ICAO

Doc 9971

Manual on Collaborative Air Traffic Flow Management (ATFM)

Third Edition, 2018

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA		
No.	Date	Entered by

FOREWORD

The purpose of this manual is to provide guidance related to the concept of collaborative decision-making (CDM), and its use in air traffic flow management (ATFM) as well as in airport operations through airport-CDM (A-CDM).

Managing traffic flows is a unique activity in civil aviation, insofar as it involves so many different actors with different, and sometimes conflicting needs. In fact, the success of ATFM is directly conditioned by the ability to enable and secure the involvement of all actors and stakeholders throughout the entire process. Enhanced capacities and increased efficiency are also needed at airports, and are, as for ATFM, a powerful incentive to implement robust collaboration, reconciling the needs from all actors and stakeholders. This manual consolidates those three topics into a single document to reflect the intricacies of CDM, ATFM and airport operations.

The guidance in this manual is intended to foster collaboration in the implementation of processes, tools and methods that will meet the specifications of each State and ICAO region. The guidance was designed to strike the right balance between worldwide standardization and local adaptation.

Part I details the fundamental notions underscoring the concept of CDM, and how to decide on a course of action articulated between two or more community members. This allows to improve the overall performance of ATM, while balancing the needs of individual ATM community members.

Part II details the purpose, uses and benefits of flow management. It provides a complete set of operational guidelines that cover the definition and improvement of capacities, the various ATFM solutions and measures, as well as the communication requirements underscoring flow management. It also provides implementation guidance in the form of a roadmap that can be adapted to each situation.

Part III expands the reach of collaboration and describes how the CDM concept applies to airport operations and aircraft turnaround. Building on the experiences of various States in different regions, and reflecting the scalability needed to ensure efficiency, this manual identifies the roles and responsibilities of actors and stakeholders, and details the methods and tools that can be used in airport collaborative decision-making (A-CDM). As is the case for the section related to ATFM, a large part of the guidance material focuses on implementation guidance and is articulated around a proposed roadmap that can be adapted to local specificities.

Acknowledgements

ICAO wishes to acknowledge the contributions to this manual from the following bodies: Eurocontrol, FAA, and the Civil Aviation Authorities of Japan, New Zealand and Singapore.

Future developments

The guidance material in this manual will be updated at regular intervals. Comments on this manual would be appreciated from all parties involved in the development and implementation of ATFM and A-CDM. These comments should be addressed to:

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GLOSSARY

ABBREVIATIONS/ACRONYMS

AAR	Airport arrival rate
ACARS	Aircraft Communication Addressing and Reporting System
ACC	Area control centre
A-CDM	Airport collaborative decision-making
ACIS	A-CDM information sharing
ACISP	A-CDM information sharing platform
ADEP	Departure airport
ADES	Destination airport
ADEXP	ATS data exchange presentation
ADP	ATFM daily plan
ADR	Airport departure rate
ADS-B	Automatic dependent surveillance — Broadcast
AFP	Airspace flow programme
AFS	Aeronautical fixed service
AFTN	Aeronautical fixed telecommunication network
AGHT	Actual ground handling time
AIBT	Actual in block time
AIM	Aeronautical information management
AIP	Aeronautical information publication
AIRM	ATM information reference model
AIXM	Aeronautical information exchange model
ALDT	Actual landing time
AMAN	Arrival manager
AMAT	Actual movement area entry time
AMHS	ATS message handling system
ANSP	Air navigation services provider
AO	Aircraft operator
AOBT	Actual off-block time
AOP	Airport operator
AP	Airspace provider
APP	Approach control service
ARCID	Aircraft identification (Call sign)
ARCTYP	Aircraft type
ARDT	Aircraft ready time
ARR	Arrival message
ASAT	Actual start up approval time
ASBU	Aviation system block upgrade
ASM	Airspace management
A-SMGCS	Advanced surface movement guidance and control system
ASP	ATM service provider
ASRT	Actual start up request time
ATA	Actual time of arrival
ATC	Air traffic control
ATCO	Air traffic controller

ATD	Actual time of departure
ATFCM	Air traffic flow and capacity management
ATFM	Air traffic flow management
ATM	Air traffic management
ATMC	Air traffic management centre
ATOT	Actual take-off time
ATS	Air traffic services
ATTT	Actual turnaround time
AU	Airspace user
CAA	Civil Aviation Authority
CBA	Cost benefit analysis
CDM	Collaborative decision-making
CEF	Capacity enhancement function
CFMU	Central flow management unit
CGNA	Centro de Gerenciamento da Navegação Aérea (air navigation management centre)
CHG	Modification message
CLDT	Calculated landing time
CNS/ATM	Communications, navigation and surveillance/air traffic management
CNL	Flight plan cancellation message
COBT	Calculated off-block time
CPDLC	Controller-pilot data link communications
CPL	Current flight plan
CSA	Common situational awareness
CTO	Calculated time over
CTOT	Calculated take-off time
DCB	Demand and capacity balancing
DCL	Departure clearance message (via data link)
DCPC	Direct controller-pilot communications
DEP	Departure message
DLA	Delay message
DMAN	Departure manager
DPI	Departure planning information message
ECAC	European Civil Aviation Conference
EDCT	Expected departure clearance time
EEZT	Estimated end of de-icing time
EIBT	Estimated in-block time
ELDT	Estimated landing time
EOBT	Estimated off-block time
ERTD	Earliest runway time of departure
ERZT	Estimated ready for de-icing time
ESP	Emergency service provider
EST	Estimated message
ETD	Estimated time of departure
ETO	Estimated time over
ETOT	Estimated take-off time
EXIT	Estimated taxi in time
EXOT	Estimated taxi out time
FAP	Future ATM profile
FCA	Flow constrained area
FDPS	Flight data processing system
FDP	Flight data processor
FF-ICE	Flight and flow — information for a collaborative environment

FIR	Flight information region
FIXM	Flight information exchange model
FMP	Flow management position
FMU	Flow management unit
FOC	Flight operation centre
FPL	Filed flight plan
FUA	Flexible use of airspace
FUM	Flight update message
GANP	Global air navigation plan
GDP	Ground delay programme
GH	Ground handler
GNSS	Global navigation satellite system
GSt	Ground stop
ICAO	International Civil Aviation Organization
IATA	International Air Transport Association
IBT	In block time
IFR	Instrument flight rules
ILS	Instrument landing system
IMC	Instrument meteorological conditions
IR	Infra-red
IWXXM	ICAO weather information exchange model
KPA	Key performance area
KPI	Key performance indicator
LDT	Landing time
LoA	Letter of agreement
MDI	Minimum departure interval
MET	Meteorology
MINIT	Minutes-in-trail
MIT	Miles-in-trail
MLAT	Multilateration
MoU	Memorandum of Understanding
MTTT	Minimum turnaround time
NAVAIDs	Aid to air navigation
NOPS	Network operations
NOTAM	Notice to airmen
OBT	Off-block time
OLDI	Online data interchange
PBA	Performance-based approach
PBN	Performance-based navigation
PIA	Performance improvement area
PMP	Project management plan
Prog	Prognosis
R&D	Research and development
REG	Aircraft registration
RFF	Rescue and firefighting
ROI	Return on investment
RTA	Required time of arrival
RVR	Runway visual range
RWY	Runway
SAR	Search and rescue
S-CDM	Surface-CDM (United States)
SIBT	Scheduled in-block time

SID	Standard instrument departure
SOBT	Scheduled off-block time
SSR	Secondary surveillance radar
STAM	Short-term ATFM measure
STAR	Standard instrument arrival
SUB	Slot swapping
SWIM	System-wide information management
TAF	Aerodrome forecast
TAS	True air speed
TCAC	Tropical Cyclone Advisory Centre
TFM	Traffic flow management
TMA	Terminal control area
TMAT	Target movement area time
TOBT	Target off-block time
TOT	Take-off time
TS	Thunderstorms
TSAT	Target start-up approval time
TTOT	Target take off time
TWR	Aerodrome control tower
UDPP	User-driven prioritization process
VAAC	Volcanic Ash Advisory Centre
VMC	Visual meteorological conditions
VTT	Variable taxi time
WAFC	World Area Forecast Centre
WAM	Wide area multilateration
WXXM	Weather information exchange model

REFERENCES

ICAO documents

Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444)
Global Air Navigation Plan (Doc 9750)
Global Air Traffic Management Operational Concept (Doc 9854)
Manual on Air Traffic Management System Requirements (Doc 9882)
Manual on Global Performance of the Air Navigation System (Doc 9883)
Manual on Flight and Flow — Information for a Collaborative Environment (FF-ICE) (Doc 9965)
Civil/Military Cooperation in Air Traffic Management (Cir 330)
Manual on the System-wide Information Management (SWIM) Concept (Doc 10039)

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PART I

COLLABORATIVE DECISION-MAKING (CDM)

Chapter 1

INTRODUCTION

1.1 THE NEED FOR COLLABORATION

1.1.1 The Eleventh Air Navigation Conference (AN-Conf/11) was held in Montréal from 22 September to 3 October 2003. At this meeting, Recommendation 1/1 was agreed upon for the "Endorsement of the global ATM operational concept". This concept was subsequently published as the *Global Air Traffic Management Operational Concept* (ICAO Doc 9854), First Edition, 2005. Central to this concept is the need to evolve towards a more collaborative environment, as noted in the AN-Conf/11 Report (AN-Conf/11 Report, Agenda item 1, 1.2.1.3):

> *"The goal, therefore, was an evolution to a holistic, cooperative and collaborative decision-making environment, where the expectations of the members of the ATM community would be balanced to achieve the best outcome based on equity and access."*

1.1.2 The concept further articulates (Doc 9854, Appendix I, 10) a high-level explanation of collaborative decision-making (CDM) including the following attributes:

a) CDM allows all members of the air traffic management (ATM) community to participate in ATM decisions that affect them (i.e., CDM is not limited to any specific domain such as an airport or en route);

b) CDM may apply to all layers of decision-making from longer-term planning activities through to real-time operations;

c) CDM can be applied actively or, through collaboratively agreed procedures, passively;

d) effective information management and sharing enables each participant to be aware of information of relevance to other participants' decisions; and

e) CDM enables any member to propose a solution (this is of greater utility when enhanced with effective information management).

1.1.3 AN-Conf/11 further articulated the need to develop ATM requirements derived from the global ATM operational concept. This was described in Recommendation 1/3 — Development of ATM requirements:

> *"That ICAO as a high priority develop a set of ATM functional and operating requirements for a global ATM system on the basis of the global ATM operational concept."*

1.1.4 As a result of the above recommendation, the *Manual on Air Traffic Management System Requirements* (Doc 9882) was developed. These requirements repeatedly express the need for CDM across all time horizons and concept components. Certain requirements focusing on collaboration include:

a) ensuring that airspace users (AUs) are included in all aspects of airspace management via the CDM process;

b) managing all airspace, and where necessary, being responsible for amending priorities relating to access and equity that may have been established for particular volumes of airspace. Where such authority is exercised, it shall be subject to rules or procedures established through CDM;

c) establishing a collaborative process to allow for efficient management of the air traffic flow through the use of information on system-wide air traffic flow, weather, and assets; and

d) modifying the AU's preferred trajectory: 1) when required to achieve overall ATM system performance requirements; and/or 2) collaboratively with the AU, in a manner that recognizes the AU's need for single-flight efficiencies.

1.1.5 Further to the development of the requirements, guidance material was sought in the application of a performance-based approach to ATM decisions. This material was described in the *Manual on Global Performance of the Air Navigation System* (Doc 9883), and provides guidance and a process towards addressing AN-Conf/11, Recommendation 3/3 — Performance framework:

"That ICAO, in consultation with the other members of the ATM community:

a) formulate the performance objectives and targets for a future global ATM system;

b) continue the definition of related performance metrics and elementary characteristics in the context of the overall behaviour of the ATM system; and

c) coordinate and harmonize all related contributions within the overall performance framework initiated by the Air Traffic Management Operational Concept Panel, including definitions, standards for reporting requirements, information disclosure and guidance for monitoring."

1.1.6 It is expected that the performance-based approach would be applied in a collaborative manner to address the most strategic decisions. The rationale for such collaboration is provided in terms of the consequences of insufficient collaboration:

a) where insufficient coordination between Air Navigation Service Providers (ANSPs), aerodromes, AUs, manufacturers, regulators and ICAO takes place, the result is a fragmented air navigation system;

b) insufficient coordination at local, regional and global levels leads to less than ideal interoperability and to geographic differences in terms of performance and maturity; and

c) a fragmented approach from an operational perspective (no gate-to-gate and en-route to en-route) leads to less than optimum flight and airport operations efficiency.

1.1.7 Doc 9883 further states that, collaboration and coordination are needed to:

a) come to an agreed vision on the expected results;

b) ensure that everyone delivers their part of (their contribution to) the required performance;

c) ensure that everyone uses a compatible approach, method and terminology; and

d) ensure that everyone's data can be integrated and aggregated to calculate overall indicators and assess system performance at a higher aggregation level.

1.1.8 While the above establishes the need for collaboration across multiple stakeholders, objectives and time horizons, an additional attribute to collaboration is the degree to which the collaborative processes are harmonized. While this document seeks to not be overly prescriptive in specifying collaborative mechanisms and processes, there are clear consequences resulting from a lack of harmonization. Some examples include:

a) Data requirements: CDM processes operate in a future information-enriched environment, with exchange of data as the primary facilitator of collaboration. Divergence in data requirements to support disparate CDM processes leads to additional required investments on the part of AUs in information infrastructure and data collection mechanisms.

b) Automation: Increased automation is expected, particularly in the faster response time CDM processes. In addition to divergent data requirements, differing CDM processes will require AU automation with tailored algorithms. Furthermore, CDM processes that are constantly changing require evolving automation.

c) Airborne scope of CDM: An extension of the collaborative process to the flight deck for the most tactical CDM processes invites greater harmonization of the required data and processes as the aircraft will operate in multiple environments.

d) Training: Similar to the need to develop new algorithms for disparate or changing CDM processes, AUs operating across boundaries require additional training to handle the variation in these processes.

e) Seamlessness: Flights will cross through boundaries in which differing CDM processes may be applied. Disparate CDM processes and data affect performance for various reasons such as inconsistent objectives, obtaining optima piece-wise, different decision times, and lack of visibility into each other’s processes.

f) Consistency across decisions: Different layers of decision-making can lead to inconsistencies. For example, agreement can be reached on broad performance objectives through CDM for strategic decisions. Operational decisions reached collaboratively may seek different operational performance objectives based upon circumstances, effectively working at odds with the strategic decisions. Processes should consider potential inconsistencies and guidelines for mitigating these inconsistencies.

g) Verification and robustness for gaining an advantage or “gaming”: Since the CDM processes are based upon information provided by multiple participants with differing objectives, the provision of false information to “game” the system in their favour is a potential concern. Lack of harmonization may make it difficult to detect, or be too robust against, the impact of these behaviours across disparate processes with the end result being a less equitable system.

1.2 DOCUMENT OBJECTIVES AND SCOPE

1.2.1 As the preceding section indicated, Doc 9854 and derived documents call for increased levels of collaboration across the spectrum of decision-making. While these documents indicate a need for, and a description of, the applicable areas of collaboration, their guidance on implementing CDM is not complete. This manual provides that additional guidance.

1.2.2 It is recognized that CDM is applicable to long-term planning activities such as infrastructure investments and procedural changes. For those types of activities, the performance-based approach, as described in Doc 9883, provides guidance on the methods for attaining collaborative, performance-focused solutions. Furthermore, given the long time horizons available for collaboration, rules, methods and roles of individual collaborating participants can be customized to the situation. Some types of decisions are out of the scope of this manual and will be covered by Doc 9883, Part I — *Global Performance* and Part II — *Performance-based Transition Guidelines*, First Edition, 2009.

1.2.3 For other types of CDM requiring additional guidance beyond the performance-based approach (e.g., agreement on day-of-operations configurations, flight-specific trajectory changes as required for queue or traffic flow management), this manual provides guidance material in the following areas:

a) CDM description in addition to overarching collaboration principles and processes, which include:

   1) a description of the ATM areas suitable for collaboration;

   2) a classification and description of the types of collaboration, and conditions under which they apply;

   3) a description of complementary decision-making, and conditions under which it may apply; and

   4) issues to be addressed when implementing collaborative processes, including the use of rules managing behaviour;

b) the role of information exchange — information sharing is central to collaborative processes; important considerations in this area are described below:

   1) data standards — why standards at a syntactic and semantic level are necessary;

   2) information quality — types of approaches for mitigating impacts, where applicable; and

   3) role of the collaborative environment — how the information for a collaborative environment supports collaboration;

c) articulating a CDM process — identifying what is necessary to describe a CDM process given an objective for collaboration, including:

   1) participants — who is participating in the collaboration;

   2) roles and responsibilities — what functions do the participants perform and how do they interact;

   3) information requirements — description of requirements and standards imposed on information exchanged as part of the above interactions;

   4) making the decision — how is a decision made; and

   5) rules — what are some rules constraining the behaviour.

———————————

Chapter 2

DESCRIPTION OF COLLABORATIVE DECISION-MAKING (CDM)

2.1 GENERAL APPROACH AND PRINCIPLES

2.1.1 CDM is a process applied to support other activities such as demand/capacity balancing. CDM can be applied across the timeline of activities from strategic planning (e.g., infrastructure investments) to real-time operations. CDM is not an objective but a way to reach the performance objectives of the processes it supports. These performance objectives are expected to be agreed upon collaboratively. Since implementing CDM likely will require investments, these will need to be justified in accordance with the performance-based approach.

2.1.2 Although information sharing is an important enabler for CDM, the sharing of information is not sufficient to realize CDM and the objectives of CDM.

2.1.3 CDM also requires predefined and agreed upon procedures and rules to ensure that collaborative decisions are made expeditiously and equitably.

2.1.4 CDM ensures decisions are taken transparently based on the best information available as provided by the participants in a timely and accurate manner.

2.1.5 The development and operation of a CDM process follows these typical phases:

1) identification of the need for CDM;

2) CDM analysis;

3) CDM specification and verification;

4) CDM performance case;

5) CDM validation and implementation; and

6) CDM operation, maintenance and improvement (continuous).

It is important that the results of all these phases be shared between the involved community members.

2.1.6 The first phase is the identification of the need to apply CDM to realize a performance improvement. This can relate to current processes/operations or to future processes. A “need statement” should refer to the process(es) to which CDM should be applied and specify the current situation, involved community members and current (or projected) performance shortfall(s). It should include a first assessment (often based on expert judgement) describing how and through which means CDM can mitigate a shortfall. Shortfalls should be identified in areas related to all eleven key performance areas (KPAs) identified in Doc 9883. While CDM has the ability to influence performance in all eleven KPAs, CDM provides a mechanism specifically well-suited to addressing the following performance areas, which are frequently difficult to quantify:

a) *Access and equity* — A global ATM system should provide an operating environment that ensures that all AUs have right-of-access to the ATM resources needed to meet their specific operational requirements and that the shared use of airspace by different users can be achieved safely. The global ATM system should ensure equity for all users that have access to a given airspace or service. Generally, the first aircraft ready to use the ATM resources will receive priority, except where overall safety or system operational efficiency would significantly improve or national defence considerations or interests dictate that priority be determined on a different basis.

b) *Participation by the ATM community* — The ATM community should have continuous involvement in the planning, implementation and operation of the system to ensure that the evolution of the global ATM system meets the expectations of the community.

2.1.7 In the second phase, CDM analysis, the process is further analysed from a decision-making perspective. The analysis should make clear what decisions are to be made, which community members are involved (or affected), which information is used in support of the decision(s), which process(es) are followed, how and through which means the decision-making process can be improved and how such an improvement could contribute to better performance.

2.1.8 The third phase, which builds on the CDM analysis, results in a shared and verified specification of the CDM process. It will address:

a) the decisions to be taken, how they are reached and finalized;

b) the community members involved and their roles/responsibilities in the decision(s);

c) agreement on objectives; there may be a shared objective with individual sub-objectives (e.g., resolve congestion while minimizing impact to one's own operation);

d) decision-making rules, processes and principles including specification of timeline/milestones, interactions, roles and responsibilities;

e) information requirements including data standards, quality, frequency and deadlines; and

f) the CDM maintenance process: review, monitoring/verification, etc.

This phase is further detailed in these guidelines and illustrated through examples.

2.1.9 The objective of the performance case, developed through the fourth phase, is to justify the decision to implement the CDM process and to make the necessary investments. It should clearly specify the costs involved and describe the benefits (using the relevant KPAs) that will result from the operation of CDM. It is important that the results of the performance case be shared between all relevant community members. In case the CDM process is an integral part of a new process, it should be integrated in the performance case.

2.1.10 The fifth phase, CDM validation and implementation, includes all steps to bring CDM into operation. It includes training and informing staff, implementation/adaptation of systems, information networks, etc.

2.1.11 Once the CDM process is operational it should be subject to a continuous and shared review, maintenance and improvement process. In this way, performance can be continually improved.

2.2 GOVERNANCE

2.2.1 Much of the approach described in the preceding section falls under a broader classification of “governance”. It is essential that a CDM process have well-articulated governance.

2.2.2 Governance is described in the 1994 World Bank report, *Governance: The World Bank’s Experience*, as follows:

> “Good governance is epitomized by predictable, open and enlightened policy making; a bureaucracy imbued with a professional ethos; an executive arm of government accountable for its actions; and a strong civil society participating in public affairs; and all behaving under the rule of law.”

2.2.3 While the above document clearly is aimed at governance of a different scope, the characteristics of good governance are applicable to the governance of any CDM process.

2.3 AREAS OF APPLICATION

2.3.1 Doc 9965 provides a concept for flight information sharing of relevance to CDM. Figure I-2-1 defines a timeline for information-provision that can be used to describe areas to which these CDM guidelines may be applied. Together with the timeline, there are other ways in which areas of application may be described, as identified below:

a) position in timeline;

b) ATM process/concept component reference; and

c) CDM objective and type of decisions it supports.

2.3.2 As already defined in Chapter 1, 1.2, this manual does not address CDM in the context of performance-based strategic planning. More guidance on this can be found in Doc 9883. Examples of areas of collaboration not addressed by this manual, but addressed through the performance-based approach include:

a) collaboration on long-term performance outcomes and targets;

b) collaboration on implementation of operational improvements, including changes to procedures, airspace organization, and infrastructure; and

c) collaboration on forecasts and post-event analyses used for long-term strategic planning.

2.3.3 Collaboration while applying the performance-based approach applies to longer time horizon activities. Given these long lead times, collaboration can be individually tailored to the circumstances.

2.3.4 Toward the end of the timeline, tactical decision-making during flight operations or just before departure may not provide sufficient time for collaboration to be accomplished effectively. This can have two distinct effects on:

a) decisions on events or new information that do not allow sufficient time for collaboration between the time of the event and the deadline for a decision; and

b) decisions for which collaboration has occurred at an earlier point in the timeline and as time progresses, there remains insufficient time to continue collaborating.

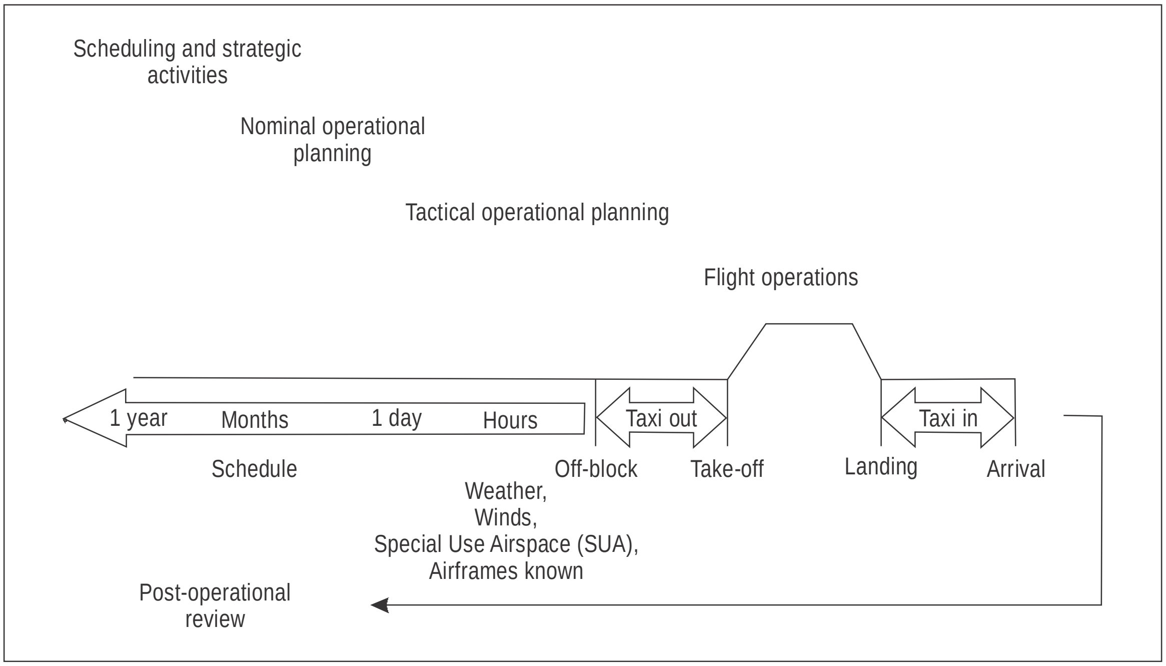

Figure I-2-1. Timeline of information provision (extracted from FF-ICE concept)

2.3.5 In both of the above cases, collaboration is applied to agree upon the processes and rules by which these time-critical decisions are made. As a result of these agreements, combined with an anticipated information-rich environment, the second of the above cases is expected to evolve into CDM.

2.3.6 CDM may also be applied to various concept components as they are executed across the timeline. Doc 9882 identifies requirements for collaboration and CDM across multiple concept components including:

a) airspace organization and management;

b) aerodrome operations;

c) demand and capacity balancing;

d) traffic synchronization; and

e) ATM service delivery management.

2.3.7 Looking at the requirements for the components across the timeline, some collaboration requirements fall under the purview of the performance-based approach (e.g., definition of airspace structures and procedures under Doc 9882, Chapter 2, Section 2.4.1, Airspace organization and management – c) R04). Other requirements indicate the need to apply CDM to establish rules or procedures.

2.3.8 Beyond the requirements for collaboration, it is clear that decisions on strategic conflict management may also benefit from CDM. However, as it is achieved through other concept components (see the extract below from Doc 9854), CDM as it applies to conflict management is covered through other components.

> *"Strategic conflict management is the first layer of conflict management and is achieved through the airspace organization and management, demand and capacity balancing and traffic synchronization components."*

2.3.9 Good practices indicate that any decision in ATM is based on the best available information and according to predefined, transparent and agreed criteria and processes. CDM becomes especially relevant when:

a) one or more decisions are required;

b) more than one stakeholder is impacted by the outcome of the decision(s);

c) one or more stakeholders are best suited to evaluating the impact of the decision(s) on their own interests; and

d) time is available prior to the decision(s) deadline to accommodate collaboration.

2.3.10 Decisions may be affected by competition between stakeholders (e.g., allocation of resources) or may benefit multiple stakeholders (e.g., relaxation of restrictions in airspace redesign).

2.3.11 The above criteria are all applicable to the areas of collaboration specifically identified in Doc 9882. For example, collaboration:

a) prior to departure (predeparture) to manage the turnaround process and departure queue;

b) to manage flows through the control and synchronization of individual flights;

c) on agreed weather forecasts to implement airspace/airport flow restrictions;

d) on timing and selection of dynamic airspace configurations;

e) to determine the relevant performance criteria to be applicable to a given period; and

f) to determine equitable unilateral responses to event(s) when time does not permit further collaboration in response to the event(s).

2.3.12 Collaboration is an integral part of the ATM system. However, this document provides guidance on subsets of CDM as defined below:

a) when CDM is applied to any concept component;

b) when time is not available to tailor the CDM process for every decision. When time is available to tailor the process to the specific situation, one would expect the performance-based approach to provide sufficient guidance;

c) when time is available to collaborate before a decision deadline. There must be enough time available to do so; and

d) when time is not available to collaborate on the decision itself, a collaborative process is applied to define the decision-making rules, and to identify the decision maker that will apply the agreed-upon rules.

2.3.13 Figure I-2-2 illustrates the cases when CDM guidance is applicable and the situation that occurs when time is expiring to a decision deadline. Some deadlines may result in a decision having to be made for planning purposes, but still subject to refinement through a collaborative process. It is noted that CDM can revert to complementary decision-making when actions at a deadline can be anticipated by all participants because sufficient information is available to determine the outcome of a looming deadline.

2.3.14 It is the dynamic nature of the ATM environment which necessitates decision-making at various time-horizons. This dynamism refers to an environment in which the future is uncertain and, as a consequence, subject to changing objectives and decisions. The impact of weather is an example of how uncertainty can require decision-making at several time-horizons. Early decisions (such as planning operations assuming an arrival delay due to forecast snow) can be made taking into consideration the uncertainty and the ability to respond closer to the time of the event. As the situation unfolds and becomes more certain, decisions respond to this more certain information, with changing decisions contributing to the dynamism.

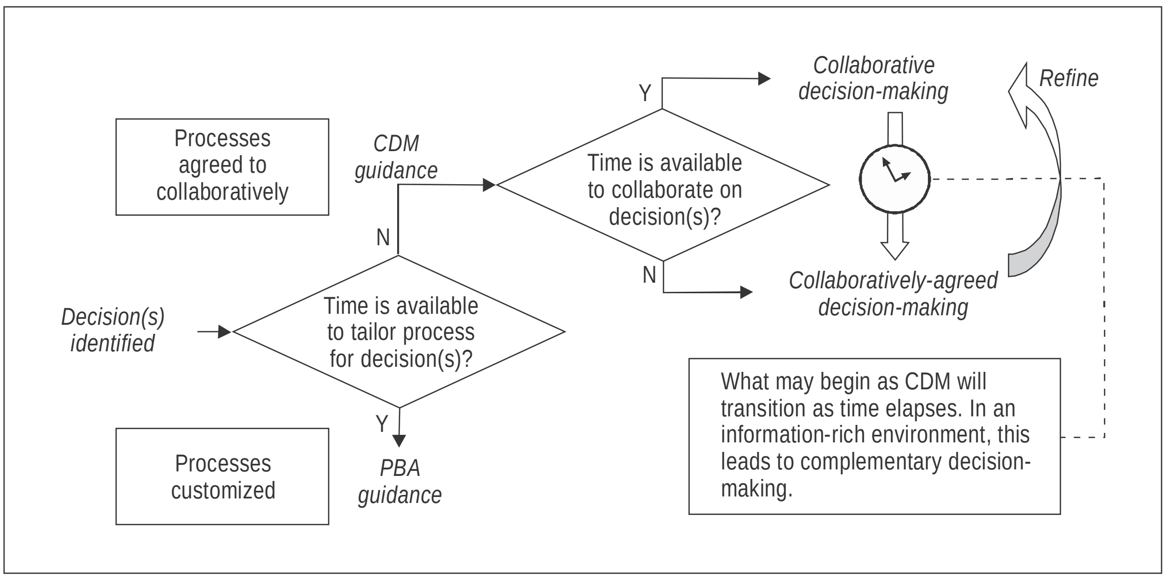

Figure I-2-2. Selection of applicable guidance material

2.4 TYPES OF CDM

2.4.1 Several situations may occur when making decisions affecting a collection of disparate stakeholders. Figure I-2-3 illustrates these situations along two principal dimensions:

Decision-making — Specifies whether decisions are made by one participant (unilateral) or if decisions are made multilaterally across multiple stakeholders. As applied to ATM, many individual decisions (e.g., across many flights) can be taken to affect an outcome.

Alignment — Identifies whether the interests of the multiple stakeholders are driven by a single common objective, or whether each stakeholder has individual objectives. In the latter case, these can be further decomposed:

> **Complementary** — The pursuit of a stakeholder's individual goals either does not affect or is in alignment with other stakeholders' goals.

Adversarial — The pursuit of a stakeholder's individual goals is in conflict with another stakeholders' goal. This is frequently the case when faced with resource contention.

2.4.2 As has already been mentioned in the preceding section, decisions which are multilateral at one point may eventually require a unilateral solution as time progresses.

2.4.3 The objective behind this classification is to provide guidance on some important considerations within each type as described below:

Multilateral decision-making with a common goal — All participants are in agreement on a common, socialized goal driving their decisions (e.g., minimize environmental noise impact given a fixed number of operations). Multilateral decision-making can be preferable in this situation when multiple stakeholders hold the best information necessary to make decisions, and it may be difficult or undesirable to share the information. In this case, it is necessary to ensure the following:

a) the relationship between the decision and the desired outcome must be known to decision makers. This can prove to be difficult when the outcome is the result of many combined decisions, some of which may not be announced yet by other stakeholders;

b) appropriate levels of information sharing must be maintained to ensure that each stakeholder has enough information to make decisions that, combined with other stakeholders' decisions, achieve the common goal; and

c) since the common goal may be insufficient to resolve the problem, additional goals, including individual goals, may be applied to resolve the problem. If these are adversarial, these need to be considered.

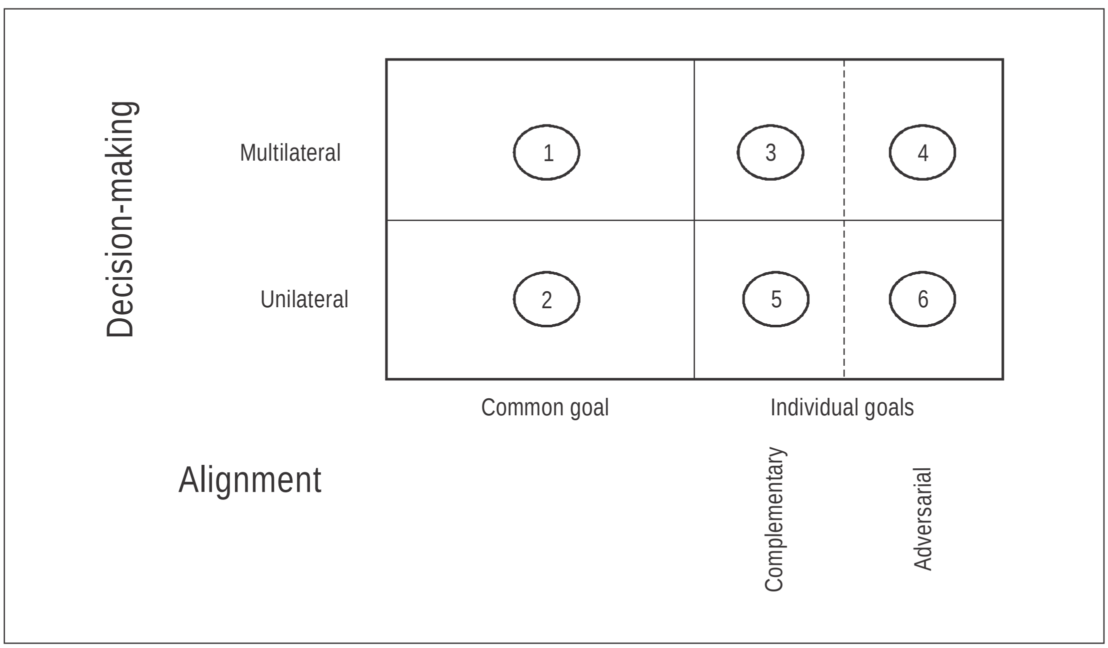

Figure I-2-3. Classification of types of CDM

Unilateral decision-making with a common goal — As in the case above, all participants are in agreement on a common, socialized goal. In this case, a single decision maker is granted the authority to make decisions towards this goal. It is necessary to ensure:

a) rules governing the decisions are collaboratively agreed-to prior to engaging in this form of decision-making. These rules must be known to all participants;

b) adequate information must be provided to the decision maker by all participants to ensure that the common goal can be attained by the decision maker given the information. Adequate information requires both that the appropriate information items be provided and that the information be of sufficient quality, stability and timeliness to support the required action by the decision maker;

c) secondary objectives may be addressed through the provision of preferences by other participants to the decision maker, with rules governing their application; and

d) the relationship between the decision being taken, the goal being pursued and the information supporting the decision must be understood. When this relationship is poorly understood, decision rules will not necessarily be capable of attaining the stipulated goal.

Multilateral decision-making with complementary individual goals — Similar to the situation with a common goal, all participants make their own decisions towards individual complementary or non-competing goals. Considerations are the same as the common goal case; with the added complexity that it may be difficult to ascertain that goals are in fact complementary. Given that CDM is frequently applied to the allocation of constrained resources, this is not likely a common situation between competing participants. However, certain situations may lead to this case, for example:

a) decisions may have geographically separate impacts;

b) as is frequently the case today, different ATM service providers (ASPs) make decisions affecting flights operating across multiple ASPs. Through the sharing of appropriate information and tailoring of processes to accommodate this information, more globally optimal solutions can be reached, even with different objectives;

c) individual objectives may align with a common goal (e.g., maximize capacity at some locations, potentially for differing purposes); and

d) once constrained resources have been allocated to participants, decisions may occur within those constraints (e.g., substitutions) to achieve a secondary objective.

Multilateral decision-making with adversarial individual goals — The case of multiple participants making individual decisions with competing objectives occurs frequently in a capacity-constrained environment. The objective of collaboration is to seek a solution which is considered acceptable (including equitable) to all participants. Several approaches and considerations to this case are:

a) a set of rules governing the process should be agreed to prior to initiating collaboration;

b) rules should include specified deadlines for decision-making. The consequence of missing the deadline should be known to all participants. One such consequence may be reversion to a single decision maker acting in accordance with known rules;

c) rules may include a mechanism for constraining the decisions of individual participants. These constraints seek to transform the problem from an adversarial one into a non-competing one. For example, capacity-constrained resources may be allocated to individual participants. Each participant may make decisions within the specified constraints in accordance with individual goals; and

d) with rules implemented through the use of information provided by participants, a verification function may be required to ensure that information is not provided specifically for the purposes of "gaming" the rules.

Unilateral decision-making with complementary individual goals — Pre-collaboration is applied to identify the decision maker and the rules by which decisions are made. Considerations for unilateral decision-making under common goals all apply. Rules may consider the differences in goals between participants through information (e.g., preferences) provided by participants.

Unilateral decision-making with adversarial individual goals — As for the case with complementary individual goals, pre-collaboration is applied. In this case, the pre-collaboration must clearly establish rules of behaviour and information-provision on the part of participants to ensure that rules are not being "gamed" through the provision of false information or through otherwise undesirable actions seeking to trigger an outcome.

2.5 HARMONIZING CDM PROCESSES

2.5.1 The preceding section described different types of decision-making circumstances and considerations for collaborating under the types of decision-making. In order to collaborate successfully, each type of decision-making requires a process for collaborating; that is, a CDM process. The description of a CDM process requires specification of interactions to a sufficient level of detail to ensure:

a) the process will allow decisions to be reached; and

b) compatibility exists when multiple decision makers (across the ATM community) are participating and potentially applying different internal processes.

2.5.2 The phased approach described in 2.1 results in the definition of a CDM process. The analysis phase of this approach must ensure that compatibility exists when differing internal processes may be interacting. For example, it is not expected that CDM processes will be defined in a manner identical across all regions of the globe or across all borders. While CDM processes may not be globally identical, with AUs operating globally, investments in automation supporting CDM would suggest that a counter-balancing performance benefit should exist to continue to justify these disparities. For tactical decision-making, some harmonization is required to ensure that processes enhance rather than degrade system performance and that the exchange of information in support of CDM can be accomplished with adequate data standards. Below are some examples of the consequences of not harmonizing CDM processes, including a lack of cross-border CDM processes:

a) as part of airspace organization and management, constraints may be provided to a flight across multiple ASPs. Multiple CDM processes may even define these in each locality. Lack of harmonization and collaboration on these constraints across these multiple ASPs and other participating ATM community members may lead to inefficient flight profiles (and potentially infeasible profiles in extreme cases);

b) having different objectives across locations applying CDM processes may lead to none of the objectives being met. For example, a focus on environment versus AU economic performance would not be aligned when time is the driver of economic performance. Collaboration could enable an end-to-end solution that is more acceptable to both than a fragmented solution; and

c) rationing of capacity-constrained resources may be accomplished through different means in different locations. Examples include first-come, first-served, ration-by-schedule, or market-based approaches. Priorities may change for flights as they enter into different airspace regions potentially resulting in flights hurrying to be first in line, only to have to wait longer (a “hurry-up-and-wait” situation).

2.5.3 Dealing with the above examples requires that CDM processes essentially make sense across boundaries. This necessitates: a) the definition of a CDM process in each location; and b) the harmonization of those processes across locations so they are not working at odds.

2.5.4 Specific areas for which CDM processes should be standardized include:

a) agreement on processes or interacting processes;

b) data/information standards; and

c) rules and compliance monitoring.

2.6 CDM PROCESS DETAILS

2.6.1 Whether one is considering the application of CDM within a single location, or one is considering the harmonization of CDM processes across multiple locations (i.e., cross-border CDM), there are some detail-oriented considerations that must be taken into account. This section highlights some of these considerations without providing a recipe for doing so, as CDM is expected to be flexible in its implementation.

2.6.2 As one develops a CDM process or attempts to harmonize potentially disparate processes, detailed end-to-end analyses of the process and interactions will likely be required. This is described in 2.1.7 as the second phase. At a minimum, these analyses will entail the following:

Understand objectives (shared and individual) — Identify the overall shared objective(s) of collaboration. Individual objectives may be at odds, difficult to establish, and will affect behaviour. Understanding objectives is critical to developing likely interactions so that the proper information exchange and control mechanism can be put in place. Together, these seek to achieve shared objectives and mitigate potentially adverse behaviour. For example, control mechanisms may need to be in place to allow the overall objective to be achieved (e.g., constrain flight changes to ensure an equitable process). These control mechanisms are described as rules governing a CDM process in 2.8.

Understand decisions being made by various participants — Once objectives are understood, the next step is to understand the decision(s) that can be made by whom to reach that objective. As one investigates these decisions, the following questions should be considered:

What are the decisions to be made? Whatever CDM process is being investigated, a set of decision variables can be affected by certain CDM participants. For example: a decision can be to impose a constraint on a flight or a defined group of flights (e.g., a participant may be allowed to have two flights use a resource within a time frame), or a flight itself can be changed (e.g., re-route, change departure time, altitude constraints).

Who makes the decision? The allocation of responsibilities for decision-making is central to defining a CDM process. In the examples provided previously, an ASP might alter the flight in accordance with CDM rules and provided information, or might allocate resources to a participant that then alters the flights to meet the resource allocation. The resulting performance may be very different depending on who has access to what information. Who decides is critical to understanding the outcome since the decision makers will seek to meet individual objectives within required constraints. If system-performance improvement (across all KPAs including access and equity) is the overall goal, then the process may have to define constraints on select groups of participants to ensure that the pursuit of individual objectives leads to system performance improvements.

What does the decision affect? The relationship among the decisions being made, the goals of the participant making the decisions (subject to constraints) and the performance outcome of those decisions should be understood. These enable an analysis of candidate processes to define a CDM process that will be feasible and best meet performance objectives.

How does one achieve convergence? When a CDM process is defined to make decisions across multiple participants, decisions may need to be collaboratively reconciled. It is important to define a process that enables this reconciliation to occur in a manner that does not lead to stalemates. One approach is to pre-collaborate to define a process to be applied when a deadlock has been reached (e.g., an algorithmic approach, or guidelines for a single unilateral decision maker to end a deadlock).

Determine the compatibility of interacting processes of various types — When multiple CDM processes interact, or when the decision discussion requires an evolving process, it is necessary to ensure that these processes are compatible. This includes:

Time evolution — When the process changes type across the decision-time horizon, decisions made at an earlier point in time may conflict with later decisions if the processes are incompatible. For example, evolution from multilateral to unilateral decision-making should make sure that decisions do not get compromised by the unilateral decision maker thereby creating deleterious performance effects.

Differences across ASPs — A single flight or flow may operate through multiple areas of jurisdiction, each with CDM processes of different types. It is important to ensure that the overall end-to-end solution can be achieved at acceptable levels of performance. For example, when multiple ASPs encounter capacity constraints affecting a shared flow, the modification of trajectories to deal with each constraint independently is not a desirable situation. It is preferable that an end-to-end solution be developed for each flight, yet this is difficult to accomplish unless the processes have methods to prioritize constraints, to allow trading between flights, or are flexible in the timing of constraints.

Ensure compatibility of interaction between various participants — CDM occurs through a continuous process of information provision and individual decision-making by various interacting participants. The process must be analysed to ensure compatibility of these interactions across boundaries. This includes:

Timing of events — Decisions made by various participants may have to be synchronized, as may the sharing of information. For example, all constraint information would ideally be provided prior to a decision altering a trajectory in order to meet constraints one at a time. Poor timing of decisions in one area can affect the decision in another area which could lead to sub-optimal trajectory choices.

Information exchange — Information that is exchanged should be subject to standards to ensure interoperability and to minimize data translation. The link between local airport processes and broader ATM network processes is ensured through execution of the CDM phases as described in 2.1. This is especially valid as described in the second phase for those ATM community members who are affected by the outcome of decisions and the need for supporting information made available through defined exchanges.

Consistency of rules — CDM processes may allow individual participants to make individualized decisions within the confines of rules (e.g., substitutions within a resource allocation). These rules are frequently defined to ensure that system performance is not adversely affected by individual participants optimizing their own performance. When multiple CDM processes interact, the rules must be investigated to ensure that the overall system performance is still not adversely impacted.

2.7 HARMONIZING DATA

2.7.1 Data exchange is critical to CDM as participants in the decision-making process must have the information necessary to make decisions consistent with the objectives sought. However, in order for information exchange to be effective, information standards must be defined to ensure compatibility and common understanding among participants and decision makers. These standards should address the following:

a) Syntactic interoperability — data formats, communications protocols, etc., must be defined to ensure the successful exchange of data between systems. Units must be considered. Formats should apply to complex data structures, not just the simplest data item;

b) Data definition — data items should be defined in a consistent manner across CDM processes that use the data. Ambiguous or duplicative data elements should be avoided;

c) Update requirements — requirements on frequency of cyclical information updates, and definition of events triggering information updates should be established. This includes requirements on the update of data whose content is derived from other updated data elements; and

d) Information quality — there are many dimensions to information quality. These include: accuracy of provided data, precision with which it is provided, stability of the data in a changing environment, and latency of information provision.

2.7.2 The application of data standards not only helps to reduce incompatibilities in decisions due to conflicting interpretation of information, but reduces development costs for automation systems interacting across disparate locations (i.e., cross-border CDM). An analysis of CDM processes to ensure that data update requirements are sufficient for successful decision-making may also be required when interacting CDM processes have disparate information and timing requirements.

2.8 HARMONIZATION OF RULES AND COMPLIANCE MONITORING

2.8.1 As the time horizon for decision-making shortens into the more tactical decision-making, there is less time available for negotiation, and collaboration is expected to be more structured. This structure consists of rules of behaviour during collaboration which include:

a) description of information to be provided by participants;

b) indication of deadlines for provision of information;

c) identification of quality of information to be provided, including accuracy;

d) allowable use of provided information and requirements on protection of provided information; and

e) identification of decision makers and constraints on decisions. These constraints can include:

1) parameters for user-responses to resource allocation (e.g., bounds on departure times, treatment of substitutions);

2) algorithms or rules for unilateral decision-making (e.g., use of information for prioritization of resource use); and

3) deadlines for decision-making and potentially switching between types of decisions (e.g., from multilateral to unilateral decision-making).

2.8.2 This structure is expected to be defined through pre-collaboration between the expected participants of the CDM process. With a structure comes the expectation that participants will abide by it; however, it may not always be in their interest to do so. As a result, a compliance monitoring function may be required to ensure that rules are followed. For example, this can include the verification of the accuracy of information when that information is used for allocation of constrained resources.

2.8.3 The rules that are agreed to for a CDM process will likely have a strong effect on the behaviour of the participants in response. In particular, the process for prioritization can be based upon:

a) observation of actual behaviour such as a first-come, first-served approach;

b) information provided reflecting intent, such as a ration-by-schedule. Observations must be consistent with the intent; and

c) global performance considerations, such as a best-equipped, best-served approach when equipage is deemed to provide system-level performance gains.

2.8.4 In each of the above, individual stakeholder performance will be affected by the stakeholder's behaviour in response to the prioritization approach. For example, scheduling decisions will reflect a desire to be prioritized highly. First-come, first-served will suggest that a "hurry-up and wait" strategy will be preferable. This indicates the need to ensure that participants in the definition of the CDM process consider the impact on individual behaviours when developing the process.

2.8.5 When dealing with the interaction between different locations, potentially with differing CDM processes, an agreed upon CDM process should be considered by the union of participants in each individual CDM process. The interaction of different constraints and rules may adversely impact the performance of the overall ATM system. As a specific example, the allocation of priorities (for assignment of access to capacity-controlled resources) across different ASPs may lead to airborne delays if a flight is considered high priority in one constrained airspace only to fly into airspace where it is considered low priority.

2.9 COMPLEMENTARY DECISION-MAKING

2.9.1 With time elapsing, a multilateral decision-making approach may not be reaching a solution that solves known capacity imbalances because individual participants seek their individual objectives in lieu of a collective one. An example includes decisions on routes required to deal with airspace congestion prior to a deadline such as a flight's planned departure time. AUs may be unwilling to re-route their own flights if other users may do so.

2.9.2 At some point a unilateral decision might be reached by the ASP assigning re-routes to the various impacted flights. This can be accomplished in an equitable manner by pre-collaborating on the precise method by which flights will be re-routed in such a situation, or by specifying an allocation of flights to each participant to be re-routed.

2.9.3 Complementary decision-making occurs when the outcome of the unilateral decision-making is known to all participants because the information and methods for deciding are also known to all participants. Another approach may be for the unilateral decision maker to pre-emptively broadcast the action before it is taken. The consequence of such a situation is that decisions made multilaterally will only be taken if they provide an improvement over the expected unilateral outcome. As a result, the performance for each individual is improved over the unilateral situation. However, it is important that the CDM process be defined in such a manner that all such decisions taken by an individual participant are “Pareto” optimal; that is, they cannot harm the performance of other participants.

Chapter 3

ROLE OF INFORMATION EXCHANGE

3.1 INTRODUCTION

Without information exchange, it is difficult to imagine collaboration. This exchange can occur with various degrees of structure. At one end, an unstructured approach to information exchange might involve teleconferences between collaborating parties affording an opportunity to ask for clarification. As more structure is incorporated, information exchange could be at a system-to-system level with algorithms on both ends exchanging information to reach individual decisions. When time is at a premium and many parties are involved, automation requires data, and more structure is required for information exchange. This chapter focuses on the information exchange in this more structured environment, as follows:

a) a future collaborative environment envisaged to support the Global ATM Operational Concept;

b) what is meant by data standardization in such an environment; and

c) defining quality of information.

3.2 THE COLLABORATIVE ENVIRONMENT

3.2.1 Doc 9965 describes the flight and flow — information for a collaborative environment concept. The future vision of this collaborative environment follows from the vision provided through Doc 9854, which states:

> "Information management will assemble the best possible integrated picture of the historical, real-time and planned or foreseen future state of the ATM situation. Information management will provide the basis for improved decision-making by all ATM community members. Key to the concept will be the management of an information-rich environment."

3.2.2 Figure I-3-1, extracted from Doc 9965, describes participants, at a high level, collaborating by providing and consuming information across various information domains. The high-level categories of participants that may be included in the collaboration are:

a) ASP;

b) airport operator (AOP);

c) AU;

d) airspace provider (AP); and

e) emergency service provider (ESP).

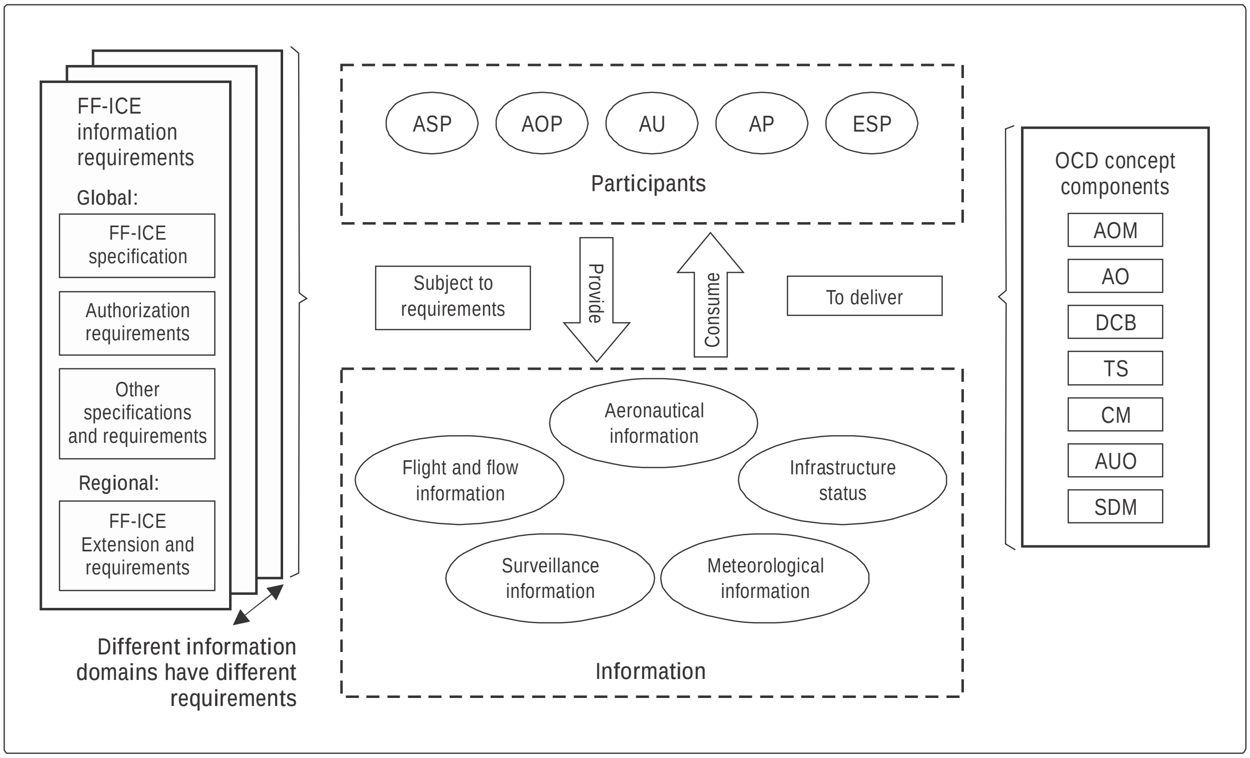

Figure I-3-1. Example information in a collaborative environment

3.2.3 One purpose of the collaboration is to deliver the concept component functionality. Each information domain would be subject to specific information requirements at a global level and potentially at a regional level as well. These requirements on information are expected to consist of:

Data specification — Successful data exchange requires specific standards for data items including the definition and the structure with which they will be exchanged. In a performance-based environment, data are also subject to requirements on quality enabling the delivery of the concept components within a target level of performance. These two aspects, data standards and information quality, are discussed in more detail in subsequent sections.

