P12.04.01 Thread 1 Validation Report

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Task contributors
NATS, NATMIG (Saab), SELEX

Abstract

This document provides the Validation Report for the set of exercises conducted under Single European Sky ATM Research Programme (SESAR) P12.04.01, within the Operational Focus Area "Airport Operation Planning and CDM". The Service addressed is DCB-0304 "Airport CDM extended to Regional Airports", and the exercises examined the use of a simple Airport Departure Data Entry Panel (ADDEP) at airports that are not equipped with advanced electronic flight strip capabilities. Two exercises were conducted in a live environment - using Southampton Airport in the UK. These assessed the feasibility of providing simple and low cost ADDEP panels, at smaller airports, and if it would improve the availability and accuracy of departure information provisions for wider stakeholders and result in benefits for network management and traffic load prediction.

The conclusions reached were that: the ADDEP provision and connectivity is indicated as feasible; and that predicted network management and traffic load prediction benefit expectations were indicated as valid.

Authoring & Approval

Prepared By		
Name & company	Position / Title	Date
[redacted]	[redacted] NATS	16/1/2012
[redacted]	[redacted] NATS	20/05/2011
[redacted] Think Research on behalf of NATS	[redacted]	20/05/2011

Reviewed By		
Name & company	Position / Title	Date
[redacted]	NATS R&D	20/05/2011
[redacted] NATS	NATS Technical Architecture	24/05/2011
[redacted] Selex Systems Integration Ltd	[redacted]	23/1/2012
[redacted]	[redacted] NATS	28/05/2012
[redacted] SAAB	[redacted]	01/06/2012

Approved By		
Name & company	Position / Title	Date
[redacted]	NATMIG [redacted]	01/06/2012
[redacted] National Air Traffic Services (NATS), UK	[redacted]	28/05/2012
[redacted] Selex Systems Integration Ltd	[redacted]	30/05/2012

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Executive summary

This report details the findings of the SESAR P12.04.01 ADDEP Validation Exercises that took place in the UK. This version contains the initial findings of the 1st ADDEP Exercise (in March/April 2011) and the update following the 2nd ADDEP Exercise (in September 2011) for which the CFMU provided additional analysis.

The scope of P12.04.01 is to develop a prototype that reflects the baseline requirements for the control of traffic flows at airports. The project makes use of an existing Electronic Flight Progress Strip (EFPS) system by modifying it to provide adequate information and functionality. This enables a low cost solution for airports that are unlikely to be equipped with advanced tower automation systems. It also presents a quick win opportunity where the project could therefore provide a cost effective solution for airports that do not require the full SESAR capabilities. Although P12.04.01 is not an operational project it has carried out validation activities as a result of an early validation opportunity identified by the project during initiation to assess the feasibility of the quick win.

The aim was to validate if providing simple and low cost ADDEP panels, at smaller airports, was feasible and if it would improve the availability and accuracy of departure information provisions for wider stakeholders and result in benefits for network management and traffic load prediction.

The conclusions reached were that:

- the ADDEP provision and connectivity is indicated as feasible; and
- network management and traffic load prediction benefit expectations were indicated as valid.

The initial plan was to conduct a single validation activity assessing the technical feasibility of the ADDEP Panel. However, during the development of this activity, potential for further validation activities were also identified. Activities for the following high level aims were proposed:

- Exercise 1 – To install an ADDEP panel in one airport tower and assess the operators' use of the system when the system is not fully integrated in the Air Traffic Management (ATM) network (i.e. the system is not sending messages external to the airport tower);
- Exercise 2 – To assess the impact of the ADDEP panel in the same airport tower when the system is integrated into the ATM network and is sending departure messages to the Central Flow Management Unit (CFMU) and adjoining Area Control Centre (ACC) units; and
- Exercise 3 – To assess the network effect when more than one airport is using an ADDEP panel and sending messages to the CFMU and adjoining ACC units.

However, due to inabilities to include other airports within the project time scales, Exercise 3 was not progressed.

The approach taken during Exercise 1 was to locate the ADDEP panel within the control tower at Southampton airport. The ADDEP client was a normal business personal computer that already existed in the tower. It was connected to the ADDEP server at National Air Traffic Services' Corporate and Technical Centre (NATS' CTC) near Southampton via NATS' business Information Technology (IT) network. The ADDEP client functioned as a web browser and was configured to view a secure page created on the server.

During Exercise 1, the Tower Controller (TWR) was requested to operate the ADDEP whilst performing their normal role. On the ADDEP panel they selected the appropriate flight strips from the bays and the relevant buttons when they issued their push-back, taxi or cleared for take-off instructions. As a result, related Air Traffic Control Departure messages were generated by the ADDEP and recorded on the server. But, the messages were not transmitted beyond the server at this stage. These messages were subsequently compared (by NATS) to the departure information that the CFMU would normally receive / provide for the airport.

NATS Network Management experts then assessed the impact of any improved accuracy in terms of likely benefit to network management. Specifically they tried to judge the use of the improved demand data for specific sectors against their respective sector flow rate by comparing it to the current situation.

Additionally, participants completed observation forms and questionnaires concerning the impact of using the tool within both the Tower visual operations and the Approach control rooms to identify: the

impact on the controller's workload of using the panel; any usability issues; and the perceived benefit or dis-benefit of using it.

Exercise 2 later repeated Exercise 1 with the ADDEP generated Air Traffic Control Departure messages being transmitted to the CFMU for their analysis and views on the effect on departure information provisions and predictability, and related impacts / benefits. Minor updates to the ADDEP system and parameters (resulting from the feedback from Exercise 1) were also included for this exercise.

The main results from Exercise 1 were:

- The data provided by the ADDEP system shows a large increase in the accuracy of the ETOT value over the current system. With ADDEP data included the end result is flight data with only 6% being outside +-10 minutes of error when comparing ETOT to TO. The current system has 43% of flights with an error of more than +-10 minutes when comparing ETOT to TO.
- ADDEP had an impact on controller workload, increasing the tasks and perceived workload of the controllers using it. However, the majority of the participants stated that workload remained manageable. The main increase in workload was during busy periods when input tasks were delegated to the Air Traffic Services Assistant (ATSA);
- Overall, the controllers had no major problems with the usability of the ADDEP panel. The integration of the system into the overall working position was a problem for some controllers and could be improved;
- The majority of controllers could see a benefit to Network Managers and APP controllers resulting from using ADDEP. Early warning that aircraft were moving on the surface was of benefit to both APP controllers for planning departures and overflights in the Terminal Control Area (TMA), but also for Local Area Supervisors (LAS) who would have earlier warning of aircraft about to enter their sector;
- The ADDEP panel had no overall positive or negative impact on safety according to the feedback from the controllers.

The following recommendations are a result of the exercise:

- The use of ADDEP should not be considered an 'extra' task for the controllers. In an operational system it should be a core task, not an additional task. In a validation exercise, the use of ATSAs for entering ADDEP data should be considered;
- The ADDEP panel should be properly integrated into a Controller Working Position (CWP) and better positioned ergonomically;
- The data generated by ADDEP should be distributed to the Network and used by network managers and other users so they can properly assess the potential benefit.
- The ADDEP Human Machine Interface (HMI) should be improved to alert controllers to wrong parameter settings and to possibly include more information (or the option to display more information) on individual aircraft. For example, due to the incorrect setting of the TAXITIME variable the 'Push Back' DPI messages were being sent with inaccurate data;
- A highlight was made that the slave ADDEP panel provides extra details to the Approach controller however this could be improved by having the flights in the correct departure order. For this reason it is recommended that the ETOT value upon the strip be updated to improve the sort order displayed to the Approach controller;
- To ensure in future exercises that all results can be evaluated it is recommended that a formal training session is provided to the participating controllers on tool use and limitations with signoff being carried out between both the controller and a system expert before the commencement of the exercise;
- The limitations of a shadow mode exercise in a live operational environment meant that some exercise objectives could not be fully assessed. The project, and the SESAR programme as a whole, should consider ways in which to balance the needs of research and development validation exercises with those of an operational environment.

The main results from Exercise 2 were:

- The feasibility of ADDEP connectivity to, and interoperability with, CFMU and other systems, by use of existing ATM messaging and connectivity mechanisms, was proven; and
- The ADDEP ability to provide information (in the form of standard A-DPI and C-DPI messages), which would significantly improve the early availability of increased accuracy TTO predictions prior to take off (as initial indicated by the Exercise 1 analysis), was further supported by the CFMU analysis.

1 Introduction

1.1 Purpose and scope of the document

This document provides the Validation Report for SESAR P12.04.01 "*Baseline for Airport Controller Tools*" under the DCB-0304 "*Airport CDM extended to Regional Airports*" service within the PAC05 "*Airport Operation Planning and CDM*" Operational Focus Area (OFA). It describes the results of validation exercises defined in the P12.04.01 VP-391 Validation Plan [7] and how they have been conducted.

The scope of P12.04.01 was to develop a prototype that reflects the baseline requirements for the control of traffic flows at airports. The project makes use of an existing EFPS system by modifying it to provide adequate information and functionality. This enables a low cost solution for airports that are unlikely to be equipped with advanced tower automation systems. It also presents a quick win opportunity where the project could therefore provide a cost effective solution for airports that do not require the full SESAR capabilities. As P12.04.01 was not an operational project, and no corresponding operational projects were active and able to provide their operational requirements for validation, the project therefore carried out its own validation activities based on the results of the early validation opportunities (as identified by the project during initiation to assess the feasibility of providing quick wins). The projects Concept of Operation (for ADDEP) P12.04.01-D10 Ed 00.01.00 [7] identified the following four High Level Operational Requirements which then formed the foundation for this Validation activity.

Requirement No.	Nature of Requirement	Method of Validation
REQ-12.04.01-OSED-HLOR.0001	The controller workload shall remain stable or possibly decrease	Live trial user assessment
REQ-12.04.01-OSED-HLOR.0002	The controller focus of attention shall remain unchanged	Live trial user assessment.
REQ-12.04.01-OSED-HLOR.0003	The accuracy of departure data the Network Manager receives from regional/small airports shall improve	Practical demonstration through live trial.

Table 1: High Level Operational Requirements

1.2 Intended audience

The intended audience is:

- Anyone involved in the preparation of the validation of the advanced ADDEP tool being developed with project 12.04.01;
- Anyone participating in the validation exercises;
- Members of the CFMU.

1.3 Structure of the document

The document is structured as follows:

- Section 1 (this section) introduces the report;
- Section 2 puts the ADDEP concept and validation process into the context of the SESAR programme;
- Section 3 summarises the preparation and conduct of the ADDEP exercises;

- Section 4 summarises the consolidated results of the ADDEP exercises (this section was not completed in the first issue version of this report and is now completed);
- Section 5 summarises the consolidated conclusions and recommendations of the ADDEP exercises (this section was not completed in the first issue version of this report and is now completed);
- Section 6 details the preparation, conduct, results, conclusions and recommendations of each individual exercise (this section has been updated for this version); and
- Section 7 is the final section and includes the applicable and referenced documents.

1.4 Acronyms and Terminology

Term	Definition
ACC	Area Control Centre
ADDEP	Airport Departure Data Entry Panel
A-DPI	Airport - Departure Planning Information message
ANSP	Air Navigation Service Provider
AOBT	Actual Off Block Time
APP	Approach
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
AFTN	Aviation Fixed Telecommunication Network
ATOT	Actual Take Off Time
ATSA	Air Traffic Services Assistant
CARS	Controller Acceptance Rating Scale
CDM	Collaborative Decision Making
C-DPI	Cancel - Departure Planning Information message
CFMU	Central Flow Management Unit
CFTO	Cleared for Take Off
CHMI	CFMU Human Machine Interface
COTS	Commercial Off The Shelf
CTC	Corporate and Technical Centre
CTOT	Cleared Take Off Time
CWP	Controller Working Position
DMEAN	Dynamic Management of the European Airspace Network
DNS	Domain Name Service
DPI	Departure Planning Information
EFDS	Electronic Flight Display Systems
EFPS	Electronic Flight Progress Strip
EGHI	Southampton Airport
EOBT	Estimated Off Block Time
E-OCVM	European Operational Concept Validation Methodology
ETOT	Estimated Take Off Time
EXOT	Estimated Taxi Out Time
FDP	Flight Data Processing System (technical system)
HLOR	High level Operational Requirement
HMI	Human Machine Interface
IFPS	Integrated Initial Flight Plan Processing System
IIS	Internet Information Server

Term	Definition
IP	Internet Protocol
IT	Information Technology
NATS	National Air Traffic Services
NM	Network Management
OFA	Operational Focus Area
POMS	Pre Operational Message Switch
SESAR	Single European Sky ATM Research Programme
SSR	Secondary Surveillance Radar
SUR	Surveillance System (technical system including remotely located sensors)
TAD	Test And Development Facility
TLPD	Traffic Load Prediction Device
TMA	Terminal Manoeuvring/Control Area
TO	Take Off
TOMS	Tactical Operational Management System
TTOT	Target Take Off Time
TWR	Tower Air Traffic
VCR	Visual Control Room
VPN	Virtual Private Network
VTT	Variable Taxi Time
X25	X25 - Message Communications Protocol

2 Context of the Validation

2.1 Concept Overview

The SESAR Concept of Operation recognises the importance of all partners sharing the same information about aircraft, in particular the trajectory. Timely and accurate information, widely shared amongst all partners in the ATM business, should allow for better collaborative decision making, network and operational management. One of the principal features of both Dynamic Management of the European Airspace Network (DMEAN) and the SESAR Concept of Operations as defined in the Definition Phase Deliverable D3 is the "Integrated Airport Operations contributing to Capacity Gains". The integration of airports, of whatever size, into the network is critical if accurate information is to be available concerning departures for those operating services at airports or about the departure status of an aircraft to the rest of the network.

Data currently used in Air Traffic Flow and Capacity Management (ATFCM) is not always the most accurate. Whilst there is a high level of accuracy for the occupancy time within a sector for aircraft that have travelled some distance, the accuracy is far less for those aircraft about to depart from local airfields. This inaccuracy reduces the effectiveness of existing demand capacity balancing techniques used by both CFMU and the Local Area Control Centre (ACC).

