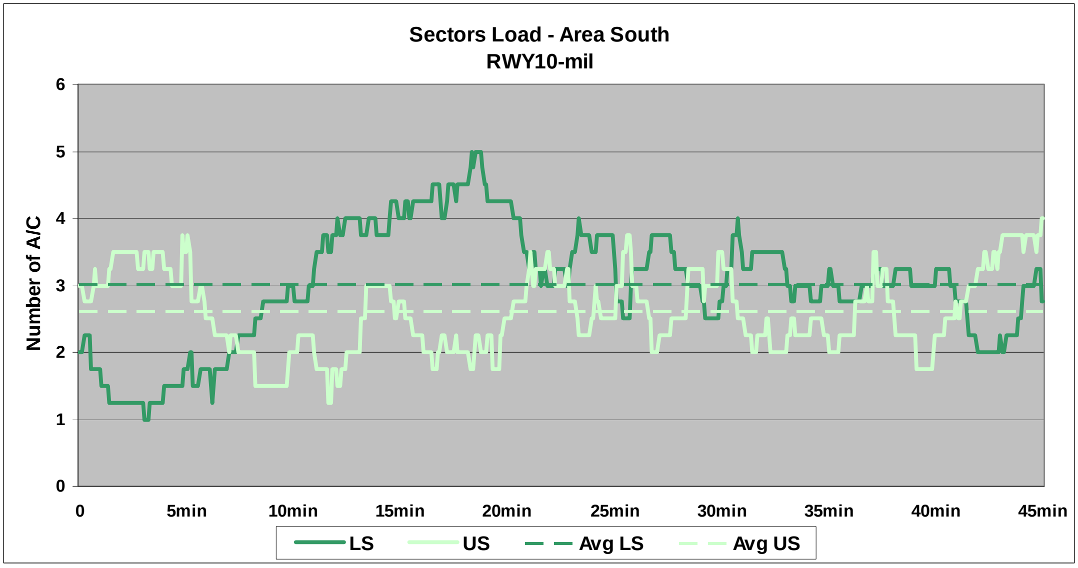
LN
UN
Avg LN
Avg UN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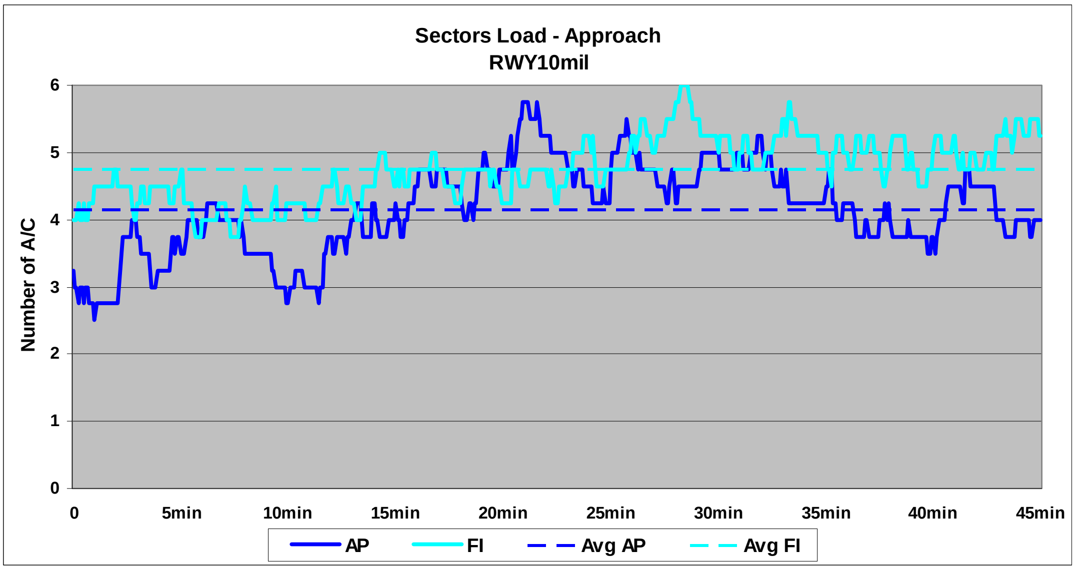
US
Avg LS
Avg US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RWY10mil
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4
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15min
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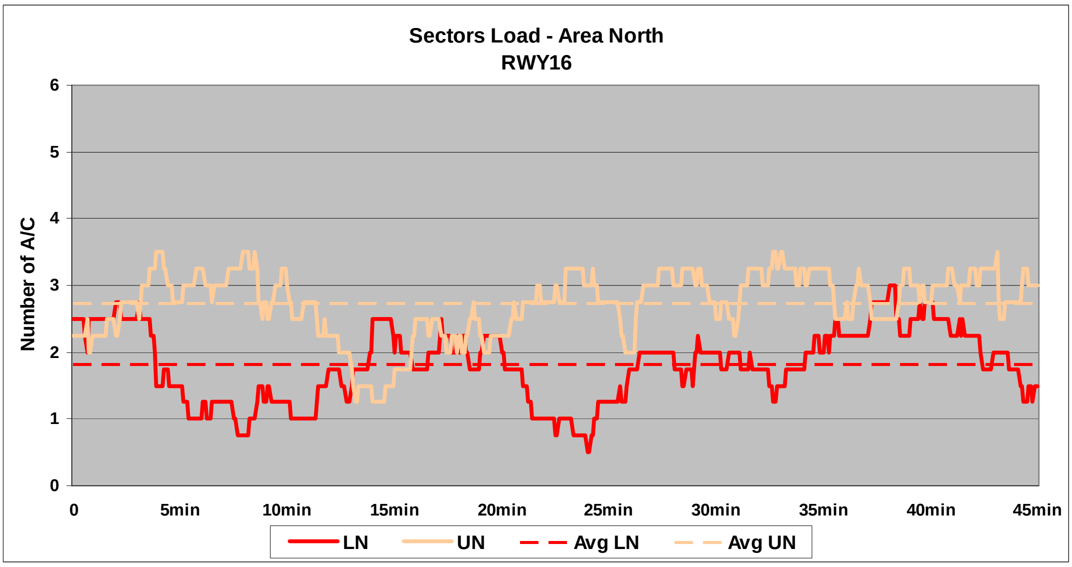
AP
FI
Avg AP
Avg FI


