



ICAO

Sixth Meeting of the Asia/Pacific Airport Collaborative
Decision Making Task Force (APA-CDM/TF/6)

Video Teleconference, 28 to 30 April 2021

Agenda Item 5 Integration of A-CDM with ATFM

DEVELOPMENT OF JOINT OPERATIONAL PROCEDURE GUIDANCE FOR THE INTEGRATION OF ATFM AND A-CDM OPERATIONS

(Presented by Hong Kong China, China, India, Republic of Korea, Thailand and CANSO)

SUMMARY

This paper presents the progress of the development of joint operational procedure guidance for the integration of Air Traffic Flow Management (ATFM) and Airport Collaborative Decision Making (A-CDM) operations and the proposal for continuing the development work by the ICAO Asia/Pacific Air Traffic Flow Management Steering Group (ATFM/SG) in collaboration with the ICAO Asia/Pacific System Wide Information Management Task Force (SWIM TF).

1. INTRODUCTION

1.1 Anticipating the enhanced benefits that can be accrued by integrated operations between ATFM and A-CDM, in particular improving operational efficiency and optimising the use of resource capacities both at the airport and in airspace at overall network levels, the Expert Group of Asia/Pacific Airport Collaborative Decision Making Task Force (APA-CDM/TF) has been studying the interoperability of A-CDM with ATFM.

1.2 Based on the ICAO Seamless Preferred Aerodrome/Airspace and Route Specifications (PARS) Phase II of the Asia Pacific Seamless Air Navigation Service (ANS) Plan, the Fifth Task Force Meeting (APA-CDM/TF/5) expected that all international aerodromes in the Asia Pacific region would operate an A-CDM system, consistent with ACDM-B0/1-2 of the ICAO Aviation System Block Upgrades (ASBU) strategy.

1.3 Moreover, the APA-CDM/TF/5 encouraged States to apply the ICAO Asia Pacific A-CDM Implementation Plan (1st Edition 2019) as guidance for making available A-CDM systems and their integration/interoperation with other systems, including the ATFM systems and aircraft operator systems, in accordance with the timeframe of ASBU Block 2 modules and elements.

1.4 Further down the road towards full interoperability of cross-border ATFM which would provide system-wide flight update information to and utilise departure planning information from A-CDM, the APA-CDM/TF/5 decided that a joint operational procedure guidance for the integration of ATFM and A-CDM operations would be needed to aid States in the implementation of such regional initiatives.

Action Item 5.2: Development of joint operational procedure guidance for the integration of ATFM and A-CDM operations, focusing the integration between A-CDM and "cross-border" ATFM in collaboration with Experts from ATFM/SG and SWIM TF, led by Hong Kong China, supported by China, India, Republic of Korea, Thailand, Group of Experts, the Civil Air Navigation Services Organisation (CANSO).

2. PROGRESS and DISCUSSION

2.1 Civil aviation authorities/organisations who have been implementing A-CDM and ATFM, were invited by ICAO, via the State Letter (Ref.: AN 3/3 - AP-AGA0049/20) dated 30 November 2020, to share:

- a) Details about national and/or local model/guidance for integrating ATFM and A-CDM operations; and
- b) Suggestions on generalising and enhancing the national and/or local models/procedures for cross-border application.

2.2 Returns from Australia, Hong Kong China, India, Republic of Korea and United States are provided in the **Appendix A** to this Working Paper and summarized as follows:

Civil aviation authorities/organisations	Response for para 2.1(a)	Response for para 2.1(b)
Airservices Australia	Principles for A-CDM and ATFM integration at network level	No information
Civil Aviation Department, Hong Kong China	Diagram showing workflow between ATFM and A-CDM	No information
Airports Authority of India	Description on the messaging interface between A-CDM and ATFM	No information
Korea Office of Civil Aviation	Review of the current issues with integration of A-CDM and ATFM	High-level suggestion on enhancing the national models for cross-border application
Federal Aviation Administration	Overview of national plan	Overview of strategic plan

2.3 In response to ICAO’s invitation, CANSO has provided an educational publication “the CANSO Guide on ATFM/A-CDM Integration” (available at <https://canso.org/publication/canso-guide-on-atfm-a-cdm-integration>). The Guide provides:

- a) A systematic approach to ATFM/A-CDM integration, focusing on operational use case and associated data exchanges;
- b) Insight into the technological enablers, recommendations, and lessons learned from integration projects around the world; and
- c) An essential reference for both Air Navigation Services Providers (ANSPs) and airport operators (AOs) preparing for the return of air traffic by ensuring the highest level of operational efficiency.

2.4 It is noted that pioneering ANSPs and AOs in the Asia Pacific Region generally have individual local/national models for integrating the operations of A-CDM and ATFM at various levels, including node-to-node, state-wide network, etc. However, there is not much detail on how these local/national models can be further enhanced into a regional “cross-border” integration model, although all reckon interoperable systems/operations across Flight Information Regions (FIRs) as a means to reap the expected benefits of system-wide collaborative decision making.

2.5 Exploring the survey results (paragraph 2.2 refers) alongside the CANSO Guide in a systematic manner would make a worthwhile contribution to the development of regional integration model. Such system engineering approach should be intended to:

- a) Transform the needs of ANSPs and AOs into a balanced system solution that meets those needs;
- b) Address the complex and technological challenges of automated operations by System-Wide Information Management (SWIM) and associated information standards, including Flight Information Exchange Model (FIXM) and ICAO meteorological information exchange model (IWXXM); and
- c) Elaborate the survey results and generalize their common features to develop the joint operational procedure guidance for the integration of ATFM and A-CDM operations, e.g. covering those topics listed in **Appendix B** to this Working Paper.

2.6 To continue the work of APA-CDM/TF with AOs as a group of key stakeholders on the integration of ATFM and A-CDM across FIRs (paragraphs 2.4 and 2.5 refer), it is proposed that an Expert Group of ATFM/A-CDM Integration should be established, reporting to appropriate APANPIRG institutional bodies with members from the following domains:

- a) Experts from AOs, ANSPs and civil aviation authorities to share knowledge and experience on A-CDM and its enabling systems;
- b) Experts from ANSPs to share knowledge and experience on ATFM and its enabling systems;
- c) International organizations such as CANSO, IATA, ICCAIA, etc. to present broad interests of various stakeholders and contribute expertise on a balanced system solution; and
- d) Experts from the SWIM TF to help the Expert Group in applying the SWIM concept and infrastructure to cross-border ATFM/A-CDM integration.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) Review the survey results contained in **Appendix A** to this Working Paper;
 - b) Endorse the follow-up action with system engineering approach proposed in **paragraph 2.5** of this Working Paper; and
 - c) Request ICAO to continue the development of joint operational procedure guidance for the integration of ATFM and A-CDM proposed in **paragraph 2.6** of this Working Paper.
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Case Study: Planned A-CDM and ATFM Integration for Australia

Case Study supplied by Airservices

1.1 Australian Operating Environment

The Australian ATM Network comprises of a single state with operations managed by Airservices Australia. The airspace assigned by ICAO to Australia covers 11% of the earth's surface, divided into two Flight Information Regions (FIRs) controlled from two major centres as shown in Figure 1. The Melbourne FIR (YMMM) covers the southern part of the Australian continent and large parts of the Indian and South Pacific Oceans, the Brisbane FIR (YBBB) covers the northern part of the Australian continent and half of the Tasman Sea (with the other half administered by New Zealand).

