INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA PACIFIC AIRPORT COLLABORATIVE DECISION MAKING (A-CDM) IMPLEMENTATION PLAN

Second Edition, 2 July 2021

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RECORD OF AMENDMENTS

AMENDMENTS				AMENDMENTS			
No.	Date applicable	Date entered	Entered by	No.	Date applicable	Date entered	Entered by

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SCOPE OF THE PLAN

The Need for Regional Guidance and A-CDM Implementation Plan

1.1 The phenomenal growth of air traffic for the past one and a half decades has caught the whole aviation world by surprise. Asia Pacific region has accounted for more than 30 percent of the global air transport market. Considering the fleet acquisition of aircraft operators in Asia Pacific (APAC) Region, this figure is expected to grow further.

1.2 The traffic growth vis-a-vis airport infrastructure has prompted ICAO to devise various methods like promulgation of new procedures, regulations, sharing of information and collaborative approach in all fields to mitigate the issues being faced by the aviation community in this region.

1.3 All stakeholders in aviation especially aircraft operators, airport operators and air navigation service providers (ANSPs) are consistently assessing their operations to minimize their carbon footprints.

1.4 ICAO APAC Region conducted the first ever seminar in conjunction with the First Meeting of the Asia Pacific Airport Collaborative Decision Making Task Force (APA-CDM/TF) to collate, compile and analyse the issues being faced by stakeholders. During this Task Force meeting, a consensus was arrived at, to complete a survey on status of A-CDM implementation at airports by the States.

1.5 The Second APA-CDM/TF meeting analysed the survey data and it was observed that many States have not initiated the process of implementing A-CDM at many airports.

1.6 It has also been observed that wherever implementation process and / or the procedures being followed are not harmonised wherein the possibility of confusion exist among the users particularly aircraft operators, Air Traffic Control (ATC), airport operators and Ground Handling Agents (GHA).

1.7 This has necessitated ICAO APAC Office to harmonise the process of implementation, sharing of data, terminologies, data formats etc.

1.8 This document has been developed by the experts nominated by States, CANSO and IATA to foster harmonized and interoperable A-CDM implementation in the Asia Pacific Region.

1.9 The document also elucidates the performance measurement mechanism to understand the gap between the intended A-CDM implementation and results so obtained. This process will enable the planners to make necessary course correction to improve the system.

1.10 Several airports within the Asia Pacific Region have implemented A-CDM to some varying degree and more airports are in the process of planning to implement A-CDM. While there will be differences across A-CDM airports to take into account local constraints and requirements, certain key A-CDM processes e.g. terminologies, start-up procedures, can be harmonised to prevent confusion among stakeholders. States should recognise the importance of harmonisation in key A-CDM processes. This is a crucial step towards the eventual local implementation of A-CDM. Subsequently, there is a need for States to work together to ensure system interoperability between Air Traffic Flow Management (ATFM) and A-CDM implementations in the Asia Pacific Region.

1.11 A-CDM can further optimise operations at the airport by taking into consideration ATFM programmes. In a scenario where local and regional networks of A-CDM and/or ATFM units are set up and connected, key stakeholders will be able to exchange useful departure and arrival information to further improve predictability of events (as compared to standalone A-CDM or ATFM) to enhance the planning and overall situational awareness for all CDM partners. The implementation of an integrated ATFM and A-CDM network will complement each other and together create a seamless air traffic environment. This would improve flight and ATM efficiency throughout the three phases of flight (arrival, turnaround and departure), benefiting all CDM partners.

PLAN DEVELOPMENT AND OBJECTIVES

Asia Pacific Seamless ANS Plan

2.1 The Asia Pacific Seamless ANS Plan includes background information and performance expectations for implementation of A-CDM in the Asia Pacific Region.

2.2 The Plan prioritizes the implementation of the Global Air Navigation Plan (GANP) Aviation System Block Upgrades (ASBUs), with ASBU modules categorized as Critical ASBU Upgrades, Recommended ASBU Upgrades or ASBU Elements that may not be Universally Implemented. The ACDM-B0/1-2 [Airport CDM Information Sharing (ACIS) - Integration with ATM Network function] and ACDM-B1/1-2 [Airport Operations Plan (AOP) - Airport Operations Centre (APOC)] ASBU modules are listed as Critical and Recommended ASBU Upgrades, respectively. ICAO GANP and APAC Seamless ANS Plan have details on ASBUs.

APANPIRG/27 Decision on Establishment of APA-CDM Task Force

2.3 Noting the benefits that accrue by the implementation of A-CDM at high density aerodromes and the implementation challenges faced by the region, APANPIRG/27 adopted the proposal to establish an A-CDM Task Force to support and assist in the implementation of A-CDM in the APAC Region. The text of the Decision is reproduced below:

Decision APANPIRG/27/2: Establishment of A-CDM Task Force

That, an Asia/Pacific Airport Collaborative Decision Making Task Force (APA-CDM/TF) is established in accordance with the Terms of Reference (ToR) at **Appendix A to AP ANPIRG27 /WP/6**.

2.4 Following APANPIRG Decision 27/2 the ICAO APAC Office through its letter Ref.: AN 3/3 — AP107/16 (AGA) dated 20 September 2016 requested States/Administrations to nominate experts/advisors having knowledge in Airport collaborative Decision Making (A-CDM) to the APA-CDM/TF.

2.5 The second task force meeting analysed the A-CDM survey data and observed that many States have not initiated the process of implementing A-CDM at many airports. *The Decision of the Task Force/2 is as under:*

5.21 A Regional A-CDM implementation plan would be drafted offline by the APA-CDM Expert Group, led by India supported by Singapore and CANSO and would include the development of a minimum suite of A-CDM milestones for Regional application.

2.6 IATA also contributed in the development of this plan.

DGCA Conference's Action Item 54/12 on Harmonization of A-CDM Practices

2.7 Noting the experience of States/Administrations gained from the implementation of A-CDM and recognizing a collaborative approach in the implementation of A-CDM would lead to the optimization of airport operations which contributes towards achieving seamless ATM in the APAC Region, the 54th Conference of the Asia/Pacific Director Generals encouraged States/ Administrations to:

- work towards harmonization of A-CDM practices in APAC Region and to participate in the ICAO Asia/Pacific A-CDM/TF; and
- implement A-CDM taking into account the cross-border ATFM operations.

EXECUTIVE SUMMARY

Airport - Collaborative Decision Making Task Force

3.1 In accordance with Decision APANPIRG/27/2: Establishment of A-CDM Task Force, the ICAO Asia Pacific Airport - Collaborative Decision Making Task Force (APA-CDM/TF) was formulated and the first APA-CDM/TF meeting was held in April 2017. Taking reference to survey data collected from States/Administrations in Asia Pacific Region regarding the status of A-CDM implementation and the discussion deliberated in the second APA-CDM/TF meeting for the need of harmonisation on A-CDM in Asia Pacific Region, especially for the process of implementation, data sharing, terminologies, data formats and framework of interoperability with other related systems. APA-CDM/TF Expert Group was tasked to develop this APA-CDM Implementation Plan as a reference to States/Administrations for implementation of A-CDM in Asia Pacific Region.

3.2 The APAC A-CDM Implementation Plan shares insights in the following areas for assisting States in planning and implementation of A-CDM in different stages.

A-CDM Phases

3.3 A-CDM project activities could be grouped into the following three phases:

- Initiation;
- Implementation; and
- Operation and Monitoring.

3.4 In the Initiation Phase, it is required to define the need and complete relevant analysis in order to make a decision for the implementation of A-CDM.

3.5 In the Implementation Phase, variety among A-CDM projects in different airports is expected due to the involvement of a broad mix of stakeholders with relatively unique operational requirements. However, the following key considerations are interpreted as commonalities among A-CDM projects:

- Clear definition of roles and responsibilities among stakeholders;
- Establishment of A-CDM Project Management Team;
- Stakeholders’ access to A-CDM data;
- Aim to achieve an effective and efficient turnaround process; and
- Development of continuous improvement culture.

3.6 In the Operation and Monitoring Phase, focus will remain on continuous improvement and development of the A-CDM system to optimize the utilization of airport infrastructure. It is crucial to define key performance indicator measurements related to TOBT and TSAT for evaluating effectiveness of A-CDM implementation.

Harmonization Framework

3.7 It is understandable that each individual airport can maintain its unique requirements in implementing A-CDM. To certain extent, the need for harmonization on the following aspects is also anticipated. Relevant reference and guidance have been laid out in the APAC A-CDM Implementation Plan.

- A-CDM terminologies and definition;
- Roles and responsibilities of A-CDM stakeholders;
- Standardization of A-CDM procedures; and
- Commonality in milestone approach.

Interoperability of A-CDM with other systems

3.8 Making reference to the ICAO Aviation System Block Upgrades (ASBU) framework, it is considered necessary to link up relevant ASBU modules and elements related to A-CDM, such as NOPS-B0, ACDM-B0, ACDM-B1, FICE-B1, the application of Common aeRonautical Virtual Private Network (CRV) and System-Wide Information Management (SWIM) for carrying regional FIXM Extension etc. There should be a project framework for integration/interoperation of A-CDM with other air traffic management (ATM) systems, especially for ATFM platform, in accordance with the ASBU roadmap. A good practice for development and implementation of interoperability among A-CDM and ATFM platforms should incorporate considerations of relevant milestones involved, open standards for sharing data with systems across border, alignment of compliance criteria in A-CDM and ATFM, and coordinated timing for data exchange matched with data availability timeline.

Research and Future Development

3.9 A-CDM has its roots in Europe and is the foundation for Single European Sky ATM Research (SESAR) concept for the use of better data and technology to make aircraft and airport operations more efficient. However, not all regions have a centric ATM network as Europe so the processes would be different in Asia Pacific Region. As air traffic management evolves and additional concepts are being introduced by the industry, changes and adjustments to A-CDM are anticipated. To assist in making the implementation of A-CDM more successful, it is recommended that a regional ATFM environment be established e.g. via a distributed multi-nodal ATFM network, which would enable a certain degree of harmonization and provide consistency for stakeholders.

3.10 Moreover, States/Administrations should also take into consideration of performance expectation dates, which are mapped with APAC Seamless ANS Plan and Regional Framework for Collaborative ATFM expectations, provided in the APAC A-CDM Implementation Plan while planning for implementation of A-CDM at their airports.

ABBREVIATIONS AND ACRONYMS

ACARS	Aircraft Communications Addressing and Reporting System
A-CDM	Airport Collaborative Decision Making
ACGT	Actual Commence of Ground Handling Time
ACISP	A-CDM Information Sharing Platform
ACZT	Actual Commencement of De-icing Time
ADIT	Actual De-icing Time
AEGT	Actual End of Ground Handling Time
AEZT	Actual End of De-icing Time
AFTN	Aeronautical Fixed Telecommunication Network
AGHT	Actual Ground Handling Time
AIBT	Actual In-Block Time
AIC	Aeronautical Information Circular
AIDX	Aviation Information Data Exchange
AIP	Aeronautical Information Publication
AIRM	ATM Information Reference Model
AIXM	Aeronautical Information Exchange Model
ALDT	Actual Landing Time
AMAN	Arrival Manager
AMHS	ATS Messaging System
AMQP	Advanced Message Queuing Protocol
ANSP	Air Navigation Service Provider
AO	Aircraft Operator
AOBT	Actual Off-Block Time
AODB	Airport Operational Database
AOM	Airspace Organization and Management
AOP	Airport Operations Planning
APOC	Airport Operations Centre
APAC	Asia Pacific
API	Application Programming Interface
ARDT	Actual Ready Time
ARZT	Actual Ready for De-icing Time
ASAT	Actual Start-up Approval Time
ASBT	Actual Start Boarding Time
ASCII	American Standard Code for Information Interchange
A-SMGCS	Advanced-Surface Movement Guidance and Control System
ASRT	Actual start-up request time
ATC	Air Traffic Control

ATCO	Air Traffic Controller
ATFM	Air Traffic Flow Management
ATFMU	Air Traffic Flow Management Unit
ATM	Air Traffic Management
ATOT	Actual Take-Off Time
ATS	Air Traffic Services
ATTT	Actual Turnaround Time
AXIT	Actual Taxi-In Time
AXOT	Actual Taxi-Out Time
BOBCAT	Bay of Bengal Cooperative Air Traffic Flow Management System
CDM	Collaborative Decision Making
CHG	Modification Message
CONOPS	Concept of Operations
CRACP	Cross Region ATFM Collaborative Platform
CRV	Common aeRonautical Virtual Private Network
CRV/OG	CRV Operations Group
CTOT	Calculated Take Off Time
DATM	Digital ATM
DCB	Demand and Capacity Balancing
DCL	Datalink Departure Clearance
DMAN	Departure Manager
DLA	Delay Message
ECZT	Estimated Commencement of De-Icing Time
EDIT	Estimated De-icing Time
EET	Estimated Elapsed Time
EEZT	Estimated End of De-Icing Time
EIBT	Estimated In-Block Time
ELDT	Estimated Landing Time
EOBT	Estimated Off Block Time
ERZT	Estimated Ready for De-icing Time
ETA	Estimated Time of Arrival
ETOT	Estimated Take-Off Time
ETTT	Estimated Turnaround Time
EXIT	Estimated Taxi-In Time
EXOT	Estimated Taxi-Out Time
FDPS	Flight Data Processing System
FF-ICE	Flight and Flow Information for the Collaborative Environment
FIR	Flight Information Region

FIXM	Flight Information Exchange Model
GDP	Ground Delay Program
GHA	Ground Handling Agent
HMI	Human Machine Interface
IATA	International Air Transport Association
ICD	Interface Control Document
ICT	Information and Communication Technology
IP	Internet Protocol
KPI	Key Performance Indicator
MTF	Major Traffic Flow
MTTT	Minimum Turnaround Time
NARAHG	North Asia Regional ATFM Harmonization Group
NOPS	Network Operations
OCC	Operations Control Center
PDS	Predeparture Sequencing
RMS	Resource Management System
SESAR	Single European Sky ATM Research
SIBT	Schedule In-Block Time
SLA	Service Level Agreement
SMAN	Surface Manager
SOBT	Scheduled Off-Block Time
SQL	Structured Query Language
STD	Scheduled Time of Departure
SWIM	System Wide Information Management
TLDT	Target Landing Time
TMA	Terminal Control Area
TOBT	Target Off-Block Time
TSAT	Target Start-up Approval Time
TLDT	Target Landing Time
TTOT	Target Take-Off Time
UML	Unified Modeling Language
VDGS	Visual Docking Guidance System
VTT	Variable taxi time
W3C	World Wide Web Consortium
XML	eXtensible Markup Language

OVERVIEW OF A-CDM

5.1 Airport collaborative decision-making (A-CDM) is a set of processes developed from the general philosophy of collaborative decision-making (CDM) in aviation and is applied to the operations at aerodromes.