Authorization requirements — The provision and consumption of information will be subject to context-sensitive authorization requirements. Participants will be able to provide, modify and obtain data only when certain conditions are met. These conditions will depend on the circumstance and the participant requesting authorization. For example, one AU will not be capable of modifying information on the flights of other AUs. As a flight transitions through multiple ASPs, authorization requirements will change.

Operational requirements — In addition to requirements on the data and the access to the data, there may be operational requirements. An example would be the requirement to provide data in order to qualify for a procedure or access to some constrained resource (e.g., level of RNP to access airspace with criteria; permission information for access to certain airspace; equipage and crew qualifications for advanced procedures). Another example involves the need for information to comply with specified constraints (e.g., trajectory complies with airspace constraints). These requirements are not expected to be static (temporally or geographically) as service delivery management will modify these as necessary to achieve performance levels in accordance with anticipated demand.

3.2.4 Given the collection of requirements with which information exchange in this collaborative environment is expected to comply, a system of checks should be in place to ensure compliance. Some checks, such as whether the document is valid and well-formed (in XML parlance), can be accomplished through the availability of an appropriate standards document (e.g., schemas). Other forms of compliance verification will require definition during the establishment of the requirements.

3.2.5 With appropriate information management, a CDM environment is created through the following:

a) the information infrastructure supports the sharing of information across a wider, extensible set of participants, thereby allowing greater participation by the ATM community and reaching shared situational awareness. Decisions can be made in a more collaborative manner with greater knowledge to determine their consequences;

b) an extensible information infrastructure supports the addition of new information items, such as preferences to enable all participants to extend their information needs as decision-making processes evolve; and

c) international data standards and information requirements enable decision automation to be developed once without customization across multiple regions. Through lower participation costs, collaboration is increased.

3.3 DATA STANDARDIZATION

3.3.1 Chapter 2, Section 2.7 of this manual indicates the need for data harmonization. Furthermore, Doc 9854 indicates that "information management will use globally harmonized information attributes". One stage of data harmonization is the development of globally applicable data standards.

3.3.2 As it relates to CDM, data standardization is pertinent to several areas within which decisions would be expected to be made through collaboration, such as:

a) areas falling under the purview of the performance-based approach (e.g., agreement on performance outcomes, operational improvement deployment, airspace redesign, projections and post-operational analysis). For these areas, decisions are expected to be supported with the necessary standardized data to enable performance evaluation. These considerations are described in Doc 9883, Appendix D, First Edition, 2009; and

b) areas involving more tactical CDM for which information is expected, in many regions, to be exchanged system-to-system. These areas include:

   1) tactical airspace organization (e.g., collaborating on defining airspace configurations for capacity);

   2) tactical capacity management (e.g., collaborating on airport/airspace configurations potentially trading capacity for efficiency); and

   3) trajectory management (including management of priority, sequences, and access).

These areas are expected to require information as illustrated by the five information domains as shown in Figure I-3-1. These domains are:

   1) aeronautical information — standards for aeronautical information would be described through the aeronautical information exchange model (AIXM);

2) flight and flow information — Doc 9965 provides initial material to define standards for the flight information exchange model (FIXM);

3) surveillance information — current standards for the ground-to-ground exchange of surveillance information;

4) meteorological information — current standards for the global dissemination of weather products. Further standards development work may be required for new aviation weather products and to make these applicable to aviation CDM (e.g., see the weather information exchange model (WXXM)); and

5) infrastructure status — standards for infrastructure status could largely be expressed using modified AIXM standards.

3.3.3 Data standardization in each of the above domains seeks to address the following:

a) data item identification — defines the universal name for the data item;

b) definition — an unambiguous definition of the data item is required. This refers to a plain-language definition of the data item;

c) syntax — this describes how the data are expressed. Descriptions of syntax should, to the extent possible, apply repeatable data types (e.g., integer, decimal, string, data) as defined in existing standards (e.g., FAQ Markup Language (FML) per ISO 19136 for standards defined in XML):

   1) the syntax of one data element may be defined as a collection of nested data elements. For example, a data element may be a list comprised of multiple data elements each with their own definitions and syntax. A trajectory would likely be composed of many other nested data elements; and

   2) valid lexical representations of the data should be identified (e.g., 10e3 and 1000 represent the same numbers);

d) constraints on syntax — these limit the set of possible data elements that can be defined within the given syntax:

   1) default values for the data type, if applicable;

   2) range and domain of the data item. This may include an enumeration of valid categorical data such as wake categories or aircraft types;

   3) maximum and minimum level of precision of the data (e.g., decimal places);

   4) restrictions on the order of appearance of data; and

   5) repeatability — how many of these data elements are allowed (e.g., multiple equipment codes, but only one aircraft type); and

e) additional information about data items:

   1) approved units — what are valid units and how they will be expressed. Constraints on syntax will vary depending on the selected unit; and

   2) accuracy and information quality — if information quality is required, how is this expressed.

3.4 QUALITY OF INFORMATION

3.4.1 Decision-making is improved with accurate information; where such data are not available, good decision-making is then based upon expected outcomes. There are many reasons why information may be of lower quality. The reasons for this determine the manner in which the information is treated. Examples include:

a) accuracy of forecast or predicted information is affected by the foreseeable horizon. It is useful to have metrics indicating the prediction accuracy together with the information. The most basic approach to dealing with such inaccuracies is to seek improvements in forecast ability, but this may be prohibitive or infeasible. Alternatively, decision-making may consider the expectation of error in a variety of manners:

   1) expectation-based decision-making;

   2) allocation of decisions between strategic and tactical decisions are based upon uncertainty; and

   3) exemption from decision-making;

b) information quality is expected to vary as a function of location, in part due to differences in available infrastructure. Any CDM process spanning localities with disparities in information quality must be able to accommodate these. It is expected that a performance-based approach would be applied to ameliorating the infrastructure where necessary;

c) when information is provided by participants for the purpose of informing of decisions pertaining to the information providers, and where interests are competitive, the possibility exists that misleading information will be provided, essential information will be omitted, or information may not be provided in the timeliest manner. These would be guided by the desire of an individual participant to obtain a beneficial outcome. In particular, the provision-of-intent information could be subject to interpretation. Chapter 2, Section 2.8 discusses the need for rules in this area;

d) ATM is dealt with in a dynamic environment. As a result, information may change frequently and significantly. Highly unstable information may prove of little use. Knowledge of the stability of the information is important when making decisions. For example, knowing that a user may significantly change its desired trajectory provides information to be used in determining demand/capacity imbalance likelihoods. The stability of the information can be managed through: a) providing indications of stability of the information; and/or b) requiring that decisions be stabilized by certain deadlines. These would be defined collaboratively when identifying the CDM processes; and

e) additional technical quality details. These include the accuracy of measured data, the fidelity or resolution of reported data, the frequency of events leading to updates, and the basis for reporting the data (such as a specific grid). For these details, one would expect requirements to be in place to define the level of quality required from information providers.

3.4.2 As part of the definition of CDM processes, one would expect the specification of data-sharing agreements between collaborating participants to be documented through Memoranda of Understanding, data specifications, and data quality documents. Reporting measures on data quality may also be explicitly articulated and reported on a regular basis.

Chapter 4

ARTICULATING A CDM PROCESS

4.1 INTRODUCTION

4.1.1 In a collaborative process, the goal is not only to achieve a desired outcome, but to achieve that desired outcome in the most efficient and effective way possible for the organization(s) and for all collaborating parties involved. This can only be achieved if the collaborating parties give as much attention to how they work together throughout the process as they do to the process itself. Without one or the other, true cooperation, synergy and teamwork cannot occur.

4.1.2 The description of a CDM process requires the identification of:

a) What is the objective of the collaboration? This includes identifying the end-product of the collaboration. CDM leads to decisions, including agreements;

b) Who are the collaborating participants?

c) How are they collaborating? This includes addressing:

   1) What are the roles and responsibilities of the individual participants towards reaching the objective?

   2) What exchange of information is required? This includes addressing how the CDM process interacts with the overall collaborative environment.

   3) What are the rules? How are they enforced?

   4) How is a decision reached/finalized?

   5) Disagreements:

      i) What process is used to handle disagreements within the group?

      ii) How will disagreements that seem irresolvable be handled?

   6) If a decision has a deadline, how are deadlocks arbitrated?

4.1.3 It is important that the CDM process be defined considering the aspects described herein, but also be detailed in unambiguous governing documents that are agreed to by all participants.

4.2 COLLABORATING PARTICIPANTS AND OBJECTIVE SETTING

4.2.1 One of the first steps in articulating a CDM process is to first understand the objective of the collaboration. An initial objective can be high-level, such as improving the allocation of delays when resource constraints require delays. With an initial objective identified, a set of participants can be defined. Participants may include both humans and automation systems.

4.2.2 The phases described in Chapter 2, 2.1, can be classified into two stages of collaboration: 1) the setting up of the CDM process (phases 1-5); and 2) the execution of the agreed-upon CDM process (phase 6). During the initial stage, identified participants collaborate on refining the objective of collaboration as illustrated in Figure I-4-1. This may lead to changes in the required participants as well. Examples of objectives include:

a) agreement on flight-specific trajectory information (e.g., push-back times, departure times, routing) in order to mitigate demand/capacity imbalances;

b) agreement on collaborated forecast products as input to capacity estimates; or

c) agreement on airspace configuration changes including timing.

4.2.3 As previously described in Chapter 3, 3.2.2, Figure I-4-1 illustrates the high-level categories of participants that may be included in collaboration, these are:

a) ASP;

b) AOP;

c) AU;

d) AP; and

e) ESP.

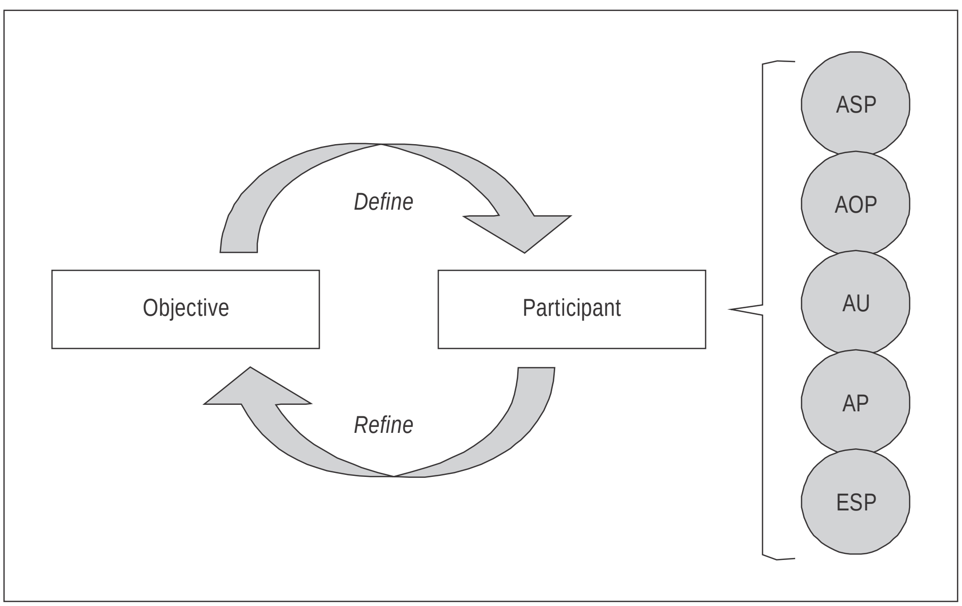

Figure I-4-1. Iterative process identifying participants and objective(s)

4.2.4 In addition to the collaborating participants listed above, depending on the specifics of a collaborative process, additional participants may include:

a) information provider — for example, a weather provider may be included for decisions impacted by weather forecasts;

b) flying public — information may be provided to the flying public to enable improved decision-making on their part; and

c) regulators — particularly during the definition of the CDM process, regulators in all areas, including economic, environment, and safety may need to be involved.

4.2.5 The identification of collaborating participants will require some iteration as well. When the purpose of the collaboration is defined, the impact of the types of decisions that are anticipated should be understood. An initial list of collaborating participants would be those participants that are expected to be impacted by the decisions, and those that are required to provide information or make related decisions. In this manner, one can feel confident that the right people are part of the process.

4.2.6 With participants and objectives established, roles and responsibilities for each stakeholder may be identified as per 4.3. These will establish the manner in which the CDM process will be executed during the second stage of collaboration.

4.3 ROLES AND RESPONSIBILITIES

4.3.1 In a CDM process, participants typically have the following overall types of roles and responsibilities:

a) consume and interpret information;

b) provide information, including the updating and sharing of data triggered by received information;

c) make a decision and share the result of that decision;

d) execute on a decision that has been made. The executing participant may or may not be the participant that made the decision; and

e) provide a service consistent with decisions that have been made.

4.3.2 Prior to describing a collaborative process, the set of specific circumstances under which the described situation may occur should be defined. There may be several sets of circumstances with different roles and responsibilities (e.g., with a limited amount of time, decision-making may be more unilateral). This effectively defines how and when collaboration is expected to begin. This may involve the specification of a participant that has the authority to determine, through a set of established rules or guidelines, when collaboration is initiated for a specific objective.

4.3.3 In an effort to better understand the collaborative process roles and responsibilities, it is frequently useful to express the process through interaction diagrams (e.g., sequence diagrams, activity diagrams) that allow an unambiguous representation of the interactions between participants. These can be used to describe:

a) which participants are providing and receiving what information and when. Information may be provided based upon identified events, an update cycle or at the discretion of the provider. It is useful to identify compulsory versus optional interactions. Deadlines on the provision of information should be specified. Standards for quality of information provision and requirements on information are expected to be in place in accordance with Chapter 3; and

b) participants expecting to react to provided information should be identified, together with what the information is used for (e.g., re-compute flight-specific push-back times, determine flights impacted by congestion). This may lead to the provision of additional information to be used by other participants, or may lead to a decision to act, such as:

   1) in some cases, the use of information may be constrained by a set of rules governing the application of the information. For example, operators may be constrained to modify flight times such that only a certain number of flights use a resource. Unilateral decision makers may be constrained to assign resources or modify departure times subject to precise algorithms based on provided information; and

   2) different participants may be assigned the responsibility to decide on different portions of the problem space (e.g., AUs may decide on individual flights, and ASPs on the allocation of capacity to AUs);

c) once decisions have been taken, it is expected that execution of those decisions by the responsible parties will follow.

4.3.4 The above applies to a more structured collaborative process with emphasis on information-exchange. Some less structured collaborative processes may involve participants in a teleconference to discuss information, however the roles and responsibilities would be defined in a similar manner as described above.

4.4 INFORMATION REQUIREMENTS

Requirements for information, as detailed in Chapter 3, must be defined in detail (e.g., through interface requirements where automation may be involved) when describing a CDM process.

4.5 MAKING DECISIONS

4.5.1 The collaborative process must indicate which participants are responsible for making which decisions as part of the definition of roles and responsibilities (see Chapter 2, 2.4). When the CDM process is first defined, the allocation of decisions into subproblems with the best decision maker responsible for its own decisions is critical. One example for distributed decision-making is to let a unilateral decision maker assign a portion of constrained resources to participants, in accordance with pre-collaborated rules ensuring an equitable process. Participants are then able to make decisions within the allocation as suitable for their own operations.

4.5.2 The process for making decisions is not expected to be static in all cases. As a deadline approaches, collaboration may not be quick enough to ensure convergence to a solution. In these cases, pre-collaboration may establish a process for timelier decision-making. This includes identifying a unilateral decision maker, defining roles and responsibilities in accordance with 4.3, and unambiguously specifying a deadline for switching to unilateral decision-making. In the example provided in 4.5.1, a unilateral decision maker may only get involved at a specified time prior to planned arrival time. Prior to that, other participants may propose their own changes. In an environment with shared situational awareness, complementary decision-making would follow as per Chapter 2, 2.9.

4.5.3 Once a decision has been made, the mechanism for communicating this decision to participants must be defined. Typically, this will be through the provision of some information (e.g., flight push-back time, desired route of flight) subject to information standards as defined in Chapter 3.

4.6 RULES AND ACCOUNTABILITY

4.6.1 The rules and mechanisms for accountability must be described as part of a CDM process (see Chapter 3).

4.6.2 The CDM process is governed by rules defining the participants, provision and consumption of information, quality of that information, expected decisions and times/events for those decisions, requirements as part of the collaborative process (see 3.2), and constraints which must be followed for decision-making. These rules and requirements are expected to be set during the CDM process definition stage and may use a collaborative performance-based approach to do so.

4.6.3 In addition to describing the rules, the consequences of not following the rules should be established a priori through the collaborative process. These may include pre-collaborated penalties (e.g., less allocation of resources in the future) when a participating member is not demonstrating accountability. This may require the need for participants to provide additional information and to have an arbitrator acting as an independent party to enforce the rules. Where possible, real-time monitoring would be preferable, but this may be prohibitive.

PART II

AIR TRAFFIC FLOW MANAGEMENT (ATFM)

Chapter 1

INTRODUCTION

1.1 AIR TRAFFIC FLOW MANAGEMENT (ATFM) PHILOSOPHY

Air traffic flow management (ATFM) is an enabler of air traffic management (ATM) efficiency and effectiveness. It contributes to the safety, efficiency, cost-effectiveness and environmental sustainability of an ATM system. It is also a major enabler of global interoperability in the air transport industry. It is important to recognize that, over time, two threads of events are going to appear simultaneously:

a) local ATFM implementations conducted worldwide are going to shape a global ATFM; and

b) standardized ATFM processes will be implemented globally.

1.2 ATFM SERVICE

1.2.1 The level of an ATFM service required in a given setting will depend on a number of factors that are addressed in this manual. An ATFM service is established to enable air navigation services providers (ANSPs) to effectively provide the required service based on the current and projected operational needs. An ATFM service which is properly designed and implemented delivers ATM performance benefits with organization, process, training, and automation matched to the operational need.

1.2.2 One key to the successful implementation of an effective ATFM service is achieving a robust coordination among aviation stakeholders. It is envisioned that ATFM is performed as a collaborative decision-making (CDM) process where aerodromes, ANSPs, airspace users (AUs) and other stakeholders work together to improve the overall performance of the ATM system. It is likewise envisioned that such coordination will take place within a flight information region (FIR), between FIRs and ultimately, between ICAO regions.

1.2.3 Initial implementations of ATFM were meant to manage air traffic demand where and when it exceeded capacity of air traffic control (ATC) services. The modern concept of ATFM has evolved to facilitate the safe, orderly and expeditious flow of air traffic by not only ensuring that ATC capacity is optimized and utilized to the maximum extent possible, but also allowing the traffic demand to be compatible with ATC capacity.

1.2.4 As a general rule, ATFM is needed whenever AUs are faced with constraints on their operations and in areas where traffic flows are significant. ATFM entails engagement firstly during the strategic phase, in the form of strategic airspace utilization planning; secondly during the pre-tactical phase, where meteorological factors and other developing constraints are assessed and mitigation plans are considered; and thirdly, during the tactical phase, which includes the period during which the aircraft is in flight.

Note.— See Part II, Chapter 4, for more information on ATFM phases.

1.2.5 Given the modern global nature of air traffic, the realization that effective management must transcend national borders and that optimal results require collaboration between all stakeholders, it would be appropriate for all States and ANSPs to consider implementing some form of ATFM.

1.2.6 ATFM and its applications should not be restricted to one State or FIR because of their far-reaching effects on the flow of traffic elsewhere. The *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) recognizes this important fact, stating that ATFM should be implemented on the basis of a regional air navigation agreement or, when appropriate, as a multilateral agreement.

1.2.7 The far-reaching effects of ATFM and the variety of stakeholders it impacts are so significant, that a regulatory support framework is essential. The notion of a regulatory framework, in the context of this manual, should be understood as a set of rules and principles governing key aspects of ATFM provisions and ensuring the appropriate involvement of all the relevant stakeholders.

Note.— See Part II, Chapter 7, for information related to the regulatory support framework.

1.3 AIR TRAFFIC FLOW MANAGEMENT OBJECTIVES AND PRINCIPLES

1.3.1 The objectives of ATFM consist of:

a) enhancing the safety of the ATM system by ensuring the delivery of safe traffic densities and minimizing traffic surges;

b) ensuring an optimum flow of air traffic throughout all phases of the operation of a flight by balancing demand and capacity;

c) facilitating collaboration among system stakeholders to achieve an efficient flow of air traffic through multiple volumes of airspace in a timely and flexible manner that supports the achievement of the business or mission objectives of AUs and provides optimum operational choices;

d) balancing the legitimate but sometimes conflicting requirements of all AUs, thus promoting equitable treatment;

e) reconciling ATM system resource constraints with economic and environmental priorities;

f) facilitating, by collaborating with all stakeholders, the management of constraints, inefficiencies, and unforeseen events that affect system capacity in order to minimize negative impacts of disruptions and changing conditions; and

g) facilitating the achievement of a seamless and harmonized ATM system while ensuring compatibility with international developments.

1.3.2 The principles of ATFM consist of:

a) optimizing available airport and airspace capacity without compromising safety;

b) maximizing operational benefits and global efficiency while maintaining agreed safety levels;

c) promoting timely and effective coordination and collaboration with all affected stakeholders;

d) fostering international collaboration leading to an optimal, seamless ATM environment;

e) recognizing that airspace is a common resource for all users and ensuring equity and transparency, while taking into account security and defence needs;

f) supporting the introduction of new technologies and procedures that enhance system capacity and efficiency;

g) enhancing predictability, for ANSPs as well as AUs;

h) helping to maximize aviation economic efficiencies and returns, and support other economic sectors such as business, tourism and cargo; and

i) constantly evolving to support the ever-changing aviation environment.

1.4 AIR TRAFFIC FLOW MANAGEMENT BENEFITS

The benefits of ATFM cover various domains of the ATM system:

a) operational:

1) enhanced ATM system safety;

2) increased system operational efficiency and predictability through CDM processes;

3) effective management of capacity and demand through data analysis and planning;

4) increased situational awareness among stakeholders and a coordinated, collaborative development and execution of operational plans;

5) improved punctuality, reduced fuel burn and other AU operating costs;

6) effective management of irregular operations and effective mitigation of system constraints and consequences of unforeseen events; and

7) provision of post-operational data related to traffic movements;

b) societal:

1) improved quality of air travel, including improved information provided to the travelling public;

2) increased economic development through efficient and cost-effective services to the projected increased levels of air traffic;

3) reduction of aviation-related greenhouse gas emissions; and

4) mitigation of the effects of unforeseen events and situations of reduced capacity, through the coordination of effective and rapid solutions to recovery.

1.5 ATFM IN THE GLOBAL AIR NAVIATION PLAN (GANP): A SET ROADMAP

1.5.1 ATFM evolutions are, like any other ATM evolutions, envisaged and described in the *Global Air Navigation Plan (GANP)* (Doc 9750) and the Aviation System Block Upgrades (ASBU). The core of the concept is linked to four specific interrelated aviation performance improvement areas (PIA). They are:

a) aerodrome operations;

b) globally-interoperable systems and data;

c) optimum capacity and flexible flights; and

d) efficient flight paths.

1.5.2 ATFM forms part of the GANP's "Optimum capacity and flexible flights" PIA. ATFM capabilities are described in the series of modules forming the network operations (NOPS) thread describing the ATFM capabilities through the successive block timelines.

1.5.3 The GANP describes an evolution from the current situation to one where traffic flows are managed using advanced complexity management tools, thereby making full use of system-wide information management (SWIM) capabilities. This evolution relies on a progressive implementation of tools that allow for dynamic sector management, and that cater to greater user involvement in the dynamic utilization of the network.

1.5.4 The guiding principles of "first-come, first-served" and "equitable access to airspace" have traditionally been very important to the ATM system, and they still underscore the logic of many such systems. The global ATM system is, however, evolving to incorporate net results relating to overall system efficiency, the environment, and operating cost into its guiding principles.

1.5.5 To support this evolution, the ATFM service must further evolve and integrate a different rationale where the "most capable" aircraft benefit from enhanced capabilities and services in order to achieve optimum ATM system performance. Likewise, the notion of equitable access to airspace may be viewed on a longer time scale rather than the short-term "first-come, first-served" model. These different rationales are progressively being incorporated into ATM and ATFM alike.

1.5.6 The ATFM service, along with ATM as a whole, will therefore undergo a considerable amount of change in the coming years, as both systems evolve to provide improvements in capacity and operational efficiency to meet the growing needs of civil aviation.

Chapter 2

THE ATFM SERVICE

2.1 OPERATIONAL NEEDS OF AN ATFM SERVICE

ATFM service relies on a number of supporting systems, processes and operational data in order to function effectively. The maturity level of these systems and processes will determine the level of ATFM service that is established. Certain elements to be considered when operating an ATFM service are:

a) ATM resources including airspace and airports' capacities;

b) traffic demand: a timely, accurate depiction of predicted flight activity for all flights utilizing an ATM resource (aerodrome, en route sector, etc.). Data should be aggregated from all available operational data sources (e.g., airline schedules, flight plan data, airport slot management information, ATM operational systems, and AU intentions);

c) the tactical, dynamic traffic situation: accurate data derived from surveillance, departure planning and flight information to increase the accuracy of short- to medium-term prediction;

d) the forecast and dynamic meteorological situation: the integration and display of a variety of meteorological data for ATFM planning and operational execution;

e) the airspace status and the availability of restricted or reserved airspace resources that affect the flows of air traffic;

f) shared ATFM tools and data interoperability: tools that enable common situational awareness through the sharing of data and operational information among stakeholders. ATFM tools that accurately display meteorological and air traffic information; and

g) institutional arrangements: formalized organizational structures (see Part II, Chapter 7) and agreements between all ATFM stakeholders in the relevant area and appropriate arrangements with adjacent ATFM units.

2.2 ESTABLISHING AN OPERATIONAL STRATEGY

2.2.1 The main goal of the ATFM strategy is to appropriately manage traffic flows to ensure safety and enhance the overall efficiency of the ATM system, recognizing that airspace and aerodromes are common resources shared by all AUs, and that equity and transparency must be maintained to the highest standard.

2.2.2 ATFM solutions yield greater benefits when they are coordinated, form part of a strategy, and are established in a collaborative manner to deal with specific challenges presented by a high demand in a given location.

Note 1.— See Part II, Chapter 4, for a detailed description of the various ATFM solutions and measures.

Note 2.— ATFM traffic data analysis can yield significant strategic benefits and can be useful for the establishment of a strategy, especially when used in conjunction with airspace and ATS route planning.

2.2.3 The most efficient utilization of available airspace and airport capacity can be achieved only if all relevant elements of the ATM system have been considered during the strategic phase. The envisaged solutions are then implemented pre-tactically and tactically.

Note.— See Part II, Chapter 4, for information on strategic, pre-tactical and tactical phases and associated actions.

2.2.4 In terms of geographic scope, the strategy and planning should, to the extent possible, focus on regional ATFM and be prioritized for appropriate major traffic flows. ATFM measures should be established and coordinated among stakeholders to avoid cumulative or contradictory effects on the same flight.

Note.— See Annex 11 — Air Traffic Services*. 3.7.5.2 "**Recommendation.** — ATFM should be implemented on the basis of regional air navigation agreements or, if appropriate, through multilateral agreements. Such agreements should make provisions for common procedures and common methods of capacity determination."*

2.2.5 ATFM normally applies to all flights using a given resource (airspace or aerodrome). In some cases, however, States may choose to prioritize or exempt certain classes of flight from ATFM measures. Examples include, but are not limited to:

a) flights experiencing an emergency, including aircraft subjected to unlawful interference;

b) flights on search and rescue (SAR) or rescue and firefighting (RFF) missions;

c) urgent medical evacuation flights specifically declared by medical authorities where flight delays would put the life of the patients at risk;

d) flights with "Head of State" status; and

e) other flights specifically identified by State authorities.

Note.— After medical flights have completed their mission they should be subject to applicable ATFM measures. Scheduled patient transfer flights are by nature non-urgent and should not be given priority under a normal operational situation. Notwithstanding any exemption from ATFM measures, exempted aircraft are included in the airport/airspace demand estimation.

2.2.6 When the envisaged solution entails the application of ATFM measures to manage a constraint, the measures should be applied in a timely manner and generally only for the period when expected air traffic demand exceeds the capacity in the constrained area. ATFM measures should be kept to the minimum and, whenever possible, be applied selectively only to that part of the system that is constrained. When delays are unavoidable, the objective should be to balance ground and airborne delays, in collaboration with AUs, to ensure that available capacity is fully utilized, while attempting to meet AUs' business needs, such as passenger and aircraft connectivity.

2.3 COLLABORATION AND ADVANCE NOTICE

2.3.1 As a set of general principles, the notion of collaboration and of advance notice should underscore the entire ATFM strategy. The ATFM solutions should be collaboratively established, in advance, by the ATFM units and all relevant operational stakeholders.

2.3.2 Notwithstanding the number of AUs involved in the design and establishment of the solutions, it is of prime importance that all potentially affected AUs (those involved in the ATFM-CDM processes and those that are not) be notified as soon as possible, either by ATC or by the ATFM unit, of ATFM measures and anticipated overload. Such notification should take place while the aircraft is on the ground to allow the information to be factored into the operational flight planning.

2.3.3 CDM provides the framework to coordinate ATFM measures among ATM stakeholders. Even though coordination does not rely on specific tools, automated tools have been found to enhance the dissemination of ATFM information and CDM process.

2.3.4 Collaborative decision-making (CDM) in the context of ATFM

2.3.4.1 The CDM process is a key enabler in any ATFM strategy, allowing for the sharing of all relevant information among decision makers and supporting an ongoing dialogue between the various stakeholders throughout all phases of flight. This process enables the various organizations to keep each other continuously updated on events resulting from the strategic to tactical phases.

2.3.4.2 CDM is built on the principle that all users have equitable access to the airspace and recognizes that stakeholders may have different priorities. It also acknowledges that the ultimate responsibility for the safety of air navigation services lies with the ANSP, which must take the final decision on initiatives to manage the flow of traffic.

2.3.4.3 Both the organization and the CDM process depend on the complexity of the ATFM service in place. The CDM process must be designed to ensure that stakeholders can discuss demand and capacity issues through regular interactions and formulate plans that consider all pertinent aspects and points of view.

2.3.4.4 Timely and regular operational briefings and conferences can not only provide an overview of both the current and future ATM situation, but they also allow for the discussion of any issues and may provide an outlook on operations for the coming period. Traffic patterns and the severity of demand and capacity imbalances will dictate the frequency of those meetings. They should occur on a daily basis at minimum, but may also become more frequent depending on the situation (e.g., evolving meteorological events). Stakeholders should include ATFM and ATS units, AUs, meteorological service, military authorities and aerodrome authorities, as applicable.

2.3.4.5 The outcome of these daily conferences should result in the publication of an ATFM daily plan (ADP) complete with subsequent updates. The ADP should be a proposed set of ATFM solutions prepared by the ATFM unit, with input from all stakeholders. It should align with the solutions established during the strategic phase and be kept under review, periodically updated and republished as required.

2.3.4.6 Feedback and review from ANSPs, AUs, and the ATFM unit during the post-operation analysis phase (see Chapter 4, Section 4.1.4.4) of the ATFM process can be used for the continuous improvement of pre-tactical and tactical planning. This feedback helps the ATFM unit identify the reason(s) for ATFM solutions. The unit can then determine corrective actions to avoid reoccurrence, if possible, and improve the implemented solutions.

2.3.4.7 In addition to the daily conferences, the ATFM unit should hold periodic and post-event analysis meetings to review the effectiveness of ATFM processes, the compliance of AUs and ATC units, the accuracy of meteorological forecasts, etc.. The objective should be to ensure the effectiveness of the chosen ATFM processes after having taken stakeholders' requirements into consideration.

Note.— See Part II, Chapter 4, Section 4.10, for information on performance.

2.3.4.8 ***CDM benefits for ATFM***

Applying CDM principles to ATFM facilitates the ability to make better decisions and provides the stakeholders with enhanced situational awareness. This awareness generates an environment where such stakeholders share a better understanding of the overall situation.

2.3.4.9 ***ATFM, CDM and civil/military coordination***

2.3.4.9.1 Civil/military coordination provides greater flexibility to stakeholders, as information on airspace availability is enhanced and shared. Some military operations, such as airspace security, live weapons firing air combat manoeuvres, etc., necessitate usage of segregated airspace and generate constraints to civilian traffic flows. Close coordination between military stakeholders and the ATFM unit ensures an optimal utilization of the airspace, meeting the (reasonable) requirements of stakeholders. National policies establish the degree of civil/military coordination in terms of ATM within each State. These policies therefore play a fundamental role in securing a State's participation in the ATFM system.

2.3.4.9.2 The processes related to flexible use of airspace involve optimum sharing of airspace under the appropriate civil/military coordination in order to achieve the proper separation between civil and military flights, thus reducing the need for permanent airspace segregation. Those principles can therefore logically be integrated in ATFM.

2.3.4.9.3 Benefits of civil/military coordination at the ATFM level include:

a) operational savings for flights due to reduced flight time, distance flown and fuel consumption;

b) route network optimization for the provision of ATS and the associated sectorization, which enable an increase in capacity and fewer delays;

c) enhanced access to airspace and increased capacity facilitated by a reduction in the ATC workload derived from reduced airspace/aerodrome congestion;

d) real-time provision of capacity in line with AUs' operational requirements; and

e) definition and use of temporary airspace reservations designed to bring an optimal response to operational requirements.

2.3.4.9.4 Involving military authorities in ATFM can help States and/or service providers develop and document a collaborative process with users of restricted airspace volumes. This should increase efficiency by enabling the use of these airspace volumes by civilian traffic whenever they are not used by the primary AU.

2.3.4.9.5 The agreements and procedures related to flexible use of airspace should specify, inter alia:

a) the horizontal and vertical limits of the airspace concerned;

b) the classification of any airspace made available for civil air traffic;

c) the units or authorities responsible for the airspace;

d) the conditions for transfer of the airspace to/from the ATS unit concerned;

e) the periods of availability of the airspace;

f) any limitations on the use of the airspace concerned;

g) the means and timing of an airspace activation warning if not permanently active; and

h) any other relevant procedures or information.

2.4 ATFM AND CONTINGENCY

2.4.1 ATFM and contingency arrangements are closely interlinked:

a) ATFM provides a process for mitigating the effects of disruption in an ATM systems resource; and

b) contingency arrangements are required in the event of a failure of the ATFM system.

2.4.2 ATFM contingency plans aimed at mitigating the effects of disruptions in the capability of any component of the ATM system should be drawn up, published and periodically reviewed. Such contingency plans should contain:

a) a description of the potential ATM resource failure (ATS unit communication failure, surveillance failure, evacuation of ATS unit operations room, unanticipated aerodrome closure, major airspace closure, etc.);

b) ATFM measures to be taken in response to disruptions (e.g., capacity reduction by 50 per cent);

c) a process for the application of ATFM measures during each contingency situation;

d) recovery procedures;

e) information on contingency points of contact, roles and responsibilities; and

f) post-contingency reporting procedures.

Note.— An example of the ATFM component of an ACC contingency plan is contained in Appendix II-A.

2.4.3 Once implemented, ATFM systems become a critical part of the ATM infrastructure. Contingency arrangements should therefore also be established in the event of an ATFM system unavailability. Such contingency plans normally consist of predetermined procedures defining reduced capacities on major traffic flows to be applied via local ATFM measures in the event of such outages.

2.4.4 It is essential that ATFM contingency plans be published in a secure but easily accessible manner for all those responsible for the application of ATFM contingency measures.

Note.— An example of the EUROPEAN Network Manager ATFCM Procedural Contingency Plan is available at European Network Manager ATFCM Procedural Contingency Plan

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Chapter 3

CAPACITY DETERMINATION

3.1 DETERMINING THE CAPACITY OF AN AIRSPACE SECTOR AND AIRPORT

3.1.1 The capacity of an ATM system depends on many factors including traffic density and complexity, the ATS route structure, the capabilities of the aircraft using the airspace, meteorological factors, air traffic management (ATM)/communications, navigation, and surveillance (CNS) equipment and controller workload. Every effort should be made to provide sufficient capacity to cater to both normal and peak traffic levels; however, when taking any action to increase capacity, the appropriate ATS authority remains responsible to ensure that safety levels are not jeopardized.

3.1.2 The number of aircraft provided with ATC service should not exceed that which can be safely handled by the ATS unit concerned. In order to define the maximum number of flights that can be safely managed, the appropriate ATS authority should assess and declare the capacity for control sectors (en-route and terminal control area) and for airports. This capacity is the "declared capacity" for the airspace or airport.

Note.— See Annex 11 — Air Traffic Services*, 3.7.5.3, related to the obligation of an ATC unit to inform the ATFM unit, if established, or the appropriate ATS unit of the inability to accommodate additional traffic.*

3.1.3 Capacity is normally expressed as the maximum number of aircraft that can be accepted over a given period of time at an ATM resource (airspace sector, waypoint, aerodrome, etc.). The normally measured time period is one hour.

3.1.4 Airspace capacities

3.1.4.1 The capacity for an airspace sector (terminal or en-route) is defined either as an entry count (maximum number of aircraft entering an airspace sector in a given period of time) or a maximum occupancy count over a specific time period (e.g., 15 minutes). Airspace capacity represents the total number of flights that a controller can handle within a sector.

3.1.4.2 In some cases, instantaneous or short duration occupancy counts (e.g., one minute) can be used to complement entry counts and allow higher values for such entry counts. Such occupancy count capacities require accurate and frequent live ATC message and surveillance data updates to the ATFM system. Occupancy counts should be available in advance of the flight entry into the given airspace and on a frequent basis.

3.1.5 Airport capacities

3.1.5.1 Airport capacities are to be established for airport operations where demand exceeds capacity on a regular basis.

3.1.5.2 The ATM capacity of an airport is normally defined as the total number of movements that an airport can handle during a given period of time. The ATM capacity is based on:

a) arrival and departure acceptance rates;

b) runway(s) in use and mode of operations (mixed or segregated arrivals/departures);

c) required separation;

d) aircraft speed;

e) fleet mix;

f) runway occupancy time; and

g) aerodrome infrastructure (e.g., availability of parking stands, congestion on the movement area).

3.1.5.3 Strategic airport slots allocated by airport authorities do not take into account the dynamic changes in ATM capacities due to meteorological and other temporary phenomena. Strategic airport slot allocations should be consistent with declared airport ATM capacities, i.e., the number of allocated strategic airport slots should not exceed the declared capacity of the airport.

Note.— Many busy airports are defined as "coordinated airports". A coordinated airport requires that an airport "slot" be issued by the airport coordinator, allowing the aircraft to arrive or depart on a specific day and time. The guidelines for such slot allocations are published by the International Air Transport Association (IATA) at Worldwide Slot Guidelines.

3.1.6 Operational capacity

In addition to the declared capacities for airports and airspaces (and the capacity associated with the strategic airport slot process), ATFM services require knowledge of the operational capacity. Operational capacity is the expected capacity associated with the tactical situation at the airport or airspace. Dynamic factors, including meteorological conditions, CNS status, fleet mix and staffing may result in an operational capacity inferior to the declared capacity. ATFM solutions (see Part II, Chapter 4) are based on the expected dynamic operational capacity.

3.1.7 Capacity determining methods

3.1.7.1 It would be extremely complex to establish a universal rule to calculate capacity. Capacity can be affected by so many variables and external considerations that standardization is simply not possible. It is therefore up to each ANSP to decide how to determine its capacity by choosing from either basic methods based on observation or highly sophisticated mathematical models.

3.1.7.2 In any case, capacity limits may be assessed using feedback from control staff, incident reports where heavy workload is a factor and real-time observations. Post-operations analysis and monitoring provide essential feedback and can be of great use to refine capacity determination.

3.1.7.3 Operational capacities are not static values, as they vary with traffic complexity and other factors. In general, sustained levels of demand superior to capacity warrant some form of ATFM intervention, whereas short demand spikes moderately above capacity may be managed through attentive oversight, without intervention. Tolerance thresholds may be defined to frame those possible variations of the capacity and to ensure that variations remain within a defined range. Figure II-3-1 illustrates the various elements that are usually taken into account when defining airspace capacities. Figure II-3-2 illustrates the main factors affecting airport capacity. Such factors may be considered as limits, but also as means to improve capacity.

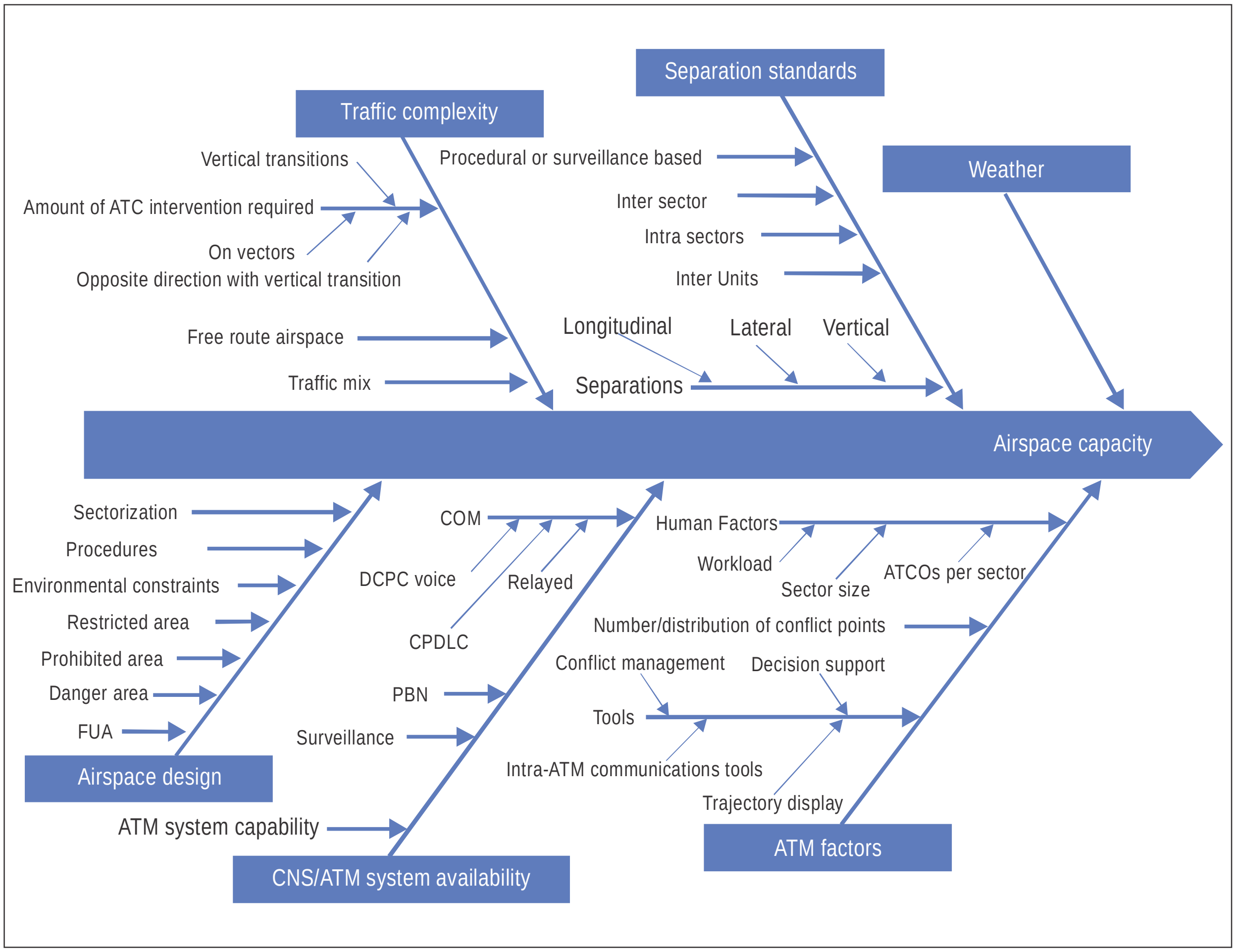

Figure II-3-1. Factors affecting airspace capacity

3.1.7.4 Capacity measurement and calculation methodologies should be developed according to the requirements and conditions of their operational environment. Calculation methodologies have already been established by States in several ICAO regions and the various methods have different levels of complexity. Examples are provided in Appendices II-B, II-C and II-D.

3.1.7.5 Each State is responsible for determining capacity, while using the methodology of its choice. Due consideration should, however, be given to the methods employed by neighbouring States, so as to ensure as much consistency as possible in the methods used to determine capacity for sectors or airports used by the same traffic flows. When regional agreements are established, this specific provision should be addressed.

Note.— See Annex 11 — Air Traffic Services*, 3.7.5.2 "**Recommendation.**— ATFM should be implemented on the basis of regional air navigation agreements or, if appropriate, through multilateral agreements. Such agreements should make provisions for common procedures and common methods of capacity determination."*

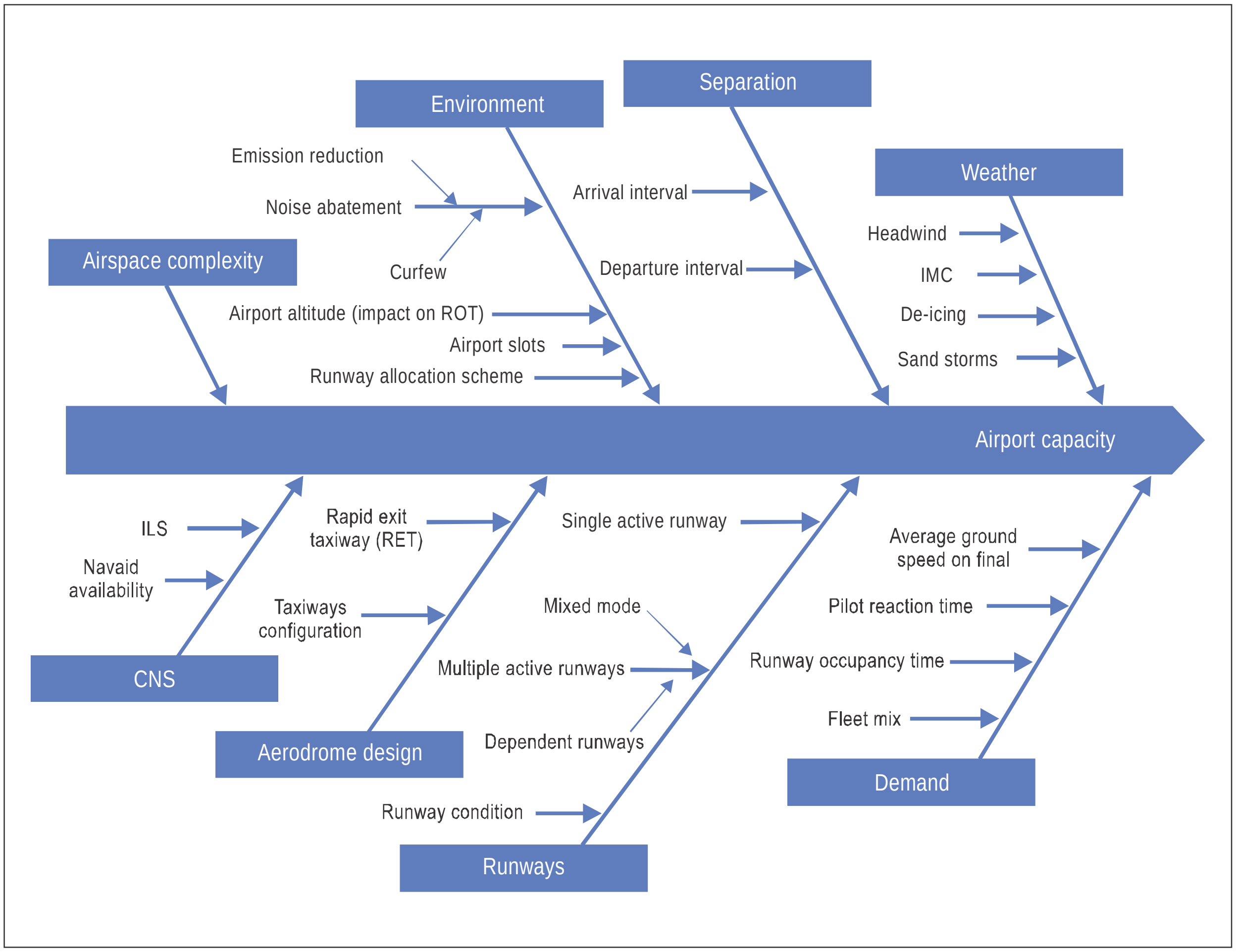

Figure II-3-2. Factors affecting airport capacity

3.1.7.6 There are two schools of thought on how to assess and establish ATC sector capacity: mathematical occupancy and complexity models, and controller workload assessment models. In both cases it is essential that the capacity calculated using these models be validated by other means (e.g., real-time observations, real-time simulations).

3.1.7.7 Mathematical occupancy and complexity models take account of:

a) traffic profile: cruise, climb, descent;

b) traffic mix: light, heavy, speed mix;

c) number and types of typical ATC interventions;

d) sector flight times; and

e) default workload per flight.

3.1.7.8 Controller workload assessment models break down the controller workload into a set of definable and measurable tasks for which average execution times are defined. These tasks include coordination, handling flight data, radio frequency, communications and conflict management. Since the amount of mental reasoning a controller uses cannot be measured, an acceptable workload threshold is normally established and capacity is assessed to be at the point where this threshold is reached. Such models require intensive participation by the control staff in establishing task execution workload metrics.

3.1.7.9 Regardless of the method chosen to establish capacities, it is strongly recommended that any major calculated increase in capacity be implemented in an incremental way. This will allow real-time experience to be fed back into the models used and will also foster air traffic controller acceptance of the calculated capacity increase.

Chapter 4

ATFM PHASES AND SOLUTIONS

4.1 FROM ATM PLANNING TO POST-OPERATIONS ATFM

4.1.1 A methodology to balance demand and capacity should be developed in order to minimize the effects of ATM system constraints. This can be accomplished through the application of an "ATFM planning and management" process. In this initiative, interactive capacity and airspace planning process, airport operators, ANSPs, AUs, military authorities and other stakeholders work together to improve the performance of the ATM system (see Figure II-4-1).

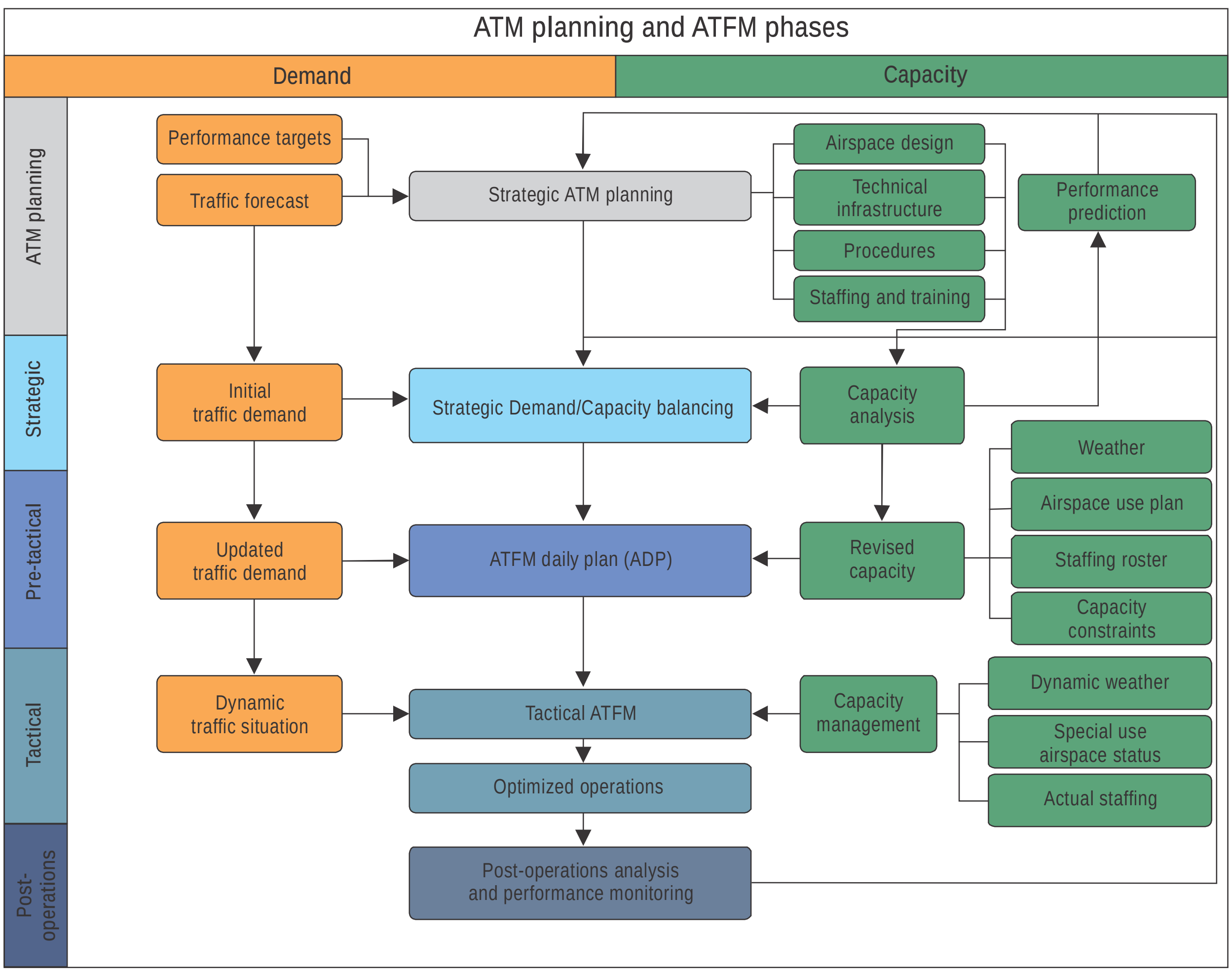

Figure II-4-1. ATM planning and ATFM phases

4.1.2 This CDM process allows AUs to optimize their participation in the ATM process while mitigating the impact of constraints on airspace and airport capacity. It also allows for the full realization of the benefits of improved integration of airspace design, airspace management (ASM) and ATFM. The process contains three equally important phases: ATM planning, ATFM execution and post-operations analysis.