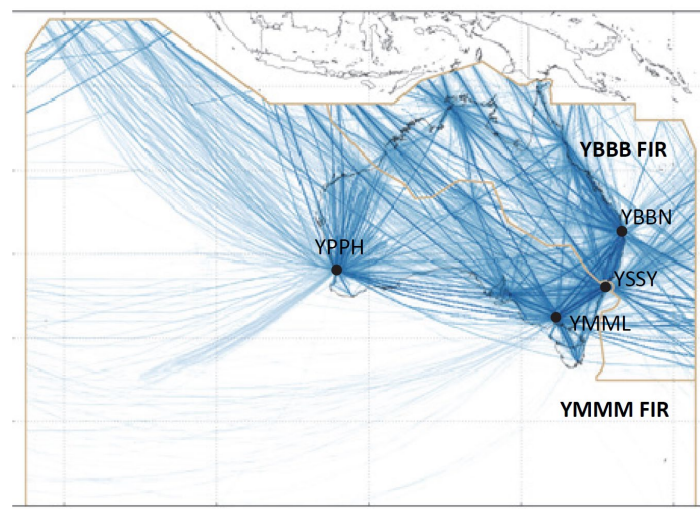


Figure 1: Australian Flight Densities, FIRs & Top Airports.

Due to vast travel distances and population concentration to only a few metropolitan areas, air transportation is the major form of inter-city travel in Australia, with approximately 1.4 million flights and 156 million passengers per year. While these numbers are a lot lower compared to the US and Europe, relative to Australia's smaller population, it represents an air transportation system roughly twice the size per capita.

Despite its large airspace, the Australian ATM Network has a unique characteristic in that a relatively high proportion of air traffic occurs between just three major airports within a relatively short flying time: Sydney (YSSY), Melbourne (YMML) and Brisbane (YBBN), often referred to as "The Triangle". Approximately 30% of the flights from these three airports departs towards the other two. These three city pairs are in the top 15 busiest city pairs in the world (by aircraft movement), with a flight taking off between Sydney and Melbourne (and vice versa) approximately every 10 minutes during peak hours.

Due to runway configurations and constraints on airport layout, Melbourne and Sydney airports in particular can experience large fluctuations in declared capacity. Even in visual conditions, wind can have a significant impact on capacity dropping the maximum arrival rates from 50 and 40 for dual runway operations, to 23 and 22 for single runway operations at Sydney and Melbourne respectively, essentially halving the available capacity.

Demand and capacity challenges in the Australian ATM Network therefore generally originate from capacity reductions at one or more of three major airports, which quickly propagate to the other two and affect the flow of traffic in and out of *The Triangle*.

Australia will therefore be implementing A-CDM at Sydney (YSSY), Melbourne (YMML), Brisbane (YBBN) and Perth (YPPH) as a Partnership between Airservices (ANSP), Australia's four major domestic airline groups and the respective four airport corporations, with the ANSP (Airservices) as the lead organisation. The aim of the partnership is to reduce cost and complexity of the A-CDM implementation by ensuring a single technology solution and consistent A-CDM procedures across the country. Further, as a partnership, buy-in to the A-CDM concept by the main stakeholders is ensured from the very start, and implementation across multiple airports raises the benefits of A-CDM from an individual airport level to an ATM Network perspective.

1.2 Current Collaborative Decision Making Processes

Australia has a mature implementation of Collaborative Decision Making (CDM) between ATC and the major domestic airlines to mitigate the impact of disruptions across the Australian ATM Network through the use of Air Traffic Flow Management (ATFM) – in particular Ground Delay Programs (GDPs) – managed by the Network Coordination Centre (NCC) in Canberra.

Planning for the ATFM measure – specifically the GDP – occurs the day prior to operations to provide airlines early notice of any constraints that may be present for the day of operations through the publication of the ATFM Daily Plan (ADP).

To support the ATFM planning process to start the day prior, the Australian ATFM systems works off schedules in first instance, which get updated by flight plans once filed on the day of operations. The planning follows a 3-step process:

1. As the first step in this planning process, airlines upload their confirmed flight schedules to ATFM system the day prior to operations to inform of the demand for the following day.
2. In the second step, the NCC establishes available capacity through a collaborative process with major domestic airlines and the Australian Bureau of Meteorology, in a process referred to as Meteorological Collaborative Decision Making (MET-CDM). The major aim of the MET-CDM process is to assess any weather risks that may affect capacity of the ATM Network and mitigate operational impact.
3. In the third step, if deemed required, the NCC publishes a GDP – with CTOTs assigned to flights based on the uploaded confirmed schedule – to balance the demand with the available capacity, as established in the first two steps.

By publishing the GDP the day prior, airlines have the opportunity to optimise their fleet operations and inform passengers of changed departure times the night before they travel.

1.3 Benefits of A-CDM at Network level

Australia's ATFM system tracks active, flight-planned and scheduled flights, but flights are considered independent (i.e. no "tail tracking" between the different GDPs). A single aircraft is likely to operate many sectors (legs) between Australia's four major airports a day, and therefore requiring multiple slots across the different GDPs. A delay on any of these sectors quickly propagates and

requires new slots to be negotiated for downstream sectors. The propagation of these sector delays are inherently difficult to estimate beyond the current airborne flight, partly due to limited (data) visibility on airport operations and low predictability of taxi-out and take-off time for the subsequent sector as schematically shown in Figure 2.

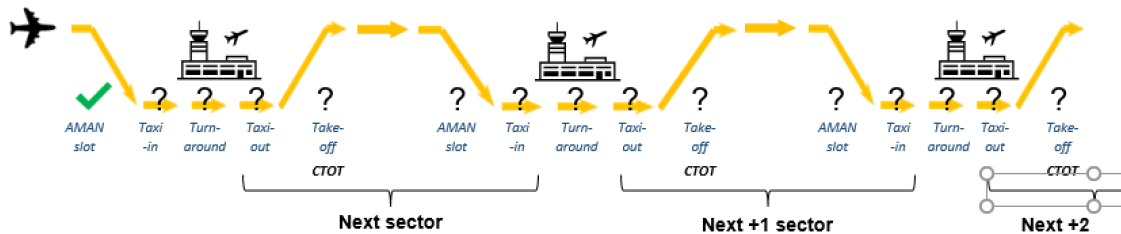


Figure 2: Uncertainty in sector delay propagation.

The benefits of A-CDM at individual airport level are well understood and demonstrated at various locations around the world. By implementation at Australia's four major airports, Airservices is further aiming for benefits at a Network level through integrating A-CDM with the centralised ATFM system in order to 'link' individual GDPs at the respective airports, and to improve the ability to predict sector delay propagation.

To realise maximum benefits of A-CDM within the context of the entire ATM Network, the integration of A-CDM and ATFM in Australia has been considered both from a technical and CDM process perspective.

1.4 Principles for A-CDM and ATFM Integration

The implementation of A-CDM needs to complement the existing CDM processes, and prevent significant complexity from requiring aircraft operators to comply with departure constraints provided by an A-CDM implementation at the departure airport (through assigning a Target Start-up Approval Time (TSAT)), with arrival constraints for ATFM at the destination airport (through a Calculated Take-off Time (CTOT)) (Figure 3).

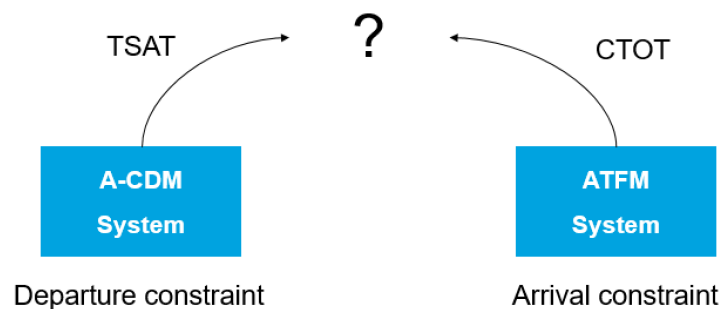


Figure 3: Potential for conflicting constraints.