5.2 A-CDM can optimize airport operations, by enhancing the turnaround process and improving flight predictability through real time data exchange for all A-CDM stakeholders. A-CDM also potentially helps to improve gate/aircraft stand management, reduce apron, taxiway and holding point congestion. A-CDM involves implementing a set of operational procedures supported by sharing of timely and accurate information amongst A-CDM stakeholders. Overall, A-CDM is about making more efficient use of existing capacity and resources, as well as potentially better recovery from disruptions. A-CDM can, in some cases reduce operating cost attributed to fuel burn, which contributes to environmental benefits.

5.3 Any implementation of A-CDM must be based on assessment of current operational constraints and the value an A-CDM implementation will generate to mitigate such constraints and / or improve current operations. There is a set of essential elements as well as best practices to consider when implementing A-CDM that will simplify and harmonize the implementation. However, each implementation must be based on careful engagement across all airport stakeholders, primarily the Airport Operator, Aircraft Operators, Ground Handling Agents, Air Navigation Service Provider and Air Traffic Flow Management Unit (if any).

5.4 Prior to A-CDM, the stakeholders worked on the basis of ***"first come first served"*** in the start-up sequence of aircraft. A-CDM works on the premise of ***"best planned best served"***, whereby ATC will optimise the predeparture sequence, by generating Target Start-up Approval Times (TSAT), using Target Off-Block Times (TOBT) submitted by Aircraft Operators or their delegate (e.g. Ground Handling Agents). It is a collaborative approach amongst all the A-CDM stakeholders and the success is ultimately dependent on the accuracy of TOBTs which are managed by Aircraft Operators.

5.5 To aid the generation of accurate TOBTs and TSATs in the A-CDM process, timely and accurate information updates are very important. The key information needed is ELDT, EIBT, ALDT and AIBT from the arriving flight that is linked to the departing flight. Timely update of this information is related to the A-CDM milestones.

A-CDM IMPLEMENTATION GUIDANCE

Overview of A-CDM Phases

6.1 A-CDM project activities may be grouped into three phases as illustrated in Figure 1:

- Initiation;
- Implementation; and
- Operation and monitoring.

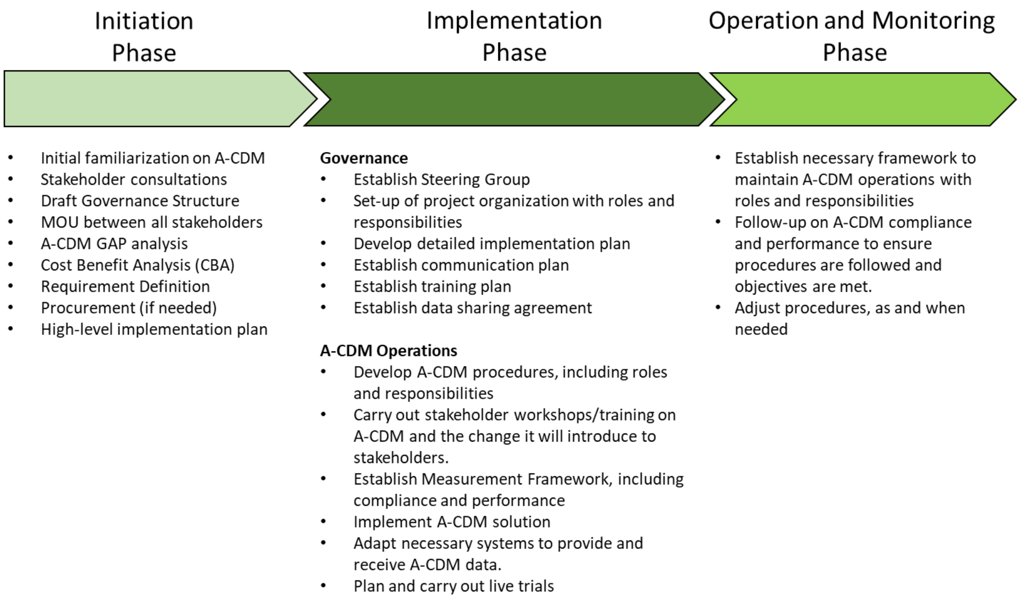

Figure 1 - Phases of A-CDM Project

6.2 The initiation phase is about defining the need, including gap analysis, making the cost and benefit analysis, and ultimately getting a decision to go ahead to invest in the implementation phase.

6.3 The project implementation phase is to undertake the activities to successfully carry out the A-CDM project, which is different from many other implementation projects due to its multi-stakeholders' involvement and impact on operations.

6.4 The operations phase is about when A-CDM is up and running. A-CDM with its procedures and supporting systems and sharing of information will be up and running 24/7 – 365 in most cases. This will also require the necessary efforts and tasks to make it successful.

6.5 This plan focuses on highlighting some of the most critical activities to consider in the implementation phase.

Key Considerations for A-CDM Implementation Phase

6.6 A-CDM Steering Group comprising of all relevant stakeholders, which is a minimum of the Airport Operator, Ground Handling Agents, ANSP and Aircraft Operators, should be set up before any implementation, with the responsibility to agree on the A-CDM processes, procedures, performance framework, data sharing and common definitions. Generally, this is initiated by the Airport Operator.

6.7 The A-CDM Steering Group should define clear roles and responsibilities in the implementation phase for the A-CDM stakeholders, i.e. "**who**" is doing "**what**" and "**when**" in the implementation project. This is not to be confused with the "roles and responsibilities" of the stakeholders in the A-CDM process, which is something different and addressed in the "Harmonization Framework" section.

6.8 A-CDM Project Management Team should be established and involve all A-CDM stakeholders during design and implementation of A-CDM project.

6.9 Ensuring early engagement with stakeholders and instilling a collaborative culture will support the success of an A-CDM implementation. This process should create clarity across A-CDM stakeholders on the objectives of the implementation, and the expectations from each party. With clear and agreed objectives across all key stakeholders, A-CDM implementation should yield projected benefits and will prevent sub-optimal operations or limited return on investment for the airport.

6.10 As A-CDM is a change in procedures, it can also be a huge cultural and behavioural change for all A-CDM stakeholders that should not be underestimated. In order to address this challenge, appropriate communication and training plans should be put in place to facilitate the understanding and impact of A-CDM for each stakeholder.

6.11 Local A-CDM Operational Procedures should be developed in collaboration with the stakeholders. These procedures need to detail at a minimum "roles and responsibilities", i.e. "**who** is doing **what**, **when** and **how**" in the A-CDM process. During this work, implementers should look to other A-CDM procedure manuals and related materials to leverage experience gained and lessons learnt. Examples can be found at ICAO APAC Website under e-Documents at https://www.icao.int/APAC/Pages/eDocs.aspx. The section "Harmonization Framework" also outlines particular parts that should be considered to ensure harmonization.

6.12 The implementation should be in a phased approach, including trials, with a minimum of disturbance to A-CDM stakeholders' operations.

6.13 A framework of reviews to track progress of A-CDM implementation should be created by the A-CDM steering group. This framework aims to ensure that the implementation phase timelines and objectives are met.

6.14 Performance framework to measure key performance indicators should be established as early as possible in the implementation phase.

6.15 Wherever ATFM is operational, it is desirable to integrate with local A-CDM to achieve optimal situational awareness for all stakeholders.

Stakeholder Access to A-CDM Data

6.16 A-CDM requires airport stakeholders to exchange timely operational information which enables collaboration in the efficient management of operations at an airport.

6.17 Data exchanges via the common interfaces should support the entire data related to A-CDM elements and milestones. Full scope messaging will provide context to enhance situational awareness.

6.18 Aviation Information Data Exchange (AIDX) could be utilized for data exchange of A-CDM data among stakeholders using commercial flight identification (outside the ATM domain). AIDX is an eXtensible Markup Language (XML) messaging standard for exchanging flight data among airlines, airports, ground handlers and other third party data consumers.

6.19 The adoption of an open source technology for an A-CDM Information Sharing Platform (ACISP) is encouraged in order to reduce the license cost to A-CDM stakeholders wishing to implement data exchange via the common Application Programming Interface (API).

Achieving an Effective and Efficient Turnaround Process

6.20 The turnaround process encompasses the complete management of an aircraft from the arrival at an airport to the departure (from AIBT to AOBT) that needs to be effective and efficient in order to contribute to a successful A-CDM implementation.

6.21 The A-CDM turnaround process involves stakeholders, operational services, data points and algorithms that are instrumental to successful turnaround of an aircraft.

6.22 To ensure good interaction amongst stakeholders, the understanding, management and ownership of TOBT is of utmost importance. This will improve performance of the turnaround.

6.23 A departure sequence capability should be introduced that produces Target Start-up Approval Times (TSATs) and Target Take Off Times (TTOTs). This is to deliver transparency, better recovery and improvements to Calculated Take-Off Time (CTOT) compliance. The capability should evolve with the A-CDM implementation and the "Operation and Monitoring" phase.

6.24 The Variable Taxi Times (VTTs) are of utmost importance for the A-CDM processes to work, including producing automated updates to Estimated In Block Times (EIBTs) as well as the Target Start-up Approval Times (TSATs) and Target Take Off Times (TTOTs). The practical implementation of VTTs can vary from static values (e.g. fixed taxi times from runways to gates) to highly dynamic VTTs that take ground movement patterns, changes at the airfield and changes to traffic flows due to weather into account. How advanced and dynamic, the VTTs need to be considered in the implementation where the complexity of traffic patterns and airport layout are factors to be considered. The more accurate the VTTs are, the better the overall predictions and sequencing of traffic will be.

6.25 The Minimum Turn-Round Time (MTTT) is also very important for the A-CDM processes to work. It comes into play to help calculating Target Off Block Times (TOBTs) based on Estimated In Block Times (EIBTs) or Actual In Block Times (AIBTs). The MTTTs will depend on factors such as aircraft type, possibly type of stand, airline procedures, destination etc. The values and implementation of MTTTs should be discussed in close cooperation with the Airline Operators to ensure accurate values are used. MTTTs not presentative of the operations will result in less accurate TOBTs as well as TSATs and TTOTs, as long as TOBTs are not manually controlled by the Airline Operator or Ground Handling Agents.

Building a Continuous Improvement Culture

6.26 A-CDM implementation involves the interaction of multiple stakeholders, processes and systems. A culture of continuous improvement amongst all stakeholders will benefit all involved.

6.27 Following its implementation, the environment at an airport will change and may require adjustments in the A-CDM processes.

6.28 After A-CDM implementation, it is important that focus remains on continuous improvement and developing the overall A-CDM system to ensure optimized utilization of airport infrastructure. The project should be able to support a suitable improvement mechanism.

6.29 A-CDM stakeholders should be able to monitor improvements from an A-CDM implementation. This should consist of:

a) Exchange of experience at regular intervals.

b) Ad-hoc meetings before any major release of new software or update of the A-CDM implementation (procedural or functional). Ideally, this should be supported by a consensus achieved by discussion amongst impacted stakeholders.

c) ICAO Asia/Pacific Office can be approached to solicit views on new implementations or improvement opportunities.

6.30 Where ATFM exists, the Airport-CDM and ATFM should collaborate to improve airport operations especially for capacity planning and impact of performance degradation at other airports.

Measure Effectiveness of A-CDM Implementation

6.31 With the implementation of A-CDM, there will be a change from current operating procedures as it introduces two new time elements, namely Target Off Block Times (TOBTs) and Target Start-up Approval Times (TSATs) and the procedures around these time elements. More specifically the operational changes relates to:

- The management, including input and updates as needed, of Target Off Block Times (TOBTs) for either the aircraft operator or the ground handler.
- The management, including input and updates as needed, of TSATs for the Air Navigation Service Provider (ANSP)
- The start-up and push back procedures.

6.32 It is very important that the impacts of these procedure changes are measured, so that the effectiveness of the A-CDM implementation can be assessed. This will allow all stakeholders to effectively monitor how the A-CDM procedures are complied with and identify where improvement can be made, which is just as important as getting A-CDM implemented in the first place.

6.33 Key performance indicators (KPIs) related to TOBT and TSAT are required to assess the effectiveness of an A-CDM implementation.

6.34 Other KPIs may be used as supplement for monitoring the performance of the A-CDM.

Measurements of TOBT

6.35 Achieving inputs and updates of TOBT as accurate as possible is one of the first steps in the A-CDM implementation. The Aircraft Operators or Ground Handling Agents will need to provide TOBT for all the departing flights to enable the A-CDM procedures to flow efficiently and effectively. Without TOBT, there will be no predictability of departure readiness and TSAT will not be available.