4.1.3 ATM planning

4.1.3.1 Three elements of ATM planning must feed the ATFM system: traffic forecast, performance targets, and the general output of ATM planning. The ATM planning phase is therefore a preparatory one. Measures taken in this step include:

a) reviewing airspace design (route structure and ATS sectors) and airspace utilization policies to look for potential capacity improvements;

b) reviewing the technical infrastructure to assess the possibility of improving capacity. This is typically accomplished by upgrading various ATM support tools or enabling navigation, communication or surveillance infrastructure;

c) reviewing and updating ATM procedures induced by changes to airspace design and technical infrastructure;

d) reviewing staffing practices to evaluate the potential for matching staffing resources with workload and the eventual need for adjustments in staffing levels; and

e) reviewing the training that has been developed and delivered to ATFM stakeholders.

4.1.3.2 Before moving forward with ATFM implementation, the following steps should be taken:

a) establish an accurate picture of the expected traffic demand through the collection, collation and analysis of air traffic data, bearing in mind that it is useful to:

   1) monitor aerodromes and airspaces in order to quantify excessive demand and significant changes in:

      i) forecast demand; and

      ii) ATM system performance targets;

   2) obtain varied demand data from different sources, for example:

      i) a comparison of recent traffic history (e.g., compare the same day of the previous week or compare seasonal high-demand periods);

      ii) traffic trends provided by national authorities, user organizations (e.g., IATA), etc.; and

      iii) other related information (e.g., air shows, major sports events, large-scale military manoeuvres); and

b) consider the complexity and cost of these measures in order to ensure optimum performance, not only from a capacity point of view but also from an economic and cost-effective perspective.

4.1.3.3 The next phase, ATFM execution, is built on declared ATC capacity. It aims to facilitate the delivery of optimal ATM services.

4.1.4 ATFM execution

ATFM execution consists of three phases: strategic, pre-tactical, and tactical. These phases should not be considered as concrete steps, but rather as a continuous planning, action and review cycle that is fully integrated in the ATM planning and post-operations processes. The involvement of operational stakeholders in each phase is of utmost importance.

4.1.4.1 *Strategic*

4.1.4.1.1 The ATFM strategic phase generally encompasses measures taken more than one week prior to the day of operation. Much of this work is accomplished two months or more in advance.

4.1.4.1.2 This phase applies the outcomes of the ATM planning activities. It takes advantage of the increased dialogue between AUs and capacity providers, such as ANSPs and airports, in order to analyse airspace, airport and ATS restrictions, seasonal meteorological condition changes and significant meteorological phenomena. It also seeks to identify, as soon as possible, any discrepancies between demand and capacity in order to jointly define possible solutions which would have the least impact on traffic flows. These solutions are not set in stone and may be adjusted according to the demand foreseen in this phase.

4.1.4.1.3 The strategic phase includes:

a) a continuous data collection and interpretation process involving a systematic and regular review of procedures and measures;

b) a process to review available capacity; and

c) a series of steps to be taken if imbalances are identified. They should aim to maximize and optimize the available capacity in order to cope with projected demand and, as a consequence, achieve performance targets.

4.1.4.1.4 The expected outcome of this phase results in the creation of a plan (more than a week in advance) listing hypotheses, resulting capacity forecasts and contingency measures. Some elements of the plan will be disseminated in AIPs, thereby aiding planners in resolving anticipated congestion in problematic areas. This will, in turn, enhance ATFM as a whole since solutions to potential issues will be disseminated far in advance.

4.1.4.2 *Pre-tactical*

4.1.4.2.1 The ATFM pre-tactical phase normally spans from one day to one week prior to operations.

4.1.4.2.2 During this phase, the traffic demand for the day is analysed and compared to the predicted available capacity. The plan, developed during the strategic phase, is then adapted and adjusted accordingly.

4.1.4.2.3 The main objective of the pre-tactical phase is to optimize capacity through an effective organization of resources (e.g., sector configuration management, use of alternate flight procedures).

4.1.4.2.4 The work methodology is based on a CDM process established between the stakeholders (e.g., flow management unit (FMU), airspace managers, AUs).

4.1.4.2.5 The tasks to be performed during this phase may include the following:

a) determining the capacity available in the various areas, based on the particular situation that day;

b) determining or estimating the demand;

c) studying the airspace or the flows expected to be affected, the aerodrome expected to be saturated, calculating the acceptance rates to be applied according to system capacity;

d) conducting a comparative demand/capacity analysis;

e) preparing a summary of ATFM measures to be proposed and submitting them to the ATFM community for collaborative analysis and discussion; and

f) at an agreed-upon number of hours before operations, conducting a last review consultation involving the affected ATS units and the relevant stakeholders, in order to fine-tune and determine which ATFM measures should be published through the corresponding ATFM messaging system.

4.1.4.2.6 The final element of this phase is the ATFM daily plan (ADP), which describes the necessary capacity resources and, if needed, the measures to manage the traffic. The plan is based on hypotheses developed in the strategic phase, refined to the expected situation. It should be noted that the time limits of the pre-tactical phase may vary, as they depend on the precision of the forecasts, on the nature of operations within the airspace and on the capabilities of the various stakeholders.

4.1.4.2.7 The ADP must be developed collaboratively and aims to optimize the efficiency of the ATM system while balancing demand and capacity. The objective is to develop strategic and tactical outlooks for a given airspace volume or airport that can be used by stakeholders as a planning forecast.

4.1.4.2.8 It is recommended that the ADP cover a 24-hour period, at the very minimum. The plan may, however, cover a shorter period of time, provided that appropriate mechanisms are in place to update the plan on a regular basis.

4.1.4.2.9 The operational intentions of AUs should be consistent with the ADP (developed during the strategic phase and adjusted during the pre-tactical phase).

4.1.4.2.10 Once the process has been completed, the agreed measures, including the ATFM measures, should be disseminated using an ATFM message, which may be distributed using the various aeronautical communication networks or any other suitable means of communication, such as the Internet, e-mail, etc.

4.1.4.3 *Tactical*

4.1.4.3.1 During the ATFM tactical phase, solutions and measures are adopted on the day of the operation. Traffic flows and capacities are managed in real time. The ADP is amended taking due account of any event likely to affect it.

4.1.4.3.2 The tactical phase aims to ensure that:

a) the measures taken during the strategic and pre-tactical phases actually address the demand/capacity imbalances;

b) the measures applied are absolutely necessary, and unnecessary measures are avoided/eliminated;

c) capacity is maximized without jeopardizing safety; and

d) the measures are applied taking due account of equity and overall system optimization.

4.1.4.3.3 During this phase, any opportunity to mitigate disturbances should be used. The need to adjust the original ADP may result from staffing problems, significant meteorological phenomena, crises and special events, unexpected opportunities or limitations related to ground or air infrastructure, more precise flight plan data, the revision of capacity values, etc..

4.1.4.3.4 The provision of reliable and accurate information is of paramount importance in this phase, since the aim is to mitigate the impact of any event using short-term forecasts. Various solutions may be applied, depending on whether the aircraft are already airborne or about to depart.

4.1.4.3.5 Proactive planning and tactical management require the use of all available information. It is of vital importance to continuously assess the impact of ATFM measures and to adjust them, in a collaborative manner, using the information received from the various stakeholders.

4.1.4.4 *Post-operations analysis*

4.1.4.4.1 The final phase in the ATFM planning and management process is post-operations analysis.

4.1.4.4.2 During this phase, an analytical process is carried out to measure, investigate and report on operational processes and activities. This process is the cornerstone in developing best practices and/or lessons learned that will further improve the operational processes and activities. It should cover all ATFM domains and all the external units relevant to an ATFM service.

Note.— A best practice is a method, process, or activity that, upon evaluation, demonstrates success, has had a positive impact, and can be repeated. A "lesson learned" documents the experience gained during an event and provides valuable insight with respect to identifying a method, process, or activity that should be used or, to the contrary, avoided in specific situations.

4.1.4.4.3 While most of the post-operations analysis process may be carried out within the ATFM unit, close coordination and collaboration with ATFM stakeholders will yield better and more reliable results.

4.1.4.4.4 The post-operations analysis should be accomplished by evaluating the ADP and its results. Reported issues and operational statistics should be evaluated and analysed in order to learn from experience and to make appropriate adjustments and improvements in the future.

4.1.4.4.5 The process should also include an analysis of items such as anticipated and unanticipated events, ATFM measures and delays, the use of predefined scenarios, flight planning and airspace data issues. The anticipated outcome (where assessed) should be measured against the actual outcome, generally in terms of delay and route extension, while taking into account performance targets.

4.1.4.4.6 All stakeholders within the ATFM service should provide feedback, preferably using a standardized electronic format, enabling the information to be used in an automated manner for the post-operations analysis.

4.1.4.4.7 In complex areas, and in order to support the post-operations analysis process, the use of an automated replay support tool, with graphical display, can be useful.

4.1.4.4.8 Post-operations analysis may be used to:

a) identify operational trends or opportunities for improvement;

b) further investigate the cause and effect relationship of ATFM measures to aid in the selection and development of future actions and strategies;

c) gather additional information with the goal of optimizing ATM system efficiency in general or for ongoing events;

d) perform the analysis of specific areas of interest, such as irregular operations, special events, or the use of re-route proposals; and

e) make recommendations on how to optimize ATM system performance and to minimize the negative impact of ATFM measures on operations.

4.1.4.4.9 In order to ensure that the relevant ATFM stakeholders are made aware of the results, the following process is recommended:

a) collect and assess data by including a comparison with targets;

b) hold a daily briefing for a broad review and further information exchange;

c) conduct weekly operations management meetings to assess results and recommend procedural, training and system changes, where necessary, to improve performance; and

d) conduct periodic operations review meetings with stakeholders.

4.2 ATFM SOLUTIONS

4.2.1 Managing traffic flows means more than simply applying ATFM measures. Flow management entails implementing an ATFM solution, which is the combination of capacity optimization and ATFM measures. ATFM is therefore a process where, confronted with an imbalance between demand and capacity, consideration is first given to optimizing the capacity, and then to choosing and implementing ATFM measures when the imbalance cannot be resolved otherwise.

4.2.2 The process for the coordination and agreement of the ATFM solution should be conducted in accordance with the CDM practices defined in Part II, Chapter 2.

4.2.3 ANSPs and AUs should, during the strategic ATFM phase, collaborate with one another in the identification and selection process of the most appropriate and acceptable types of ATFM solutions applicable to any given area. This allows all stakeholders to understand, from the onset, the application parameters, processes and procedures. This helps reduce misunderstandings, increases compliance, and prevents induced dysfunctions during operations. It also facilitates discussions on foreseeable capacity reductions (due to, for example, aerodrome infrastructure works or ATM system transitions) or on ways to address significant demand increases during periods of limited capacity (especially in the case of special and/or unforeseen events).

4.2.4 ATFM operation manuals are often used to list the ATFM solutions used in a given airspace and aerodrome. This information can also be published in national AIPs and/or regional supplementary procedures.

4.3 DESCRIPTION OF THE ATFM PROCESS

The following example provides a general outline of the steps involved in the actions/analyses for ATM system optimization (see Figure II-4-2 for a simplified representation of the interactions involved):

a) *determine capacity*: review/assess airport/airspace sector capacity for accuracy;

b) *assess demand*: determine forecasted demand for a specific time frame, 15-minute period(s), hour(s), etc.;

c) *analyse and compare demand and capacity levels:* focus more specifically on the periods in which demand exceeds available capacity. Automated tools greatly enhance the ATFM analytical process;

d) *apply the CDM model*: communicate the situation to the facilities and stakeholders involved through the means available, using the CDM processes;

e) *determine, using CDM, the action required for mitigating a demand/capacity imbalance*: after requesting and collecting information, determine the most appropriate ATFM solutions (e.g., capacity optimization, ATFM measure) for the situation;

f) *disseminate information*: using the means of communication established to that end, inform, in a timely manner, the parties involved about the ATFM solutions to be applied or of the cancellation thereof;

g) *monitor the situation*: examine the situation periodically, as necessary, to ensure that the ATFM solutions mitigate the consequences of the imbalance. If necessary, re-assess and adjust accordingly; and

h) *conduct a post-event analysis*: evaluate the effectiveness of the ATFM solution and catalogue the best work practices. This analysis may be conducted by reviewing the weekly or monthly report of the FMU/flow management position (FMP).

4.4 CAPACITY OPTIMIZATION

4.4.1 ATFM is based on continuous and anticipated considerations of all possible air traffic flow management solutions through an iterative process that spans from strategic planning through to post-operations analysis. Any new element of information can therefore be immediately integrated. Anticipating events minimizes their impact on the ATM system, and it also provides the opportunity to refine the plan further, or, in other words, to optimize capacities.

4.4.2 Optimization aims to match capacity with demand and to select the most appropriate set of measures if it is not possible to adjust the ATM system to meet the demand.

4.4.3 Capacity optimization is the part of an ATFM solution that identifies additional capacity to address a demand/capacity imbalance. The following capacity optimizations are commonly used in ATFM:

a) sectorization and associated configuration;

b) flexible use of airspace (FUA); and

c) balancing arrival and departure capacity.

Note.— Local solutions may also be available to optimize capacity.

4.4.4 *Sectorization and associated configuration.* The capacity of an airspace can be optimized by the sectorization associated with the specific airspace and surrounding airspace(s). When faced with a specific capacity shortfall, a new airspace configuration (e.g., number of sectors, sector configuration, controller staffing positions) can increase the overall capacity through a more appropriate distribution of ATC workload.

4.4.5 *FUA.* Through the use of FUA, and with coordination between airspace users such as the military and/or recreational airspace users, opportunities to increase civil airspace capacity in specific conditions can be identified. When an airspace capacity shortfall exists and access to restricted, prohibited, or dangerous airspaces can improve capacity, ATFM units should identify if a previous arrangement is applicable in order to address the demand/capacity imbalance.

4.4.6 *Balancing arrival and departure capacity*. In short periods of operation, the configuration of an aerodrome (e.g., runway usage by operations including mixed-mode operations) can impact available capacity. When a demand/capacity imbalance is identified, ATFM units should identify if a change to the operational aerodrome configuration can provide additional capacity to mitigate the imbalance.

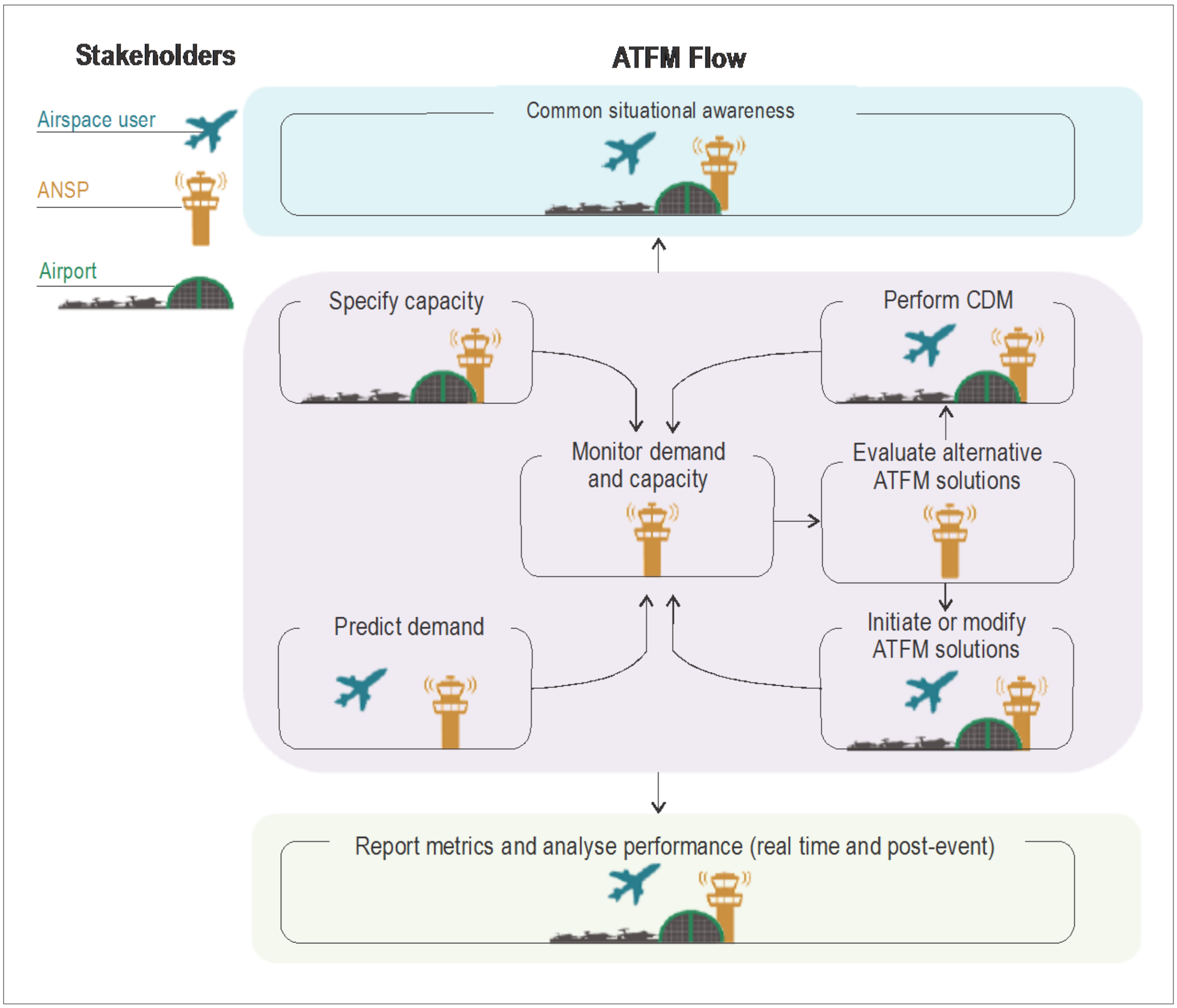

Figure II-4-2. ATFM Process Description

4.5 ATFM MEASURES

4.5.1 General considerations

4.5.1.1 ATFM measures are techniques used to manage air traffic demand according to system capacity. Some ATC instructions or procedures (such as radar vectors or speed control instructions) can be considered as ATFM measures.

4.5.1.2 ATFM measures are important initiatives for managing the flow of air traffic. They are very efficient when used to manage traffic demand, however, they can have a significant impact on AUs, and should only be implemented and used when necessary to maintain the safety and efficiency of the ATM system, minimizing as much as possible the impact on flight operations.

4.5.1.3 Table II-4-1 illustrates various ATFM measures applied during the pre-tactical and tactical phases. The table also outlines how these measures are applied as well as the usual timeframe associated with their use. The list below is not exhaustive and provides guidance on where the measures fall on the ATFM timeline.

Table II-4-1. Summary of ATFM measures

ATFM measure	*Constraint*			*Control mechanism*	*Time frame*	*Requirements to be effective*
	Airport arrivals	*Airport departures*	*Airspace*			
GDP	X	X	X	CTOT	Pre-tactical and tactical	Participation in percentage and distance
Re-route			X	Flight path change to avoid constraint	Pre-tactical and tactical	Access to airspace and published routes
Ground stop	X			Prevent departures from specific aerodromes to address existing tactical load on an arrival aerodrome	Tactical	
MIT/MINT	X		X	Time- or distance-based separation on a single stream of traffic	Tactical	
MDI	X		X	Time-based separation from departures from the same aerodrome	Tactical	
Fix balancing	X		X	Flight path change to avoid	Tactical	
Level capping			X	Flight path change to avoid	Tactical	

4.5.1.4 ATFM measures should generally only apply during periods when demand exceeds capacity and should not apply on a routine basis. The frequent application of ATFM measures suggests an imbalance between ATM capacity and traffic demand, which should be addressed in a more strategic fashion.

4.5.1.5 As ATFM systems grow in maturity, they evolve, tending to use variations of ATFM measures, or to combine different measures. It is important, however, that ATFM measures be clearly understood and accepted by the ATM community (ATC and AUs). It is therefore strongly recommended that initial solutions be comprised of a basic set of ATFM measures and that more refined solutions, based on more complex measures, be implemented only when the ATFM system has reached a good level of maturity.

4.5.1.6 *Ground delay programme (GDP).* GDP is a pre-tactical or tactical ATFM measure in an ATM process where aircraft are held on the ground in order to manage capacity and demand in a specific volume of airspace or at a specific aerodrome. In the process, departure times are assigned to corresponding available entry slots into the constrained airspace or arrival/departure slots into/from the constrained aerodrome. A GDP aims to, among other things, minimize airborne delays. It is a flexible programme, and its form may therefore vary depending on the needs of the ATM system. GDPs are best developed in a collaborative manner even though they are typically administered and managed by a FMU or a national/international ATFM centre. When a GDP is scheduled to last for several hours, the likelihood of slots having to be revised increases, as conditions could change. There should therefore be a system in place to advise AUs and/or pilots of departure slots as well as of any changes to the GDP.

4.5.1.7 *Ground stop (GSt).* GSt is a tactical ATFM measure taken in reaction to an unpredicted adverse situation. Some selected aircraft remain on the ground. Due to the heavy impact of ground stops on AUs (mostly due to the absence of notice), alternative ATFM measures should be explored and implemented prior to a GSt, time and circumstances permitting. GSt is also sometimes known as a “zero rate ATFM measure”. The GSt is typically used:

a) in cases where capacity has been severely reduced at aerodromes due to significant meteorological events or due to runway closures, for example, as a result of aircraft accidents/incidents;

b) to preclude extended periods of in-flight holding; to preclude a sector/centre reaching near saturation levels or aerodrome gridlock;

c) in the event a facility is unable or partially unable to provide air traffic services due to unforeseen circumstances; and

d) when routings are unavailable due to severe meteorological or catastrophic events.

4.5.1.8 *Minutes-in-trail (MINIT) and miles-in-trail (MIT).* These items are tactical ATFM measures and are expressed as the number of minutes or miles between each successive aircraft at an airspace boundary point. The workload associated with its compliance falls on the air traffic controller because of potential upstream network effects. As such, regular usage of MINIT or MIT may indicate that more appropriate ATFM measures should be used in their places.

4.5.1.9 *Minimum departure intervals (MDIs).* MDIs are tactical ATFM measures and are applied by setting a rate of departure flow of, as an example, three minutes between successive departures from a single aerodrome. MDIs are typically applied for short periods when a departure sector becomes excessively busy, when sector capacity is suddenly reduced (due to equipment failure, meteorological conditions, etc.), or to support demand smoothing at an arrival aerodrome with a short-term demand/capacity imbalance.

4.5.1.10 *Re-routing.* Route-based ATFM measures (horizontal or vertical) aim to remove a number of flights scheduled to arrive at a constrained ATM resource. Re-routings are usually organized in scenarios and can be mandatory or advisory.

4.5.1.11 A re-routing is normally issued to ensure that aircraft:

a) operate along with a required flow of traffic;

b) remain clear of constrained airspace; and

c) avoid areas of known meteorological conditions of such a nature that aircraft must circumvent it.

4.5.1.12 *Mandatory re-routing scenarios.* These cover the mandatory diversion of flows to offload traffic from constrained areas.

4.5.1.13 *Alternative or advisory routing scenarios.* The routes are made available to AUs on an optional basis to offload traffic from certain areas. It is important to note that where such "optional" routing scenarios are not taken up by airspace users, mandatory ATFM measures will normally be required.

4.5.1.14 *Re-routing scenarios catalogue.* This catalogue is composed of a set of collaboratively developed, published, predefined routes to address reoccurring route scenarios. The set of options is an assistance tool that allows efficient route coordination during periods of system constraint.

4.5.1.15 *Level capping scenarios.* These scenarios are carried out by means of flight level restrictions limiting climb or descent.

4.5.1.16 *Fix balancing.* This tactical ATFM measure, usually applied during flight, aims to distribute demand and avoid delays. The aircraft is assigned a different arrival or departure fix than the one indicated in the flight plan. This can also be used, for example, during periods of convective meteorological conditions where a standard instrument arrival (STAR) or a standard instrument departure (SID) is unusable.

Note.— Applying fix balancing before flight allows AUs to enhance fuel planning and reduces ATM and pilot workload.

4.5.2 Selection of the appropriate ATFM measure

4.5.2.1 Selecting the appropriate measure, or set of measures, is outlined in Figure II-4-3. Selection begins when an imbalance appears between demand and capacity that cannot be resolved with a capacity optimization action, occurring in an aerodrome or in a given airspace. Minor imbalances are usually dealt with by ATC on a tactical basis. Lead time, i.e., the time at which a problem is detected, will have an influence on the chosen measure.

4.5.2.2 Short notice or unplanned repetitive use of tactical ATFM measures such as MDI, MINIT and MIT, may indicate that other forms of ATFM measures, such as GDP, that can be applied with more advance notice should be considered. It should also be noted that the workload associated with MIT or MINIT generally falls on the tactical ATC controller (ATCO), and increases ATC workload. This could lead to a situation where further ATFM measures are needed to cope with the consequences of previous ATFM measures.

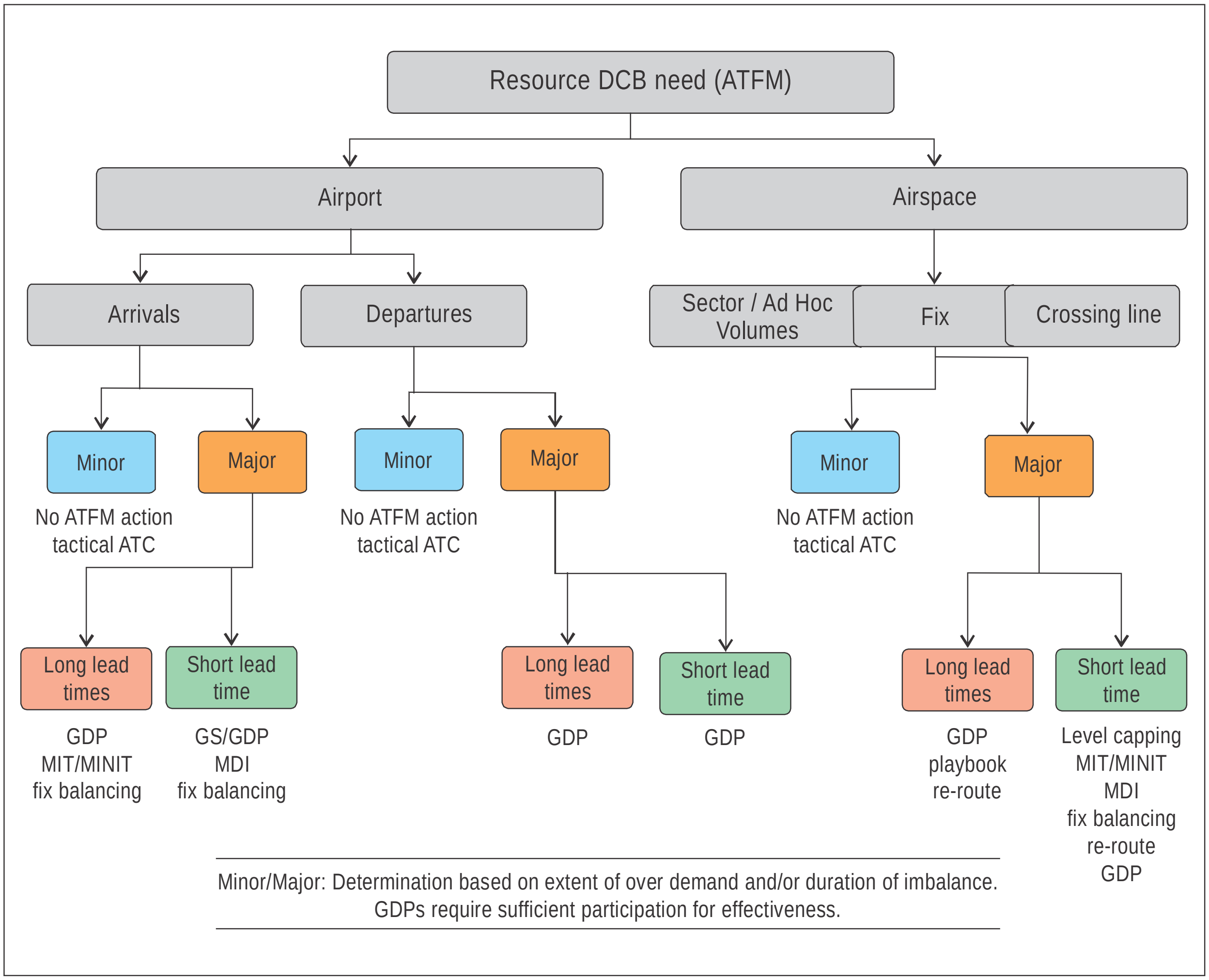

Figure II-4-3. Example of selection process of ATFM measures

4.6 FLIGHTS SUBJECT TO MULTIPLE ATFM MEASURES

A single flight can be subject to multiple ATFM measures. ATFM systems normally apply the single most constraining measure. If system optimization is not available, the States/ATFM units must have policies and CDM procedures in place to deal with these cases.

4.7 ACTIONS TAKEN TO MITIGATE THE IMPACT OF ATFM MEASURES

4.7.1 Some measures can be taken by the AU to mitigate the impact of a proposed ATFM measure based on their business model: slot swapping is the most commonly used method. Re-routings, even though they are ATFM measures, may also be used by AUs to that end, when, for example, an AU opts for a longer route or a speed reduction in order to avoid a congested area at a specific time. In all cases, such mitigations can only be chosen following an established CDM process.

4.7.2 *Slot swapping* can be applied either manually or via automated means. The ability to swap ATFM departure slots gives AUs the possibility to change the order of departure of the flights that should fly in a constrained area. This action provides AUs with the ability to manage and adapt their business model to a constrained environment.

4.7.3 *Airborne holding* may be complementary to ground delay programmes and ground stops. AUs may, in collaboration with the ANSP, choose to use this programme to keep a small inventory of holding aircraft during periods of congestion, to maintain demand pressure on the approach. The supply of available aircraft can prevent losing opportunities when departure demand is not constant or when meteorological conditions vary.

4.7.4 It is recognized that airborne holding is a last-resort measure, as in-flight holding places a very heavy burden on both AUs and ANSPs. In the event that the arrival of a given flow of traffic needs to be delayed, measures such as slowing aircraft well before the planned top of descent, and making use of required time of arrival (RTA) have proven to be effective. Most of these techniques make good use of aircraft capabilities and usually reduce operating costs and environmental impacts without increasing the workload of the ATC.

4.8 EVOLUTION OF ATFM MEASURES

4.8.1 As ATFM systems and experience develop, variations and new types of ATFM measures are emerging. New short-term measures bridge the gap between ATC and ATFM. They usually consist of ATC actions that have an ATFM purpose or make use of aircraft capabilities to ensure an RTA at the constrained ATM resource. New applications of ATFM measures to an individual flight are considered to minimize the impact on the overall traffic flow. Finally, delay intent strategies can be established, allowing the AU to choose a method of delay absorption.

4.8.2 *Short-term ATFM measures (STAM).* Such measures are usually variations of the measures described above including MDI and level capping. STAMs are normally selected and implemented by ATCOs rather than regional ATFM units during the tactical phase. They are normally of very limited duration and applied to individual flights or small numbers of flights using a constrained ATFM resource. It is essential that information on the application of STAMs be shared with the ATFM unit in charge of the ATFM area and be accurately reflected in the shared information on the trajectory of affected flights.

4.8.3 *Calculated time over (CTO) and required time of arrival (RTA).* Traditional ground delay measures use CTOT (calculated take-off time) calculated back from the required time at the constrained ATM resource (CTO or RTA). Most modern aircraft and AU flight planning systems are fully capable of integrating the required time at the constrained resource directly into their FMS and trajectory plan. This can enable the flight to manage its speed in order to meet the ATFM constraint with a high degree of accuracy. The use of CTO and RTA delegates the compliance responsibility for ATFM measures more to the AU while the ATS unit takes on an oversight role. Any effect on ATC (e.g., reduction of true air speed (TAS) en-route) must be notified and coordinated with the affected ATC units, preferably via online data interface (OLDI) or other appropriate means. The transition from traditional ground delay measures to time-over/arrival time ATFM measures is a gradual process that requires education and collaboration to ensure that requirements are understood and met. Such techniques should be considered as advanced and require substantial experience for their implementation.

4.8.4 *Cherry picking.* ATFM measures are traditionally applied to a traffic flow, e.g., all flights planned to use an ATM resource (sector or point). Advanced cherry picking techniques are increasingly used whereby a small number of flights are assigned delays or re-routing in order to meet capacity constraints without regulating the entire traffic flow. Such cherry picking measures have been demonstrated to reduce overall delay. However, it is essential that control mechanisms be in place to ensure that such measures are used in an equitable manner (i.e., that the same flights are not regularly penalized).

4.8.5 *Use of delay intent strategies.* Advanced ATFM systems and advanced CDM processes enable the AU to indicate the intention to absorb the ATFM delay via a mix of delay on stand, delay on the manoeuvring area or delay in flight. The use of such strategies minimizes the impact on AU operations. However, such strategies require effective and mature CDM processes to ensure that all affected stakeholders can manage such complex combinations of options.

4.9 REPORTING

4.9.1 To assess the efficiency of the ATFM service, stakeholders including ANSPs, AUs and airport operators should compile the statistical data required to produce reports showing delays, their causes, and any trends in the statistics. Delays should be broken down by reason and geography, to support analysis. ANSPs are encouraged to provide the data in an electronic format to facilitate further processing by stakeholders.

4.9.2 Following the publication of delay reports, ANSPs should meet with stakeholders to discuss the results and attempt to identify mitigations and corrective actions to improve performance.

4.10 ATFM PERFORMANCE AND MEASUREMENT

4.10.1 ATM performance

An ATFM service can provide significant business and operational benefits to the ATM community, by delivering flexible operations within defined and agreed sets of rules. Enhanced safety, reduced delays, improved flight efficiency and the associated cost benefits are some practical outcomes that can result from the delivery of a proactive ATFM service. The key to fully realizing these benefits lies in the implementation and application of ATFM services at a system-wide level (e.g., regional, subregional and/or global). Furthermore, the adoption of a performance-based approach (PBA) to implement ATFM would ensure that the deployment of ATFM-related capabilities and solutions have measurable benefits on ATM performance.

Note.— See the Manual on Global Performance of the Air Navigation System *(Doc 9883) which describes the process for developing performance objectives, metrics and indicators in the context of overall ATM system behaviour responding to ATM community expectations. Many provisions are relevant for ATFM as this manual provides guidelines for setting performance objectives and targets, as well as for monitoring, evaluating and forecasting system performance.*

4.10.2 Measuring ATM performance

4.10.2.1 Measuring the performance of an ATFM system enables users to identify its contribution to the overall ATM operational environment and understand how performance improves as techniques and technology enable new capabilities. To measure and assess variations of ATFM performance, a baseline performance assessment is needed. It is then used to measure targeted improvements.

4.10.2.2 In establishing an ATFM operational baseline, several factors appropriate to the individual region, State or ANSP must be considered. Such factors range from a basic definition of airport and airspace capacity, to complex multi-metric performance schemes. The latter are commonly used in complex airspace volumes where significant data are available and have been gathered over many years.

4.10.2.3 An initial understanding of airport capacity and demand, airspace capacity limitations and actual throughput, together with forecasted traffic trends, forms a good basis to establish a baseline.

4.10.2.4 As operations evolve and more data become available, the measurement of more complex metrics, such as ATC workload with associated traffic levels, becomes possible. With these measurements in place, analyses can be conducted, and the airspace capacity can be regularly reviewed and adjusted. Further analysis over time can even help in identifying needed airspace changes or service improvements.

4.10.3 Implementing a performance system

4.10.3.1 Once the performance of an ATFM system is measured, and its contribution has been demonstrated to the overall ATM performance, the performance of ATFM can be managed. Best practices indicate that establishing performance management is best considered when developing ATFM services. Performance management systems can range from a basic level to largely complex ones.

4.10.3.2 The most basic schemes require the creation of simple targets to be attained and measured against actual performance. This can be developed for an ATC unit, aerodrome, ANSP or State.

4.10.3.3 Complex schemes, such as those established in Europe at a regional and subregional level, involve establishing ANSP and State targets in support of common European goals, with financial incentives and penalties associated with actual performance. In such schemes, local units also develop targets in support of the wider goals of the network.

4.10.3.4 Improvements should always be the main objective of any performance management plan. The metrics considered for the plan should therefore be common to all stakeholders' interests.

4.10.4 Choosing metrics and establishing a review process

4.10.4.1 In the case of ATFM, stakeholders include regulatory bodies, ANSPs, military agencies, AUs and AOPs. All have a common interest in:

a) safety;

b) delay; and

c) flight efficiency.

4.10.4.2 It is therefore logical that the development of suitable performance metrics for each of these areas would be a good starting point.

4.10.4.3 Once metrics are established and the relevant stakeholders agree to targets, a review process must be created to ensure that progress is appropriately tracked and measured. This process should consider the most appropriate time interval required to ensure target compliance and enable corrective action if required. Depending on the metric, the intervals can be daily, weekly, monthly or annually. On the other hand, certain performance metrics in some ANSP operations are measured on an hourly basis.

4.10.5 Focus on delay metrics — Principles of delay analysis

4.10.5.1 Delays are very generally associated with ATFM provisions. Even though the systematic association of delay to flow management is no longer warranted as more emphasis is placed on managing flows with a view to minimizing delays and possible disruptions, the fact is that delay measurement can reflect some level of performance of the ATFM system, and is consistently used to do so.

4.10.5.2 The following considerations should be taken into account:

a) common definitions related to ATM delays, causes and metrics are very important and should be agreed upon across ANSPs and other stakeholders as required;

b) certain ANSPs and airport authorities measure airlines' on-time departure performance, which then makes this metric important; and

c) delays should be calculated for each phase of flight.

4.10.5.2.1 Departure:

a) all time spent in airline ramp/gate area should be measured;

b) taxi time should be measured including taxi-out duration;

c) all time spent in penalty box, de-ice pads, etc. should be measured; and

d) all movement area delays should be measured.

4.10.5.2.2 En-route:

a) all airborne holding delays should be measured; and

b) linear hold (route extensions, use of RTA, etc.) delays need to be measured.

4.10.5.2.3 Arrival:

a) arrival delays should be measured (Arrival delay is, financially speaking, more relevant to airlines than on-time departure.); and

b) all movement area delays should be measured, including taxi-in duration allowing to identify times exceeding normal taxi-in time.

4.10.5.3 Delay classifications include:

a) push-back delay (e.g., actual versus requested push-back);

b) departure delay (actual versus estimated take-off time, e.g., ATOT minus ETOT or AOBT minus EOBT);

c) ATFM delay, e.g., CTOT minus ETOT;

d) taxi-out delay (time spent waiting in queue for take-off);

e) total airborne holding minutes;

f) route extension in time and distance, by flight phase; and

g) arrival delay (actual versus planned landing time).

4.10.6 Accountability for ATFM delays

Delays have a great impact on AUs, since their route networks and schedules are built based on connections. The reliability of these connections enables passengers to board connecting flights, ensures that aircraft are available for the next leg of flight, and impacts the gate availability for following aircraft. On-time performance is therefore crucial for AUs. Every minute counts and delays represent costs. Although this AU perspective is understandable, metering delays in terms of cost is not feasible nor useful from a global ATFM perspective. However, delays need to be accounted for and analysed, as they clearly have an impact on the overall system performance.

4.10.7 Attribution and accountability for ATFM measures

4.10.7.1 All ATFM stakeholders must share a common understanding of the reasons for ATFM measures and of the entity that should be held accountable for them (aerodrome infrastructure, ANSP, external hazard, etc.). Appropriate and agreed definitions should be contained in local ATFM procedures. A set of reasons for ATFM measures and accountable agencies is provided below (the list is not meant to be exhaustive).

4.10.7.2 Factors under ANSP control:

a) flight calibration/flight check;

b) equipment (CNS) maintenance or failure;

c) staffing;

d) flight arrival and departure sequencing; and

e) non-optimization of capacity and configurations.

4.10.7.3 Factors under State control:

a) activation of restrictions or reservations of airspace that affect capacity;

b) special events: air shows, VIP activity, special sporting events; and

c) availability of special use airspace during periods of adverse meteorological conditions or other constraints.

4.10.7.4 Factors under airport control:

a) aerodrome infrastructure and configuration;

b) aerodrome construction affecting capacity;

c) runway closure;

d) taxiway closure;

e) de-icing delays (exceeding unimpeded normal processing time);

f) runway decontamination (sweeping, ploughing) and inspections;

g) runway capacity reduction caused by the AOP's failure to decontaminate;

h) delay in completing a flight (deplaning) due to gate unavailability; and

i) delay in completing a flight (deplaning) due to service unavailability (ground transport, handling, customs, etc.).

4.10.7.5 Factors under AU control:

a) inability to depart at the estimated time of departure (ETD) due to delayed inbound aircraft and flight preparation; and

b) inability to depart at a controlled departure (slot) time that is at or later than ETD.

4.10.7.6 Uncontrollable factors include capacity reductions due to significant meteorological conditions or unforeseen events.

4.10.7.7 To date, standardized ATFM delay calculation metrics have not been developed. On the one hand, this is due to the difficulties associated with defining what constitutes a delay and, on the other hand, to the difficulty in determining which party (ANSPs, airport authorities or AUs) has control over how delays are imposed or mitigated. In order to measure system efficiency and to identify issues affecting system performance over a specific area, a global effort is needed to harmonize the definition of delay and the methods of delay reporting. This effort should be a shared responsibility among the ANSPs, aerodromes, AUs and other stakeholders that form part of the ATFM process in the concerned area.

4.10.8 Performance schemes

4.10.8.1 Where performance schemes are subject to incentive and penalty, the regulatory body responsible should be involved in the development of the performance scheme at an early stage.

4.10.8.2 The creation and development of performance schemes, particularly at the regional and subregional level, is complex and may require the establishment of wide-ranging regulatory actions to ensure that all stakeholders adhere to the common rules. This may also include a minimum level of ATFM service to be provided, placing clear enforcement obligations on stakeholders.

4.10.8.3 The performance schemes required at a global level will need to be carefully considered and must consider the skill level of the individual. Most of the indications provided in Section 4.10 will, however, be applicable in the majority of cases.

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Chapter 5

ATFM SERVICE INTERFACES

5.1 DATA, INFORMATION AND CONTROLS EXCHANGED IN AN ATFM SERVICE

5.1.1 Two types of interfaces are usually considered when one is exploring ATFM service interfacing:

a) interfaces associated with a single deployment of an ATFM service; and

b) interfaces associated with ATFM-service-to-ATFM-service deployment to support cross-border ATFM.

5.1.2 The interfaces used for a single deployment are applicable when the ATFM service deployed is the only one in the region. Those used for an ATFM-service-to-ATFM service interface are relevant when such parts exist in a multi-nodal ATFM network.

5.1.3 A key enabler in supporting the global development and further harmonization of ATFM is the enhancement of cooperation and coordination among stakeholders regarding ATFM-related activities. States should therefore ensure that operational data from ATFM actors and services (e.g., flight data information, capacity information, ATFM measure information, meteorological information) are exchanged not only within their ICAO regions, but also across ICAO regional boundaries, in order to achieve more efficient traffic flow management.

5.1.4 The following topics apply to both types of ATFM system interfaces:

a) benefits of data exchange;

b) data exchange policy;

c) international data exchange specifications; and

d) data type description and harmonization.

5.2 BENEFITS OF DATA EXCHANGE

5.2.1 Data sharing and exchange facilitates the collaboration and interaction between national as well as international ATFM units and enables common situational awareness. It also allows for a coordinated and comprehensive system response to ever-changing conditions in the ATM network. Appendix II-E proposes a sample agreement between States related to ATFM data exchange.

5.2.2 This, in turn, leads to increased safety and efficiency in air traffic operations, and more specifically to:

a) increased efficiency for traffic flows;

b) reduced delays;

c) enhanced predictability and reliability of airspace users' schedules; and

d) reduced impact on the environment from greenhouse gas emissions and noise pollution.

5.2.3 It also optimizes contingency responses to unforeseen events and network disruptions.

5.3 DATA EXCHANGE POLICY

5.3.1 The provision, retention and distribution of ATFM data should be covered by an ATFM data policy.

5.3.2 Whereas the widespread sharing of ATFM data generally benefits the ATFM network and its operational stakeholders, appropriate safeguards for its correct use should be put in place.

5.3.3 ATFM data is normally supplied for operational ATFM purposes, and an ATFM data policy should define:

a) the duration and backup arrangements of data storage for investigation and post-operational purposes;

b) the restrictions on the release of data to the general public and to commercial organizations;

c) the provisions for the release of data to State, judicial and authorized investigative agencies;

d) the restrictions on the use of ATFM data for other than operational ATM purposes;

e) the provisions for the cost recovery associated with the retrieval and supply of ATM data; and

f) the restrictions regarding the provision of data on military and other special status flights.

5.4 INTERNATIONAL DATA EXCHANGE SPECIFICATIONS

5.4.1 To support the global development and harmonization of ATFM, ANSPs must ensure that the data shared comes from a valid and authoritative source. ANSPs should utilize methodologies capable of data exchange that are secure, efficient and in compliance with all applicable identified and agreed upon standards.

5.4.2 Flight data information is provided to ATFM units and operational stakeholders for the purpose of air traffic management. Such data should not be released to third parties unless this is covered by a predefined data policy.

5.4.3 Specifications for connectivity should abide by existing standards for this type of data exchange and be documented by interface control documents.

5.4.4 Data type description and harmonization

The primary data for ATFM services is reliable and accurate flight intent data. This data can be provided by the various organizations responsible for the authorization or execution of flights. The following data associated with flight intent can be provided to ATFM services for use in demand predictions:

a) AU marketing schedule data;

b) airport strategic slot data;

c) AU flight intent updates;

d) ANSP ATM automation system data (e.g., ATS messages via aeronautical fixed telecommunication network (AFTN) or ATS message handling systems (AMHS), or data provided by the flight data processing (FDP) component) including:

   1) flight plans (FPL ATS message or comparable data);

   2) flight plan amendments (CHG ATS message or comparable data);

   3) flight plan cancellation (CNL ATS message or comparable data);

   4) indication of departure (DEP ATS message or comparable data)

   5) indication of arrival (ARR ATS message or comparable data);

   6) indication of flight delay (DLA ATS message or comparable data); and

   7) flight coordination (CPL and EST ATS messages or comparable data);

e) aerodrome departure planning and arrival information;

f) correlated surveillance data (e.g., ADS-B, SSR, WAM, MLAT); and

g) aircraft position report (airspace user provided position report).

Note 1.— See the Procedures for Air Navigation Services — Air Traffic Management *(PANS-ATM, Doc 4444), Section 11.4.2, Movement and control messages.*

Note 2.— In the framework of implementing SWIM, flight plan messages would be transitioned into FF-ICE through the FIXM, supported by AIXM and WXXM.

5.5 INTERFACES ASSOCIATED WITH A SINGLE DEPLOYMENT OF AN ATFM SERVICE

5.5.1 Data exchange is the sharing of information required for the effective provision of an ATFM service. As depicted in Figure II-5-1, the data to be shared include information related to the flight intent, capacity, aerodrome and airspace demand, ATFM measures, and CDM actions for the purpose of cooperation and coordination of air traffic flow management activities between ATFM stakeholders. This view is associated with the deployment of a single ATFM service.

5.5.2 The requirement for data sharing covers many different areas. As described in this manual, there is a requirement for the ATFM function to be regularly updated with information on the overall ATM resources (e.g., airspace status and aerodrome infrastructure) in order to understand the impact on the available capacity.

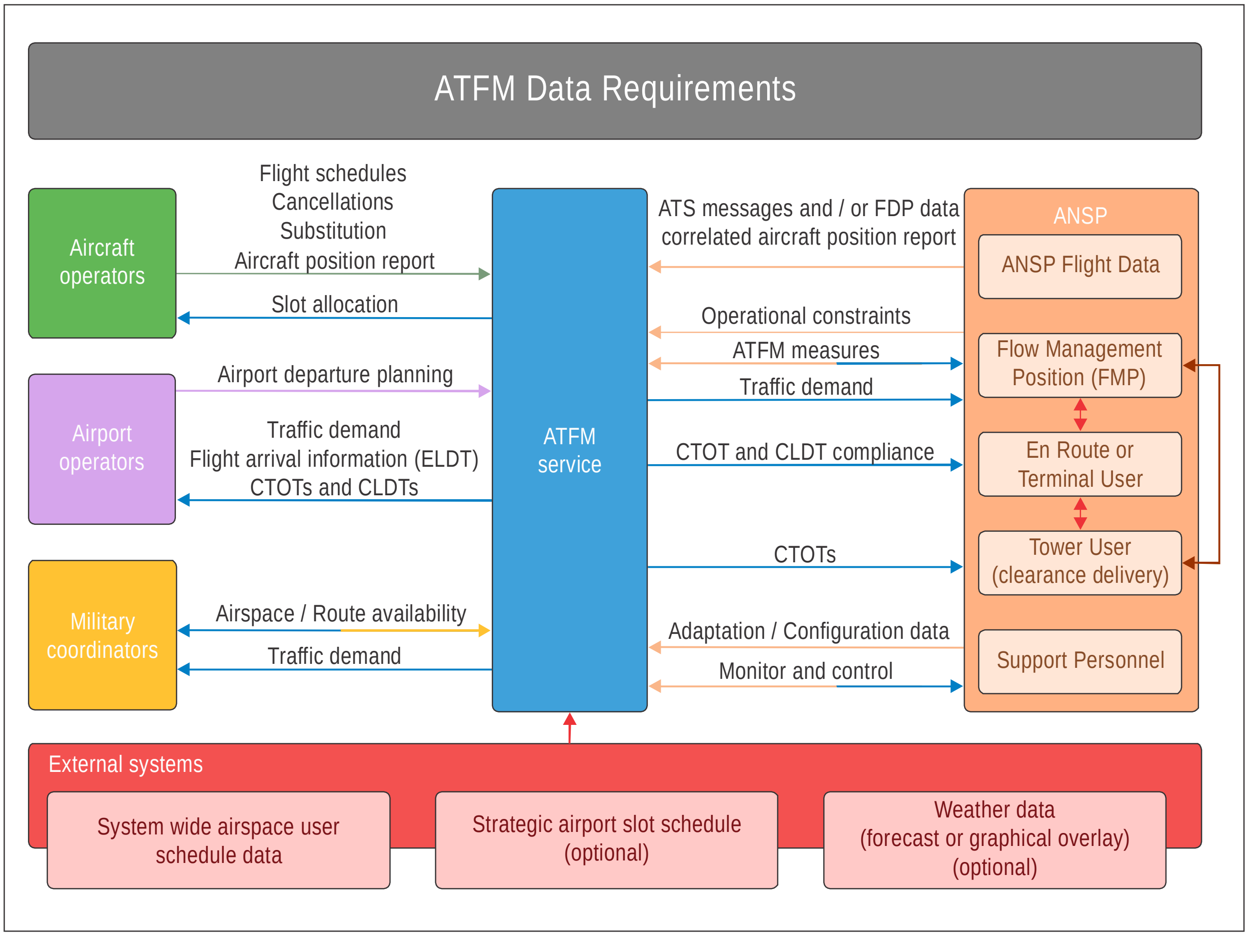

Figure II-5-1. Data requirements for a single deployment of an ATFM service

5.5.3 Many established ATFM units rely on systems that contain comprehensive details of the ATS organization and its areas of responsibility. These systems contain essential information to support ATFM planning and daily operations including ATS routes and routing systems, aerodromes, SIDs, STARs, navigational aids (NAVAIDs), and ATC sectorization.

5.5.4 Where such systems are available, the effectiveness of the ATFM service usually depends on the completeness and accuracy of the associated information and on the timely availability of data changes.

5.5.5 The ATFM unit also needs access to accurate and timely data with regard to ATC demand. Throughout the various ATFM phases (strategic, pre-tactical, and tactical), AUs must provide descriptions of all flights intending to operate in the area under the responsibility of the ATFM unit. Accurate aircraft performance characteristics and meteorological models are also required in order to assess the impact of various operations.

5.5.6 The ATFM unit needs access to current information on the dynamic aerodrome and airspace traffic demand and capacity situation in order to support ATFM decisions and ATFM measure implementation. This information may be provided to the ATFM service or may be derived by the ATFM service.

5.5.7 Information exchanged among stakeholders is applied to facilitate ATFM during the various phases of ATFM operations, as outlined in Chapter 4, Section 4.1.

5.6 ATFM TO ATFM SYSTEM EXCHANGES

5.6.1 ATFM system-to-system exchanges

5.6.1.1 The global nature of aviation, visible through the increasing traffic flows worldwide, necessitates a global and collaborative approach to planning, implementation and operation.

5.6.1.2 ATFM areas suffer from a lack of predictability and stability of demand due to the lack of accurate information on flights entering the area. European experience clearly shows that such “peripheral airspaces” are prone to unpredictable traffic surges, suffer from a disproportionate volume of incorrect and missing flight plans, and need to provide a capacity buffer to compensate for the increased level of traffic unpredictability.