The Australian A-CDM and ATFM integration is guided by the following main principles:

1. Arrival ATFM slot is nominally of higher priority than position in A-CDM Pre-Departure Sequence (PDS).

2. PDS at the departure port is a dynamic sequence (order) rather than fixed slot allocation (times).
3. A change in ATFM arrival slot at the arrival port (CLDT/CTOT) automatically results in a nominally compliant position in the PDS at the departure port (TTOT/TSAT)

Principle 1 states that within the overall ATM Network, nominally, arrival constraints are of higher importance than departure constraints, i.e. nominally delays should be incurred on the ground rather than in the air. Practically, this means that within the A-CDM PDS, priority is assigned to flights with a CTOT assigning a TSAT that ensures an ATFM-compliant departure (refer to 1.6 on PDS equity).

Principle 2 states that the PDS is more tactical tool than an ATFM slot manager; the PDS needs to respond to operator changes in Target Off Block Time (TOBT) close to departure. Rather than assigning *fixed time slots* (like an ATFM slot manager), focus should therefore be on delivering the right pushback *sequence*.

Principle 3 states that ATFM slot changes performed by CDM stakeholders are automatically send to the PDS and actioned; i.e. a change of CLDT/CTOT in ATFM system results in automatic re-assignment of TSAT aiming for ATFM compliance. On the other hand, a (significant) change to TOBT (and potentially TSAT) in the A-CDM system does not result in an automatic ATFM slot re-assignment. The A-CDM system will show an alert that based on the TOBT update by the operator, a new TSAT was assigned that will result in departure time non-compliant with the assigned ATFM slot. Manual action is required in line with pre-existing CDM processes where an operator is required to apply for a new ATFM slot, if the original slot cannot be operated to.

1.5 Collaborative Management of Flight Updates

Collaborative Management of Flight Updates is one of the EUROCONTROL A-CDM Concept Elements, and it is implemented within the Australian context as follows.

Anticipated airport configurations (and departure rates) will be pre-set in the four A-CDM implementations the day prior as part of the development of the overall plan for the Network (same configurations that are used to plan for any possible GDPs). Schedule information and any ATFM constraints (CTOTs) for the day of operations will be send from the ATFM system to the four A-CDM implementations as soon as available. This combination of anticipated airport configurations, schedules and ATFM constraints allows for pre-processing of TOBTs (as driven by schedule) and TSATs (driven by departure demand vs capacity and CTOTs).

On the day of operations, real-time arrival time updates are being send from the ATFM system to the A-CDM implementations to provide an accurate estimate of arrival time at the destination airport, taking into account operator supplied schedule, ATFM slots, and tactical in-flight updates.

In the Australian implementation, TOBTs for subsequent sectors will be automatically updated whenever a local A-CDM implementation determines that based on an updated arrival time of the inbound flight and minimum turn-around time, the original schedule of the outbound flight (next sector) cannot be met. This automatic update of the TOBT ceases whenever an airline performs a manual TOBT update, or when the aircraft has arrived at the destination airport (whichever occurs first). The philosophy behind this implementation choice is that prior to arrival of the inbound flight, the variables that impact TOBT of the outbound flight are within the ANSP domain (e.g. enroute and arrival delays) and not directly transparent to the aircraft operator; while when the aircraft has

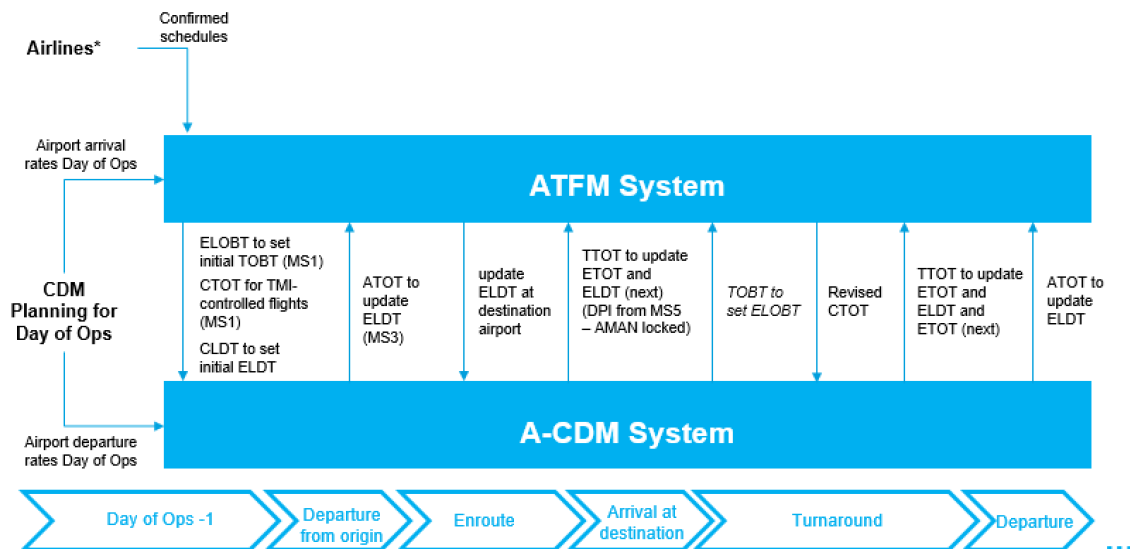
arrived at the gate, the variables that subsequently impact TOBT are within the aircraft operator domain (e.g. late passengers etc.), and thus the aircraft operator becomes responsible for keeping the TOBT updated.

From A-CDM Milestone 5 ‘Final Approach’ (referred to as ‘Sequenced in AMAN’ in Australian implementation), Departure Planning Information (DPI) is being send from the local A-CDM implementation to the centralised ATFM system. From this Milestone, the flight is locked in the arrival sequence for landing, ensuring an accurate Estimated Landing Time (ELDT), Estimated In-Blocks Time (EIBT) for the inbound flight and therefore TOBT and TTOT for the outbound flight (next sector).

DPI messaging in the Australian context is the sending of updated estimated Target Take-Off Times (TTOTs) and TOBTs from the A-CDM PDS to the centralised ATFM system:

- TTOTs send by the A-CDM system update the departure time estimate in the ATFM system to update the demand prediction across the network for both airport and airspace resources.
- TOBTs send by the A-CDM system can set Earliest Off-Block Times (ELOBT) in the ATFM system to ensure that upon a GDP activation or revision, flights will not get assigned an unachievable ATFM slot.

A schematic overview of the Collaborative Management of Flight Updates in the Australian A-CDM-ATFM context is shown in Figure 4.



* Integration of Airline system with ATFM and A-CDM system during Day of Ops not displayed

Figure 4: Collaborative Management of Flight Updates in the Australian A-CDM-ATFM context.

The combination of departure (DPI) and arrival time updates allow to estimate the propagation of network delay. E.g. a flight on arrival into Melbourne triggers a DPI for its next sector to Sydney. The ATFM system subsequently updates the departure time to Sydney, as well as the arrival time in Sydney. This updated arrival time in the ATFM system for Sydney is send to the Sydney A-CDM implementation and triggers an automatic (preliminary) TOBT update for the following sector to Brisbane.

1.6 Equity in A-CDM Pre-Departure Sequence

As previously stated, a relative high proportion of departures from especially Sydney (YSSY), Melbourne (YMML), Brisbane (YBBN) depart to the other two. This means that when GDPs are active at any of these ports, the PDS at the departure port may have a high proportion of flights with a CTOT that will be automatically prioritised (to ensure ATFM compliance). As a result, during times of high departure demand (or times of low departure capacity), inequitable TSAT delay distribution may occur where flights without a CTOT receive more delay.