Flight plans need to be filed, as a minimum, three hours in advance giving details of the Estimated Off Block Time (EOBT) based upon the operator's scheduled departure time. Depending on circumstances, the difference between the *estimated* and *actual* time the aircraft departs can vary by 15 minutes either way. This leads to a considerable degree of inaccuracy of the data within the network. The situation is improved at airports that are equipped with advanced automation tools using advanced Electronic Flight Progress Systems (EFPS). As the turnaround of the aircraft progresses, these automated tools can provide more accurate DPI messages to CFMU. For airports not equipped with such tools, and which lack a suitable business case for such an investment, the earliest that the regional ACC is aware of the impending departure is when the airport's tower requests a clearance and, often, for the actual departure time, when the aircraft enters the Centre's radar coverage activating its flight plan.

This level of uncertainty about departures makes it difficult to judge when a regulation needs to be applied and, erring on the side of caution when they need to be applied some two hours in advance, regulations are often applied unnecessarily. It can also impact on sector management, leading to sectors being split for longer than necessary resulting in an inefficient use of the operations room resources, or worse an unexpected overload for a sector leading to a possible safety event.

The premise behind the concept of operation assessed in these validation activities is to equip these airports with a low cost ADDEP which has the capability to provide accurate electronic pre-departure information to the CFMU and the projects Concept of Operation P12.04.01-D10 Ed 00.01.00 [7] for the ADDEP provides further details for the concept expectations Thus, the validation activity aims are to confirm if: the panel is easy to use, has a minimal impact upon the operator's workload in the tower, and that there would be benefit to the efficiency of the network and safety in the operation were the ADDEP to be introduced into service.

Validation Exercise ID and Title	*EXE-12.04.01-VP-391 : Live Exercise in Southampton Airport to assess the use of an ADDEP panel*
Leading organization	NATS
Validation exercise objectives	Quantify the impact on accuracy of departure data against existing estimates and actual data; Quantify the loss of data due to lack of use, respecting that this device will be used in shadow-mode; Assess the integrity of data, respecting that this device will be used in shadow-mode; Identify the impact on tower controller workload due to the use of the ADDEP; Assess the usability of the ADDEP panel; Assess benefit to the tower due to the use of the panel in integrating the airport's operation in to the ATM network; Assess the level of support provided by the slave display to the approach controllers; Identify the safety impact of the ADDEP panel.
Rationale	The hypothesis that the use an ADDEP panel at airports will improve the accuracy of departure data into the network improving the quality of the demand picture at individual sectors. As the first validation exercise, this activity assessed the overall feasibility of integrating an ADDEP panel into a candidate airport and assessing if the TWR Air Traffic Control Officer (ATCOs) were comfortable using the system.
Supporting DOD / Operational Scenario / Use Case	N/A
OI steps addressed	DCB-0304 Airport CDM extended to Regional Airports
Enablers addressed	N/A
Applicable Operational Context	Airport, Network Management, Information Management
Expected results per KPA	Predictability – The use of the ADDEP Panel would increase the predictability (at Network level) of aircraft departures. Efficiency – The use of the ADDEP panel would improve the quality of sector management and reduce the likelihood of unnecessary regulations and re-sectorisations. Safety – the use of the ADDEP panel does not negatively impact safety. Capacity – the ADDEP panel does not significantly increase controller workload
Validation Technique	Shadow Mode Exercise
Dependent Validation Exercises	EXE-12.04.01-VP-404, EXE-12.04.01-VP-TBC

Table 2: Concept Overview

2.2 Summary of Validation Exercises

2.2.1 Summary of Expected Exercises outcomes

The initial plan was to conduct a single validation activity assessing the technical feasibility of the ADDEP Panel. The initial plan was to conduct a single validation activity assessing the technical

feasibility of the ADDEP Panel. However, during the development of this activity, potential for further validation activities were also identified. Activities for the following high level aims were proposed:

- Exercise 1 – To install an ADDEP panel in one airport tower and assess the operators' use of the system when the system is not fully integrated in the Air Traffic Management (ATM) network (i.e. the system is not sending messages external to the airport tower);
- Exercise 2 – To assess the impact of the ADDEP panel in the same airport tower when the system is integrated into the ATM network and is sending departure messages to the Central Flow Management Unit (CFMU) and adjoining Area Control Centre (ACC) units; and
- Exercise 3 – To assess the network effect when more than one airport is using an ADDEP panel and sending messages to the CFMU and adjoining ACC units.

However, due to inabilities to include other airports within the project time scales, Exercise 3 was not progressed.

The main stakeholder groups were the operators (TWR ATCO), Airports, Air Navigation Service Providers (ANSPs) and Airlines. Their expected outcomes of the validation process were as follows:

- ATCO – To have evidence that the use of the ADDEP panel will not impact significantly on their workload or the safety of the service provided by them;
- Airports (those not equipped with an electronic flight data capability) – The airports expected to have evidence that a low cost alternative is feasible and will lead to them being integrated into the flow management environment. To have evidence that this will lead to the potential development of collaborative decision-making at their airfields;
- ANSPs – To have evidence that use of the ADDEP panel at airports would provide more accurate departure data, better demand information at sector level and therefore reduce the need to apply unnecessary regulations;
- Airspace Users – To have evidence that the service provided to them in areas with shared departure data would be of better quality and with less delay through reduced regulations.

2.2.2 Benefit mechanisms investigated

The Tower ATC operations staffs were provided with a touch sensitive ADDEP display screen to communicate pre-departure information directly to CFMU.

The ATC operator within the tower was provided with departure details of an aircraft three hours in advance through receipt from Integrated Initial Flight Plan Processing System (IFPS) or the ACC of the flight plan pre-departure details submitted by the aircraft operator. The details of each flight was displayed on the ADDEP within a "flight strip" and these were organised into separate "bays", each covering a separate state for the aircraft from "Departure" to "Taxing" to "Cleared for Take Off". The flight details included call sign, destination aerodrome and EOBT amongst other information. The flight details for the aircraft were also displayed on the ADDEP within the departure bay.

The screenshots for the initial ADDEP panel used for Exercise 1 is shown in Figure 1, and the updated version, used for Exercise 2, is shown in Figure 2.

Following boarding of the aircraft and closure of the aircraft doors the pilot requested approval to start up from the TWR controller; ATC subsequently requested a departure clearance for the aircraft from the local ACC. Following receipt of the departure clearance, the TWR controller issued start up approval to the pilot at which point the pilot was able to request push back then taxi clearance to the runway holding point. At this point the TWR controller pushed the "Push Back" button on the ADDEP; this action initiated the sending of a DPI message to CFMU containing the Target Take Off Time (TTOT) and calculated by summing the Actual Off Block Time (AOBT), in this case the time that the "Push Back" button was pressed, and the Estimated Taxi Out Time (EXOT) for the airfield. The "flight Strip" on the ADDEP then moved from the Departure Bay to the Start-Up / Push-Back Bay.

The aircraft then taxied to the departure point for the runway.

On arrival at the departure point for the runway the pilot requested clearance to depart. When appropriate the TWR controller gave the pilot clearance to take off. At this stage the TWR controller pushed the "Cleared for Take Off" button on the ADDEP.

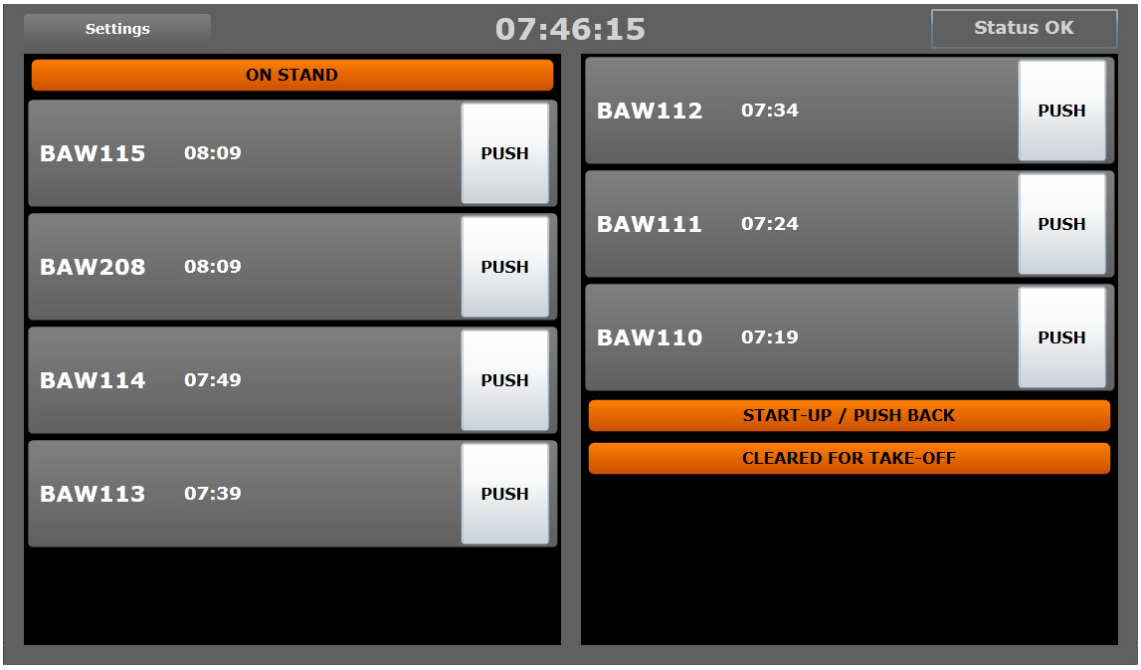

Figure 1: Screenshot of Exercise 1 ADDEP controller displays

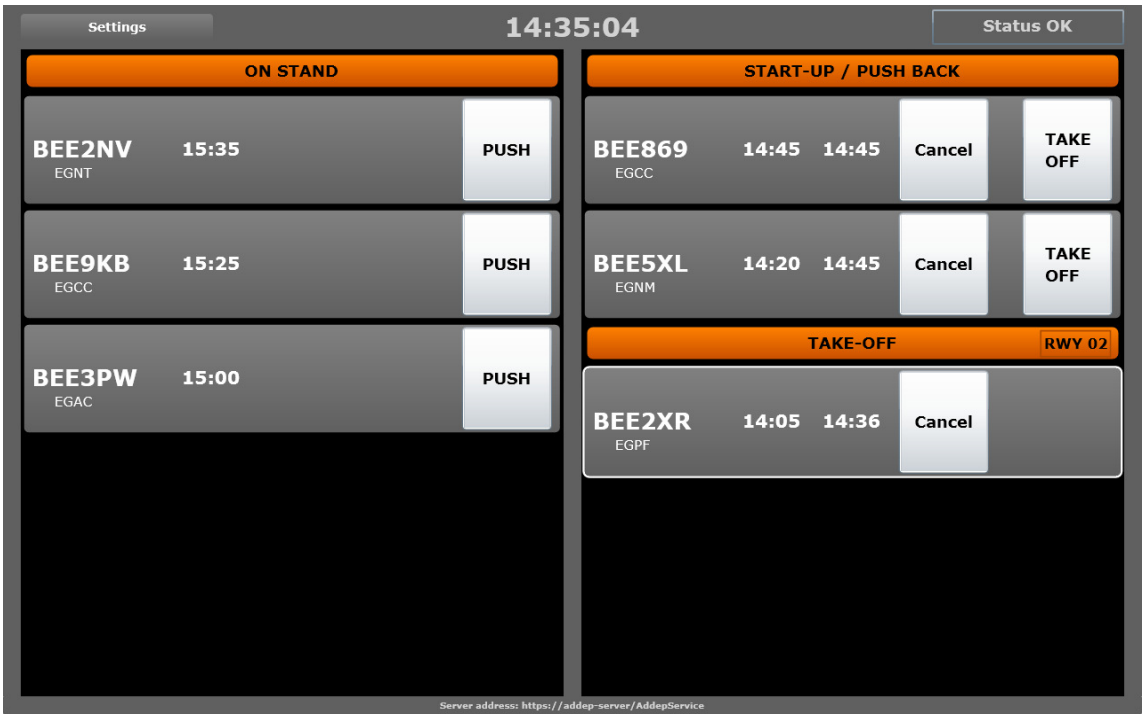

Figure 2: Screenshot of Exercise 2 ADDEP controller displays

If at any time during taxing the aircraft needed to either return to the stand or remain on the taxiway, the TWR controller was able to push the “Cancel Button”- this initiated the sending of a Cancel DPI message to CFMU. The Flight Strip for this aircraft was then returned to the previous bay and depending upon the reason for the aircraft’s return, the Aircraft Operator either needed to send a Delay Message to CFMU or cancel the original Flight Plan by sending a Cancel Message and then file a new flight plan. In the former case the pilot may have re-requested “Push Back if the problem was resolved. However, if the original Flight Plan was cancelled then the original Flight Strip was removed

from the Departure Bay on receipt of the cancel message from CFMU. A new Flight Strip was displayed following the successful filing of a new flight plan.

On departing the airfield, the aircraft entered radar coverage of the ACC and the ATC system may have recognised the departure through correlation of the Secondary Surveillance Radar (SSR) code against the flight plan.

After a predetermined time, the display screen stopped displaying the Flight Data concerning the departed flight.

2.2.3 Summary of Validation Objectives and success criteria

The validation objectives and corresponding success criteria are listed below. It should be noted that the original objectives and criteria listed were for Exercise 1 (EXE-12.04.01-VP-391) only. The objectives were defined and baselined prior to the identification of the full set of three exercises and planning of the subsequent activities. It was expected that the project level validation objectives could be updated during planning of the next exercises.

Impact on Accuracy	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0010	Quantify the impact on accuracy of departure data against existing estimates and actual data
CRT-12.04.01-VALP-0050.0010	Operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP

Loss of Data	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0020	Quantify the loss of data due to lack of use, respecting that this device will be used in shadow-mode
CRT-12.04.01-VALP-0050.0020	The loss of data still leaves an operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP

Integrity of Data	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0030	Assess the integrity of data, respecting that this device will be used in shadow-mode
CRT-12.04.01-VALP-0050.0030	The loss of data integrity still leaves an operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP

Controller Workload	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0040	Identify the impact on tower controller workload due to the use of the ADDEP
CRT-12.04.01-VALP-0050.0040	No significant increase in workload that is likely to affect the tower operation

Usability	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0050	Assess the usability of the ADDEP panel
CRT-12.04.01-VALP-0050.0050	Participants agree that the panel is deployable with only minor modifications required

Integration of the Airport into the Network	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0060	Assess benefit to the tower due to the use of the panel in integrating the airport's operation in to the ATM network
CRT-12.04.01-VALP-0050.0060	Network Managers asses that any improved accuracy in departure data would reduce the frequency of departure delays.
CRT-12.04.01-VALP-0050.0060 (revised for exercise 2 due to limited scope and time frame)	NATS Network Managers asses if the predicted departure information, that the ADDEP can provide, would improve the local network management and their short term sector traffic capacity prediction abilities.