5.6.1.3 Data exchange arrangements should be prioritized by the size of traffic flows and the requirement to fill “data gaps” on the periphery of ATFM areas. This will make a significant contribution in improving the predictability and stability of each ATFM area network.

5.6.1.4 In order to improve the tactical predictability of an ATFM service, ATC activation, correlation surveillance information and aerodrome departure planning and arrival information for all flights well prior to their entry time (where obtainable) should be made available to an ATFM unit. It is recommended that this information cover an area of three hours’ flying time from the ATFM unit’s area of responsibility.

5.6.1.5 In order to improve pre-tactical predictability for an ATFM service, ATC activation and a subset of airport departure planning information should be shared in real time to each transited ATFM unit as soon as this information becomes available in any ATFM/ATM system.

5.6.1.6 Such data exchange arrangements bring significant benefits such as:

a) ATM resources (ATFM, ATC units and aerodromes) within an ATFM area can operate at optimum or maximum capacity with all partners benefiting from the same improved level of predictability;

b) major traffic flows can be efficiently managed across ATM regions, as a common long-range situational awareness is established;

c) the collaborative management of major traffic flows between regions, when security situations and other disruptive factors disturb or threaten to disturb normal traffic patterns, can be achieved;

d) the horizon of ATFM can be extended to include all traffic entering an ATFM area in the processes of capacity optimization and appropriate ATFM measures; and

e) AUs, aerodromes and other ATM stakeholders will benefit from increased predictability and expanded flexibility of operations.

5.6.1.7 The exchange of such real-time data fully supports two of the key performance improvement areas of the GANP:

a) globally-interoperable systems and data; and

b) optimum capacity and flexible flights.

5.6.2 A specific type of ATFM system-to-system exchange: the distributed multi-nodal system

5.6.2.1 Interfaces associated with ATFM-service-to-ATFM-service deployment support multi-nodal cross-border ATFM.

5.6.2.2 Multi-nodal ATFM provides a path for ANSPs in a common geographic region to autonomously deploy ATFM/CDM systems and processes. It sets technical requirements for the implementation of the regional ATFM operational concept for cross-border ATFM (involving more than one ANSP in deploying an ATFM system).

5.6.2.3 In order for ANSPs to develop ATFM services which operate in a multi-nodal environment, a standard interface definition is required for ATFM-service-to-ATFM-service data and control exchange. Regional and global interoperability of communications is critical to the implementation of effective, network-based cross-border ATFM.

5.6.2.4 The ATFM-service-to-ATFM-service interface definition needs to address the following data types and controls:

a) flight information (e.g., flight identification, aircraft type, departure aerodrome (ADEP), destination aerodrome (ADES), expected event time (e.g., off-block time (OBT), take-off time (TOT), landing time (LDT), and in block time (IBT)), route of flight, source of flight intent information);

b) resource information (e.g., aerodrome configurations, airspace configurations, capacity, route availability);

c) ATFM measure information (e.g., constrained resource (e.g., aerodrome or airspace), start and end times, type (e.g., GDP, GSt, MINIT or MIT); and

d) CDM actions (e.g., pre-flight flight cancellations, slot substitutions, flight intent updates).

5.6.2.5 The ATFM-service-to-ATFM-service interface definition benefits the end users that can interact with a single ATFM service and have access to all relevant data and control for ATFM/CDM across the multi-nodal ATFM network. Figure II-5-2 depicts the use of this interface framework.

5.6.2.6 The definition of the ATFM-service-to-ATFM-service interface to support multi-nodal cross-border ATFM requires two components:

a) logical data definition; and

b) formatting for data exchange.

Note.— The specific interface definition requires development and is not included in this document.

5.6.2.7 The logical data definition is the set of flight, resource, ATFM measure, and CDM action data and controls that every ATFM service joining a multi-nodal network must be able to provide and process.

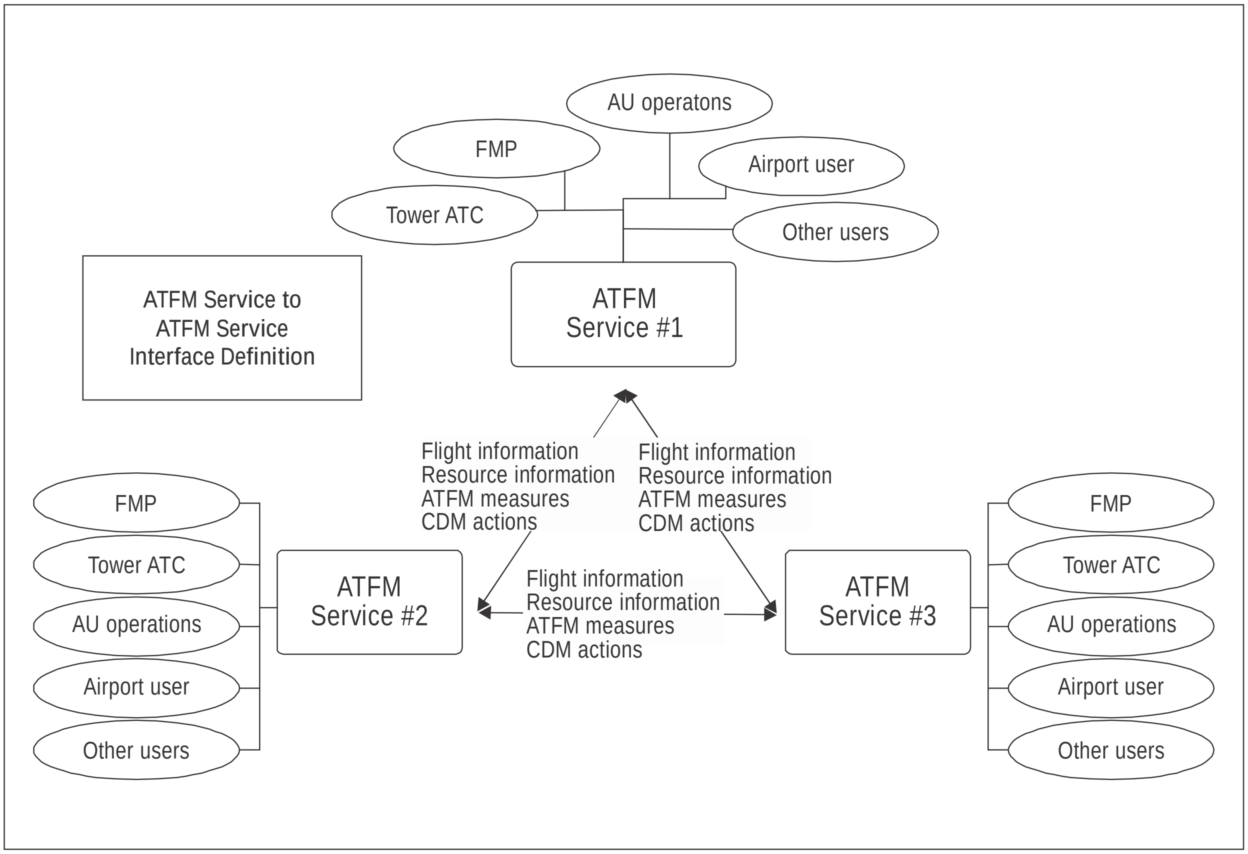

Figure II-5-2. ATFM-service-to-ATFM-service interfaces

5.7 ATFM DATA COMMUNICATIONS

5.7.1 ATFM is one of the ATM information domains which embraces information sharing based on the concept of SWIM. Using SWIM services, interoperable information exchange between providers and users of ATM data will be enabled. Although the SWIM concept is generally accepted, an incremental approach to its adoption is needed due to the legacy systems currently in place and the developing nature of its standardization.

5.7.2 Although the needs of States for ATFM may vary, it is recognized that air traffic service units (ATSU) may participate in collaborative ATFM without any dedicated ATFM systems or terminals. In such cases, ATFM messages conforming to ATS data exchange presentation (ADEXP) version 3.1 may be used for the distribution of ATFM measures. The ADEXP model provides machine-readable information that can also be read by humans, rendering it usable for the distribution of ATFM information on computer-based displays and in text form.

Note.— The EUROCONTROL specification for ADEXP provides a format for use in on-line, computer-to-computer message exchange and for message exchange over switched messaging networks. It is used in current generation ATM automation and supporting systems, and was used in the development of FIXM.

5.7.3 Within the current context, the aeronautical fixed service (AFS) may provide a suitable method of distributing the ADP and ATFM measure information to ATS units based on the use of ADEXP.

5.7.4 The *Manual on Flight and Flow — Information for a Collaborative Environment (FF-ICE)* (Doc 9965) describes the requirements for flight and flow information sharing between members of the ATM community. The FIXM is being developed as an enabler for FF-ICE, as identified in the GANP. FIXM will therefore serve as a global standard ensuring interoperable information exchanges within the flight and flow domains. In addition to the globally applicable baseline FIXM content, FIXM supports the definition of extensions to ensure adaptability to regional and local needs. An ATFM service interface definition relying on FIXM will commonly be a combination of standard FIXM components and extensions, as needed, for a comprehensive definition.

5.7.5 FIXM is part of an ATM information exchange model suite, including, but not limited to, the AIXM covering the aeronautical domain, and the ICAO weather information exchange model (IWXXM) covering the meteorological domain. Together, these information exchange models are intended to provide global standards under the umbrella of the ATM information reference model (AIRM) as foreseen by the SWIM concept documented in the *Manual on System-Wide Information Management (SWIM) Concept* (Doc 10039) and the *Global Air Navigation Plan* (Doc 9750), thereby ensuring cross-domain semantic interoperability.

Note.— More information on FIXM is available at FIXM.

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Chapter 6

ATFM COMMUNICATION

6.1 COMMUNICATION

The communication and exchange of operational information among stakeholders on a real-time basis forms the backbone of ATFM. This exchange may be accomplished by a variety of means including telephone calls, web conferences, e-mail messages, and electronic data exchange including, but not limited to web page displays. The purpose of the information exchange is to increase stakeholder situational awareness, improve operational decision-making, and enhance the efficiency of the ATM system.

6.2 STAKEHOLDER ATFM COMMUNICATION

6.2.1 An ATFM unit requires several layers of communication. As a basis for the exchange of information, notices to airmen (NOTAMs) and AIP supplements could initially be used to distribute instructions relating to the application of ATFM measures. For example, strategic ATFM routing information and certain ATFM operating procedures could be published as a NOTAM or in the AIP supplement.

6.2.2 As the functionality of an ATFM unit progresses, consideration should be given to the development of a more ATFM-specific communication structure for the notification of ATFM measures and solutions.

6.2.2.1 For example, to facilitate the awareness of AUs, the ATFM unit should produce and distribute the ADP on the day prior to the operation, in order to provide a summary of the planned operations and of the ATFM measures in their area of responsibility. It would also provide an opportunity to distribute any specific instructions or communication requirements associated with those measures. This communication should also be updated by ADP amendments.

6.2.2.2 In order to ensure that AUs and other stakeholders can properly use and apply this information, a standard format should be employed.

6.2.3 In addition to the production and distribution of ADPs, the ATFM unit should exchange ATFM information with other individuals in the unit to provide information and guidance.

6.2.3.1 These exchanges could be used for the initial publication of changes in the availability of runways, ATS routes, or airspace in the area, and serve as the vehicle for new and amended ATFM operating procedures, which affect all users.

6.2.4 The ADPs and ATFM information exchanges should be transmitted via agreed-upon means to ATC units, AUs, and other stakeholders who wish to be included on the distribution list. These exchanges should also be made available on associated ATFM unit websites.

6.2.5 Each national AIP should include information on specific arrangements for dealing with ATFM issues and coordination matters, in the same section as is located the brief description of the ATFM system. The AIPs should also include the telephone numbers of relevant ATFM units, in the event that they would need to be consulted for advice and/or information.

Note.— See Annex 15 — Aeronautical Information Services *– Appendix 1, ENR 1.9 "Air traffic flow management and airspace management", for the obligations of States related to the publication of ATFM information in their respective AIP.*

6.3 ATFM COMMUNICATION REQUIREMENTS

6.3.1 For consistency, the appropriate authority should ensure that a single entity oversees the dissemination of ATFM information as well as its measures, and is responsible for monitoring, collecting and disseminating the information. Such oversight will ensure that applicable information is shared by all ANSPs and operational stakeholders in a timely and efficient manner. As a best practice, this information should be available electronically and kept current.

6.3.2 Examples of applicable ATFM information include, but are not limited to:

a) significant aerodromes and their terminal areas:

  1) meteorological (MET) information having an effect on capacities (e.g., winds, runway visual range (RVR), thunderstorms (TS);

  2) aerodrome and approach control (APP) infrastructure issues affecting routings or capacity;

  3) capacity-limited APP areas including SIDs and STARs;

  4) current and planned aerodrome runway configurations;

  5) airport arrival and departure rates;

  6) airport arrival and departure demand; and

  7) applicable ATFM measures and off-load options;

b) en-route airspace:

  1) MET information having an effect on capacities (e.g., TS);

  2) en-route sector configurations, capacities and demands;

  3) infrastructure issues affecting routings or capacity; and

  4) airspace issues affecting routings or capacity (e.g., reserved airspace);

c) general:

  1) ATFM stakeholder planning teleconferences information, including schedules and joining instructions;

  2) information pertaining to ATFM strategic, pre-tactical, and tactical plans; and

  3) links to ATFM-related information such as:

    i) meteorological conditions;

ii) ACC and APP contact information;

iii) letters of agreement;

iv) route information;

v) global navigation satellite system (GNSS) operational status;

vi) NOTAMs; and

vii) contingency plans.

6.3.2.1 Specific categories of information will be determined by the ATFM unit in collaboration with stakeholders.

6.3.3 ATFM units should develop an operations manual framing the roles of the respective facilities in addressing the ATFM measures process. This operations manual should also contain procedures to be followed by AUs, aerodromes and ATC. It should be available to the public and published following CDM processes. For example, the manual should include provisions to:

a) coordinate and disseminate information related to the implementation of ATFM measures through specified means such as telephone calls, aeronautical messages, web pages, or any other suitable method;

b) disseminate information resulting from the constant monitoring and adjustment of ATFM measures; and

c) disseminate information resulting from the timely cancellation of ATFM measures.

6.4 COMMUNICATING ATFM INFORMATION

6.4.1 AUs and ATFM units are required to communicate and exchange information for the purposes of CDM and information dissemination.

6.4.2 When selecting communication methods, consideration should be given to maximizing the value and content of the information and minimizing the time and workload required.

6.4.3 The following communication methods are offered as examples:

a) *scheduled telephone (or web) conferences*. ATFM units hold periodic operational conferences (at least daily) to discuss the operational context and outlook with affected stakeholders. The composition of the attendee list may vary based on circumstances. Appendix II-F provides a template for the planning and organization of such ATFM conferences;

b) *ad hoc telephone (or web) conferences*. ATFM units hold operational conferences as required to discuss the operational context and outlook with affected stakeholders. The composition of the membership is similar to the periodic conferences and may be increased/adjusted as required by the circumstances. The purpose of ad hoc conferences is to ensure collaboration among affected stakeholders and agree on the timing and selection of ATFM measures, as required; and

c) *automated web page or ATFM operational information system*: ATFM units may create a web page or an information system containing relevant ATFM information (e.g., ADP). The purpose is to share information about the ATM system in order to develop a common situational awareness and minimize workload.

6.5 ATFM TERMINOLOGY AND PHRASEOLOGY

6.5.1 In order to promote harmonization and interoperability of CDM/ATFM systems and procedures, recommended terminology was developed based on existing ATFM implementations, as well as on references from the existing FIXM data dictionary.

6.5.1.1 Flight Time Event ATFM Terminology was selected to provide harmonization with airport collaborative decision-making (A-CDM), which is the subject of Part III of this manual. Flight Time Event ATFM Terminology adopts a four-character format, where the last three characters represent the time of flight such as “TOT” representing “take-off time”, while the first character represents status of the terminology. For example, the character “A” in ATOT represents “actual” take-off time.

6.5.1.2 The various flight time events are:

a) off-block time (OBT): aircraft departure from parking position;

b) take-off time (TOT): take off from runway;

c) time over (TO): time over a fix, waypoint or particular location typically where air traffic congestion is expected;

d) landing time (LDT): landing on runway; and

e) in-block time (IBT): aircraft arrives at parking position.

Note.— This terminology attempts to avoid use of the term “departure” or “arrival” due to the ambiguity in specifying a “departure” and “arrival” flight time event, taking different meanings in different stakeholders’ perspective. For example, an aircraft operator may understand “actual time of departure” as actual off-block time (AOBT) in the recommended terminology. In contrast, an air traffic controller may understand “actual time of departure” as actual take-off time (ATOT) in the recommended terminology.

6.5.2 ATFM Terminology — General

Table II-6-1. General ATFM Terminologies

Acronym	*Term*	*Definition*
AAR	Airport arrival rate	The arrival capacity of an airport normally expressed in movements per hour.
ADR	Airport departure rate	The departure capacity of an airport normally expressed in movements per hour.
FCA	Flow constrained area	A sector of airspace where normal flows of traffic are constrained, which could be caused by meteorological conditions, military exercise, etc.
FMP	Flow management position	A position that monitors traffic flows and implements or requests ATFM measures to be implemented.
GDP	Ground delay programme	An ATFM measure where aircraft are held on the ground, in order to manage capacity and demand in a specific volume of airspace or at a specific aerodrome. In the process, departure times are assigned.
GSt	Ground stop	A tactical ATFM measure taken in reaction to an unpredicted adverse situation, where select aircraft remain on the ground.
MINIT	Minutes in trail	A tactical ATFM measure expressed as the number of minutes between successive aircraft at an airspace boundary point.
MIT	Miles in trail	A tactical ATFM measure expressed as the number of miles between successive aircraft at an airspace boundary point.
SUB	Slot swapping	The ability to swap departure times gives AUs the possibility to change the order of flight departures that should fly into a constrained area.

6.5.2.1 *ATFM Terminology — Flight Event Time*

Table II-6-2. ATFM terminologies for Flight Event Time

Acronym	*Term*	*Definition*
SOBT	Scheduled off-block time	The time that an aircraft is scheduled to depart from the parking position.
EOBT	Estimated off-block time	The estimated time that an aircraft will start movement associated with its departure.

Acronym	*Term*	*Definition*
COBT	Calculated off-block time	A time calculated and issued by an ATFM unit, as a result of tactical slot allocation, at which a flight is expected to push back/vacate its parking position so as to meet a CTOT, taking into account start and taxi time.
AOBT	Actual off-block time	The time the aircraft pushes back/vacates its parking position (equivalent to airline/handlers ATD – actual time of departure and ACARS = OUT).
CTOT	Calculated take-off time	A time calculated and issued by an ATFM unit, as a result of tactical slot allocation, at which a flight is expected to become airborne.
ETOT	Estimated take-off time	The estimated take-off time taking into account EOBT plus estimated taxi-out time.
ATOT	Actual take-off time	The time that an aircraft takes off from the runway (equivalent to the air traffic control ATD – actual time of departure).
ETO	Estimated time over	Estimated time at which an aircraft would be over a fix, waypoint or particular location typically where air traffic congestion is expected.
CTO	Calculated time over	Time calculated and issued by an ATFM unit, as a result of tactical slot allocation, at which a flight is expected to be over a fix, waypoint or particular location. The implementation of this constraint may be carried out through tactical ATC intervention, such as speed control or route extension, or by having the aircraft meet the constrained time through the use of its Flight Management System RTA function.
CLDT	Calculated landing time	A landing time calculated and issued by an ATFM unit, as a result of tactical slot allocation at which a flight is expected to land on a runway.
ELDT	Estimated landing time	The estimated time that an aircraft will touch down on the runway (equivalent to ETA).
ALDT	Actual landing time	Actual time an aircraft lands on a runway (equivalent to ATC ATA – actual time of arrival = landing, ACARS = ON)
SIBT	Scheduled in-block time	The time that an aircraft is scheduled to arrive at its first parking position.
AIBT	Actual in-block time	The time that an aircraft arrives in-blocks (equivalent to airline/handler ATA – actual time of arrival, ACARS = IN).

6.5.2.1.1 Flight Event Time ATFM Terminologies can be mapped to each flight event time and status as per Table II-6-3.

Table II-6-3. Flight Event Time Terminology mapped to specific flight event time and status

Flight Event Times	*Scheduled*	*Flight plan*	*ATFM measure*	*ATFM system estimate*	*Actual*
Off-block time (OBT)	SOBT	EOBT	COBT		AOBT
Take-off time (TOT)			CTOT	ETOT	ATOT
Time over (TO)			CTO	ETO	ATO
Landing time (LDT)			CLDT	ELDT	ALDT
In-block time (IBT)	SIBT				AIBT

6.5.3 Use of ATFM terminology

6.5.3.1 One of the objectives of this manual is to develop and promote standard terminology and phraseology for the exchange of ATFM voice and automated messages. The information contained herein is therefore intended to reflect the current use of plain language and provide a basis for harmonization.

6.5.3.2 ATFM operations should be conducted in a simple and concise manner, using common language. The use of local or regional colloquial terms or acronyms should be avoided as they could induce confusion.

Note.— Coordination with international stakeholders may impose the use of the English language.

6.5.3.3 The use of standardized terminology guarantees the uniform delivery of ATFM messages among various ATFM units on a global scale. This includes the concept of modular and structured ATFM messages and defines the components of the message as who, what, when, where and why.

6.5.3.4 As with any communication model, it is the responsibility of both parties (sender and receiver) to ensure that the message is clear, concise, correctly understood and applied as requested.

6.5.3.5 Each ATFM coordination exchange should have five components (who, what, when, where, why) that contain plain language elements and that, when combined, provide a complete ATFM message.

a) **WHO –** This identifies the parties involved. Who is transmitting and receiving the message?

Examples: CGNA THIS IS COLOMBIA FMU
CENAMER ACC THIS IS PANAMA ACC
CCFMEX THIS IS ATCSCC
JCAB THIS IS CFMU

b) **WHAT –** This identifies the objective to be achieved.

Examples: REQUEST 30 MILES IN TRAIL
REQUEST 3 MINUTES IN TRAIL
REQUEST GROUND STOP

c) **WHEN** – This identifies the time and/or duration of the ATFM objective to be achieved.

Examples: WITH IMMEDIATE EFFECT UNTIL 1700 UTC
FROM 2000 UTC TO 2130 UTC

d) **WHERE** – This identifies the location of the ATFM objective to be achieved. It is often preceded by a modifying clause, indicating what aircraft or traffic the restriction will apply to. The modifying clause and the location combination are used to construct the “where” component. Where applicable, ICAO location designators should be used.

Examples: FOR ALL AIRCRAFT LANDING SKBO
FOR ALL TRAFFIC LANDING HECA
FOR ALL TRAFFIC FILED VIA B881

e) **WHY –** This identifies the reason for the ATFM objective.

Examples: DUE TO SEVERE THUNDERSTORMS OVER SKBO
DUE TO A LONG-RANGE RADAR OUTAGE
DUE TO EXCESS SECTOR DEMAND
DUE TO AN AIRCRAFT INCIDENT

6.5.3.6 *Exchange example*. The following is an example of a complete message:

CGNA THIS IS COLOMBIA FMU. REQUEST 30 MILES IN TRAIL FOR ALL AIRCRAFT LANDING SKBO WITH IMMEDIATE EFFECT FROM NOW UNTIL 1700 UTC DUE TO SEVERE THUNDERSTORMS OVER SKBO

6.5.3.7 *Exchange amendment*. The amendment of an ATFM message should include similar elements but with additional modifiers. These modifiers may include:

a) CHANGE;

b) AMEND;

c) REDUCE;

d) INCREASE; and

e) DECREASE.

6.5.3.7.1 *Exchange amendment example*.

GUAYAQUIL FMP THIS IS LIMA FMP, REDUCE YOUR MILES-IN-TRAIL TO SPIC FROM 30 MILES-IN-TRAIL TO 20 MILES-IN-TRAIL FROM 1400 UTC TO 1700 UTC DUE TO IMPROVING METEOROLOGICAL CONDITIONS AT SPIC

6.5.3.8 The cancellation of an ATFM exchange should contain a cancelling word or phrase. Cancellation exchanges should also identify which exchange is being cancelled because several ATFM measures could be in place at once. Normally, it is not necessary to state the reason for the cancellation, but it may be included. A cancelling word or phrase may include:

a) CANCEL;

b) RESUME;

c) RESUME NORMAL; and

d) RELEASE.

6.5.3.8.1 *Exchange cancellation example*.

CARACAS FMU THIS IS GEORGETOWN FMU, CANCEL THE GROUND STOP FOR GEO DUE TO THE RUNWAY NOW OPEN

6.5.4 ATFM Phraseology

6.5.4.1 Table II-6-4 outlines the phraseology to be used for communication between the ATC unit and pilots on ATFM operations:

Table II-6-4. ATFM Phraseology

Circumstance	*Phraseology*
Calculated take-off time (CTOT) delivery resulting from a slot allocation. The CTOT shall be communicated to the pilot at the first contact with ATC.	CTOT (*time*)
Change to CTOT resulting from a slot revision.	REVISED CTOT (*time*)
CTOT cancellation resulting from a slot cancellation.	CTOT CANCELLED, REPORT READY
Flight suspension until further notice.	FLIGHT SUSPENDED UNTIL FURTHER NOTICE, DUE (*reason*)
Flight de-suspension.	SUSPENSION CANCELLED, REPORT READY
Start-up requested too late to comply with the given CTOT.	CTOT EXPIRED, REQUEST A NEW CTOT
Denial of start-up when requested too late to comply with the given CTOT. (Where supported by State regulation or procedure.)	UNABLE TO APPROVE START-UP CLEARANCE DUE CTOT EXPIRED, REQUEST A NEW CTOT
Start-up requested too early to comply with the given CTOT.	REQUEST A NEW CTOT

Circumstance	*Phraseology*
Denial of start-up when requested too early to comply with the given CTOT. (Where supported by State regulation or procedure.)	UNABLE TO APPROVE START-UP CLEARANCE DUE CTOT (*time*), REQUEST START-UP AT (*time*)

Chapter 7

ATFM STRUCTURE AND ORGANIZATION

7.1 STATE RESPONSIBILITY AND OVERSIGHT OF ATFM

ATFM is a part of ATM services and is therefore addressed by the provisions contained in Annex 11 — *Air Traffic Services*, Chapter 2, Section 2.1, which establishes the obligation of States towards the designation of authority responsible for providing such services.

7.2 ATFM SERVICE STRUCTURE AND ORGANIZATION

7.2.1 Each State should ensure that an ATFM organizational structure which meets the needs of the aviation community is developed. This structure should, at a minimum, allow the management and oversight of:

a) the ATFM service; and

b) the coordination and exchange of information, both internally and externally.

7.2.2 The structure should also ensure:

a) the existence of a line of authority for the implementation of decisions; and

b) compliance with the mission requirements assigned to the ATFM services.

7.2.3 A line of authority to support the ATFM service should, as shown in Figure II-7-1, include the following:

a) an ATFM service manager;

b) the flow management unit (FMU) that provides ATFM service for a specific set of ATS units; and

c) flow management positions (FMPs) at specific ATS units responsible for the day-to-day ATFM activities.

7.2.4 Once the line of authority has been established, the ATFM service itself can be designed bearing in mind the following:

a) an aerodrome control tower can be served by an FMP. This duty can be added to an existing position, or it may require its own dedicated position. In any case, the control tower FMP coordinates with the FMP at the approach control unit or with the ACC where there is no ATFM function on approach;

b) an approach control unit can be served by an FMP. This duty can be assigned to an existing position in the approach control unit or it may require one or more dedicated positions, depending on the workload. The approach control unit FMP coordinates with the FMU at an ACC;

c) an ACC can be served by an FMU. This ATFM structure in an ACC is more complex and may consist of a number of traffic management coordinator positions to meet the needs of the ACC as well as the units for which it is responsible. Some functions may require dedicated staff. This will be dictated by the workload induced by:

1) approach control coordination;

2) departure control coordination;

3) en-route coordination;

4) meteorological briefing/forecasting coordination;

5) airspace user liaison;

6) military liaison;

7) airport coordination;

8) post-operations analysis; and

9) additional support functions that may be required, such as administrative and information technology coordination. The additional functions of crisis management coordinator may also be required, as applicable;

d) a group of ACCs can be served by a national or an international ATFM entity that oversees and coordinates the activities of the various units located in its area of responsibility. An international ATFM entity will perform multiple functions for numerous ACCs. Each function may, depending on the workload, be combined or require dedicated positions. The functions may include:

1) traffic management coordination;

2) organization of traffic planning;

3) meteorological briefing/forecasting coordination;

4) NOTAM/messaging coordination;

5) coordination of activities affecting capacities (i.e., flight calibration/flight check coordination);

6) airspace user liaison;

7) military liaison;

8) information technology coordination and operational data management;

9) technical operations coordination (Communications Unit (COM), NAV, surveillance and ATM infrastructures and systems);

10) crisis management coordination; and

11) post-operations analysis.

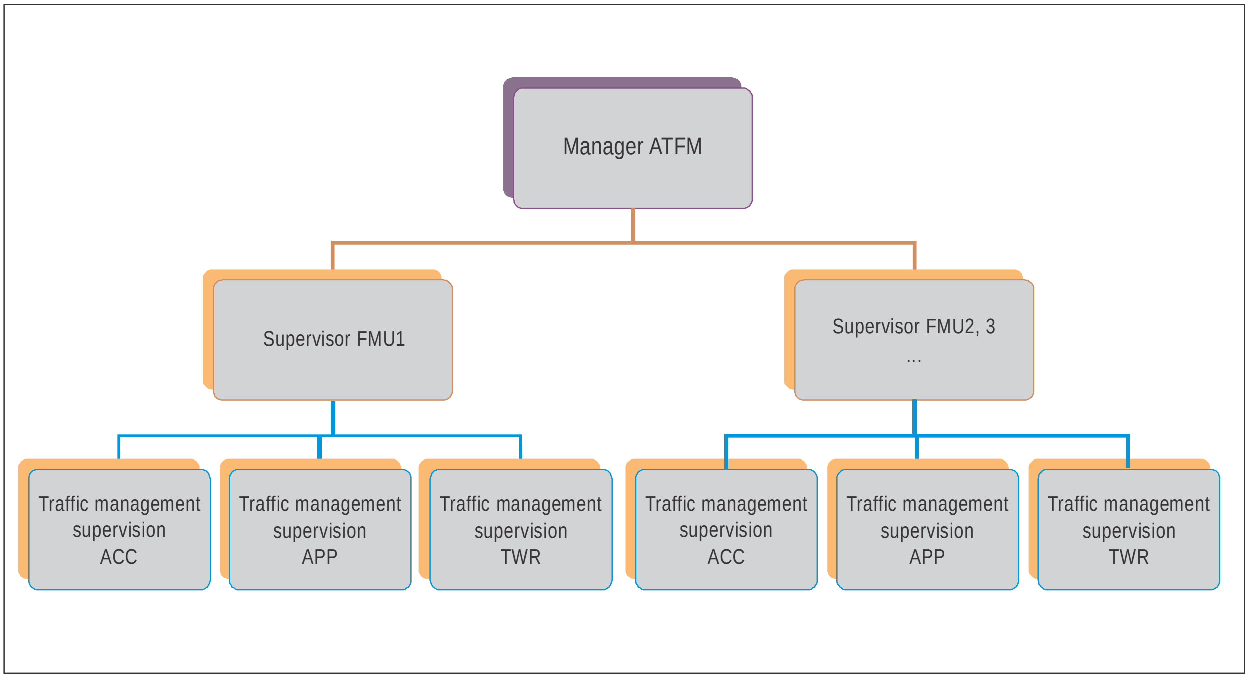

Figure II-7-1 Sample of an ATFM line of authority

7.3 COORDINATION WITHIN ATFM

7.3.1 The ATFM centre is responsible for the dissemination of information and for coordination among the facilities located in its area of responsibility for national, intraregional and interregional coordination.

7.3.2 ATFM relies on efficient coordination and collaboration, and CDM is the cornerstone of flow management. One of the ATFM structure roles is therefore to enable and facilitate CDM. In order to do so, the coordination methodology implemented with ATFM establishes a protocol to ensure that each level of the organization is consulted and informed of ATFM activities in a timely and accurate manner. This method is reflected in the description of the roles and responsibilities described in Section 7.4.

Note.— See Part II, Chapter 2, Section 2.3.1 of this manual for information on CDM applications to ATFM.

7.3.3 The formal standardization of various coordination processes, through letters of agreement (LOA) or other appropriate documentation, enhances the efficiency of collaboration, as these processes define the conditions under which the coordination should be executed and the required partners. Formal standardizations should therefore be developed as much as possible to ensure coordination and collaboration between the units involved in ATFM.

7.4 ROLES AND RESPONSIBILITIES OF STAKEHOLDERS IN AN ATFM SERVICE

7.4.1 Since ATFM structures should be adapted to the challenges in the region where they are implemented, there can be variations in the roles and responsibilities, as described in this section. The various elements and tasks depicted below were extracted from a generic organizational model and can be modified to meet the needs of each specific environment.

7.4.2 This section describes the roles and responsibilities of a number of stakeholders relevant to ATFM operations. These stakeholders should form the backbone of the CDM processes established to support ATFM. Local conditions may dictate that stakeholders other than those presented in this section are needed. At a minimum, however, this section provides a sound list of actors to consider for participation.

7.4.3 Flow management unit (FMU)/flow management position (FMP)

7.4.3.1 FMUs/FMPs monitor and balance traffic flows within their areas of responsibility in accordance with ATM directives. They also direct traffic flows and implement approved traffic management measures. As mentioned in 7.2.3, their operations are overseen by the appropriate authority. FMU/FMP duties usually include:

a) liaising with the ATS units within their area of responsibility to understand the current and anticipated capacity conditions;

b) collecting all relevant information, such as meteorological conditions, capacity constraints, infrastructure outages, runway closures, automated system outages, and procedural changes that affect ATS units. This may be accomplished through various means available, such as teleconferences, e-mail, Internet, or automated data gathering;

c) ensuring the distribution of all relevant information to the appropriate stakeholders, relying on the CDM processes supporting ATFM operations, and on the structures implemented to disseminate the information (such as websites, for example);

d) coordinating, with the affected stakeholders relying on CDM processes, the formulation of strategies to manage the flows in order to deal with, in accordance with the scenarios established at a strategic level, anticipated capacity/demand imbalance including those processes pertaining to routine operations, significant meteorological conditions, abnormal levels of traffic demand, and more generally to significant capacity constraints, planned or unplanned. Such coordination generally involves daily telephone and/or web conferences as required;

e) creating and distributing the ATFM daily plan (ADP) based on the previous coordination;

f) executing the daily plan and continuously monitoring, in real time, the ATM system, managing ATFM measures (implementing or cancelling them when no longer required, adjusting hourly capacities, etc.) in coordination with the relevant units (meteorological units, adjacent ATS and ATFM units, etc.);

g) documenting, in real time, a complete description of all ATFM measures (for example, ground delay programmes, miles-in-trail) in a designated log. This should include, among other data, for each measure, the start and end times, the affected stakeholders and flights, and its justification; and

h) managing regular (daily as well as at ad hoc intervals) post-operations analyses, participating in continuous improvement programmes.

7.4.3.2 For the units responsible for ATFM over the airspace of a group of States, proper coordination and harmonization of ATFM is increasingly necessary, taking due account of a network perspective. This is best conducted through regular contact between the ATFM units. Contact can be organized distinctly from the CDM, underscoring ATFM operations. It should be noted that mutual participation in each other’s CDM conference calls can yield increased benefits for the parties concerned.

7.4.4 Airspace users (AUs)

7.4.4.1 AUs participate in the ATFM process by providing and updating flight plan or airspace utilization information as well as by participating in CDM processes (e.g., discussing ATFM strategies to improve flight efficiency and participating to share their priorities with the other stakeholders). AUs are essential stakeholders in the CDM processes and generally participate in telephone conferences and/or provide input and participate as CDM web-based interfaces.

Note.— From a general point of view, participation of AUs in the CDM processes is consistent with the actions envisaged in the GANP user-driven prioritization process (UDPP).

7.4.4.2 The term “airspace user” is a broad denomination and encompasses different actors, both civil and military. Their actions can therefore be broken down by function, into airline operation centres, pilots, and military authorities. AUs encompass all entities that make use of airspace and that affect the availability of airspace.

7.4.4.3 The role of an AU is to:

a) provide strategic input into capacity/demand scenarios and mitigation plans, including internal measures such as schedule compression;

b) ensure that the latest schedule information and flight planning information are supplied to the ATFM service;

c) participate in ATFM/CDM teleconferences;

d) provide tactical input into capacity/demand scenarios and the selection of required appropriate ATFM measures;

e) perform mitigating actions supported by the ATFM service;

f) ensure ATFM information such as ATFM measures (calculated take-off time (CTOT)) is distributed to each affected flight;

g) comply with the ATFM measures in place, for example, CTOT compliance; and

h) participate in post-event analyses.

Note.— See Part II, Chapter 4, Section 4.7 for information regarding actions to mitigate the impact of ATFM measures.

7.4.4.4 Pilots play a specific role in ATFM insofar as they are to operate their flights in compliance with relevant ATFM measures. This may include adhering to controlled times, re-routes, or altitude capping restrictions. Pilots also have the responsibility to communicate with ATC if they foresee not being in a positon to comply with a given measure. They should also be aware of the ATFM measures intended to affect them, in order to ensure that the flight is not operated in a way that intentionally negates the delay absorption measure (e.g., accelerating to offset the effects of a GDP).

7.4.4.5 Lastly, military users are a specific kind of AU. Their needs and the impact of their actions on the network can carry significant consequences. Military users therefore have a specific role to play in ATFM. Their use of airspace ranges from reserving blocks of airspace needed for the conduct of specific missions to operating flights in the exact same way as a civilian operator. For the purpose of simplicity, in this section the term military user refers, without distinguishing among them, to military authorities, flying units and non-flying airspace users (such as ranges, etc.). As far as ATFM is concerned, military users are therefore expected to:

a) provide airspace utilization plans to the appropriate ATC and ATFM units in a timely manner in accordance with flexible use of airspace (FUA) principles when relevant;

b) ensure that operations comply with the agreed-upon FUA plan and advise the appropriate unit immediately of completion or cancellation of FUA operations;

c) participate in ATFM/CDM teleconferences or provide input to the calls;

d) ensure that the latest flight information is supplied to the ATFM system;

e) ensure that the flights comply with the ATFM plan in place;

f) coordinate with the ATFM/ATC unit(s) for tactical release of airspace or permission to fly through restricted/active airspace when required by circumstances; and

g) participate in post-event analyses.

7.4.5 ATS units

7.4.5.1 ATS units providing ATC services play a central role in ATFM. Whereas each unit controls flights at different moments, the roles and responsibilities of ATS units are similar within their specific area of responsibility (aerodrome, approach, area). They are expected to:

a) participate in relevant ATFM/CDM teleconferences;

b) provide input regarding capacity and configuration for their area of responsibility;

c) provide strategic input into capacity/demand scenarios;

d) provide pre-tactical input into capacity/demand scenarios;

e) provide tactical input into capacity/demand scenarios;

f) deliver aircraft as per the ADP, ensuring compliance with ATFM measures;

g) monitor resource throughput and ATC workload during ATFM situations and request amendments, when necessary;

h) liaise with the unit responsible for ATFM to ensure that the ATFM plan is suitable, if not part of an ACC/approach control unit; and

i) participate in post-event analyses.

7.4.5.2 ATS units are responsible for developing and implementing operational procedures related to cross-border operational principles. The procedures are generally formalized using ad hoc LOAs.

7.4.6 Airport operators

The term “airport operator” refers to any entity involved in the management of an airport. Airport operators’ involvement can be direct, or when they operate from an airport collaborative decision-making (A-CDM) standpoint, coordination can occur through the A-CDM structures. Some of the tasks listed below can therefore be carried out in A-CDM, in which case they are then used in ATFM upon coordination between ATFM and A-CDM structures. In terms of ATFM, airport operators are expected to:

a) participate in relevant ATFM/CDM teleconferences;

b) provide input to the strategic capacity declaration of airports;

c) coordinate with the pertinent ATFM/ATC unit and affected airspace users to schedule activities such as construction, maintenance and repairs or snow removal that will affect the flow of traffic or the airport capacity;

d) participate in CDM coordination discussions where the airport capacity will be affected by meteorological conditions, maintenance or other airport-related issues; and

e) participate in post-event analyses.

Note.— See Part III of this manual, entitled Airport Collaborative Decision-Making, for the roles and responsibilities of airport operators.

7.4.7 Meteorological service provider

7.4.7.1 There are a variety of meteorological phenomena that can impact traffic and trigger the need for flow management. As a result, MET information providers play a crucial role in ATFM, both in forecasting those events to mitigate their consequences, as well as in providing accurate real-time meteorological information. Adverse meteorological conditions can impact an aerodrome — in which case MET service providers would be involved in A-CDM if it has been set up for that aerodrome (thunderstorms, fog, significant changes in surface wind speed or direction) — or can cover large portions of airspace (squall lines, tropical cyclones, frontal systems, etc.). The involvement of MET services in ATFM is systematically relevant, whether it is direct or indirect (in the case of A-CDM processes, for example).

7.4.7.2 In ATFM, MET service providers are expected to:

a) participate in ATFM/CDM coordination discussions (teleconferences) where meteorological conditions will affect capacity;

b) provide accurate and timely information on meteorological conditions at aerodromes, digital gridded forecasts of upper wind and temperature, and information about significant meteorological conditions that have an influence on capacity of a given volume of airspace or an airport; and

c) participate in post-event analyses.

7.4.8 States

7.4.8.1 Even though States and State authorities are not required to be systematically involved in the daily operations of ATFM, they still have specific responsibilities, the first of which is, as indicated in Annex 11, 3.7.5.1 to ensure that ATFM is “implemented for airspace where air traffic demand at times exceeds, or is expected to exceed, the declared capacity of the air traffic control services concerned.”

7.4.8.2 States are also responsible for the publication of ATFM procedures and information in the State AIP.

7.5 TRAINING REQUIREMENTS: ATFM TRAINING

7.5.1 An ATFM service should be staffed by personnel with sufficient knowledge and understanding of the ATM system they are supporting and the potential effects that their work may have on the safety and efficiency of air navigation. To ensure this and in line with their training policies, States and ANSPs should establish core training plans to educate the ATFM service staff in the importance of the availability, continuity, accuracy and integrity levels required for the services provided.

7.5.2 In addition to the staff of the ATFM unit itself, there are several other units/areas/entities where staff should be aware of and understand the ATFM services provided and the specific roles and responsibilities they carry in this process. Units where ATFM is exercised or directly experienced and where staff therefore need training include:

a) ATC;

b) aircraft operators;

c) pilots;

d) airport operators;

e) military, both service providers and users; and

f) regulatory bodies (CAAs and equivalent).

7.5.3 An ATFM service is provided at different levels of responsibility, each with its own training requirements. These levels include operations management and supervision, and planning and execution of the service and essential support staff. In addition, there are different support functions, CDM partners and general ATM personnel who should be considered when developing training requirements.

Note.— Detailed guidance material has been developed within the Association of South-East Asian Nations (ASEAN) and is available as Appendix E of the framework document that can be found at Asia/Pacific Framework for Collaborative ATFM.

7.5.4 ATFM training can be divided into a number of phases.

7.5.4.1 *Ab initio training.* This ensures that new ATFM staff possess the necessary contextual knowledge to be able to follow the more detailed, job-related training.

7.5.4.2 *Basic training.* The ATFM core and its associated operational topics are covered in a comprehensive fashion.

7.5.4.3 *On-the-job training.* A substantial amount of practical application of the occupation is undertaken under appropriate supervision, in order to ensure that the acquired knowledge from the basic training course(s) can be applied in an autonomous manner.

7.5.4.4 *Advanced training.* Advanced ATFM analysis and application techniques are studied.

7.5.4.5 *Recurrent/Refresher training.* This involves updating competencies on a regular basis, in accordance with the latest operational requirements, new methodology/technologies applied, and application of exceptional and contingency measures.

7.5.5 It is generally not considered necessary for ATFM personnel to be subject to a full licensing system similar to that of air traffic controllers. It is, however, strongly recommended that ATFM personnel be subject to structured competency assessment schemes upon initial employment and future evaluations.

Chapter 8

ATFM IMPLEMENTATION

8.1 INTRODUCTION

8.1.1 This chapter describes the sequential steps to be undertaken to establish an ATFM structure from initiation to post-implementation analysis. The degree of effort spent on each step will depend on the nature of the structure (from a local unit operating from a single airport to a major international entity). The structures are described in the section detailing the various concepts of operations that must be established.

8.1.2 The ATFM implementation strategy is usually developed in sequential phases in order to allow all concerned parties to gain sufficient knowledge and experience. An implementation project for ATFM is usually applied as outlined in Figure II-8-1. These phases are described throughout the chapter. The process begins with an interest in implementing ATFM and ends with the post-operational analysis. During the process, regular evaluations are carried out to cope with variations in the initial requirements.

8.1.3 The entire process is structured around continuous stakeholder participation ensured through CDM. Even though the States and ANSP retain final responsibility for the implementation, CDM underscores the complete process.

8.1.4 Finally, consideration is given to the regulatory requirements that underscore ATFM implementation, the involvement of regulatory authorities and the use of automation in ATFM.

8.2 GENERIC CONSIDERATION ON ATFM IMPLEMENTATION

8.2.1 ATFM implementation should be supported by adequate quality and change management processes.

8.2.2 Even though ANSPs may not have the operational requirement to implement ATFM within their own areas of responsibility, they may be expected to participate in ATFM by adhering to regional or multilateral agreements.

8.2.3 Implementing ATFM in an international environment requires a common understanding and robust coordination among all relevant stakeholders. ATFM is performed as a CDM process where airports, ANSPs, AUs, military entities, and a large number of stakeholders collaborate to improve the overall performance of the ATM network in a given region.

8.2.4 The level of an ATFM service required in each region or defined area will depend on a number of factors. It is important to note that an ATFM service may be simple or complex depending on the requirements in the ANSP's area of responsibility. Even relatively simple ATFM services, when properly designed and implemented, can enable ANSPs to effectively provide the required service. To ensure the successful implementation at the level of a given region, all ATFM implementations must be coordinated and in synch with all ANSPs.

Figure II-8-1. ATFM implementation steps

8.2.5 The following elements should underscore the implementation of an ATFM service:

a) a project management approach should clearly define the tasks for each stakeholder and contain milestones;

b) the ANSP should oversee the implementation process in collaboration with the relevant oversight authorities, involving, when relevant, affected stakeholders; and

c) the personnel who will lead the development of ATFM should be identified. Best practices indicate that the ANSP usually takes the lead and key stakeholders from AUs, airport operators, and military authorities should be involved in the planning, development and implementation of ATFM.

8.3 STEP 1: IDENTIFYING THE NEED FOR ATFM

8.3.1 This step begins with the realization by a given stakeholder that there is a need for ATFM. The early signs of such needs are often overlooked, as ATC systems are built to deal with variations in traffic levels. Defining a level of strain that would automatically trigger ATFM implementation is therefore impossible. To simplify, the fact that constraints — of any given kind — are being imposed on traffic should trigger ATFM implementation.

8.3.1.1 Examples of such constraints include the frequent use of defined re-routings, a regular request to sequence traffic using larger separation standards, etc.

8.3.2 Notwithstanding the importance of local analysis to determine the need for ATFM, every ANSP should consider the implementation of some form of ATFM. Aviation is a global activity. Considering that effective ATM must transcend national borders and that optimal results require collaboration between all stakeholders, the chances of not needing ATFM at all are rather small.

8.3.2.1 When implementing ATFM, consideration should be given to the evolution of the ATFM concept as outlined by the GANP, which states that ATFM is designed to be an enabler of:

a) improved access to airspace and aerodromes;

b) better utilization of available airspace and airport capacities;

c) reduced fuel burn through better planning and coordination; and

d) reduced occurrences of undesired sector overloads.

8.3.2.2 What is more, ATFM involves engagement during the:

a) strategic phase: in the form of strategic airspace utilization planning;

b) pre-tactical phase: where meteorological and other developing constraints are assessed and mitigation plans are considered; and

c) tactical phase: when ATFM measures are normally applied, including when the aircraft is in flight.

8.3.2.3 Finally, the degree of involvement from each State and ANSP will vary depending on national and regional needs. States and ANSPs should collaborate with their airspace users and neighbouring States to determine how and when to implement ATFM.

8.4 STEP 2: REQUIREMENT ASSESSMENT

8.4.1 Before implementing ATFM/CDM, the ANSP should assess the operational requirements to determine what is needed and what could be expected from ATFM. This analysis will, in turn, be closely linked to the scope of ATFM implementation; either basic ATFM processes, domestic ATFM, subregional or regional. Further explanation on the various ATFM processes are contained in Section 8.5, which provides guidance on the concept of operations for each case.

8.4.2 ANSPs should perform an analysis of ATM operations to determine which implementation would be most appropriate for their area of responsibility. Factors to be taken into consideration during this assessment are as follows (note that this should not be construed as an exhaustive list):

- Does demand exceed capacity on a regular basis in airspace or aerodromes?
- Are there periods of high ATC workload?
- Does the anticipated growth in traffic indicate that demand will exceed capacity in the future?
- Are special requirements from AUs (e.g., military, remotely piloted aircraft systems (RPAS), commercial space) having an impact on airspace capacity?
- Are there significant increases in seasonal demand (holiday season) resulting in demand exceeding capacity?
- Are aircraft operators experiencing increased elapsed flight times?
- Are there noise abatement procedures causing capacity reduction?
- Is there frequent airborne holding, vectoring, speed control and/or surface queuing?
- Are there capacity constraints caused by meteorological conditions, VIP movements, sporting events, military exercises, equipage outages, political unrest, labour issues or other factors?
- Are there flights departing from airfields within the ANSP area of jurisdiction for other FIRs where ATFM measures are in place?
- What is the ratio of domestic versus international traffic?
- Are there multiple resources (aerodromes or airspace) within the area of responsibility of the ANSP which require ATFM/CDM?
- Are the variety of aircraft types and equipage impacting the airspace capacity?
- Are there CNS and ATM considerations that give rise to capacity issues?
- Are major changes in CNS equipage changes likely to affect capacity during implementation?
- What are the airport resources and processes (A-CDM)?
- Are there political and institutional factors which could affect the implementation of ATFM in the State or region?

8.4.3 Answers to the above questions, and others established locally, will provide a sound basis to evaluate what is needed and formulate the requirements that ATFM will have to meet.

8.5 STEP 3: CONCEPT OF OPERATION ESTABLISHMENT — VARIATIONS FOR EACH TYPE OF ATFM IMPLEMENTATION

8.5.1 Once the ATFM/CDM requirements have been assessed, the ANSP(s) should develop the ATFM scope for the relevant area of responsibility. This is usually established during the drafting of a concept of operation (CONOPS) document. The CONOPS should describe the type of ATFM that is envisaged; the geographic dimension (domestic, cross-border, regional), and the scope (phases of ATFM covered, extent of measures, etc.). Acquired experience from other regions is an invaluable resource for developing the CONOPS. What is more, a vast array of technological solutions are available to support all types of ATFM operations (centralized supported by local FMUs, decentralized, multi-nodal, hybrid, etc.).

8.5.2 In its initial application, ATFM need not complicate processes, procedures or tools. The goal is to collaborate with system stakeholders and to communicate operational information to AUs, ANSPs, and to other stakeholders in a timely manner. It can be performed using simple methods such as e-mail and point-to-point telephone calls designed to exchange information of operational significance and to relay information on factors affecting capacity, system constraints and significant meteorological conditions.

8.5.3 Domestic, cross-border and regional ATFM

8.5.3.1 A State may have the required number of domestic flights to make domestic ATFM effective without including international flights. Experience and best practices indicate that a minimum of 70 per cent participation of flights in an ATFM measure, such as a GDP, is needed to provide the expected operational and efficiency benefits. Concern could be raised when only domestic flights are subjected to ATFM measures, while international flights are exempted. This can be seen as imposing an unfair burden on national or local carriers, even though the State may have enough domestic flights for ATFM to be implemented. This issue can be mitigated through the drafting of a CONOPS which includes international flights (in the initial implementation or at some stage in the future) in order to ensure that the distribution of delay is fair, equitable and efficient.

8.5.3.2 Numerous domestic ATFM/CDM implementations (in Australia, Japan, and South Africa) have provided proof of the benefits of a national ATFM cell. All participants recognize, however, the relevance of including international flights in ATFM measures. An ANSP may therefore initially implement domestic ATFM/CDM, however, the long-term plan should include an “upgrade” to cross-border regional ATFM to incorporate international flights.

8.5.3.3 Regional ATFM aims to maximize the efficiency and effectiveness of ATM across the area of responsibility of more than one ANSP. It therefore contributes directly to the objectives, principles and benefits of ATFM. More specifically, it aims to achieve a seamless ATM environment over a region or subregion.

8.5.3.4 The main objectives of regional ATFM are those outlined in Part II, Chapter 1, Section 1.2, However, the international dimension will bring a special focus on global efficiency, international collaboration, and system predictability across a wide area. Finally, it should also be noted that, thanks to international ATFM, important operational synergies and economies of scale can be achieved.

8.5.3.5 ATFM should be envisaged at the regional/subregional level when national actions cannot resolve the issues, or if remedial actions go beyond the area of responsibility of a single ATFM centre. Such cases include but are not limited to:

a) domestic, international, and possibly airborne flights included in the ATFM measure; and

b) aerodromes or airspaces located in small-sized States or regions.

8.5.3.6 When establishing regional ATFM, one of the main elements to recognize is early notice, which should be given to the associated facilities and ATM units. For example, increasing the separation between inbound traffic is one of the most frequently used ATFM measures in case of overload. That measure has, however, a significant impact on the ACC and the local ATFM unit that implements it. For this specific measure, as for all other ATFM measures, the first notion to be integrated when establishing international ATFM is the notion of advanced notice to neighbouring facilities. It must be integrated in the coordination procedures set up between adjacent facilities. Appropriate CDM processes will also spread the benefits of advance notice to the operators, as well as to all the relevant stakeholders.