6.36 The following measurements are related to TOBT.

Table 1 - Measurement of TOBT

Name of indicator	TOBT input participation rate
Value of Indicator	Allows the A-CDM project team to see the amount of participation from airlines/ground handling agents in TOBT inputs before proceeding to measure the accuracy and use TOBT for pre-departure sequencing.
Data requirement	Manual TOBT updates/inputs
Formula	Track number of TOBT inputs from each airline and ground handling agent through different time references before departure, e.g. at TOBT-10mins, -20min and -40mins
Indicator Forms	Participation rate in TOBT inputs and when does it occur
Tips/Warning	It is important to achieve a high % of participation in order for the A-CDM concept to work. A-CDM with low participation rate will lead to questions on fairness when TSAT is used for pushback and eventually the collaborative concept may fail. To improve participation rate, more A-CDM awareness workshops or compliance measures may be required.
System requirements	Data analysis tool of the A-CDM portal if available or TOBT input records

Table 2 - Accuracy of TOBT

Name of indicator	TOBT Accuracy
Value of Indicator	Allows airlines/ground handling agents to understand whether their TOBT submission workflow/process is effective in achieving an accurate TOBT. Allows the A-CDM project team to assess whether the TOBT quality is acceptable and can be used to generate TSAT. It also gives a general indication of compliance rate for TOBT submission.
Data requirement	• TOBT • Actual Ready Time (ARDT) and/or Actual start-up request time (ASRT)
Formula	• Compare TOBT against ARDT and/or ASRT • Compare TOBT against AOBT
Indicator Forms	• Accuracy of TOBT • TOBT compliance rate
Tips/Warning	Low TOBT accuracy with high TOBT participation rate indicates that the airline/ground handling may have to improve their internal workflow/process for updating of TOBT. How to measure the accuracy of the TOBT depends on the procedures applied for the A-CDM implementation. To be able to measure the TOBT accurately, it is highly recommended that pilot shall call ready

Name of indicator	TOBT Accuracy
	within a window of the TOBT and that ATC indicates this time via an ARDT or ASRT.
System requirements	• Data analysis tool of the A-CDM portal if available or TOBT input records • AOBT from appropriate source ARDT and/or ASRT from an Electronic Flight Strip system or alternative means.

Note: *Some European airports benchmark their TOBT compliance at 80%.*

Measurement of TSAT

6.37 A Pre-Departure Sequencer/Departure Manager solution might be used for pre-departure sequencing in the A-CDM implementation, which should be generating an optimal TSAT to achieve the best sequence to maximize runway throughput and regulate traffic to holding point. However, if ATC or pilots are not adhering to the TSAT, the benefits will not be achieved.

6.38 TSAT compliance plays an important role in achieving the objective of reducing taxi-out time and also shows the level of commitment to TSAT in the A-CDM procedures.

Table 3 - Measurement of TSAT

Name of indicator	**TSAT Compliance**
Value of Indicator	Allows the A-CDM project team to assess whether ATC is following the TSAT for pushback and also pilots' adherence to the TSAT procedure.
Data requirement	• TSAT • Actual Start-up Approval Time (ASAT) • AOBT
Formula	• Compare ASRT and/or ASAT against TSAT • Compare AOBT against TSAT
Indicator Forms	• TSAT compliance rate
Tips/Warning	If the compliance level is low, it may mean either the A-CDM procedures are not followed by ATC/Pilots or ATC did not enforce TSAT compliance or the TOBT submitted by airlines/ground handling agents is not up to desired accuracy. How to measure the compliance to the TSAT depends on the procedures applied for the A-CDM implementation. To be able to measure the compliance it is highly recommended that pilot request within a window of the TSAT and that ATC indicates this time via an ASRT. ATC shall also give the start-up approval within the given TSAT window and indicate this via an ASAT.

Name of indicator	**TSAT Compliance**
System requirements	• Data analysis tool of the A-CDM portal if available or TSAT records from DMAN/PDS • AOBT from appropriate source • ASRT and/or ASAT from an Electronic Flight Strip system or alternative means.

Note: *Some European airports benchmark their TSAT compliance at 80%.*

HARMONIZATION FRAMEWORK

A-CDM Terminologies and Definition

7.1 As more and more airports adopt A-CDM, it is important that implementations strive for harmonization with respect to certain areas. This relates to certain procedures, roles and responsibilities as well as having common understanding of terminologies.

7.2 Groups with limited interaction often develop their own semantic references; airport stakeholders are not an exception as they may use different terminologies to cover the same reality. A lack of common definitions and understanding of terms across the stakeholder community can exacerbate misunderstanding and contribute to the lack of common situational awareness.

7.3 As an example, "arrival time" to an air traffic controller (ATCO) could mean at the point of touchdown, whereas for an airline or ground handling agencies "arrival time" may be understood as the time when an aircraft is at the gate. This disparity in a common definition of terms leads to a lack of shared awareness and clarity of the operational picture, which can lead to confusion and result in increased inefficiencies.

7.4 As A-CDM brings stakeholders together as part of the procedures and collaboration, it is of highest importance to implement common acronyms and definitions that are agreed and understood by all. To ensure harmonization not only at the local airport level in an A-CDM implementation but at the regional APAC level the following A-CDM definitions are highly recommended to be adopted as part of an A-CDM implementation.

7.5 These acronyms and definitions are aligned with overarching ICAO definitions, where applicable, as well as EUROCONTROL A-CDM acronyms and definitions.

Table 4 – A-CDM Acronyms and Definitions

Acronyms	Definition	Explanation
ACGT	Actual Commence of Ground Handling Time	The time when ground handling on an aircraft starts, can be equal to AIBT (to be determined locally)
ACZT	Actual Commencement of De-icing Time	The time when de-icing operations on an aircraft starts
ADIT	Actual De-icing Time	The actual time that the de-icing activity takes. Metric AEZT – ACZT
AEGT	Actual End of Ground Handling Time	The time when ground handling on an aircraft ends.
AEZT	Actual End of De-icing Time	The time when de-icing operations on an aircraft end
AGHT	Actual Ground Handling Time	The total duration of the ground handling of the aircraft. Metric AEGT - ACGT
AIBT	Actual In-Block Time	The time that an aircraft arrives in-blocks.
ALDT	Actual Landing Time	The time that an aircraft lands on a runway.
AOBT	Actual Off-Block Time	Time the aircraft pushes back /vacates the parking position.
ARDT	Actual Ready Time	When the aircraft is ready for start-up/push back or taxi immediately after clearance delivery, meeting the requirements set by the TOBT definition
ARZT	Actual Ready for De-icing Time	The time when the aircraft is ready to be de-iced
ASAT	Actual Start Up Approval Time	Time that an aircraft receives its start-up approval

Acronyms	Definition	Explanation
ASBT	Actual Start Boarding Time	Time passengers are entering the bridge or bus to the aircraft
ASRT	Actual Start Up Request Time	Time the pilot requests start up clearance
ATOT	Actual Take-Off Time	The time that an aircraft takes off from the runway.
ATTT	Actual Turnaround Time	Time taken to complete turnaround. Metric AOBT – AIBT
AXIT	Actual Taxi-In Time	Time taken to taxi to stand after landing Metric AIBT – ALDT
AXOT	Actual Taxi-Out Time	Time taken from pushback to take-off Metric ATOT – AOBT
CTOT	Calculated Take-Off Time	A time calculated and issued by the appropriate air traffic management unit as a result of tactical slot allocation, at which a flight is expected to become airborne
ECZT	Estimated Commencement of De-icing Time	The estimated time when de-icing operations on an aircraft are expected to start
EDIT	Estimated De-icing Time	Metric EEZT – ECZT
EEZT	Estimated End of De-icing Time	The estimated time when de-icing operations on an aircraft are expected to end
EIBT	Estimated In-Block Time	The estimated time that an aircraft will arrive in-blocks. **NOTE –** This can sometimes be referred to as Estimated Time of Arrival (ETA) by Aircraft Operator. It is important to clarify the ETA in relation to EIBT and ELDT.
ELDT	Estimated Landing Time	The estimated time that an aircraft will touch-down on the runway. **NOTE –** This can sometimes be referred to as Estimated Time of Arrival (ETA) by ATC. It is important to clarify ETA in relation to EIBT and ELDT.
EOBT	Estimated Off-Block Time	The estimated time at which the aircraft will start movement associated with departure; also associated with the time filed by aircraft operator in the flight plan
ERZT	Estimated Ready for De-icing Time	The estimated time when the aircraft is expected to be ready for de-icing operations
ETOT	Estimated Take-Off Time	The estimated take off time taking into account the EOBT plus EXOT.
ETTT	Estimated Turnaround Time	The time estimated by the AO/GHA on the day of operation to turn-round a flight taking into account the operational constraints
EXIT	Estimated Taxi-In Time	The estimated taxi time between landing and in-block
EXOT	Estimated Taxi-Out Time	The estimated taxi time between off-block and take off. This estimate includes any delay buffer time at the holding point or remote de-icing prior to take off
MTTT	Minimum Turnaround Time	The minimum turnaround time agreed with an AO/GHA for a specified flight or aircraft type
SIBT	Schedule In-Block Time	The time that an aircraft is scheduled to arrive at its first parking position.

Acronyms	Definition	Explanation
SOBT	Schedule Off-Block Time	The time that an aircraft is scheduled to depart from its parking position; associated with airport slot allocated **NOTE –** this is typically referred to as Scheduled Time of Departure (STD) by the Aircraft and Airport Operators.
TOBT	Target Off-Block Time	The time that an Aircraft Operator or Ground Handling Agent estimates that an aircraft will be ready, all doors closed, boarding bridge removed, push back vehicle available and ready to start up / push back immediately upon reception of clearance from the control tower.
TSAT	Target Start-up Approval Time	The time provided by ATC taking into account TOBT, CTOT and/or the traffic situation that an aircraft can expect start-up / push back approval.
TLDT	Target Landing Time	Targeted Time from the Arrival management process at the threshold, taking runway sequence and constraints into account. It is not a constraint but a progressively refined planning time used to coordinate between arrival and departure management processes. Each TLDT on one runway is separated from other TLDT or TTOT to represent vortex and/ or SID separation between aircraft
TTOT	Target Take-Off Time	The Target Take Off Time taking into account the TOBT/TSAT plus the EXOT. Each TTOT on one runway is separated from other TTOT or TLDT to represent vortex and/ or SID separation between aircraft

Roles and Responsibilities of A-CDM stakeholders

7.6 This section outlines the general responsibilities of the A-CDM stakeholders as part of the A-CDM process and procedures. It is recommended that any implementer tries to adopt this approach as far as practically feasible. However, it is recognised that local airport rules etc. might prohibit this.

7.7 The **Aircraft Operator** is generally responsible for:

- Providing the Flight Plan and any subsequent updates, i.e. DLA/CHG messages.
- Managing and providing TOBT either themselves or through their authorised GHA.
- Ensuring the flight crew is aware of the channels where TOBT and TSAT information can be obtained, as it is dependent on local procedures.
- Ensuring that their flight crew are aware of start-up and pushback procedures.
- Any change in registration or type of aircraft of ARR/DEP flights, the same should be provided to A-CDM system either directly or through a connected system (like AODB, CHG/FPL message)

7.8 The **Ground Handling Agent**, when authorised by aircraft operator, is responsible for providing information as mentioned in the responsibilities listed above for the Aircraft Operator

7.9 The **Airport Operator** is generally responsible for:

- Providing flight schedule information and any changes therein;
- Providing aircraft parking stand and gate planning/allocation and any changes therein; and
- Overall coordination of the A-CDM process during implementation and operations, including monitoring of performance of A-CDM operations.

7.10 The **Air Navigation Service Provider** (ANSP) is generally responsible for:

- Providing runway-in-use and planned runway-in-use;
- Providing expected runway capacity, and minimum arrival/departure separation;
- When applicable, providing flow control restrictions, e.g. Minutes in Trail and/or Miles in Trail; and
- Ensuring that start-up is issued in accordance with TSAT

7.11 ELDT can be collected from different sources, such as airlines, ANSP and ATFM. In the arrival phase of the flight, ANSP is normally the source for providing the latest updates on ELDT.

7.12 The role of the ANSP can vary in the context of A-CDM in relation to how the pre departure sequencing is handled. There are two different scenarios as follows:

(a) If pre departure sequencing capability available (e.g. a DMAN already installed in the ATC TWR): the ANSP should make arrangements to integrate pre departure sequencing tool's output with A-CDM system.

(b) If pre departure sequencing capability not available: the ANSP should provide appropriate procedures and requirements to generate pre departure sequence.

7.13 The **Air Traffic Flow Management Unit (ATFMU)**, when established, is generally responsible for:

- Balancing of Demand and Capacity;
- Receiving relevant A-CDM data from airports;
- Coordination of Calculated Take Off Times (CTOTs/ATFM slots); and
- Provision of updated ATFM restrictions

7.14 In cases where de-icing is applied, **the De-icing Operator** is generally responsible for:

- Providing the de-icing status of the aircraft
- Prediction of the Estimated De-icing Times such as ECZT, EEZT

Standardization of A-CDM Procedures

7.15 Since the introduction of A-CDM, there have been many airports that have adopted the A-CDM philosophy. The expansion of implementations has led to some differences in procedures and processes. These differences may create problems for stakeholders. A harmonized approach can reduce workload. Although these differences do not constitute a compromise to safety, they create unnecessary additional layers of complexity.

7.16 Standardisation of certain A-CDM procedures to drive efficiency and overall performance is necessary. On the other hand, individual airport may have its unique implementation plan and should have the flexibility to layout its local processes and procedures, which are adapted to its own environment and operational need. However, there are a number of standards that could be applied globally (e.g. TOBT/TSAT procedures and compliance windows). The operations of stakeholders need to be standardized wherever possible, as the burden of differing processes may bring in inefficiency, confusion and costs.

7.17 The way in which procedures and processes are designed needs to incorporate input from A-CDM stakeholders. This should be a collaborative approach, which ultimately all the stakeholders agree to.

7.18 Non-compliance of procedures should be discussed by the steering group, to remove the difficulties faced by the A-CDM Stakeholders.

