International Civil Aviation Organization

The Sixth Meeting of the APANPIRG ATM Sub-Group (ATM/SG/6)

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Agenda Item 4: ATM Systems (Modernisation, Seamless ATM, CNS, ATFM)

POST-OPERATION ANALYSIS FOR M771 ATFM OPERATIONAL TRIAL

(Presented by Singapore)

SUMMARY

This paper presents the post operation analysis for ATFM measures implemented for flow control measures on M771 to Shanghai, Pudong, from 15 January 2018 to 14 April 2018. It highlights the importance of cooperation from stakeholders to ensure enhanced predictability, smoother air traffic flow and resource allocation efficacy.

1. INTRODUCTION

1.1 At the ICAO ATM/SG/5 & APANPIRG/28 Meetings, Singapore presented a proposal to mitigate the impact of flow control measures from downstream Area Control Centres (ACCs) on ATS Route M771. The aim of the proposal was to trial the ATFM concept, which would provide predictability to aircraft operations operating on the route affected by such flow control measures. A 3-month ATFM operational trial was subsequently initiated on 15 January 2018 for flights bound for Pudong (ZSPD) affected by the flow restrictions.

1.2 The post operations analysis was conducted and the report had been disseminated to stakeholders. In order to continue the momentum and offer predictability for stakeholders to enable better allocation of resources, the operational trial to ZSPD was re-initiated from 18 June 2018 while works on the inclusion of other destinations as part of Phase 2 for flights affected by flow restrictions was being developed.

1.3 The adopted phased approach for ATFM operational trials on M771 were as follows:

Phase 1

- Concept of Operations Development (July – Nov 2017)
- Engage stakeholders and conduct Demonstration Trial on processes and procedures for aircraft operators with flight bound for ZSPD (Dec 2017)
- Conduct 3-month Operational Trial (Jan – Apr 2018)
- Gather feedback from stakeholders

Phase 2

- Continue on Phase 1 Operational Trial (Jun – Dec 2018)
- Conceptualising the combination of Phase 1 operations with flights utilising ATS route M771 to other constrained airspace/airport such as ZSAM, ZSFZ and ZSQZ.

- Engage new and existing stakeholders on processes and procedures for flights utilising ATS route M771 to the constrained airspace/aerodromes
- Conduct Operational Trial
- Gather feedback from stakeholders for both Phase 1 and Phase 2 trials

Phase 3

- Conceptualising the use of ATFM measures for Large Scale Weather Deviation Procedure on ATS route M771
- Identify and explore implementation of ATFM measures on other ATS routes

2. DISCUSSION

2.1 The aim of developing this ATFM initiative on ATS Route M771 is to offer advance information to stakeholders of the expected delay for flights as soon as Notice to Airmen (NOTAM) informing of flow control restriction was received. This is done through the issuance of Calculated Take-off Time (CTOT) and Calculated Time Over (CTO) to the affected flights before they depart. In doing so, stakeholders, being informed of their expected delay, could better manage their resources without having the need to scramble at the very last minute

2.2 This initiative leverages on existing ATFM concepts that are being carried out as part of the Distributed Multi-Nodal ATFM Network and Collaborative Miles-In-Trail Conversion Program (CMCP). It is also important to note, that like any collaborative ATFM effort, the effectiveness can only be realized when stakeholders such as air navigation service providers, airspace users and airport operators collaborate and cooperate to achieve the desired outcome of enhanced predictability and better resource allocation.

2.3 Key Performance Indicators (KPIs) were identified to measure performance of the ATFM implementation. The KPIs aims to enable Air Navigation Service Providers (ANSPs) to identify areas for improvement as well as communicate to stakeholders how actions can affect the performance of the system.

2.4 For the purpose of this trial, the following 6 KPIs and their correlating values were identified:

KPI	Value of KPI
CTOT Compliance	Shows the actual number of flights compliant to traffic management initiatives (TMIs) and the performance of ANSP TMI actions. High compliance rate assists in Air Traffic Management (ATM) in managing traffic flow and enhance in total ATM capacity. Using this KPI, further analysis could be done to investigate reasons for non-compliance flights and to improve accordingly.
CTO Compliance	Shows the actual number of flights compliant to TMIs and the performance of ANSP TMI actions. High compliance rate assists ATM in managing traffic flow and enhancing total ATM capacity. Using this KPI, further analysis could be done to investigate reasons for non-compliance flights and to improve accordingly.

Notification Lead-time	Shows the amount of lead time given to stakeholders to inform them of NOTAM issued for flow control measures in place affecting airspace user's operations. By measuring the performance of lead-time given, analysis on disruption to the number of flights could be assessed.
CTOT Lead-time	Shows the amount of lead time given to stakeholders. It was derived using the time ATFM unit issued CTOT, to the aircraft's estimated take off time submitted in its FPL. Larger CTOT lead-time aids stakeholders in resource management planning. Further analysis could be done to assess how CTOT could be issued earlier to increase more lead-time given to stakeholders.
Estimated Elapsed Time (EET) Verification	Helps identify inaccuracies of EET in FPL and/or ATFM system. Accurate or minima differences between FPL and ATFM system's EETs would assist better allocation of CTOT and CTO to enhance total ATM capacities. In identifying the inaccuracy, ATFM system could be tweaked and/or airlines could be engaged to understand differences in EET.
FPL Submission	Measures the time airspace users took to file FPL for the affected flights when requested. FPL is the enabler for ATFM unit to pre-plan allocation of slots for CTOT and CTO issuance. Correlating with CTOT Lead-time KPI, the earlier that FPLs had been received, the sooner CTOTs and CTOs could be issued thus increasing the time for stakeholders' resources re-allocation etc. Further analysis could be done through engagements with airspace users on the "late" submissions of FPLs.

2.5 Post operations analysis done on the 3-month trial recorded 202 flights affected by the flow control measures. There were 51 NOTAMs issued by downstream ACC implementing flow control measures, 11 extensions and 16 revisions to the NOTAMs. The detailed report can be found in **Annex A**.

