INTERNATIONAL CIVIL AVIATION ORGANIZATION
WACAF AND ESAF REGIONAL OFFICES

AFI AIRPORT COLLABORATIVE DECISION MAKING (A-CDM) IMPLEMENTATION GUIDE

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This guidance material was developed by the AFI A-CDM Project Team, approved by the AAO-SG/8, endorsed by AASPG/1 and published by ICAO WACAF and ESAF Regional Offices.

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FOREWORD

The *AFI A-CDM Implementation Guide* is published by WACAF and ESAF Regional Offices who are Secretariate to the AAO/SG on behalf of the accredited States and International Organizations involved. This document has been developed in accordance with the objectives of the current edition of the Global Air Navigation Plan (GANP), and the outcomes of consultation with States and International Organizations.

The approval for this document and its future versions is under the responsibility of the Airspace and Aerodrome Operations Subgroup (AAO-SG). The subgroup has tasked the A-CDM project team to review the document regularly as may be required to reflect current implementation activities and alignment with the current edition of the GANP.

WACAF and ESAF regional offices Secretariat will publish, on behalf of the States and International Organizations involved, revised versions of the guide.

Copies of the guide may be obtained from the ICAO WACAF and ESAF regional offices.

RECORD OF AMENDMENTS

AMENDMENTS				
No.	Date applicable	Date entered	Pages affected	Reason for amendment

1. Chapter 1: Introduction

1.1 Purpose of the document

1.1.1 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.

1.1.2 A-CDM has globally been identified as a way to generate common situational awareness, which will foster improved decision making within aerodromes, by sharing relevant surface operations data among the local stakeholders involved in aerodrome operations. Airport Collaborative Decision Making is regarded as an important enabler that will improve operational efficiency, predictability and punctuality among airport partners and on the air traffic management (ATM) network.

1.1.3 The ICAO WACAF and ESAF Regional Offices have been conducting several activities in the Region since 2015 to raise awareness on the benefits of implementing Collaborative Decision-Making at airports in the AFI region. The main issues observed by the participants during these activities were the lack of practical guidance to facilitate implementation of A-CDM.

1.1.4 The purpose of this document is to provide a step-by-step approach with ready-to-use templates to guide airports through the A-CDM implementation process. The document was developed by experts nominated by States, in order to foster the effective implementation of A-CDM within the AFI region.

1.2 Scope

1.2.1 This guide is intended to cover the fundamental principles for the effective implementation of the ASBU element ACDM B0/1 “Airport CDM Information Sharing” which is the foundation of A-CDM.

1.2.3 In future editions, this document may evolve and include guidance for the implementation of ASBU element B0/2-Integration with ATM Network function and subsequent ASBU elements when available. This is why it’s important for stakeholders, especially airport operators, to consider the need for their processes and systems to have the capability at a point of time to integrate and interoperate with the ATM network, including national or regional ATFM services.

2. Chapter 2: Understanding A-CDM

2.1 What is A-CDM?

2.1.1 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 aerodromes operations. The main objective of A-CDM is to generate a common situational awareness that will foster improved decision-making.

2.1.2 A-CDM defines the rules and procedures used by aerodrome stakeholders to share information and collaborate. These, in turn, help to optimize the use of all aerodrome resources, reduce arrival and departure delays, and improve predictability during regular and irregular operations.

A-CDM concept

2.1.3. The aerodrome airside system can be split in various modules, each bearing a set of inherent characteristics and facing distinct operational issues. These include:

a) **airspace, or terminal manoeuvring area (TMA):** flexible airspace which aircraft fly along dedicated trajectories, that may or may not be based on standard procedures. The main actors in this module are pilots and approach air traffic controllers;

b) **runway(s) system:** composed of paved infrastructures including runways, runway entries and runway exits with strong geometrical constraints. They are equipped with specific radio navigation, markings and lighting equipment. They are used by pilots, local and ground air traffic controllers or ground services;

c) **taxiways system from the runway(s) to the apron:** taxiways form a static yet well-organized network, with a lot of intersections. They are also equipped with markings and lighting equipment and used by pilots, ground air traffic controllers or ground services;

d) **apron:** a wide and complex dynamic network with specific markings and lightning equipment. Various vehicles must drive on the apron (aircraft, tugs, ground handling vehicles, buses, etc.), and they operate in a crowded and less predictable environment; and

e) **aircraft gates:** these are static but must deal with a dynamic usage. Various vehicles circulate around gates (aircraft, tugs, buses, fuel trucks, catering trucks, luggage dollies, jet ways, etc.) with a variety of drivers.