Support to Approach Controllers	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0070	Assess the level of support provided by the slave display to the approach controllers
CRT-12.04.01-VALP-0050.0070	Approach controllers agree that the slave display would provide benefit.

Impact on Safety	
Identifier	**Description**
OBJ-12.04.01-VALP-0050.0080	Identify the safety impact of the ADDEP panel
CRT-12.04.01-VALP-0050.0080	Any negative impact on safety can be mitigated.

2.2.3.1 Choice of metrics and indicators

The list of indicators and metrics chosen to assess the objectives was as follows:

Objective	Indicator
OBJ-12.04.01-VALP-0050.0010	Accuracy of estimated take off time (ETOT) against actual take off time (ATOT) – continuous, automatic
OBJ-12.04.01-VALP-0050.0020	# flights for which no pushback message was generated - integer, automatic # flights for which no Cleared For Take Off (CFTO) message was generated – integer, automatic
OBJ-12.04.01-VALP-0050.0030	Expert assessment of measures for OBJ-12.04.01-VALP-0050.0010 and OBJ-12.04.01-VALP-0050.0020 in relation to each other.
OBJ-12.04.01-VALP-0050.0040	Bedford Rating Scale, observations and debriefs.
OBJ-12.04.01-VALP-0050.0050	Controller Acceptance Rating Scale (CARS), observations and debriefs.
OBJ-12.04.01-VALP-0050.0060	Interview and expert assessment, based on quantitative data from OBJ-12.04.01-VALP-0050.0010
OBJ-12.04.01-VALP-0050.0070	Observations and debriefs.
OBJ-12.04.01-VALP-0050.0080	Observations and debriefs.

2.2.4 Summary of Validation Scenarios

The Exercise 1 validation activity took place during February, March and April 2011 shadowing actual traffic at Southampton airport in the UK. As such, it was not necessary or possible to design and plan any specific scenarios. Exercise 2 activity took place during September 2011, although due to

workload and operational commitments, the CFMU analysis of the ADDEP transmitted messages and the performance aspects was not able to be completed until January 2012.

To allow for better distinction in the analysis, two high level scenarios were defined based on departures from Southampton's RWY02 and RWY20. This was to distinguish results based on the different taxi times required for either runway. All validation objectives were addressed for each scenario.

Identifier	Description
SCN-12.04.01-VALP-0050.0010	Southampton Airport Departures on Runway 02 during February, March, April 2011
SCN-12.04.01-VALP-0050.0020	Southampton Airport Departures on Runway 20 during February, March, April 2011

Whilst Exercise 2 was performed over a period of 3 days, the CFMU analysis was only performed for one of these days (the 6th of Sept – which was viewed as the most typical day for operations) and reflected the runway operations for that day (which was for departures from RWY02), and this aligned with scenario SCN-12.04.01-VALP-0050.0010

2.2.5 Summary of Assumptions

- The validation exercise used live traffic experienced at Southampton Airport during the dates of the exercise;
- Use of the ADDEP panel was not mandated. Therefore it was only used when the controllers were content that it would not compromise operations;
- The operating controller updated the TAXITIME on the settings page of ADDEP when runway changes occurred to ensure accurately calculated ETOT;
- The operating controller was trained in the use of ADDEP to ensure the button push operations and setting changes occurred in an acceptable time window.

2.2.6 Choice of methods and techniques

Supported Metric / Indicator	Platform / Tool	Method or Technique
Accuracy of Estimated/Cleared Take Off Time (E/CTOT) against ATOT	ADDEP Panel data logging	Analysis of quantitative data from data logs.
# flights for which no pushback message was generated - integer, automatic	ADDEP Panel data logging	Analysis of quantitative data from data logs.
# flights for which no CFTO message was generated – integer, automatic	ADDEP Panel data logging	Analysis of quantitative data from data logs.
Integrity of Data	ADDEP Panel data logging and expert judgement	Analysis of quantitative data from data logs.
Usability of ADDEP Panel	Qualitative assessment	Bedford Rating Scale, observations and questionnaires.
Controller Workload	Qualitative assessment	Controller Acceptance Rating Scale (CARS), observations and questionnaires.
Benefit to the ATM Network	Interviews and Qualitative assessment	Interview and expert assessment, based on quantitative data from OBJ-12.04.01-VALP-0050.0060, and for Exercise 2 from the revised OBJ-12.04.01-VALP-0050.0060.
Support to Approach Controllers	Qualitative assessment	Observations and questionnaires.

Impact on Safety	Qualitative assessment	Observations and questionnaires.

Table 3: Methods and Techniques

2.2.7 Validation Exercises List and dependencies

The plan for the P12.04.01 Validation, as shown in Figure 3, was to conduct 3 validation exercises in a step-wise approach, each with greater level of technical maturity and complexity.

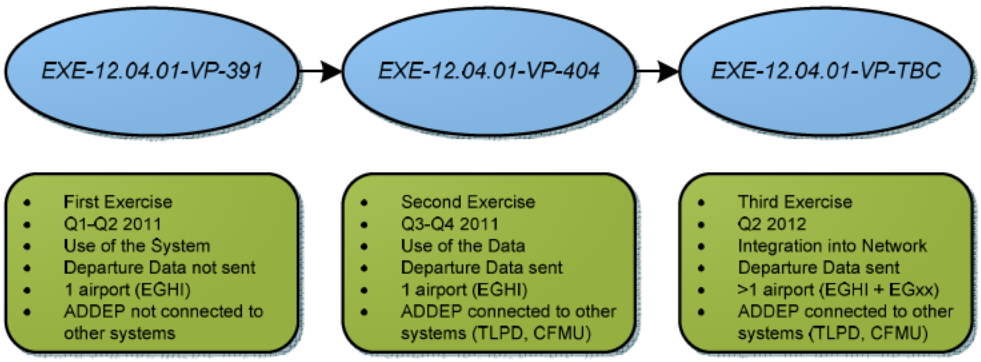

Figure 3: Validation Exercises List and dependencies

1. ADDEP Exercise 1 – To install an ADDEP panel in one airport tower and assess the operators' use of the system when the system is not fully integrated in the ATM network (i.e. the system is not sending messages external to the airport tower);
2. ADDEP Exercise2 – To assess the impact of the ADDEP panel in the same airport tower when the system is integrated into the ATM network and is sending departure messages to the CFMU and adjoining ACC units;
3. ADDEP Exercise3 – To assess the network effect when more than one airport is using an ADDEP panel and sending messages to the CFMU and adjoining ACC units. This exercise was subsequently not performed.

3 Conduct of Validation Exercises

3.1 Exercises Preparation

Prior to each exercise, and in line with the European Operational Concept Validation Methodology (E-OCVM), a validation plan was produced detailing the objectives, scenarios, indicators, metrics, data collection methods and exercise design.

The controllers were given an opportunity to familiarise themselves on the use of the ADDEP panel and Temporary Operating Instructions (TOI) were issued for the duration of the exercise. In addition the following technical tasks were performed:

- ADDEP Exercise 1:
  - Installation of the ADDEP server in the Test And Development facility (TAD) at CTC;
  - Domain Name Service (DNS) configuration for access to Internet Information Server (IIS) web server by web address;
  - Installation of client and screen and Southampton Airport (EGHI) tower;
  - Internet Protocol (IP) link between ADDEP server and Tactical Operational Management System (TOMS).
- ADDEP Exercise2:
  - X25 link with Pre-Operational Message Switch (POMS);
  - Message address adjusted to include the Tactical Operational Management System (TLPD) server and CFMU test network.

Exercise 3 was not performed.

3.2 Exercises Execution

Exercise ID	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date	Actual Exercise start analysis date	Actual Exercise end date
EXE-12.04.01-VP-391	ADDEP Exercise 1	01/02/2011	28/04/2011	01/04/2011	30/05/2011
EXE-12.04.01-VP-404	ADDEP Exercise 2	05/09/2011	7/09/2011	09/01/2012	20/01/2012

Table 4: Exercises execution/analysis dates

3.2.1 ADDEP Exercise 1

The approach taken during the validation exercise was to locate the ADDEP within the control tower at Southampton airport. The ADDEP was a normal business personal computer that already existed in the tower. It was connected to the ADDEP server at NATS' Corporate and Technical Centre near Southampton via NATS' business IT network. ADDEP functioned as a Web browser and was configured to view a secure page created on the Server.

During the validation exercise, the TWR Controller was, whilst performing their normal role, requested to operate the ADDEP. They could select the appropriate flight strip from the bays displayed on the panel and select the button for the push-back, taxi or cleared for take-off instruction.

As a result of these actions, the ADDEP Server then generated ATC-DPI and CNL-DPI message (that would be transmitted from the Server to the CFMU for Exercise 2) and these were internally recorded

on the Server. Later, these messages were compared by NATS analysts with the departure information the CFMU would normally receive for the airport and would then use to provide updates to others.

Network Management experts then assessed the impact of any improved accuracy in terms of likely benefit to network management. Specifically they tried to judge the use of the improved demand data for specific sectors against their respective sector flow rate by comparing it to the current situation.

Additionally, participants completed observation forms and questionnaires concerning the impact of using the tool within both the Tower visual operations and the approach control rooms to identify: the impact on the controller's workload of using the panel; any usability issues; and the perceived benefit or dis-benefit of using it.

3.2.2 ADDEP Exercise 2

For exercise 1 the provision of flight plan, and update, information for the ADDEP system was performed by using the existing operational message provisions to NATS (over operational circuits from CFMU) and via an internal NATS provided feed. However, no information was returned to CFMU. For Exercise 2 additional technical work was need to set up, test, and gain approval to provide a return path (for the A-DPI messages) via the NATS AFTN switch, operational AFTN circuits, and the CFMU message switch, to the CFMU test system.

As for Exercise 1, the TWR Controller was, whilst performing their normal role, requested to operate the ADDEP. However, the CFMU experts then assessed the quality of the received A-CDM messages and their views on any improved accuracy related to their CFMU network management information provisions.

A NATS Network Management expert was requested to asses if the results provided from the CFMU indicated that the predicted departure information, that the ADDEP can provide, would improve the local network management and short term sector traffic capacity prediction abilities.

3.3 Deviations from the planned activities

The original exercise validation plan (EXE-12.04.01-VALP-391) was for observations to be made from within the Visual Control Room (VCR) to measure variables around panel use and ensure there were no other external factors which impact the accuracy of the findings. Subsequently during the exercise, access to the Tower was not given due to limitations of the operational environment.

Some objectives could not be fully realised and for this reason the original validation plan were now being split out into three to allow early benefits to be realised and fed into subsequent exercises.

The new exercises were (EXE-12.04.01-VP-404 and EXE-12.04.01-VP-xxx). Access has been approved to the VCR to carry out EXE-12.04.01-VP-404 to ensure the assumptions being made in the analysis of EXE-12.04.01-VP-391 results, error in TAXITIME, were correct and could be eliminated for EXE-12.04.01-VP-404 analysis.

Whilst the initial plan had been to only provide an ADDEP device in the Visual Control Room at Southampton, additional local benefits were identified as potentially achievable from the installation of a second 'slave' display in the Approach Room (which also operates the departures). Thus, an additional display was installed and available during both Exercises 1 and 2, in order to allow benefit comments to be collected.

3.3.1 Deviations with respect to the Validation Strategy

Since P12.04.01 is not in the operational thread of the overall SESAR work structure, it did not originally produce a Project Level Validation Strategy nor was it included in the top down Airport Validation Strategy for Step 1 produced by WP06.02. The project does not therefore deviate from any pre-existing strategy.

As noted earlier in this report, shortly after the start of the P12.04.01 validation activity, an opportunity for further assessment in subsequent exercises was identified.

It was anticipated that the results from the P12.04.01 validation activity would be used "bottom up" for the WP06.02 Validation Strategy.

3.3.2 Deviations with respect to the Validation Plan

The original validation plan contained one exercise (EXE-12.04.01-VP-391) and a single set of objectives, scenarios, indicators and metrics all allocated to that one exercise. Due to the opportunities for further exercises mentioned above and due to certain objectives not being able to be realised in the single validation exercise, the validation plan could be updated. The validation objectives, indicators and metrics could then be split out from the single exercise and, where applicable, copied into two newly created exercises along with newly created objectives etc. The VALP update would then contain information on all the exercises.

However, due to there being only differences in the scope and involvements the provision and analysis of data (between Exercise 1 and Exercise 2) analysis the VALP was not considered as needing to be revised and as the one revised objective could be identified in this document.

4 Exercise Results

This section will summarise the results from all the exercises. As such, it was only fully completed for update of this document once all the exercises had been completed. However, the individual exercises results for Exercise 1 were presented (in Section 6) of the initial issue version.

4.1 Summary of Exercises Results

The exercises were focused on assessing the ADDEP against following High Level Operational Requirements. The following results were achieved for the High Level Operational Requirements:

Identity	Requirement	Result
REQ-12.04.01-OSED-HLOR.0001.	The controller workload shall remain stable or possibly decrease	This was demonstrated by the absence of contradiction in the user assessment and feedback from the live trials.
REQ-12.04.01-OSED-HLOR.0002	The controller focus of attention shall remain unchanged	This was demonstrated from the expert assessment of the information provided from the live trials.
REQ-12.04.01-OSED-HLOR.0003	The accuracy of departure data the Network Manager receives from regional/small airports shall improve	This was demonstrated by the achievement of both the live trials and by the Exercise 2 demonstrated ability to provide and use existing types of operational messages and infrastructure connectivity.

Table 5: High Level Operational Requirements - Results

4.1.1 Results on concept clarification

The results confirmed that the concept of providing simple and low cost ADDEP panels, at smaller airports, to improve the availability and accuracy of departure information provisions for wider stakeholders would be feasible and would result in benefits for network management and traffic load prediction

4.1.2 Results per KPA

The validation exercise results indicated that HLORs 1 to 3 were achievable within the operational in the test environment and that they should therefore be achievable were the ADDEP to be formally implemented for operational use (i.e. with the provision of any additional hardware and connectivity resilience that would be required).