Sectors Load - Area North
RWY16
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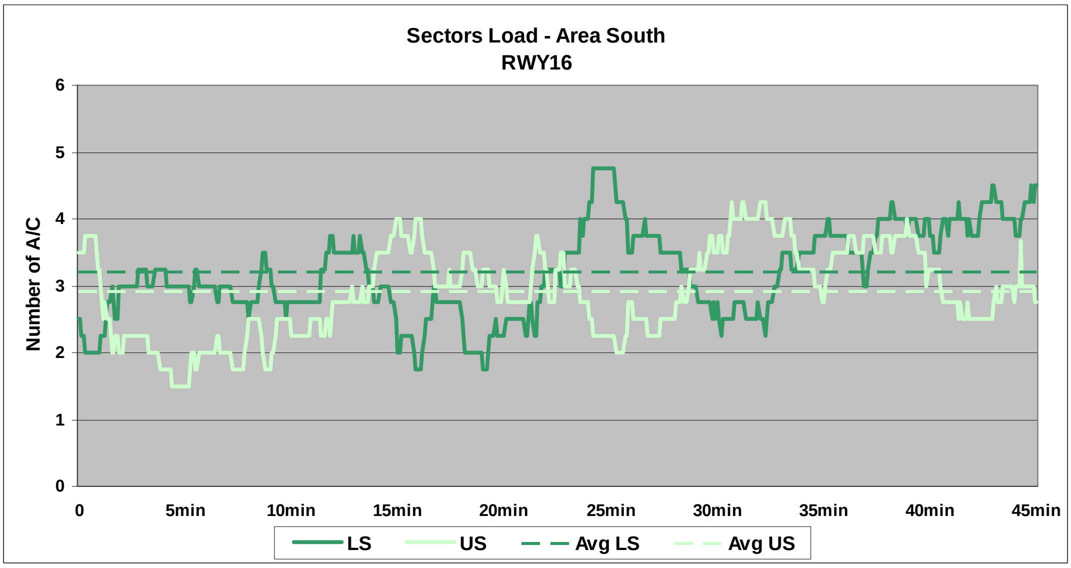
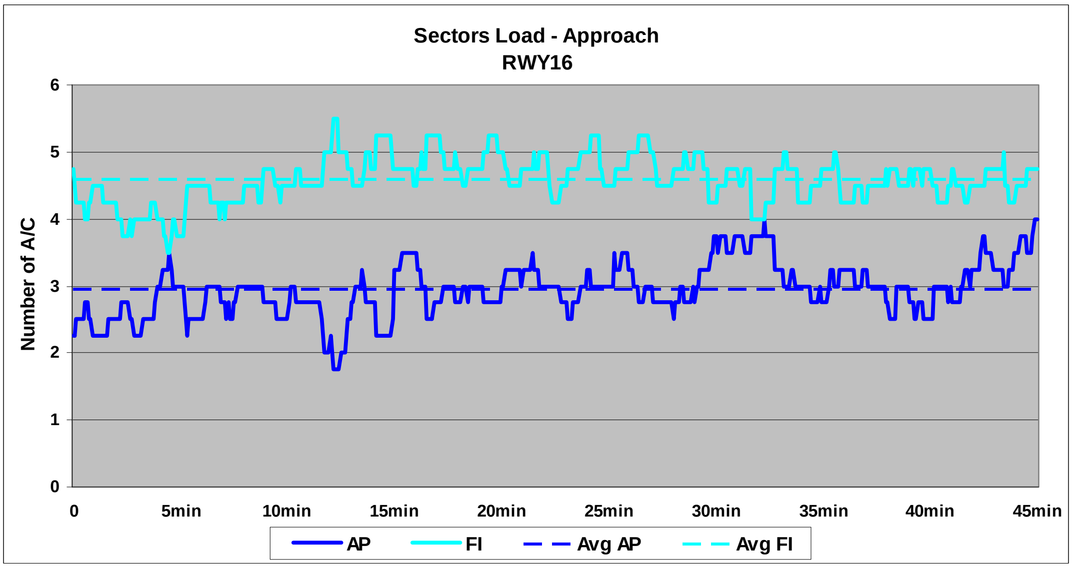
6
0
5min
10min
15min
20min
25min
30min
35min
40min
45min
LN
UN
Avg LN
Avg UN


Sectors Load - Area South
RWY16
Number of A/C
0
1
2
3
4
5
6
0
5min
10min
15min
20min
25min
30min
35min
40min
45min
LS
US
Avg LS
Avg US


Sectors Load - Approach
RWY16
Number of A/C
0
1
2
3
4
5
6
0
5min
10min
15min
20min
25min
30min
35min
40min
45min
AP
FI
Avg AP
Avg FI

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