8.5.3.7 While each local ATFM unit retains the authority to decide on the type of measures it would like to implement when demand exceeds capacity, it is paramount that the ATFM units possess a common view of the situation, and that the impact of each measure required by a local ATFM unit is collectively assessed at the level of the region or subregion. CDM may be used to involve the relevant stakeholders in the decision to implement the ATFM solutions that are needed in their region.

8.5.3.8 Regional ATFM is therefore, in its basic principles, no different from domestic ATFM: it relies on transparency, information exchange and collaboration. The difference arises from the number and variety of stakeholders. This generates additional complexity, but yields a significant benefit as it allows providers from various States to collaborate and anticipate rather than be confronted with the consequences of ATFM measures implemented locally.

8.5.3.9 In an ideal scenario the ATFM service for a given region would be provided by a centralized ATFM organization supported by local FMUs. In many regions of the world, however, a single ATFM organization may not be feasible due to political and institutional considerations. In these instances, emphasis is placed on collaboration and on projects such as the multi-nodal cross-border ATFM.

8.5.3.10 Confronted with the hurdles associated with the establishment of a central ATFM unit, some States have decided to implement international cross-border ATFM relying on national resources and international cooperation. In this case, multiple States/ANSPs in a region implement and operate ATFM systems, which impact multiple FIRs/sectors of airspace/aerodromes (possibly in more than one State) as is illustrated in Figure II-8-2.

8.5.3.11 In this concept, each ANSP operates an independent, virtual ATFM/CDM node supported by an interconnected information-sharing framework. The flows of air traffic are then being effectively managed based on a common set of agreed principles among the participating ANSPs and airports. A node comprised of the ANSP and associated aerodromes is able to manage the demand and capacity through adjustments in aircraft calculated landing times (CLDTs), which generate calculated take-off times (CTOTs) for particular aircraft at the departure airport.

8.5.3.12 Each ANSP performs demand and capacity balancing within its own area of authority. Where ATFM measures require participation of regional and international flights, the flows will be managed by the agreed coordination procedures.

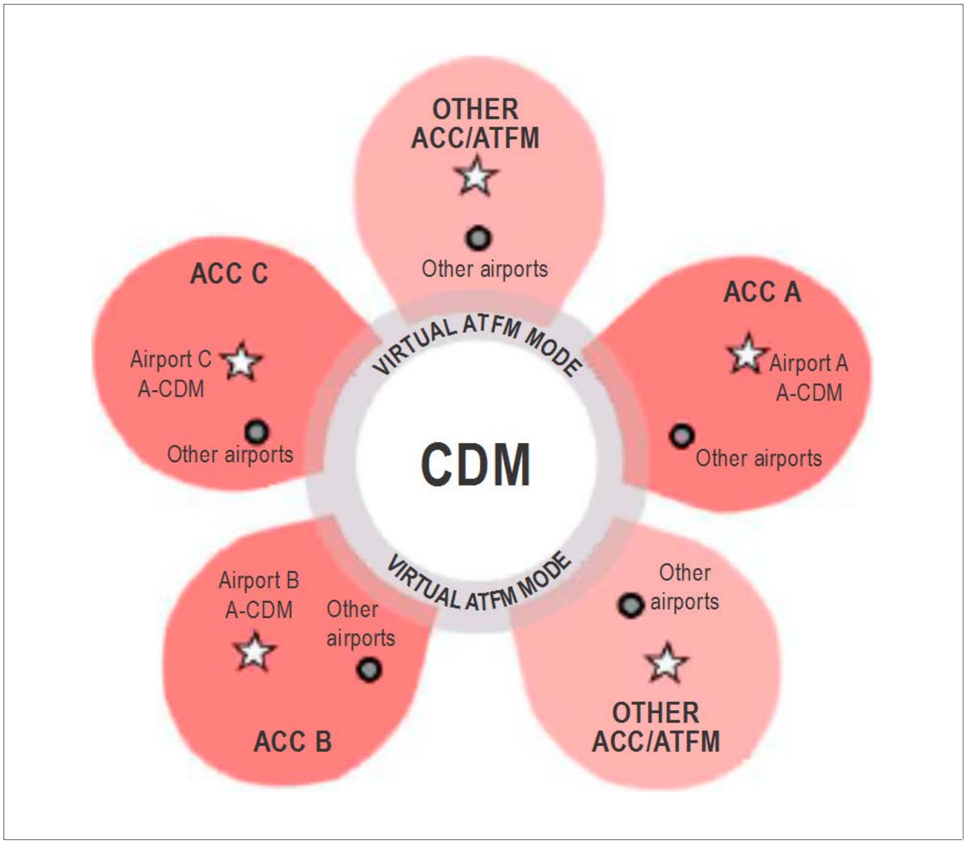

Figure II-8-2. Proposed distributed multi-nodal ATFM network concept

8.5.4 Key components of the different ATFM/CDM concepts

Table II-8-1. Key components of the different ATFM concepts

	Domestic ATFM	*Regional ATFM*	*Regional ATFM cross-border multi-nodal*
System capability and functionality	ANSP has an independent ATFM system.	Centralized ATFM organization for multiple ANSPs within a geographical region.	Each ANSP has an independent ATFM system which is connected in a distributed ATFM network sharing ATFM information.
	ANSP manages demand/capacity of its own airspace and airport(s).	Shared responsibility between each local FMU and central unit for management of demand/capacity of each ANSP's airspaces and airport(s).	ANSP independently manages demand/capacity of its own resources.
	Only domestic traffic is subject to ATFM measures.	Geographical region's flights subject to ATFM measures.	Flights participating in ATFM nodes within the region subject to ATFM measures.

	Domestic ATFM	*Regional ATFM*	*Regional ATFM cross-border multi-nodal*
	CDM is performed by stakeholders via software web interfaces or accepted messaging protocols.	Multi-level CDM processes and applications via web interfaces and accepted messaging protocols (legacy and SWIM messaging) applied in all ATFM processes.	CDM is performed by stakeholders via software web interfaces or accepted messaging protocols.
	National procedures published by each State in the national regulations and AIP.	Common set of procedures for the geographical region's ATFM contained in the *Regional Supplementary Procedures* (Doc 7030) and common operations manual.	Individual procedures published by each ANSP, though normally coordinated and harmonized based on common operating procedures.
		Centralized compliance measurement and reporting.	
Specify capacity and demand prediction	Demand prediction – flight progress is via manual input or automated data feed (e.g., FDP, AMHS, or AFTN).	Demand prediction – centralized flight planning function ensures single and accurate demand picture throughout the region.	Demand prediction – flight progress is via manual input or automated data feed (e.g., FDP, AMHS or AFTN) to each node.
		ATFM measure assignments are automatically dispatched to all affected stakeholders and are visible via web interfaces and SWIM messaging.	
	Capacity management – inputs from FMP and FOC are via ATFM web-based interface.	Capacity management – inputs from FMP and FOC are via ATFM web-based interface. All constraints are reconciled to avoid conflicting measures.	Capacity management – inputs from FMP and FOC are via ATFM web-based interface. Conflicting ATFM measures must be manually resolved.
Evaluate alternatives, initiate/modify ATFM measures	Aircraft operators perform CDM with airport operators for ground/surface delay intent.		
	ATFM slot assignments can be viewed via software, web interface and notifications.		

8.6 STEP 4: GAP ANALYSIS ASSESSMENT

8.6.1 Once the type of implementation has been chosen and a CONOPS reflecting the choices made has been established, a gap analysis should be completed to identify the existing baseline, in terms of technical capabilities and implementation requirements.

8.6.2 The aim of the gap analysis is to compare what is available to what is needed. More specifically, what procedures are used against those needed to perform as decided in the CONOPS.

8.6.3 At this stage, procedures are not developed. The necessary functionalities are assessed and evaluated. The actual work of designing the procedures will take place at a later stage.

8.7 STEP 5: DEFINING REQUIREMENTS

8.7.1 Step 5 builds on the conclusion of the gap analysis. Procedures are put in place and support tools are considered so as to enable the functionalities that were envisaged.

8.7.2 The definition of what is needed covers procedures, tools, processes, and organization of the various flows (of information, and/or decisions) based on the information that the stakeholders need at each stage of ATFM provision.

8.7.3 During this stage, implementation strategies can be discussed and carried out: a phased approach, for example, may facilitate implementation. During the first phase, all the ATFM units share data and maintain a common awareness, informing the various stakeholders of the ATFM measures to be used in their respective areas of responsibility. The second phase could then consist of centres coordinating the measures before their actual implementation. This allows the envisaged set of measures to be further improved, as all stakeholders are involved in the decision-making process, thus increasing the robustness of the chosen set of measures.

8.7.4 ATFM, as with any CDM project, begins with an effort of collaboration and communication. To support such a project, elements of common situational awareness should be defined, as reflected in Figure II-8-3. In this regard, the ATFM implementation team should establish protocols to secure communications as well as a list of required information.

8.7.5 Various communication protocols should be established, including frameworks detailing:

a) the mandatory provision of required airspace and demand data (schedules, flight plans, etc.) to the ATFM system;

b) the regular exchange of ATFM information;

c) the exchange of ATFM data for periodic post-operational analysis; and

d) the exchange of ATFM information in case of exceptional disruptions or unexpected difficulties.

8.7.6 The analysis should also be based on the type of information to be exchanged in order to establish situational awareness, as illustrated in Figure II-8-3.

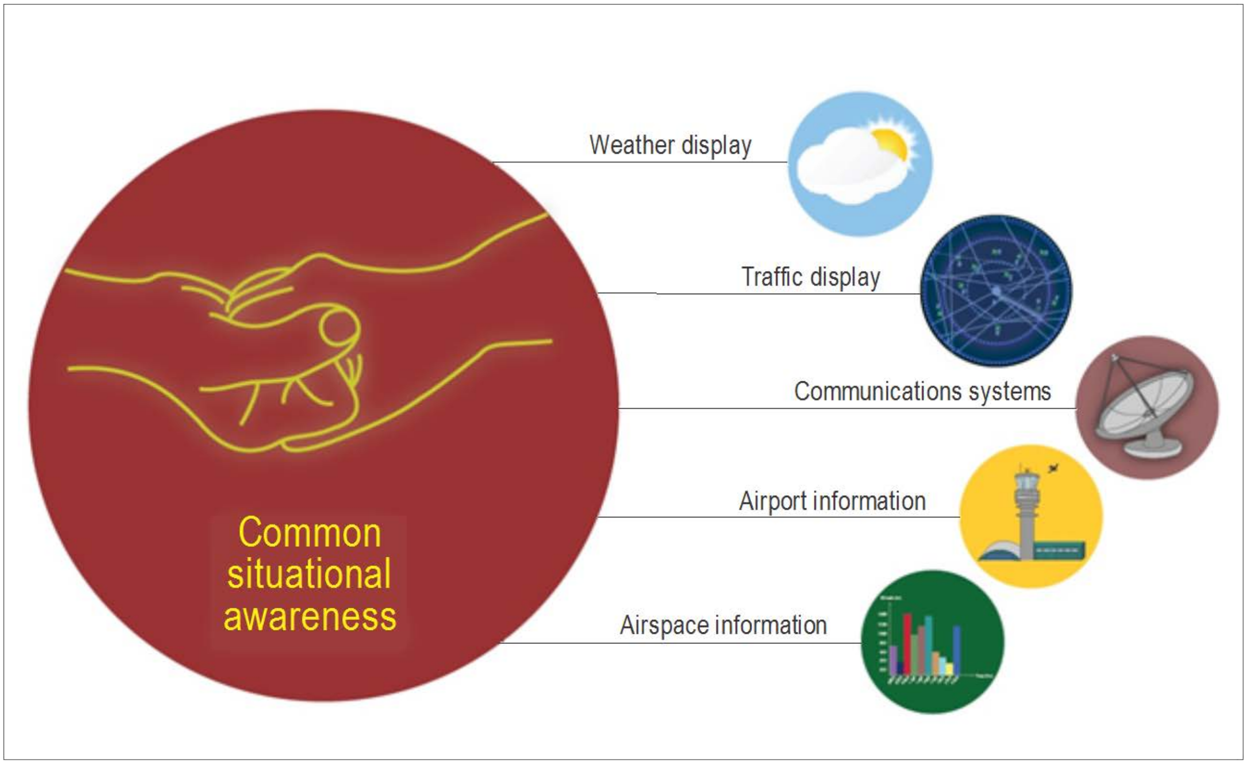

Figure II-8-3. Elements of common situational awareness

8.7.6.1 The type and format of the information related to capacities should also be identified. Such information includes:

a) ATC capacity, specified by airport or airspace volume, runway status and capacities;

b) traffic demand: flight schedule, flight plans, surveillance updates;

c) ATM systems or CNS disruptions having an impact on capacity; and

d) other information impacting ATC capacity (such as military activities, route availability).

Note.— See Part II, Chapter 5 for information on ATFM messages.

8.7.6.2 The meteorological information that can be used collaboratively to assess its impact on capacity should be identified. Sources for such information include (but are not limited to):

a) meteorological offices;

b) meteorological watch offices;

c) aeronautical meteorological stations;

d) world area forecast centres (WAFC);

e) tropical cyclone advisory centres (TCAC);

f) volcanic ash advisory centres (VAAC).

Note.— See the Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services (Doc 9377) *for information related to the sources of meteorological information as well as for the means to display the information in the units.*

8.7.6.3 The tools to collaboratively display traffic, capacity-related and meteorological information should be identified.

8.7.6.4 The appropriate communication tools and means of communication should be identified and may include:

a) telephone conferencing systems;

b) web-based conferencing systems;

c) web-based information dissemination and discussion portal similar to a blog format;

d) electronic chat to support tactical discussion;

e) dedicated SWIM services;

f) operational information web pages; and

g) any other appropriate means.

8.8 STEP 6: RESOURCE PROCUREMENT AND PROCEDURE DEVELOPMENT

8.8.1 Step 6 builds on the conclusions of Step 5: the procedures and the tools that are needed have been identified and procurement for the acquisition or in-house development can begin.

8.8.2 It is fundamental to remember that ATFM does not rely on tools or costly pieces of equipment. Significant benefits can be attained with simple collaboration and common sense. Collaboration is required to ensure that procedures are executed in a systematic manner. It is, however, also true that well-designed tools adapted to each situation can enable increased efficiency and support a safe and efficient execution of such procedures. ATFM implementation should strike the right balance between simplicity of use and expected results.

8.8.3 In this step, the ATFM structures that are needed should be designed and the CDM processes that will be used in ATFM are established (for guidelines on CDM, see Part I, Chapter 2).

8.8.4 Applicable ATFM operational letters of agreement (LoA) should be developed (Appendices II-G and II-H, respectively, provide template LoAs between an FMU/ACC and between ANSPs);

8.8.5 In this step, a model for establishing the airport arrival rate (AAR) at the relevant airports should be developed and applied and terminal and sector capacities should be established where necessary (see Part II, Chapter 3 for guidelines on capacity determination).

8.8.6 During this step, the appropriate location for FMU and FMP should be established, and the personnel in charge identified, along with the means of contact and the operational phone numbers for each stakeholder identified in the ATFM management structure.

8.8.7 Finally, it is also during this step that consideration should be given to safety management system (SMS) processes, as is the case when new ATFM tools and procedures induce a significant change to existing procedures, in line with existing provisions in the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444), Chapter 2, 2.6.1.1;

8.8.8 Upon completion of this step, the structures, processes and tools are in place. This marks the beginning of staff training.

8.9 STEP 7: TRAINING

8.9.1 Step 7 builds on the work established during the previous steps. It also builds on the education and work that was conducted since the beginning of the project.

8.9.2 Stakeholders usually need to be educated and convinced of the benefits before completely accepting and becoming part of the implementation process. As such, programmes must be developed to educate all levels in stakeholder organizations, from operational staff to executive management. These programmes should include workshops, seminars, etc. Printed and electronic media can also be used to promote the concept and its benefits.

8.9.3 Experience dictates that it is imperative to obtain executive and senior management support from the units identified in Part II, Chapter 7, Section 7.4. Confidence and support from upper management will greatly aid in the transition to ATFM to be undertaken by the various units. It is therefore also important to identify and train the appropriate stakeholders from the onset of ATFM implementation.

8.9.4 Training is a key factor for success for all staff members directly involved in ATFM operations. Training requirements for ATFM are established in Part II, Chapter 7, Section 7.5.

8.10 STEP 8: DOCUMENT PUBLICATION

8.10.1 Any ATFM system should be supported by formal international, regional and national agreements (i.e., letters of agreement) in accordance with the recommendation in Annex 11 — *Air Traffic Services*, 3.7.5.2. The aeronautical information related to ATFM must be published in accordance with Annex 15 — *Aeronautical Information Services*. ATFM procedures must be consistent with Doc 4444.

8.10.2 The various manuals and procedures underscoring ATFM operations should also be published and communicated when relevant. Specific agreements may be needed as some data shared in ATFM can be seen as sensitive when pertaining to flight programmes for airlines, for example, or for military users. In those instances, specific agreements framing the distribution and the use of the data communicated through ATFM may need to be established.

8.11 STEP 9: OPERATIONAL IMPLEMENTATION

Implementation should be carried out according to the principles listed in the project management plan (see Part II, Chapter 8, 8.2.5), which includes a detailed testing and integration programme prior to operational service.

8.12 STEP 10: POST-IMPLEMENTATION REVIEW

A post-implementation review of the operational service should be executed to evaluate its effectiveness, possible operational issues and to develop corrective actions, if necessary.

8.13 REGULATORY REQUIREMENTS TO SUPPORT ATFM

8.13.1 ICAO provisions for ATFM are contained in Chapter 3, Section 3.2 of Doc 4444. Regional ATFM provisions should be published by means of Doc 7030 by each ICAO region where ATFM is established. Detailed procedures for the application of flow management should be published by means of an ATFM operations manual and temporary operational instructions for each flow management area. Due to the wide and collaborative nature of ATFM provisions, the operational procedures should be published and freely available to all ATFM stakeholders.

8.13.2 At the national level it is also a requirement to publish a summary of flow management procedures in the national AIP (Annex 15, Section ENR 1.9).

8.13.3 As an operational ATFM function, it is appropriate that ATFM should be subject to the oversight of the responsible national or regional regulatory oversight body. Whereas ATFM does not have the same safety impact as ATC, it is nevertheless suggested that an appropriate level of regulatory oversight be established.

8.13.4 Regulatory authorities are important stakeholders in ATFM. They therefore should be fully involved in the development and implementation of the ATFM process, from the project's conception.

8.14 AUTOMATION

8.14.1 An assessment of the requirements necessary in order to carry out ATFM will dictate whether ATFM can be carried out manually or whether automation is required. Many ANSPs began executing ATFM manually and then implemented automated solutions when manual processes became cumbersome and unable to balance demand and capacity.

8.14.2 Managing flows entails a succession of actions, some of which can be automated. For the purpose of this analysis on automation, ATFM actions will be separated into two distinct sections: ATFM processes and ATFM measures.

8.14.3 Depending on the operational need, these actions may be performed manually or via automated processes using decision support tools. New automated solutions are constantly being developed. However, insight into the practices of existing ATFM operations can be used by ANSPs during the procurement phase of ATFM implementation for cost-effective and operationally successful acquisitions.

8.14.4 Benefits of ATFM process automation and measures for stakeholders

8.14.4.1 *Consistency and quality*. While ATFM processes can be dynamic and circumstances may often not be the same, automated processes will bring about consistency and quality in decision-making. For example, an automated system can apply pre-determined arrival rates based on previous ATFM processes.

8.14.4.2 *Time saving*. Automation reduces the number of tasks stakeholders need to do manually. Manual tasks take time and may be prone to error, which can be very costly to stakeholders. Automated systems can predict demand and resources continuously, whereas attempting to carry out this function out manually is very time consuming.

8.14.4.3 *Metric visibility*. When modelling ATFM measures, automation can quickly produce metrics on how effective an ATFM measure can or cannot be. The decision-making process can be greatly assisted by automated systems, thereby producing decision-assisting metrics.

8.14.4.4 *Improved operational efficiency*. Efficiency by definition describes the extent to which time, effort and cost are effectively applied for the intended task or purpose. Process automation reduces the time it takes to achieve a task, and the effort required to undertake the task. For example, calculating CTOTs for multiple flights during a GDP using an automated solution will be much faster and more accurate than attempting to do so manually, leading to improved operational efficiency.

8.14.4.5 Compliance with standard operational procedures can be enhanced by automation, as the automated tools can be set to produce decision support metrics and provide information based on pre-programmed parameters. Standard operating procedures could dictate the AAR during certain meteorological conditions, for example.

8.14.4.6 *Enhanced situational awareness and CDM*. Automated information dissemination and the ability to carry out CDM via internet connectivity enhances the ability of stakeholders to be kept current on ongoing situations and on how to optimize their operation through automated CDM processes.

8.14.4.7 Automation leads to a reduction in costs for stakeholders. Automated processes lead to efficiencies in an ATFM unit and to other stakeholders for all the above-stated reasons.

8.14.5 Implementing ATFM automation

8.14.5.1 ATFM can only be automated once robust processes have been established and when each and every stakeholder knows its role and responsibility. Automation aims to ensure rapid and effective reactions. It is fruitless if the time saved in automation is then lost by stakeholders because their expectations are unclear. The first thing to consider prior to automation is therefore to secure robust ATFM processes and to ensure that CDM underscores ATFM operations.

8.14.5.2 Once robust processes are in place, automation can be introduced using a number of supporting tools that will perform analysis, and generate and relay alerts in an automated manner.

Note.— The following presents an example of ATFM automation in a mature ATFM environment. A constraint is identified which is anticipated to reduce the capacity of a particular resource. In order to balance the demand against the amended capacity, an ATFM measure must be implemented. Automation is enacted by an ATFM system which is able to predict the demand on the resource. The system takes into consideration the newly reduced capacity and models a GDP which will balance the demand against the capacity. The automation system will enable the ATFM manager to continue modelling the GDP until an acceptable ATFM measure can be implemented. In addition, the automated system will distribute the required actions (CTOTs) by AU and ATC units. Finally, the system could have an automated CDM platform for stakeholders to carry out automated CDM.

8.14.6 Automation of ATFM processes

ATFM processes are identified in Part II, Chapter 4, and represented in Figure II-4-1. The extent of their automation is identified in Table-II-8-2.

Table II- 8-2. Automation of ATFM processes

ATFM process	*ATFM subprocess*	*Automated, manual, or both*	*Comments*
Strategic ATM planning	Performance targets	Manual	
	Traffic forecast	Both	
	Airspace design	Both	Simulation analysis is a key component to airspace design; however, airspace design itself is normally performed manually.
	Technical infrastructure	Manual	
	Procedures	Manual	
	Staffing and training	Manual	
	Performance prediction	Both	
Strategic demand and capacity balancing (DCB)	Initial traffic demand	Automated	Access to flight intent prior to submission of a flight plan.
	Capacity analysis	Manual	Some automated capacity capabilities are available for static capacity of airports and airspace. This is primarily a manual function for operational capacity determination.
ATFM daily plan (ADP)	Updated traffic demand	Automated	Operator flight intent, access to flight plan related data.
	Revised capacity (e.g., MET, airspace use plan, staffing roster, capacity constraints)	Manual	Research and limited operational use of dynamic capacity determination is available. This is primarily a manual function for operational dynamic capacity determination.
Tactical ATFM	Dynamic traffic situation	Automated	Access to flight data and surveillance.
	Capacity management (e.g., dynamic MET, special use airspace status, actual staffing)	Manual	Research and limited operational use of dynamic capacity determination is available. This is primarily a manual function for operational dynamic capacity determination.
	ATFM measures	Both	See the next subsection on ATFM measures.
	Slot swapping	Both	
	Airborne holding	Both	

ATFM process	*ATFM subprocess*	*Automated, manual, or both*	*Comments*
Post-operations analysis and performance monitoring		Both	Automated data collection and standard reports are available. Ad hoc analysis of operational data requires manual techniques.

8.14.7 Automation of ATFM measures

ATFM measures are used specifically to balance demand with available capacity at aerodromes and airspaces. Airspace elements associated with ATFM measures can include sectors, terminal control areas (TMAs), ad hoc volumes of airspace, fixes, and crossing lines. Table II-8-3 indicates if each ATFM measure defined in Part II, Chapter 4, Section 4.5 has ever been operationally proven via an automated decision support capability.

Table II-8-3. Automation of ATFM measures

ATFM measure	*Automated, manual, or both*	*Comments*
Re-routing (level capping scenarios)	Manual	
Fix balancing	Manual	
Re-routing (re-routing scenarios)	Both	Automated in mature instances.
Re-routing (alternative re-routing scenarios)	Both	Automated in mature instances.
Catalogue of re-routing options	Both	Automated in mature instances.
Miles/minutes in-trail (MIT/MINIT)	Manual	
Minimum departure intervals	Manual	
Ground delay programme (GDP)	Automated	
Airspace flow programme (AFP)	Automated	
Ground stop (GSt)	Both	

APPENDIX II-A

SAMPLE CONTINGENCY PLAN

	INITIAL ACTION				*RECOVERY*	
OCCCURRENCE	*AFFECTED AREA*	*CONTINGENCY MEASURE*	*TFV TO BE USED*	*RATE*	*ACTIONS*	*RATE*
EVACUATION OF THE ACC	LXXXACC	Traffic transferred to adjacent ATC units. Stop all departing traffic.	Configuration sent by LXXXFMP	0/60	Gradual recovery If possible, use Contingency Room Config 3A	By FMP/NMC
RADAR FAILURE	LXXXACC	Traffic transferred to adjacent ATC units. Stop all departing traffic.	Configuration sent by LXXXFMP	0/60	Gradual recovery If possible, use Config 3A	GIO-0/60 MXX-0/60 APR-0/60 until negotiated with NMC
GROUND AND R/T FAILURE	LXXXACC	Back-up system. Back-up system failure No ATC service is provided.	Configuration sent by LXXXFMP	0/60	Gradual recovery If possible, use Config 3A	GIO-20/60 MXX-20/60 APR-20/60 until negotiated with NMC
TELEPHONE FAILURE	LXXXACC	Tuned Configuration. Use of backup system.	Configuration sent by LXXXFMP	Watch Superv. Criteria	Gradual until normal.	By FMP/NMC
OWER FAILURE	LXXXACC	Tuned Configuration. Use of backup system.	Configuration sent by LXXXFMP	Watch Superv. Criteria	Gradual until normal.	By FMP/NMC
FDPS	LXXXACC	Tuned Configuration.	Configuration sent by LXXXFMP	Watch Superv. Criteria	Gradual until normal.	By FMP/NMC
STAFF SHORTAGE	LXXXACC	Tuned Configuration.	Configuration sent by LXXXFMP	Default Capacities	Gradual until normal.	By FMP/NMC
STRIKES	LXXXACC	Tuned Configuration. with national management of measures	Configuration sent by LXXXFMP	Default Capacities	Gradual until normal.	By FMP/NMC

APPENDIX II-B

DETERMINING THE AIRPORT ARRIVAL RATE

Note.—This appendix provides an example of a simplified methodology for determining the acceptance rate at an airport. This methodology is based on the scientific process developed by the Federal Aviation Administration (FAA) for establishing the acceptance rate, as outlined in FAA Order JO 7210.3Z, Facility Operation and Administration*, Chapter 10, Section 7.*

1. DEFINITIONS

1.1 *Airport acceptance rate (AAR).* A dynamic parameter specifying the number of arrival aircraft that an airport, in conjunction with terminal airspace, ramp space, parking space and terminal facilities, can accept under specific conditions during any consecutive 60-minute period.

1.2 *Airport primary runway configuration.* An airport configuration which handles three per cent or more of the annual operations.

2. ADMINISTRATIVE CONSIDERATIONS

a) Identify the organization responsible for the establishment and implementation of AARs at selected aerodromes;

b) establish optimal AARs for the aerodromes identified; and

c) review and validate the aerodrome primary runway configurations and associated AARs at least once each year.

3. DETERMINING AARs

3.1 Calculate optimal AAR values for each airport runway configuration for the following meteorological conditions:

a) visual meteorological conditions (VMC): meteorological conditions allow vectoring for visual approaches;

b) marginal VMC: meteorological conditions do not allow vectoring for visual approaches, but visual separation on final is possible;

c) instrument meteorological conditions (IMC): visual approaches and visual separation on final are not possible;

d) low IMC: meteorological conditions dictate Category II or III operations.

3.2 Calculate the optimal AAR as follows:

a) determine the average ground speed crossing the runway threshold and the spacing interval required between successive arrivals;

b) divide the ground speed by the spacing interval to determine the optimum AAR; and

c) formula: ground speed in knots at the runway threshold divided by spacing interval at the runway threshold in miles.

Note.— When the quotient is a fraction, round down to the next whole number, or refer to Table II-App B-1.

Example: 130 KTS/3.25 NM = 40 Optimum AAR = 40 arrivals per hour

125 KTS/3.0 NM = 41.66 round down to 41 Optimum AAR = 41 arrivals per hour

Table II-App B-1. Optimum AAR

	Nautical miles between aircraft at the runway threshold									
	3	3.5	4	4.5	5	6	7	8	9	10
	Potential AAR									
Ground speed at the runway threshold										
140 knots	46	40	35	31	28	23	20	17	15	14
130 knots	43	37	32	28	26	21	18	16	14	13
120 knots	40	34	30	26	24	20	17	15	13	12
110 knots	36	31	27	24	22	18	15	13	12	11

3.3 Identify any conditions that may reduce the optimum AAR. Conditions include:

a) intersecting arrival and departure runways;

b) lateral distance between arrival runways;

c) dual use runways — runways that share arrivals and departures;

d) land and hold short operations;

e) availability of high speed taxiways;

f) airspace limitations and constraints;

g) procedural limitations (noise abatement, missed approach procedures);

h) taxiway layouts; and

i) meteorological conditions.

3.4 Determine the adjusted AAR using the previous factors listed for each runway used in an airport configuration:

a) add the adjusted AARs for all runways used in an airport configuration to determine the optimal AAR for that runway configuration;

b) real-time factors may require dynamic adjustments to the optimal AAR. These include:

1) aircraft type and fleet mix on final;

2) runway conditions;

3) runway/taxiway construction;

4) equipment outages; and

5) approach control constraints;

c) formula: potential AAR — adjustment factors = actual AAR.

Table II-App B-2. Example of actual AAR

RUNWAY CONFIGURATION	*AAR for VMC*	*AAR for MARGINAL VMC*	*AAR for IMC*
RWY 13	24	21	19
RWY 31	23	20	17

APPENDIX II-C

DETERMINING SECTOR CAPACITY

Note.— This appendix provides an example of a simplified methodology for determining sector capacity at an area control centre *(ACC). This methodology is based on the process developed by the Federal Aviation Administration (FAA) for establishing sector capacity. The formula is based on two assumptions: first, sectors work best when they handle no more than 25 aircraft during any 15-minute period; and second, sectors work best when they handle no more than 18 aircraft during any one-minute period. The 25 aircraft assumption led to the determination that each aircraft requires 36 seconds of a controller's work time. Therefore:*

(15 minutes x 60 seconds = 9 000 seconds. 9 000 seconds ÷ 25 aircraft = 36 seconds)

1. Sector capacity is determined using the average sector flight time in minutes from 0700 hours to 1900 hours., Monday through Friday, for any 15-minute time period.

2. The formula used to determine sector capacity is:

$$\frac{(average\ sector\ flight\ time\ in\ minutes) \times (60\ seconds)}{36\ seconds} = sector\ capacity\ value_{Optimum}$$

3. Steps to follow:

   a) manually monitor each sector by observing and recording the average flight time in minutes;

   b) after the average flight time is determined:

      1) multiply the value by 60 seconds in order to compute the average sector flight time in seconds;

      2) then divide by 36 seconds because each flight takes 36 seconds of a controller's work time; and

      3) this is the sector capacity value (optimum).

4. Adjustments:

   a) the optimum value for a sector is then adjusted for factors such as:

      1) airway structure;

      2) airspace volume (vertically and laterally);

      3) complexity;

      4) climbing and descending traffic;

      5) terrain, if applicable;

6) number of adjoining sectors that require interaction; and

7) military operations.

5. Alternatively, Table App-C-1 can be used.

6. The flying-time-based method for calculating capacity attempts to account for the primary limit for sector capacity and controller task workload, through an assumption that a controller spends 36 seconds providing ATC services to each flight. This assumption does not account for dynamic changes in sector traffic complexity characteristics over time, nor the benefits realized as new capabilities are deployed. Sector complexity profiles characterizing each sector's operations over a period of time can provide a more accurate statement of sector capacity levels. Key tasks accounted for by the complexity profile include entry, exit, non-RADAR arrival, non-RADAR departure, vertical transition, coordination, separation assurance, delay, etc.

Table II-App C-1. Simplified method

Average sector flight time (in minutes)	*Optimum sector capacity value (aircraft count)*
3	5
4	7
5	8
6	10
7	12
8	13
9	15
10	17
11	18
12 or more	18

APPENDIX II-D

CAPACITY PLANNING AND ASSESSMENT PROCESS

Note.— This appendix provides information developed by the European Organisation for the Safety of Air Navigation (EUROCONTROL) related to the ATFM capacity and planning assessment process.

1. A PERFORMANCE-DRIVEN PROCESS

1.1 The overriding objective is to develop a capacity assessment process that contributes to the requirement to:

> *"provide sufficient capacity to accommodate the demand in typical busy hour periods without imposing significant operational, economic or environmental penalties under normal circumstances."*

1.2 To address this issue, an annual capacity planning and assessment process, as well as a cyclical process that identifies and quantifies the capacity requirements for the short- and medium-term, should be put in place.

1.3 To effectively determine future capacity requirements, it is necessary to monitor current capacity performance. The following indicators should be used:

a) average ATFM delay per flight: ratio between the total ATFM delay and the number of flights in a defined area over a defined period of time. The ATFM delay is described as the duration between the last take-off time requested by the aircraft operator and the take-off slot allocated by the ATFM function, in relation to an airport (airport delay) or sector (en-route delay) location; and

b) effective capacity: traffic volume that the ATM system in the area concerned could handle with one minute per flight average en-route ATFM delay. This capacity indicator is derived from a linear relationship between delay variation and traffic variation.

2. METHODOLOGY TO ASSESS FUTURE CAPACITY REQUIREMENTS

2.1 The objective of a medium-term planning and assessment exercise is to provide predictions of the capacity requirements for the ATM system. This is preferably done through the use of a future ATM profile (FAP): a combination of different modelling and analysis tools. See Figure II-App D-1.

2.2 FAP comprises ATFM simulation facilities, as well as spreadsheet and macro-based analysis and reporting tools, that assess and quantify how much capacity is delivered by specific airspace volumes within the current ATM system and evaluate the current and future capacity requirements at both the ACC and sector group levels.

Step 1. In order to provide an accurate prediction of the capacity requirements of the concerned area, it is necessary to know the current capacity offered. FAP should establish a capacity baseline for each ACC and defined sector group.

Step 2. The next task is to provide a prediction of the future demand on each ACC (and defined sector group) over the next five years, according to the expected traffic growth and distribution over the future route network.

Step 3. FAP should carry out an economic analysis, balancing the cost of capacity provision and the cost of delay, on the assumption that each ACC is operating at, or close to, its economical optimum and that the target level of delay has been achieved.

Step 4. FAP should then produce, for each ACC in the area concerned (if more than one) and each of the defined sector groups, a five-year capacity requirement profile. Percentage increases with respect to the measured capacity baseline are provided.

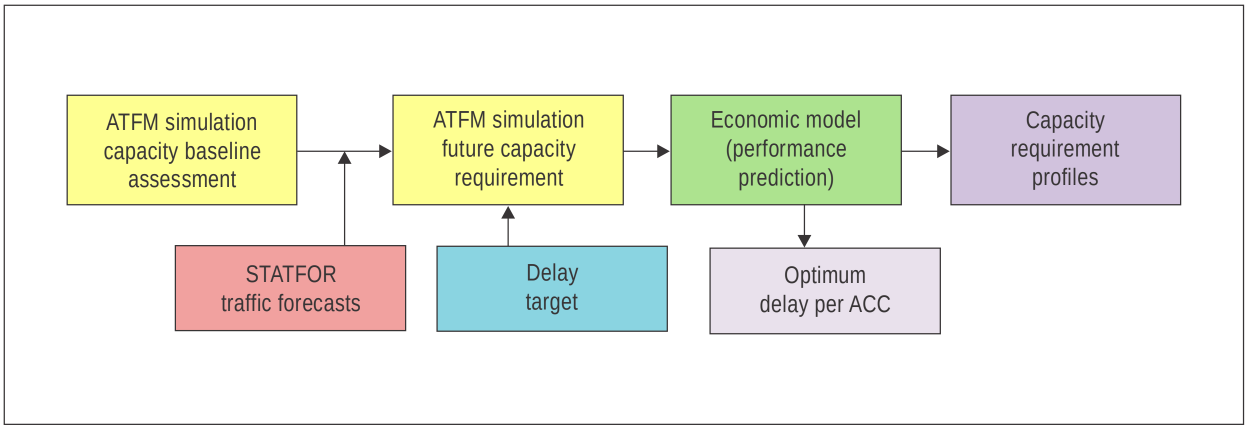

Figure II-App D-1. Key FAP processes

3. EXPECTED DEMAND ON THE FUTURE ROUTE NETWORK

3.1 Medium-term capacity requirements

3.1.1 Medium-term capacity requirements at ACC or sector group levels can be assessed only once one has a picture of the expected traffic volume and distribution over the future route network in the area concerned.

3.1.2 The expected demand at ACC or sector group levels should be assessed by the FAP tool from:

a) the forecasted traffic growth;

b) the future route network evolution and traffic distribution, simulated by an airspace modelling tool; and

c) airport capacity constraints, assessed from information gathered from various sources on current and planned airport capacities.

3.2 Future route network evolution and traffic distribution

3.2.1 The capacity requirement for an ACC or sector group is clearly dependent on the distribution of traffic over the network in the area concerned, horizontally and vertically. The demand to be accommodated in the future is determined by taking into account the desire of users to fly the most direct routes and optimum vertical profiles, in the context of the anticipated evolution of the route network.

3.2.2 Modifications to the route network and traffic distribution can induce significant changes in terms of the demand (and therefore the required capacity) at individual ACCs, even during periods of reduced traffic growth.

3.2.3 It is assumed that aircraft will follow the shortest routes available on the network between city pairs, according to the future route network, on essentially unconstrained vertical profiles. Nevertheless, some existing structural traffic distribution scenarios are retained. There is no “dispersion” of flights between equivalent routes between city pairs.

3.2.4 Traffic flows respecting these assumptions should be simulated by the appropriate tools and serve as an input to the FAP simulations. These simulations should result in an appropriate horizontal and vertical traffic distribution over the future route network, allowing for the determination of unconstrained demand in each ACC.

4. COST DATA AND ECONOMIC MODELLING

4.1 Capacity has a cost, but insufficient capacity, which in turn generates delay, has an even greater cost. Both capacity and delay costs are borne by airspace users. It is therefore necessary to determine the level of ATC capacity which can be justified from a cost point of view, i.e., the optimum trade-off between the delay and cost of ATC capacity.

4.2 The cost of capacity and the cost of delay are regional parameters depending on:

a) total capacity provided;

b) marginal capacity cost (ATC complexity, price index, equipment, etc.);

c) total delay generated;

d) delay sensitivity (network effects, hourly traffic distribution); and

e) cost per minute of delay (traffic mix).

4.3 Consequently, each ACC has its own capacity cost and delay cost curves. These curves interrelate as network effects within the area concerned change according to modifications in capacity offered at other ACCs.

4.4 The total cost curve (the sum of the delay cost and the capacity cost) determines the optimum cost model capacity for each ACC for the current traffic demand. However, to assess capacity requirements for the future, it is necessary to incorporate the future demand into the model to form an updated total cost curve for each ACC.

4.5 CALCULATION OF THE REQUIRED CAPACITY PROFILES

4.5.1 After the economic analysis or cost optimization for the future traffic demand is carried out, the final step in the process takes place. FAP carries out another iterative ATFM simulation by increasing capacity at the ACC offering the best return on investment (ROI), until the overall delay target is reached. See Figure II-App D-2.

4.5.2 When the agreed target delay is reached, the capacity target for each ACC is expressed in terms of the capacity increase that was necessary in order for the convergence to be achieved. Simulations are carried out for the final year of the planning cycle and for any year when changes to ACC or sector group configurations occur. Capacity levels are interpolated for intermediate years.

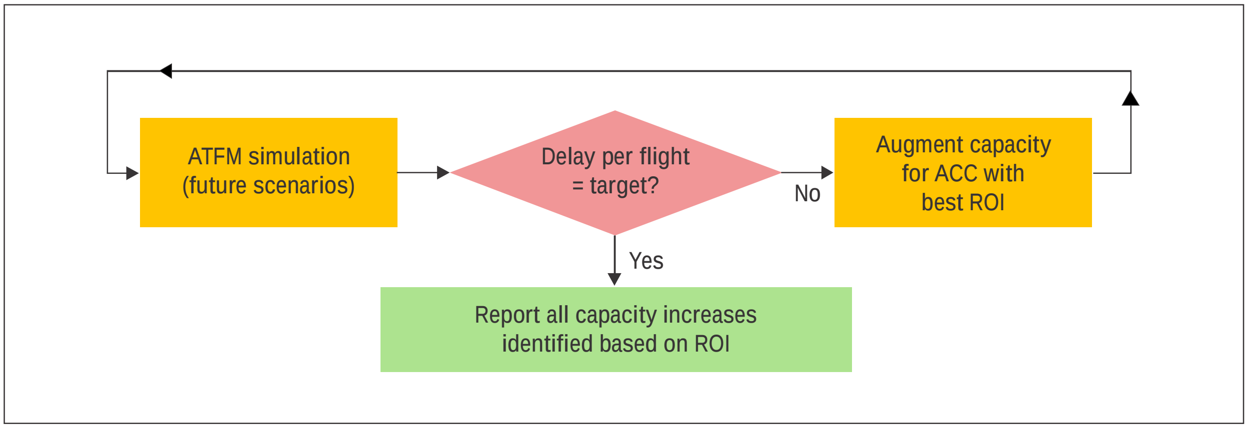

Figure II-App D-2. Iterative ATFM network simulations with best ROI to achieve target delay

4.5.3 The capacity target level corresponds to the cost optimum delay for the ACC to meet the overall delay target adopted by the appropriate authority and represents the ACC capacity required to cover:

a) the expected demand and, if appropriate;

b) the current capacity shortfall, i.e., the difference between the optimum capacity and the current capacity (as described in the previous section).

4.5.4 Figure II-App D-3 shows ACCs with a capacity surplus (blue), shortfall (red) and with optimum capacity (green) levels. For the ACC with an optimum capacity, the requirement is to cover the forecasted traffic increase. For the ACC with a capacity shortfall, the requirement is to cover both the shortfall and the traffic increase, and for the one with a surplus, the requirement is to achieve the optimum capacity in the medium term, without costly over provision.

4.5.5 If the network delay is close to the target delay, the optimum delay at the ACC level is an effective tool to identify areas that still have a capacity gap.

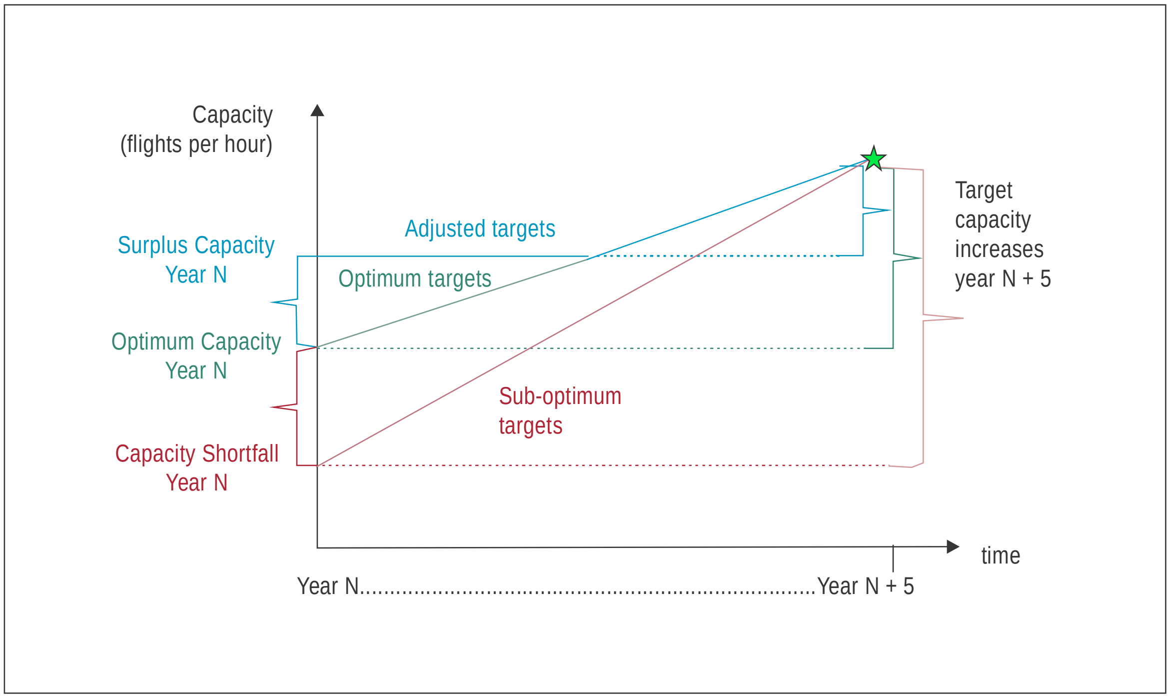

Figure II-App D-3. Current v. target capacity

5. CAPACITY PLANNING WORK PROGRAMME

Table II-App D-1 describes the different phases of the annual work programme and lists the required actions and responsibilities.

Table II-App D-1. Actions, deadlines and responsibilities

Event	*Action ATFM function*	*Action ANSPs*
October–December: Coordinate capacity planning meetings for the short- and medium-terms.	Provide all relevant data enabling the ANSP to prepare a first draft of the local capacity plan: – as data becomes available; and – at least two weeks before the meeting.	Prepare the draft capacity plan prior to the meeting with capacity enhancement function (CEF). Ensure the participation of both planning and operational staff at the meeting.
November–December: Complete the capacity plan.	Complete the capacity chapter: – by the end of December.	Finalize the capacity plan: – by the end of November.

Event	*Action ATFM function*	*Action ANSPs*
November–February: Produce ATFM and capacity report from previous year.	Coordinate and agree with ANSPs on the content with respect to the analysis of ACC performance: – by the end of January.	Review and agree to the ACC performance analysis content provided by the ATFM function: – by the end of January.
	Finalize report: – by the end of February.	
January: Agree and develop the medium-term capacity profile scenarios.	Prepare the airspace scenario data for profile calculation following coordination with ANSPs: – by the end of February.	Provide the ATFM function with details of configuration changes (planned or proposed) during the five-year planning cycle for ACCs and requested sector groups: – by the end of January.
February: Release of short- and medium-term traffic forecasts.	Convene meetings and provide the forum for all relevant information to be included in the short- and medium-term forecast: – during the calendar year.	Attend the user group meetings and ensure that all information relevant to the traffic forecast is provided to the ATFM function: – by the end of December.
	Provide the new medium-term traffic forecast: – by the end of February.	
	Merge the short- and medium-term traffic forecasts.	
March: Calculate medium-term capacity profiles (including optimum delay per ACC).	Calculate the optimum delay for each ACC: – by mid-March.	Agree on the capacity profiles and optimum delay per ACC for use as a basis in the local capacity plan: – by the end of April.
	Calculate the capacity requirement profiles for ACCs and requested sector groups: – by mid-March.	
March: Calculate the delay forecasted for the coming vacation season and next two years.	Create the delay forecast for the coming vacation season and the next two years: – by mid-March.	Ensure that the local capacity plan is up to date and accurate, and communicate any changes to the ATFM function: – before mid-February.

Event	*Action ATFM function*	*Action ANSPs*
March: Hold annual meeting of a capacity-planning task force.	Organize the task force meeting, invite contributions, compile the agenda and write the report.	Attend the meeting with the appropriate planning and operational participation and be prepared to share best practice capacity planning.
April: Publish the operations plan for the coming vacation season.	Incorporate vacation capacity into the plans: – by mid-March.	Ensure that up-to-date capacity information for the coming vacation season is made available and that any changes are communicated to the ATFM function for inclusion in the plan: – by the end of February; and – as they occur, throughout the vacation season.
	Release the first version of the vacation plan: – by mid-March.	
May: Coordinate and agree on medium-term capacity profiles.	Coordinate bilaterally with ANSPs and agree to the profiles that will be used as the basis for local capacity planning in the medium term: – by the end of March.	
	Present the capacity profiles to the next meeting of the appropriate authorities for approval: – at the May meeting.	
June: Publish the medium-term ATM capacity plan.	Collect and consolidate all the local medium-term capacity plans and complete an analysis of the expected situation at the network and local levels: – by the end of April.	
July: Publish ACC capacity requirement profiles.	Release the document: – by the end of July.	
July–August: Assess ACC/sector group capacity baseline.	Inform ANSPs of the reference dates and request confirmation of data quality: – by the end of June.	Confirm that fully accurate sector capacity and opening scheme data will be provided to the ATFM function: – one week before the reference period.

Event	*Action ATFM function*	*Action ANSPs*
	Calculate the baselines for ACCs and requested sector groups according to the airspace structure scenarios defined for the capacity profiles: – by the end of August.	
	In addition to the baseline assessment, calculate the capacity baselines using appropriate simulation and calculation tools: – by the end of August.	Ensure that the sector capacity and opening scheme data are sufficiently accurate for the baseline assessment: – two AIRAC cycles before the start of the AIRAC containing the measurement period.
September–October: Coordinate ACC capacity baselines with the ANSPs.	Communicate the baseline results to ANSPs on a bilateral basis for discussion and agreement: – by mid-September.	Agree on the capacity baselines for the next planning cycle: – prior to meeting the appropriate authorities.
	Present the agreed ACC baselines to the next meeting of the appropriate authorities: – at the October meeting.	

5.2 CAPACITY-PLANNING MEETINGS

5.2.1 The ATFM function should visit the majority of ANSPs in the area concerned to collect information on capacity plans for the next five years and the coming vacation season on an annual basis. It is essential to the improvement of ATM capacity, at overall network levels, for each ACC to have a robust capacity-planning process and a realistic capacity plan.

5.2.2 ANSP capacity plans for each ACC should be published in a local implementation plan, together with other relevant capacity information (e.g., capacity delivered during the previous vacation season, future capacity requirements, expected performance in the medium term, and the current and expected capacity of major aerodromes).

5.2.3 Prior to each meeting, the ATFM function provides the ANSP with a set of data enabling them to prepare the preliminary capacity plan, tailored to local conditions. The data set should include the following:

a) a report and analysis of the capacity delivered during the previous vacation season;

b) the value of the (vacation) capacity baseline indicator for each ACC and requested sector group;

c) the optimum delay for each ACC to meet the network target delay;

d) a set of five-year ACC capacity requirement profiles for high, low and medium traffic growth (shortest available routes over the future route network) and for the current route network;

e) similar capacity requirement profiles for requested sector groups;

f) detailed medium-term traffic forecast;

g) the latest short-term traffic forecast per State;

h) short- and medium-term delay forecast for each ACC;

i) differences in demand between current routes and shortest routes, and current routes and cheapest routes scenarios; and

j) other relevant capacity information.

5.2.4 ANSPs are to prepare a first draft of the capacity plan for the meeting, which is discussed and updated in an interactive session, using appropriate simulation and calculation tools. To facilitate the discussion and ensure a realistic capacity plan, ANSPs should ensure the presence of both planning and operational staff.

5.2.5 The plan should detail the capacity enhancement actions planned each year of the capacity planning cycle, together with a realistic assessment of the contribution of these initiatives to the overall annual capacity increase.

EUROCONTROL definitions of terms used in this attachment

ACC/sector group capacity. The theoretical maximum number of flights that may enter an ACC or sector group per hour, over a period of time (e.g., three hours), without causing excessive workload in any of the sectors. This capacity indicator is used for capacity planning and monitoring purposes and has no operational value. The indicator is calculated mathematically using a validated methodology.

Capacity baseline. The value of the capacity indicator (see above) for the ACC and defined sector groups.

Capacity profile. The evolution of required capacity over the five-year planning cycle, considering certain assumptions, for a specified volume of airspace (ACC or defined sector group), in terms of absolute demand (flights per hour) and annual percentage increases. These values are published annually and are used as a basis for local capacity planning by ANSPs.

Declared sector capacity or monitoring value. The value the ANSP declares to the central flow management unit (CFMU) as the maximum number of flights per hour that can enter a sector before the application of an ATFM regulation becomes necessary. Several values may exist depending on the ATC environment at the time (airspace, equipment, traffic pattern, staffing, meteorological conditions, etc.). The value can change according to the situation at the ACC.

Declared traffic volume capacity. The capacity for a given period of time for a given traffic volume, as made known by the ANSP to the ATFM function, so that it can provide the ATFM service. As with sector capacity, the value can change depending on the ATC environment at the time at the ACC.

Elementary sector. Primary component of the airspace structure, one or more of which may be combined to form a sector. In some cases the elementary sector can be the same as the operational sector; in other cases, the elementary sector is never open operationally without being combined with one or more other elementary sectors.

Network effect. The network effect is the phenomenon where regulations placed on parts of the network affect the demand structure observed in other parts of the network. Network effects range from simple interactions of cause and effect, to more complex interactions between groups of sectors, where causes are repeatedly retriggered by effects, involving several oscillations before a stable equilibrium is reached. Affected sectors could be adjacent, in the same region, or distant sectors located on the far side of the European Civil Aviation Conference (ECAC) zone.

Sector. Primary operational component of the airspace structure that can be considered as an elementary capacity reference of the ATM system. A sector is made up of one or more elementary sectors.