To ensure delay distribution within the PDS is as equitable as possible, the PDS uses the CTOT compliance window (when required) to ensure that flights departing within vicinity of one another, are allocated balanced TSAT delays.

Further, as part of the Network CDM concept (see 1.8), CTOT compliance from a certain departure airport may be suspended if it has been determined that departure capacity at that airport is the limiting factor on of the ATM Network. For example, if strong crosswinds at Sydney (YSSY) dictate the use of a single runway only (less than 50% of normal capacity), Sydney (YSSY) capacity becomes the limiting factor of the ATM Network; CTOT compliance for flights departing Sydney (YSSY) may subsequently be suspended to ensure the PDS can deliver the most optimal pushback sequence given the limited available capacity.

1.7 ATFM Compliance Management

Upon implementation of A-CDM at an airport, the local tower ATC will be no longer presented with COBT/CTOT information. Instead, Tower ATC will be shown TOBT/TSAT on their strips and will manage TOBT & TSAT compliance (-5/+5 mins).

ATFM compliance will be embedded in the TSAT assigned by A-CDM. The A-CDM system will not allow a TSAT that results in a TTOT < CTOT - 5 mins. Early non-compliance with ATFM is therefore prevented through the TSAT allocation logic, and TSAT compliance management.

Preventing late non-compliance with ATFM will become the responsibility of the aircraft operator. Up to pushback, the aircraft operator will be required to perform an ATFM slot change when a TOBT update results in a TSAT and TTOT update outside of the ATFM compliance window (aircraft operator will receive warning from A-CDM system). After pushback, compliance is no longer measured and referred to as 'departure accuracy' as the aircraft operator is no longer solely responsible for achieving the CTOT. The only exception is during a ground stop enforced by ATC.

Placing the responsibility of ATFM compliance (i.e. preventing late non-compliance) with the aircraft operator has been possible due to a mature CDM environment and a mature relationship between ANSP and aircraft operators where all parties understand that a predictable network is a responsibility by all stakeholders. This is further enabled through transparent post-operational reporting available to all CDM stakeholders, driving a culture of accountability by all.

1.8 Network Collaborative Decision Making

The proposed integration of the multiple A-CDM systems with the centralised ATFM system provides improved predictability 'beyond the airport turnaround' into the next sector (see figure 5). Aircraft operators benefit from predictability for the next two or more sectors of an airframe as it performs multiple back-and-forth sectors on the East Coast per day. While the accuracy on an individual flight level reduces beyond the next sector, it is anticipated to remain sufficient on *flow* level. This allows

for an earlier warning of network delay propagation, allowing timely action to be coordinated with the CDM stakeholders.

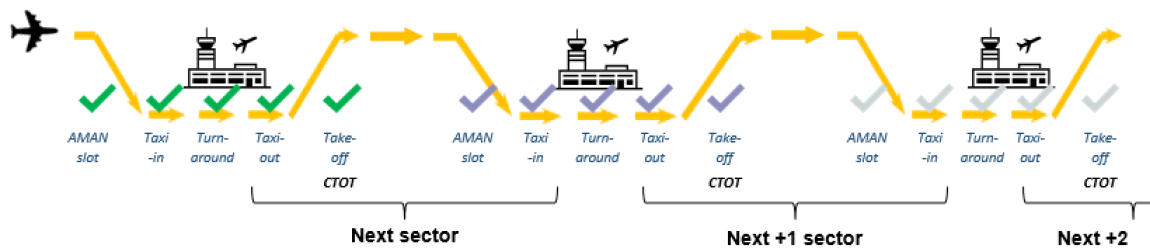


Figure 5: Improved predictability of sector delay propagation.

Current CDM is predominately focussed at managing arrival demand through adjusting airport arrival acceptance rates and associated GDP revisions. The impact of departure demand is often not adequately considered. For example, when recovering from adverse events, often large departure delays occur as arrival demand has been prioritised. Departure delays subsequently impact on the arrival flows at the destination airport. In some cases, the tactical arrival rate is lowered in order to clear (some of the) departure queue, which increases airborne delays. The impact of an adverse event at one airport, may therefore ripple unpredictably throughout the network and lengthen the time it takes for all stakeholders to recover.

A-CDM provides improved visibility of real-time arrival and departure demand throughout the network. Collaborative decision making will be able to include considerations of arrival and departure balancing, to ensure a smoother recovery from an adverse event, and mitigate the impact on the remainder of the network.

Integrating A-CDM into network management provides common and real-time situational awareness of local/network pain points, allowing to make collaborative decisions in the context of stakeholder priorities, to enact the right controls to unlock latent airspace, runway and gate capacity, thereby improving customer experience: Network-CDM (Figure 6).

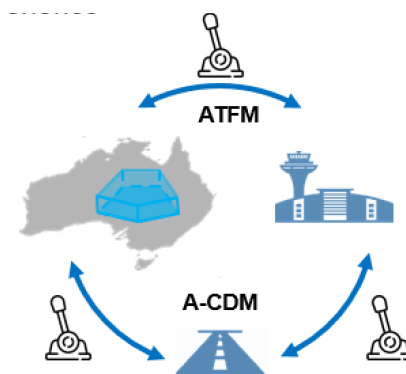


Figure 6: Network CDM: unlocking latent airspace, runway and gate capacity.

1.9 Lessons Learned

Lesson 1 – Change Management: don't underestimate the difficulty of explaining the interaction between ATFM and A-CDM

Despite the mature CDM environment in Australia and the mature relationship between the ANSP, airlines and airports, it took considerable effort to explain to operational SMEs across the different organisations how ATFM and A-CDM would work together. The establishment of the core Integration Principles presented earlier significantly assisted to convince key stakeholders that no such situation would occur where an aircraft operator would be confronted by conflicting ATFM and A-CDM constraints.

Lesson 2 – Identify the strengths of your local CDM implementation and leverage those to reduce complexity