Target Off Block Time (TOBT) and Target Start-up Approval Times (TSAT)

7.19 The Target Off Block Time (TOBT) and Target Start-up Approval Time (TSAT) are critical to the A-CDM process. Based on an accurate prediction of aircraft readiness for departure, the TOBT, from Aircraft Operator, or appointed/designated Ground Handling Agents, ATC can plan the optimal pre-departure sequence and TSAT at which aircraft are dispatched from the parking stands. This dynamic mechanism between the prediction of when all ground handling activities will end, i.e. at the defined TOBT and the allocation of TSAT, are the core pillars of A-CDM. This is also what it referred to as “Best planned, best served” principles.

7.20 TOBT is defined as “The time that an Aircraft Operator or Ground Handling Agent estimates that an aircraft will be ready, all doors closed, boarding bridge removed, push back vehicle available and ready to start up / push back immediately upon reception of clearance from the control tower.”

7.21 TOBT can be predicted by tracking the flight events, so-called Milestones, that occur prior to landing and during the turnaround process. In order to achieve TOBT accuracy, close coordination of turnaround activities and sharing of operational information among different stakeholders are needed.

7.22 TOBT is the most important timing of the turnaround process and this timing is essential for the calculation of TSAT.

7.23 The TOBT should be confirmed/input at least “X1” minutes prior to the SOBT/EOBT and available for all stakeholders [**X1 is preferably 30-40**].

7.24 TSAT is defined as “the time provided by ATC taking into account TOBT, CTOT and/or the traffic situation that an aircraft can expect start-up / pushback approval”. In order to determine the TSAT an A-CDM implementation should consist of departure management capability (including VTT), such as Pre-Departure Sequencer or Departure Manager.

7.25 The TSAT should be published at least "X2" minutes prior to the TOBT and available for all stakeholders [**X2 is preferably 30-40**].

Sharing of TOBT and TSAT

7.26 Sharing of the TOBT and TSAT information to flight crew is fundamental for a successful A-CDM implementation. Dependent on the local procedures and total system solution this information sharing may be done in multiple ways. How it is done needs to be agreed with the stakeholders. Examples of how to share the TOBT and TSAT to the flight crew are:

- VDGS / A-VDGS (preferred)
- Mobile application available to flight crew
- Airport Operator or Ground Handler designated role communicates TOBT and TSAT directly to flight crew.
- Aircraft Operator or Ground Handler communicates the TOBT and TSAT.
- ATC communicate the TSAT when pilot reports ready for start-up and pushback (only applicable when Pilot reports to ATC ready at TOBT)

A-CDM Start-up Procedures

7.27 Currently, airports that have fully adopted A-CDM processes, exhibit differences in their requirements for when pilots should be ready for start-up and pushback, and report ready for start-up and pushback. These differences may cause confusion, in particular to pilots who operate several airports.

7.28 The operating procedure related to Start-up and Pushback in the A-CDM process must clearly define the requirement of the time at which pilot should initiate call for start-up.

7.29 Irrespective of the TSAT, the aircraft should report/be ready for start-up/pushback at TOBT +/- "X3" minutes [**X3 is preferably 5**].

7.30 Pilots should request start-up/pushback clearance at the TSAT +/- "X4" minutes [**X4 is preferably 5**].

7.31 ATC will approve start-up/pushback or advise the pilots of the current/updated TSAT.

7.32 Any time the TOBT or TSAT cannot be met, or an earlier departure is required, the TOBT should be updated expeditiously by Aircraft Operator or/Ground Handling Agent.

7.33 Departure clearance should be requested via Data Link Departure Clearance (DCL) at TOBT/TSAT +/- X5 minutes (X5 is defined by the local airport authority). If DCL is not available, departure clearance should be requested via RTF/Clearance Delivery at TOBT/TSAT +/- X5 minutes.

Milestone Approach

7.34 The Milestone approach is defined to:

(a) Start and end the A-CDM process for any flight that is defined to be part of the A-CDM process and;

(b) Update information about the flight at certain points during the inbound, turnaround or outbound phase.

7.35 In the A-CDM Process, 16 milestones are defined as per the EUROCONTROL Manual. It is important to note that not all 16 have to be used for a successful A-CDM implementation at an airport but some are required and some are optional. Ultimately, which milestones are used is dependent of the local A-CDM rules, procedures and data availability.

7.36 The Figure 2 depicts all the 16 milestones as they occur in relation to the flight phases, i.e. inbound, turn around and outbound. Please note that the figure does not show how the milestones occur in relation to time. Another important note is that Milestones 1 and 2 are related to the outbound flight from the A-CDM airport and not related to the inbound flight coming to the A-CDM airport.

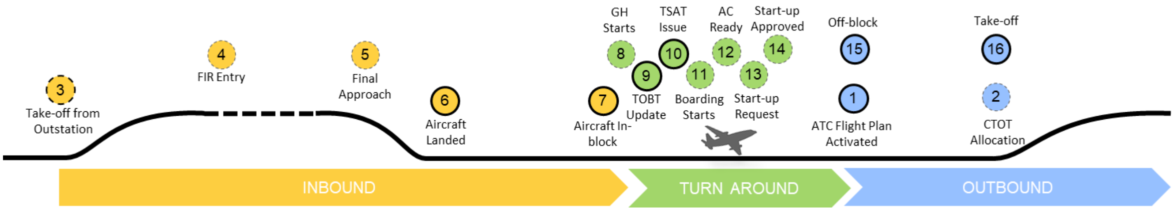

Figure 2: 16 Milestones of A-CDM in relation to the Flight Phases

7.37 The Table 5 provides a comprehensive overview of the milestones including:

- What the purpose of the milestone is;
- How the Milestone is triggered;
- What data needs to be provided;
- A-CDM Actions;
- Example of system(s) that can provide the data; and
- Whether the Milestone is required or optional.

Table 5: Overview of the 16 A-CDM Milestones

Milestone	Purpose of the Milestone	Milestone is triggered by	Data Elements	A-CDM Actions	Example of system(s) that typically has this data (and should share it)	Required/ Optional
MS1 ATC Flight Plan Activated	• Starts the A-CDM process for a flight • To check the data consistency between Airport Slot and Airline's flight plan data (EOBT vs SOBT, aircraft registration and aircraft type)	• ATC flight plan is submitted by Aircraft Operator (this happens typically at EOBT-3hrs but can also be later)	• Schedule Time of departure and arrival for the flight (STD/SOBT and ETA/SIBT) • Flight Plan EOBT • Gate/Stand	• Calculate: ELDT, EIBT, TOBT, TSAT, TTOT • Present/Disseminate: ELDT, EIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• TWR Flight Data Processing System • ACC Flight Data Processing System • AODB/RMS	• Required
MS2 CTOT Allocation	• To allow early awareness of departure delay if there are en-route/destination airport constraints Note 1: Multi-Nodal ATFM Trial currently issues CTOT at latest time of EOBT-1.5hrs Note 2: BOBCAT CTOT is available at EOBT-2hrs	• CTOT issued by relevant ATFM Unit/cross-border ATFM nodes	• CTOT	• Calculate: TSAT BASED on CTOT • Present/Disseminate: ELDT, EIBT, EOBT, SOBT, TOBT, TSAT, CTOT	• ATFM System or similar capability	• Required for a fully integrated A-CDM – ATFM solution but not for a local A-CDM implementation
MS3 Take-off from Outstation	• To provide an ELDT at early stage by using FPL EET + ATOT. • To revise system generated TOBT, TSAT and TTOT if required • Allow early awareness of deviation from scheduled in-block time for resource planning.	• Take-off from up-station	• ELDT	• Re-calculate: EIBT, TOBT, TSAT, TTOT • Present/Disseminate: ELDT, EIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• ACC Flight Data Processing System • ACARS	• Optional
MS4 FIR Entry	• To estimate ELDT and prompt alert if potential gate conflict is anticipated. • To revise system generated TOBT	• Aircraft crosses a defined fix on FIR boundary or enters the FIR.	• ELDT	• Re-calculate: EIBT, TOBT, TSAT, TTOT • Present/Disseminate: ELDT, EIBT, EOBT,	• ACC Flight Data Processing System • Extended AMAN • ACARS	• Optional

Milestone	Purpose of the Milestone	Milestone is triggered by	Data Elements	A-CDM Actions	Example of system(s) that typically has this data (and should share it)	Required/ Optional
	• Allow early awareness of deviation from scheduled in-block time for resource planning.			SOBT, TOBT, TSAT, TTOT		
MS5 Final Approach	• To provide a highly accurate and stable ELDT/TLDT as landing sequence is confirmed • To revise system generated TOBT • Allow for awareness of deviation from scheduled in-block time for resource planning.	• Aircraft enters the TMA	• TLDT or ELDT	• Re-calculate: EIBT, TOBT, TSAT, TTOT • Present/Disseminate: TLDT/ELDT, EIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• ACC Flight Data Processing System • AMAN • ACARS	• Optional
MS6 Aircraft Landed	• To revise system generated TOBT • Allow for awareness of deviation from scheduled in-block time for resource planning.	• Aircraft touches down on runway	• Actual Landing Time (ALDT)	• Re-calculate: EIBT, TOBT, TSAT, TTOT • Present/Disseminate: ALDT, EIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• ACC Flight Data Processing System • AMAN • ACARS	• Required
MS7 Aircraft In-Blocks	• To revise system generated TOBT	• Aircraft arriving at the parking stand	• Actual In-Block Time (AIBT)	• Re-calculate: TOBT, TSAT, TTOT • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• A-SMGCS • Docking System • ACARS • AODB	• Required
MS8 Ground Handling Starts	• To revise system generated TOBT Note: For a normal turnaround flight MS8 and MS7 occur at the same time. MS8 and MS7 will not be the same for flights which are on the first operation of the day/are delayed/have been long term parked.	• Actual start of turnaround activities	• AGHT	• Re-calculate: TOBT, TSAT, TTOT • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• Same as MS7	• Optional

Milestone	Purpose of the Milestone	Milestone is triggered by	Data Elements	A-CDM Actions	Example of system(s) that typically has this data (and should share it)	Required/ Optional
MS9 TOBT Update	• Confirm and take control of TOBT • To check the feasibility of TOBT vs SOBT/EOBT.	• TOBT confirmation/update into A-CDM portal from EOBT-"X1" minutes Note: "X1" is need to be determined locally to fit the operations at the airport. Recommended to be 30 to 40 minutes.	• TOBT	• Re-calculate: TSAT, TTOT • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, TSAT, TTOT	Manual input via: • A-CDM Portal • Mobile Apps • Airline/GHA systems	• Required
MS10 TSAT Issue	• To allow decision making based TOBT and TSAT values • Create a stable pre-departure sequence	• At TOBT – "X2" minutes, TSAT will be published Note: "X2" is need to be determined locally to fit the operations at the airport. Recommended to be 30 to 40 minutes.	• TSAT	• Re-calculate: TTOT • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• A-CDM/PDS	• Required
MS11 Boarding Starts	• To check if boarding has started as expected.	• Actual start for Boarding of passengers	• ASBT	• Re-calculate: - • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, TSAT, TTOT	• AODB/RMS • Manual input in A-CDM Portal	• Optional
MS12 Aircraft Ready	• Post analysis to measure aircraft readiness against the TOBT • Automate removal of TOBT and TSAT based if rules are not followed based on local procedures	• The call from the pilot to ATC to report ready within "X3" minutes of TOBT Note: The value of "X3" is based on local procedures. "X3" is highly recommended to be +/5 minutes	• Actual Ready Time (ARDT)	• Re-calculate: - • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, ARDT, TSAT, TTOT	Manual input in • Electronic Flight Strip System • A-CDM portal/HMI	• Optional
MS13 Start Up Request	• To measure pilot's adherence to TSAT. • Automate removal of TOBT and TSAT based if rules are not followed based on local procedures	• The call from the pilot to ATC to request pushback/start-up clearance within "X4" minutes of TSAT. Note: The value of "X4" is based on local procedures. "X4" is highly recommended to be +/5 minutes	• Actual Start-up Request Time (ASRT)	• Re-calculate: - • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, ARDT, ASRT, TSAT, TTOT	Manual input in • Electronic Flight Strip System • A-CDM portal/HMI	• Optional

Milestone	Purpose of the Milestone	Milestone is triggered by	Data Elements	A-CDM Actions	Example of system(s) that typically has this data (and should share it)	Required/ Optional
MS14 Start Up Approved	• To measure ATC's adherence to TSAT • Automate removal of TOBT and TSAT based if rules are not followed based on local procedures	• The call from ATC to pilot to give clearance for push and start clearance within "X5" minutes of TSAT. Note: The value of "X5" is based on local procedures. "X5" is highly recommended to be +/5 minutes	• Actual Start-up Approve Time (ASAT)	• Re-calculate: - • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, TOBT, ARDT, ASRT, TSAT, ASAT, TTOT	Manual input in • Electronic Flight Strip System • A-CDM portal/HMI	• Optional
MS15 Off Block	• To check if the aircraft has gone off blocks as per TSAT • Update Target Take-Off Time (TTOT) generated by DMAN/PDS if required	• Aircraft commence pushback	• Actual Off Block Time (AOBT)	• Re-calculate: TTOT • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, AOBT, TTOT	• A-SMGCS • Docking System • ACARS • Manual input	• Required
MS16 Take Off	• End of A-CDM process and relevant stakeholders are updated with the take-off information. • Flight is removed from the A-CDM process	• Aircraft lift-off the runway	• Actual Take-Off Time (ATOT)	• Re-calculate: - • Present/Disseminate: ALDT, AIBT, EOBT, SOBT, AOBT, ATOT	• A-SMGCS • ACARS	• Required

A-CDM Performance Indicators

7.38 In order to measure the performance of A-CDM, the post-implementation performance needs to be compared against the same performance indicators that were utilised before implementation.