Each module entry and exit can be associated with one or more specific milestone, defined as a timestamp.

2.1.4. Ideally, A-CDM aims to enhance operations in all modules. However, airports may choose to target any module or any sequence of modules for optimization tailored to the specific operational and capacity concerns at their aerodrome. During implementation, A-CDM projects can aim to strengthen any given milestone or a set of milestones for improvement. This approach is known as **the milestone approach.**

Benefits

2.1.5 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.

2.1.6 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.

2.1.7 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.

Paradigm shift

2.1.8 Prior to the A-CDM concept, the stakeholders worked on the basis of "first come first served" in the aircraft start-up sequence. A-CDM works on the premise of "best planned best served", whereby ATC will optimize the pre-departure 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).

2.1.9 A-CDM is a collaborative approach amongst all the A-CDM stakeholders, and the success of its implementation is ultimately dependent on the **accuracy and quality of Target Off Block Times (TOBTs)** which are managed by Aircraft Operators.

2.1.10 To ensure the generation of accurate **TOBTs and TSATs in the A-CDM process**, timely and accurate information updates are very important.

ASBU element A-CDM information sharing (ACIS)

2.1.11 **Information sharing** serves as the foundation for airport collaborative decision-making. It is the element that ties the stakeholders together in their aim to efficiently coordinate and manage operations.

2.1.12 **The Airport CDM Information Sharing Platform (ACISP),** which consists of systems, tools and user interfaces, is the means used to reach that aim, by providing a single, common set of data describing the status and intentions of a flight, together with documented actions from the A-CDM partners on the system. An ACISP may range from a simple A-CDM dialog system to a more advanced and complex system (app, webpage, etc.) depending on the technical possibilities of the CDM airport and its stakeholders.

2.1.12 **The Turn-round Process (Milestones approach)** tracks the progress of a flight in the Airport CDM Information Sharing Platform by a continuous sequence of significant events, known as milestones. A successfully completed milestone will trigger the decision-making process for downstream events and influence both the further progress of the flight and the accuracy with which progress can be predicted.

2.1.13 **Variable taxi time**: Taxi Time is the time that an aircraft spends taxiing between its parking stand and the runway or vice versa. It includes the time taken for pushback, and the time spent on the runway when lining up or vacating

- Accurate taxi times are essential for calculating important times in the Milestone Approach to improve the traffic predictability. Knowledge of realistic taxi times in different conditions (e.g. normal operations, low visibility operations…) enables ATC to optimize the push back, taxi and take-off sequence and hence reduce queuing and taxiway congestion.

- At complex airports the layout of runways and parking stands can result in a large difference in taxi time. Instead of using a standard default value, a calculation of the different permutations based upon historic data, operational experience and/or an integrated tool will provide a set of more realistic individual taxi times. **For A-CDM, these individual taxi times are referred to as Variable Taxi Time.**

- For arrivals, a realistic taxi time helps to provide an accurate in-block time, which will be beneficial for stand and gate planning and ground handling resource management.

- For departures, a realistic taxi time will provide an accurate take-off time, which can be used by the network manager, if applicable, to update the flight profile within the Enhanced Tactical Flow Management System (ETFMS) and hence optimize flow and capacity management of air traffic.

2.1.14 **The pre-departure sequence** is the order that aircraft are planned to depart from their stands (push off blocks). It should not be confused with the pre-take-off order where ATC organize aircraft at the holding point of a runway.