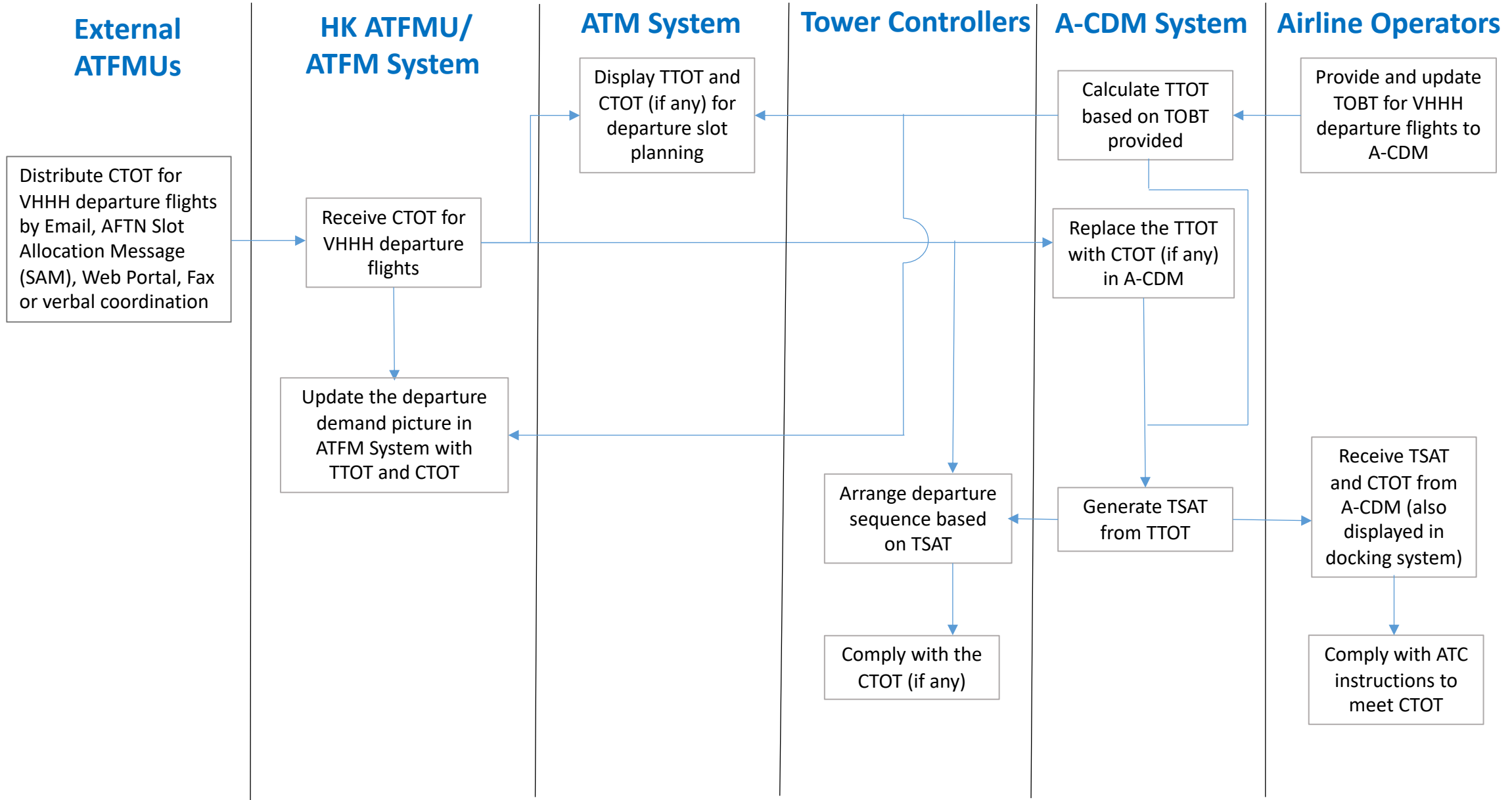
Within the Australian context, the ANSP and airlines were able to agree on a shared responsibility on ATFM compliance management. This significantly reduced the integration complexity by simplifying the changes to ATC tower technology. It is noted that each operational environment is different due to different traffic patterns, different airlines, and different cultures. What works for one environment does not necessarily work for another environment; but the key lesson is to leverage local strengths to keep things as simple as possible!

1.10 Contact

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Hong Kong, China Model for Integrating ATFM and A-CDM Operations



ACDM C-ATFM INTEGRATION IN INDIA

INTRODUCTION

Air traffic in India continues to grow rapidly and this trend is likely to continue to expand into the future. Increased traffic is expected at many of the existing airports. This increase in demand requires a corresponding effort to utilize systems capacity efficiently. This will require Air Traffic Flow Management (ATFM) capabilities for effective Demand and Capacity Balancing (DCB). The ATFM tools will enable improved management of demand and capacity and will help system stakeholders to deal with the increased complexity of the nation's air routes.

Airport CDM (A-CDM) aims at improving the overall efficiency of airport operations by optimising the use of resources and improving the predictability of events of operation. Increased predictability can be of significant benefit for all major airport and ATFM operations; it raises both productivity and cost-efficiency and also eco-friendly.

The scope of A-CDM is Airport specific whereas ATFM caters to wide airspace comprising several Airports. In India, CATFM at New Delhi serves the nation's airspace. Integration of A-CDM and ATFM will benefit both the system by exchanging relevant, timely and reliable data. Collaborative Flight Update, an important concept element of A-CDM will require integration of A-CDM and ATFM.

The Central Air Traffic Flow Management is responsible for ensuring the balance between the capabilities of providing Air Traffic Control Services and the demand for air movements in the Indian airspace. Acts strategically in the planning phase of scheduled flights and tactically during the daily operation, minimizing impacts from fluctuating the balance between capacity and demand in order to ensure the safety of operations, regularity and punctuality of flights. The system to be implemented at the Center is specifically designed to increase the efficiency of ATFM measures by applying separations in flight, ground delays and rerouting path. The situational awareness being generated by the system, allows all users to participate collaboratively to determine flow management measures to be adopted.

BENEFIT

Integration between A-CDM and ATFM will benefit both systems. A-CDM will be generating TSAT taking into account any ATFM measure from ATFM. Similarly, timely and reliable data from ACDM systems will benefit the ATFM system to generate more accurate ATFM measures and to deal with Demand and Capacity Balancing.

FUNCTIONS

The C-ATFM System's main functions are:

- Receive and process flight information associated with the operation of flights scenery as well as the state of operability of ATS units, technical resources, infrastructure and meteorological phenomena that affect the national air navigation;
- Allow the definition of strategic actions, pre-tactical and tactical, in order to optimize the use of airspace with existing resources and meeting the demands of the sectors involved.
- Follows the best practices and recommendations for Human Machine Interfaces for the sector, such as FAA - Human Factors Design Standard (HFDS), ensuring adequate consideration to the science of human factors.

- Greater interoperability and global harmonization of systems from the use of international standards to exchange messages.
- Decision support functionality via graphics and easy interoperability components, with information to be shared collaboratively among the system's users.
- The system process the flight plans data received by the AFTN network or through files of Repetitive Flight Plans (RPL).
- Processes the correlation (association) between the flights plans data and flights tracks generated by the surveillance system.
- Performs the exchange of messages with ATS Control Centers (ACC / APP) responsible for Air Traffic Services (ATS) in the Flight Information Regions (FIR), which ensure the balance between capacity and demand of users of these airspaces.

The C-ATFM System implements the appropriate interfaces to/from the external systems or external database to enable accurate traffic demand and capacity modeling and projections.

External Systems C-ATFM System relates to the following external systems for exchange automatically data with them:

- Foreign ATFM/ATC Systems: to implement data exchange with foreign ATFM/ATC Systems.
- MET System: provides weather information in the area of interest in text format, binary or image. • AIS System: this interface allows you to receive data published by NOTAM.
- ATC Systems: provides information in real-time to generate a national mosaic through the data generated by the surveillance system (radar, ADS-B, ADS-C and MLAT). Also enables the exchange of data from the flight plan for the generation of the national air situation.
- AOCC (Airport Operations Center): provides airport status, aircraft parking stands and off-block time.
- Airline Operations: this interface allows the forwarding of flight plans (FPL) and related messages (CHG, CNL and DLA).
- Military Operations: establishes connectivity between the C-ATFM and military installations to receive flight plans directly from the user for flights that will cross in civil airspace.
- Airport CDM: provides Target Off-Block Time (TOBT) where the aircraft will be ready to begin operations at the aerodrome.

A-CDM INTERFACE DESCRIPTION

For tactical planning of air operations at an airport is necessary that the information about the events of execution is updated dynamically for all involved sectors. In this sense the C-ATFM should receive information about these events in order to enable the planning of the implementation with the greatest accuracy possible. The interface with the A-CDM will allow such information to be used in real-time by users of the C-ATFM System. The interface allows the C-ATFM to receive Departure Planning Information Message (DPI) forwarded by the A-CDM system, including Target Off-Block Time (TOBT). To send departure information, the A-CDM system should use a DPI message formatted in ADEXP (as described below) and the route then automatically via Web Service whenever updated information is available. The interface also enables transmitting DPI Message from C-ATFM to A-CDM (AOBD System) to send information, including ETA, CTA and CTOT.