4.1.3 Results impacting regulation and standardisation initiatives

No impacts for regulation or standardisation were indicated. However, it was noted that whilst existing AFTN messaging and X25 protocols were used for this validation, the system was designed to directly use TCP connectivity; but this is not yet recognised for the exchange of ATM for messages between stakeholder systems

4.2 Analysis of Exercises Results

The analysis of results for both the exercises is set out in section 6.

The overall conclusions reached were that:

- the ADDEP provision and connectivity is indicated as feasible; and
- network management and traffic load prediction benefit expectations were indicated as valid.

4.2.1 Unexpected Behaviours/Results

None

4.3 Confidence in Results of Validation Exercises

4.3.1 Quality of Validation Exercises Results

Whilst there were some issues with the ADDEP systems clock synchronisation for Exercise 2, these were not considered as significantly impacting the overall results as the CFMU system clock was used for all the CFMU received messages and provided an indicative measure of the time between receipt of the ADDEP provided messages and existing messages for other sources (e.g. FSA messages which identified when the national FDP and SUR systems have identified the aircraft post departure).

4.3.2 Significance of Validation Exercises Results

Whilst P12.1.4 is a technical project that falls within the remit of the SESAR Airport Controller Tools, the results of this validation indicate benefits for the Network Management and ATCC Traffic (sector) Load prediction related operations.

5 Conclusions and Recommendations

The report concludes that:

> Providing simple and low cost ADDEP panels, at smaller airports is considered to be feasible and, by their improved availability to supply earlier and improved predictability departure information, they would result in network management and traffic load prediction benefits for wider stakeholders.
> Specifically:

a. Improved accuracy TTOT departure information would be available upon issue of the actual start-up clearance to the aircraft from the TWR ATC - rather than when the aircraft has departed and is seen by the ACC's SUR and reported as correlated by the FDP system). For Southampton, where the average taxi time for departures from the northerly runway was estimated as being 5 min's, the indicated improvement was approx 7 min's. For longer average taxi times a greater improvement would be expected.

b. The improved TTOT is based on the actual start-up and airport estimated taxi-time This represents a much smaller time window for the TTOT prediction – rather than being based on the aircraft operator filed Flight Plan and update submissions.

Whilst the exercise focused on the use of the ADDEP for Departure provisions for external stakeholders; additional internal benefits were indicated for use to provide the Approach room with visibility of the departure situation. It is recommended that these benefits should be perused.

The following factors, all indicate that the existing ADDEP applications can be adapted to also provide other services – such as a combined arrivals and departures provision for the tower.

a. the simplicity of providing and using the ADDEP web page on a standard PC, and using a standard web browsers provision within in a tower;

b. the use of low cost and standard IT industry COTS Software and Hardware products;

c. the technical feasibility of connectivity between the tower equipment and the Server;

d. the ability to use standard web based security methods;

e. the abilities to connect the ADDEP Server to existing systems using existing standard ATM messages and interfaces;

f. no bespoke applications are required in the tower provisions and

g. the flexibility of the server based application.

It is therefore recommended that SESAR should consider such further development, as this would offer additional local and external benefits for tower operations.

6 Validation Exercises reports

6.1 ADDEP Exercise 1 Report (EXE-12.04.01-VP-391)

6.1.1 Exercise Scope

The purpose of this exercise was to assess the use of the ADDEP system within the control tower of a regional airport – Southampton airport in the UK. During the exercise, the TWR Controller was, whilst performing their normal role, requested to operate the ADDEP in Shadow Mode. They could select the appropriate flight strip from the bays displayed on the panel and select the button for the push-back, taxi or cleared for take-off instruction. The resulting departure messages were not relayed to the CFMU or any external units.

The following validation objectives were addressed:

Identifier	Description
OBJ-12.04.01-VALP-0050.0010	Quantify the impact on accuracy of departure data against existing estimates and actual data
OBJ-12.04.01-VALP-0050.0020	Quantify the loss of data due to lack of use, respecting that this device will be used in shadow-mode
OBJ-12.04.01-VALP-0050.0030	Assess the integrity of data, respecting that this device will be used in shadow-mode
OBJ-12.04.01-VALP-0050.0040	Identify the impact on tower controller workload due to the use of the ADDEP
OBJ-12.04.01-VALP-0050.0050	Assess the usability of the ADDEP panel
OBJ-12.04.01-VALP-0050.0060	Assess benefit to the tower due to the use of the panel in integrating the airport's operation in to the ATM network
OBJ-12.04.01-VALP-0050.0070	Assess the level of support provided by the slave display to the approach controllers
OBJ-12.04.01-VALP-0050.0080	Identify the safety impact of the ADDEP panel

Table 6: Exercise 1 Objectives

Quantitative analysis of the accuracy of updated departure times compared to actual departure times was performed and compared to data from when ADDEP was not being used. Qualitative analysis was performed on observations and questionnaire responses from the exercise participants. This analysis was further used as input to subjective opinion gathering from Network Managers.

6.1.2 Conduct of Validation Exercise 1

6.1.2.1 Exercise Preparation

Prior to the exercise, and in line with the E-OCVM, a validation plan was produced detailing the objectives, scenarios, indicators, metrics, data collection methods and exercise design.

The controllers were given an opportunity to familiarise themselves on the use of the ADDEP panel and Temporary Operating Instructions were issued for the duration of the exercise. In addition the following technical tasks were performed:

- Installation of the ADDEP server in the TAD at CTC;
- DNS configuration for access to IIS web server by web address;
- Installation of client and screen and EGHI tower;
- IP link between ADDEP server and TOMS – this was then replaced with receive only X25 message feed connection from the NATS AFTN switch.

6.1.2.2 Exercise execution

The system was operating in shadow mode during February, March and April 2011. During that period the system was used daily, for 16 hours a day between 06:00 and 22:00. The TWR ATCOs were asked to use the ADDEP panel to enter push back, taxi and take off clearance actions.

The use of the ADDEP panel was not mandated so the controllers would not use it if they felt that it in any way compromised the safety or quality of their service provision.

Data from the ADDEP panel was not sent to any external unit such as CFMU, but log data was collected by an ADDEP server at NATS' CTC from where it was extracted and analysed.

6.1.2.3 Deviation from the planned activities

The original exercise (EXE-12.04.01-VP-391) involved observations to be made from within the VCR to measure variables around panel use and ensure there were no other external factors which impact the accuracy of the findings. Access to the Tower was not given due to limitation of the live operational environment.

As a result of this lack of access, the indicators, metrics and data collection methods for some objectives had to be changed during the exercise. The questionnaires that had originally been planned (including CARS, Bedford Rating) could not be administered in person by the validation team. Alternative questionnaires with more general questions were instead completed by the controllers in their own time and without the presence of the validation team. Of the 15 controllers who were given questionnaires, ten were returned along with one from an ATSA. Not every controller answered every question.

6.1.3 Exercise Results

6.1.3.1 Summary of Exercise Results

Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
OBJ-12.04.01-VALP-0050.0010	Quantify the impact on accuracy of departure data against existing estimates and actual data	Operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP	Data accuracy improvement to point where all AC depart within accuracy guidelines, however highlights need for accuracy in settings.
OBJ-12.04.01-VALP-0050.0020	Quantify the loss of data due to lack of use, respecting that this device will be used in shadow-mode	The loss of data still leaves an operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP	Network Managers foresee any extra data which improves accuracy as an operationally significant improvement.
OBJ-12.04.01-VALP-0050.0030	Assess the integrity of data, respecting that this device will be used in shadow-mode	The loss of data integrity still leaves an operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP	Network Managers foresee any extra data which improves accuracy as an operationally significant improvement. Data outside of low integrity not effecting network as excluded.
OBJ-12.04.01-VALP-0050.0040	Identify the impact on tower controller workload due to the use of the ADDEP	No significant increase in workload that is likely to affect the tower operation	Majority of controllers reported only *some* increase in workload and that workload remained manageable.
OBJ-12.04.01-VALP-	Assess the usability of the ADDEP panel	Participants agree that the panel is deployable	Minor modifications suggested proper evaluation

0050.0050		with only minor modifications required	needed.
OBJ-12.04.01-VALP-0050.0060	Assess benefit to the tower due to the use of the panel in integrating the airport's operation in to the ATM network	Network Managers asses that any improved accuracy in departure data would reduce the frequency of departure delays.	Network Managers foresee benefit due to the use of ADDEP
OBJ-12.04.01-VALP-0050.0070	Assess the level of support provided by the slave display to the approach controllers	Approach controllers agree that the slave display would provide benefit.	Majority of APP controller see ADDEP as a benefit to their work.
OBJ-12.04.01-VALP-0050.0080	Identify the safety impact of the ADDEP panel	Any negative impact on safety can be mitigated.	Participants state that ADDEP has no impact on safety (neither positive nor negative)

Table 7: Validation Objectives and exercises results.

For the analysis four distinct days (16th, 17th, 18th and 21st of March) have been chosen from the exercise. In this time the system received and processed 98.9% of the flights that were controlled in paper. This has taken into account the flights which were not processed due to a communication error between the ADDEP server and the ATFN network. These four days also represented a full shift sequence meaning that it included as many controllers as possible.

The graphs contained in the following sub-sections depict a typical day's flights from within the exercise, this has been done to keep the graphs clear and not overload the reader with data.

The following sub-sections further detail the analysis of each objective.

6.1.3.1.1 Results on System Objectives

Impact on Accuracy

Identifier	Description
OBJ-12.04.01-VALP-0050.0010	Quantify the impact on accuracy of departure data against existing estimates and actual data
CRT-12.04.01-VALP-0050.0010	Operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP

To quantify the impact on accuracy caused by the use of the ADDEP panel, current accuracy needed to be baselined. The comparison of this baseline data with data from when ADDEP was being used allows the accuracy and improvement of the data to be shown.

Figure 4 and Figure 5 (both overleaf) depict the accuracy of the ETOT compared to ATOT leading up to Take Off (TO) when ADDEP was not being used. Figure 4 shows the 16 flights which had adjustments made to the filed EOBT which combine with TAXITIME to create ETOT. Figure 5 shows the accuracy of the 47 flights which had no amendments made to the flight plans EOBT. The data from these 2 graphs is the baseline data used for comparison against the same flights when ADDEP was being used.

Figure 6 (overleaf) shows how this data changed when the ADDEP data is included. Note that since ADDEP sends messages for all flights there is no graph showing flights which did not have an update associated with them. Figure 7 then shows the data in Figure 6 with the axis reduced to show a "zoomed in" view (i.e. more detail) of the effect ADDEP has on the data in the last 25 minutes before ATOT.