- Pre-departure sequence aims to enhance flexibility, increase punctuality and improve ATFM slot adherence, where applicable.

- Based on aircraft progress by using the TOBT, as well as the operational traffic situation on the aprons, taxiways and near runways, it provides a Target Start Up Approval Time (TSAT) which places each aircraft in an efficient predeparture sequence. This results in more optimized traffic flows towards the runways than the “first come first served” method.

2.1.15. The Target Start-up Approval Times (TSATs), Target Take Off Times (TTOTs), Variable Taxi Times (VTTs) and optimal pre-departure sequence are critical to ensure a successful A-CDM implementation. Information sharing must first be enabled using the milestone approach which will be optimized with the use of accurate VTTs and efficient pre-departure sequences.

2.1.16. Each implementation must be based on local operations, resources and constraints. Furthermore, 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) is critical.

Key enablers for the implementation of ACIS

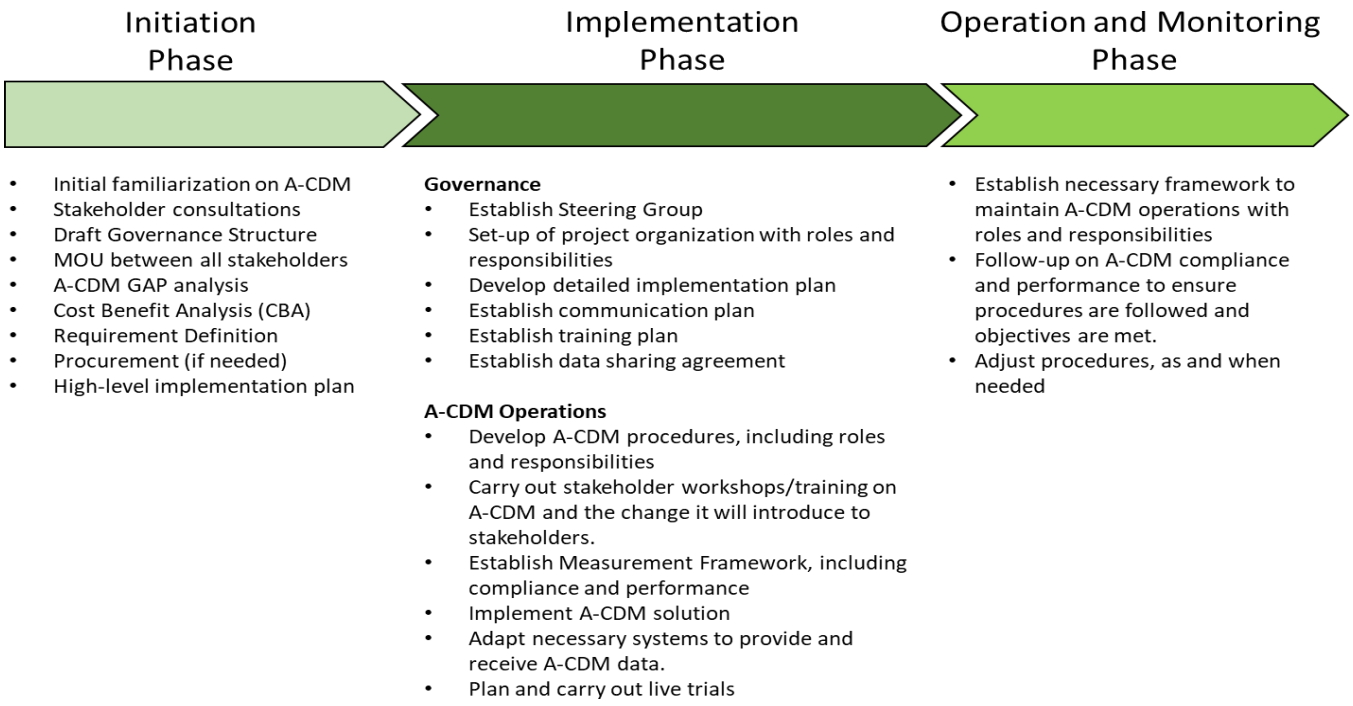
ENABLERS