CONFIGURATION

The A-CDM Client program is configured to send automatically following DPI messages to ATFM Server:

- a) Modification of the aircraft type
- b) Modification of the aircraft registration
- c) Modification on estimated TOBT of more than 5 minutes.
- d) Modification on estimated TSAT of more than 5 minutes.
- e) Modification on estimated TTOT of more than 5 minutes.
- f) Update of actual AOBT
- g) Update of actual ATOT
- h) Update of actual ALDT
- l) Update of actual AIBT

ATFM client program is configured to send automatically following DPI messages to A-CDM Server:

- a) Route point update in more than 3 minutes: ELDT.
- b) Application of ATFM measure: CTOT.

Departure Planning Information (DPI) Message This message is used by the A-CDM system to provide the C-ATFM updated planning departure information. The message should be sent by A-CDM in the events of:

- modification on take-off or off-block time of more than 5 minutes.
- modification of the aircraft type and/or aircraft registration. This message is also used by the C-ATFM to provide the A-CDM with updated information about the flights. The message should be sent by C-ATFM in the events of:
 - modification on Estimated Time of Arrival (ETA) more than 3 minutes.
 - application of ATFM program for Calculated Time of Arrival (CTA) and Calculated Take-Off Time (CTOT).

The message DPI should be sent in ADEXP format, according to the following syntax: `DPI_MESSAGE := "-TITLE DPI"+ orgnid + arcid + adexp + ades + eobd + eobt + (aibt) + (tobt) + (tsat) + (ttot) + (atot) + (aobd) + (aobt) + (aldt) + (arctyp) + (reg) + (eta) + (cta) + (ctot) + timestamp`

The DPI message will have your data formatted in accordance with the standard ADEXP, as specified below:

Primary Field	Description	Classification
-TITLE	Message title. In this case, should be "DPI"	M
-ORGNID	The designator of an addressee having originated a message	O
-ARCID	Aircraft Identification. May be the registration marking of the aircraft, or the ICAO designator of the aircraft operator followed by the flight identifier.	M
-ADEP	ICAO location indicator of the aerodrome of departure or the indication 'AFIL' meaning an airfiled flight plan or 'ZZZZ' when no ICAO location indicator is assigned to the aerodrome of departure.	M
-ADES	The ICAO location indicator of the aerodrome of destination or 'ZZZZ' when no ICAO location indicator is assigned to the aerodrome of destination.	M
-EOBD	Estimated Off-Block Date.	M
-EOBT	Estimated Off-Block Time.	M
-AIBT	Actual In-Block Time. This information is sent from A-CDM to C-ATFM.	O
-TOBT	Target off-block time. The message should contain this field and/or TSAT. This information is sent from A-CDM to C-ATFM.	O
-TSAT	Target startup approval time. The message should contain this field and/or TOBT. This information is sent from A-CDM to C-ATFM.	O
-TTOT	Target take-off time. This information is sent from A-CDM to C-ATFM.	O
-ATOT	Actual Take-Off Time. This information is sent from A-CDM to C-ATFM.	O

-AOBD	Actual Off_Block Date. This information is sent from A-CDM to C-ATFM.	O
-AOBT	Actual Off_Block Time. This information is sent from A-CDM to C-ATFM.	O
-ALDT	Actual Landing Time. This information is sent from A-CDM to C-ATFM.	O
-ARCTYP	Type of aircraft (ICAO identification of the type) or ZZZZ. This information is sent from A-CDM to C-ATFM.	O
-REG	Registration markings, as ICAO field 18 REG/. This information is sent from A-CDM to C-ATFM.	O
-ELDT	Estimated landing time. This information is sent from C-ATFM to A-CDM.	O
-CLDT	Calculated Landing Time. This information is sent from C-ATFM to A-CDM.	O
-CTOT	Calculated Take-Off Time. This information is sent from C-ATFM to A-CDM.	O
-TIMESTAMP	The time at which an event occurred.	M

Classification:

M – Mandatory

O – Optional

EXAMPLE:

-TITLE DPI
 -ORGNID VIDPACDM
 -ARCID ETH3739
 -ADEP VIDP
 -ADES HAAB
 -EOBD 141217

- EOBT 1030
- AIBT 1700
- TOBT 1035
- TSAT 1035
- TTOT 1036
- ATOT 1039
- AOBD 141217
- AOBT 1040
- ALDT 1645
- ARCTYP B773
- REG ETAPS

- TITLE DPI
- ORGNID VIDPACDM
- ARCID ETH3739
- ADEP VIDP
- ADES HAAB
- EOBD 141217
- EOBT 1030
- ETA 1230

- TITLE DPI
- ORGNID VIDPACDM
- ARCID ETH3739
- ADEP VIDP
- ADES HAAB
- EOBD 141217
- EOBT 1030
- CTA 1240
- CTOT 1045
- TIMESTAMP 141217104100

The C-ATFM will be prepared to receive DPI message in two formats:

<message>

- TITLE DPI
- ORGNID VIDPACDM
- ARCID ETH3739
- ADEP VIDP
- ADES HAAB
- EOBD 141217

-EOBT 1030
-AIBT 1700
-TOBT 1035
-TSAT 1035
-TTOT 1036
-ATOT 1039
-AOBD 141217
-AOBT 1040
-ALDT 1645
-ARCTYP B773
-REG ETAPS
-TIMESTAMP 141217104100
</message>

DPI response

C-ATFM system shall produce DPI responses simply composed by a text message with a statement regarding the DPI request message processing. The system shall issue the following messages:

1. "SUCCESS – Flight Plan <ARCID> successfully update."

This message shall be issued once C-ATFM receives, interprets the DPI message request correctly, and successfully associates this message to an existing flight plan within System's database.

2. "SUCCESS – Message received successfully."

This message shall be issued once C-ATFM receives, interprets the DPI message request correctly, and however, cannot associate this message to an existing flight plan within System's database.

3. "ERROR – the following message is undefined and is going to be discarded:

<MESSAGE>"

This message shall be issued once C-ATFM receives, and however, is not capable to identify of what kind of message type is this DPI request about.

4. "ERROR – The message was not correctly processed due to the following error message(s): <MESSAGES>"

This message shall be issued once C-ATFM receives, and however, is not capable to correctly interpret the DPI message request. This incapability will be related to either:

- 1) the absence of one of all the required fields for the message; or 2) due to syntactical malformation of one or more fields used within the message.

IMPLEMENTATION

Integration of A-CDM and ATFM systems have been carried out in a phased manner.

As of date, the AAI ACDM Team has completed Integration of seven Indian Airports.

- 1] Kolkata Airport;
- 2] Mumbai Airport;
- 3] Chennai Airport;
- 4] Trivandrum Airport;
- 5] Ahmedabad Airport;
- 6] Guwahati Airport;
- 7] Jaipur Airport;

Delhi International Airports Limited has completed the integration of Delhi Airport.