7.39 Measurement of A-CDM performance is an iterative process and the feedback mechanism is an integral part of it.

7.40 Measurement of A-CDM performance can be better realized based on commonly agreed indicators.

7.41 Table 6 below provides examples of A-CDM performance indicators for reference.

Table 6 – Examples of A-CDM Performance Indicators

Strategic Performance Indicator	Performance Driver	Performance Indicator	Performance Measurement	Milestone Measurement	Stakeholders
1) Improve punctuality and reduce delays	Turnaround punctuality	Turnaround compliance	➢ (ARDT - AIBT) - MTTT > or = 5 minutes (%) ➢ (ARDT - AIBT) - (SOBT – SIBT) > or = 5 minutes (%) ➢ AOBT – ARDT > or = 5 minutes (%)		Aircraft Operator Airport
	Arrival punctuality	In Block Time accuracy	➢ ALDT – ELDT (minutes) ➢ ALDT - ELDT > or = 5 minutes (%) ➢ AIBT - SIBT > or = 15 minutes (%) ➢ AIBT – EIBT (minutes) ➢ AXIT – EXIT (minutes) ➢ # of missed approaches, go arounds per day per RWY (Include explicit times for the missed approaches for each runway)	@ Milestones 3, 4 and 5 @ Milestones 3, 4 and 5 @ Milestones 3, 4, 5 and 6 @ Milestones 3, 4, 5 and 6	Aircraft Operator Airport
	Departure punctuality	➢ Off Block accuracy (lag) ➢ Reduce departure delays	➢ AOBT - SOBT > or = 15 minutes (%) ➢ ATOT - TTOT > or = 5 minutes (%) ➢ Measure delay @ AOBT-SOBT (minutes) ➢ AXOT - EXOT (minutes)	@ Milestones 4,5,6,7,9,10,12, 13,14,15 @ Milestones 4,5,6,7,9,10,12, 13,14,15	Aircraft Operator Airport ATFM

Strategic Performance Indicator	Performance Driver	Performance Indicator	Performance Measurement	Milestone Measurement	Stakeholders
	Reduce taxi out delay in minutes	➢ Average taxi out time in minutes across a 12 month period ➢ Taxi-out time against benefit baseline (lead) ➢ Taxi-out time accuracy (lag)	➢ Taxi-out delay (minutes) to benefit baseline (minutes and fuel) ➢ Average (ATOT – AOBT) – benefit baseline (minutes) ➢ Taxi Out Time delay converted to fuel consumption on a flight by flight basis based on # engines and engine type	@ Milestone 15	ATC Aircraft Operator Airport
2) Optimise Airport Infrastructure	Improvement in the gate/bay/stand Utilisation % Time	Overall gate/bay/stand actual occupation time	➢ Compare the overall actual gate/bay/stand occupation time with scheduled gate/bay/stand occupation time (minutes deviation) per flight ➢ Measure ARDT - AIBT per gate/bay/stand per flight by aircraft type	N/A	Airport Aircraft Operators
	Improvement in the gate/bay/stand Utilisation % Usage	➢ Gate/bay/stand usage ➢ Assess gate/bay/stand delay (lag)	➢ Measure # of turns (rotations) on each gate/bay/stand per day by Aircraft type ➢ AOBT - SOBT (minutes) ➢ AOBT - SOBT > or = 15 minutes (%) ➢ Average TSAT – TOBT > or = 15 minutes (%)	@ Milestones 9, 10, 12, 13, 14, 15	Airports
3) Gate /Bay / Stand Management	Reduce the number of late gate/bay/stand changes (e.g. 10 minutes before ALDT)	➢ Gate/bay/stand allocation and passenger gate/bay/stand freezing time (lag) ➢ Gate/bay/stand allocation accuracy (lag) ➢ Gate/bay/stand/bay conflicts (lag)	➢ # of late gate/bay/stand changes within [(ALDT- 10 min) to ALDT] ➢ Number of gate/bay/stand changes after landing [ALDT to AIBT] ➢ # of bay conflicts per day	@ Milestones 4, 5, 6, 7	Airports

Strategic Performance Indicator	Performance Driver	Performance Indicator	Performance Measurement	Milestone Measurement	Stakeholders
4) Strategic Slot Management	Increase the # of flights that meet strategic slot compliance	Airport strategic slot adherence	➢ AIBT - SIBT -/+ 30 minutes (%) ➢ AOBT- SOBT -/+ 30 minutes (%)	N/A	Aircraft Operators Airports
5) Reduce emissions	Reduce emission from engines on ground	Emission from engines on ground (lead)	➢ Taxi-out delay (minutes) to benefit baseline (minutes and Co2)	N/A	ATC Aircraft Operators Airports
6) Congestion	Reduce number of aircraft moving simultaneously on the manoeuvring area	➢ Number of aircraft queueing on sequence in high demand periods	➢ Queue length (ATOT-AOBT) over a 15 min period, per hour over a 24 hour period	N/A	ATC Aircraft Operators Airports
7) ATFM Slot adherence	Increase ATFM slot adherence	Number of aircraft compliant with ATFM slot (CTOT)	➢ ATOT – CTOT	@ Miletone16	

INTEROPERABILITY OF A-CDM WITH OTHER SYSTEMS

8.1 This section, referring to the ICAO Aviation System Block Upgrades (ASBU) framework, links the ASBU modules and elements related to Airport Collaborative Decision Making (A-CDM) and outline a project framework to integrate/interoperate A-CDM with other systems of Air Traffic Management (ATM) in accordance with the time frame of ASBU Block 1 modules and elements.

Interactions between A-CDM and Other Systems

8.2 In the global aviation network, each airport is a node serving other aviation entities to achieve the safe, secure and efficient interoperability of ATM systems as a whole. The ASBU framework underpins and realizes such principle with a systems engineering approach to set the target implementation time frames for sets of operational improvements, referred to as 'modules', including A-CDM, Air Traffic Flow Management (ATFM) and various enablers of ATM efficiency and effectiveness.

8.3 There are two Blocks of A-CDM incorporating four ASBU elements relevant to the scope of guidance in this document: ACDM-B0/1 – *Airport CDM Information Sharing (ACIS)*, ACDM-B0/2 – *Integration with ATM Network Function*, ACDM-B1/1 – *Airport Operations Plan (AOP)* and ACDM B1/2 – *Airport Operations Centre*. The Block 0 elements combine and reconcile efforts of aviation entities in-and-around an airport to achieve an effective and efficient turnaround process. As the upgrade from Block 0, Block 1 elements will pave the way towards a cross-border network of collaborative ATFM, the node-based decision making process at airports will be enhanced by sharing up-to-date relevant information and by taking into account the preferences, available resources and the requirements of the stakeholders at the airport.

8.4 To achieve the aims of Block 1 A-CDM elements, the implementation phase of Block 0 elements should be ideally interoperable-by-design so that A-CDM is not only a local system serving an airport but also a node with adequate capabilities and features for integration with domestic air traffic flow management and interoperability with other systems of the cross-border net-centric airspace.

8.5 To effectively formulate and develop the implementation phase of A-CDM, the following ASBU modules and elements as well as their interactions with A-CDM should be studied in depth and incorporated gradually, where relevant, into an A-CDM implementation:

(a) Air Traffic Flow Management (ATFM) under NOPS B0/1-5 and NOPS B1/1-10.

(b) System Wide Information Management (SWIM) over the Common aeRonautical Virtual Private Network (CRV) under SWIM-B2/1-5.

(c) Flight Information Exchange Model (FIXM) under FICE-B0/1 and B2/1-9.

8.6 Appendix 1 provides more information about the ASBU modules and elements interacting with A-CDM. Full details are available on the ICAO GANP Portal at https://www4.icao.int/ganpportal/ASBU.

Systems View of A-CDM and Other Systems

8.7 In the contemporary context of ATM systems, 'system' has moved beyond the equipment for Communications, Navigation, Surveillance and ATM (CNS/ATM) and 'interoperability' has moved beyond the computerisation interfaces documented by the Interface Control Document (ICD). In the most general sense, system means a configuration of parts joined together by a web of relationships e.g. a man-made system encompassing actors and machines as well as the interoperability between equipment and procedures. The systems engineering approach can be extended, beyond the formulation of high level requirements of ASBU modules and elements, deep down for the development and implementation of the ASBU elements selected by individual aviation entities concerned including airport authorities and air navigation services providers.

8.8 Being holistic in flavour, efforts of systems engineering can harmonise and entail outcomes of all specialties and actors to enable a successful system which achieves users' satisfaction. To address specific operational needs of A-CDM and ATFM at a region, sector or airport, systems engineering efforts would be needed to mix and match the adoption of evolving operational concepts and the acquisition of numerous emerging technologies such as Demand and Capacity Balancing (DCB), Linked Arrival Management and Departure Management (AMAN/DMAN), Flight and Flow Information for the Collaborative Environment (FF-ICE), AIXM, FIXM, CRV, SWIM, etc.

8.9 Before implementation of the selected solutions, systems engineering principles can be used to tackle domain-specific problems and evaluate trade-offs between innovations and risks. Harmonising with the global wheel of ASBU, systems engineering practice can be followed to orchestrate the complete development of various CNS/ATM systems by applying a set of life-cycle building blocks and aligning technologies to meet targets of ASBU.

8.10 Under the systems view, A-CDM can be implemented as a specific application of CDM in the airport environment and ATFM facilities are being developed in an ecosystem with a domestic and cross-border network of many advanced, legacy and aged systems that airports are physical nodes inside virtual ATFM nodes on the network. Appendix 2 provides use cases for interoperability of A-CDM with other systems, especially for ATFM.

Project Framework for Integration/Interoperation of A-CDM with ATFM Systems

8.11 In line with the timeframe of ICAO ASBU, the outcomes from Block-0 implementations of A-CDM and ATFM could be leveraged to ensure the interoperability of equipment, procedures and practices among the pioneering aviation authorities and administrations in the Asia Pacific Region. This will set the guidelines and successful templates for all aviation entities to join the roadmap.

8.12 A good practice for development and implementation of A-CDM initiatives should:

(a) Utilize ATFM measures e.g. CTOT from NOPS-B0 (ATFM) and various milestones from ACDM-B0 e.g. (list to be advised) to collectively improve the efficiency and effectiveness of air traffic services and airport operations;

(b) Contribute to regional and sub-regional efforts for the standardisation of flight and flow data as well as the development of Implementation Guidelines and Interface Control Documents for ASBU Block 1 Implementations;

(c) Collaborate among stakeholders on development aligning with A-CDM-B1 module's aim for integration of A-CDM with ATFM;

(d) Leverage the solid foundation established from ACDM-B0 and NOPS-B0 modules and take A-CDM into consideration when developing ATFM techniques and algorithms for network operations in multi-nodal and/or harmonised settings;

(e) Explore the performance improvement through the application of CRV and SWIM for regional FIXM Extension to pave the way for the acquisition of full data-driven ATFM and A-CDM facilities;

(f) Realise the potential of FIXM for richer content exchanges, as promulgated in ASBU FICE-B1 module, between automated systems of A-CDM and the ATFM network in the APAC region; and

(g) Establish the systems engineering plan that holistically covers conceptualisation, development, acquisition and implementation of the abovementioned ASBU Block 1 initiatives and trials to bring fruitful outcomes to aviation users of the systems.

8.13 Beyond the document-based interoperability of equipment interfaces, regional and/or sub-regional coordination should be made to develop model-based interfaces for computerisation between A-CDM, ATFM and ATC systems, with the following steps:

(a) Make agreements between the A-CDM and ATFM communities on the choice of '**Milestones**' for developing interoperable procedures between A-CDM and ATFM.

(b) Compromise the '**Compliance**' of flights meeting both A-CDM milestones and ATFM measures.

(c) Develop and materialise Concept of Operations (CONOPS) for Interoperability between A-CDM and ATFM processes.

(d) Identify data items and the 'Timeline' of their exchanges needed to realise the CONOPS and develop the common operating procedures for processing and utilizing the data items.

(e) Research and develop model-based '**Interfaces**' to enable the automation of data processing and information utilization.

(f) Develop and implement operational trial projects to verify and validate the interoperable elements and components.

(g) Articulate the outcomes of trial to develop reference models with reusable elements and components so as to minimise the redesign efforts of Members.

(h) Complete formal adoption of the reference models e.g. FIXM Extension into the ICAO documents.

8.14 Instead of a big bang implementation, the steps suggested above should be performed in an iterative manner, via forums and working groups among experts from members of APA-CDM/TF and ATFM/SG. The incremental approach has to bridge in-depth studies of integration/interoperation between A-CDM and ATFM as well as to foster close liaison for developing A-CDM and ATFM network operations in more collaborative manner.

CURRENT SITUATION

A-CDM Task Force Survey Outcome

Overview of Survey Results

9.1 The Survey Questionnaire was sent out to 39 States (including USA) and 2 SAR (Hong Kong, China and Macao, China). 15 APAC States/Administrations (Australia, Bhutan, China, Hong Kong China, Fiji, India, Japan, New Zealand, Pakistan, Philippines, Republic of Korea, Singapore, Thailand, USA and Viet Nam) responded to Survey Questionnaire.

9.2 The percentage of States/Administrations responding to survey questionnaire was 38.5%.

9.3 At the time of the survey the APAC Seamless ATM Plan, Version 2.0, September 2016, included the expectation that all high-density aerodromes (aerodromes with more than 100,000 aircraft movements per annum) should operate an A-CDM system serving the Major Traffic Flow (MTF) and busy city pairs.

9.4 Based on 2015 ICAO data, the 51 busiest Asia/Pacific aerodromes were (Page 41 of APAC Seamless ATM Plan, Rev. 2.0 refers, in alphabetical order):

1. Australia (Sydney, Melbourne, Brisbane);
2. China (Beijing, Shanghai Pudong and Hong Jiao, Guangzhou, Hong Kong, Xi'an, Shenzhen, Chengdu, Kunming, Hangzhou, Chongqing, Xiamen, Wuhan, Zhengzhou, Changsha, Nanjing, Qingdao, Urumqi, Dalian, Guiyang, Tianjin, Haikou, Sanya);
3. India (New Delhi, Mumbai, Chennai, Bangalore);
4. Indonesia (Jakarta, Surabaya, Bali, Makassar);
5. Japan (Haneda, Narita, Fukuoka, Osaka, Sapporo, Naha);
6. Malaysia (Kuala Lumpur);
7. New Zealand (Auckland);
8. Philippines (Manila);
9. Republic of Korea (Incheon, Jeju, Gimpo);
10. Singapore (Changi);
11. Thailand (Suvarnabhumi, Don Mueang);
12. United States (Honolulu); and
13. Viet Nam (Ho Chi Minh, Hanoi).