Sector capacity. The maximum number of flights that may enter a sector per hour averaged over a sustainable period of time (e.g., three hours), to ensure a safe, orderly and efficient traffic flow. Some ANSPs manage sector capacities tactically over a shorter period of time (e.g., 15 minutes). However, for global assessment purposes, the hourly figure is used as standard.

Sector group. Group of sectors that strongly interact with each other through close and complex coordination, satisfying the agreed concept of operations.

Traffic volume. Airspace component based on traffic flow that serves as a reference to design the ATC sectors.

———————————

Appendix II-E

SAMPLE LETTER ATM EXCHANGE AGREEMENTS

Note.— This appendix provides a sample format regarding an agreement for the exchange of ATM data between States.

AGREEMENT

BETWEEN

(State XX)

AND

(State YY)

THE EXCHANGE OF AIR TRAFFIC FLOW MANAGEMENT DATA

State XX and State YY may also be individually referred to as “Party” or collectively as “Parties”.

INTRODUCTION

The Parties, recognizing the need for a collaborative effort to work jointly in a coordinated fashion on issues of common interest, have agreed that such objectives will be pursued through cooperation activities as follows:

ARTICLE I
OBJECTIVE

The purpose of this Agreement is to establish the terms and conditions for cooperation between (State XX) and (State YY), in the exchange of non-critical radar and flight data information. This exchange of data will enhance the cooperation and coordination of air traffic management (ATM) activities between (State XX) and (State YY).

ARTICLE II
SCOPE OF WORK

(State XX) and (State YY) agree to exchange flight data and other information concerning international and domestic instrument flight rules (IFR) for aircraft to enhance the cooperation and coordination of ATM activities. This data will be used by the parties for the following purposes:

a) maintenance of a complete and reliable database for such information;

b) dissemination to aviation users; and

c) enhancement of cooperation and coordination of air traffic flow management activities between (State XX) and (State YY).

ARTICLE III
PROCEDURES

3.1 *Purpose of use.* The exchange of flight data and other information shall be exclusively for the purposes set forth in this Agreement. The use of the information and data for purposes beyond the scope identified in this Agreement, or the release of any information or data to a third party not identified in this Agreement, must be authorized in writing by the party from which the information or data originated.

3.2 *Coordination.* The Parties will meet at such times and places as may be requested by either Party to jointly review the programme and consider new procedures or requirements. Activities to accomplish the objectives will be discussed at bilateral/multilateral meetings and documented by the appointed Chairpersons in the reports of those meetings.

3.3 *Scope of data.* The flight data or information to be exchanged shall not include any sensitive data on flights exempted by either Party for security or safety reasons. The exchange of flight data or information applicable to sensitive State and military aircraft will be provided for those areas where the Parties have responsibility for provision of air traffic services. The data shall be formatted to be usable in each system and exchanged using data communications systems as mutually agreed.

3.4 *Types of data.* Types of data to exchange include non-critical radar and flight data information concerning international and domestic instrument flight rules (IFR) for aircraft, including flight and flight plan modifications, cancellations, amendments and all other related changes.

3.5 *Communications protocol.* The information shall be exchanged using an agreed data communications protocol. The communications protocol and other necessary requirements shall be arranged as mutually agreed. The Parties agree to provide, at the earliest possible date, a notice of the proposals for the development of changes to hardware, software and documentation applicable to traffic management data and supporting interfaces.

3.6 *Responsibility of provision.* Except for technical or operational reasons, information and data will be exchanged continuously as it becomes available. Each Party shall operate and maintain communication hub(s) and line(s) to be used for data exchange.

ARTICLE IV
RELEASE OF DATA TO THIRD PARTIES

4.1 Data on State and military aircraft shall not be released to a third Party, unless approved through mutual agreement by both Parties.

4.2 All data may be released by (State XX) or (State YY) to aviation stakeholders through programmes under the same terms and conditions found in the agreements entered into between the (State XX) or (State YY). Air navigation service providers (ANSPs), aircraft operators, national security or safety authorities and research and development (R&D) institutes for ATM improvement are defined as aviation stakeholders. (State XX) and (State YY) shall be responsible for data administration in the provision for those stakeholders.

4.3 Each Party shall make every effort to ensure that the other Party's air traffic flow management data is not released or re-broadcast through unrestricted, public access mass media communications technology, such as the internet, without the written consent of the other Party.

ARTICLE V
FINANCIAL PROVISIONS

Each Party shall bear the cost of any activity performed by it under this Agreement.

ARTICLE VI
IMPLEMENTATION

6.1 The designated points of contact between (State XX) and (State YY), for the coordination and management of this Agreement are:

1.	For (State XX):	Manager Address – phone – fax – e-mail
2.	For (State YY):	Manager Address – phone – fax – e-mail

6.2 The designated points of contact between (State XX) and (State YY) for technical issues under this Agreement are:

1.	For (State XX):	Manager Address – phone – fax – e-mail
2.	For (State YY):	Manager Address – phone – fax – e-mail

ARTICLE VII
ENTRY INTO FORCE AND TERMINATION

This Agreement will enter into force upon the date of the last signature and remain in effect for the duration of its associated annex. Either Party may terminate the Agreement on six (6) months' written notice to the other Party.

ARTICLE VIII
RESOLUTION OF DISPUTES

Any disagreement, dispute or claim arising from or relating to this Agreement will be resolved amicably through direct negotiations between the Parties.

ARTICLE IX
FINAL PROVISIOINS

This Agreement and any amendments thereto shall supersede any and all previous arrangements, cooperation agreements and/or memoranda of understanding between the Parties in relation to the cooperation matters described herein.

IN WITNESS WHEREOF, the Parties hereto, via their duly authorized representatives, have signed this Agreement in duplicate.

______________________________	______________________________
For (State XX)	For (State YY)
______________________________ (signature)	______________________________ (signature)
(printed name):______________________	(printed name): ______________________
Title: ____________________________	Title:____________________________
Date:____________________________	Date: ____________________________
At (City): __________________________	At (City):__________________________

____

APPENDIX II-F

SAMPLE INTERNATIONAL ATFM OPERATIONS PLANNING TELEPHONE CONFERENCE FORMAT

Note.— This appendix provides a sample format that can be used by an ATFM unit for facilitating an ATFM operations planning telephone (or web) conference.

Greeting and introduction

xxxx planning telcon
Covering the timeframe from xxxx UTC to xxxx UTC

Situation

The current situation is: …

Issues

We will be discussing: …

Common MET Products — working from

a) the ICAO Area "_" Prog Chart, valid xxxx UTC for (Date)

b) the ICAO Area "_" IR Satellite photo, valid xxxx UTC for (Date)

Planning discussion

Recommend organizing the discussion by geographic areas (for example, from north to south, or east to west, in the regional airspace).

Significant meteorological activity

a) thunderstorm activity;

b) turbulence; and

c) volcanic ash plumes.

Terminal discussion

For select aerodromes:

a) airport/sector capacities;

b) projected terminal demand;

c) airport constraints, such as construction projects or NAVAID outages;

d) anticipated traffic management measures;

e) expanded miles-in-trail;

f) potential airborne holding; and

g) potential ground stops.

En-route discussion

a) en-route constraints, such as frequency outages or NAVAID outages;

b) route discussion and issues;

c) anticipated traffic management measures;

d) expanded miles-in-trail; and

e) potential airborne holding.

Additions to the plan

Including any pertinent tactical updates.

Stakeholder input

Comments and questions.

Next planning telcon: xxxxx

APPENDIX II-G

SAMPLE LOA BETWEEN FMU and ACC

LETTER OF AGREEMENT
BETWEEN
ANSP1 AIR TRAFFIC MANAGEMENT CENTRE
AND
ANSP2 AREA CONTROL CENTRE

Document Management

Table of Contents

Checklist of Effective Pages

Subject	*Pages*	*Issue Date*
Letter of Agreement	1-8	mm,dd,yyyy
Attachment 1 – Commercial Telephone Numbers for ATFM Coordination	9	mm,dd,yyyy

Overview

Introduction	The following document is a letter of agreement (LoA) between ANSP1 Air Traffic Management Centre (ATMC) and ANSP2 Area Control Centre (ACC) hereinafter referred to as "facilities". The letter of agreement details information sharing, flow control application, and flow control coordination procedures.
Objective	Statements of confirmed procedures are applicable between (STATE NAME 1) and (STATE NAME 2) ATS units with respect to aircraft operating on routes between the ANSP1 and ANSP2 flight information regions (FIRs).
Scope	The procedures contained in this operational letter of agreement supplement or detail those prescribed by Annex 2 — *Rules of the Air*, Annex 10 — *Aeronautical Telecommunications*, Annex 11 — *Air Traffic Services*, the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444), the *Regional Supplementary Procedures* (Document 7030), and local aeronautical information publication (AIP) and air traffic services (ATS) instructions.
Deviation	In the event of unusual circumstances, duty watch supervisors of ANSP1 ATMC and ANSP2 ACC, by mutual consent, may modify the content of the letter of agreement on a time-to-time basis, for specific periods.
Responsibility	This letter of agreement is applicable to air traffic flow management service along the common FIR boundary between ANSP1 FIR and ANSP2 FIR.
Effective Date	This letter of agreement comes into effect at 0000UTC on DD MM, YYYY. Once effective, this letter of agreement cancels and replaces the letter of agreement between ANSP1 Air Traffic Management Centre and ANSP2 Area Control Centre dated dd/mm/yyyy.

Policy and Definition

Policy	Both facilities recognize the following definitions prescribed in ICAO PANS-ATM, and introduce procedures according to the policy that flow control should be implemented to a minimum on condition that available ATC capacity is utilized to the maximum extent.
Definition	**Air traffic flow management (ATFM).** A service established with the objective of contributing to a safe, orderly and expeditious flow of air traffic by ensuring that ATC capacity is utilized to the maximum extent possible and that the traffic volume is compatible with the capacities declared by the appropriate ATS authority. **Flow control.** Measures designed to adjust the flow of traffic into a given airspace, along a given route, or bound for a given aerodrome, so as to ensure the most effective utilization of the airspace.

Coordination procedures

Information sharing

When ANSP1 ATMC or ANSP2 ACC recognizes an event which affects or might affect orderly traffic flow between the FIRs, the facility shall provide the other facility with the information, and both facilities should keep sharing information while the traffic flow is affected by the event. Events for which information should be shared mutually are as follows:

a) capacity falls at defined international airports caused by:

   1) runway closure;

   2) severe meteorological conditions; or

   3) other adverse effects;

b) malfunction of ATC systems, such as radar, flight data processing system (FDP), radar data processing system (RDP), or communication systems;

c) flow control restrictions at the responsible facility's request on aircraft destined for other FIR; or

d) other adverse effects on international traffic flow.

Paragraph a) described above refers to the following aerodromes:
AIRPORT1 (AAAA), AIRPORT2 (BBBB), AIRPORT3 (CCCC), and AIRPORT4 (DDDD).

Information is not necessarily provided with flow control coordination, but would be rather provided at the possible phase of flow control. Information provision should be made timely when the event is predicted and/or has begun/changed/dissolved.

Flow control application

Both facilities are able to implement flow control in the events previously cited and additionally when:

a) excessive airborne holdings arise or are predicted; or

b) necessary to ensure the safety of aircraft operations.

Flow control is implemented by specifying some of the following restrictions at the FIR boundary to the aircraft destined for the affected airport(s) or airspace:

a) minimum longitudinal interval by time or distance at the same altitude;

   e.g., "50 nm interval at the same altitude over FIX, FIX for AAAA airport."
   e.g., "15 minutes interval at the same altitude over FIX, FIX for BBBB airport."

b) minimum longitudinal interval by time or distance regardless of altitude;

   e.g., "50 nm interval regardless of altitude over FIX, FIX for CCCC airport."
   e.g., "10 minutes interval regardless of altitude over FIX, FIX for DDDD airport."

c) the number of aircraft which is acceptable in a specific time frame; or

e.g., "a rate of 5 aircraft per hour from 0200UTC until 0300UTC, over FIX for AAAA airport."

d) limitation of acceptable altitude;

e.g., "Flight levels 290, 310 and 390 are not available for northbound aircraft passing FIX on AIRWAY."
e.g., "only FL360 and above are available."

Minimum separation prescribed in the letter of agreement between ANSP1-A ACC and ANSP2 ACC, ANSP1-B ACC and ANSP2 ACC shall be met in any case.

The time interval is also applicable in radar hand-over circumstances.

Flow control coordination

Flow control coordination should involve the following items:

a) the cause of flow control implementation;

b) flow control restrictions;

c) fixes/waypoints or airways to where restrictions are applied;

d) objects of restrictions (objects of restrictions shall be only the aircraft which are destined for the affected airport or airspace);

e) start/end time (effective time at paragraph c)); and

f) expected time of next coordination (if possible).

Information provision or coordination should be periodically made while the flow control is applied.

If urgent action is not necessary, flow control shall be requested at least sixty (60) minutes prior to the time when the restriction becomes effective to ensure that the accepting facility makes necessary coordination with other relative ATC facilities.

Exempted aircraft

a) The following aircraft which should be given priority over other aircraft or which should not be delayed for any reason may be exempted from flow control restrictions. Coordination regarding this exemption is made between ANSP1 ATMC and ANSP2 ACC. Coordination between transferring/receiving ACCs is allowed in urgent cases such as:

   1) aircraft in a state of emergency;

   2) aircraft engaged in search and rescue missions;

   3) aircraft operating for humanitarian reasons;

4) aircraft carrying the Head of State/region or distinguished visitors of State/region; and/or

5) aircraft carrying a patient who needs urgent treatment;

b) aircraft from which a transfer control message had been transmitted before the flow control decision was made are exempted from flow control restrictions. Coordination regarding this exemption should be made between transferring/receiving ACCs.

ANSP1 ATMC assumes the responsibility for making ANSP1's ACCs fulfil the flow control restrictions which ANSP1 ATMC admits in the coordination with ANSP2 ACC.

Alternative route coordination

When ANSP1 ATMC and/or ANSP2 ACC require to change the route of inflow traffic between FIRs due to the outage of NAVAIDs, temporary airspace restrictions or other reasons, those routes should be mutually coordinated and confirmed prior to coming into operation. ANSP1 ATMC and/or ANSP2 ACC shall inform each other of the alternative route at the earliest possible.

Communication systems

Use of communication systems for coordination shall be in the following order of priority:

a) direct speech circuit (DA);

b) commercial telephone (commercial telephone numbers are shown in Attachment 1);

c) aeronautical fixed telecommunication network (AFTN) or ATS handling message system (AHMS); and

d) any other means of communications available.

ANSP2 ACC will initiate a test of the direct speech circuit on the first day of each odd numbered month at 0100UTC.

ANSP1 ATMC will initiate a test of the direct speech circuit on the first day of each even numbered month at 0100UTC.

Evaluation

Both facilities shall record every flow control operation and evaluate the process of coordination and effectiveness of ATFM periodically and jointly for the purpose of ATFM operational improvement.

Revision

Revision conditions

This agreement shall be revised whenever a modification to ICAO Standards, Recommended Practices and/or Regional Supplementary Procedures and operating procedures or instructions which might affect the procedures contained in this agreement occurs or when new communications facilities, or air traffic services which might affect these procedures, are commissioned.

When fewer than thirty (30) days exist between an identified need to revise this agreement and the effective date of the revision, the respective centre managers or their designated deputies shall confirm via telephone, followed by a confirming fax message signed by both parties, on the nature of the change and publish the change to staff by a suitable local unit instruction. Formal exchange of signed copies of the revised document shall take place as soon as practicable thereafter.

As for the revision to Attachment 1 (commercial telephone numbers for ATFM coordination), one (1) week prior notice meets the revision conditions.

Signed in ANSP1 and ANSP2.

NAME1
Director
ANSP1 Air Traffic Management Centre
ORGANIZATION, STATE NAME1

NAME2
Director
ANSP2 Area Control Centre
ORGANIZATION, STATE NAME2

Attachment 1

Commercial telephone numbers for ATFM coordination

1) ATMC

   i) Tel: XX-XX-XXX-XXXX (primary)
   XX-XX-XXX-XXXX (secondary)

   ii) Fax: XX-XX-XXX-XXXX (Operation Room)
   XX-XX-XXX-XXXX (Office)

2) ACC

   i) Tel: XX-XX-XXX-XXXX (primary)
   XX-XX-XXX-XXXX (secondary)

   ii) Fax: XX-XX-XXX-XXXX (Operation Room)
   XX-XX-XXX-XXXX (Office)

APPENDIX II-H

TEMPLATE LETTER OF AGREEMENT BETWEEN ANSPs ON FLOW MANAGEMENT

LETTER OF AGREEMENT

EFFECTIVE DATE: xx/xx/xx

SUBJECT: AIR TRAFFIC FLOW MANAGEMENT COLLABORATION

ANSP 1 and ANSP 2 enter into this letter of agreement (LOA) to facilitate the safe and efficient movement of air traffic between and over both countries.

1. PURPOSE

The purpose of this LOA is to establish continuity of operations and air traffic flow management (ATFM) procedures between Flow Management Unit 1 (FMU 1) in (city/country) and Flow Management Unit 2 (FMU 2) in (city/country). This LOA is not intended to replace any local agreements between ANSP 1 area control centres (ACCs) and ANSP 2 ACCs. This LOA will promote coordination and collaboration between FMU 1 and FMU 2 regarding traffic management measures and the routing of aircraft into and out of ANSP 1 and ANSP 2 airspace. FMU 1 and FMU 2 will be the primary points of contact for coordinating ATFM measures and operations between ANSP 1 and ANSP 2.

2. SCOPE

The procedures outlined are for use by FMU 1 and FMU 2 to provide normal air traffic services.

3. ACRONYMS

ACC	Area control centre
ANSP	Air navigation services provider
ATFM	Air traffic flow management
CDM	Collaborative decision-making
FMU 1	actual name of Flow Management Unit 1
FMU 2	actual name of Flow Management Unit 2
OP	Operations plan
RVSM	Reduced vertical separation minima

4. BACKGROUND

4.1 ANSP 1 and ANSP 2 have established operational agreements creating cross-border communications and a seamless operational atmosphere. This agreement incorporates FMU 1 and FMU 2 operational procedures and practices.

4.2 Traffic flow management continues to evolve as new procedures and technologies are developed. ANSP 1 ATFM measures may include departures from ANSP 2 aerodromes. Likewise, ANSP 2 ATFM measures may include departures from ANSP 1 aerodromes.

4.3 The ATFM measures coordinated by either FMU may include miles-in-trail, minutes-in-trail, ground delay measures, ground stops and reroute initiatives.

Note.— This list is not all inclusive and other ATFM measures may be developed and coordinated to meet operational needs.

5. RESPONSIBILITIES

5.1 The responsibilities for FMU 1 operations include:

a) the management of traffic to ANSP 1 destinations and through ANSP 1 airspace:

1) coordinating with FMU 2 before implementing ATFM measures that may impact ANSP 2 aerodromes;

2) when ANSP 2 aerodromes are included in an ATFM measure, advise FMU 2:

i) before implementing the ATFM measure;

ii) what the ATFM parameters are; and

iii) when the ATFM measure is cancelled;

3) coordinating with FMU 2 before implementing aircraft reroutes affecting departures from ANSP 2 aerodromes or airspace;

4) including FMU 2 ATFM measures in the ATFM operations plan (OP) when it is likely that ANSP 1 stakeholders will be affected by these measures; and

b) ensuring that FMU 2 is informed of situations and conditions, in ANSP 1 airspace, that may require implementing ATFM measures affecting ANSP 2 traffic.

5.2 The responsibilities for FMU 2 operations include:

a) flow management of traffic to ANSP 2 destinations and through ANSP 2 airspace:

1) coordinating with FMU 1 before implementing ATFM measures that impact departures from ANSP 1 aerodromes;

2) when ANSP 1 aerodromes are included in an ATFM measure, advise FMU 1:

i) before implementing the ATFM measure;

ii) what the ATFM parameters are; and

iii) when the ATFM measure is cancelled;

3) including FMU 1 ATFM measures in the ATFM OP when it is likely that ANSP 2 stakeholders will be affected by these measures; and

4) coordinating with FMU 1 before implementing aircraft reroutes impacting departures from ANSP 1 aerodromes or airspace;

b) ensure that FMU 1 is informed of situations and conditions, in ANSP 2 airspace, that may require implementing ATFM measures affecting ANSP 1 traffic.

5.3 The responsibilities for FMU 1 and FMU 2 include:

a) streamline coordination. FMU 2 will be FMU 1's sole point of contact with ANSP 2 and FMU 1 will be FMU 2's sole point of contact with ANSP 1 with regard to cross-border ATFM measures and routing of aircraft;

b) implement and manage ATFM measures, as necessary, to relieve congestion and to ensure the orderly flow of air traffic consistent with an equitable distribution of delays;

c) limit the impact of ATFM measures on stakeholders and implement only those measures that will adequately address the system constraint;

Note 1.— The principal ATFM measures to be implemented will consist of miles-in-trail, minutes-in-trail, reroutes, en-route spacing measures, ground delay measures, and ground stops.

Note 2.— This list is not all inclusive and other ATFM measures may be developed and coordinated to meet operational needs.

d) collaborate on the design of preferred routes and severe meteorological conditions avoidance routes that involve the use of both ANSP 1 and ANSP 2 airspace or resources; and

e) provide feedback and share data on the impact and assessment of joint ATFM measures, as required.

6. IMPLEMENTATION

The procedures outlined in this letter of agreement will be implemented by operational personnel at FMU 1 and at FMU 2.

7. REVIEW PERIOD

FMU 1 and FMU 2 agree to participate in a yearly review of this document.

Original signed by:

____________________	_________________________
ANSP 1	ANSP 2
Date: __________________	Date: ________________
____________________	_________________________
FMU 1	FMU 2
Date: __________________	Date: ________________

Appendix A

FMU 1

Phone number(s) 123 456 789

Appendix B

FMU 2

Phone number(s) 123 456 789

____

PART III

AIRPORT COLLABORATIVE DECISION-MAKING

Chapter 1

WHAT IS A-CDM?

1.1 DESCRIPTION AND PURPOSE OF A-CDM

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

Note.— A-CDM stands for Airport CDM and is widely known as such. It is remarked, however, that the official terminology for "airport" in Annex 2 — Rules of the Air*, Annex 6 —* Operation of Aircraft*, Annex 11 —* Air Traffic Service*s and Annex 14 —* Aerodromes*, is "aerodrome"*, *which is defined as follows: a defined area on land or water (including any buildings installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.*

1.1.2 A-CDM allows aerodromes, aircraft operators, air traffic controllers, ground handling agents, pilots and air traffic flow managers to exchange operational information and work together to efficiently manage operations at aerodromes[1]. A-CDM may also enhance the planning and management of en-route operations.

1.1.3 A-CDM defines the rules and procedures used by aerodrome stakeholders to share information and collaborate as outlined in Figure III-1-1. 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.

1.1.4 A-CDM allows all stakeholders to optimize their operations and decisions in a collaborative environment, in light of their preferences, known constraints, and the forecasted situation. The decision-making process is facilitated by not only the sharing of accurate and timely operational information by means of a common toolset, but also by the application of agreed-upon processes and procedures.

1.1.5 The main objective of A-CDM is therefore to generate a common situational awareness that will foster improved decision-making. A-CDM does not, however, dilute or suppress the responsibilities associated with decisions. Decisions are still made, and A-CDM partners remain accountable and responsible for their actions. They are, however, taken in a collaborative manner and as a result are better understood and applied.

1.2 A-CDM AND THE AVIATION SYSTEM BLOCK UPGRADES

The fifth edition of the *Global Air Navigation Plan (GANP)* (Doc 9750), is designed to guide the evolution of air transport by leveraging existing technologies and anticipating future developments based on State/industry agreed operational objectives (Aviation System Block Upgrades (ASBUs)). A-CDM is addressed in the GANP, more specifically, in the ASBUs, as the A-CDM thread under the airport operations section of *Performance Improvement Area 1*. A-CDM is composed of two modules: B0-ACDM and B1-ACDM (pertaining to Block 0 and Block 1, respectively). Each block identifies targeted timelines for the operational improvements associated with A-CDM technologies and procedures.

1. At the time of publication of this manual, this definition is being considered for inclusion in Annex 14.

Furthermore, the A-CDM Blocks are designed to serve as a planning tool to help States implement A-CDM in a globally harmonized and consistent manner. The ASBU methodology thus defines a flexible approach to implementing A-CDM and allows States to advance their capabilities based on their unique operational requirements.

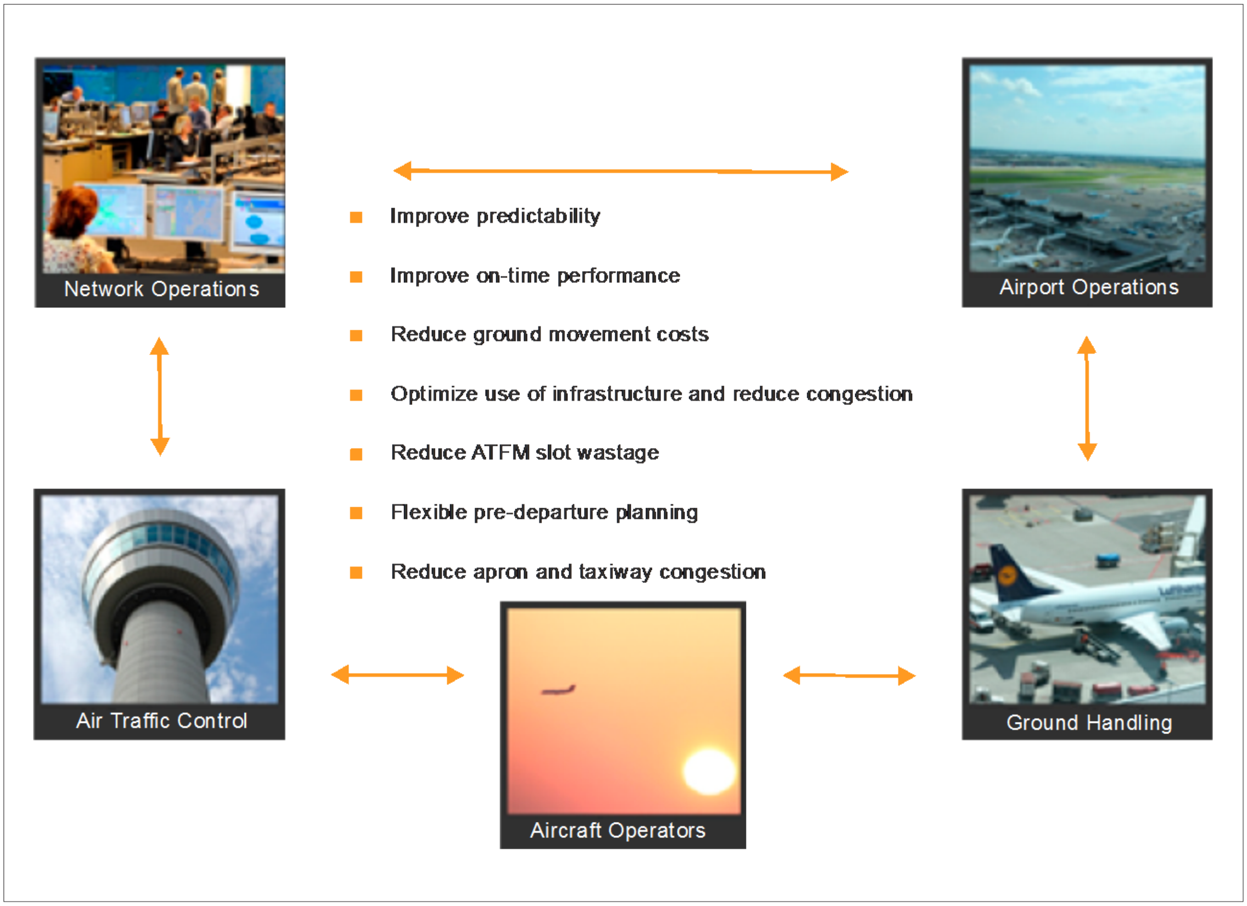

Figure III-1-1. A-CDM flows of information

1.2.1 B0-ACDM

1.2.1.1 The first block pertaining to A-CDM is entitled *Improved Airport Operations through Airport-CDM*.

1.2.1.2 This module is defined so as to implement "collaborative applications that will allow the sharing of surface operations data among the different stakeholders on the airport. This will improve surface traffic management reducing delays on movement and manoeuvring areas and enhance safety, efficiency, and situational awareness". The module is applicable locally "for equipped/capable fleets and already established airport surface infrastructure."

1.2.1.3 The module is also linked to two other Block 0 modules: B0-RSEQ and B0-SURF. B0-RSEQ, entitled *Improved Traffic Flow through Sequencing (AMAN/DMAN)* will introduce system capabilities to provide assistance for runway sequencing and metering. In particular, for departures, the sequence will improve start/push-back clearances, reduce taxi time and ground holding, deliver more efficient departure sequences, reduce surface congestion and effectively and efficiently make use of terminal and aerodrome resources. B0-SURF, entitled *Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)* and B1-SURF, which includes Enhanced Vision Systems (EVS), implement additional capabilities to the aerodrome surveillance environment by taking advantage of cooperative surveillance, providing the means to establish the position of all aircraft and vehicles, to specifically identify targets with individual flight/vehicle identification. Ground vehicles operating on the manoeuvring area will therefore be equipped so as to be visible to tower ground surveillance display systems.

1.2.2 B1-ACDM

B1-ACDM is entitled *Optimized Airport Operations through A-CDM Total Airport Management*. The module is defined so as to enhance the planning and management of airport operations and allow their full integration for ATM using performance targets compliant with those of the surrounding airspace. This entails implementing collaborative airport operations planning and, where needed, an airport operations centre (APOC). The module is applicable to airport operations planning for use at all airports (sophistication will depend on the complexity of the operations and their impact on the network) and APOCs to be implemented at major/complex airports (sophistication will depend on the complexity of the operations and their impact on the network).This block is not applicable to aircraft.

1.2.3 A-CDM guidance and ASBUs

This manual describes the airport collaborative decision-making concept. It is an intermediate release between B0-ACDM and B1-ACDM. It also has links with B0-RSEQ and, when necessary, with B0-SURF. As the maturity and experience of different implementations across the globe increase, the manual will be updated to include guidance on the full airport operations centre concept.

1.3 INFORMATION SHARING: THE FOUNDATIONAL BLOCK OF A-CDM

1.3.1 Transparency and information sharing serve as a foundation for A-CDM. Information sharing is the element that ties the stakeholders together in their aim to efficiently coordinate and manage operations.

1.3.2 A-CDM information sharing (ACIS) supports the involvement of the actors and stakeholders in A-CDM that are presented in Figure III-1-2. However, the means to achieve ACIS may range from a simple A-CDM dialog system to a more advanced A-CDM information sharing platform (ACISP), depending on the technical possibilities of the CDM airport and its stakeholders.

Note.— See Part III, Chapter 3 for more information on ACIS.

1.3.3 Link with air traffic flow management (ATFM)

1.3.3.1 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.

1.3.3.2 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.

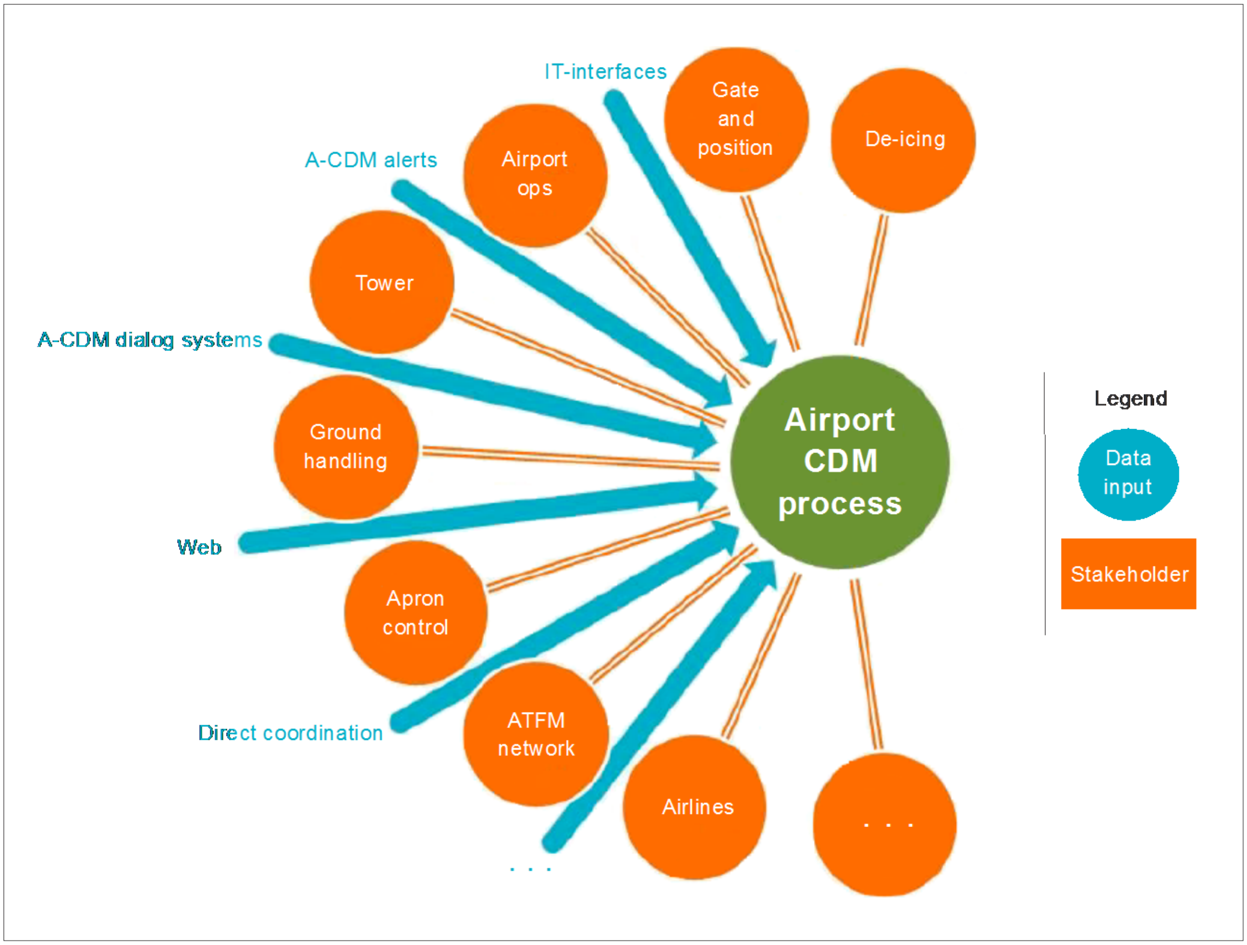

Figure III-1-2. A-CDM partners and data flows

1.3.3.3 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, as is illustrated in Figure III-1-3.

Note 1.— See Part II for more information on ATFM.

Note 2.— Ghost flight plans appear when two flight plans refer to a single flight.

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

Note.— See Part III, Chapter 3, 3.3.5 for more information on the exchange of information on A-CDM and ATFM.

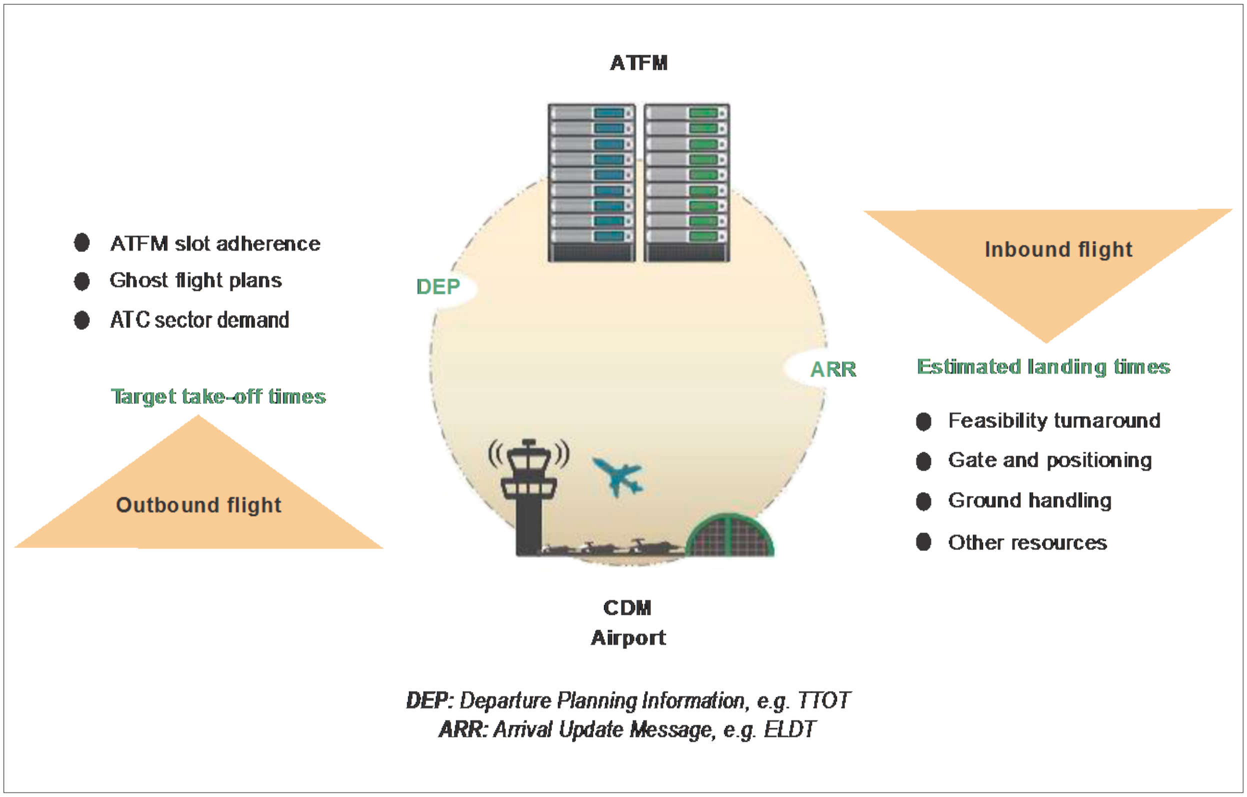

Figure III-1-3. Information exchanges between A-CDM and ATFM

1.3.4 Regular and irregular operational activities

1.3.4.1 ***Regular operations***

A-CDM regular operations are defined as operations where the planned (scheduled) demand does not exceed the given capacity, and no disturbances of any kind influence the balanced relationship of capacity and demand.

1.3.4.2 ***Irregular operations***

A-CDM irregular operations are defined as operations where the planned (scheduled) demand exceeds the given capacity, due to either adverse situations (meteorological conditions, workers' strike, accident, etc.) or as a knock-on effect from earlier disturbed operations.

1.3.4.3 ***Irregular operations of a planned nature***

A-CDM allows stakeholders to better plan for and agree to measures and actions, if circumstances are known well in advance of the event/situation, e.g., planned runway closure.

1.3.4.4 ***Unplanned irregular operations***

A-CDM allows stakeholders to better manage and recover from unexpected situations or events, by making use of the most up-to-date and accurate information available and by adhering to previously agreed A-CDM procedures.

1.3.4.5 ***Implementation: A-CDM regular operations***

A-CDM yields positive results for all operations. Experience has shown that implementing A-CDM optimizes the use of available capacities and resources at a CDM airport. Having well-defined A-CDM processes in place ensures that operations are seamless and well managed, whether the circumstances in which they are applied is regular or not.

1.4 BENEFITS OF A-CDM

1.4.1 A number of successful A-CDM implementations have been monitored and documented since 2007. As a result of their success, the proven benefits of these implementations are listed below, and generally fall into three categories:

a) operational;

b) financial; and

c) other (e.g., environment).

1.4.2 In most cases, operational benefits may also bring about financial advantages. This is typically the case when meteorological conditions deteriorate. With A-CDM, normal traffic operations can be maintained for longer periods of time, which reduces the delays that would otherwise be generated because of the adverse conditions. A-CDM may also optimize the use of gates and stands, which may, in turn, reduce the need for extra expenditures (i.e., expansion), a crucial factor, especially in areas where space is limited. These are examples of situations where A-CDM has a direct positive financial impact on general operations.

1.4.3 Safety is, in general, not listed as a category for which A-CDM yields direct benefits. A-CDM is commonly seen as yielding indirect benefits for safety, providing for an overall improvement in the quality of services delivered. It should be noted that, as is the case for all major changes in operational procedures, implementation is usually validated within the framework of the SMS implemented by the ANSP as part of the SSP.

Note.— See *Annex 19* — Safety Management, *Chapter 3*.

1.4.4 Table III-1-1 lists the major benefits identified for the various stakeholders involved in A-CDM implementation. This is not an exhaustive list, as many other benefits exist. Since the benefits often depend on local considerations, they cannot all be listed.

Table III-1-1. A-CDM benefits for stakeholders

	Operational	*Financial*	*Others*
Benefits for airport operators			
Increased airport throughput under irregular operations (e.g.: fewer cancelled flights).	X	X	
Increased revenue from increased declared capacity.	X	X	
Improved airport operational efficiency (e.g., better use of gates, fewer last-minute gate changes).	X	X	X
Improved punctuality of flights at an airport (e.g., increased stability of the process).		X	
Improved airport image from the passengers' point-of-view.		X	
Improved use of available resources and capacities.	X	X	
Benefits for aircraft operators			
Decrease in taxi time.		X	X
Decrease in wait time at the runway.		X	X
Improved passenger management.	X	X	
Improved punctuality for each departure.		X	
Improved turnaround efficiency.	X	X	
Benefits for air traffic control services			
Increased ATFM departure time adherence.	X		
Decrease in taxi time.	X		X[2]
Decrease in ATCO workload.	X		
Improved stability of operations in adverse situations.	X	X	
Decreased coordination needs with ATFM services.	X		
Increased airport throughput.		X	

2. While this might not be seen as a direct benefit for ANSP, some ANSP are subject to regulations whereby they have environmental performance objectives.

	Operational	*Financial*	*Others*
Benefits for ground handlers			
Improved use of available resources.	X	X	
Improved turnaround efficiency.	X	X	
Improved stability of operations in adverse situations.	X	X	
Benefits for air traffic flow management units			
Increased ATFM departure time adherence.	X		
Increased accuracy of departure times.	X		
Reduction of wasted ATFM slots.	X	X	
Decreased coordination needs with local ATC.	X		
Increased sector capacities (e.g., reduction of buffers).	X	X	

1.5 RULES AND ACCOUNTABILITY

1.5.1 Rules and mechanisms for accountability are essential components of an A-CDM process and should be agreed upon prior to implementation.

1.5.2 The A-CDM process is governed by rules defining who should participate, the information that should be provided and used as well as the quality of said information. These rules also cover the expected decisions and times/events related to those decisions, generally laying out the collaborative process and the constraints which must be followed for decision-making.

1.5.3 These rules and requirements are expected to be set during the CDM process definition stage and may use a collaborative performance-based approach to do so. In addition to describing the rules, the consequences of not following such rules should be established *a priori* through the collaborative process. The adoption of these rules may be formalized by way of a memorandum of understanding (MoU) signed by the A-CDM partners at large.

Note 1.— See Appendices III-A and III-C for examples of MoUs for A-CDM.

Note 2.— See Part III, Chapter 3, 3.5.5 related to the use of agreements framing and securing the provision and use of data in A-CDM. Examples of such an agreement may also be found in Appendix III-C.

1.6 IMPLEMENTATION OF A-CDM: DECLINATION OF AN IDENTICAL CONCEPT

1.6.1 The need for A-CDM to be scalable and adaptable to local constraints makes it impossible to describe a standard process to be applied to all situations. There are, however, a number of similarities between all A-CDM projects since they are all organized on the same basic principles. Building on those commonalities, a high-level and generic description can be made of A-CDM organizations worldwide. From an organizational point of view, the entire set-up of activities conducted in the scope of A-CDM can be split into different modules.

1.6.2 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, de-icing 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.

1.6.3 Each module entry and exit can be associated to one or more specific milestone, defined as a timestamp. This caters to the description of a modular A-CDM implementation, tailored to the specific operational and capacity concerns of the organization at each aerodrome.

1.6.4 In general, A-CDM aims to enhance operations in all modules. However, A-CDM projects may choose to target any module or any sequence of modules for optimization. Along these lines, A-CDM can aim to strengthen any given milestone as a prime target for improvement. The required information and tools can therefore be adjusted to the way A-CDM addresses any of the specific modules.

1.6.5 There are various examples of A-CDM implementation worldwide. Two regions of the world have developed comprehensive approaches to A-CDM, using established guidelines and high-level principles. The components of the respective approaches of Europe and the United States are outlined hereafter, as they can provide useful information for implementation. The variations in their concepts provide a clear illustration of the notion of scalability: A-CDM is successful when it is custom-built to meet the needs of the aerodrome and the region in which it is implemented.

1.6.6 Although the focus allocated to various parts of the process differs, both A-CDM processes share a number of common objectives:

a) the management of airport surface traffic flows and runway departure queues to optimize airport capacity and airspace resources while reducing fuel burn and emissions;

b) the provision of real-time access to aircraft positioning on the aerodrome, coupled with timely sharing of accurate operational data among stakeholders, providing the opportunity to manage airport demand; and

c) the provision of connectivity between aerodrome surfaces and ATFM, fostering the establishment of a common operational picture.

1.6.7 It should be noted that in Europe, as in the United States, information sharing is the baseline of all processes and is used to build common situational awareness.

1.6.8 The European A-CDM

1.6.8.1 A-CDM in Europe focuses very much on the turnaround process of flight and the related events at airports. The aim is to link the arriving flights with the departing flights to ensure the flights' turnaround planning feasibility. The European A-CDM process is composed of the following elements:

a) information sharing to ensure common situational awareness;

b) milestone approach to track the progress of the flight event;

c) variable taxi time for more accurate in-block and take-off time predictability;

d) predeparture sequencing to plan when aircraft leave their stands (push off-blocks);

e) adverse conditions to complete A-CDM processes for various operations; and

f) collaborative management of flight updates to connect the local A-CDM to the ATM network.

1.6.8.2 With A-CDM, a set of new planning times will be introduced to manage the A-CDM process. These times are called target times, e.g., TOBT (target off-block time), TSAT (target start-up approval time), and TTOT (target take-off time).

1.6.9 The United States surface CDM

1.6.9.1 As the operation and organization at airports in the United States differ from those in Europe, the United States surface CDM (S-CDM) focusses on the management of airport surface traffic flows and runway departure queues.

1.6.9.2 S-CDM forms one important part of the overall approach of the United States to CDM: the S-CDM process reflects the consensus reached by surface stakeholders. S-CDM capabilities and corresponding procedures are transparent, flexible, agile and capable of supporting distinct needs of individual airports and the unique business models of a diverse set of flight and airport operators.

1.6.9.3 S-CDM is designed to transition airport surface operations from first-come, first-served, to a performance-based surface operation. A first-come, first-served approach has been shown to promote extended queue length in the United States. To this end, S-CDM has been geared towards departure metering with the aim to provide ATC with an efficient departure sequence.

1.6.9.4 Departure metering creates a "reservoir" of aircraft to provide ATC with the number and mix of aircraft appropriate for maintaining an efficient departure flow while minimizing the time aircraft wait in extended departure queues. Departure metering takes place when a demand/capacity imbalance is predicted. The duration of the imbalance defines the duration of metering.

1.6.9.5 Departure metering is founded on earliest runway time of departure (ERTD), defining a manageable, efficient queue length, calculating a target take-off time (TTOT) and target movement area entry time (TMAT).

1.6.9.6 The use of TMAT allows individual aircraft operators to manage their crews, gates, aircraft push-backs and engine starts on ramp, hard stands and non-movement areas and to meet their own business objectives. What is more, flight operators can substitute TMATs between metered flights.

1.6.9.7 Metering when demand exceeds capacity for a specific resource, coupled with the ability to substitute aircraft, is consistent with other ATFM measures such as ground delay programmes (GDPs) and slot swapping or collaborative trajectory options.

1.6.9.8 S-CDM builds on successive layers of articulated capabilities and procedures such as:

a) transparent, real-time sharing of current and forecasted operational information, improving situational awareness and enabling continuous, accurate predictability of airport demand;

b) tactical and strategic management of airport aircraft traffic flows to better manage departure queues to eliminate excessive taxi-out times and measurably improve departure efficiency;

c) management of arrival traffic flows to increase total airport throughput with balanced arrival and departure demand;

d) analysis, measurement and monitoring capabilities to better understand operational performance; and

e) global harmonization, which facilitates standardization across international airport surface programmes and the United States surface concept, and supports the ASBU Block-0 goals.

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Chapter 2

A-CDM PARTNERS AND STAKEHOLDERS

2.1 INTRODUCTION

2.1.1 A-CDM is an operational process that is usually carried out by operational staff. The participants involved in A-CDM decision-making processes will vary from aerodrome to aerodrome, but will always be composed of at least three different partners: the aerodrome operator, aircraft operators, and the ANSP.

2.1.2 Other entities, such as centralized network managers (e.g., the European Organisation for the Safety of Air Navigation (EUROCONTROL) in Europe and the Federal Aviation Administration (FAA) in United States), ground handlers and other aircraft service providers, third-party apron management service providers (when relevant), airport terminal operators, and meteorological service providers may also have essential roles to play depending on the circumstances and specific requirements of an aerodrome (ownership, governance, service provision, infrastructure, etc.).

2.1.3 The key to a successful A-CDM lies in ensuring that the process meets local needs and requirements and is adapted to local constraints. A-CDM is scalable. This notion of scalability will logically be reflected in the description of the roles and responsibilities of the various partners and stakeholders. The descriptions provided below are therefore of a generic nature. Further considerations related to scalability are outlined in Part III, Chapter 5.

2.2 ROLES AND RESPONSIBILITIES OF PARTNERS AND STAKEHOLDERS IN A-CDM

Table III-2-1 presents a brief overview of the partners and stakeholders at a CDM airport, along with their various exchanges with one another. Additional partners may, depending on local/national circumstances, be included in the A-CDM process.

Table III-2-1. Roles and responsibilities of typical partners and stakeholders in A-CDM

Partner/ stakeholder	*Responsibility in A-CDM*	*Relationship with A-CDM (examples)*
ANSP	Provides ATC services. In the case of A-CDM, it is mainly the ATC tower at the CDM airport.	*ATC needs:* Updated CDM situational information such as planned TOBT, gate/stand number allocation. *ATC provides:* Updated estimated and actual landing for arriving flights' TSAT and TTOT for departing flights.

Partner/ stakeholder	*Responsibility in A-CDM*	*Relationship with A-CDM (examples)*
Aircraft operator	Operates aircraft. This includes the flight operator or a nominated representative.	*Aircraft operations need:* Updated CDM situational information such as planned, estimated and actual landing, in-blocks, TSAT and TTOT. *Aircraft operations provide:* Flight plan and other data related to the flight, planned, estimated and actual times related to progress of turnaround such as TOBT.
Aerodrome operator	Operates and manages all or part of the movement area. The above may include the airport operations centre, as well as stand and gate management.	*Aerodrome operator needs:* Updated CDM situational information such as planned, estimated and actual landing, in-blocks, TOBT, TSAT and TTOT. *Aerodrome operator provides:* Airport schedule information, relevant aerodrome resources allocation, gate and position planning.
ATFM unit	Manages traffic flow. In the process, the unit can provide flight plan and ATFM data. It may relay information to the ANSP.	*ATFM needs:* Departure planning information. *ATFM provides:* Flight plan data, calculated take-off times (ATFM slots), arrival update messages (ELDT).
Ground handling agents/aircraft service provider	Provides handling services to aircraft operators. The scope and nature of the services are usually the subject of a local agreement.	*Ground handling needs:* Updated CDM situational information such as planned, estimated and actual landing, in-blocks, TSAT and TTOT. *Ground handling can provide:* Data related to the progress of turnaround such as TOBT.
De-icing operator	Provides all services related to the de-icing of an aircraft.	*De-icing operation needs:* Updated information about aircraft requesting de-icing and the ERZT and TSAT. *De-icing operations can provide:* Status of de-icing for the particular aircraft. Prediction of EEZT.

Partner/ stakeholder	*Responsibility in A-CDM*	*Relationship with A-CDM (examples)*
Military authority	Provide services when involved in operations at aerodromes where A-CDM is a common procedure. *Remark: In general, A-CDM does not deal with military flights used in military operations.*	*Military authority needs:* Updated CDM situational information such as planned, estimated and actual landing, in-blocks, TSAT and TTOT. *Military authority provides:* Flight plan and other data related to the flight, planned, estimated and actual times related to progress of turnaround such as TOBT.

2.3 A-CDM PARTNERS

2.3.1 Air navigation services providers

2.3.1.1 With their responsibility to operate the ATC system safely and efficiently, ANSPs play a critical role in controlling aircraft operations on the manoeuvring areas (i.e., runways and taxiways). In some cases, the ANSP may also assume responsibility for apron control, while, in other cases, this responsibility will be handled by an airport operator, aircraft operator or third-party ramp control provider.

2.3.1.2 ANSPs are also responsible for tactical traffic management measures, whether they be local or from a broader international ATFM unit. It should be noted that regardless of their origin, ATFM measures must be integrated in the A-CDM decision-making process.

2.3.1.3 In many States, ANSPs may also provide some or all of the aerodrome surface surveillance and communication systems that are utilized by A-CDM programmes. They are also typically the source of real-time runway throughput/capacity data and key flight milestone times.

2.3.1.4 Depending on the relationship between aerodromes and ANSPs, the infrastructure needed to control traffic in the air or on the ground may be owned by the aerodrome, the ANSP, or partially by both. This may also influence the way A-CDM is implemented.

2.3.1.5 As is the case for aircraft operators, ANSPs often have multiple sub-entities that need to be involved in the development and implementation of A-CDM programmes, including the local (e.g., air traffic control towers), terminal (e.g., approach control facilities), and ATFM facilities (e.g., national system control centres).

2.3.1.6 At A-CDM aerodromes, the ANSP is one of the main partners by ensuring procedure adherence during the predeparture and departure phase of the flights, e.g., giving clearances based on A-CDM target times.