2.6 Post operations analysis for the initial implementations showed that there were gaps in information dissemination where stakeholders were unfamiliar with the processes and procedures. Subsequent implementations had seen stakeholders gaining familiarity with some aircraft operators submitting flight plans for their affected flights within 30 minutes of the first notification. The enhanced predictability for airlines had enabled them to better manage their resources such as crew and fleet. For ATC, the pre-planned slot allocation at the convergence waypoint had enabled them to plan ahead and smoothen traffic flow.

2.7 The trial had been successful so far with stakeholders requesting CTOTs when the trial had ended. There are still areas of potential improvements and that is where all stakeholders, through further communication, could narrow knowledge gaps with information sharing and appreciation of the potential benefits that this initiative will bring about.

2.8 Understanding the intent of this initiative would enable stakeholders to have a better appreciation to avoid undesired outcomes. For example, failure to comply with ATFM restriction will result in unnecessary airborne holding which increases workload and reduces efficiency in flight and air traffic management. Cooperation and feedback after measures from stakeholders is certainly a key enabler for pre-tactical actions planning to ensure that traffic continues to flow smoothly in this region.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) participate actively in the implementation of ATFM measures

c) engage relevant stakeholder to achieve objectives of ATFM measures

d) discuss any relevant matters as appropriate

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ANNEX A

REPORT OF THE ATS ROUTE M771 ATFM OPERATIONAL TRIAL TO DESTINATION ZSPD FROM 15 JANUARY 2018, 0000UTC To 14 APRIL 2018, 2359UTC

1. Aim

1.1. This report aims to update stakeholders on the outcome from the ATFM Operational Trial on ATS route M771 conducted from 15 January to 14 April 2018.

1.2. CAAS would also like to take this opportunity to express our appreciation to stakeholders for their commitment and support to make this ATFM Operational Trial possible. This report enables CAAS to share with stakeholders the outcome of the trial and explore areas where processes and procedures could be further improved to enhance the ATFM operations.

2. Background

2.1. Flow control restrictions imposed on ATS route M771 for flights bound for the North Asia Region arose from downstream demand-capacity imbalance resulting from factors such as adverse weather, ad-hoc airspace restrictions or any other situation that warrants a reduction in airport or airspace capacity. These restrictions are typically put in place on impromptu basis with little reaction time for stakeholders to make the necessary adjustments to traffic flow. The restrictions typically entails the need for flights to be spaced from 25 to 240 minutes regardless of the flight levels.

2.2. Realizing the urgent need to offer predictability to stakeholders, CAAS developed the concept of operations for ATS route M771 ATFM measure as an interim solution for flights departing Indonesia, Malaysia and Singapore.

2.3. This initiative leverages on existing ATFM concepts that are being carried out as part of the Distributed Multi-Nodal ATFM Network and Collaborative Miles-In-Trail Conversion Program (CMCP). It is also important to note, that like any collaborative ATFM effort, the effectiveness can only be realized when stakeholders such as air navigation service providers, aircraft operators and airport operators collaborate and cooperate to achieve the desired outcome of enhanced predictability and better resource allocation.

2.4. The initiative was carved into phases to progressively equip stakeholders with the necessary knowledge of operations and to gradually enhance air traffic management by implementing the concept on other routes and/or constrained aerodromes/airspace. The details of the phases are as follows;

Phase 1

- Concept of Operations Development (July – Nov 2017)

- Engage stakeholders and conduct Demonstration Trial on processes and procedures for aircraft operators with flight bound for ZSPD (Dec 2017)
- Conduct 3-month Operational Trial (Jan – Apr 2018)
- Gather feedback from stakeholders

Phase 2

- Engage and conduct Demonstration Trial on processes and procedures for aircraft operators utilising ATS route M771 to other constrained airspace/aerodromes
- Conduct Operational Trial
- Gather feedback from stakeholders

Phase 3

- Conceptualising the use of ATFM measures for Large Scale Weather Deviation Procedure on ATS route M771
- Identify and explore implementation of ATFM measures on other ATS routes

3. Overview of Concept

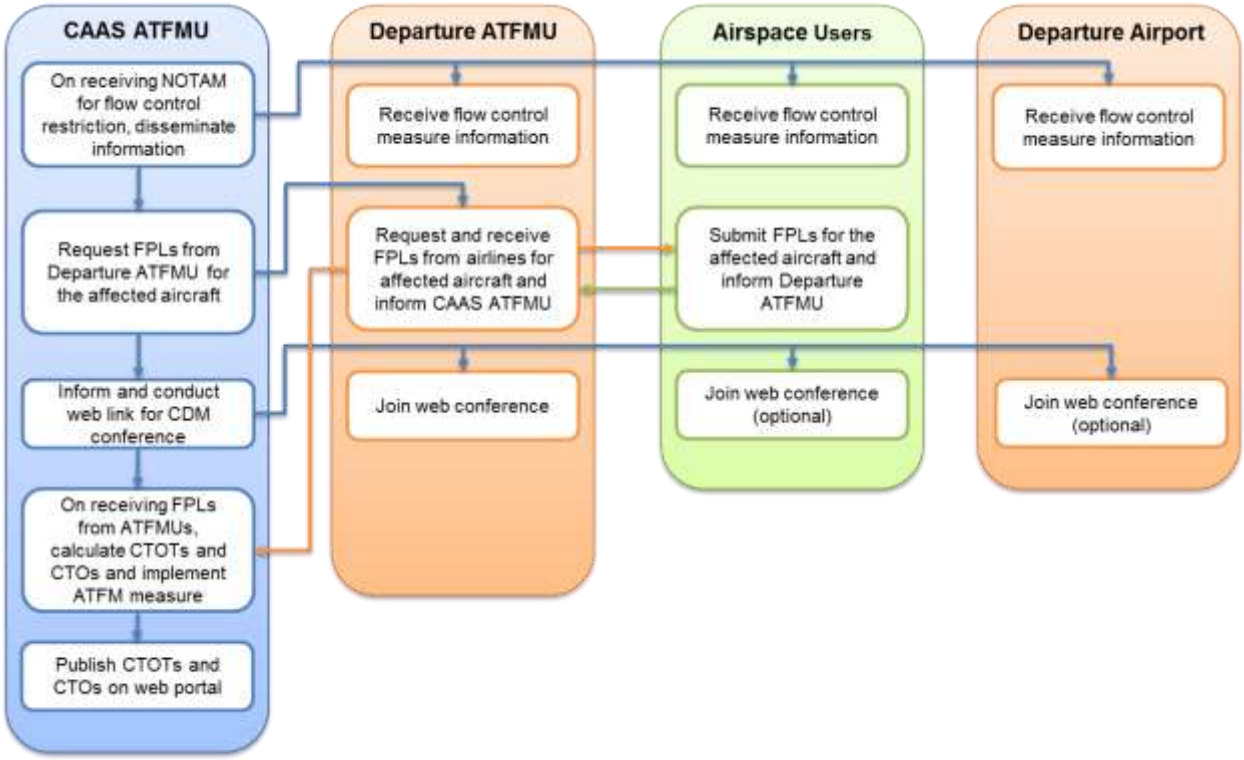
3.1. The impromptu flow control restrictions have great impact to ATM and airlines' scheduled operations. Previously, aircraft would only be made aware of their ground delay upon requesting for Air Traffic Control clearances. The delay, with little or no advance notices could go up to 20 hours, leaving passengers stranded in the plane, being disembarked causing inconveniences and missing their connection flight. Resources such as gate allocation and ground handlers' movement were greatly disrupted as well due to the lack of pre-planning information available.