ABBREVIATIONS

Abbreviation	Description
AAI	Airports Authority of India
ACC	Area Control Center
A-CDM	Airport CDM
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance – Contract
AFTN	Aeronautical Fixed Telecommunication Network
AIBT	Actual In-Block Time
AIS	Aeronautical Information Service
ALDT	Actual Landing Time
ANS	Air Navigation Service
AOBD	Actual Off_Block Date
AOBT	Actual Off_Block Time
APP	Approach Control

ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATOT	Actual Take Off Time
ATS	Air Traffic System
C-ATFM	Central Air Traffic Flow Management
CDM	Collaborative Decision Making
CTA	Calculated Time of Arrival
CTOT	Calculated Take-Off Time
EOBD	Estimated Off-Block Date
EOBT	Estimated Off-Block Time
ETA	Estimated time of arrival
FAA	Federal Aviation Administration
FIR	Flight Information Region
FPL	Flight Plan
HFDS	Human Factors Design Standard
MET	Meteorology
MLAT	Multilateration
NOTAM	Notice to Airmen
RPL	Repetitive Flight Plan
SICD	System Interface Control Document
TMU	Traffic Management Unit
TOBT	Target off-block time
TSAT	Target startup approval time
TTOT	Target take-off time

DEVELOPING A JOINT OPERATIONAL PROCEDURE GUIDANCE FOR THE INTEGRATION OF ATFM AND A-CDM OPERATIONS

Status

1.1 To handle the ever-increasing volume of air traffic safely and efficiently within limited airspace, ROK has introduced and operated the A-CDM and ATFM systems. A-CDM was first introduced at Incheon International Airport in December 2017. At the establishing stage, the focus was on establishing and operating a system in which 38 basic milestone information, such as TOBT and TSAT, could be shared among airport operators, airlines, ground handling companies and controllers (Stage 1). Currently, it is in the process of establishing an integrated A-CDM system (Step 2) that can link with the DMAN (Departure Manager) and expand to de/anti-icing flights, and plans to make an advancement (Step 3) that aims to full automation of A-CDM. With the introduction of A-CDM, Incheon International Airport experienced a 6.6% reduction in ground movement time, 9% reduction in fuel volume and 8.7% reduction in carbon emissions per aircraft in 2018. In addition, from 2018 to 2020, flight punctuality improved by about 19.5%¹ and the delay rate decreased by about 3.9%². Based on these achievements, the plan has been established to build A-CDMs for 3 busy airports - Gimpo, Gimhae, and Jeju airports. Those airports are expected to complete pilot operations in 2020 and actually operate the A-CDM in 2021.



1.2 Since 2018, ATFM system has been in full operation and the Air Traffic Control Center located in Daegu, Air Traffic Management Office, has been conducting comprehensive flow management for Incheon FIR for 24 hours, 365 days. When hazardous weather or unusual events expected, the Air Traffic Control Center analyzes the impact on air traffic, possible changes of abnormal situation, and the magnitude of delay. Based on the analysis results, the

¹ (flight punctuality) If the station has been off-blocked within 15 minutes of the flight planning time

² (flight delay) standard take-off and landing time + 30 minutes or more for domestic flights and + 1 hour of more for international flights

ATCC performs CDM with stakeholders such as civil and military controllers, airlines, airport operators, and meteorological officers. Through CDM, ROK can share information and determine the optimal response. For the measures of ATFM, it includes COBT/CTOT issue, distance/time separation, altitude limit, and rerouting. In 2019, CTOT issuance reduced the delay by approximately 148,538 hours, saving about 876,374 tonnes of fuel and approximately 2,769,342 tonnes of CO₂ on the A330-300 basis. However, the domestic airspace is heavily influenced by restriction on flow management of neighboring China and Japan and the rigid operation system due to the dualization of civil and military forces and the blocked north directions. To overcome these limitations, ROK has continued efforts to improve flow management such as the establishment of international cooperation system and the development of Korean ATFM.

1.3 Both of A-CDM and ATFM systems are one of cooperative decision support tool, which suggest the need for integration of the two systems. A more accurate CTOT can be calculated when milestone information related to ground movement from A-CDM is provided to ATFM, and flow management measures issued by ATFM can be applied in a timely and appropriate manner when supported by real-time information sharing systems such as A-CDM are supported.

Status of Interoperation Model between A-CDM and ATFM

2.1 For Incheon International Airport, key aircraft time information (TOBT, TTOT, TSAT, AOBT, AIBT, etc.) produced by A-CDM is send to ATFM systems. For Incheon International Airport, key aircraft time information (TOBT, TTOT, TSAT, AOBT, AIBT, etc.) produced by A-CDM is delivered to ATFM systems. For ATCC in Daegu, CTOT containing ATFM measures are issued and shared with stakeholders to recalculate TSAT and TTOT

2.2 When the ATFM system generates CTOT, the Incheon International Airport operator shares the CTOT with the airline, the ground handling company and other stakeholders through the A-CDM operating system (including mobile). Incheon Control Tower determines TTOT in consideration of the CTOT and the operation situation shared, and manually provides TTOT to airlines and others if necessary. Since TTOT are re-established based on TSAT, airlines and ground handling companies are using CTOT, modified TTOT, and final TSAT for aircraft operations, while airport operators are utilizing them for the assignment and operation of the attached apron.

2.3 During the first phase of the A-CDM operation, Incheon airport faced difficulties in calculating TTOT/TSAT for de/anti-icing aircraft and calculating TTOT/TSAT that reflects external constraints in real time. A-CDM operation excluded de/anti-icing procedure in its milestone. The A-CDM operation excluded de/anti-icing procedure when generating milestone, which made it difficult to calculate the exact TSAT for aircraft requesting de/anti-icing. In addition, the updated TTOT/TAST with CTOT could not reflect external constraints (such as route restriction and air traffic flow management) in real time. To solve

these problems, the need was raised for the establishment of A-CDM de/anti-icing procedures and the introduction of DMAN that supports the reflection of various external constraints in real time and issuance of accurate TSAT.

2.4 To this end, Incheon airport is pushing for the upgrading of A-CDM (2nd stage) with the goal of the end of 2021. The goal of 2nd stage is to optimize the departing order of aircraft through DMAN and improve the TSAT accuracy. By introducing DMAN to the A-CDM, A-CDM can generate variable taxi time (VTT) considering runway operations, aircraft class and ground congestion, etc. It is also able to comprehensively reflect external constraints of route and ATFM to aircraft departure management and TTOT calculation.

2.5 Upon receipt of a coordinated landing time (CLDT) to be developed by the ATCC in the future, the A-CDM system can produce more accurate EIBT and TOBT. More sophisticated time information management would help improving the efficiency of airport operations and aircraft operational timeliness.

2.6 The A-CDM, which will be applied to Gimpo, Gimhae and Jeju International Airport, has a similar system. All A-CDM information and apron change information produced is delivered to the ATFM system. CTOT information from ATFM is utilized to calculate the TTOT/TSAT. From 2021, TTOT and TSAT reflecting CTOT will be provided to controllers and airlines using flow management messages. This A-CDM system is a single system linked to the ATFM system, therefore it is easy to apply A-CDM to other international airports in ROK.

Disturbance for Integrating ATFM and A-CDM

3.1 However, the ROK currently has several limitations to be considered as having a complete integration between the two systems. As mentioned before, ATFM transmits the COBT, CTOT to A-CDM, which updates the TTOT of A-CDM and recalculates the TSAT, TTOT to meet it. As for ATFM, the milestone information of A-CDM are collected but not reflected in the actual CTOT calculation, and ATFM workers are performing their work by referring to this. Unlike systems in other countries, the ATFM system in ROK calculates COBT and CTOT based on the EOBT or SOBT of first entered flight plan and those calculated time cannot be updated through time information such as TOBT and AOBT collected in real time. This can be attributed to the lack of a priority conceptualization of how to utilize the collected time information between the two systems since they were built simultaneously and individually. To overcome these limitations and ensure full interconnection between the two systems, automatic reflection of time information between the two systems is required based on the accumulated A-CDM and ATFM operational experience, resulting in real-time milestone renewal.

3.2 Another problem is about the collection of information. The TOBT, one of the key milestones in A-CDM, is information produced by an airline or a ground handling company

that can be collected only when the agency's cooperation is guaranteed. However, current aviation laws in ROK are lack of the basis for the collection of information for A-CDM or ATFM about related agencies, which cause difficulties for the operators of A-CDM (Incheon International Airport Corp. and Korea Airports Corporation). Prior to the integration of A-CDM and ATFM, legal grounds for the collection and utilization of information are need to be assured.