2.3.2 Aircraft operators

2.3.2.1 Aircraft operators include scheduled air carriers (passenger and cargo), charter and air taxi operators, general and business aviation, as well as the armed forces, all of which play a central role in A-CDM processes. They are directly affected by the decisions that are taken through A-CDM processes. What is more, they also need to provide up-to-date data regarding flight statuses. Their role is therefore paramount to ensure that A-CDM decisions can be made on the basis of information that is as accurate as possible. The various elements of data that can be provided by aircraft operators are described in Table III-2-1 and include, among other things, flight plans, target off-block times, information regarding turnaround times, and flight priorities.

2.3.2.2 Aircraft operators may also have considerable control over the allocation and utilization of parking stands and gates. As noted above, such cases typically arise when an operator or group of operators lease(s) terminal facilities on an exclusive basis.

2.3.2.3 It is important to note that aircraft operators often have multiple sub-entities that need to be considered when developing and implementing A-CDM systems, notably their ground handling agents or flight dispatch and local station operations.

2.3.3 Aerodrome operators

2.3.3.1 As the entities responsible for the provision of aerodrome facilities — including runways, taxiways, aircraft parking aprons and terminals — aerodrome operators have an essential role to play in A-CDM programmes. They also plan and implement capital improvements at the aerodrome. These capital expenditures can include technology and infrastructure that support A-CDM.

2.3.3.2 In general, aerodrome operators also have direct control over the allocation and utilization of aerodrome facilities such as aircraft parking stands, de-icing facilities, and terminal infrastructure.[1] A number of aerodrome operators also provide ground handling services such as aircraft handling, baggage handling, fuelling, cleaning and catering/provisioning — activities that need to be considered in assessing aircraft readiness to push back in A-CDM decision-making processes. In many cases, aerodrome operators are in a position to act as a neutral party among competing aircraft operators and as such can serve as a facilitator for A-CDM decision-making.

2.3.3.3 Generally speaking, European aerodrome operators have been at the forefront of the various A-CDM implementation programmes. They are responsible for the maintenance of the agreements as well as their associated procedures and process descriptions that have been used to establish the A-CDM programmes. Aerodrome operators elsewhere in the world, including those in Canada, India, Republic of Korea, South Africa and the United States, are in the process of assuming similar roles.

2.4 A-CDM STAKEHOLDERS

2.4.1 ATFM/network operators

In some cases, a State or group of States may be served by an ATFM unit that manages network operations. In such instances, crucial A-CDM pieces of information such as arrival and departure times are already exchanged in the framework of ATFM and network management. ATFM units are therefore critical stakeholders in A-CDM processes, as they possess data related to changes in flight plans and slot allocations and centralize information not only on the status of flights en-route, but also regarding flight cancellations and diversions.

Note.— See Part III, Chapter 3, 3.3.5 for information on the messages used to exchange information between ATFM and A-CDM.

1. This is, however, not always the case. Many airports in the United States, for example, lease terminal facilities to airline tenants and turn over day-to-day operational responsibilities for these facilities to the airlines.

2.4.2 Ground handlers/aircraft service providers

2.4.2.1 Ground handlers and other aircraft service providers can provide a subset of information regarding a departing flight during the turnaround phase. The data they provide are necessary for the accurate estimation of turnaround times, off-block times, and take-off times at departure aerodromes.

2.4.2.2 Real-time updates from these service providers, which in some cases can be aerodrome or aircraft operators, are important to ensure effective A-CDM processes.

2.4.2.3 Finally, it should be noted that ground handling agents act, in many cases, as A-CDM representatives for the airlines operating on a given A-CDM aerodrome without being based there. In these cases, since they act in almost a double capacity, they are an important partner in the A-CDM process.

2.4.3 Apron management service

In some instances, a specific provider is tasked to provide a service to regulate the activities and the movement of aircraft and vehicles on an apron.

2.4.4 De-icing service providers

2.4.4.1 Although de-icing may be seen as part of winter operations, its influence on aerodrome capacity can be so severe that a de-icing situation can be referred to as adverse. In general, de-icing operations have a significant impact on the operations which follow as well as on any associated A-CDM process. In these instances, any change brought about by the de-icing sequence must be reflected further down the line.

Note.— See Part III, Chapter 3, 3.3.6 for information on adverse conditions.

2.4.4.2 The de-icing sequence is typically established by the de-icing service provider in collaboration with the ground handlers, aircraft operators and ATC. To create an efficient de-icing sequence, and to ensure its impact on other aerodrome operations is taken into account, it is important to include the de-icing service provider in the CDM information-sharing process.

2.4.5 Weather services

2.4.5.1 Weather services provide forecasted and actual meteorological information that are relevant for all ATM activities and therefore not specific to A-CDM. Meteorological conditions influence the decisions made during an A-CDM process, e.g., planning the predeparture sequence during aircraft de-icing phases.

2.4.5.2 The level of involvement by weather services in an A-CDM process is determined by the impact that meteorological events are likely to have on airport operations. The involvement is usually apportioned to the severity of the phenomena that occur in the vicinity of the aerodrome.

2.4.6 Military authorities

In situations where joint civil/military operations take place in A-CDM aerodromes, military authorities can have a significant role as partners in the CDM process. It should be noted that military movements at airports vary considerably. With this in mind, a local decision may be needed to define the input required by military partners into the A-CDM process.

2.4.7 Civil aviation authorities

CAAs are not direct A-CDM partners, however, their support to implementation could be of significant value. Since their responsibilities usually cover various airports over a given region, they could be instrumental in setting up rules and regulations that would frame A-CDM implementation within their State or their area of responsibility. They could therefore be a vector of consistency in A-CDM practices. Nevertheless, it should be noted that, in some States, the CAA could be responsible for approving or certifying A-CDM implementations.

2.4.8 Other entities

2.4.8.1 Other entities with important information to share regarding conditions that may affect aerodrome or aircraft operations should also be considered as possible A-CDM participants. Such entities include independent meteorological offices, third-party apron management service providers and A-CDM technology/software solution providers.

2.4.8.2 Examples of deliverables from each stakeholder can be found in Table III-2-1.

2.5 VARYING ROLES OF A-CDM PARTICIPANTS

2.5.1 A-CDM is scalable: the range of the participants to an A-CDM process, as well their respective levels of participation, are commensurate to the objectives of A-CDM. Since the roles and responsibilities of each may vary, they cannot be specifically described and assigned in a definitive manner. The description provided in the previous sections is consistent with the general practices currently in use worldwide and cover the full range of A-CDM operations. The allocation of responsibility to each stakeholder, and its relationship with the CDM process in the description, is therefore more indicative than it is prescriptive.

2.5.2 Every A-CDM participant has a specific role. For example, a specific stakeholder might have certain roles and responsibilities in a certain aerodrome, which may differ in another aerodrome. These roles may vary depending on the infrastructure of the CDM aerodrome, the operational data that participants share, as well as the operational decisions that participants have the authority and responsibility to make.

2.5.3 In some cases, an aerodrome operator may have the responsibility/authority for managing aircraft gate/stand allocation and utilization. In such a case, the aerodrome operator would generally maintain detailed information regarding estimated and actual block-in and block-out times. At some locations, the aerodrome operator may also provide ground handling services directly to aircraft operators, in which case the aerodrome operator may have detailed data regarding ground handling milestones (e.g., when fuelling, passenger and baggage loading, and/or catering/cleaning service were completed).

2.5.4 In other cases, aerodrome operators may have limited or no direct responsibility/authority for gate/stand assignments, having leased these facilities on a long-term basis to either aircraft operators or third-party terminal operators. In such cases the aircraft operators or third-party terminal operators would typically have the data and decision-making capability necessary to facilitate A-CDM processes.

2.5.5 Similarly, the roles of ANSPs may also vary. In some cases, the ANSP may assume responsibility for apron control. In others, the ANSP may assume control responsibilities for the manoeuvring area of the airport only and leave apron control responsibilities in the hands of an aerodrome operator, an aircraft operator, or a third-party apron management service provider.

Note.— See Annex 14 — Aerodromes, *for the definition of manoeuvring area, movement area and apron.*

2.5.6 A-CDM programmes must therefore not only consider the roles that participants have at a specific aerodrome, but also the operational data they can provide as well as their share of responsibility in the decision-making process.

2.5.7 In most aerodromes, A-CDM processes are very similar. The inputs to the process, however, as well as the responsibilities of each stakeholder, may vary from aerodrome to aerodrome. These inputs are dictated by local usages, local constraints and methods.

Chapter 3

A-CDM METHODS AND TOOLS

3.1 INTRODUCTION

3.1.1 This chapter describes various A-CDM methods with a focus on implementation. At the airport where A-CDM is implemented, decisions on many issues may be made locally, to allow for flexibility and to ensure that the decisions are based on the specific conditions in which any given airport operates. How A-CDM implementation then drives technical considerations is also subject to local pragmatism and to financial decisions.

3.1.2 The description of the methods hereafter articulates the minimum level of required functionality, as opposed to providing an exhaustive description of each and every functionality. As was previously emphasized, the notion of scalability reflected, for example, in the modular approach to A-CDM, underscores the entire concept and the guidance provided. Each airport operates under specific circumstances, and A-CDM must be organized to meet the need of the platform where it is implemented as a matter of priority.

3.1.3 This guidance material does not, however, preclude the need for detailed specifications to be established for each of the described elements. Such specification will, however, be developed as part of the A-CDM implementation project, taking due account of local deviations from the theoretical description as well as of prevailing circumstances that may justify a different approach to the one presented in this manual to achieve the same result.

3.1.4 This chapter contains a description of common A-CDM elements relevant for all actors and which underscore any phase of A-CDM operations. It also describes A-CDM elements relevant to certain actors at specific moments of A-CDM operation. These elements can usually be found in A-CDM projects worldwide and are chronologically depicted in an A-CDM timeline.

3.2 A-CDM COMMON ELEMENTS

3.2.1 Information sharing

3.2.1.1 Information sharing is the principal common element and is also the foundation of all other functions of A-CDM. While it is central to the notion of A-CDM, it also yields benefits of its own.

3.2.1.2 A-CDM information sharing, in any phase of its operation, aims to generate a common situational awareness for A-CDM partners/stakeholders. The accuracy of the information exchanged is key to its success: Continuous updates are constantly required.

3.2.1.3 Common situational awareness ensures transparency with regard to each A-CDM partner's needs and objectives, and enhances the understanding of each stakeholder's limits. Enhanced understanding strengthens trust-building between actors and stakeholders. Transparency between parties will therefore safeguard their confidence and guarantee a long-term commitment to the A-CDM process.

3.2.1.4 Information sharing is the connecting element tying the partners together in their aim to efficiently coordinate airport activities. A-CDM information sharing supports local decision-making for each of the partners and facilitates implementation of A-CDM elements. This is achieved by connecting the A-CDM partners' data processing systems to provide a single, common set of data which describes both the status and intentions of a flight. This set of inter-related, constantly updated data then forms the backbone of A-CDM and serves as a platform for information sharing between partners.

3.2.2 A common language

3.2.2.1 A-CDM implementation may also ensure the generation of a single set of acronyms and definitions, reconciling sometimes diverging denominations. The various actors employ language elements that are specific to their domain of activity. A-CDM, relying on enhanced information exchanges, naturally leads all participants to agree on a common denomination.

3.2.2.2 In keeping with the notion of A-CDM scalability and the importance of tailoring A-CDM to local constraints and obligations, local considerations and circumstances will govern the use of these language elements and will therefore drive the amendments brought to the language used locally. As exchanges between CDM airports seldom occur directly, but more frequently through the interface of ATFM when it is implemented, detailed standardized definitions are not proposed in this manual.

3.3 A-CDM ELEMENTS

3.3.1 Variable taxi time

At complex airports, the varying layouts of runways and parking stands may result in a large difference in taxi times. Instead of using a standard default value, a calculation of the different permutations based on historical data and operational experience, possibly using an ad hoc integrated tool, may provide a set of more realistic individual taxi times. The variable taxi time calculation enhances the accuracy of the target times for both arriving and departing aircraft and increases overall compliance with the various target times.

3.3.2 Turnaround process

3.3.2.1 The turnaround process generally encompasses the operations occurring between the arrival of the aircraft at the aerodrome and its departure from the aerodrome. The process is based on the constant exchange of flight progress updates between airport operators, ATC, ground handling agents, air traffic flow managers, aircraft operators and other A-CDM stakeholders.

3.3.2.2 The constant exchange of messages and information enables improved adherence to A-CDM processes. This ensures that the best use of all available resources and capacities is made, which may reduce departure delays, resulting in better slot management and improving airport operational efficiency.

3.3.3 Departure management

A-CDM enhances departure management by enabling traffic managers and controllers to provide each departing aircraft with accurate target times. Because those times are coordinated with the various partners and stakeholders, they are robust and allow for more efficient departure sequences, organized, sometimes, from as far as the start-up approval time. The result is a smooth, efficient traffic flow to the departure runway with reduced queuing at the runway hold point.

3.3.4 Networking

3.3.4.1 A-CDM is, by nature, a local project which is airport centred. However, since it improves coordination among the various actors and stakeholders operating on a given airport, A-CDM actually facilitates communication with surrounding ATM facilities. A-CDM allows the exchange of information for inbound and outbound flights and links the local A-CDM process to ATFM services, when those are available. In situations where ATFM services are not available, A-CDM strengthens the link between the airport and ATC services.

3.3.4.2 The coordination between ATFM and A-CDM during the turnaround process is handled through a constant exchange of flight messages or relevant data. It is called A-CDM collaborative management of flight updates. The exchange typically includes information for arriving flights (e.g., ELDT), sent by the network to the CDM airport, as well as departure planning information for departing flights (e.g., TTOT), sent from the CDM airport to the network.

3.3.4.3 In these instances, where a flight departing from a CDM airport is affected by a GDP, and has, by way of consequence, a target time of departure (generally expressed as a CTOT), this information is then fed into A-CDM and taken into account by the various actors and stakeholders. This ensures a higher compliance with the assigned take-off time and allows for more efficient use of aerodrome resources.

Note.— See Part II, Chapter 4, for information on ATFM measures including phases and solutions.

3.3.4.4 The connection between A-CDM and ATFM also benefits each system. A-CDM improves the efficiency of ATFM by strengthening the quality of estimated times of departures and enhanced application of ATFM measures, allowing best use of available capacity, e.g., sector capacity. In addition, local airports will benefit from updated information related to arrival times and will therefore be able to better plan for arrivals and departures.

Note.— See Part II, Chapter 5, for information on exchange messages.

3.3.5 Departure and arrival coordination between ATFM and A-CDM

3.3.5.1 Generally speaking, it is essential to ensure that the airport is informed of anything that may affect the aircraft’s landing time. It is equally important that the airport communicate information likely to affect a predicted take-off time. At CDM airports, an A-CDM Information sharing (ACIS) platform usually consolidates the constraints of the different actors. The ACIS usually plays a key role in the exchange of information within the airport and with neighbouring units. These exchanges fill the gap between the last information sent by the aircraft operator through flight planning messages such as filed flight plan (FPL), delay (DLA) or change (CHG) messages and the information known at the airport.

3.3.5.2 In the context of SWIM and of the use of FF-ICE, messages will be replaced by information exchange, In this context, emphasis is based on the information contained in the message and not on the message itself. The information exchanged is therefore of relevance in any kind of set-up or organization of ATS.

3.3.5.3 Two specific types of messages are generally exchanged between CDM airports and ATFM units. The denomination of the messages is generic, however the precise names allocated to the messages may vary from one system to another. Furthermore:

a) departure planning information (DPI) messages, or equivalent, are sent by the CDM airport to the ATFM unit or the ATM unit responsible for the given CDM airport; and

b) flight update messages (FUM), or equivalent, are messages that are received by the CDM airport from the ATFM unit if it exists or neighbouring ATS units.

3.3.5.4 ***Departure planning***

3.3.5.4.1 For a given flight, ATFM receives an FPL message several hours before take-off. In some cases, DLA and CHG messages might provide updated estimates of the take-off time. However, these FPL, CHG and DLA messages are issued by aircraft operators who are not always aware of the local situation or the constraints imposed by airport operations. They are therefore unable to provide a fully accurate take-off time estimate.

3.3.5.4.2 It might occur that for reasons outside the aircraft operator's control (de-icing situations, runway changes, etc.), the take-off time mentioned in an FPL, CHG, or DLA message is no longer relevant.

3.3.5.4.3 The A-CDM updated information is based on data from local aircraft operator representatives, handlers, the aerodrome, aerodrome control tower (TWR), etc., and is therefore more consistent. It reflects the advancement of the turnaround process and airport constraints, etc. A-CDM systems orchestrate processes where aircraft operators, ground handling agencies, airport operators and ATC work collaboratively to optimize traffic handling.

3.3.5.5 ***Departure planning information (DPI) message***

3.3.5.5.1 The purpose of the DPI message is to supply ATFM with flight-data-related updates that are only available from sequencing tools (e.g., departure manager(DMAN)), CDM airport systems and TWR systems, or data that is only available shortly before departure. DPI messages improve the accuracy of flight plan data.

3.3.5.5.2 The DPI message can be triggered by ATC (TWR) systems, by sequencing tools (e.g., DMAN) or by CDM systems at airports.

3.3.5.5.3 The main data received via the DPI message include:

a) an accurate estimate of the TTOT;

b) the taxi-time (EXOT); and

c) the standard instrument departure (SID).

3.3.5.5.4 If available, the DPI message may also contain updates on:

a) the aircraft type; and

b) the aircraft registration.

3.3.5.6 ***Flight update messages*** (***FUM)***

3.3.5.6.1 The purpose of the FUM is to inform airports on the progress of a flight.

3.3.5.6.2 The FUM is sent from ATFM to the airport and is used to supply airports of destination (ADES) with an ELDT, and the STAR-entry point (SEP) or the last point in the flight plan route with the corresponding estimated time over (ETO).

3.3.5.6.3 The first FUM is usually sent three hours before landing and, subsequently, whenever significant flight updates occur.

3.3.6 Adverse situations

3.3.6.1 Many different events, both planned and unplanned, can disrupt regular operations at an aerodrome and reduce its capacity to levels substantially lower than the one employed during regular operations. A-CDM is a powerful tool which can be used to mitigate the negative impact of such adverse conditions.

3.3.6.2 There are various types of adverse conditions. Some may be foreseen with a varying level of accuracy in both their scope and likely effects. They can sometimes be planned for and generally have predictable consequences (e.g., snowy conditions, dust storms, industrial action affecting the maintenance of elementary services). Specific A-CDM procedures can be designed to cater for such instances.

3.3.6.3 Other adverse conditions include those of a less predictable nature and are likely to generate disruptions on various levels. Events such as fire or aircraft incident/accident fall into this category and, in terms of procedures, are more difficult to prepare for. In fact, too detailed, pre-determined procedures may even be more of a hindrance than a help. In these instances, the added value accrued by A-CDM relies on allowing effective communication between relevant stakeholders.

3.3.6.4 In the event of adverse conditions, the aim is therefore to manage the reduced capacity in the best possible way. This optimization also facilitates a swift return to regular capacity once adverse conditions no longer prevail. This is mainly made possible by using the improved information-sharing results from the previous elements.

3.4 A-CDM TIMELINE

3.4.1 Introduction

A-CDM operations at a CDM airport is a process which usually encompasses events on the day of operations. Nevertheless, there are instances where an A-CDM process could be applied for pre-tactical purposes. Such processes are detailed below.

3.4.2 The modular approach

3.4.2.1 An A-CDM process could be described as a sequence of modules. As was established in Part III, Chapter 1, Section 1.6, the description of successive modules allows identification of the common process with identical milestones, taking due account of local specificities.

3.4.2.2 The A-CDM timeline may also be described using different possible milestones. An A-CDM process milestone could be either a certain point in time or an operational event. The definition of each milestone and the actions usually associated with each milestone must be decided upon locally, as local constraints and conditions will dictate. A-CDM milestones are then articulated in a process that entails for each solution an inbound, turnaround and outbound phase (Figures III-3-1, III-3-2, III-3-3 and III-3-4 refer).

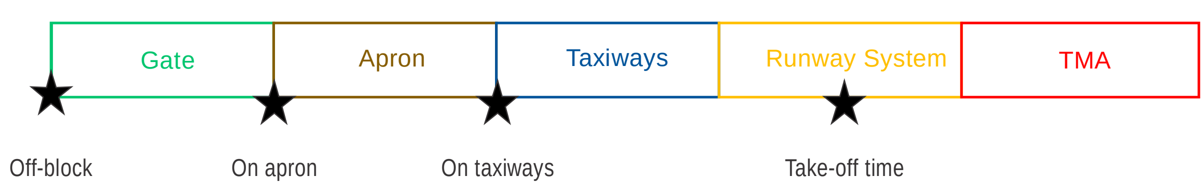

Figure III-3-1. A-CDM timeline using modular representation

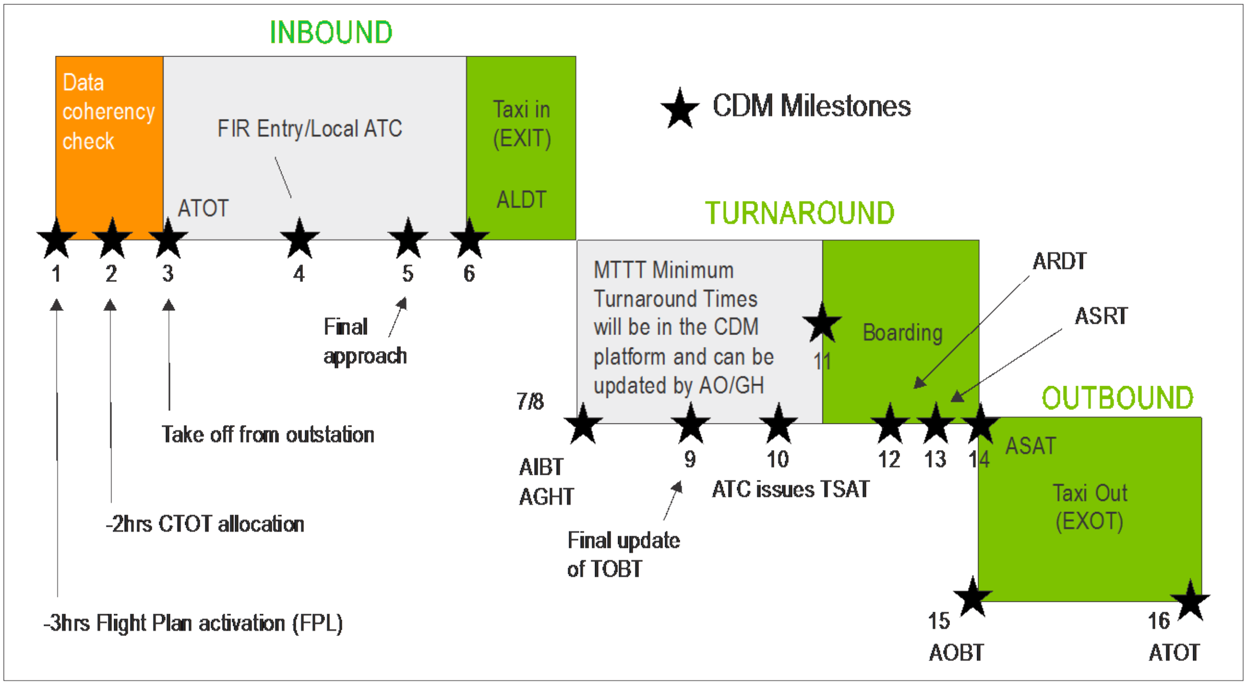

Figure III-3-2. A-CDM milestones used in Europe and other parts of the world

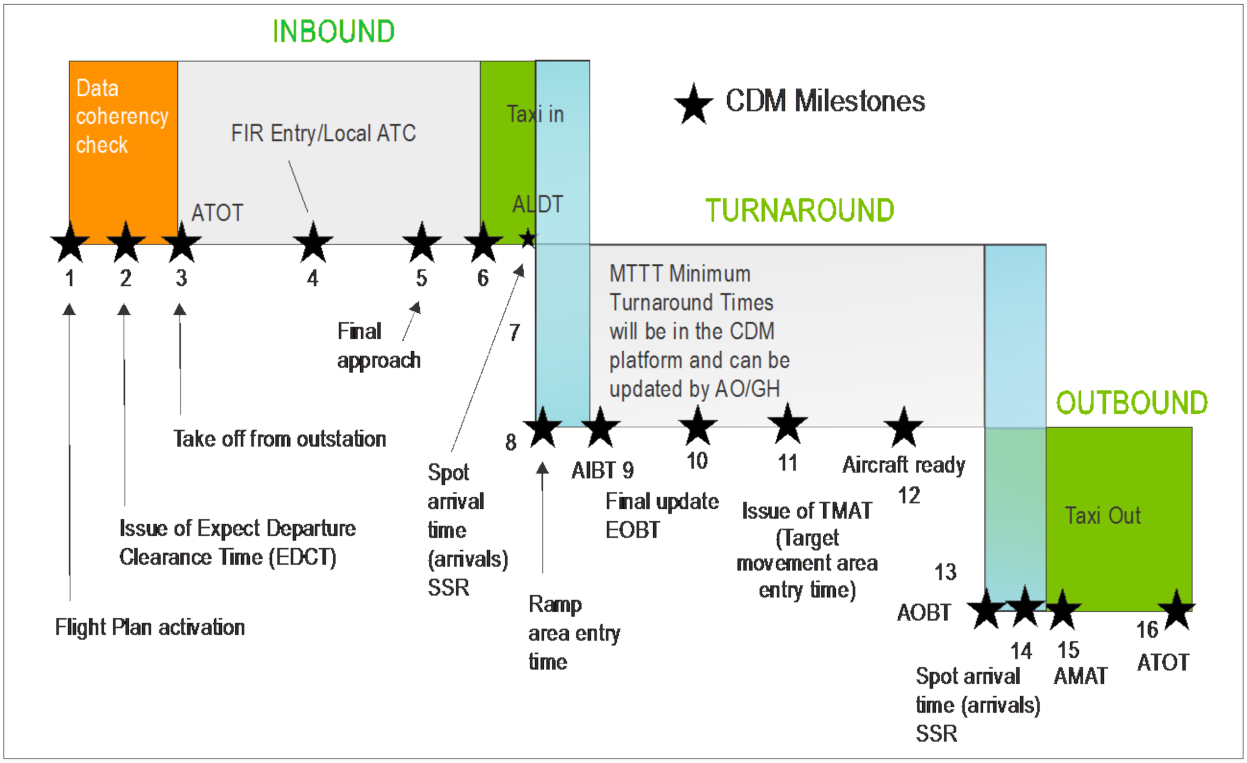

Figure III-3-3. A-CDM milestones used in the United States (Surface CDM)

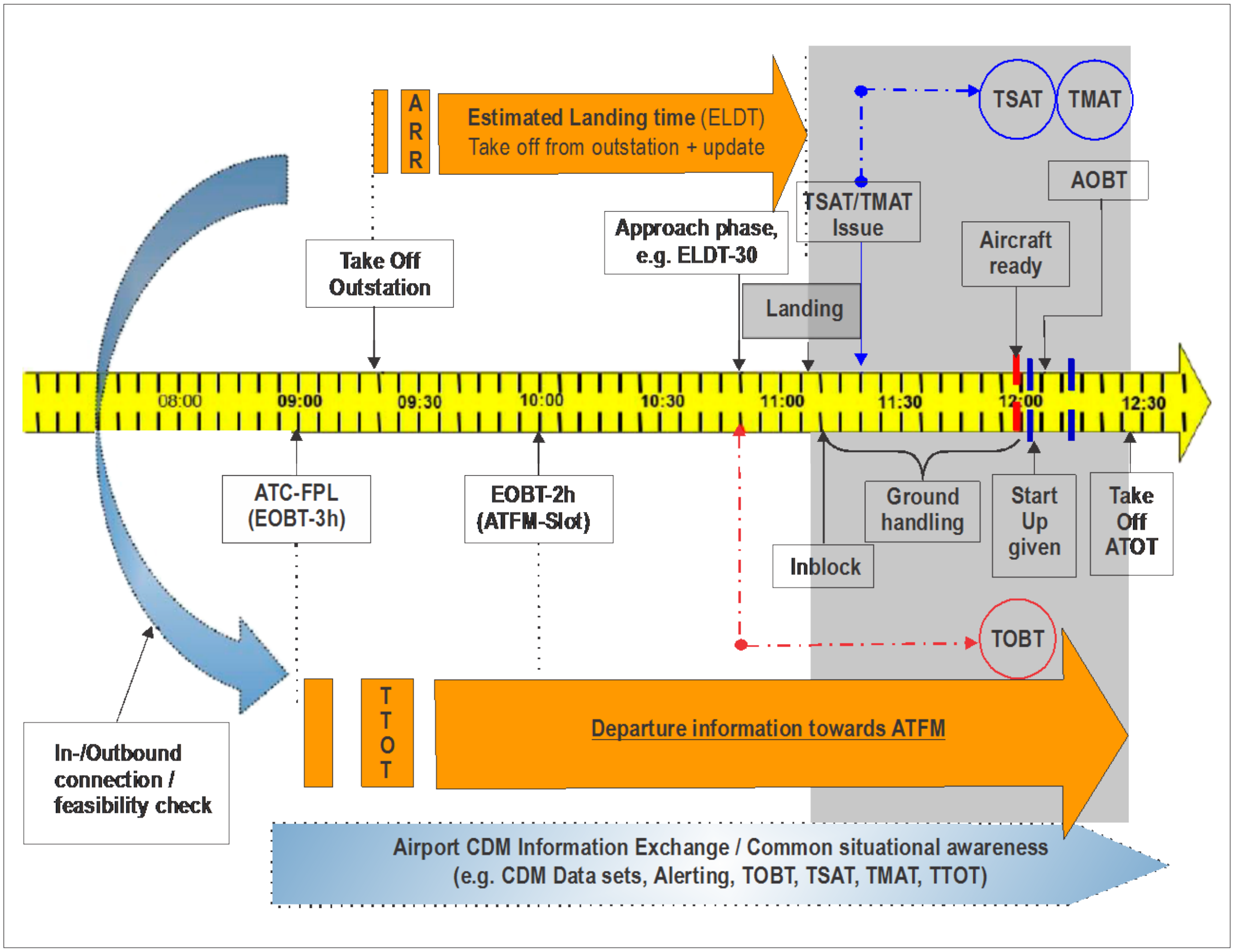

Figure III-3-4. A-CDM process timeline

3.4.3 Pre-flight information

3.4.3.1 The main purpose of this phase, from an A-CDM perspective, is to confirm that the flight will take place.

3.4.3.2 The A-CDM process generally starts with a flight plan and airport data coherency check. The type of information to be used at this stage depends on regional, national or local circumstances. However, the coherency check usually covers the following elements:

a) information from ATC services (FPL) e.g., EOBT, aircraft registration (REG), ADES, aircraft identification (call sign) (ARCID), aircraft type (ARCTYP), SID;

b) information extracted from airport schedule information e.g., REG, SID, flight number, ARCTYP; and

c) information on airport slots e.g., SOBT (from the entity airport slot coordinator).

3.4.3.3 The coherency check of the flight information is used to correlate, confirm and collate the different information to a single A-CDM data set for each flight. The objective is to reduce the amount of duplicate or inaccurate information. This will, on the one hand, allow for a clearer representation of the expected traffic demand and, on the other hand, will mainly provide robust data that will then be used throughout the entire information exchange process and, when relevant, shared with ATFM systems.

3.4.4 The inbound phase

3.4.4.1 The purpose of A-CDM during the inbound phase is to enhance the distribution and use of advance arrival information to/by stakeholders when the flight is inbound to the CDM airport.

3.4.4.2 The distribution of information is enhanced by the establishment of robust methods of distribution adapted to the aerodrome. These methods range from a simple phone call to advanced automated systems. Here again, local specificities and constraints will dictate what those measures are and determine the level of automation required, if any.

3.4.4.3 While the methods used to distribute the information are significant, the identification, the referencing of the possible sources of such information, and the process to prioritize it, are of equal importance. For that reason, the inbound phase and the typical types and sources of information that could be considered include:

a) estimated landing times (collected by phone contacts or directly extracted from radar information or from ATFM);

b) flight information, e.g., REG, ARCTYP; and

c) status data, confirming the active status of the flight (information such as the confirmation of the fact that the aircraft has taken off from its departure aerodrome).

3.4.4.4 A-CDM will, for the inbound phase:

a) enhance the calculation of the estimated in-block times, and consequently improve gate usage and position planning;

b) allow the verification of the feasibility of the outbound flight information for any arriving aircraft based on updated arrival information (see Figure III-3-5); and

c) enhance resource planning, e.g., ground handling.

3.4.5 The turnaround phase

3.4.5.1 The purpose of A-CDM in the turnaround phase is to further improve the common situational awareness of all partners and to provide the most accurate estimation of departing aircraft readiness by using reliable off-block times, either EOBT or TOBT.

3.4.5.2 The E/TOBT is a point in time that is monitored and confirmed, either by the aircraft operator or its ground handling agent. This point marks the completion of all ground handling processes: the aircraft doors are closed, the passenger boarding bridges have been removed from the aircraft, which is ready to receive start-up approval and push-back/taxi clearance.

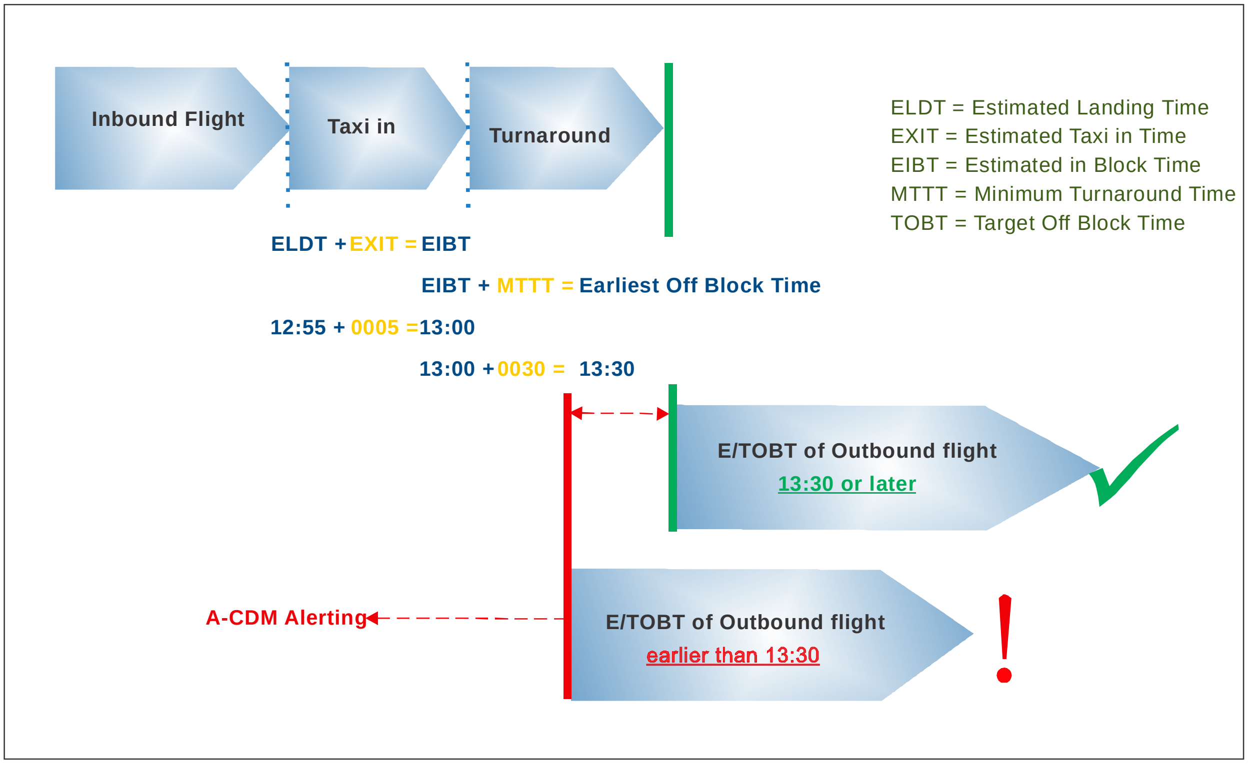

Figure III-3-5. Sample feasibility check of a flight turnaround based on arrival information

3.4.5.3 All ground handling processes, except push-back and remote de-icing, are based on the E/TOBT. The E/TOBT is used as the optimum time for coordination. The conditions to update it are therefore usually rather specific. Where EOBT is used, it requires to be updated only if there is a difference of 30 minutes or more (if not regulated differently in ICAO subregions). Where TOBT is used, the requirement is to update if there is change of five minutes or more.

3.4.5.4 The use of a TOBT also allows for further enhancements to other A-CDM processes/procedures. Information gained could, for example, be used for:

a) calculation of the predeparture sequence;

b) aircraft de-icing planning;

c) earlier indication that a flight will not be ready, e.g., TOBT cancellation in case of a technical problem with the flight;

d) updated information about target take-off times for ATFM; and

e) enhanced use of other resources, e.g., gate and position planning.

3.4.6 Departure — outbound phase

3.4.6.1 The purpose of A-CDM for the outbound phase is to optimize planning of the departing flights.

3.4.6.2 A-CDM facilitates the sequencing of flights for departure and can assist ATC to sequence flights for the outbound phase. In terms of the A-CDM process, this is known as *predeparture sequencing*. The way the predeparture sequencing is carried out is different if apron control is provided by ATC or if it is provided by the aircraft operator.

3.4.6.3 When ATC is responsible for apron control, ATC will organize the predeparture sequencing TOBT. Since the TOBT establishment was enhanced by A-CDM in the turnaround process, flights can depart from their stands in a more efficient and optimal order. In those cases, ATC usually issues target start-up approval times (TSAT) as a result of the predeparture sequencing, thereby allowing traffic flows to be regulated as they move towards the runways more efficiently (see Figure III-3-6 for an example of a predeparture calculation). The situation is identical if aerodrome operators (instead of ATC) are responsible for apron control.

3.4.6.4 For the CDM airports where aircraft operators are responsible for the start-up and push-back of aircraft, the organization is slightly different. In these cases, the predeparture sequence may be based on the issuance by ATC of a target movement area time (TMAT). The objective and end result are, however, identical: streamlining the flow of departing aircraft in the most efficient manner possible.

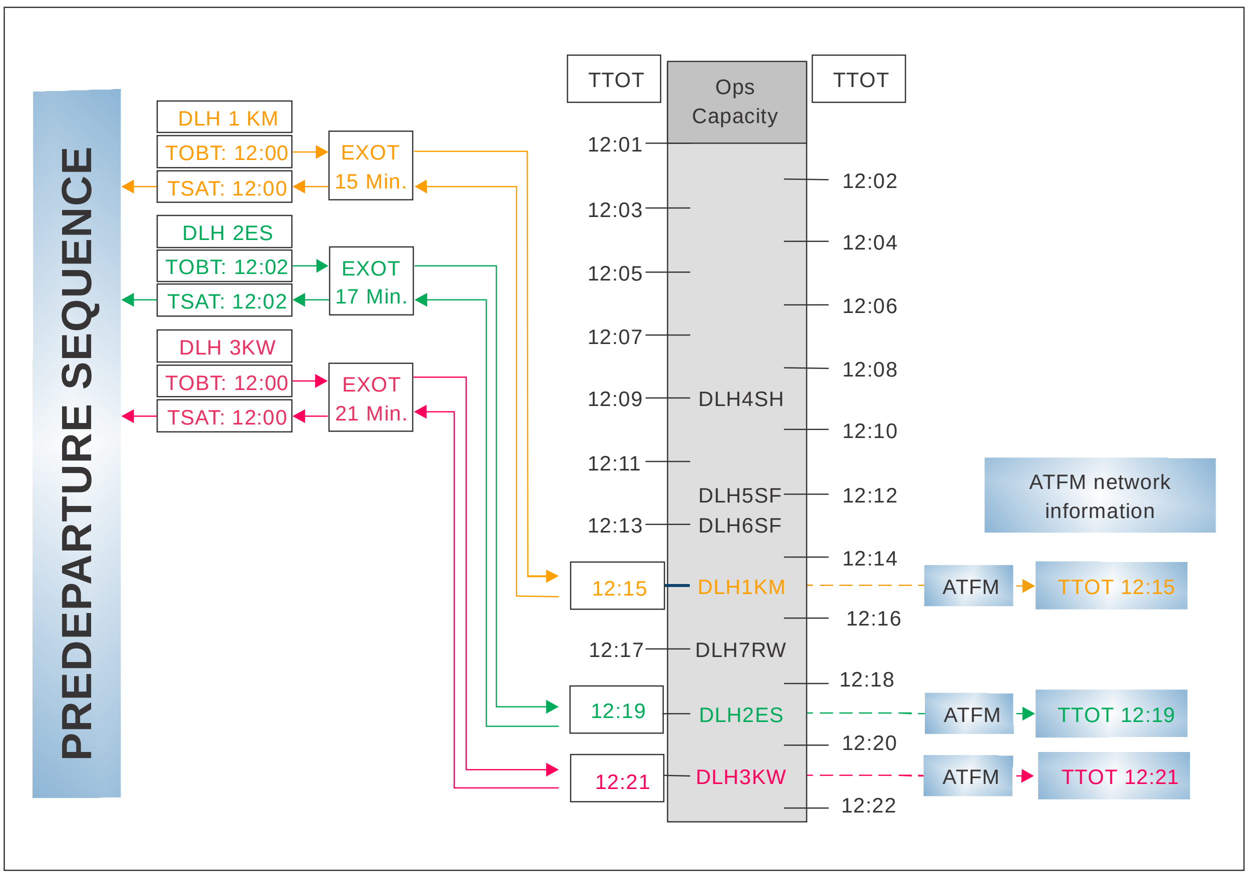

Figure III-3-6. Example of a predeparture sequence calculation

3.4.6.5 The predeparture sequencing is therefore mainly based on E/TOBT. It should, however, also take into account other factors when they are relevant, such as variable taxi time calculations, any ATFM restriction (e.g., CTOT) and real available operational capacity.

3.4.6.6 A-CDM, in its predeparture sequencing and activities, is also likely to provide for further enhancements to the overall efficiency of the system, as it could also:

a) allow for more efficient de-icing scheduling;

b) improve consistency in the determination of aircraft take-off order, by taking into account and combining aerodrome priorities with ATC or ATFM requests;

c) enhance aircraft taxi planning;

d) provide updated resource planning, e.g., gate and position planning; and

e) enhance the quality of the information provided to ATFM systems with updated pre-take-off information.

3.5 INFORMATION IN A-CDM

3.5.1 Introduction

As indicated in Section 3.2 describing A-CDM common elements, information sharing and gaining common situational awareness are the foundations of A-CDM. Depending on regional, national or local circumstances, the types of information needed and shared to build that foundation can vary, and their sources may be different. The following sections describe various types of A-CDM information, depending on their nature. Mention is also given to the systems that can be used to exchange the information as well as to the means to ensure the quality of data throughout the process.

3.5.2 Groups/types of information

3.5.2.1 The information used to provide A-CDM can be further classified in two main categories:

a) *live data.* This usually serves to perform real-time updates to the A-CDM flight data set, e.g., ELDT, TOBT, etc.; and

b) *static data.* This serves as a basis for the establishment and design of an A-CDM process calculation and must be kept current, but not constantly updated, e.g., minimum turnaround time (MTTT), variable taxi time (VTT), contact details (e.g., person responsible for TOBT).

3.5.2.2 The information to be considered for A-CDM is extremely diverse and will depend on local circumstances. However, the information usually considered in the various A-CDM implementation projects worldwide may be grouped into distinct families: airport operators; aircraft operators; ground handlers; ATC systems; and ATFM systems. These groupings are detailed in Figure III-3-7.

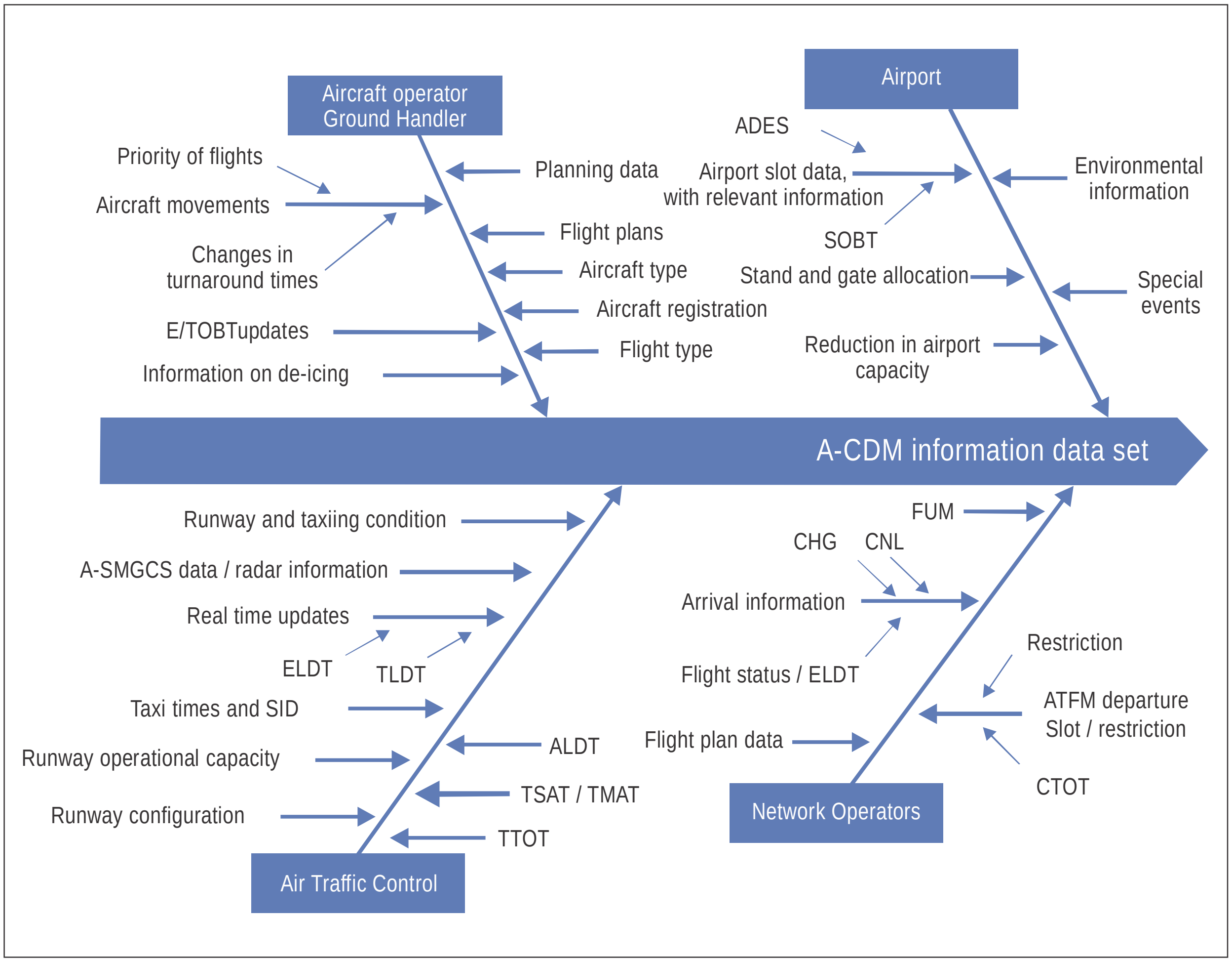

Figure III-3-7. Information in A-CDM

3.5.3 Methods to exchange information

3.5.3.1 The structure that provides the overall environment through which A-CDM partners may share information securely, with the assurance that data is accurate, relevant, timely and authoritative, is often referred to as the A-CDM information sharing (ACIS).

3.5.3.2 The ACIS is the foundation for implementing any A-CDM element. The purpose of an ACIS is two-fold: firstly, it provides a consistent and secure display of all the relevant information needed for the A-CDM elements, and secondly, it creates the environment that enables the sharing of all relevant events by using the different means of reporting routines that have been agreed upon. These may or may not be automated (IT interfaces, web-based A-CDM CSA tools, docking guidance systems, etc.). Where automation is not available, the exchange of information relies on any other kind of standardized reporting routine (which can be as simple as verbal coordination), provided it is included as a routine report, as a procedural step.

3.5.3.3 ACIS performance principles support local decision-making for each partner and facilitate the implementation of A-CDM elements by:

a) providing a single, common set of data describing the status and intentions of a flight;

b) connecting A-CDM partners' data processing systems; and

c) serving as a platform for information sharing between partners.

3.5.3.4 The general principle of ACIS may be defined as providing the right information to the right people at the right time.

3.5.4 Information quality

3.5.4.1 Data quality is usually expressed in terms of accuracy, timeliness, reliability, stability and predictability, based on a moving time window.

3.5.4.2 The efficiency of the A-CDM process and of its subprocedures and derived decisions is highly dependent on the quality of the information input by any one of the partners. Only reliable information inputs will lead to reliable A-CDM results. This obvious fact can apply to single flights (e.g., TOBT quality), as well as to specific overall results (e.g., input of operational capacity value input into the predeparture sequencer).

3.5.4.3 In order to ensure reliable and consistent use of data for A-CDM operations, the roles and responsibilities of all partners must be formalized by way of a specific agreement (see Part III, Chapter 1, Section 1.5 as well as Section 3.5.5 of this chapter, related to the use of such agreements to secure the flows of information).

3.5.5 Securing the flow of information

3.5.5.1 A-CDM is based on the voluntary cooperation of the various partners and operates successfully when all recognize the mutual benefits that A-CDM will accrue for all. In most instances, however, A-CDM brings together stakeholders that usually compete with one another. It is therefore rather common in any A-CDM implementation project that a level of reluctance to communicate must be overcome to secure the flow of information underscoring A-CDM operations.

3.5.5.2 To do so, and to ensure the provision and proper use of data, the roles and responsibilities of all partners must be formalized by specific agreements of varying levels of precision and detail. The exact denomination of these agreements cannot be strictly determined and is highly dependent on the local use at the airport. The key element, however, is the formality that the signing of said agreements induces.

3.5.5.3 Examples of agreements include, inter alia:

a) MoUs;

b) service level agreements;

c) A-CDM contracts;

d) interface descriptions; and

e) letters of agreement (LoA).

Note.— See Appendix III-A for an example of an A-CDM agreement framing information quality by way of specific service level agreements and Appendix III-C for an example in which data quality requirements are included directly in the agreement governing A-CDM.

3.5.5.4 The formalization of specific agreements defining the roles and responsibilities of each partner, and providing an accurate description of the use of the provided data, will therefore often be the key to success. This formalization usually ensures reliable and consistent provision of data, and generally frames the issue of access to data, and of its use, clearly stating which data are available to whom and to what end. These agreements would, for example, provide to the participants the assurance that each airline operator would have access to its own data only. It must be noted that sensitive commercial information shall not be accessible to competing aircraft operators, but only to other partners such as ATC or airport operators.

3.5.6 Data assurance control

Data assurance control is provided by data management, which consists of:

a) data filtering (e.g., filtering data according the display requirements for each A-CDM partner);

b) data recording (e.g., registration of all information, its sources and input times that are entered in the A-CDM system); and

c) data storage (e.g., the manner in which data is physically stored and how it is made available for post-analysis functions).

3.6 ACTIVITY AND SUCCESS MESUREMENT: KEY PERFORMANCE INDICATORS (KPIs)

3.6.1 Activity measurement is not systematically justified in all A-CDM implementation projects. It is not a compulsory element, at most it is nice to have as opposed to being a must-have.

3.6.2 Scalability is a fundamental factor to ensure success in A-CDM implementation. A-CDM is relevant for small-sized projects at regional airports and is different from major endeavours affecting international operations. The set-up will be significantly different and, logically, so will the performance areas that will reflect the improvements that were made possible.

3.6.3 It is therefore not relevant to measure the performance of a single solution. The purpose of this section is therefore to propose a comprehensive set of data, drawing on the existing multiple indicators already in use to monitor A-CDM worldwide. In general, the analysis should cover areas such as efficiency (including predictability), capacity and punctuality.

Note.— A proposed list of A-CDM KPIs may be found in Appendix III-D.

3.6.4 The objectives and related KPIs for an A-CDM implementation are generally divided into two categories:

a) generic objectives and KPIs for all A-CDM partners; and

b) specific target objectives and KPIs defined for each A-CDM partner.

3.6.5 Should it be decided to set up performance measurement, the first step is to identify the relevant KPIs for the given project. The final step entails baselining these KPIs to establish a benchmark so as to allow a meaningful comparison of the data taken before and after the evaluation.

Chapter 4

A-CDM IMPLEMENTATION

4.1 A-CDM IMPLEMENTATION ROADMAP

4.1.1 Many steps must be taken from the initial interest to the final stage of A-CDM implementation. For instance, the decision to launch the project must be supported by a full process. This chapter generically describes this process with a specific focus on key elements that are instrumental to its success. There is no ideal A-CDM scenario: each situation is different and will warrant different solutions. However, with the experiences drawn from previous A-CDM implementations worldwide, a number of good practices have been identified and may be summarized in a typical roadmap, as presented in Figure III-4-1. The most significant aspects are further developed in this chapter.

Note.— For the content of this chapter, the term A-CDM partner is used to reference the combination of A-CDM actors and stakeholders (as defined in Part III, Chapter 2).

4.1.2 In very general terms, the following steps should be taken when starting an A-CDM project:

a) trigger the interest and secure the cooperation of all partners;

b) write out clear objectives;

c) establish a timeline with roles and responsibilities;

d) write out the plan; and

e) start implementation;

4.1.3 Once the A-CDM project has started, the following actions should take place:

a) evaluate the findings from initial implementation; and

b) adjust the plan as necessary.

4.2 LESSONS LEARNED AND BEST PRACTICES

Three distinct elements underscore every successful implementation of A-CDM worldwide: an initial convincing to actively engage all parties; an unbiased view of the work to be achieved in order to reach the objective; and finally, an effective multi-party project management approach. These elements are hereafter described as *best practices.* Notwithstanding these best practices, the real challenges of an A-CDM project are to ensure that all airport partners see the benefits for the airport as a whole, as well as for themselves, and that enough effort is invested during the development of the project through trust-building to find common solutions as opposed to appointing blame.