3.2. The aim of this M771 ATFM initiative through the issuance of Calculated Take-off Time (CTOT) and Calculated Time Over (CTO) was to offer advance information to stakeholders of the expected delay for flights as soon as Notice to Airmen (NOTAM) informing of flow control restriction was received. In doing so, stakeholders, being informed of their expected delay, could better manage their resources without having the need to scramble at the very last minute.

3.3. Leveraging CMCP's concept, the separation required between aircraft as published in the NOTAM was back calculated by using flight's scheduled time over waypoint DUDIS on ATS route M771 and converted into CTOT. This initiative had been made possible with the participation of Indonesia, Malaysia and Singapore in the Distributed Multi-Nodal ATFM Network, with Indonesia and Malaysia capable to receive and comply with CTOT, and Singapore capable to generate, deliver, receive and comply with CTOT.

3.4. CAAS had developed the concept of operations and detailed the processes and procedures involved during the activation of flow control measures. The 2 flow charts below gives an overview of the roles and actions required from stakeholders.

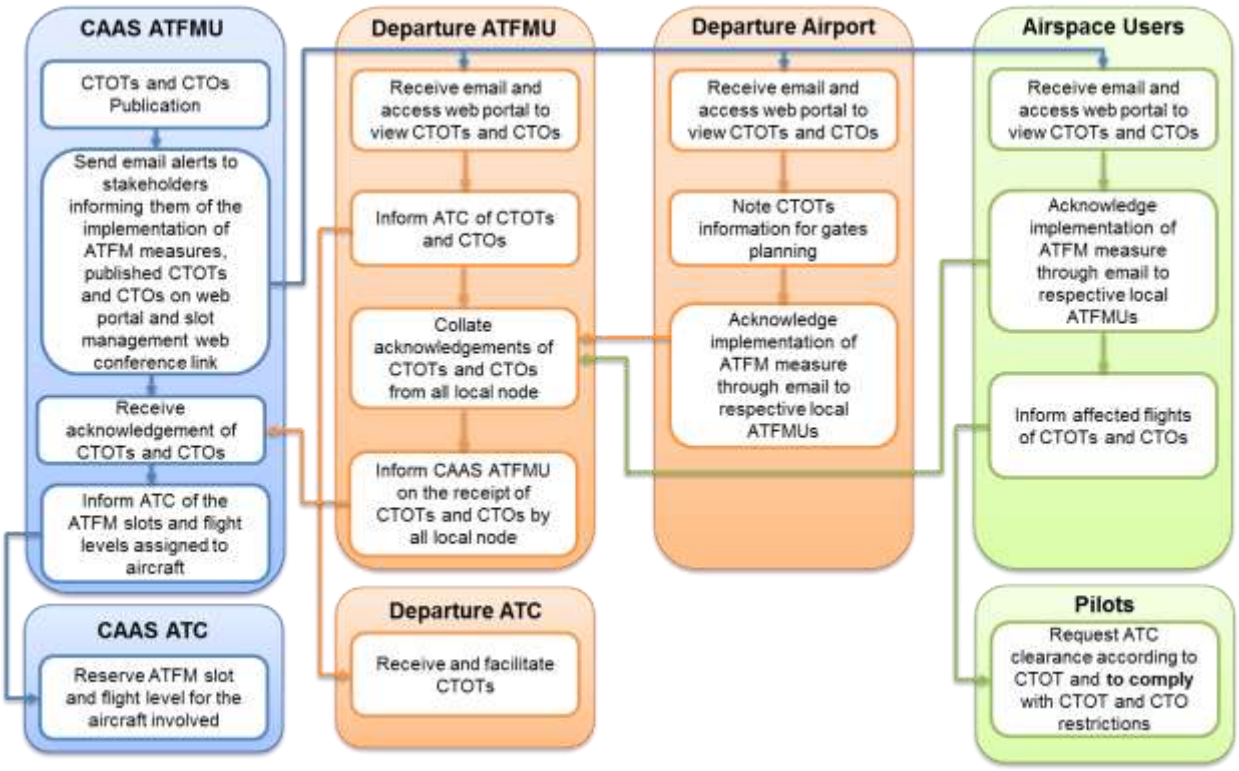
3.5. Flow chart 1 outlined the processes and procedures involved upon CAAS ATFM Unit receiving NOTAM from downstream Area Control Centre (ACC) informing of flow control restrictions of e.g. 120 minutes longitudinal separation regardless of flight levels. The dissemination of information and submission of flight plan (FPL) kick-started the preparation work needed for allocation of CTOT and CTO. It is essential that FPLs are being submitted within 1 hour when first notified by ATFM Units so that CTOT and CTO information could be generated and published as soon as possible.



Flow Chart 1 – Dissemination of NOTAM

3.6. Flow chart 2 outlined the processes and procedures of CTOTs and CTOs publication. With transparency of CTOTs and CTOs information, stakeholders should endeavour to comply with CTOT and CTO. These includes departure airport facilitating aircraft to meet CTOT timing of -5 / +5 minutes and pilots requesting for start-up at the appropriate timing. Stakeholders must bear in mind that it is a shared responsibility by stakeholders to reap the most benefit out of this initiative. Non-compliance would lead to higher workload for stakeholders and entails unnecessary airborne holding to meet the required longitudinal separation.