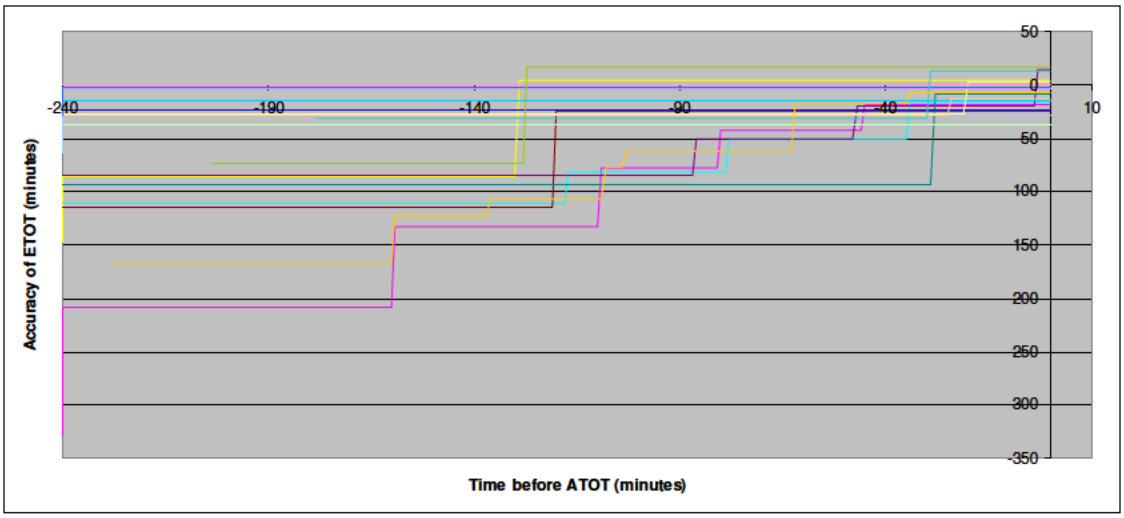

Figure 4: ETOT accuracy baseline no ADDEP multi DPI

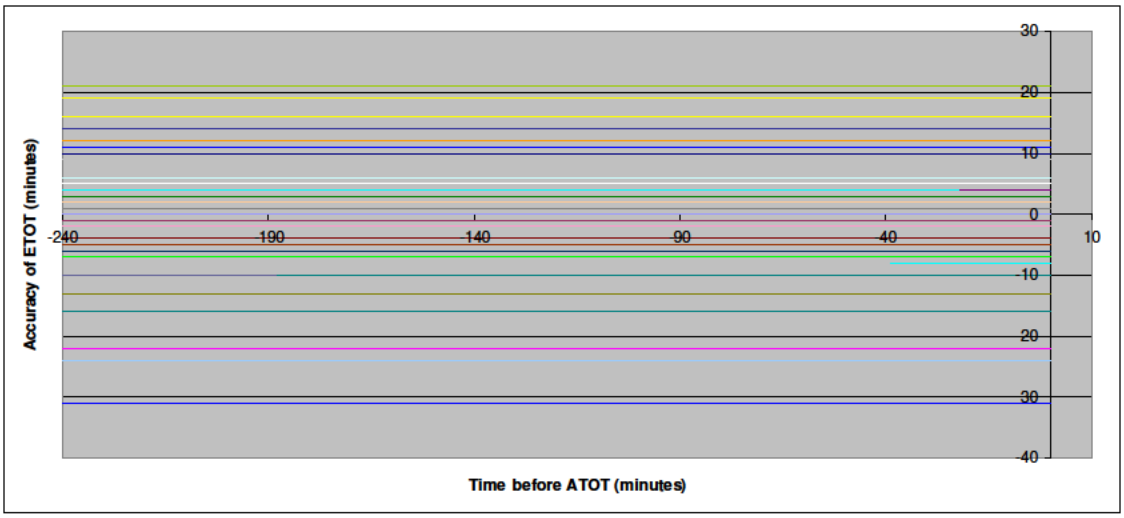

Figure 5: ETOT accuracy baseline no ADDEP only FPL

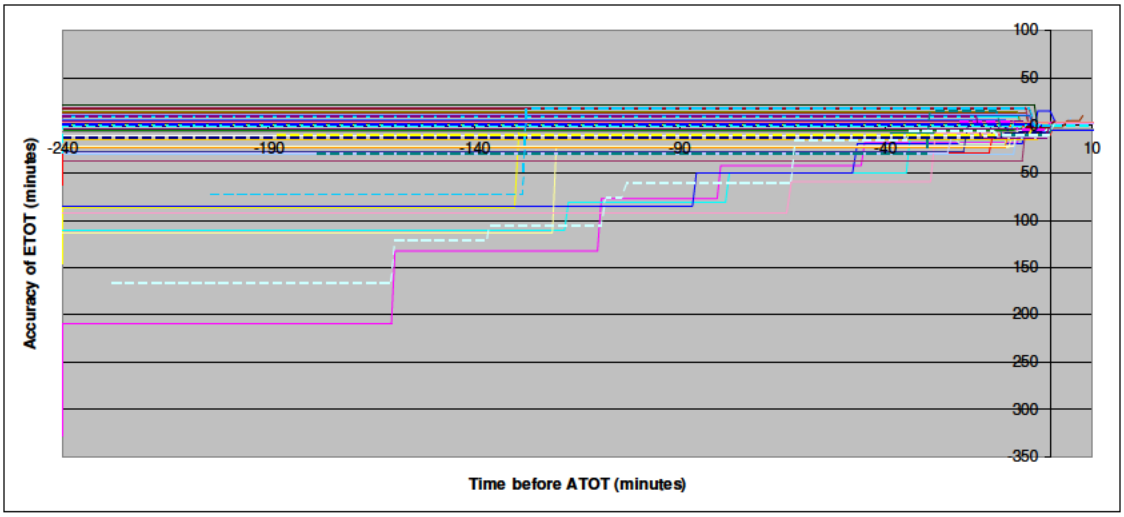

Figure 6: ETOT accuracy with ADDEP input

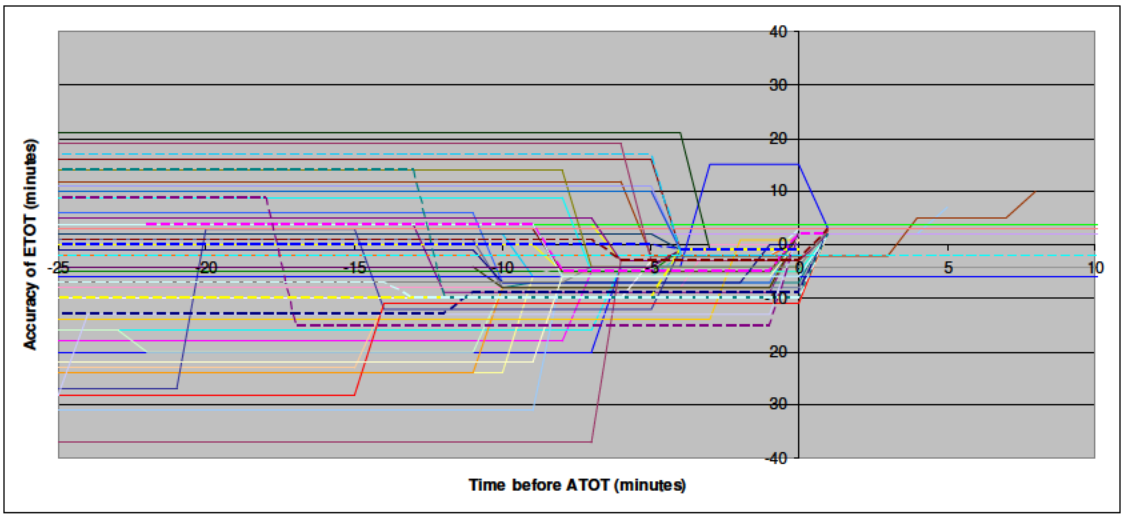

Figure 7: ETOT accuracy with ADDEP expanded view

When comparing the data certain comparisons can be made, including the number of aircraft for which TO was within the +-10 minute window of the ETOT with and without ADDEP. It is also possible to compare how many flights have an update made to their ETOT during the lead up to TO.

Figure 8 (overleaf) is a boxplot showing the accuracy of the predicted ETOT compared to ATOT at chosen time intervals. The values in red are the baseline data (i.e. ADDEP was not being used) and the values in green are the ADDEP data (i.e. ADDEP was being used).

The plot shows that within the 240 minutes to 15 minutes before ATOT, the accuracy of the data is more or less the same with ADDEP and without ADDEP. It then shows a decrease in the median accuracy of data in the final 10 minutes before ATOT when ADDEP is being used. However once a message was received for all flights at -5 minutes the variance in the data when ADDEP is used was reduced to a point where the median and inter-quartile ranges were narrower than without ADDEP, however they are still less accurate overall. In summary, when ADDEP was being used, the ATOT versus ETOT was more inaccurate in the last 10 minutes before ATOT, but more consistent.

Post-exercise analysis indicates that this is most likely due to an error in the setting of the TAXITIME variable within the system. The TAXITIME variable is used to calculate the ETOT and, if wrong, may cause data to be consistently inaccurate as the ETOT calculation is done when the initial 'Push Back' button push takes place. Due to the current system over estimating[1] the TAXITIME and the ADDEP system underestimating[2] the TAXITIME the results at -10 minutes show a less accurate ATOT versus ETOT overall (median accuracy) with ADDEP but a more consistent variance in the accuracy. The ADDEP data is consistently around 6 minutes out and this ties in with a consistent 6 minute taxi time error.

Since it was not possible to make observations in the tower there is no conclusive evidence to corroborate this theory. The assumption is that with the correcting setting of the TAXITIME the data will show a large increase in the accuracy of the data from 10 minutes before TO.

[1] The Current System is the paper operation which is currently in use in a non-EFPS tower. This system is where an initial flight plan is filed and subsequently updated, if necessary, by either delay message/s or regulation/s. The ADDEP system still uses these messages however also includes its own DPI to enhance the accuracy of the aircraft data.

[2] The ADDEP TAXITIME was set at the default 2 minutes throughout the exercise. 2 minutes was the expected taxi out time for RWY02, but due to back-track, the expected taxi out time for RWY20 is closer to 8 minutes. ADDEP provides the ability for this time to be updated but during the exercise the operators did not change time when they changed runway.

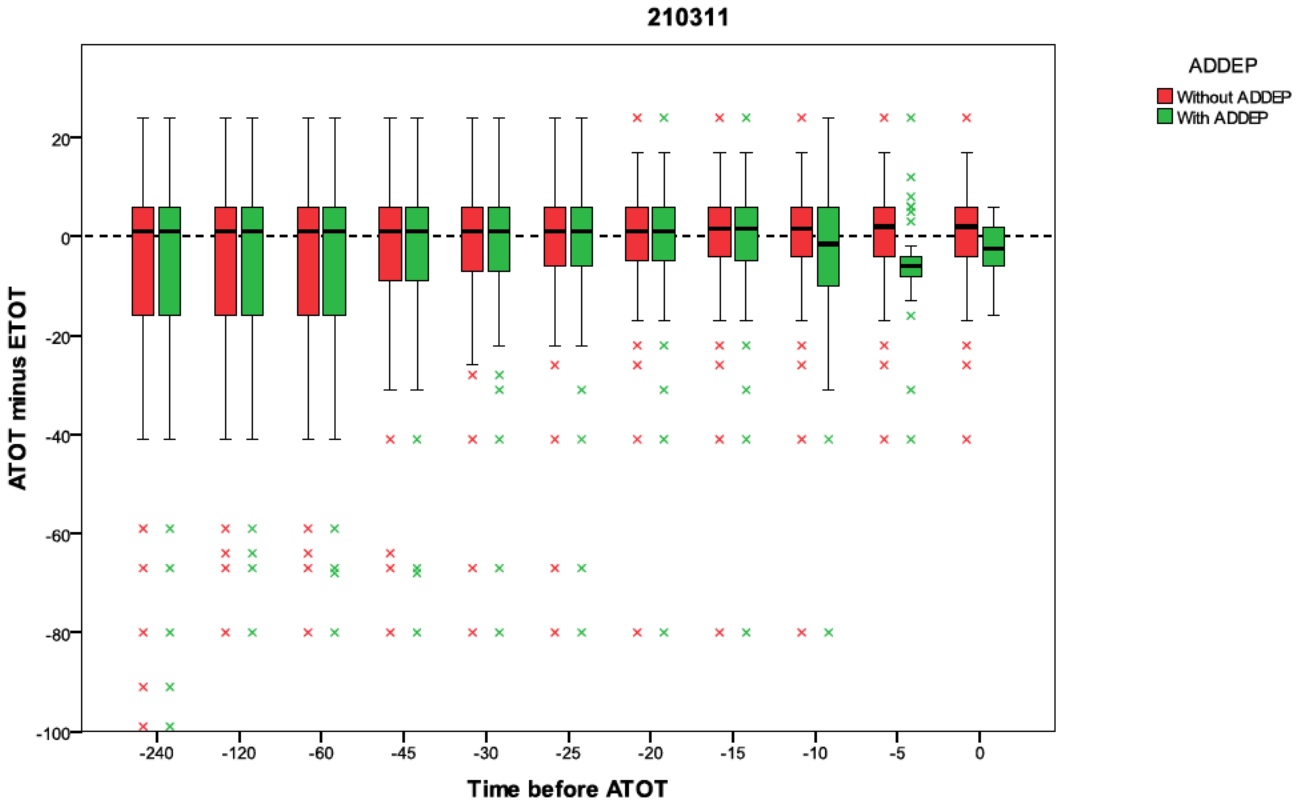

Figure 8: ETOT accuracy box plot | baseline and ADDEP comparison

Loss of Data

Identifier	Description
OBJ-12.04.01-VALP-0050.0020	Quantify the loss of data due to lack of use, respecting that this device will be used in shadow-mode
CRT-12.04.01-VALP-0050.0020	The loss of data still leaves an operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP

Of the 98.9% of flights for which ADDEP processed data, 11.1% indicate that they were either late or completely missed. However since sanity checks in the current system will only accept cred ble data and append this to its current estimates then any data used from the ADDEP panel will improve estimates.

Analysis for this objective is best done on a per day basis, and from this size of dataset a judgement on the impact of the use of the ADDEP panel can be made. Data is transmitted on a per flight basis meaning that as data is lost due to human or machine causes the day's improvement will still stay positive until the point where all data is lost. At this point it would be neither a positive or negative improvement due to the standard messages still being in the network.

The "*operationally significant improvement*" is best realised by the comments from the meeting with the Network Manager (see Section 6.1.3.1.2, Integration of the Airport into the Network). The key quotes from the Network Manager are:

- *At that [0-10 minute] range you are in the tactical or final decision phase and this would make life a lot easier.*
- *This would help crystallise final decisions.*
- *The key thing for us is knowing that an aircraft is on the move [on the ground]. Knowing it is moving can be more important that knowing it is airborne.*
- *In places like the Channel Islands where you might have 10 minute ground and 10 minutes airborne before you know the aircraft is moving, you are getting a good 20 minutes pre-warning.*

The key points to pick out are that any information received which is more accurate or timely is an operationally significant improvement. Therefore it will allow more confidence in the decisions being made by the Local Area Supervisor in regards to sector configurations and staffing. The other point to highlight is that although it would be beneficial to have ADDEP input for all aircraft it is not necessary for it to still be deemed a significant improvement.

Integrity of Data

Identifier	Description
OBJ-12.04.01-VALP-0050.0030	Assess the integrity of data, respecting that this device will be used in shadow-mode
CRT-12.04.01-VALP-0050.0030	The loss of data integrity still leaves an operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP

Figure 9 shows how the added data received from the use of the ADDEP system has reduced the variance of the error in ETOT, however the median is worse when ADDEP data is included. This is down to the assumption that the TAXITIME variable was not adjusted to account for the aircraft having to back track prior to takeoff.

If the integrity of departure data from the ADDEP-equipped airfields degrades, due to either human or machine fault, there are fail safes put into both the ADDEP system and the system using the data where checks ensure that the data is more accurate and not spurious or going to cause any problems to the network.

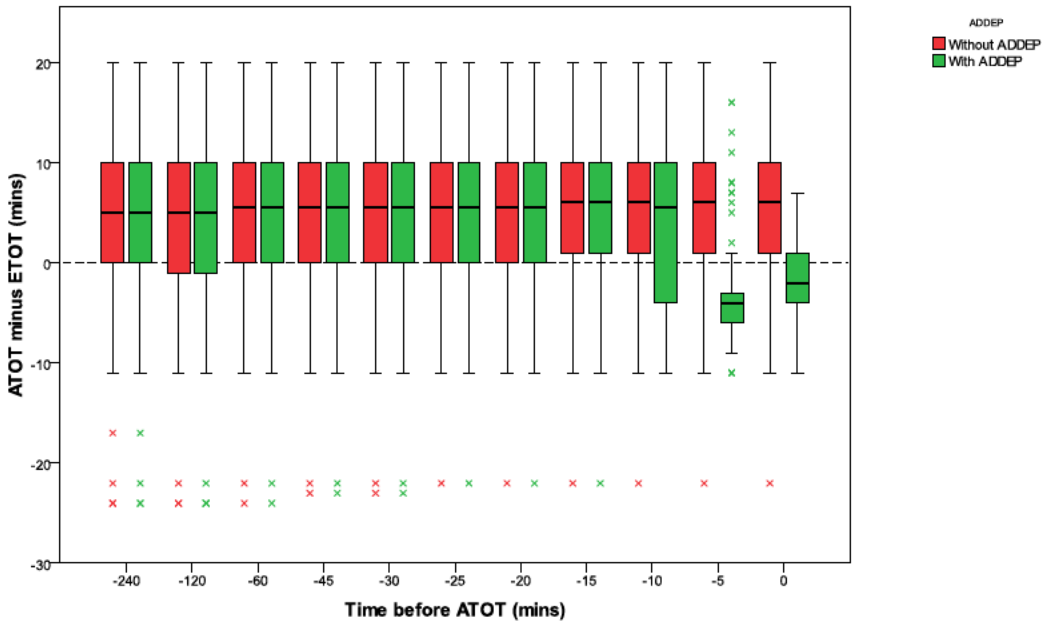

Figure 9: Boxplot depicting reduction in variance of data

It is assumed that it is the TAXITIME being set incorrectly which caused the effect on integrity, but variance was less. The improvement in accuracy and quantity of data creating a lower variance was confirmed as a benefit to the Network within the meeting with the Network Manger who made the point – "*The key thing for us is knowing that an aircraft is on the move [on the ground]. Knowing it is moving can be more important that knowing it is airborne".*

The facts that the ADDEP system sends a DPI message to the Network upon the 'Push Back' button push is enough to highlight to the end user of tools, such as TLPD, that the aircraft is moving and is imminently airborne and therefore allows the user to crystallise the decisions they are making from the information supplied to them.