9.5 The percentage of States/Administrations responding to survey questionnaire, where A-CDM was recommended to be implemented, was about 85%.

9.6 With the high percentage in response rate of approximately 85%, the survey was considered to be finalized.

9.7 A summary of A-CDM survey is presented in **Table 7** that includes respondents, what airports are part of the current implementation scope and by what year.

Important Notes

9.8 Bhutan and Pakistan have no plans for A-CDM as it is deemed by the States that their airports will not implement A-CDM. Therefore, they are not considered as part of the survey results.

9.9 Philippines indicated implementation of extended ATFM but not how that specifically relates to what airport/airports. Due to ambiguous replies to the survey questions, these replies are not included as part of the survey results.

9.10 Survey replies from USA were not included in the report as those airports are outside APAC Region.

9.11 The legend for the **Table 7** is as follows:

- A Year value of "0" indicates that no data was provided by the respondent
- Green marked airports indicates that implementation is completed.
- Yellow marked Administrations/airport indicates they are not included in the Survey results in this version of the document.

Table 7: Summary of A-CDM Survey (Updated at APA-CDM/TF/4)

Administration	Airport	Year Implemented/Planned
Australia	**Brisbane**	2019
	Sydney	2020
	Perth	2020
	Melbourne	2020
Bhutan	**No info**	0
China	**Kunming Changshui**	2014
	Beijing Capital	2017
	Shanghai Hongqiao	2013
	Shanghai Pudong	2016
	Chengdu Shuangliu	2017
	Guangzhou Baiyun	2016
	Xi'an Xianyang	2017
	Shenzhen Baoan	2016
Hong Kong, China	**HKIA**	2017
Fiji	**Nadi**	2018
India	**Bengaluru**	2013
	Delhi	2013
	Mumbai	2015
	Kolkata	2018 (APA-CDM/TF/4)
	Chennai	2018 (APA-CDM/TF/4)
	Shamshabad	0
	Jaipur	2019 (APA-CDM/TF/4)
	Ahmedabad	2019 (APA-CDM/TF/4)
	Trivandrum	2019 (APA-CDM/TF/4)
	Guwahati	2019 (APA-CDM/TF/4)
Japan	**Chitose (Sapporo)**	2018
	Narita	2020
	Haneda	2020
Malaysia	**Kuala Lumpur**	2021 (APA-CDM/TF/4)
New Zealand	**Wellington**	2015
	Auckland	2016
	Christchurch	2019
Pakistan	**No info**	0
Philippines	**Manila**	2022 (APA-CDM/TF/4)
Singapore	**Changi**	2016

Administration	Airport	Year Implemented/Planned
ROK	**Incheon**	2017
	Gimpo	2020 (APA-CDM/TF/4)
	Gimhae	2020 (APA-CDM/TF/4)
	Jeju	2020 (APA-CDM/TF/4)
Thailand	**Suvarnabhumi**	2020 (APA-CDM/TF/4)
	Don Muang	2020 (APA-CDM/TF/4)
Vietnam	**Tan Son Nhat**	2020
	Noi Bai	2020
	Da Nang	2021

Notable Issues

9.12 The implementation of A-CDM in the APAC region is moving forward and already up to date 16 airports have implemented A-CDM according to response from the member states. According to the survey, 16 more will implement A-CDM by the end of 2021. However, some respondents have indicated very aggressive time plans in relation to where they are in the process. Their responses indicate some underestimation of the complexity and time actually needed to implement A-CDM.

9.13 The responses to the survey indicate some areas where further investigations might be needed, or where more clear guidance material and also training would be of help. These areas are:

- **Relationship between the A-CDM conceptual elements and milestones**. These are discrepancies in the responses indicating that the implementation of milestones and their purpose might not be fully understood.

- **How to measure the success of an A-CDM implementation.** All respondents indicated very clear objectives related to implementation A-CDM but at the same time not all have established how to measure that these objectives are achieved – this holds true for some of the airport that have already implemented A-CDM as well.

- **Getting all stakeholders engaged as well as managing an A-CDM project**.

PERFORMANCE IMPROVEMENT PLAN

10.1 A-CDM-related performance expectations at A-CDM program airports are illustrated in **Table 8** to map with APAC Seamless ANS Plan and Regional Framework for Collaborative ATFM expectations.

10.2 APAC States/Administrations should consider performance expectation dates provided in the **Table 8** while planning for implementation of A-CDM at their airports.

<table>
<tr><th colspan="7">Table 8 - A-CDM-related performance expectations mapped to relevant APAC Seamless ANS Plan and Regional Framework for Collaborative ATFM expectations</th></tr>
<tr><th>GANP</th><th colspan="2">Seamless ANS Plan, V 3.0, Nov. 2019</th><th colspan="2">Regional Framework for Collaborative ATFM</th><th colspan="2">APA-CDM Implementation Plan (proposed)</th></tr>
<tr><td>ASBU</td><td>Performance Expectation</td><td>Timeframe</td><td>Performance Expectation</td><td>Timeframe</td><td>Performance Expectation</td><td>Timeframe</td></tr>
<tr>
<td rowspan="4"><u>ACDM-B0/1</u>: Airport CDM Information Sharing (ACIS)

<u>Description</u>:
This element represents the first collaboration step among stakeholders involved in aerodrome operations. It consists in the definition of common specific milestones for flight events occurring during surface operations. The stakeholders involved have to, based on accurate operational data, achieve the agreed milestones.
<u>Maturity level:</u>
Ready for implementation

<u>ACDM-B0/2</u>: Integration with ATM Network Function
<u>Description</u>:
This element consists in feeding arrival information from the network into A-CDM and at the same time to coordinate specific departure milestones. The involved stakeholders have to, based on accurate operational data, achieve the agreed milestones.
<u>Maturity level:</u>
Ready for implementation</td>
<td rowspan="4">7.3 All international aerodromes should operate an A-CDM system for Airport CDM Information Sharing (ACIS) integrated with the ATM network function consistent with ACDM-B0/1 – 2 (Priority 1).</td>
<td rowspan="4">PARS Phase II (expected implementation by 07 November 2019)</td>
<td rowspan="3">7.17 ATFM, AMAN/DMAN and A-CDM systems should be integrated through the use of common fixes, terminology and communications protocols to ensure complementary operations.

FIXM version 3.0 or later, extended where necessary is the agreed format for exchange of ATFM information in the Asia/Pacific Region.</td>
<td rowspan="3">Phase 1B
25 May 2017</td>
<td>1. Local A-CDM procedures, supported by systems supporting the exchange of TOBT and TSAT between aircraft operators and the ATC Control Tower, should be implemented</td>
<td>Phase 1 – Local A-CDM

As soon as practicable, preferably before November 2020</td>
</tr>
<tr>
<td>2. All A-CDM Airports should establish variable taxi-times for all combinations of gate or apron and runway holding points</td>
<td>As soon as practicable, preferably before November 2020</td>
</tr>
<tr>
<td>3. Where implemented, pre-departure sequencing procedures and systems should be integrated with A-CDM.</td>
<td>As soon as practicable, preferably before November 2020</td>
</tr>
<tr>
<td>7.24 Tactical ATFM at ATFM Program Airports should be implemented using:

i. Ground Delay Programs (CTOT); or
ii. Minutes in trail (MINIT) or miles in trail (MIT) or other ATFM measures specified in ICAO Doc 9971 – Manual for Collaborative ATFM</td>
<td>Phase 1B,
25 May 2017</td>
<td>1. A-CDM and ATFM system should be integrated by:

a) ATFM systems taking TOBT and/or TTOT into account when determining CTOT (if applicable); and

b) A-CDM systems taking CTOT into account when determining TSAT;</td>
<td>Phase 2 Domestic Integration

Preferably before November 2022</td>
</tr>
</table>

Table 8 - A-CDM-related performance expectations mapped to relevant APAC Seamless ANS Plan and Regional Framework for Collaborative ATFM expectations						
GANP	**Seamless ANS Plan, V 3.0, Nov. 2019**		**Regional Framework for Collaborative ATFM**		**APA-CDM Implementation Plan (proposed)**	
ASBU	Performance Expectation	Timeframe	Performance Expectation	Timeframe	Performance Expectation	Timeframe
			7.25 All States should ensure that local ATC procedures and, where available, CDM processes facilitating compliance with received CTOT are implemented. *Note 1: At controlled aerodromes, CTOT compliance should be facilitated through the cooperation of the aircraft operator and the issuance of ATC clearances. As a minimum, CTOT should be made available to the relevant ATC tower and the aircraft operator;* *Note 2: For flights departing aerodromes where an ATC service is not provided, CTOT information should be made available to the aircraft operator and the first ATS unit providing services to the flight.* *Note 3: States planning to implement ground delay programs should ensure adequate time is provided for local procedure development and promulgation at aerodromes where CTOT will be applied.*		-	
			7.26 CTOT for individual aircraft should, where necessary, be revised, cancelled, suspended or de-suspended.	Phase 1B 25 May 2017	4. TSAT issued for individual aircraft should, where necessary, be revised.	**Phase 1 – Local A-CDM** ***Preferably before November 2020***

Table 8 - A-CDM-related performance expectations mapped to relevant APAC Seamless ANS Plan and Regional Framework for Collaborative ATFM expectations						
GANP	**Seamless ANS Plan, V 3.0, Nov. 2019**		**Regional Framework for Collaborative ATFM**		**APA-CDM Implementation Plan (proposed)**	
ASBU	Performance Expectation	Timeframe	Performance Expectation	Timeframe	Performance Expectation	Timeframe
			Distributed multi-nodal ATFM information distribution capability utilizing FIXM version 3.0 (or later) should be implemented, including: i. Sharing of ADP and dynamically updated demand and capacity data for all ATFM program airports, and for en-route airspace supporting the busiest city pairs and high density major traffic flows; ii. Slot allocation information for all flights subject to ATFM programs, including as a minimum CTOT, CTO and CLDT information; iii. Authorized user functions for slot amendment, cancellation or suspension (ATFMU), and slot-swapping (aircraft operator and ATFMU); and iv. Automated slot compliance monitoring and reporting, supplemented where necessary by authorized inputs by ATFMU, ATSU or airspace operator.	Phase 2, 8 November 2018	**N/A**	
			Full interoperability of cross border ATFM, A-CDM, AMAN, DMAN, ATM automation and airspace user systems should be implemented, utilizing FIXM 3.0 (or later), to provide seamless gate-to-gate collaborative ATFM operations.	Phase 2, 8 November 2018	Exchange A-CDM information with Cross Border ATFM for seamless gate-to-gate collaborative ATFM operations	**Phase 3 – Cross-boundary network ATFM integration.** ***Preferably before November 2025***

Table 8 - A-CDM-related performance expectations mapped to relevant APAC Seamless ANS Plan and Regional Framework for Collaborative ATFM expectations

GANP	**Seamless ANS Plan, V 3.0, Nov. 2019**		**Regional Framework for Collaborative ATFM**		**APA-CDM Implementation Plan (proposed)**	
ASBU	Performance Expectation	Timeframe	Performance Expectation	Timeframe	Performance Expectation	Timeframe
			7.36 Ground Delay Programs utilizing CTOT should be applied to: i. aircraft destined for constrained ATFM Program Airports, that have not yet departed; and ii. aircraft planned to operate through constrained airspace where tactical ATFM measure CTO at RFIX or AFIX is in place, that have not yet departed.	Phase 2, 8 November 2018	**N/A.**	
ACDM-B1/1: Airport Operations Plan (AOP):	7.18 All international aerodromes should operate an A-CDM system integrated with the ATM network, and an AOP and where practicable an APOC consistent with ACDM-B1/1 – 2.	Seamless PARS Phase III (expected implementation by 03 November 2022)	-	-	Develop and implement collaborative Airport Operations Plan (AOP)	***Preferably before November 2023***
ACDM-B1/2: Airport Operations Centre (APOC)	7.18 All international aerodromes should operate an A-CDM system integrated with the ATM network, and an AOP and where practicable an APOC consistent with ACDM-B1/1 – 2.	Seamless PARS Phase III (expected implementation by 03 November 2022)			-	-

RESEARCH AND FUTURE DEVELOPMENT

The Evolution of A-CDM

11.1 A-CDM has its roots in Europe and is the foundation for many European SESAR concepts for use of better data and technology to make aircraft and airport operations more efficient. Wider potential for success lies in integrating the networks. Connectivity and data sharing amongst a constellation of A-CDM airports will ultimately deliver optimal performance. The wider benefits of A-CDM should be considered in addition to local enhancements.

11.2 The evolution of A-CDM, and the manner in which the implementation process is introduced throughout the world, should be given due consideration. The most replicated model of A-CDM is the European version, interfacing with EUROCONTROL. However, not all regions have such a centric ATM network, so the processes may be different in other regions. To assist in making the implementation of A-CDM more successful, it is recommended that a regional ATFM environment be established e.g. via a distributed multi-nodal ATFM network, which would enable a certain degree of harmonization and provide consistency for stakeholders.

11.3 One of the most important aspects of A-CDM from a global perspective is the architecture that interfaces airports with a central airspace management system. A model for exchanging information between A-CDM and ATFM should be kept in mind during A-CDM implementations.

11.4 The industry is seeing other facets of airspace management using A-CDM concepts to provide the required data to fulfil continuity between major traffic flows, and high density aerodromes. This will create other hybrid type A-CDM processes that are best suited for regional requirements. One such concept that has been developed in Southeast Asia is known as the Distributed Multi-Nodal ATFM Network. Some regional requirements like data exchange amongst different ATFM applications may require appropriate system design and adaptation, but the primary purpose remains to mitigate airborne flow constraints that contribute to overflow in ATC sector capacities, which result in unanticipated en-route delays.