Flow Chart 2 – Publication of CTOTs and CTOs



3.7. CAAS starts monitoring and records data from the start of process chain, i.e. receive of NOTAM notification, as depicted in flow charts 1 and 2 till the end of process chain where aircraft crosses the waypoint DUDIS on ATS route M771.

3.8. The data by itself would not be sufficient. The data have to be analysed to acquire meaningful information to assess success of measures. For this trial, CAAS had identified Key Performance Indicators (KPIs) as shown in the next section.

4. Key Performance Indicators

4.1. In order to measure effectiveness of any Air Traffic Management (ATM) operational performance, there is a need to identify KPIs. KPIs will enable Air Navigation Service Providers (ANSPs) to identify areas for improvement as well as communicate to stakeholders how actions can affect the performance of the system. Likewise, CAAS had identified the following KPIs to measure performance for this M771 ATFM operational trial to measure its performance:

a) CTOT Compliance

Value of KPI	This KPI shows the actual flight compliance to traffic management initiatives (TMIs) and the performance of ANSP TMI actions. It assists Air Traffic Management (ATM) in managing traffic flow and enhancing total ATM capacity.
Formula	[Actual Take Off Time (ATOT)] – (CTOT)

b) CTO Compliance

Value of KPI	This KPI shows the actual flight compliance to traffic management initiatives (TMIs) and the performance of ANSP TMI actions. It assists Air Traffic Management (ATM) in managing traffic flow and enhancing total ATM capacity.
Formula	[Actual Time Over (ATO)] – (CTO)

c) Notification Lead-time

Value of KPI	This KPI shows the amount of lead time given to stakeholders to inform them of flow control measures in place affecting airspace users operations. The lead time acts as a notification of flow control measures in place.
Formula	(Time of CAAS ATFMU notification of flow control measure) – [Estimated Off Block Time (EOBT)]

d) CTOT Lead-time

Value of KPI	This KPI shows the amount of lead time given to stakeholders. Lead time provides advance information on expected take off time and aids stakeholders in resource management planning.
Formula	(Time CAAS ATFMU issued CTOT) – EOBT

e) Estimated Elapsed Time (EET) Verification

Value of KPI	This KPI helps identify inaccuracies of EET in FPL and/or ATFM system. Accurate EETs will assist better allocation of CTOT and CTO to enhance total ATM capacities.
Formula	(Actual EET) – (ATFM System EET)

f) FPL Submission

Value of KPI	This KPI measures the time airspace operators took to file FPL for the affected flights when requested. FPL is the enabler for ATFMU to pre-plan allocation of slots for CTOT and CTO issuance. It assists in better lead time to be given to stakeholders for better resource allocation.
Formula	(Time FPL received by CAAS ATFMU) – (Time CAAS ATFMU send out notification on flow control measure requesting for FPL)

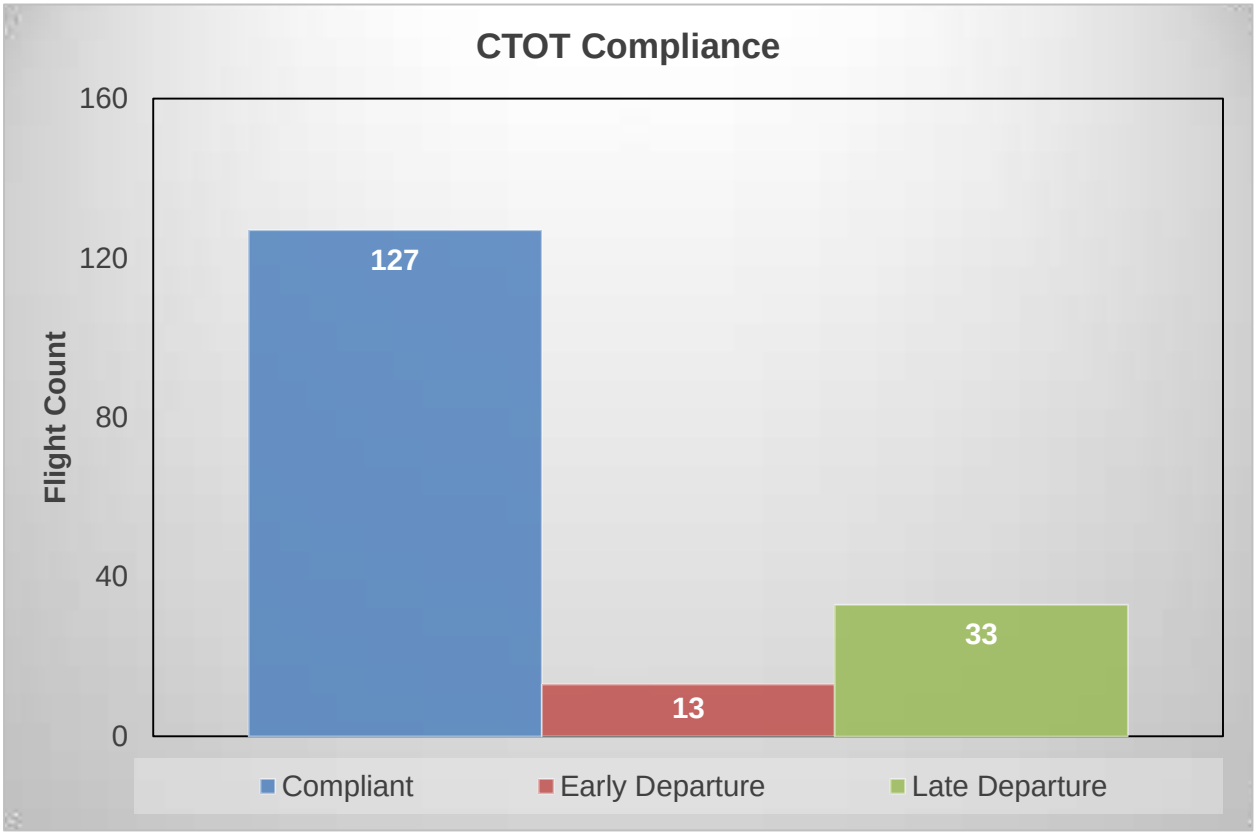
5. Post Operation Analysis (POA)

5.1. POA was conducted for M771 Phase 1 operational trial. Between 15 Jan 2018, 0000UTC and 14 Apr 2018, 2359UTC, there were 51 NOTAMs of flow control measures activated by downstream Area Control Centres (ACCs). There were also 11 extension and 16 revision NOTAMs being transmitted.