6.1.3.1.2 Results on Operator Objectives

Controller Workload

Identifier	Description
OBJ-12.04.01-VALP-0050.0040	Identify the impact on tower controller workload due to the use of the ADDEP
CRT-12.04.01-VALP-0050.0040	No significant increase in workload that is likely to affect the tower operation

In the questionnaires, the controllers were asked if the use of the ADDEP panel had any impact on their workload or if the use of ADDEP took their workload to unmanageable levels[3].

The majority of controllers (60% - 6 out of the 10 respondents who answered the question) rated the impact of ADDEP on workload from "No Increase" to "Some Increase" The remaining 40% (4 out of 10 respondents) rated it between "Some Increase" to "Significant Increase". 55% of the respondents (5 out of 9 who answered this question) also stated that using the ADDEP panel did not take their workload to a point where they deemed it unmanageable.

[3] There were two workload questions and only some controllers answered both questions

Overall it can therefore be said that using the ADDEP panel had caused an increase in workload, but that workload remained manageable.

The main reason stated for the increase in workload was the opinion that ADDEP was a "*distraction*". Several controllers stated that the extra tasks and use of the panel distracted them from their other tasks and out-the-window view. They felt that they spent too much time "*keeping ADDEP up to date*".

A hypothesis is that the results above may be partially attributable to the validation technique used for the exercise i.e. shadow mode system in a live environment. The controllers had to use ADDEP in parallel with their existing systems, hence it did create extra, non-mandatory tasks. In operations it is likely that ADDEP would be more integrated from both a working position and procedural point of view and its use would be mandatory

A final contributory factor to the workload increase was missing data. During the early weeks of the exercise at least, some flights were not shown in the ADDEP flight list or appeared too late. This contributed to mental workload trying to understand why the flight was not present and, often, writing up a note on observation forms to identify the "bug" for the technical team.

In many cases, the controllers commented that when they did get busy, they stopped using the ADDEP panel since its use was not mandatory. It became an extra task (not a core task) and therefore a low priority. The controllers stated in the questionnaires that, in some instances, they would often delegate the task of ADDEP inputs to an ATSA. If an ATSA was not available, the inputs were not made and the ATCO might try and "catch up" when the busy period passed. Late input of information during busy periods decreased the accuracy of the ADDEP information right at the moment when the information might be needed most.

Usability

Identifier	Description
OBJ-12.04.01-VALP-0050.0050	Assess the usability of the ADDEP panel
CRT-12.04.01-VALP-0050.0050	Participants agree that the panel is deployable with only minor modifications required

Certain aspects and functions of the tool did not get used, leading to a detrimental effect on the output data of the tools i.e. TAXITIME. This seems to have arisen from a lack of formal training on the system and understanding of how it all works together to give the improvement in accuracy the system is designed to provide. For this reason it is recommended that formal training on the system is provided for future exercises.

Although an in-depth human factors study was not possible in this exercise, some feedback stated that the panel did not fit into the existing CWP and that ergonomics were negatively impacted. They felt that the overall desk configuration resulted in more head down time, and that the positioning of the ADDEP screen made it awkward to use. It was not possible to move the screen as doing so resulted in the view of a runway holding point being blocked.

As with the workload results, this may be partially due to the use of a completely stand-alone ADDEP alongside an operational system in a shadow mode exercise. In operations the ADDEP panel could be more integrated into a revised CWP, positioned properly and therefore be easier to use.

In terms of improvements to the overall system, the controllers had some recommendations:

- The tasks of ADDEP input could be delegated to the ATSA. This would reduce the controller tasks, certainly during the exercises and possible in operations;
- The HMI could be improved to include more information on the flights e.g. Point of departure info, squawk, destination, initial waypoint.

A further suggestion from the validation team (i.e. not raised directly by the controllers themselves) concerns the issue of incorrect parameters being used. Notice of incorrect parameters could be given via the HMI to the operators to avoid the example observed in the exercise where the system was using the wrong expected taxi out time.

During the analysis of the data it was realised that the Operating Controller did not update the TAXITIME when a change in runway took place. At EGHI the change in runways effects the duration of time it takes for the aircraft to taxi from the stand to the runway - if this variable is not updated in the system this has a negative effect on the ETOT calculations. The calculated ETOT (AOBT + TAXITIME) is included in the DPI message sent by the ADDEP server on the 'Push Back' button push. This has the implication that the ADDEP system is sending inaccurate data without the controller knowing and therefore having a detrimental effect on the accuracy of the data in the Network. As the times on the strips were not updated when the ETOT was recalculated there was no way for the controllers to have seen this. If the Network has inaccurate data in at this early stage then this has an effect on the decisions made further down the flight path by adjacent units.

Integration of the Airport into the Network

Identifier	Description
OBJ-12.04.01-VALP-0050.0060	Assess benefit to the tower due to the use of the panel in integrating the airport's operation in to the ATM network
CRT-12.04.01-VALP-0050.0060	Network Managers asses that any improved accuracy in departure data would reduce the frequency of departure delays.

None of the exercise participants could identify a benefit to them of using the ADDEP panel. Several controllers commented in the questionnaires that they found it difficult to justify the use of ADDEP when they could see no benefit for their own operations. They felt that this, coupled with the extra tasks brought on by using ADDEP, negatively impacted their overall perception of the system.

However, they did recognise the benefit to APP controllers and the Network Managers. Therefore, providing Network Managers could see a benefit, the success criteria for this objective could still be met.

A meeting was held with a Network Manager to discuss the benefit they foresaw the ADDEP data could bring to the network and the people who use it. One of the topic of discussion put forward was would the higher accuracy of data lead to a reduction in departure delays. The following are direct quotes from the meeting detailing the topic discusses and the responses, both good and bad, given:

The meeting was started with a brief overview of the system, how it works and the intended implementation. The graphs from Figures 2 through to 8 (above) were presented to the Network Manager as a visual depiction of the accuracy of ETOT when ADDEP data was included in the Network.

The following bullet points list quotes given by the Network Manager during a discussion about the results shown in the graphs:

- *[When presented with the data for when ADDEP is not being used]* About 10% are never updated. We get that all the time but there is nothing we can do about it.
- *[When presented with the data for when ADDEP is used]* You can see that in the planning arena it's not much help. In the 0-10 minute range.
- At that *[0-10 minute]* range you are in the tactical or final decision phase and this would make life a lot easier.
- This would help crystallise final decisions.
- The data is useful and we would want it.
- It uses information that is there, but we could never capture it.
- This could give confidence in the data or act as an alert.
- It adds more stability to a dynamic picture.

The Network Manager was then asked if there was a specific tool or system which the data produced by ADDEP would have a benefit in. TLPD was noted as the main tool and the following quotes were given:

- The benefit purely from a TLPD point of view is already clear to see.
- For TLPD we will take data from any source as long as it enhances the value.

- You could slave off the data and import it into TLPD. You could see what is moving, not moving, late….
- The key thing for us is knowing that an aircraft is on the move *[on the ground]*. Knowing it is moving can be more important that knowing it is airborne.
- For CFMU Human Machine Interface (CHMI) alone there is no real benefit. TLPD is where we will get most benefit as it is the primary tool for traffic managers.
- For a exercise if you are sending data to the CFMU we may want the data direct. We don't take DPI from the CFMU so would like that data from you.
- If you can show the TPLD linking to this that would be a very strong case.

The Network Manager was then asked how the tool would work in the Network if it were to be used in a larger environment and also to comment on where, in their opinion, the best gains would be. The following quotes were given by the Network Manager:

- It's all positive, especially if we are able to expand it out.
- In places like the Channel Islands where you might have 10 minute ground and 10 minutes airborne before you know the aircraft is moving, you are getting a good 20 minutes pre-warning.
- It would be interesting to see this in Norwich and Exeter, maybe Bristol and Cardiff too.
- How many airports could this be useful for? Where should I stop? East Midlands, Birmingham, Hurn, Luton, Cardiff, Bristol, into the FAB for Dublin and Cork? Aldergrove and Belfast Harbour, Aberdeen, London City…
- It would also be of use to airports where full EFPS may be planned but for some reason implementation is delayed or it isn't working. For example in places like Manchester.
- *[with regards the SOU data already being quite accurate]* You are at an airport where 90% of the aircraft are FlyBe. FlyBe know the importance of the EOBT. They go to a real effort to take traffic management to heart and they work a lot with us already. It would be interesting to see how it would work at an airport where they are not the main airline.
- *[Regarding when maximum benefit might be expected]* On days of high traffic complexity in sectors like London Middle. Take the East Midlands, Birmingham, Bristol and Cardiff outbounds all coming into S25. They can get people into place.
- On days of high departure delay e.g. Low visibility, things tend to slow down anyway. When things are slow maybe it's not such a big benefit.

A final question was asked in regards to what effect the higher accuracy of data in the network would have on departure delays:

- Departure delays could be reduced however I feel this would only be realised once the system was installed into a wider environment as the data from one tower would work together with other towers data to make the final decision if a local flight[4] regulation needs to be applied.

Feedback from the exercise controllers backed up the positive view of the Network Manager, suggesting that ADDEP would benefit the network. One scenario was raised by a controller who suggested that ADDEP did not stop last minute time restrictions being placed on aircraft that had already pushed back.

Support to Approach Controllers

Identifier	Description
OBJ-12.04.01-VALP-0050.0070	Assess the level of support provided by the slave display to the approach controllers
CRT-12.04.01-VALP-	Approach controllers agree that the slave display would provide

[4] A local flight regulation is a delay applied to an individual or set of aircraft by means of either a telephone call informing the controller that the aircraft or aircrafts must be kept on the ground or by takeoff clearance not being given by the proceeding unit.

0050.0070	benefit.

Most controllers (TWR and APP) stated that ADDEP would have a benefit to the Approach controllers.

Much in the same way as the early information would benefit Network Managers, the controllers in the exercise (who performed both TWR and APP roles at different times) felt that the early availability of information would help with their planning. They stated that the information in ADDEP could be used to observe aircraft starting up and pushing back and therefore of benefit for planning overflights. They felt that their situational awareness as APP controllers was increased and that they may also be more able to predict future workload.

One minor critique was that the panel allowed the APP controller to see an impending departure rush, but not necessarily the departure order.

Safety

Identifier	Description
OBJ-12.04.01-VALP-0050.0080	Identify the safety impact of the ADDEP panel
CRT-12.04.01-VALP-0050.0080	Any negative impact on safety can be mitigated.

The controllers were asked if their use of the ADDEP panel had any impact on safety. The majority of controllers (66%, or 6 of the 9 who answered this question) felt that using ADDEP had no detrimental effect on safety of their operations. However, 83% of controllers (5 of the 6 who answered this question) also stated that they saw no positive impact on safety as a result of using ADDEP. One respondent did suggest that the greater accuracy of data output from ADDEP would have an overall, general benefit and this could include a safety benefit.

6.1.3.1.3 Results impacting regulation and standardisation initiatives

Not applicable.

6.1.3.2 Analysis of Exercise Results

Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results	Validation Objective Analysis Status per Exercise
OBJ-12.04.01-VALP-0050.0010	Quantify the impact on accuracy of departure data against existing estimates and actual data	Operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP	Improvement in data accuracy over current method, proven with data and Network Manager views	Partially assessed Conclusion not yet reached NOK
OBJ-12.04.01-VALP-0050.0020	Quantify the loss of data due to lack of use, respecting that this device will be used in shadow-mode	The loss of data still leaves an operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP	Loss of data minimal. Views of Network Manager show any data with higher accuracy is an operationally significant improvement	Partially assessed Conclusion not yet reached NOK
OBJ-12.04.01-VALP-	Assess the integrity of data, respecting that	The loss of data integrity still leaves an	Lack of integrity in data refused at	Success Criterion

0050.0030	this device will be used in shadow-mode	operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP	network level due to system checks. All data received post system checks deemed operationally significant improvement.	is achieved OK
OBJ-12.04.01-VALP-0050.0040	Identify the impact on tower controller workload due to the use of the ADDEP	No significant increase in workload that is likely to affect the tower operation	Majority of controllers reported only *some* increase in workload and that workload remained manageable.	Success Criterion is achieved OK
OBJ-12.04.01-VALP-0050.0050	Assess the usability of the ADDEP panel	Participants agree that the panel is deployable with only minor modifications required	Minor modifications suggested.	Partially assessed Conclusion not yet reached NOK
OBJ-12.04.01-VALP-0050.0060	Assess benefit to the tower due to the use of the panel in integrating the airport's operation in to the ATM network	Network Managers asses that any improved accuracy in departure data would reduce the frequency of departure delays.	Network Managers foresee great benefit due to the use of ADDEP	Success Criterion is achieved OK
OBJ-12.04.01-VALP-0050.0070	Assess the level of support provided by the slave display to the approach controllers	Approach controllers agree that the slave display would provide benefit.	Majority of APP controller see ADDEP as a benefit to their work.	Success Criterion is achieved OK
OBJ-12.04.01-VALP-0050.0080	Identify the safety impact of the ADDEP panel	Any negative impact on safety can be mitigated.	Participants state that ADDEP has no impact on safety (neither positive nor negative)	Success Criterion is achieved OK

Table 8: Validation Objectives Analysis Status in this exercise

6.1.3.2.1 Unexpected Behaviours/Results

During the exercise it was intended that members of the NATS validation team would observe the use of the system from within the tower during shadow mode operations. Due to the limitations of the live environment and the size of the control tower, it was not possible for the validation team to make the observations themselves, thus impacting the analysis.

It is worth noting that this type of limitation may be experienced in other projects where live exercises are more operationally restricted than simulations.