11.5 As air traffic management evolves, and additional concepts are introduced by the industry, changes and adjustments to A-CDM may be required. This will most certainly contribute to the complexities of data exchange. However, the industry must not lose sight of harmonizing A-CDM.

A-CDM and ATFM in Asia/Pacific Region

Distributed Multi-Nodal ATFM and A-CDM

11.6 The third Meeting of the APANPIRG ATM Sub-Group (ATM/SG/3), held in Bangkok Thailand from 3 – 7 August 2015, endorsed *Asia/Pacific Framework for Collaborative Air Traffic Flow Management (The Framework)* and its companion document – *Asia/Pacific Regional Air Traffic Flow Management Concept of Operations (CONOPS)*. Both documents, aligned with *Doc 9971 Manual on Collaborative Air Traffic Flow Management (ATFM)*, provide guidance and a common regional framework for regional ATFM development and harmonization.

11.7 The core concept of *The Framework* is the Distributed Multi-Nodal ATFM Network, envisaging the regional cross-border ATFM as interconnected States and/or sub-regional groups operating in an interoperable, multi-FIRs, multi-States, cross-border collaborative ATFM network, using common information, terminology and communication protocols for information exchange and sharing.

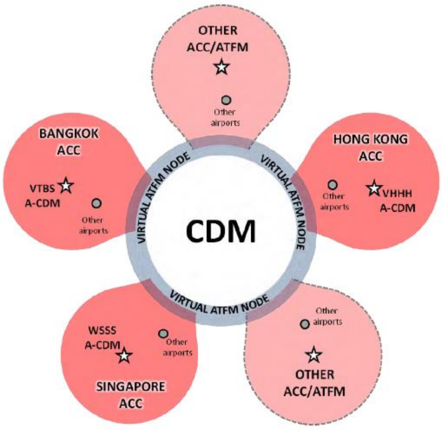

Figure 3 - Concept of A-CDM within a multi-nodal ATFN network

11.8 FIXM 3.0 (or later) was adopted as the agreed ATFM information exchange model. A minimum set of ATFM information was identified to be added into the FIXM Extension for ATFM information distribution and sharing in the region.

11.9 Based on *the Framework*, each State will develop ATFM capability according to its needs and requirements, and the overarching goal of seamless ATM across the Asia/Pacific Region. Under the concept of the Multi-Nodal ATFM Network, each State/Administration will form a node of the multi-nodal network, and should be led by an agreed ANSP as the "Node Leader".

11.10 Within an ATFM node, there may be a number of airport operators with access to the Node arranged by the Node Leader, facilitating their participation in the cross-border ATFM initiatives, while the Node Leader should ensure the Node is ready and able to participate in the Regional Cross Border ATFM process.

11.11 The A-CDM allows the exchange of information for inbound and outbound flights and links the local A-CDM process to ATFM services, strengthening the link between the airport and ATFM services. The ATFM will be benefited from the A-CDM information regarding the flights' departure while the A-CDM system will also be benefited from the information of the arriving flights from the ATFM system. The information exchange between A-CDM and ATFM will further improve the predictability.

11.12 In line with *the Framework*, the A-CDM development, implementation and integration with ATFM/ATM within a Node should be coordinated between the airport authorities and the Node Leader.

11.13 The adoption of the communication protocols for A-CDM information exchange depends on the scope of the communication, the agreed communication protocols stipulated in *the Framework* should be adopted if the communication is for cross-border, while any protocols considered appropriate by the stakeholders within a Node of the Multi-Nodal ATFM Network could be adopted if the communication is within a Node. The Aviation Information Data Exchange (AIDX), for example, is the most commonly used information exchange format for A-CDM application in some regions, and could be one of the optional formats for the information exchange between A-CDM and the Node in the Asia/Pacific region.

11.14 The A-CDM development in parallel with the ATFM development in the region required the identification of the minimum set of A-CDM data attributes for local A-CDM implementation, as well as the data attributes necessary for the integration between A-CDM and ATFM.

The Multi-Nodal ATFM Operational Trial Project

11.15 The Multi-Nodal ATFM Operational Trial Project was evolved from a Tripartite CDM project by Hong Kong China, Singapore and Thailand in 2012. Up to now, there are 11 States/Administrations participated in the Project.

11.16 The Project was planned to be executed in 3 Phases. In Phase I, which was completed in 2016, the Project focused on the airport capacity and demand balancing by using the Ground Delay Program (GDP) as the ATFM measure. In Phase II, which has been started in late 2017, the airspace capacity and demand balancing has been taken into consideration. The Project expected to be integrated into the global ATFM network in its Phase III.

North Asia Regional ATFM Harmonization Group (NARAHG)

11.17 The Northeast Asia Regional ATFM Harmonization Group (NARAHG) was jointly established by China, Japan and the Republic of Korea in 2014. In 2015, the NARAHG launched a Project to develop the Cross Region ATFM Collaborative Platform (CRACP).

11.18 The CRACP is one of the solutions for ATFM information exchange in cross-border ATFM networks. A desktop computer with CRACP application software forms a CRACP Terminal, which is installed in end-user's ATFM unit and is networked through Internet as in Stage 1 of the Project. The information exchanged between CRACP Terminals covers those required by ATFM/CDM process in the ATFM phases of pre-tactical, tactical and Post Operation Analysis.

11.19 The A-CDM systems, developed by China, Japan and ROK, respectively, have no connection with the CRACP at the moment.

FIXM version 4.1 Extension Data Attributes

11.20 FIXM version 4.1 was released in December 2017 and the validation of FIXM version 4.1 Extension was completed in April 2018.

11.21 Based on the operational scenarios developed for the SWIM in ASEAN Demonstration, additional data attributes required to be exchanged among stakeholders involving in A-CDM operation and to support the integration between ATFM and A-CDM were identified. Considering that these data attributes are flight-specific, FIXM would be the appropriate information exchange model to support the aforementioned operations. Consequently, the FIXM version 4.1 Extension was further developed to include these data attributes.

11.22 **Table 9** shows the list of data attributes currently included in the FIXM version 4.1 Extension developed.

Table 9: FIXM version 4.1 Extension Data Attributes

Estimated	Calculated	Target	Actual
		TOBT	AOBT
		TSAT	
	CTOT	TTOT	
ETO	CTO		ATO
ELDT	CLDT		

Other	
Trajectory	**Aircraft Track**
• ETO • CTO • ATO • Flight level or Altitude • Waypoint	• Ground speed • Bearing • Flight level or Altitude • Position (Designator or Latitude/Longitude or Relative Point) • Time over position

11.23 A system-to-system interconnection test between Singapore and Thailand to validate the exchange of developed FIXM version 4.1 Extension was successfully conducted in March/April 2019 using the Flight Information Update use case, involving the distribution of ATFM and A-CDM related data attributes, designed based on the AMQP (Advanced Message Queuing Protocol) messaging protocol.

Participation of MET organisations in CDM

Asia/Pacific Regional Guidance for Tailored Meteorological Information and Services to support Air Traffic Management Operations

11.24 An ad-hoc group under ICAO APAC Meteorological Requirements Task Force (MET/R TF) developed the *Asia/Pacific Regional Guidance for Tailored Meteorological Information and Services to support Air Traffic Management Operations*. This guidance document, approved by APANPIRG/29, is available on the ICAO Asia/Pacific Regional Office eDocuments web-page at:

https://www.icao.int/APAC/Pages/eDocs.aspx

11.25 This guidance aims to foster States' implementation and enhancement of meteorological (MET) information and services for air traffic management within the Asia/Pacific region and captures most of the necessary processes from preparatory to operational phases.

Participation of MET organisations in CDM

11.26 MET CDM is a process involving the development within aeronautical meteorological services of an understanding of the effects of weather on ATM to support an accurate prediction of arrival/departure rates and en-route airspace capacity and configuration. The expected role of a MET organization in CDM is to provide necessary meteorological information at and around relevant aerodromes and air routes, and within relevant airspace, in a timely manner. Rapid identification of the possible cause of adverse weather conditions affecting ATM operations, and airport or airspace capacity, allows both ATM and MET organizations to take immediate action in a collaborative manner to mitigate the impact.

11.27 Future development of A-CDM should include development of the capability for MET organizations to actively participate in A-CDM processes, including the collaborative information exchange processes to support timely and relevant MET information supporting A-CDM.

APPENDICES

Appendix 1 – Relationships between A-CDM and ASBU Modules

Introduction

1. This appendix supplements the technical description of "Interoperability of A-CDM with Other Systems" to facilitate the formulation and development of the Implementation Phase of A-CDM and provides links to full details of Aviation System Block Upgrades (ASBU) elements in the ICAO document "Aviation System Block Upgrades – The Framework for Global Harmonization".

A-CDM in the Global Aviation Network

2. In the global aviation network, each airport is a node serving other aviation entities to achieve the safe, secure and efficient interoperability of Air Traffic Management (ATM) systems as a whole. The ASBU framework underpins and realizes such principle with a systems engineering approach to set the target implementation time frames for sets of operational improvements including Airport Collaborative Decision Making (A-CDM), Air Traffic Flow Management (ATFM), and various enablers of ATM efficiency and effectiveness.

3. The ASBU elements in ACDM, combines and reconciles efforts of aviation entities in-and-around an airport to achieve an effective and efficient turnaround process. This process involves stakeholders, operational services, data points and algorithms that are instrumental to successful turnaround of an air aircraft. The performance of participating flights is usually measured by their compliance with the 'milestones' - the progress of a flight from the initial planning to the take off. The prime aim is to get the aircraft airborne as quick as reasonably practicable.

4. As the upgrade will pave the way towards a cross-border network of collaborative ATFM that the node-based decision making process at the airport will be enhanced by sharing up-to-date relevant information and by taking into account the preferences, available resources and the requirements of the stakeholders at the airport. With this advancement in interoperability, the collaborative Airport Operations Planning (AOP) and Airport Operations Centre (APOC) will enhance the planning and management of the Airport operation and allow full integration with ATM.

A-CDM with Air Traffic Flow Management

5. According to the ICAO Standards and Recommended Practices (SARPs) Annex 11 Chapter 1: "ATFM has the objective of ATFM contributing to a safe, orderly and expeditious flow of air traffic by ensuring the air traffic control capacity is utilized to the maximum extent possible, and that the traffic volume is compatible with the capacities declared by the appropriate Air Traffic Services authority."

6. Building up from ASBU NOPS elements, ATFM is used to manage the flow of traffic in a way that minimizes delays and maximizes the use of the entire airspace. Collaborative ATFM can regulate traffic flows involving departure slots, smooth flows and manage rates of entry into airspace along traffic axes, manage arrival time at waypoints or flight information region (FIR)/sector boundaries and re-route traffic to avoid saturated areas.

7. With the improvements under ASBU NOPS elements, ATFM can be integrated with airspace organization and management (AOM) to accommodate the use of free routings. The ATFM algorithms and techniques can be enhanced to:

(a) regulate traffic flows involving departure slots, smooth flows and

(b) manage rates of entry into airspace along traffic axes,
(c) manage arrival time at waypoints, flight information region or sector boundaries,
(d) reroute traffic to avoid saturated areas, and
(e) address system disruptions including crisis caused by human or natural phenomena.

8. According to the ICAO Manual on Collaborative Air Traffic Flow Management (Doc 9971), it is a general rule that "ATFM is needed whenever airspace users are faced with constraints on their operations, and in areas where traffic flows are significant".

9. However, as limited by the current capabilities of most ATFM facilities, the ATFM process is commonly applied to regulating traffic flows (or balancing demand of airspace users) by means of ground delay program, level capping, airspace flow program, minimum departure, miles in trial, minutes in trial, etc. Some of these ATFM measures may counteract the benefits of the A-CDM turnaround process. In the worst case, passengers are delayed inside fuselage the aircraft has been off-block to taxiway or is airborne amid 'flow control'.

10. In a nut shell, when delays of flight operations cannot be avoided, collaborative decisions must be made orderly and timely to balance the impacts on airports and airspaces for the sake of all aviation entities and stakeholders in an open and fair manner.

A-CDM with System Wide Information Management

11. The ASBU SWIM elements will create the aviation intranet to enable node-based A-CDM sharing up-to-date relevant information with other aviation entities including domestic, cross-border and regional AFTM units so that the preferences, available resources and the requirements of the stakeholders at the airport can be taken into account with a process of collaborative decision-making (CDM) by all parties concerned. The implementation of system-wide information management (SWIM) services provides the infrastructure and essential applications based on standard data models and internet-based protocols to maximize interoperability when interfacing systems for A-CDM, ATFM and other ATM functions.

12. The goal of SWIM is to realize a global network of ATM nodes, including the aircraft, providing or using information. Aircraft operators with operational control centre facilities will share information while the individual user will be able to do the same using other applications. The support provided by the ATM network will in all cases be tailored to the needs of the user concerned, e.g. A-CDM and ATFM.

13. In the Asia Pacific Regions, the current implementation of the Common aeRonautical Virtual Private Network (CRV) enables a cross-border, high-speed and secured communication network, which serves as a key enabler for implementation of a number of seamless ATM initiatives. The implementation and operation of CRV network is overseen by the ICAO CRV Operations Group (CRV/OG), while several civil aviation authorities are working on the data implementation and SWIM over CRV.

A-CDM with Cross-Exchange of Structured Information

14. Relevant ASBU element(s) addresses the need for information integration and supports a new concept of ATM information exchange fostering access via the SWIM services. This includes the cross-exchange of common elements with the initial introduction of the ATM Information Reference Model (AIRM), which integrates and consolidates ATM information in a transversal way. Key exchange models include:

(a) Flight Information Exchange Model (FIXM) for flight and flow information and aircraft performance-related data,

(b) ICAO Meteorological Information Exchange Model (IWXXM) for information related to weather, and

(c) Aeronautical Information Exchange Model (AIXM) for digital format of the aeronautical information that is in the scope of Aeronautical Information Services (AIS) in accordance with the ICAO SARPs Annex 15.