5.2. During the operational trial period, a total of 202 flights were affected. The affected flights were issued with CTOTs and CTOs for waypoint DUDIS where flights departing Indonesia, Malaysia and Singapore converge before transiting into Ho Chi Minh ACC.

5.3. *CTOT Compliance*

5.3.1 The actual flight compliance to TMIs assist ATM in managing traffic flow and enhancing total ATM capacity. Ground Delay Program (GDP) utilising CTOT is the primary mean of issuing ATFM measure. The measurement of CTOT compliance helps in understanding difficulties faced on the ground which could arise due to runway congestion, poor ground movement planning or pure disregard of CTOT restriction etc. In sharing information and engaging the airlines and airport of departures which falls under Early and Late Departures in the chart below, areas of improvement could be made and potentially beneficial to all stakeholders to improve internal processes and procedures.



5.3.2 From the analysis of the data collected, 73.4% of the flights departed within -5 / +5 minutes of the compliance window and 7.5% of the departures had departed between 6 to 95 minutes early from the assigned CTOT. The reasons for early departures could be due to the following:

a) Non-compliance by aircraft operator

b) Information gap resulting in non-receipt of CTOT by aircraft operator

5.3.3 The remaining 19.1% of the departures had departed between 6 to 46 minutes late from the assigned CTOT. Some of the reported reasons for late departures and possible reasons were as follows:

a) Non-facilitation by departure aerodrome

b) Last minute change of aircraft due to technical

c) Late arrival of aircraft and remote handling resulting in late turnaround

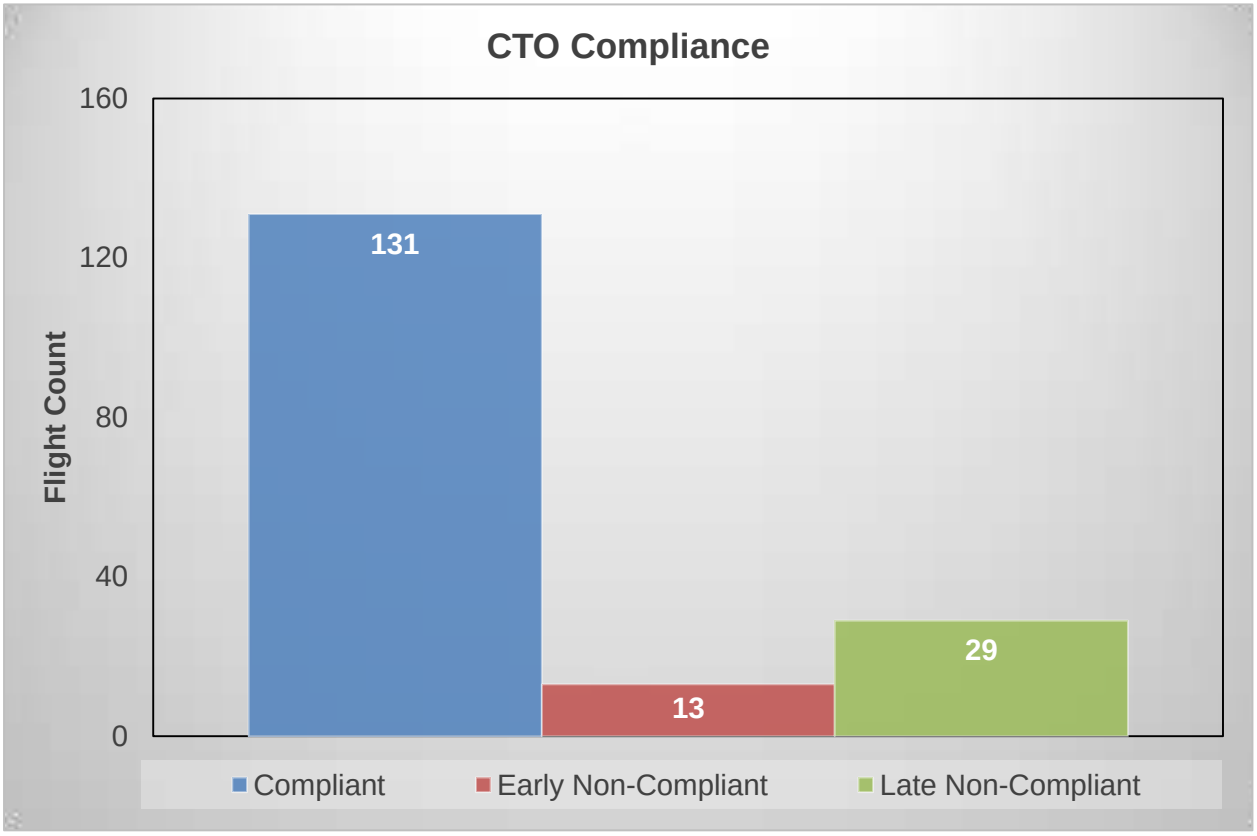
d) Ground congestion

e) Missing passengers

f) Foreign Object Debris (FOD) on runway

5.4. *CTO Compliance*

5.4.1 Similar to CTOT compliance, CTO compliance measurement assist ATM in managing traffic flow and enhancing total ATM capacity. The CTO is a guidance for aircraft to comply so that the aircraft does not speed up or slow down purposefully en-route. By issuing CTO, it also ensures that the required minimum longitudinal separation is achieved at waypoint DUDIS, the transfer of control point between Ho Chi Minh and Singapore Flight Information Region (FIR).



5.4.2 There was a clear co-relation between CTOT and CTO compliance. 75.7% of the flights crossed waypoint DUDIS within the compliance window of -5 / +5 minutes, 7.5% of the flights were early and 16.8% of the flights crossed DUDIS late.