6.1.3.3 Confidence in Results of Validation Exercise

6.1.3.3.1 Quality of Validation Exercise Results

All data received from the exercise was taken from the ADDEP server at NATS' CTC and CFMU. Specific examples were taken from this data to provide the results of the analysis. During the exercise certain technical issues were experienced which had a detrimental effect on the data in the ADDEP toolset taking it to a point where it was deemed unusable. These faults included losses of connection with the AFTN network and server side services failing. Due to these faults being external from the exercise it was recognised as a sensible idea to exclude these days of data from the exercise analysis.

6.1.3.3.2 Significance of Validation Exercise Results

From the month long exercise four distinct days (16th, 17th, 18th and 21st of March) were chosen from the exercise. In this time the system received and processed 98.9% of the flights that were controlled in paper. This took into account the flights which were not processed due to a communication error between the ADDEP server and the ATFN network. These four days also represented a full shift sequence meaning that it included as many controllers as possible.

The validation exercise was a live exercise therefore scenarios could not be controlled. The exercises took place throughout the whole time the airport was in operation covering a wide range of traffic and situations. Therefore there was no opportunity for controlled experiment design so no statistical inference can be made. Operational significance was judged by subject matter experts.

The results only apply to the use of ADDEP at Southampton Airport and the same results may not be reached as a result of the integration of the system into other towers. However, Southampton airport was chosen as it represents a typical candidate operational environment in which a system like ADDEP might be deployed and therefore while results should not be considered *conclusive* for other towers, they can be considered *representative*.

6.1.4 Conclusions and recommendations

6.1.4.1 Conclusions

The data provided by the ADDEP system shows a large increase in the accuracy of the ETOT value over the current system. With ADDEP data included the end result is flight data with only 6% being outside +-10 minutes of error when comparing ETOT to TO. The current system has 43% of flights with an error of more than +-10 minutes when comparing ETOT to TO.

ADDEP had an impact on controller workload, increasing the tasks and perceived workload of the controllers using it. However, the majority of the participants stated that workload remained manageable. The main increase in workload was during busy periods when input tasks were delegated to the ATSA.

Overall, the controllers had no major problems with the usability of the ADDEP panel. The integration of the system into the overall TWR controller working position was a problem for some controllers and could be improved.

The majority of controllers could see a benefit to Network Managers and APP controllers resulting from using ADDEP. Early warning that aircraft were moving on the surface was of benefit to both APP controllers for planning departures and overflights in the TMA, but also for Network Managers who would have earlier warning of aircraft about to enter their sector.

The ADDEP panel had no overall positive or negative impact on safety according to the feedback from the controllers.

6.1.4.2 Recommendations

The following recommendations are a result of the exercise:

- The use of ADDEP should not be considered an ‘extra’ task for the controllers. In an operational system it should be a core task, not an additional task. In a validation exercise, the use of ATSAs for entering ADDEP data should be considered.
- The ADDEP panel should be properly integrated into a CWP and better positioned ergonomically.
- The data generated by ADDEP should be distributed to the Network and used by network managers and other users so they can properly assess the potential benefit.
- The ADDEP HMI should be improved to alert controllers to wrong parameter settings and to possibly include more information (or the option to display more information) on individual aircraft.
- Due to the incorrect setting of the TAXITIME variable the ‘Push Back’ DPI messages were being sent with inaccurate data. There is no means of displaying the calculated ETOT value on the display and hence no means for the controller to visualise this value and ensure its

accuracy. For these reasons it is recommended that the newly calculated ETOT value be displayed on the ADDEP strip once the 'Push Back' button is pressed.

- A highlight was made that the slave ADDEP panel provides extra details to the Approach controller however this could be improved by having the flights in the correct departure order. For this reason it is recommended that the ETOT value upon the strip be updated to improve the sort order displayed to the Approach controller.
- To ensure in future exercises that all results can be evaluated it is recommended that a formal training session is provided to the participating controllers on tool use and limitations with signoff being carried out between both the controller and a system expert before the commencement of the exercise.
- The limitations of a shadow mode exercise in a live operational environment meant that some exercise objectives could not be fully assessed. The project, and the SESAR programme as a whole, should consider ways in which to balance the needs of research and development validation exercises with those of an operational environment.

6.2 ADDEP Exercise 2 Report

6.2.1 Exercise Scope

The purpose of this exercise was primarily to enable the CFMU to assess the quality and the potential benefits from departure messages being provided for Southampton airport, as a typical small airport.

In addition, it provided a further opportunity for: ATC Controller responses and regarding to safety, usability and workload aspects; and for further assessment potential Network Management and, more specifically, local traffic management and traffic load predictability.

The following validation objectives were therefore applicable:

Identifier	Description
OBJ-12.04.01-VALP-0050.0010	Quantify the impact on accuracy of departure data against existing estimates and actual data – by CFMU.
OBJ-12.04.01-VALP-0050.0030	Assessment of the integrity of data – by CFMU.
CRT-12.04.01-VALP-0050.0060 (revised for Exercise 2)	NATS Network Management assessment as to if the predicted departure information, that the ADDEP could provide, would improve the local network management and short term sector traffic capacity prediction abilities.
OBJ-12.04.01-VALP-0050.0040	Confirmation of the impact on tower controller workload due to the use of the ADDEP and following the post Exercise 1 update to the ADDEP display.
OBJ-12.04.01-VALP-0050.0020, 0030, 0040, 0050, 0070,& 0080	Re-assess the results for these objectives and in view of the improved usability of the ADDEP following the post Exercise 1 update to the ADDEP display.

Table 9: Exercise related Objectives

6.2.2 Conduct of Validation Exercise

6.2.2.1 Exercise Preparation

Prior to the exercise, the following operational and technical tasks were performed:

- Temporary Operating Instructions were issued for the duration of the exercise.
- The internal, to NATS, receive only X25 message feed connection from the ADDEP Server to the NATS AFTN switch was updated to also allow A-DPI messages to be sent.

- AFTN circuit and message routings were set up to allow the A-DPI messages to be forwarded from the NATS AFTN message switch to the CFMU AFTN message switch
- CFMU set up internal connectivity and recording provisions for the collection and analysis of the Southampton ATC provided A-DPI messages.

6.2.2.2 Exercise execution

The ADDEP was used during normal airport operating hours from the 5th to the 7th of Sept 2011. The TWR ATCOs were requested to use the ADDEP panel to enter push back, taxi and take off clearance actions for departing aircraft. However, use of the ADDEP was not mandated, so the ATCOs would not need to use it if, or when, they felt that safety or the quality of their service provision was in any way compromised.

A-DPI and C-DPI messages from the ADDEP panel were transmitted, in real time, to the CFMU, where they were collected and later (in Jan 2012) analysed for their conformance with standards and performance against the existing operational information provisions. Although three days of data collection was proposed to reduce the CFMU impacts, agreement was that only the most typical day's data would be analysed and in detail. This report and associated follow up investigations are summarised in Appendix A.

6.2.2.3 Deviation from the planned activities

Due to external technical infrastructure problems the use of the system was compromised during the morning of the 5th. Thus, results from that day were not considered as good candidates for analysis.

6.2.3 Exercise Results

6.2.3.1 Summary of Exercise Results

Impact on Improved Data Availability and Accuracy

CFMU analysis indicated is summarised in their report synopsis (as reproduced in Appendix A, A.1.2). This indicated that the ADDEP provision of A-DPI and C-DPI message significantly improved the early availability and the accuracy of predicted TTOT information. It indicated an improvement over the current availability situation where information is based on the operator filed information and an accurate update is not made available until after take off when the aircraft is correlated and identified by the ATCC SUR and FDP systems.

The indications were that the ADDEP significantly improved predicted take off accuracy by 7.5 min and its availability from the time at which the start-up clearance was issued.

Figure 9 in Appendix A indicates the relative improvement.

It should be noted that, on the day for which the analysis was performed, the average start-up to take off time parameter setting used by the ADDEP was set to only 5 mins[5]. Where there is a greater average taxi out time, a proportionate improvement in the early availability of the improved accuracy TTO information, from the A-DPI messages, would be expected.

The NATS Network Management Expert assessment is included in Appendix 1 (A.2.1).

Loss of and Integrity of Data

The CFMU provided report data files indicate that all the ADDEP provided A-DPI and C-CPI messages were received, they were all in conformance with CFMU syntax requirements, they could be correlated with flights within the CFMU system, and none were subject to corruption.

However, the infrastructure failures on the 5th indicated that; whilst the technical infrastructure provided resilience from data corruption the provision of single link circuits was venerable to technical

[5] For the runway in use at Southampton this parameter value reflects the TWR ATCOs estimated average start-up and taxi-out time.

single points of failure. However, this was a trial and back-up and diverse connectivity infrastructure link provisions are normally provided for operational systems.

Controller Workload and Safety

Results indicated that the TWR ATCOs performed ADDEP input actions for all flights whilst the system was available (i.e. except for the periods on the 5th, when use of the system was compromised by external technical infrastructure problems).

No reports were received to indicate that use of the ADDEP had any significant impacts on controller workload or safety.

Usability

Anecdotal reports from the TWR ATCOs indicated that the improvements made to the ADDEP display, as a result of the comments from Exercise 1, were considered a useful improvement and the additional information was appreciated.

6.2.3.1.1 Unexpected Behaviours/Results

Although the average start-up to take off time parameter setting used for the ADDEP was set to 5 min's. Indications from the CFMU analysis results are that the parameter used may not represent the correct actual average time as measured during the analysis period. However, the parameter value used was viewed as reasonable for the exercise. This also represented a probable minimum A-DPI provision period for most small airports.

CFMU analysis also stated that '80 of 111 A-DPI messages indicated a TTOT outside of the normally accepted Departure Tolerance Window'. Although not relevant to the ADDEP validation, this indicates that aircraft operators were not always meeting network management expectations for updating their filed Flight Plans.

For a small number of cases the indications from the CFMU results were that the controller inputs to the ADDEP were performed retrospectively. These were identified in the results of the further analysis as shown in Table 12 in Appendix A.

6.2.3.2 Analysis of Exercise Results

Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results	Validation Objective Analysis Status per Exercise
OBJ-12.04.01-VALP-0050.0010	Quantify the impact on accuracy of departure data against existing estimates and actual data	Operationally significant improvement in the accuracy of departure data from airports equipped with ADDEP	Improvement in data accuracy over current method, proven.	Success Criterion is achieved OK
OBJ-12.04.01-VALP-0050.0060 (revised)	NATS Network Management assessment as to if the predicted departure information, that the ADDEP could provide, would improve the local network management and short term sector traffic capacity prediction abilities.	NATS Network Management Expert assesses that early availability and confidence in the likely accuracy of departure data would improve the local network management and short term sector traffic capacity prediction abilities.	NATS Network Management Expert foresees benefits from the use of ADDEP	Success Criterion is achieved OK
OBJ-12.04.01-VALP-	Re-assess the improved usability of	As for Exercise 1	No adverse factors identified or adverse	Success Criterion

0050.0020, 0030, 0040, 0050, 0070,& 0080	the ADDEP following the post Exercise 1 update to the ADDEP display.		comments received[6]. Positive anecdotal comments.	is achieved OK

Table 10: Validation Objectives Analysis Status in this exercise

6.2.3.3 Confidence in Results

6.2.3.3.1 Quality of Validation Exercise Results

Some timing differences, between the ADDEP system clock and the CFMU standard time, were indicated on analysis of the CFMU provided results. However, as the CFMU message recording times could be used for a consistent analysis this did not impact their overall analysis. No other quality issues were identified regarding the Exercise 2 provisions and the report mechanisms applied by the CFMU were those they would normally use for operational analysis and reporting.

6.2.3.3.2 Significance of Validation Exercise Results

There is a close correlation between the CFMU reported results for predictability improvements and those from the NATS analysis for Exercise 1 and both have similar benefit indications.

6.2.4 Conclusions and recommendations

6.2.4.1 Conclusions

The exercise provided further evidence to indicate that the High Level Operational Requirements are achievable and the CFMU provided results supported the expectations for benefit provisions.

More specifically, the exercise concludes that:

> Providing simple and low cost ADDEP panels, at smaller airports is considered to be feasible and, by their improved availability to supply earlier and improved predictability departure information, they would result in network management and traffic load prediction benefits for wider stakeholders.
> Specifically:

a. Improved accuracy TTOT departure information would be available upon issue of the actual start-up clearance to the aircraft from the TWR ATC - rather than when the aircraft has departed and is seen by the ACC's SUR and reported as correlated by the FDP system). For Southampton, where the average taxi time for departures from the northerly runway was estimated as being 5 min's, the indicated improvement was approx 7 min's. For longer average taxi times a greater improvement would be expected.

b. The improved TTOT is based on the actual start-up and airport estimated taxi-time This represents a much smaller time window for the TTOT prediction – rather than being based on the aircraft operator filed Flight Plan and update submissions.

6.2.4.2 Recommendations

The overall recommendations from Exercise 1 remain unchanged.

In addition, following additional recommendations made as result of this exercise:

a. The parameter used for the airport taxi times (for each runway) could be updated following further message provisions and analysis of results (CFMU recommendation);

[6] Comments related to incorrect time indications were provided in relationship to the 5th. However, infrastructure issues were identified that had compromised the ADDEP system on that day.

b. The existing ADDEP applications could be easily adapted to also provide other services – such as a combined arrivals and departures provision for the tower.

7 References

7.1 Applicable Documents

[1] V&V Plan Latest version
[2] SESAR V&V Strategy Latest version
[3] Template Toolbox Latest version
[4] Requirements and V&V Guidelines Latest version
[5] Toolbox User Manual Latest version
[6] European Operational Concept Validation Methodology (E-OCVM) - 2.0 [March 2007]
[7] Concept of Operation (for ADDEP) P12.04.01-D10 Ed 00.01.00

7.2 Reference Documents

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

[8] 12.04.01-D08-Validation Plan

Appendix A - Exercise 2 Analysis Reports

A.1 CFMU Analysis of ADDEP Provided Messages

A.1.1 CFMU Summary Report

The CFMU provided their normal analysis report. This comprises of a number .XLS spread sheets each addressing standard areas of analysis. Whilst this included ADDEP specific aspects, it also included analysis of other operational aspects. As the .XLS files also provide detailed levels of analysis which beyond the level needed for this report, they are not included here.

However, the CFMU provided zip files (EGHI_20110906) containing the multi-sheet .XLS files, and the later provided operational log files (CFMU Oplogs), are retained within the project area on the SESAR Intranet).