15. The data interoperability between A-CDM and ATFM can be assured by the use of FIXM found on the concept of flight object and the widely adopted eXtensible Markup Language (XML). This common model of structured information for flight object will effectively enable ground-ground exchanges before departure, under relevant ASBU element(s), such as FICE.

16. Coordination with SWIM and ATFM are being made for inclusion of A-CDM attributes in the FIXM Extensions tailored for airports in the Asia Pacific Region.

A-CDM under Network-centric Collaborative Decision-Making

17. Merging the synchronized outcomes from a range of ASBU elements, SWIM would be required to support the implementation of collaborative decision-making (CDM).

18. By SWIM-enabled applications of CDM for more complex situations, ATM will be able to offer/delegate to the users the optimization of solutions to flow problems. It will let the user community take care of competition and their own priorities in situation when the network or its nodes (airports, sector) does no longer provide actual capacity commensurate with the satisfaction of the schedules.

Appendix 2 – Use Cases for Interoperability of A-CDM with Other Systems

Introduction

1. This appendix provides use cases to highlight ways that A-CDM can be implemented as a local system serving an airport as well as a node with adequate interfacing capabilities for integration and interoperation with air traffic flow management (ATFM) and other systems of the cross-border net-centric airspace.

2. In the context of System Wide Information Management (SWIM), "interoperability" means the ability of information and communication technology (ICT) systems and of the business processes they support to exchange data and to enable the sharing of information and knowledge. The interoperability of A-CDM can range from close integration of specialized computer systems in-and-around an airport implementation and loose coupling of service-based automation systems in a regional net-centric airspace.

3. To achieve effective and efficient sharing of information, a user interface is needed to allow quick and easy viewing and input of information taking into consideration heavy airport and air traffic control (ATC) workload scenarios.

4. To facilitate automated interactions, a system interface is needed to demark a shared boundary across which two or more of these different systems and their software applications to communicate, exchange data, and use the information that has been exchanged.

5. The interfacing capability of an A-CDM implementation can be categorized by the following use cases and options according to their degree of integration and spectrum of interoperability.

Use Case 1 - Interfaces of Standalone A-CDM Platform

6. In an operation without A-CDM, information about key airside processes is typically sourced from multiple different systems leading to gaps and inefficiencies. With A-CDM, a common platform collates data from the airport and ATC systems and presents it to operational stakeholders in a format that helps them make more informed decisions.

7. In general, an A-CDM web portal can be used as a specially designed website that brings information from diverse sources in a uniform way so that stakeholders will access information about the key airside processes through the web portal. It is then incumbent on the stakeholders themselves to update their plans, resourcing decisions and working practices to make best use of the information and optimize performance accordingly.

8. The web portal essentially facilitates a common milestone process that corresponds to significant events across each of the airside processes to enable and ensure a level of consistency across the airport and its airside entities that are adopting an A-CDM information sharing function. The successful completion of each milestone triggers operational decisions for stakeholders concerned with future events in the process.

9. In addition to the web portal as user interface, an A-CDM platform may offer application programming interface (API) for other systems to automatically receive and send A-CDM information. These system interfaces may have an inter-system messaging capability based on proprietary communications protocols or various de facto engineering standards.

10. Through its system interfaces, an A-CDM platform can extract process-information about airport and flight operations. Then, the A-CDM algorithms can combine and evaluate the information collected. With both the user and system interfaces, the A-CDM will share the updated information and milestones (including pre-departure sequence and related estimated times) to optimize the flow of outbound traffic.

11. Options of interfacing automated systems for A-CDM may include:

(a) Dedicated data links may be used between the A-CDM platform and each of its partnering systems for conveying milestones and messaging on one-to-one basis.

(b) The A-CDM platform may be connected to the Aeronautical Fixed Telecommunication Network (AFTN) for sharing information with destination airports, air traffic control units, air traffic flow management units and the wider air transport network.

(c) A cloud-based solution may be used to enable economies of scale by providing a common platform to multiple airports as a single A-CDM implementation and link the A-CDM implementation to other systems with a great range of interoperability allowing access by service-oriented APIs, web service, and the like based on open standards and industry good practices.

12. The deployment of a standalone A-CDM platform can reduce the exposure of existing critical systems like the Airport Operations Database (AODB) and Flight Data Processing System (FDPS) to the risks of corruption when introducing the new A-CDM. Moreover, existing systems can continue to follow their specific roadmaps for upgrade or replacement with minimum dependencies on the evolving A-CDM functions.

13. However, the lack of network-wide interoperability cannot automatically validate information in multiple disparate systems, while manual cross-checks are required to identify and resolve discrepancies on each system concerned. With more systems interacting with a standalone A-CDM implementation, the risks of errors and delays in the net-centric CDM process will be increased.

<u>Use Case 2 - Net-centric Interfaces of A-CDM</u>

14. Under the initiatives of Aviation System Block Upgrades (ASBU), SWIM suggests the use of service-oriented architecture (SOA) to realize the concept of information-centric and net-centric air traffic management (ATM) operations. As one of the prime objectives of net-centric CDM, airport integration with ATFM Unit shares more precise and detailed information about airside processes and an optimized departure sequence by taking into account both aerodrome and airspace slots as well as other prevailing operational circumstances such as weather changes and military aviation activities.

15. Several options for network connectivity and system interoperability are available for interfacing A-CDM via ATFM into the global aviation network.

16. An A-CDM platform may connect to an ATFM Unit via a dedicated AFTN connection, but the interoperability between A-CDM and ATFM is constrained by the text-based communications characteristics of AFTN.

17. An A-CDM platform may connect to an ATFM Unit via a peer-to-peer data link that can support internet protocol based (IP-based) communications according to the interface control document (ICD) agreed between the A-CDM platform and the ATFM Unit. The ATFM Unit will act a broker or agency to optimize the flow of air traffic in and out the airports, which participate in the A-CDM platform. The interface between A-CDM and ATFM may use communication protocols, which

are different from that of the global aviation network, so the ATFM Unit has to provide data conversion as well as align interactions between network actors.

18. The Unified Modeling Language (UML), as a developmental modeling language, can be used to provide a standard way for visualizing the design of system interfaces for SWIM-enabled applications as well as showing the structure of the data to be exchanged.

19. The use of Flight Information eXchange Model (FIXM), which is a UML model, will ensure both syntactic interoperability and semantic interoperability.

20. For specifying data formats and communication protocols, eXtensible Markup Language (XML) or Structured Query Language (SQL) standards are among the tools of syntactic interoperability. These tools are also useful for lower-level data formats, such as ensuring alphabetical characters are stored in a same variation of ASCII or a Unicode format (for English or international text) in all the communicating systems including ATS Messaging System (AMHS).

21. Beyond the ability of two or more computer systems to exchange information, semantic interoperability is the ability to automatically interpret the information exchanged meaningfully and accurately in order to produce useful outcomes as defined by the end users of both systems. To achieve semantic interoperability, both A-CDM and ATFM must refer to a common information exchange model, such as FIXM. Based on unambiguously defined content in all information exchange requests, what is sent from donor/owner is the same as what is understood at the requester/receptor.

22. Other open standards are expected to be applied at all levels of the SWIM framework, which include the World Wide Web Consortium (W3C) specifications (World Wide Web Consortium (W3C), 2013) and the standards for network layer exchange.

23. An A-CDM platform may connect to an ATFM Unit based on the implementation specifications of SWIM which may be defined on a local, sub-regional, regional and/or global scale conforming to open standards. The A-CDM milestones, together with process information for improving the milestones and related estimated times, are exchanged via the SWIM infrastructure based on information management standards. The seamless interoperable data exchange and services will benefit the global aviation network as a whole.

Use Case 3 - A-CDM Interfaces for Cross-border ATFM

24. In practice, an A-CDM implementation should establish a roadmap for maintaining and improving its interfacing capability based on the most cost-effective solutions at the time to serve its users and stakeholders. A system-view approach with reference to the above options and the ICAO ASBU roadmap could be a reasonable choice.

25. Under the systems view, A-CDM can be implemented as a specific application of CDM in the airport environment and ATFM facilities are being developed in an ecosystem with a cross-border network of many advanced, legacy and aged systems that airports are physical nodes inside virtual ATFM nodes on the network. An example of multi-nodal ATFM network, as illustrated in Figure A2-1, is being developed for the Southeast Asian sub-region and its adjacent Flight Information Regions (FIRs).

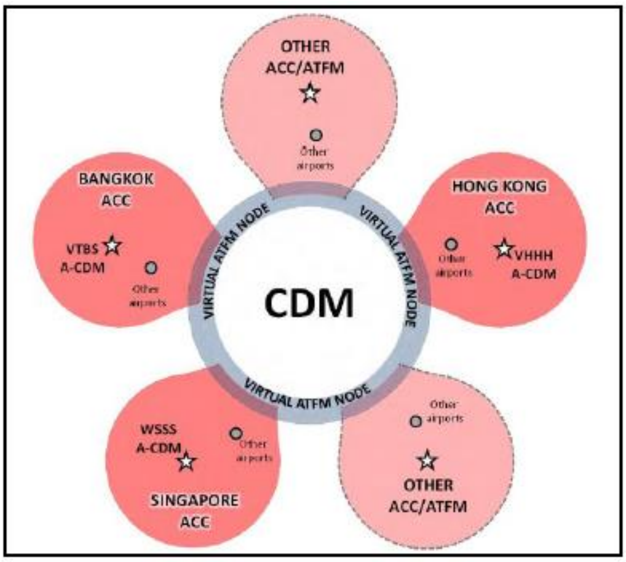

Figure A2-1 - Concept of A-CDM within a multi-nodal ATFM network

26. A mature ATFM network should provide a platform for airport operators and air traffic management units to collaboratively apply the most effective and efficient ATFM measures with considerations of the A-CDM milestones in a timely manner. One example would be the use of Calculated Take-Off Time (CTOT) from BO-NOPS (ATFM) and various milestones from B0-ACDM e.g. Target Off-Block Time (TOBT) and Target Start-up Approval Time (TSAT).

27. Targeting a common goal through the systems view, the systems engineering (an interdisciplinary field of engineering and engineering management) should be applied to holistically tackle both technical and operational complexities of A-CDM, in particular when A-CDM being involved in cross-border ATFM. Data exchange schemes in compliance with FIXM and SWIM would be part of the practical solutions. Service orientation is a means for integration across diverse systems. Ultimately, the silo effect caused by islands of A-CDM and ATFM systems can be eliminated.

28. System-wide predictability and situation awareness of air traffic will be the fruit results from interoperable A-CDM and ATFM based on common data models, i.e. FIXM. In long run, the continuous improvement of predictability based on the concepts and tools of data analytics will not only be useful for planning, strategic and pre-tactical phases of AFTM but also help accurate decision making for operations related to A-CDM and the tactical phase of ATFM. The roles and interactions for integrated A-CDM and ATFM is summarized in **Table A2-1**.

Table A2-1: A-CDM roles within the ATFM Operational Phases

	Planning	Strategic	Pre-Tactical	Tactical	Post-Ops
Time Frame	Continual	< 6 months > 1 day	1 day prior	Day of operations	Day After
ATFM Role	Strategic ATFM planning	Strategic DCB planning	AFTM Daily Coordination and Next Day Planning	Tactical ATFM	Post-Ops Analysis
ATC Role				Tactical ATC	
A-CDM Role			A-CDM Planning	A-CDM Operations	A-CDM Performance Analysis

29. With a view to delivering both the airport-based and network-based roles/functions, SWIM-compliant "enterprise services" can be applied to organizing distributed resources into an integrated solution that breaks down information silos and maximizes business agility. The service-oriented nature of SWIM modularizes ICT resources, creating the loosely coupled business processes of A-CDM and ATFM that integrate information across net-centric systems.

30. Being mutually dependent, a well-designed service-oriented architecture critically relies on the availability of business process solutions that are relatively free from the constraints of the underlying ICT infrastructure, because this enables the greater agility that businesses are seeking.

31. An SWIM-enabled application provides end users with more accurate and comprehensive information and insight into processes. It also offers the flexibility to access the service in the most suitable form and presentation factor, whether through the web browser or through a rich client. Dynamic applications are what enable businesses to improve and automate manual tasks, to realize a consistent view of customers and partner relations, and to orchestrate business processes that comply with internal mandates and external regulations.

32. Although SWIM is the external enabler entity of ATM and the benefits of SWIM arise from the end-user applications that make use of it and not SWIM itself, it can bring benefits by allowing end-user applications from the simple to the most complicated to make full use of the complete ATM data. For a simple start on local scale to interface an A-CDM platform with ATFM, existing infrastructures built on open standards can usually be reused without great changes, although some harmonization issues will need to be addressed.

33. To institute SWIM as "enterprise services", systems engineering can help an A-CDM implementation to design and manage complex systems over their life cycles. The systems engineering process begins by discovering the real problems that need to be resolved, and identifying the most probable or highest impact failures that can occur – systems engineering involves finding solutions to these problems across the interdisciplinary domains of ATM. The outcome of such efforts will be an engineered system for integrated A-CDM and ATFM with a combination of SWIM-enabled components that work in synergy to collectively perform the net-centric CDM.

Appendix 3 – Examples of A-CDM guides, AIP Supplement, AIC for notification of A-CDM operational trial / implementation

Note:- Examples are posted in ICAO APAC Website e-Documents and can be accessed at

https://www.icao.int/APAC/Pages/eDocs.aspx

Appendix 4 – References

1. Manual on Collaborative Air Traffic Flow Management (Doc 9971), Third Edition, 2018

2. EUROCONTROL A-CDM Implementation Manual, Version 5, March 2017

3. Airport Collaborative Decision-Making: Optimisation through Collaboration, CANSO

4. IATA Recommendations for A-CDM Implementation