5.4.3 With comparison from 5.3, the analysis had shown that 4 late departure flights had cross DUDIS within the compliance window. The reason for this result might be due to aircraft speeding up en-route to meet the CTO compliance window. Tactical intervention by

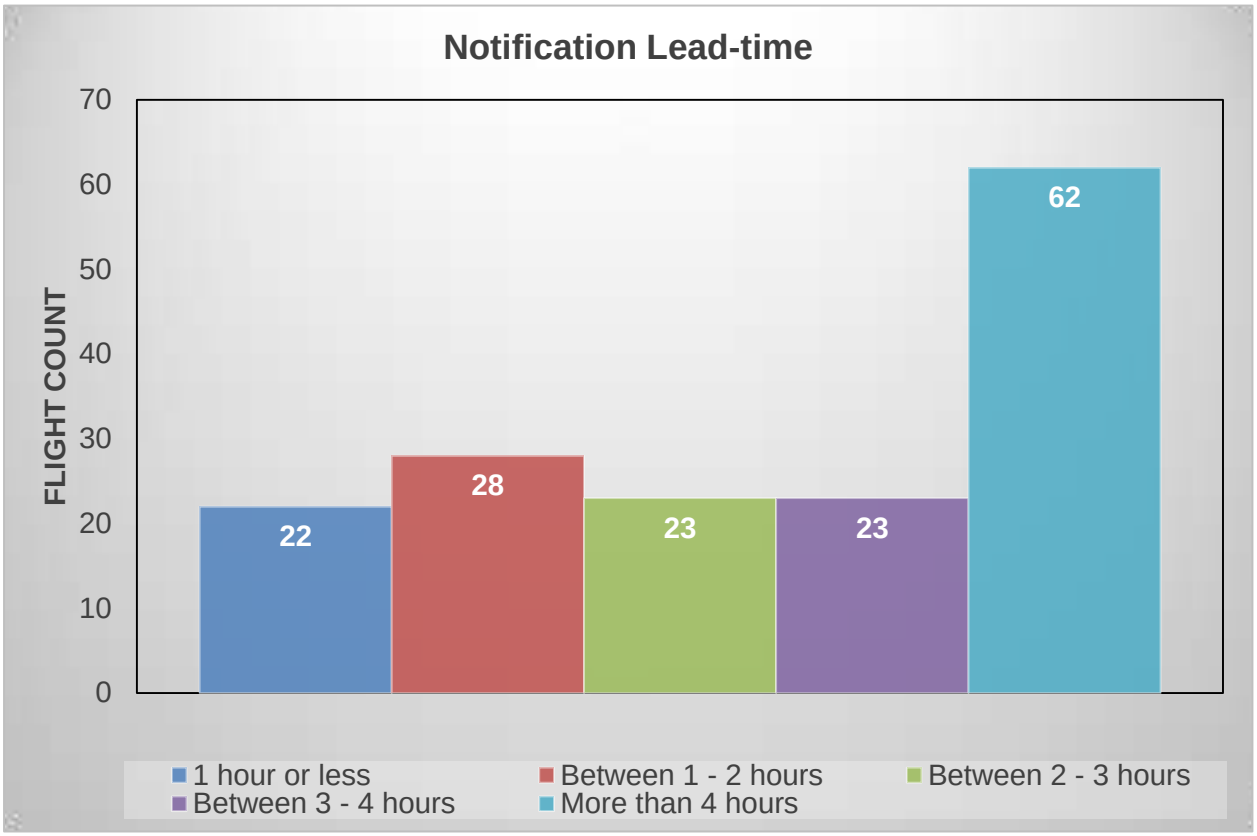
Air Traffic Control (ATC) might had taken place as well by means of track shortening or asking aircraft to speed up in order to meet the CTO compliance window.

5.4.4 Ideally, ATC and/or aircraft operators' tactical inventions to speed up or reduce speed en-route should not have taken place as it increases workload. The base CTOT issued should be complied with in order not to create abnormal speed up or slow down, track shortening or lengthening which disrupts the normal daily operations.

5.5. *Notification Lead-time*

5.5.1 Notification lead-time shows the amount of lead time given to stakeholders to inform them of flow control measures in place affecting airspace users operations. It was calculated by measuring the time email was sent out by CAAS AFTMU to the EOBT of flights.

5.5.2 By measuring the performance of lead-time given, analysis on disruption to the number of flights could be assessed. More lead time would enable airspace operators to make informed decisions such consideration to re-route flights concerned and on the contrary, little lead-time meant that the disruption caused would be greater.



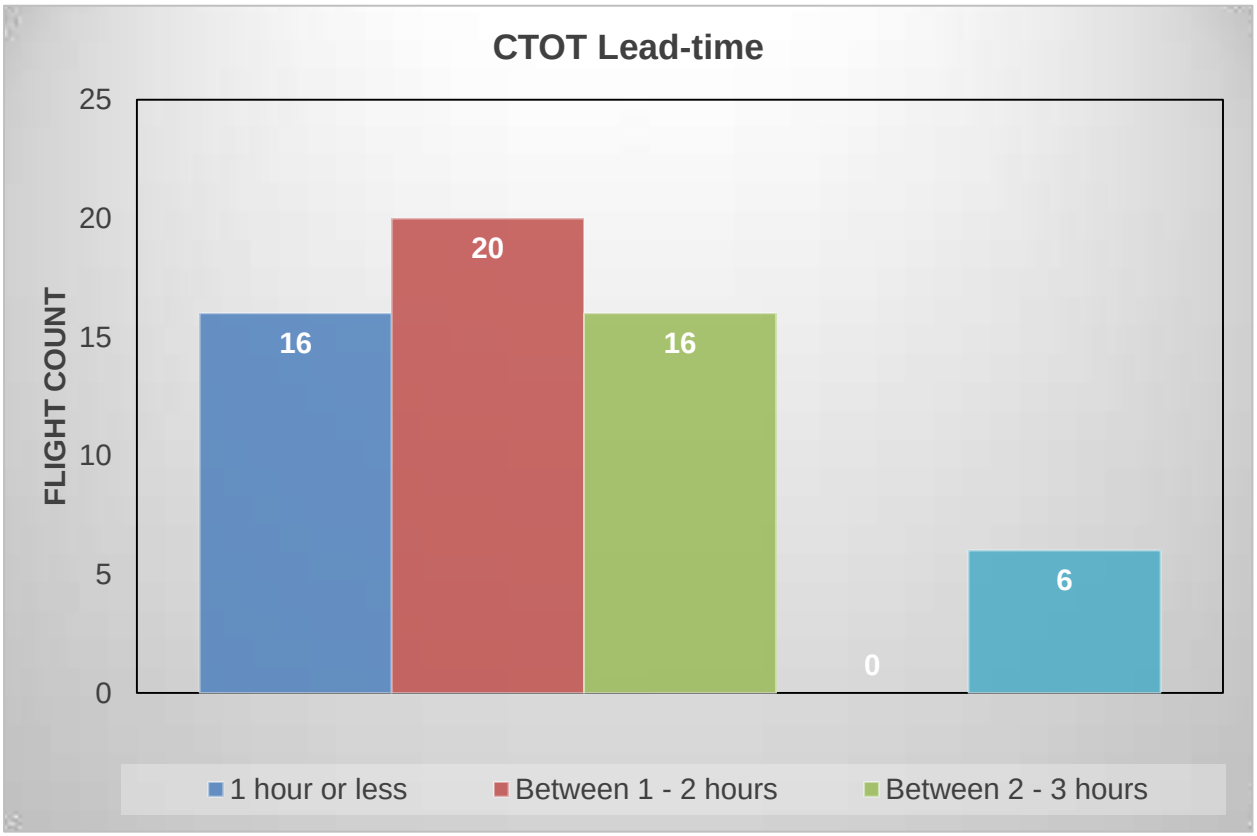
5.5.3 The analysis on notification lead-time showed that 50 flights were informed of flow control measures with less than 2 hours of notification. These flights will suffer the most disruption as they would have little or no time to make alternative arrangements.