The following is the summary of the CFMU evaluation, as performed on 06/09/2011:

R01: Syntax errors:

None

R02: Uncorrelated DPI messages:

Number of A-DPI received: 121
Number of C-DPI received: 9.
All these DPI messages could be correlated to flight data in ETFMS

R04: Not fully processed DPI messages:

None

R05: Completeness:

A-DPI messages were received for all flights.
C-DPI messages were received for 12% of the flights.
The percentage of C-DPI messages was rather high and requires investigation.

R06: Count per flight:

For 39% of the flights one A-DPI has been received.
For 58% of the flights two A-DPI messages have been received.

Receiving two DPI messages for one flight is not really a problem but requires investigations. It may mean that in most cases the initial estimate of the TTOT was not accurate. Possibly the taxi-time requires further tuning.

R08: taxi-time:

121 DPI messages contained a TT of 5min
9 DPI messages contained a VTT of 1min (to be verified[7]).

[7] The project confirmed that the taxi time provided by the ADDEP, in the A-DPI message, is a fixed parameter value for the runway in use and is not individually entered or changed VTT for each flight. Whilst this parameter could be varied by the controllers, during the exercise remained set to 5 min's. However, the CFMU analysis highlighted that when a second A-DPI message was provided (due to taxi delays) it included a new TTOT, but retains the original off blocks and taxi times. Although the taxi time provided in an update is irrelevant when the aircraft is cleared for take off, re-provision of the original taxi time is recognised as being technically incorrect.

R09: Filing time to TOT:

On average the A-DPI messages were sent 4min before the TTOT in the message.
This is normal.

R11: Predictability.

The A-DPI messages significantly improved predictability:
As indicated by graph in spreadsheet R11 (this is shown in Figure 10).

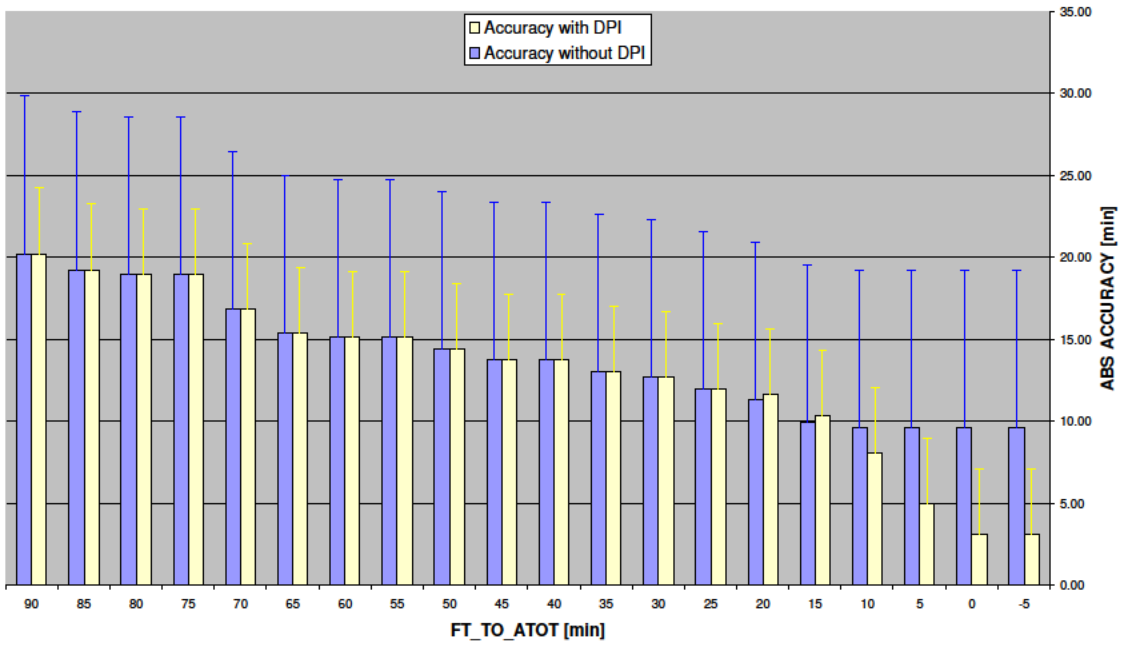

Figure 10: ADDEP Improvement in Accuracy of Predicted to Actual Take Off Times

R12: Accuracy progress with anticipation:

The A-DPIs provided significant improved TOT predictions from 7.5 min before take-off onwards.

R13: adherence to ATFM slots:

6 A-DPI messages were received for regulated flights.
2 A-DPIs (so 33%) contained a TTOT before STW.
However all (4) flights departed inside STW (so 100% slot adherence).

R14: adherence to departure tolerance.

80 of the 111 A-DPI provided a TTOT inside Departure Tolerance Window.
This is a rather low percentage (72%) as Aircraft Operators should update their flight plans.

R15: FAM suspended flights.
One flight was suspended by FAM (Aircraft Callsign = GMEGN. A FLS (not reported as airborne) was sent after the reception of the ATC-DPI. But, no FSA message or CPRs were been received for this flight. So, the DEP received could be a 'fake' one, because the flight is not confirmed by the radar plots (CPRs) CFMU would have expected a C-DPI for this flight so this requires investigation.

R3, R7, R10 were not reported.

A.1.2 NATS Investigation of issues from CFMU Report

The following table below includes the further investigations and analysis performed to address the CFMU identified and potential ADDEP related problems/ issues.

Callsign	CFMU Log time	MSG/Action	ADDEP file for 6th Sept	Created (ADDEP system time)	ADDEP A-DPI Msg Content	Problem / Comment
BEE761	22:56	FPL (on 5/9)				
	06:17	**FSA** & FUM				
	06:18	**A-DPI**	001.txt	06 September 2011, 06:19:04	HSE001	**Flight Already activated - CFMU**
					FF EGZYDPHI EGTTZGZP	**So, controller may have input ADDEP start & take off action retrospectively.**
					060619 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE761	
					-ADEP EGHI	
					-ADES EGPH	
					-EOBT 0610	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 0624	**Should have been 0623**
					-AOBT 0619	
					-AOBD 110906	
						Three flights all departing at same time. BEE761, BEE5ME & BEE1IY
BEE5ME	22:54	FPL (on 5/9)				
	03:57	FUM & SAM				
	04:17	FUM & SAM				
	06:14	**FSA**				Correct departure FSA

	06:18	**A-DPI**	002.txt	06 September 2011, 06:19:14	HSE002	**So, controller may have input ADDEP start & take off action retrospectively.**
					FF EGZYDPHI EGTTZGZP	
					060619 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE5ME	
					-ADEP EGHI	
					-ADES EHAM	
					-EOBT 0605	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 0624	**Should have been 0623**
					-AOBT 0619	
					-AOBD 110906	
	06:26	FSA				This is an en-route FSA, giving time/level/route information for BPK
BEE1LY	22:46	FPL (on 5/9)				
	06:06	**FSA** & FUM				
	06:19	**A-DPI**	003.txt	06 September 2011, 06:19:30	HSE003	**Flight Already Active - CFMU**
					FF EGZYDPHI EGTTZGZP	**So, controller may have input ADDEP start & take off action retrospectively.**
					060619 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE1LY	
					-ADEP EGHI	
					-ADES EGPF	
					-EOBT 0555	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 0624	**Should have been 0623**
					-AOBT 0619	

					-AOBD 110906	
	07:42	FUM				**No later FSA seems to have been received.**
BEE3DJ	22:52	FPL (on 5/9)				
		various SAM, SRM, REA actions				Flight supposed to be airborne
	09:46	FLS & FUM				Not reported airborne
	09:55	**A-DPI**	033.txt	06 September 2011, 09:56:02	HSE033	**Flight Suspended - CFMU**
					FF EGZYDPHI EGTTZGZP	
					060956 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE3DJ	
					-ADEP EGHI	
					-ADES LFMN	
					-EOBT 0905	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 1001	**Should have been 1000**
					-AOBT 0956	
					-AOBD 110906	
	10:07	**A-DPI**	035.txt	06 September 2011, 10:07:22	HSE035	**Flight Suspended**
					FF EGZYDPHI EGTTZGZP	However, this DPI reflects correct ADDEP action for take off clearance provided later than an earlier provided TTOT.
					061007 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE3DJ	
					-ADEP EGHI	
					-ADES LFMN	
					-EOBT 0905	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 1008	**Should have been 1007**

					-AOBT 0956	
					-AOBD 110906	
	10:10	**FSA** & FUM				
	10:15	**FSA**				
BEE5AM	17:49	FPL				
	18:51	DLA				
	18:55	DLA				
	20:41	**A-DPI**	128.txt	06 September 2011, 20:41:36	HSE128	
					FF EGZYDPHI EGTTZGZP	
					062041 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE5AM	
					-ADEP EGHI	
					-ADES EGNT	
					-EOBT 2030	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 2047	**Should have been 2046**
					-AOBT 2042	
					-AOBD 110906	
	20:50	**FSA**				
	20:51	**A-DPI**	129.txt	06 September 2011, 20:51:46	HSE129	**Flight Already activated - CFMU**
					FF EGZYDPHI EGTTZGZP	However, this DPI reflects correct ADDEP action for take off clearance provided later than an earlier provided TTOT.
					062051 EGTTZDZD	**So, controller may have input ADDEP take off action retrospectively.**
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE5AM	
					-ADEP EGHI	
					-ADES EGNT	

					-EOBT 2030	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 2052	**Should have been 2051**
					-AOBT 2042	
					-AOBD 110906	
GMEGM	19:17	FPL (on 5/9)				One of Several different leg FPs Cardiff, Durhan, S'ton, Cardiff
	08:07	**FSA** & FUMs				Cardiff to Durham
	09:57	**FSA** & FUMs				Durham to Southampton
	10:14	**FSA** & FUMs				Southampton to Cardiff
	11:27	**A-DPI**	054.txt	06 September 2011, 11:28:16	HSE054	
					FF EGZYDPHI EGTTZGZP	
					061128 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID GMEGN	
					-ADEP EGHI	
					-ADES EGFF	
					-EOBT 1130	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 1133	**Should have been 1132**
					-AOBT 1128	
					-AOBD 110906	
	11:30	**FUM**				
	12:03	FLS				**Not Reported as airborne - went VFR?**
	12:04	DEP				
BEE869	23:09	FPL (on 5/9)				
		several FUM				
	15:04	**DLA**				
		several FUM				
	15:36	A-DPI	088.txt	06 September 2011, 15:36:24	HSE088	

					FF EGZYDPHI EGTTZGZP	
					061536 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE869	
					-ADEP EGHI	
					-ADES EGCC	
					-EOBT 1515	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 1541	**Should have been 1540**
					-AOBT 1536	
					-AOBD 110906	
	15:42	**FSA**				
	15:42	FUM				
	15:48	**A-DPI**	090.txt	06 September 2011, 15:49:14	HSE090	**So, controller may have input ADDEP take off action retrospectively.**
					FF EGZYDPHI EGTTZGZP	
					061549 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE869	
					-ADEP EGHI	
					-ADES EGCC	
					-EOBT 1515	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 1550	**Should have been 1549**
					-AOBT 1536	
					-AOBD 110906	
EZE96G	21:45	FPL (on 5/9)				

	18:26	FLS & FUM				The original EOBT was 1745, TAXITIME 5, at 17.50 the flight started to be monitored and shifted every 5 minutes.
	18:26	**A-DPI**	121.txt	06 September 2011, 18:27:00	HSE121	**CFMU report Flight Suspended**
					FF EGZYDPHI EGTTZGZP	
					061826 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID EZE96G	
					-ADEP EGHI	
					-ADES EGPD	
					-EOBT 1745	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 1832	**Should have been 1831**
					-AOBT 1827	
					-AOBD 110906	
	18:37	**A-DPI**	123.txt	06 September 2011, 18:38:14	HSE123	**CFMU report Flight Suspended**
					FF EGZYDPHI EGTTZGZP	
					061838 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID EZE96G	
					-ADEP EGHI	
					-ADES EGPD	
					-EOBT 1745	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 1838	**Should have been 1837**
					-AOBT 1827	
					-AOBD 110906	
	18:40	**FSA**				
	18:40	FUM				

	18:49	**FSA**				
BEE245	23:22	FPL (on 5/9)				
	14:44	CHG				
	16:36	DLA				
	19:02	DLA				
	21:40	**FSA**				
	21:44	**A-DPI**	130.txt	06 September 2011, 21:45:16	HSE130	**So, controller may have input ADDEP start & take off action retrospectively.**
					FF EGZYDPHI EGTTZGZP	
					062145 EGTTZDZD	
					-TITLE DPI	
					-DPISTATUS ATC	
					-ARCID BEE245	
					-ADEP EGHI	
					-ADES EGJJ	
					-EOBT 2100	
					-EOBD 110906	
					-TAXITIME 0005	
					-TTOT 2150	**Should have been 2149**
					-AOBT 2145	
					-AOBD 110906	

Table 11: Additional Analysis of CFMU identified issues/problems

Note.

CFMU confirm that a FLS "Not Reported as airborne" is provided by the Flight Activation Monitoring function. This is applied to the flights which do not take off/land according to their EOBT. For these flights, CFMU would expect an updated EOBT would be provided through a DLA message. In the cases identified above this had not occurred.

At the late stage when the CFMU report was provided it was not possible to identify why the percentage of C-DPI messages was rather high.

A.2 NATS Network Management Expert Assessment

A.2.1 Airport Departure Data Entry Panel Assessment

P12.4.1 Step1 Release1 NATS Network Management Expert review conducted by Matt Greenaway (UK FMP, SWP7.2 & P7.6.3/7.6.5)

ADDEP has been trialled at Southampton Airport, and as such provides a good operational baseline as it is likely to be at small to medium sized airports where this tool is most likely to be introduced.

In this instance the impact is felt from around 10min's prior to departure, where a tower ATCO would initiate the sending of a (TTOT) DPI message on the issuance of a Push & Start clearance. The accuracy of the output is roughly a 3 fold improvement which in its self is very desirable, but the other large gain is the reliability and timeliness of the data.

With this type of data available to Network Management (delivered from as many sources as possible) certainty levels rise, meaning less network management interventions (regulations/STAM) would be required, and for those occasions where intervention is required the knowledge that individual flights may still be available to accept a modification is a big step forward.

- **END OF DOCUMENT -**