Enabler Category	Enabler Type	Enabler Name	Description / References	Stakeholders	Year
Operational procedures	Operations	Surface operation milestones procedure	Reference: Manual on Collaborative Air Traffic Flow Management (ATFM) ICAO Doc 9971	Airport operator, ANSP, Aircraft operator, Ground handling agent	2013
Ground system infrastructure	Airport systems	ACIS system	A simple A-CDM dialog system to a more advanced A-CDM Information sharing platform (ACISP) to achieve A-CDM information sharing.	Airport operator, ANSP, Aircraft operator, Ground handling agent	2013
Training	-	Training requirements for ACIS	Training in the operational standards and procedures	Airport operator, ANSP, ATM network function, Aircraft operator, Ground handling agent	2013
Operational procedures	Phraseology	ACIS Phraseology	Phraseology for the implementation of ACIS. References: Procedures for Air Navigation Services-Air Traffic Management (Doc 4444)	ANSP, Aircraft operator	2013

2.2 A-CDM Project Phases

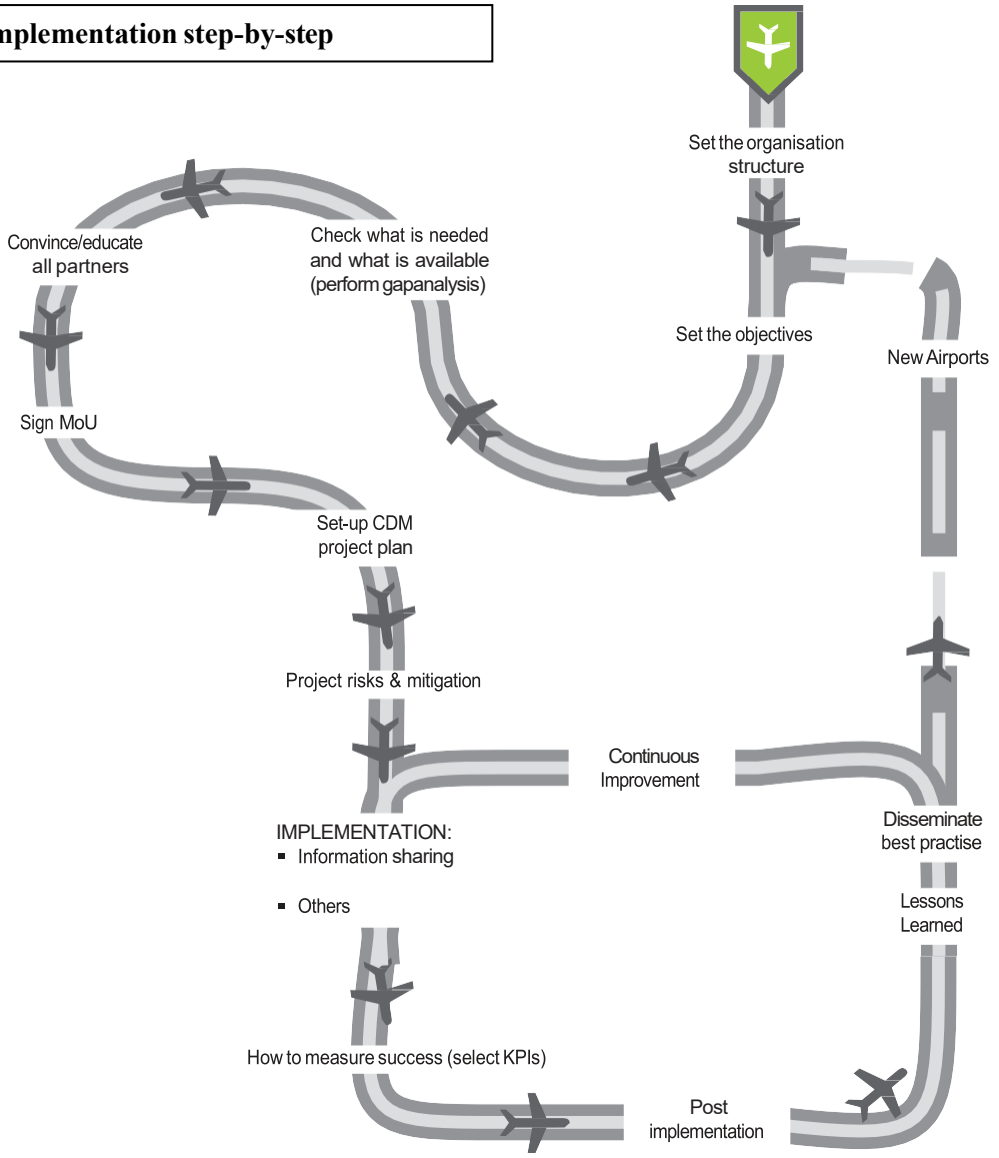
2.2.1 A-CDM project activities may be grouped into three phases as illustrated below:

- Initiation.
- Implementation (including planning for implementation);
- Operation and monitoring.



The subsequent chapters of the document will describe each phase, and provide, as annexes, ready to use templates to guide States and airports in their implementation.

A-CDM implementation step-by-step



3. Chapter 3: The initiation phase

3.1 Objective

3.1.1 The purpose of the initiation phase is to establish 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 of A-CDM,

3.1.2 The initiation phase consists of activities related to:

- Initial familiarization on A-CDM
- Stakeholder consultations
- Draft governance structure
- MoU between all stakeholders
- A-CDM gap analysis
- Cost benefit analysis (CBA)
- Requirement definition
- Procurement if needed
- High-level implementation plan

3.2 Templates for the initiation phase

The following table lists the drafts templates developed to guide airports in completing successfully the initiation phase:

INITIATION PHASE			
Attachment to chapter 3	Templates	Objective	References used
Attachment 3.1	Content of the Initial familiarization on the A-CDM template	*Initial familiarization on A-CDM*	
Attachment 3.2	A-CDM stakeholders checklist template	*Stakeholder consultations*	
Attachment 3.3	Stakeholders' consultation process checklist template	*Stakeholder consultations*	
Attachment 3.4	A-CDM gap analysis template	*Gap analysis*	ICAO Global air navigation plan (GANP)
Attachment 3.5	Cost benefit analysis template	*Cost benefit analysis*	`
Attachment 3.6	MoU between stakeholders' template	*MoU between stakeholders*	
Attachment 3.7	A-CDM draft governance structure template	*Draft governance structure*	
Attachment 3.8	A-CDM KPI template	*Requirement definition*	

ATTACHMENTS TO CHAPTER 3
(restructure the pagination by chapter)

4. Chapter 4 – Implementation phase

4.1 Objective

4.1.1 The purpose of the 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.

4.1.2 The implementation phase consists of the following activities:

Governance (Planning)	A-CDM operations
- Establish steering group	- Develop A-CDM procedures
- Develop detailed implementation plan	- Carry out stakeholder workshops/training
- Establish communication plan	- Establish measurement framework
- Establish training plan	- Implement A-CDM solution
- Establish data sharing agreement	- Adapt necessary systems to provide/receive data
	- Plan and carry out live trials

4.2 Templates for the implementation phase

The following table lists the drafts templates developed to guide airports in completing successfully the implementation phase, including planning activities:

IMPLEMENTATION PHASE			
Attachment to chapter 4	Templates	Objective	References used
Attachment 4.1	A-CDM steering group terms of reference (ToR) template	*Steering group establishment*	ICAO Global air navigation plan (GANP)
Attachment 4.2	Roles and responsibilities for the project organization template	*Project organization set up*	
Attachment 4.3	Training plan template (contents and type)	*Stakeholder training*	ICAO Global air navigation plan (GANP)
Attachment 4.4	Implementation plan template	*Detailed implementation plan*	ICAO Global air navigation plan (GANP)
Attachment 4.5	A-CDM information sharing (ACIS) system phraseology	*Data sharing and exchange*	ICAO Doc 4444
Attachment 4.6	A-CDM data checklist template	*Data sharing and exchange*	TBN