3.3 Finally, the operation of the consultative group is limited. Currently, the ROK has the consultative body for collaborative decision-making in which related stakeholders exchange opinions and participate in decision-making. However, the current CDM is focused on tactical flow management, making it difficult to decide on what needs to be discussed from a macro perspective, such as integrating A-CDM-ATFM. To ensure smooth integration between the Korean ATFMS and the advanced decision support tools (DMAN, etc.) to be developed in the future, it is necessary to redefine the role of the consultative group. It plans to expand the scope of attendance presently limited to flow managers and control room workers to include higher decision makers, and to reorganize and operate existing CDM consultative bodies to ensure CDM at the strategic stage through discussion with related agencies.

3.4 Therefore, the ROK government is planning research and development to upgrade ATFM and prepare integrated operational procedures ('21~'25), and plans to amend legislation to prepare the basis for data collection ('21). Finally, the ways of integrating A-CDM-ATFM would be discussed from a macro perspective by expanding the scope of participation of the CDM consultative group and activating their roles.

Suggestion on enhancing the national models for cross-border application.

4.1 Considering the current status of A-CDM-ATFM linkages in ROK, the case of Hong Kong and India reported in the 5th APAC ACDM T/F, and the CANSO guide on ATFM/A-CDM integration, the core of the integrated operation between the two systems is the establishment of information sharing system. When ATFM provides flow control measures (COBT, CTOT, etc.) and expected operation-time information (ELDT, etc.), and A-CDM shares real-time airport departure situations (off-block, start-up, take-off time, etc.) with ATFM, more accurate traffic awareness and prediction can be possible. However, all of this information sharing cannot be done at once, and as mentioned in the CASNO guide, it requires a scalable and step-by-step level of information sharing, which is likely to be feasible through platform deployment, such as data centers and ATFM portal sites.

Information sharing level (Note: CANSO Guide)

- a) ATFM → A-CDM: Information on ATFM slot information
- b) ATFM → A-CDM: Flight updates information
- c) A-CDM → ATFM: Departure information

Using the platform, more efficient information sharing can be ensured by collecting comprehensive data including domestic and international flight plans, airline operating schedules, information produced by A-CDM and ATFM, etc. and by establishing a unified system to manage the quality of the data.

4.2 In addition to the establishment of an information sharing system, studies on detailed logic should be conducted to reflect shared information in each system. For A-CDM, it is necessary to determine which milestones should be updated based on ATFM measures and thus set the timing for the collection of ATFM information. ATFM should be able to prioritize information that can increase the effectiveness of the CTOT among real-time A-CDM milestone, which requires an operational procedure or algorithm to update the CTOT in real time.

4.3 In conclusion, the A-CDM-ATFM integration system needs to be established by taking into account the international cooperative characteristics of the Asia-Pacific region. ROK-China-Japan and Southeast Asia have individual ATFM systems, from which regional ATFM cooperation was formed. Integrated A-CDM and ATFM systems are not limited to a single country and are intended for internationally harmonized air traffic management. Multilateral, collaborative and universal nature system should be established, not just for ROK. Therefore, efforts for implementation from the ICAO Asia-Pacific region and countries are need to establish a phased integration system in consideration of traffic volume between countries and regions, such as support for establishing individual consultative bodies.

U.S. Department of Transportation
Federal Aviation Administration

Office of International Aviation
Washington, D.C. 20591



FAX NUMBER (202) 267-5499
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DATE: December 23, 2020

TO: Mr. Arun Mishra
ICAO Regional Director
Asia and Pacific Region, Bangkok

FROM: Ms. Ashlei Nadler
Principal Staff Officer
Interagency Group on International Aviation

PAGES: 2

Dear Mr. Mishra:

This is in response to ICAO Bangkok letter AN 3/3 - AP-AGA0049/20 dated November 30, 2020, requesting input to the development of joint operational procedure guidance for the integration of ATFM and A-CDM operations.

The United States provides the following information:

i. Details about national and/or local model/guidance for integrating ATFM and ACDM operations:

Currently, the surface movement and locations of aircraft are still largely known only to the controllers who are using out the window (OTW) views, surface surveillance, or verbal reports to follow aircraft surface progression. The lack of shared situational awareness between or among air traffic control facilities, ramp towers, flight operators, and airport operators leads to excessive fuel consumption in taxiing, increased environmental impacts, sub-optimal integration of traffic into overhead flows, difficulty in meeting Traffic Flow Management System (TFMS) and Time Based Flow Management (TBFM) traffic flow restrictions, and overall system optimization. Terminal Flight Data Manager (TFDM) is the FAA system for managing surface operations and is expected to be implemented over the next several years. As different entities in the National Airspace System (NAS) start communicating data with the tower, TFDM will consolidate such data and provide services including electronic flight data with

surveillance integration, integrated traffic flow management, and a series of surface management tools. TFDM will provide the consolidated data back to all the associated entities and stakeholders involved with surface operations at the local airport. TFMS, TBFM and TFDM will be integrated to share data across all platforms and increase efficiencies at all levels of the operation.

ii. **Suggestions on generalising and enhancing the national and/or local models/procedures for cross-border application.**

The goal is global harmonization and inter-operability which facilitates interoperability across international Airport CDM programs and the FAA's Surface CDM concept. Near-term objectives are to continuously monitor capacity and demand, proactively manage departure queues and improve the management of arrival traffic flows. Mid-term and later objectives include interoperability/global harmonization with the European Airport CDM Programme, ICAO ASBU initiatives, and other international CDM programs.

Best regards,

A handwritten signature in black ink, appearing to read "Ashli Nadler". The signature is written in a cursive style with a long horizontal flourish extending to the right.

DEVELOPMENT OF JOINT OPERATIONAL PROCEDURE GUIDANCE FOR THE INTEGRATION OF ATFM AND A-CDM OPERATIONS

A. Details about national and/or local model/guidance for integrating ATFM and A-CDM operations

- A1. Concept of operations (CONOPS) describing the characteristics of the integrated ATFM/A-CDM model from the viewpoint of efficiency and effectiveness of overall workflow
- A2. Details of the operational workflow of integrated ATFM/A-CDM
- A3. The implementation model for computerising the integration of ATFM and A-CDM
- A4. Data items exchanged between the ATFM and A-CDM systems
- A5. Use of data items for updating flight information, including flight plan and current flight trajectory
- A6. Interaction and influence of flight update and departure Information on ATFM measures and A-CDM milestones
- A7. The methods for engaging stakeholders in the integrated processes of ATFM and A-CDM
- A8. The integration planning and execution of the integrated processes
- A9. The methods for verifying the information quality and validation the operational workflow
- A10. The key performance indicators for measuring the successful integrated system

B. Suggestions on generalising and enhancing the national and/or local models/procedures for cross-border application

- B1. Concept of operations (CONOPS) describing the characteristics of the cross-border model for integrated ATFM/A-CDM from the viewpoint of efficiency and effectiveness of cross-border workflow
- B2. Operational workflow suggested for cross-border application
- B3. Considerations and constraints for generalising the national/local ATFM and A-CDM operational workflow
- B4. Data items suggested for cross-border application
- B5. Support tools suggested for integrated cross-border ATFM/A-CDM application
- B6. Key performance indicators for cross-border application
- B7. Timeframe suggested for planning and execution of cross-border integration
- B8. Verification and validation methods suggested for cross-border integration
- B9. Methods suggested for engaging cross-border stakeholders