5.6. *CTOT Lead-time*

5.6.1 Allocation of CTOT would be of airspace users' outmost interest as it provides advance information on expected take off time and aids stakeholders in resource management planning.

5.6.2 The CTOT lead-time was derived from the time CAAS ATFMU issued CTOTs to airspace users compared to the affected flights' EOBT.

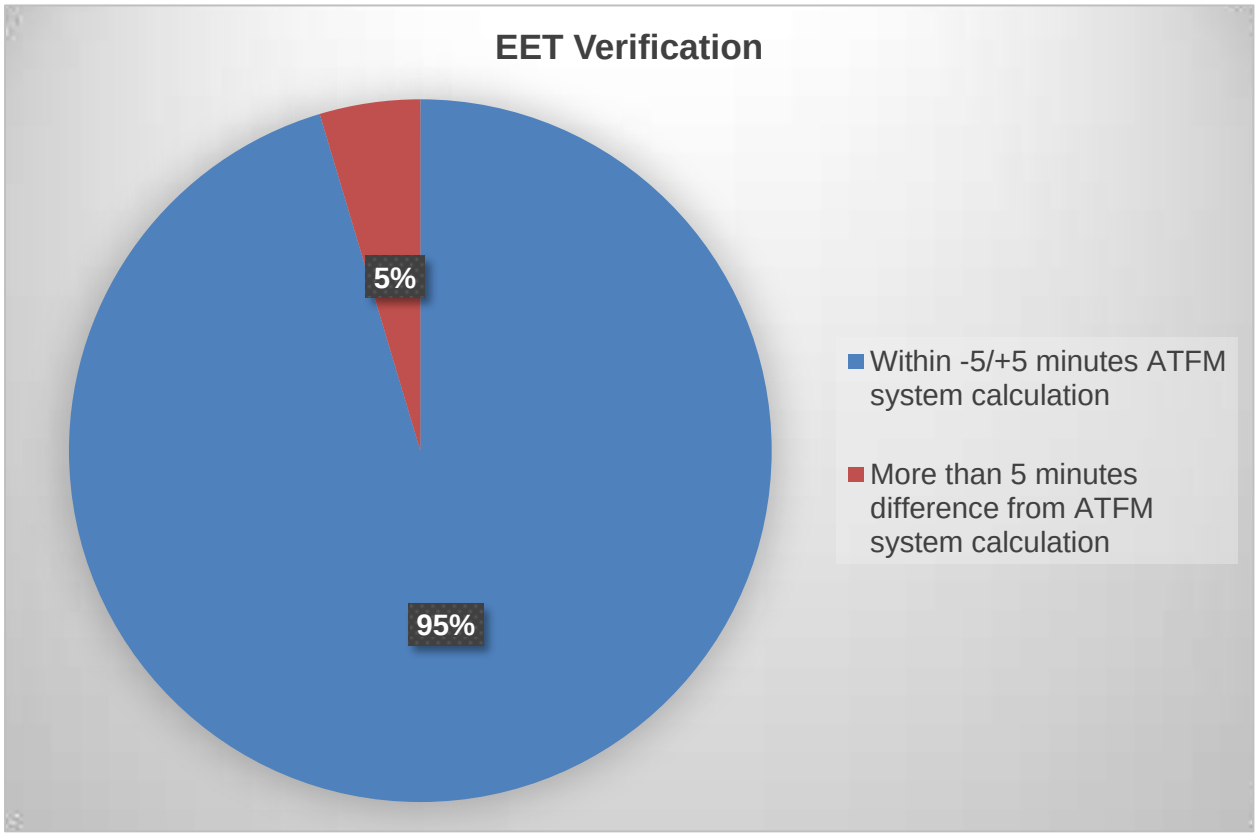
5.6.3 Longer CTOT lead-time enables stakeholders to assess airspace users' delay and subsequently to effectively re-allocate resources.



5.6.4 The CTOT analysis was done on 58 flights due to missing data. It was captured that 36 flights had encountered 2 hours or less lead time which might not have been effective for them to reallocate resources. This is mainly due to the impromptu activation of flow control measures from downstream ACCs.

5.7. *EET Verification*

5.7.1 In order to achieve ATM operational efficiency, airspace usage have to be utilised optimally. EET verification is the comparison of actual flight time with CAAS ATFMU's system calculated flight time. The purpose is to assess the accuracy of ATFM's system calculation in order to maximise the available ATM resource.