IMPLEMENTATION PHASE			
Attachment to chapter 4	Templates	Objective	References used
Attachment 4.7	Data sharing agreement template	*Data sharing and exchange*	
Attachment 4.8	A-CDM milestone procedure template including roles and responsibilities of stakeholders	*A-CDM procedures*	ICAO doc 9971
Attachment 4.9	Requirement for A-CDM information sharing (ACIS) system checklist template	*A-CDM procedures*	

ATTACHMENTS TO CHAPTER 4
(restructure the pagination by chapter)

5. Chapter 5 – Operation and monitoring phase

5.1 Objective

5.1.1 The purpose of the operation and monitoring phase is to ensure A-CDM procedures, supporting systems and information sharing processes are operational and effective.

5.1.2 The operation and monitoring phase consists of the following activities:

- Establish necessary framework to maintain A-CDM operations with roles and responsibilities
- Follow-up on A-CDM compliance and performance to ensure procedures are followed and objectives are met
- Adjust procedures, as and when needed

5.2 Templates for the operation and monitoring phase

The following table lists the drafts templates developed to guide airports in completing successfully the operation and monitoring phase:

OPERATION AND MONITORING PHASE			
Attachment to chapter 5	Templates	Objective	References used
Attachment 5.1	TBOT and TSAT performance measurement	*A-CDM compliance and performance*	
Attachment 5.2	A-CDM performance metrics	*Framework to maintain A-CDM operations*	

ATTACHMENTS TO CHAPTER 5
(restructure the pagination by chapter)

APPENDIX A

A-CDM with Air Traffic Flow Management (ATFM)

13. 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*."

14. Building up from B0-NOPS Network Operations, 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 reroute traffic to avoid saturated areas.

15. With the improvements under B1-NOPS, 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.

16. 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".

17. However, as limited by the current capabilities of most ATFM facilities, the ATFM process is commonly applied to regulate traffic flows (or balance demand of airspace users) by means of a ground delay program, level capping, an 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, the passengers are delayed inside the fuselage, the aircraft has been off-block to taxiway or is airborne amid 'flow control'.

18. 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, reflecting data for the full trajectory of a flight.

19. As mentioned in Doc. 9971, A-CDM aims to improve the exchange of information among actors and stakeholders and therefore to improve local operations. However, it is also a key enabler in linking these operations to the ATM network.

20. While ATFM is not a prerequisite to the realization of A-CDM, it is evident that any form of ATFM (or network operations/management) will benefit from being connected to A-CDM. Operations conducted at a CDM airport will be enriched by enhanced arrival information from the ATM network. Network operations will also benefit from more accurate departure information from CDM airports

21. For countries or regions without ATFM services, A-CDM could be the enabler to connect adjacent ATC units or other airports.

A-CDM and the "System Wide Information Management" or SWIM

22. System Wide Information Management (SWIM) is a new way for managing and exchanging information. It replaces the current ground-ground point-to-point information exchange by an aviation intranet relying on internet technologies enabling information services to be provided to the ATM community. In order to facilitate publish/subscribe and request/reply based information exchange through standardized information services, provisions for the information service content and service overview are defined and appropriate SWIM governance established.

23. SWIM is expected to enable node-based A-CDM sharing up-to-date relevant information with other aviation entities including other airports, airlines, 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.

24. SWIM's goal is to create 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.

There is a need of implementation of an APIRG Region Digital Network within swim to 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 *A-CDM with Cross-Exchange of Structured Information* .

25. The ASBU module, B1-DATM Digital ATM information, addresses the need for information integration and supports a new concept of ATM information exchange fostering access via 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.

26. The data interoperability between A-CDM and ATFM may be assured by the use of FIXM found on the concept of flight object and the widely adopted extensible Mark-up Language (XML). This common model of structured information for flight object will effectively enable ground-ground exchanges before departure, under the ASBU module, B1-FICE.

APPENDIX B

Project team members