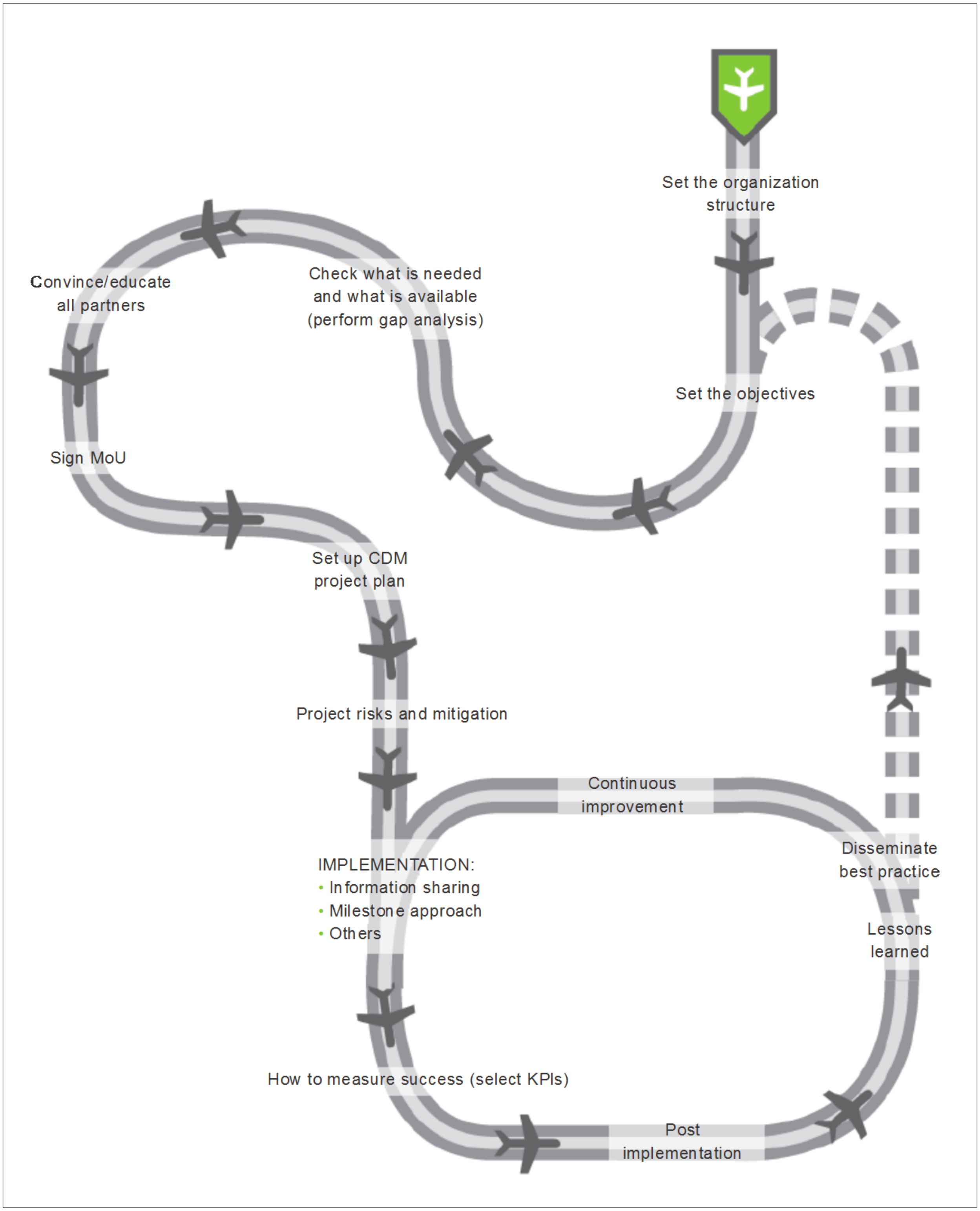

Figure III-4-1. Generic A-CDM general implementation roadmap

4.2.1 Getting started: The initial convincing

4.2.1.1 To succeed, A-CDM managers (i.e., those in charge of driving the implementation phase of A-CDM) must secure the initial buy-in from A-CDM actors and stakeholders. The challenge is that they must do so on the sole virtues of A-CDM, the benefits of which are, at this stage, still unknown to the community. Very often the first steps of an A-CDM project therefore involve significant amounts of discussion to ensure that all the airport partners see the benefits for the airport as a whole, as well as for themselves. An education programme conceived specifically for the partners is therefore an essential element to launching an A-CDM operation. This would encourage the partners to participate and actively support both the implementation and the daily running of A-CDM. Their engaged involvement would also increase the chances of their satisfaction with the project's benefits.

4.2.1.2 While most potential partners recognize A-CDM as being beneficial and worth introducing, when it comes to actually sharing information or establishing links for closer cooperation, the enthusiasm is likely to diminish as potential problems may arise. This is not entirely unexpected: A-CDM brings together operations that have matured individually and that need to develop common processes and procedures to communicate with one another. This is one of the main problems which A-CDM needs to resolve.

4.2.1.3 Any project may entail a number of challenges, some of which cannot be known until they are encountered. Current A-CDM implementations have thus far consistently demonstrated several possible challenging areas. One of the biggest challenges is that of culture change, which not only means changing existing procedures or processes, but also creating and maintaining a no-blame-culture. Issues, constraints, shortcomings or resource unavailability are shared within A-CDM to find a common solution, not to identify a culprit. Appointing blame for any failure or shortcoming is the best way to ensure that crucial pieces of information are never shared.

4.2.2 Getting started: A gap analysis

4.2.2.1 After setting the local requirements for the A-CDM project (identifying the modules and milestones to be used) and while the project is still in the analysis phase, a gap analysis is helpful to determine what is missing and needs to be developed. This analysis is beneficial from an operational and technical point of view, for the A-CDM platform, as well as for the related processes and operational procedures.

4.2.2.2 The gap analysis is considered as a baseline measurement. As such, it may be used to measure the progress and final performance of the project (see Part III, Chapter 3, Section 3.6 on possible KPIs). The analysis may also be used as input to a cost benefit analysis (CBA), which will provide advanced information on expected benefits as well as on foreseen costs and investments. (See Appendix III-D on possible KPIs).

4.2.2.3 In many projects, the involvement of an external party to perform the gap analysis was found to yield a greater likelihood of success.

4.2.3 A project management approach

4.2.3.1 Once the content and benefits of A-CDM are understood and the objectives have been set, the most crucial phase begins: the organization of A-CDM activities. In this phase, the project is properly managed according to an agreed timeline with all the partners involved.

4.2.3.2 A-CDM projects require support from all levels within the organizations of the partners involved. This consists of top management support and a project manager with the required skills to perform and lead a multi-partner project. In addition, as A-CDM is by nature an operational project, the involvement of operational staff is key to its success. Figure III-4-2 lists the various partners in a typical A-CDM organization.

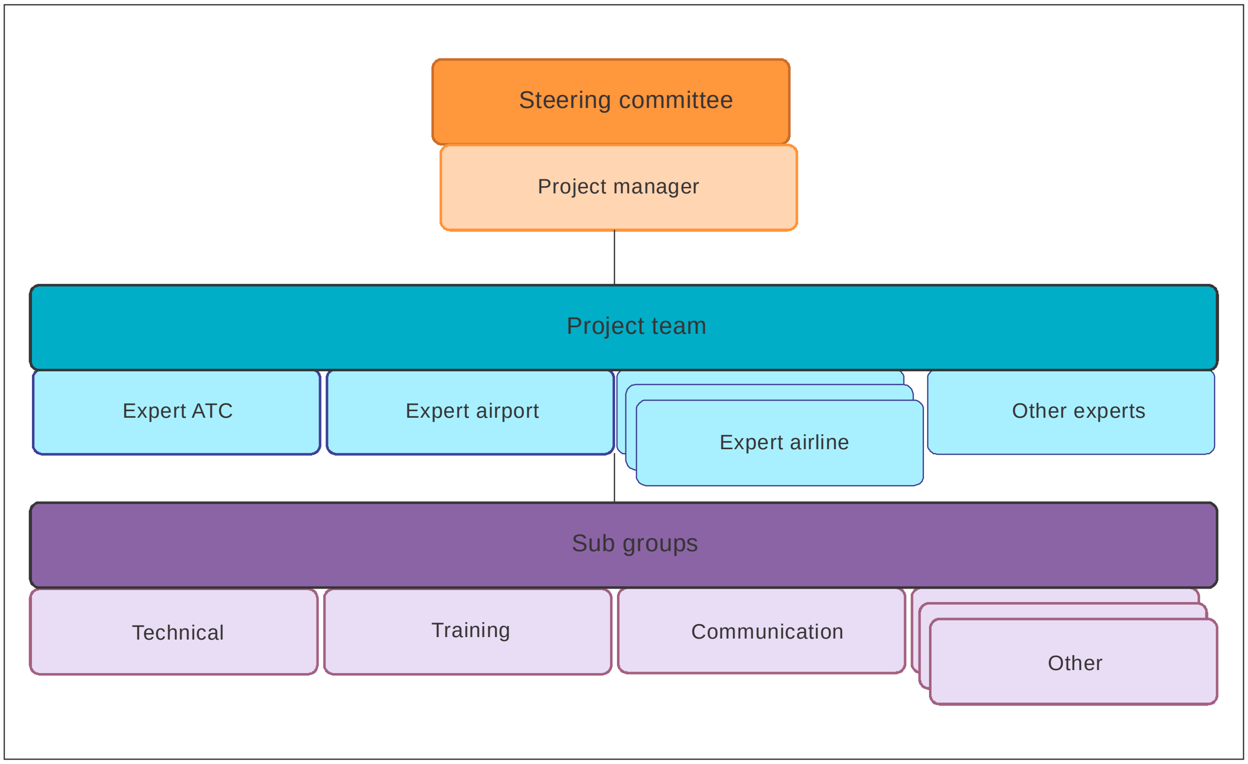

Figure III-4-2. Example of A-CDM project organization

4.2.3.3 An A-CDM project generally consists of:

a) a steering committee comprising managers, actors and stakeholders who signed the project MoU;

b) a project manager, selected by the steering committee;

c) a project core team, comprised of experts from operational units where A-CDM processes will be implemented; and

d) subgroups, established to carry out specific tasks on various subjects (e.g., system adaptation).

4.2.3.4 Once all the actors and involved stakeholders have indicated their willingness to implement the selected functionality, a common multi-partner project management plan (PMP) is usually created to organize all activities, projects and planning.

4.2.3.5 Furthermore, in order to ensure reliable and consistent project development during the implementation and operations phases, the roles and responsibilities of all partners are usually formalized in a comprehensive MoU. The main objectives of the MoU are to:

a) ensure technical mechanisms which allow for the sharing of information;

b) implement procedures which increase traffic predictability;

c) promote the information exchange between the local A-CDM project and the network operations; and

d) set up monitoring mechanisms which process the proposals for improvements.

4.2.3.6 In addition, the MoU clarifies the general obligations which A-CDM actors and stakeholders have towards the project. These include:

a) actively participate and commit to implement A-CDM decisions;

b) cooperate in all functional specifications;

c) ensure the interaction between their systems and the local A-CDM platform;

d) provide the necessary information to the platform and require quality standards; and

e) guarantee the presence of a representative in the different phases of the project to support and control its development, as well as during the implementation of the adopted solutions.

4.2.4 Conclusion

The above-mentioned elements were identified as having contributed to the successful implementation of a variety of A-CDM projects worldwide, as they guarantee a balanced and consistent involvement of actors and stakeholders from the initial stages until the final operating phases of the project. A-CDM is a local project before anything else. Local constraints and specific needs might therefore dictate different solutions. The principles that underscore the operations of the envisaged structures would, however, remain identical.

4.3 ILLUSTRATIONS OF SUCCESSFUL A-CDM IMPLEMENTATION

To date, A-CDM has been successfully implemented in the following countries:

a) Austria (Vienna airport);

b) Belgium (Brussels airport);

c) Czech Republic (Prague Ruzyne airport);

d) France (Paris, Charles De Gaulle airport);

e) Finland (Helsinki airport);

f) Germany (Munich, Frankfurt, Düsseldorf, Stuttgart, Berlin-Schönefeld airports);

g) Italy (Rome Fiumicino, Milan Malpensa, Venice airports);

h) New Zealand (Auckland airport);

i) Norway (Oslo airport);

j) Spain (Madrid, Barcelona airports);

k) Switzerland (Zürich airport);

l) United Kingdom (London Heathrow, London Gatwick airports); and

m) United States (New York, John F. Kennedy airport).

4.4 EXAMPLES OF A-CDM PROJECTS

4.4.1 Japan

Japan started the development of a global strategy in order to respond to the increase in air traffic demand generated by the 2020 Tokyo Olympic and Paralympic Games. Japan recognizes the necessity to improve the ATM operations of the metropolitan airports (Tokyo and Narita international airports) in order to accommodate the event. In this context, Japan has promoted the development of these airports as a package of "operational improvements" and "enablers" based on Japan's future ATM programme CARATS (Collaborative Actions for Renovation of Air Traffic Systems). This package includes the introduction of A-CDM in connection with arrival, departure and surface management functions (AMAN/DMAN/SMAN), in the context of the system wide information management (SWIM) concept. In addition, A-CDM will be closely connected to the national ATFM function to optimize the flow management system of the entire Japanese airspace. Japan refers to concepts from both the United States and Europe in order to develop its own concept and the systems that support A-CDM implementation. The plan is to introduce the A-CDM process in a phased manner. Initial operations of A-CDM and DMAN/SMAN have already been implemented through the application of several parts of A-CDM elements such as information sharing, the milestone approach and target start-up approval times (TSAT) operation at Tokyo International Airport (RJTT) since 2013. This initial operation will continue to be reviewed for the further development at RJTT with implementation at Narita International Airport (RJAA) in 2018. CARATS is collaboratively working with the airport authority of Narita Airport Cooperation Ltd. (NAA) to introduce A-CDM into RJAA. These phased approaches will be upgraded to the full implementation of A-CDM, complete with related system development for ATC operation, A-CDM platform and ATFM function by 2019.

4.4.2 United States

4.4.2.1 A John F. Kennedy (JFK) departure metering was first planned for the "Bay" runway closure (31L) in 2010. Since this was one of JFK's primary departure runways, it was felt that the impacts would be significant and the JFK departure metering concept (allocating departure slots to JFK departures) became a reality. The initial metering was managed through the use of a spreadsheet where a small staff of metering specialists would manage the departure queue using the called departure rate (a predefined rate of departures established for a given runway) as the guide. This was typically a problem, especially at JFK, since the called rates were typically lower than actual capabilities. This resulted in a managed flow but was easily upset by changing conditions. Even with these problems, the airlines at JFK quickly realized the significant fuel savings experienced by waiting at the gate rather than sitting on the tarmac. The airlines approached the Port Authority (which manages the JFK airport) and asked that the departure metering system be maintained. To continue this operation, a more robust system was needed: one that could manage the complexities of the New York operation and JFK. A departure management software was therefore implemented. The success of this programme cannot be stressed enough. The savings and efficiency realized by this programme have pushed JFK to a new level of performance and customer satisfaction.

4.4.2.2 One of the key points contributing to the success of the programme is the software that manages the metering, as well as the constant updates and feedback received from the user group. The user group itself, which meets once a month, involves the metering desk employees, all the ramp towers and the airlines. This meeting allows the review of the previous month's operations and provides valuable feedback to the vendor. What is more, the vendor provides support for the training of new staff members, as well as recurrent training for existing members. This activity is either done in a lab environment or in the facility for on-the-job training.

4.4.2.3 The JFK metering system was recently evaluated to ensure its effectiveness is maintained and continues to yield significant results. Benefits accrued from annual fuel savings and reduction in lost passenger time have been evaluated to some USD 123 million, a reduction of 44 000 metric tons of CO2 emissions, 152 000 person days of passenger time, average taxi-in times reduced by over three minutes as compared to 2009, and average taxi-out times reduced by five minutes as compared to 2009. What makes these numbers even more impressive is that JFK experienced a major runway closure of one of its primary departure runways for five months in 2015 while experiencing an eight per cent growth in traffic. It should also be noted that JFK averages 98 per cent compliance with the metering times (and the allocated slot times), yet another impressive statistic.

4.4.2.4 The next phases will see a deeper involvement of the ANSP and the FAA in what started as a local project. In addition, the use of the surface management tools will be expanded to other major airports operated by the Port Authority. There are many moving parts that make this system run effectively, but the main lesson to be learned is the importance which teamwork plays in making this programme so successful.

4.4.3 Europe

4.4.3.1 A-CDM in Europe has a long history. Munich Airport was the pioneer of A-CDM when it became fully implemented in 2007. Following its success in Munich, a wider deployment programme has been rolled out across Europe. There are now 20 fully implemented airports with A-CDM procedures in place, covering almost all the continent's busiest hubs, with more airports expected to follow in the coming years.

4.4.3.2 The European A-CDM implementations are based on the European A-CDM implementation manual and European Community specification (EU CS 303212). The European airports, in conjunction with EUROCONTROL and the aircraft operators, continue to work together to:

a) exchange information on best practices;

b) achieve a common understanding of A-CDM in Europe; and

c) harmonize A-CDM procedures and processes wherever possible.

4.4.3.3 A-CDM is seen as one of the main ways to integrate airports with the entire European ATM network and may also be used to understand and predict how individual airport operations will impact such a network.

4.4.4 New Zealand: Auckland

4.4.4.1 ***Background***

Auckland Airport (AIAL) is the largest airport in New Zealand with traffic set to exceed 16.5 million passengers during 2017. It is a single runway operation and runs both an international and domestic terminal. AIAL provides an apron management service at the international terminal.

4.4.4.2 ***The reason for A-CDM in Auckland***

4.4.4.2.1 Auckland Airport was experiencing three key operational challenges:

a) its physical location within the global aviation network;

b) a truly multi-stakeholder environment; and

c) an accelerated growth, outpacing infrastructure build.

4.4.4.2.2 New Zealand is at the bottom of the globe and is largely reliant on airline connectivity elsewhere, which often results in low on-time performance (60 per cent average) for arriving aircraft. In addition, the schedule contains many peaks, with a number of arriving and departing spikes throughout the day. Finally, during the 2014-2017 period, traffic passenger has, in Auckland Airport, increased by almost ten per cent yearly. This placed the current operations under much pressure due to capacity constraints.

4.4.4.2.3 In facing these challenges, AIAL considered the need to develop an agile operation that could respond to these challenges on a daily basis. AIAL began to explore operational concepts that might enable this.

4.4.4.3 ***The solution***

4.4.4.3.1 AIAL established a Collaborative Operations Group (known as the COG) five years ago. The establishment of the COG was to set up a structured framework of operational collaboration across all the key stakeholders at various organizational levels. It has representation from ATC, airlines, ground handlers and border agencies.

4.4.4.3.2 However, in seeking to find a solution to enable operational agility and efficiency, AIAL identified the need to share early and accurate real-time information among COG partners, the assumption being that this would improve the quality of planning and decision-making across the airport. AIAL undertook international research and determined that the EUROCONTROL A-CDM concept best met the objective that AIAL was trying to achieve.

4.4.4.3.3 During 2013, AIAL undertook a significant investment in the replacement of its core airport operating system (AOS). One of the requirements of this project was to provide the technical system capability to introduce A-CDM. AIAL partnered with a New Zealand-based vendor as part of this project. In parallel with the development of this technical solution, AIAL began to socialize the A-CDM concept and perceived benefits with its key COG partners. A-CDM champions from each organization were thereafter identified and enrolled early.

4.4.4.4 ***Objectives of the A-CDM project***

4.4.4.4.1 AIAL commenced with the A-CDM project in January 2014. Key objectives included leveraging the existing collaborative framework of COG undertaking a phased approach and generally keeping it simple. In line with this, stage one only required the ground handlers to provide an update of the target off-block time (TOBT) to an accuracy level of +/- 5 minutes.

4.4.4.4.2 The A-CDM project had two distinct work streams. One was operational, which focused on agreeing on the milestones and related procedures, while the other was the technical stream, which focused on how the information would be integrated and presented through the A-CDM portal. A key benefit was that the portal was developed within the CDM partner group, with ground handlers and airlines having an input into how the information would be displayed. An MoU was developed between all CDM partners.

4.4.5 Singapore

4.4.5.1 Singapore Changi Airport's A-CDM programme is one of the major projects to meet the ever-growing demands of air traffic, which saw a growth of 31 per cent between 2010 and 2015. To meet tomorrow's demand as an air-hub, Singapore Changi Airport is constructing a new passenger terminal which will double its current capacity, and a third runway to accommodate the projected traffic movements. Keenly aware of the complexity and intricacy of aerodrome operations, the Civil Aviation Authority of Singapore (CAAS), which provides the ATS, collaborated with the Changi Airport Group, the airport operator, the airline partners and ground handling agents, to optimize Changi Airport's capacity utilization and operational efficiency through an A-CDM project that began in 2013. Operational since 2016, the objectives of Changi A-CDM remain to improve gate management and airport resources, improve on-time performance with a better turnaround process, and optimize departure efficiency by reducing congestion and runway queue time, thereby improving fuel savings for airline operators.

4.4.5.2 Transparency and trust were recognized as the pillars of a successful A-CDM programme and are critical in building an operationally viable and sustainable procedure. Among the major hurdles encountered by the project team was information sharing. A two-pronged approach was adopted: at the management level, clear policy direction to cooperate and share information was given, and at the working level, enhancing the understanding of each other's operations and making full use of the available information to work out a common set of procedures. As an example, in the pre-A-CDM days when information was not shared, ATC would become aware that an aircraft was ready to push-back from the parking gate only when the pilot had made a request for ATC clearance, therein being reactive. Since the introduction of A-CDM, ATC has a much better situational awareness of the impending departing aircraft and, together with the airport operations centre, plans the movement of aircraft within the aerodrome to minimize congestion and delay. This process also assists the airline operators and ground handling agents, providing them with better awareness of the movement of their fleet, and improves the effectiveness of their resource deployment, e.g., ground engineers, catering crews. Finally, as part of the regular programme, cross-organization familiarization will remain as a regular feature of the A-CDM programme.

4.4.5.3 The long-term goal is to synchronize the process of A-CDM with the process of ATFM to harmonize information sharing and CDM at both local and regional levels. The early awareness of ground delay programmes using calculated take-off times (CTOTs) from the regional multi-nodal ATFM network will be shared with local airport partners through the A-CDM network to enhance their decision-making process. The availability of CTOTs will improve pre-tactical planning decisions such as stand and gate management for airport operations, re-timing of flights and slot swapping for airlines, and better allocation of resources for ground handling agents. The A-CDM network will also be able to supplement the ATFM network by improving slot adherence through optimal push-back times and provide early indications on possible deviations from CTOTs due to delay in turnaround activities.

4.4.5.4 The ATFM and A-CDM networks will complement each other and, together, create a seamless air traffic flow set of operations within Changi Airport. This would improve efficiency throughout the three phases of flight (arrival, turnaround and departure). The integrated network will also decrease runway queuing times for departures and airborne holding for arrivals, benefiting both airlines and the environment in terms of fuel savings and carbon emissions. Ultimately, it will also improve the overall passenger experience at Changi Airport with fewer occurrences of diversions and with smoother traffic flow.

APPENDIX III-A

GENERIC MOU BETWEEN A-CDM PARTNERS AND STAKEHOLDERS

INTRODUCTION

A-CDM involves a wide range of interactions between the various partners who are diverse in nature, both in terms of business interests and organizational characteristics. It is essential that their agreement to work together for the common good be summarized in a Memorandum of Understanding (MoU), to be signed and followed by all the partners.

This appendix contains a generic example of an A-CDM MoU which, when completed with the site specific details, can be used for a given A-CDM project. Use of this model is recommended, as it contains, or prompts for, all the information that has been shown to be essential for the smooth operation of an A-CDM project.

This sample is designed to provide the framework of cooperation between airport partners. Cooperation between an airport and the network operations must also be based on an MoU, the model for which is available from the network operations.

CONTENT

***

Article 1 — Description of the project

1.1 Airport collaborative decision-making (A-CDM) is a concept which aims to improve the throughput of air traffic at airports. This will be achieved by providing all Contracting Partners with accurate, timely and relevant information, allowing better decisions to be made.

1.2 The objective of the project is to improve the aircraft turnaround process, ensuring the best possible use of airport infrastructure and resources to the benefit of all Contracting Partners.

Article 2 — Objectives of the MoU

This MoU has been signed by the Partners with the following primary aims:

a) create a cooperative framework in which to implement A-CDM;

b) ensure technical mechanisms allowing for common information sharing;

c) implement procedures which increase traffic predictability;

d) promote the exchange of information between the local A-CDM project and the network; and

e) set up monitoring mechanisms in order to enable the evaluation of improvements and proposals for further optimization.

Article 3 — Obligations of the Contracting Partners

The Contracting Partners accept the following obligations:

a) ensure active participation in all levels and phases of the project as required;

b) support the development/validation of all functional specifications;

c) follow the agreed A-CDM operational procedures and rules; and

d) share information under the agreed conditions and act on the shared information.

Article 4 — Organization

The following project structure has been agreed upon:

a) the steering group will consist of representatives from the Contracting Partners;

b) the steering group will appoint the A-CDM project manager; and

c) the terms of reference for the steering group, working group and subgroups, as appropriate, are in Attachment XX of this MoU.

Article 5 — Costs

5.1 Costs associated with equipment or resources will be covered by the Partner concerned. This will also apply to any system adaptation or integration unless otherwise agreed.

5.2 Where an interface is required between Partners, each one will try to minimize the cost impact on the other. The provision and use of data to and by the Contracting Partners is free of charge.

5.3 Partners who are not signatories to this MoU wishing to access data may be allowed to do so with the agreement of the steering group. For using data under such a special dispensation, a charge is applicable as described in Attachment YY of this MoU. The charge can be avoided by becoming a signatory of the MoU.

Article 6 — Responsibilities of the Contracting Partners providing data

6.1 The Contracting Partners shall:

a) enter and maintain in the A-CDM database, the data for which they are responsible;

b) be responsible for the accuracy and timeliness of the data they enter and maintain in the A-CDM database;

c) participate in A-CDM data monitoring by using agreed key performance indicators (KPIs), perform a post-operational analysis and make results available to the other Contracting Partners; and

d) grant other Contracting Partners access to the data contained in the A-CDM database.

6.2 The detailed arrangements for the provision of data to the A-CDM database are the subject of service level agreements between the Contracting Partners.

Article 7 — Confidentiality

7.1 The Contracting Partners shall keep confidential all information coming to their knowledge in the course of A-CDM operations relating to the business associations and transactions of the other Partners.

7.2 This includes technical or commercial arrangements, documents and materials a Partner may acquire while working under this MoU, provided however, that this obligation on a Contracting Partner shall not apply to knowledge or information which is in the public domain.

7.3 Contracting Partners shall keep confidential the substance of any report, test, recommendation, or advice which they have given to another Contracting Partner in connection with the A-CDM operation.

7.4 Contracting Partners may exchange information among themselves on the basis of service level agreements and with the network on the basis of agreements concluded on their behalf by [enter name of appointed representative].
(Section to be completed with provisions required/agreed locally.)

Article 8 — Dispute resolution

(Section to be completed with appropriate local provisions.)

Article 9 — Amendments

Amendment proposals to this MoU, including termination, must be submitted in writing to the steering group at least ninety (90) days in advance, which will handle such proposals in accordance with the process described in its terms of reference.

Article 10 — Signatures of Contracting Partners

The Contracting Partners hereby agree that this MOU shall be effective from [date].

Printed names/signatures /titles

____

APPENDIX III-B

TEMPLATE OF GENERIC AERONAUTICAL INFORMATION PUBLICATION (AIP) PROVIDED TO EUROCONTROL STATES IMPLEMENTING A-CDM

A-CDM procedure — background

The airport collaborative decision-making (A-CDM) start-up procedure is based on the existing *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) start-up time procedures contained in its paragraph 7.4.1.1. The corresponding phraseology remains unchanged. The availability of CDM platforms at an aerodrome does not pre-empt aircraft operators and ground handling agents from their responsibilities of issuing necessary modifications to the filed flight plan, whether there be delays or changes (DLA or CHG).

A-CDM partners

The operational partners who together apply the A-CDM concept on their airport are listed below.

– *Airport operator* – A-CDM partner often responsible for gate and stand planning. Receives target start-up time (TSAT) and target take off time (TTOT) from the predeparture sequencer, among inbound and other planning information from other sources.

– *Ground handling agent* – A-CDM partner delegated responsible for target off-block time (TOBT) input to the CDM platform. Receives TSAT and TTOT from predeparture sequencer.

– *Aircraft operator* – A-CDM partner overall responsible for TOBT input to the CDM platform. Receives TSAT and TTOT from the predeparture sequencer.

– *Flight crew* – Aircraft operator staff responsible in exceptional cases for TOBT handling, based on local procedures. Receives TOBT and TSAT and optionally TTOT from the CDM platform or predeparture sequencer, and is responsible to act on this information.

– *ATC (departure clearance position*) – A-CDM partner responsible to monitor aircraft readiness and TOBT, and act on this information. Assigns TSAT and TTOT or revisions via the predeparture sequencer and acts on it.

– *Apron control* – A-CDM partner responsible to act on TSAT. Receives TOBT and TSAT from the CDM platform or predeparture sequencer.

A-CDM operations

The airport partners will provide and act on information that is sent to the A-CDM platform and/or the predeparture sequencer. These are central enablers for A-CDM operations.

The predeparture sequencer is addressed as a separate component of the A-CDM platform (even when in some cases it appears as an integrated functionality of the CDM platform) because it addresses the final responsibility within the role of ATC to consider traffic density and network operations constraints.

A-CDM platform
The central information database is the technical enabler for the information-sharing concept element. All stakeholders have access to this platform. TSAT input is obtained directly from the predeparture sequencer.

Predeparture sequencer
The predeparture sequencer is the technical enabler under the responsibility of ATC, for the predeparture sequencing concept element using TOBT and estimated taxi out time (EXOT) as input, in order to calculate TSAT and TTOT. These predictions will be fed back to the CDM platform and can be generated automatically or manually.

1. A flight plan check shall be performed.
   <local additional text>

2. Issue of target off-block time (TOBT)
   <local additional text>

3. Updates of the target off-block time (TOBT)
   <local additional text>

4. Issue of target start up approval time (TSAT)
   <local additional text>

5. Events at TOBT
   <local additional text>

6. TSAT
   <local additional text>

7. Start-up and push-back
   <local additional text>

8. Coordination with network operations
   <local additional text>

9. Contact partners
   For more information, partners can be contacted.
   <local additional text>

____

APPENDIX III-C

EXAMPLE OF AN MOU:
FAA MEMBERSHIP AGREEMENT FOR COLLABORATIVE DECISION-MAKING (CDM) EXCHANGE OF DATA
EFFECTIVE DATE: JANUARY 1, 2015

1. **Parties**

This Membership Agreement is entered into by and between the Federal Aviation Administration (FAA) and _______________. The parties do hereby agree and obligate themselves to abide by the rights, responsibilities, and other conditions defined in this agreement. Non-compliance with the conditions of this agreement may result in the termination of access to CDM data.

2. **Authority**

The FAA's authority to enter into this agreement is governed by 49 U.S.C. 106 (l) and (m).

3. **Purpose**

This Membership Agreement: (1) establishes the authority by which the FAA and industry exchange CDM data and (2) identifies the rights and responsibilities of the parties. The exchange of CDM data is solely intended to support FAA and industry flow management decision-making associated with the daily management of aircraft flight operations.

4. **Principles**

4.1 In the CDM data exchange process, individual industry CDM members provide specific data elements to the FAA Traffic Flow Management System (TFMS). The FAA: (1) aggregates and processes that data into a form that is appropriate for use in the CDM process and (2) distributes that processed data to all government and industry CDM members. The CDM initiative provides for common situational awareness among participating stakeholders, improved demand predictions, enhanced traffic management decisions and reduced delays.

4.2 CDM membership is predicated on a realized systemic benefit to the National Airspace System (NAS) resulting from the exchange of unique flight data between the requesting NAS stakeholder and the FAA. CDM membership applications will be evaluated in part by the benefit provided to the NAS as a whole. This benefit adjudication may include number of unique flights, strategic benefit of unique flight data, or other operational advantages as determined by the FAA.

5. **Definitions**

5.1 **Air traffic flow management (ATFM):** the air traffic management operational function that balances the aviation industry demand for air traffic control (ATC) services with the capacities and capabilities of the ATC system.

5.2 **Collaborative decision-making (CDM):** a joint government/industry initiative aimed at improving ATFM by enhancing information flow within the aviation community and adding a customer focus to decision-making. CDM is an operating paradigm where ATFM decisions are based on a shared, common view of the NAS, resulting in ATM decisions and actions that are most valuable to the system.

5.3 **National Airspace System (NAS):** the complex collection of personnel, airspace, aircraft, equipment, and any and all other aviation components that comprise the United States' aviation system.

5.4 **NAS user**: a person or organization that operates or manages aircraft operations within the NAS utilizing NAS resources.

5.5 **CDM data:** industry-generated, unique flight data provided in real time as input to the CDM process; or FAA-generated aggregate information that is based upon the industry data. At the discretion of the agency, CDM data may be expanded to include other FAA-generated elements determined by the agency to enhance customer collaboration.

5.6 **CDM products**: applications provided to CDM members to enhance situational awareness, including but not limited to: TSD-C, diversion recovery web page, tactical customer advocate (TCA) web page, and FAA testing and training systems.

5.7 **CDM member**: a NAS user organization that: (1) provides raw CDM data to the FAA, (2) receives processed CDM data from the FAA, and (3) collaboratively works with the FAA traffic flow management function in responding to NAS demand-capacity imbalances and other system constraints.

5.8 **CDM service provider**: a vendor under contract to a CDM member that provides the communications network that enables the exchange of CDM data and information between the FAA and the CDM members.

5.9 **Third party**: an entity not directly involved in a transaction between the FAA and CDM member.

6.0 Roles and responsibilities

6.1 Federal Aviation Administration (FAA)

The FAA shall:

6.1.1 provide the CDM member with specifications, communications protocols, equipment requirements, interface requirements, standards, message formats, and other relevant technical information and support as necessary to transmit, receive, interpret, and analyse CDM data;

6.1.2 provide a point of contact for twenty-four (24) hours technical support;

6.1.3 encrypt FAA processed CDM data in accordance with the current industry standard;

6.1.4 provide the CDM member or the member's CDM service provider with physical access to the encrypted CDM data;

6.1.5 release encrypted CDM data and provide CDM product access to CDM members only after the CDM member has demonstrated the capability to provide raw CDM data consistent with the documented data quality standards defined by the FAA;

6.1.6 provide processed CDM data consistent with the accuracy, reliability, maintainability and availability of the operational traffic management system and/or other processing and communications capabilities;

6.1.7 have the sole right to relocate, upgrade, and/or update the CDM data stream in order to take advantage of advances in technology and for other reasons. The FAA shall provide notice of such changes not less than sixty (60) days prior to their implementation;

6.1.8 have the right to identify and disclose to the CDM Steering Group (CSG), CDM members not in compliance with, or in violation of, this agreement and may interrupt, or direct the interruption of, the CDM data stream until such time that compliance is demonstrated to the satisfaction of the FAA CDM point of contact (POC) identified in paragraph 15.0 below;

6.1.9 have the right, with timely and appropriate advance notification and coordination, to modify and amend this agreement if it is in the interest of the United States Government, the aviation industry, or the general public; and

6.1.10 have the right to rate and identify CDM members not in compliance with the expected level of performance as specified in Attachment B of this agreement.

6.2 **CDM member**

The CDM member shall:

6.2.1 acquire and maintain the hardware, software, communications, facilities, training, and any and all other resources needed to transmit, receive and interpret the CDM data. In the event the CDM data stream is relocated, upgraded, updated and/or modified, the CDM member shall be responsible for providing and maintaining the hardware, software, communications, facilities and any and all other resources needed to continue to transmit, receive and interpret the CDM data;

6.2.2 provide unique industry-generated CDM data to the FAA TFMS consistent with the data elements and quality standards as specified in Attachment A of this agreement; and consistent with the accuracy, reliability, maintainability and availability of the CDM member's operational system and/or other processing and communications capabilities;

6.2.3 ensure any third-party accessing CDM data or products for research, development, analyses, conclusions or other capabilities commissioned by the CDM member abides by the terms of this agreement. Third party access must be limited to a specific period of performance and not allow for a long-term pass-through of CDM data that circumvents the CDM Membership Agreement or FAA data release processes. The contracting CDM member and/or third party must clearly indicate on any and all outcomes based on CDM data that these products and results are not guaranteed, sponsored, warranted or endorsed by the FAA;

6.2.4 ensure that all contracts related to CDM data: (a) reflect the rights, responsibilities, exclusion of warranties, limitation of remedies, indemnification and other conditions defined in this agreement; (b) prohibit contacting the FAA CDM POC or the air traffic control system command centre (ATCSCC) in the event of technical or system problems, and (c) prohibit contacting the FAA CDM POC, any FAA air traffic control facility, or the ATCSCC regarding operational traffic flow management matters; and

6.2.5 track and report to the FAA on an annual basis any member-provided third-party access related to CDM data.

7.0 **Exclusion of warranties**

All warranties, expressed or implied, are excluded from this agreement and shall not apply to the data or services that the CDM member, CDM service provider, or any other data recipient receives under this agreement. There is no warranty of merchantability or of fitness for a particular purpose for the data or services that the CDM Member, CDM service provider, or any other data recipient receives under this agreement.

8.0 **Limitation of remedies**

The FAA shall not be liable to the CDM member, CDM service provider, or any other data recipient for any loss, damage, claim, liability, expense or penalty, or for any indirect, special, secondary, incidental or consequential damages deriving from the use of the CDM data.

9.0 **Indemnification**

9.1 The CDM member, CDM service provider, and/or any other data recipient agrees to indemnify and hold harmless the Government and their respective officers, employees and agents, from and against all claims, demands, damages, liabilities, losses, suits and judgments (including all costs and expenses incident thereto), which may accrue against, otherwise be chargeable to the government by reason of, or as a direct and proximate result of, that CDM member's or CDM service provider's use of the CDM data or software received under this agreement.

9.2 Software data rights: all data, software and documentation furnished by the Government to the CDM member pursuant to this agreement are provided on an "as is" basis.

10.0 **Changes and modifications**

Changes and/or modifications to this agreement shall be in writing and signed by the original FAA signatory or his/her representative, designee or successor. The modification shall cite the subject agreement and shall state the exact nature of the modification. No oral statement by any person shall be interpreted as modifying or otherwise affecting the terms of this agreement.

11.0 **Disputes**

Where possible, disputes will be resolved by informal discussion between the parties. In the event the parties are unable to resolve any disagreement through good faith negotiations, the dispute will be resolved by the Director, System Operations, ATCSCC. The decision is final unless it is timely appealed to the FAA Administrator, whose decision is not subject to further administrative review and, to the extent permitted by law, is final and binding.

12.0 **Construction of the agreement**

This agreement is an "other transaction" issued under 49 U.S.C. 106 (l) and (m) and is not a procurement contract, grant or cooperative agreement. Nothing in this agreement shall be construed as incorporating by reference or implication any provision of federal acquisition law or regulation.

13.0 **Termination of this agreement**

13.1 Any party may terminate its participation in the CDM activity under this agreement by written notice to the remaining parties provided no termination may be effective in less than ninety (90) days from the date of such written notice.

13.2 If the CDM member fails to abide by the requirements of this agreement and its failure is not cured within five (5) working days of the initial notice of noncompliance, the CDM member's access to data, information and systems covered under this agreement may be terminated immediately by the FAA for cause.

13.3 Whenever written notice of termination is issued by or received by the CDM member, the CDM member shall immediately return all government equipment (if any), software and documentation that the Government issued to the CDM member under this agreement.

14.0 **Duration**

This agreement shall be effective on the date that the FAA signatory below executes it and shall remain in effect for five (5) years or until terminated, whichever is earlier.

15.0 **FAA CDM point of contact**

The point of contact for all matters pertaining to the present agreement is ______________________.

— — — — — — — —

Attachment A to the Membership Agreement

CDM data elements

The exchange of flight data is a fundamental tenet of CDM and a requirement for membership. The application, connectivity and protocols used to exchange messages are detailed in the *CDM Message Protocol Specification* document.

Information that must be exchanged within CDM data exchange includes, but is not limited to:

a) flight create — message sent to create a flight;

b) flight modify — message to update data, such as times, for a flight; and

c) flight cancel — message that indicates a flight has been cancelled. Identifies a cancelled flight to ensure that resources are not engaged and/or fully utilized. (CNX)

Information that should be exchanged within CDM data exchange includes, but is not limited to:

a) actual off-block time (AOBT). The actual time at which a flight has sent a “block out” message from the gate or parking location. This information will be used to help determine the accuracy of light operators’ earliest off block time (currently known as OUT time);

b) actual take off time (ATOT). The time at which a flight lifts off from the runway as reported by the CDM member via a CDM message. If the CDM member sends more than one value, the most recently submitted time is contained in this field: otherwise the value is null (currently known as the OFF time);

c) actual landing time (ALDT). The actual time the flight has landed on the runway. Sharing arrival information provides essential information to facilitate gate conflict and demand/capacity imbalance predictions (currently known as the ON time);

d) actual in-block (AIBT). The actual time the flight has blocked in at the gate. Sharing arrival information provides essential information to facilitate gate conflict and demand/capacity imbalance predictions for both gate and departure predictions on availability (currently known as the IN time);

e) aircraft tail/registration. The unique alphanumeric string that identifies an aircraft. Sharing the unique registration number will allow the surface system to identify possible turnaround conflicts and other departure problems;

f) gate assignment. Airport gate that is assigned to a flight. Gate information will lead to more accurate ramp transit time (RTT) calculations and therefore more accurate ETD;

g) earliest off-block time (EOBT). Time when the flight operator plans for an aircraft to push back from its assigned gate. The system can forecast surface demand vs. capacity based on flight operator’s best estimation of push-back time. The fidelity of EOBT is required for proper surface predictions and process;

h) flight intent. The flight intent would be limited to flight operator plan to push back early during a delay metering programme and hold in the aircraft movement area;

i) initial off-block time (IOBT). The initial off-block that a flight provided. Used to save the original off-block time of the flight. Useful for flight data matching (currently known as IGTD);

j) earliest runway time of departure (ERTD). Flight operator provided runway departure time;

k) simplified substitutions, as necessary for the flight operator and/or member;

l) trajectory option sets, as necessary for the flight operator and/or member; and

m) other data elements as detailed in the *CDM Message Protocol Specification* document.

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Attachment B to the Membership Agreement

Data quality

Ensuring data quality is one of the primary concerns of the traffic flow management community. The Data Quality Report Card (DQRC) provides a measure of the quality of the data feed for each CDM member. Poor data quality can negatively impact the system by creating inaccurate traffic demand predictions.

Data quality code of conduct

a) Flight data submitted to the FAA, whether via Official Airline Guide (OAG) schedule data, CDM messages, or individual flight plan, must represent how the flight is planned to operate:

1) flights must only be created that have a real intent to operate. Flights shall not be created for the purpose of gaining more slots or better control times;

2) operators must submit and update accurate, expected flight operating times. False or inaccurate times or times that do not represent how the flight is planned to be operated shall not be submitted for the purposes of gaining more advantageous slots;

3) estimated time en-route must represent the most accurate time based on the planned route of flight and cruise speed, and forecasted en-route winds; and

4) operators must notify the FAA of maintenance, test or ferry/repositioning flights as soon as they are known via CDM message or normal flight plan filing. Operators will not be permitted to substitute with these flights and they should not be filed for the purpose of gaining more slots or better control times.

b) In order to provide the FAA with strategic route planning capabilities operators are expected to file IFR flight plans, trajectory options sets, and/or early intent messages at least four hours prior to estimated time of departure.

c) Operators must eliminate and correct data errors.

d) Operators must comply with assigned expect departure clearance times, FAA-assigned routes (i.e., required reroute, collaborative trajectory options programme (CTOP) assigned trajectory, or other assigned trajectory) and operate flights in accordance with filed flight plan parameters.

e) Flights must not be filed with the intention of requesting an airborne change of destination or route to avoid delay associated with a traffic management programme (ground delay programme, ground stop, airspace flow programme, CTOP, etc.).

f) Delay shall not be allocated, through substitutions, to a flight that cannot or will not absorb that delay (e.g., airborne or international flight).

g) When applying substitutions, SCS must be the preferred method over attempting a twenty minute window substitution.

h) EDCT change requests must be accompanied by an appropriate and accurate reason for the request.

i) Operators should release slots generated by a traffic management programme that have been cancelled and flagged as "held" once those slots are no longer usable by the operator, so that other operators or FAA automation can make use of the slots.

Data Quality Report Card (DQRC):

The data quality web site and database generate three metrics (time-out cancels, cancelled but flew, and undeclared). Each of the metrics relate directly to the ability of the traffic flow management system (TFMS) to accurately predict traffic demand within the traffic management planning time frame. The DQRC metrics are as follows:

a) *time-out cancels.* A time-out cancel is a flight that TFMS expects to operate, but either never does, or operates well after its estimated time of departure (ETD). TFMS has no alternative but to wait for some time period after the expected departure time and eventually drop the flight from the demand predictions. The current rule is that a flight with a flight plan or a CDM flight create message is time-out cancelled by TFMS 90 minutes after its ETD; a flight only with OAG data is time-out cancelled 10 minutes after its ETD. A sample scenario of a time-out cancel is: the member submits a CDM create message for a flight, does not operate the flight, and never sends a cancel message for a flight. If a member sends a cancel message for a flight, it will not be considered a time-out cancel. Time-out cancels cause TFMS to over-predict the traffic demand. *For grading purposes, time-out cancels are computed as a percentage of all flights created in the TFMS for the member;*

b) *cancelled-but-flew flights.* A cancelled-but-flew flight is a flight that the member cancels but that ends up operating. A sample scenario of a cancelled-but-flew is: the member sends a CDM create message, files a flight plan, sends a CDM cancel message, and then TFMS gets a departure message for the flight from ATC. If the member cancels a flight but re-instates it with a CDM message before it operates, the flight is not considered a cancelled-but-flew flight. Cancelled-but-flew flights cause TFMS to under-predict traffic demand. *For grading purposes, cancelled-but-flew flights are computed as a percentage of all flights cancelled by the member;* and

c) *undeclared flights.* An undeclared flight is a flight that operates without prior notice to TFMS. The prior notice can be either the flight being in the OAG schedule, or the member sending a CDM create or modify message for the flight. A sample scenario of an undeclared flight is simply a flight that operates and for which a flight plan is the first notification that TFMS received of this flight. Undeclared flights cause TFMS to under-predict the demand. *For grading purposes, undeclared flights are computed as a percentage of all of the member's flights that operate.*

CDM members are expected to have no unacceptable (F, based on grading criteria detailed below) grades on any metric during the six month time span, and would be expected to make corrective actions to improve marginal performance to at least a satisfactory (A, B or C, based on grading criteria detailed below) level. Some month-to-month fluctuation is to be expected, so the primary grade for each category will be a six-month, sliding average. Unacceptable averages for any category will trigger communications between ATCSCC quality control resources and the CDM member to develop plans for improvement. Failure of the CDM member to improve the quality of data provided through the CDM process is grounds for termination of the CDM agreement in accordance with Section 14 of the agreement. The DQRC will be produced monthly and distributed to the industry members of the CSG.

Grading criteria

The grading scheme is based on average performance and variability for each metric across all CDM members. Airlines performing significantly better than average (that is, that have a lower percentage score for a metric) will receive good grades, and those performing significantly worse than average will receive marginal or unacceptable grades.

The list below shows the initial criteria for determining letter grades. This data was computed by Volpe and represents a 6-month span from December 2003 through May 2004. The averages and standard deviations of scores for each metric were computed and the following conversion was applied:

A = At least .5 standard deviations better (lower) than average.
B = Between .5 standard deviations better and .5 standard deviations worse than average.
C = Between .5 standard deviations and 2.5 standard deviations worse than average.
F = More than 2.5 standard deviations worse than average.

Based on the criteria above and the computed averages and standard deviations, the following table shows the letter grade criteria:

Table III-Att B-1. Per cent-to-letter grade conversion table

	A	B	C	F
Time-out cancels (% of planned flights)	% ≤ .8	.8 < % ≤ 2.5	2.5 < % ≤ 6.2	6.2 < %
Cancelled-but-flew (% of airline cancels)	% ≤ 1.2	1.2 < % ≤ 3	3 < % ≤ 6.6	6.6 < %
Undeclared flights (% of flights that operated)	% ≤ .7	.7 < % ≤ 2.1	2.1 < % ≤ 4.9	4.9 < %

The criteria will be re-calculated each January using the available data from the previous 6-month period (July through December). CDM members will be advised of any changes in the grading criteria.

APPENDIX III-D

EXAMPLES OF A-CDM KPI

General considerations

The final decision with regards to the number, kind and definition of key performance indicators (KPIs) is made during the local implementation of A-CDM. Any additional locally defined or already available KPI may be used. This appendix provides an example of objectives, and associated drivers and indicators with calculation methods.

A structured presentation

A structured presentation of performance indicators ensures that a more accurate analysis of the operations and therefore fosters improvements of A-CDM in the long run.

The KPIs may be structured around strategic objectives. For each objective, one or more strategic performance drivers may be defined. A strategic performance driver can, in turn, be associated to a number of performance drivers. In turn, those performance drivers are associated to various performance indicators and measures.

Note.— The level of A-CDM contribution to that performance can also be a useful indication.

Example of KPIs strategic objective, performance drivers and indicators:

Strategic objective	Increase airport efficiency
Strategic performance driver	Improve punctuality and reduce delays
A-CDM contribution	All A-CDM elements

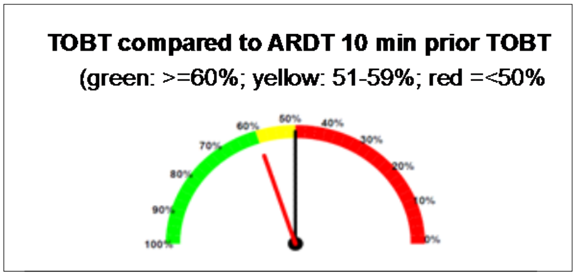
Performance driver	*Performance indicator*	*Performance measurement*
Optimize turnaround time predictability	Turnaround compliance	Measure ATTT vs. (SIBT-SOBT)*. Compare MTTT to ATTT.
Improve arrival time (ARR) predictability	– Estimated in-block time (EIBT) predictability – Estimated landing time (ELDT) predictability	Measure EIBT vs. time (timeliness). Measure ELDT vs. time (timeliness).
Improve departure time (DEP) predictability	TOBT accuracy and predictability	Compare TOBT to aircraft ready time (ARDT)*. *see specific KPI sample below
Improve the DEP predictability	TSAT accuracy and predictability	Compare TSAT to AOBT.

Performance driver	*Performance indicator*	*Performance measurement*
Reduce aircraft operators/ ground handlers/ANSP reaction times	READY reaction time	Measure AOBT vs. ARDT.
Reduce average delay of ARR flights (*)	Average delay of ARR flights ARR punctuality index	Compare actual in block time (AIBT) to schedule in block time (SIBT). Measure minutes delay per delayed movement.
	Time recovery ratio	Measure percentage (DEP delay < ARR delay)/ARR delay percentage. Calculation: number of rotations which DEP delay is smaller than ARR delay divided by number of ARR delays.
Reduce average delay of ARR flights *	Time lost ratio	Measure percentage (DEP delay > ARR delay)/ARR delay percentage. Calculation: number of rotations which DEP delay is bigger than ARR delay divided by number of ARR delays.
Reduce average delay of DEP flights *	Average delay of DEP flights DEP punctuality index	Compare AOBT to SOBT Measure minutes delay per delayed movement.
Improve punctuality *	Punctuality recovery ratio	DEP punctual/ARR not punctual percentage.
Reduce average delay *	Delay recovery time	Compare ARR delay in minutes to DEP delay in minutes.

**Detailed formulas for a specific KPI sample, with measurement methods:*

KPI Name	*TOBT Quality (Compare TOBT to ARDT).*
Strategic objective	*Increase airport efficiency.*
Strategic performance driver	*Improve punctuality and reduce delays.*
A-CDM contribution	*All A-CDM elements/implemented TOBT procedure.*
Specific performance driver	*Improve departure predictability.*
Performance indicator	*TOBT accuracy and predictability.*
Performance measurement	*Difference of TOBT (40 min prior TOBT, 10 min prior TOBT and at timestamp ARDT) compared to ARDT.*

Measurement description	*Average value of absolute difference per departure flight, percentage departure flights, which did not exceed a defined quality value (freely selectable parameter, e.g., five minutes), as well a relative frequency.*
Measurement algorithm:	*For TOBT 10 min prior, 40 min prior, at ARDT* $\mathbf{n}_{DEP}$: number of all departures Average $\sum \frac{\mathbf{|TOBT-ARDT|}}{\mathbf{n_{DEP}}}$ **n1:** number departures with $|\mathbf{TOBT} - \mathbf{ARDT}| \leq \mathbf{Quality\ value}\ (\mathbf{e.g.\ 5\ min})$ percentage value: $\frac{\mathbf{n_1}}{\mathbf{n_{DEP}}}$
Data source	*Airport aircraft operator database.*
Data fields	*TOBT (40 min prior TOBT, 10 min prior TOBT and at timestamp ARDT); ARDT; Number departures (n_{DEP}).*
Dimension (compression)	*Average value [min] per period (parameter), percentage value [%] within quality value (parameter) per period (parameter), a relative frequency per period (parameter).*
Evaluation frequency	*Freely selectable parameter.*
Historicizing	*Only after A-CDM implementation available.*
Target	*Defined percentage value, e.g., 10 min prior TOBT = 60%.*
Remark	*Could be further elaborated, e.g., based per airline or ground handling agent or person/unit responsible for TOBT.*
Graphic depiction	*Different possibilities, e.g., tachometer view:*



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