5.7.2 Analysis showing 95% of flights' EET within the compliance window had ascertained that system's calculation was accurate for ATS route M771. This also meant that flights should be able to comply with CTOT at ground to meet the CTO at waypoint DUDIS.

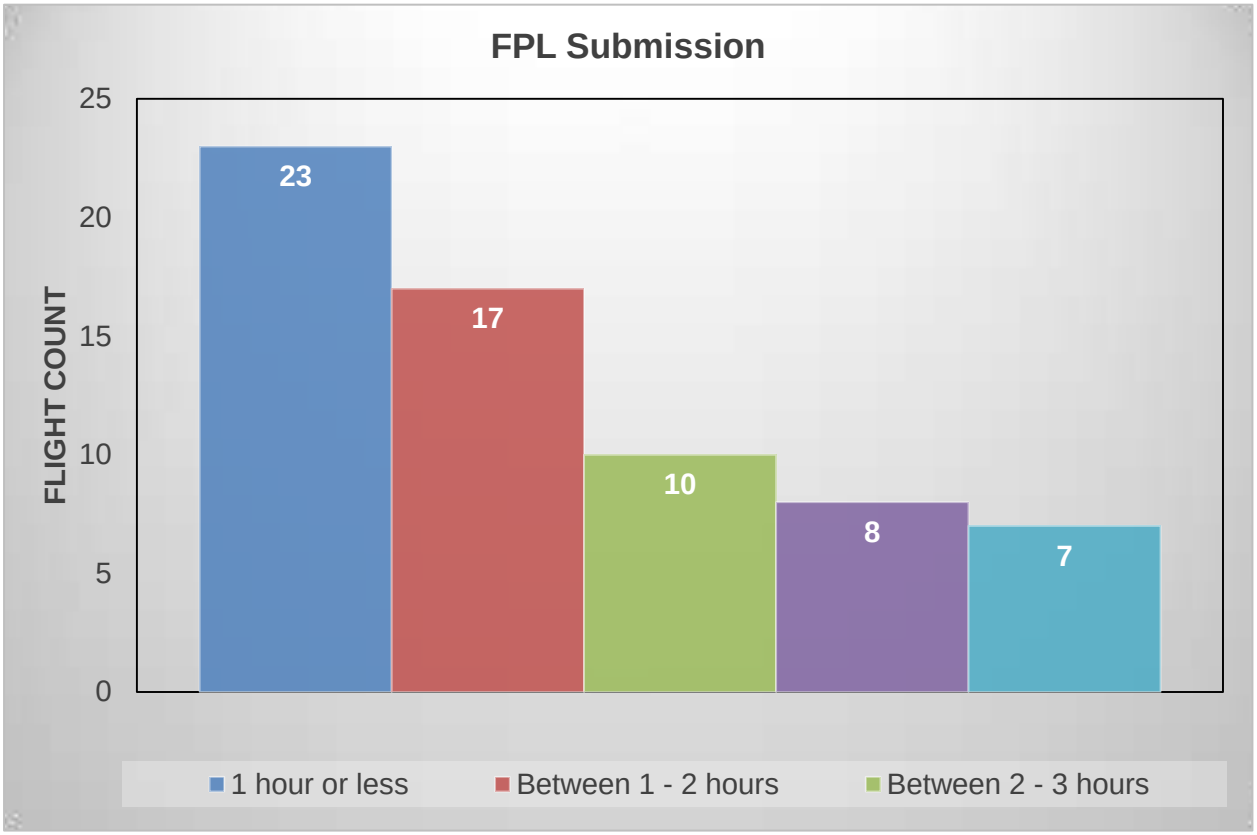
5.7.3 Investigations were carried out on the 5% of flights which differed 6 to 35 minutes between the ATFM system and actual flight time. One of the reasons for deferring time was due to the initial error in calculation and had since been rectified. Subsequently differences were found that EETs differences might be due to track shortening given by ANSP and also due to ad-hoc holding required by neighbouring ACC to cross waypoint DUDIS.

5.8. *FPL Submission*

5.8.1 FPL submission performance measures the time taken by airspace users to file FPL (if yet to do so) for their affected flights when requested by ATFMU and it is vital to the success of the M771 operational trial.

5.8.2 In order for CAAS ATFMU to distribute CTOT and CTO promptly, FPLs need to be submitted in order to gather the filed off block time of aircraft and subsequently to allocate slots accordingly. As such, airspace users are requested to file FPL within 1 hour from notification in order to distribute the ATFM restrictions promptly.

5.8.3 Aircraft operators that submitted FPL within 1 hour from ATFMU requested time and those that had filed in advance before the notification of flow control measures were given CTOT and CTO promptly after the 1 hour mark. The earlier aircraft operators receive their CTOT and CTO, the sooner they can reallocate resources effectively within their respectively stakeholders.



5.8.4 From the analysis, 23 flights had submitted FPL upon request. In addition, there were 57 flights with FPL already filed before the request for their submission. Effectively, this meant that 80 flights were allocated CTOT and CTO and they could start their resource management processes promptly.

5.8.5 As for the remaining flights that had submitted their FPL after the 1 hour mark, they were given CTOT and CTO from the leftover slots which essentially meant that they were queued behind those that had complied with the FPL submission timeline regardless of their planned off block time.

6. Summary

6.1. Post operations analysis for the initial implementations showed that there were gaps in information dissemination where stakeholders were unfamiliar with the processes and procedures. Subsequent implementations had seen stakeholders gaining familiarity with some aircraft operators submitting flight plans for their affected flights within 30 minutes of the first notification. The enhanced predictability for airlines had enabled them to better manage their resources such as crew and fleet. For ATC, the pre-planned slot allocation at the convergence waypoint had enabled them to plan ahead and smoothen traffic flow.

6.2. The trials have been successful so far, although there are still areas of potential improvements. Through further engagement with stakeholders, knowledge gaps can be narrowed and there can be better sharing and appreciation of the potential benefits that this initiative will bring about. Understanding the intent of this initiative would enable stakeholders to have a better appreciation to avoid undesired outcomes. For example, failure to comply with ATFM restriction will result in unnecessary airborne holding which increases workload and reduces efficiency in flight and air traffic management.

6.3. Cooperation from stakeholders is certainly a key enabler for pre-tactical actions planning to ensure that traffic continues to flow smoothly in this region.