

Doc 9971
AN/485



Manual on Collaborative Air Traffic Flow Management

Approved by the Secretary General
and published under his authority

Second Edition – 2014

International Civil Aviation Organization

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Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 University Street, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

First edition 2012
Second edition 2014

**Doc 9971, *Manual on Collaborative
Air Traffic Flow Management***
Order Number: 9971
ISBN 978-92-9249-418-6

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FOREWORD

Collaborative decision-making (CDM) is defined as a process focused on how to decide on a course of action articulated between two or more community members. Through this process, ATM community members share information related to that decision and agree on and apply the decision-making approach and principles. The overall objective of the process is to improve the performance of the ATM system as a whole while balancing the needs of individual ATM community members.

The purpose of this manual is to present the CDM concept as a means to reach the performance objectives of the processes the concept supports in a consistent and harmonized manner.

Future developments

Comments on this manual would be appreciated from all parties involved in the development and implementation of CDM. These comments should be addressed to:

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GLOSSARY

ABBREVIATIONS/ACRONYMS

AAR	Airport acceptance rate
ACC	Area control centre
A-CDM	Airport-CDM
ADP	ATFM daily plan
AFTN	Aeronautical fixed telecommunication network
AIM	Aeronautical information management
AIXM	Aeronautical information exchange model
AMAN/DMAN	Arrival/departure management
ANM	ATFM notification message
ANSP	Air navigation services provider
AOBT	Actual off-block time
AOP	Airport operator
AP	Airspace provider
APP	Approach control service
ASM	Airspace management
ASP	ATM service provider
ATC	Air traffic control
ATCO	Air traffic controller
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
AU	Airspace user
CDM	Collaborative decision-making
CEF	Capacity enhancement function
CFMU	Central flow management unit
CGNA	Centro de Gerenciamento da Navegação Aérea (air navigation management centre)
CLDT	Calculated landing time
CNS/ATM	Communications, navigation and surveillance/air traffic management
CPDLC	Controller-pilot data link communications
CTOT	Calculated take-off time
DCB	Demand and capacity balancing
DCPC	Direct controller-pilot communications
ECAC	European Civil Aviation Conference
EOBT	Estimated off-block time
ESP	Emergency service provider
ETD	Estimated time of departure
ETOT	Estimated take-off time
FAP	Future ATM profile
FDPS	Flight data processing system
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
FOIS	Flight operation information system
FUM	Flight update message
GDP	Ground delay programme
GS	Ground stop
IATA	International Air Transport Association
IFR	Instrument flight rules
IMC	Instrument meteorological conditions
IR	Infra-red
KPA	Key performance area
LoA	Letter of agreement
MDI	Minimum departure interval
METAR	Aerodrome routine meteorological report
MINIT	Minutes-in-trail
MIT	Miles-in-trail
NAVAIDs	Aid to air navigation
NOP	Network operations plan
PBN	Performance-based navigation
Prog	Prognosis
R&D	Research and development
RDPS	Radar data processing system
ROI	Return on investment
RTA	Required time of arrival
RWY	Runway
S-CDM	Surface-CDM
SID	Standard instrument departure
STAR	Standard instrument arrival
STATFOR	Statistic 2 forecast service
TAF	Aerodrome forecast
TFM	Traffic flow management
TMA	Terminal control area
TOBT	Target off-block time
TOD	Top of descent
TSAT	Target start-up approval time
TWR	Aerodrome control tower
VMC	Visual meteorological conditions

REFERENCES

ICAO documents

Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444)
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 (Doc 9965)
Civil/Military Cooperation in Air Traffic Management (Cir 330)

PART I

COLLABORATIVE DECISION-MAKING (CDM)

Chapter 1

INTRODUCTION

1.1 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) any member being able 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 as 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, be 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), airports, AUs, manufacturers, regulators and ICAO takes place, the result is a fragmented air navigation system;
- b) insufficient coordination at local, regional and global levels lead 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 is 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 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: The 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 to 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 prior 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, the 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;
- d) examples of present-day CDM processes, which include:
 - 1) airport and surface CDM;
 - 2) network operations planning;
 - 3) coordination of airspace use;

- 4) CDM under adverse weather;
- 5) special traffic management programmes and security; and
- 6) use of collaborative working groups and tools.

1.3 RELEVANT ICAO DOCUMENTS

The following documents provide additional background on CDM including its role in the concept, areas requiring collaboration, guidelines for collaboration on strategic planning decisions and an information-sharing approach to support it:

- a) *Global Air Traffic Management Operational Concept* (Doc 9854), First Edition, 2005;
 - b) *Manual on Air Traffic Management System Requirements* (Doc 9882), First Edition, 2007;
 - c) *Manual on Global Performance of the Air Navigation System, Part I — Global Performance and Part II- Performance-based Transition Guidelines* (Doc 9883), First Edition, 2008; and
 - d) *Manual on Flight and Flow — Information for a Collaborative Environment (FF-ICE)* (Doc 9965).
-

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 pre-defined 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:

- a) identification of the need for CDM;
- b) CDM analysis;
- c) CDM specification and verification;
- d) CDM performance case;
- e) CDM validation and implementation; and
- f) CDM operation, maintenance and improvement (continuous).

It is important that the results of all these phases are 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 9854. 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 significant 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, the 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 my 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.

The above 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 what the costs are and the benefits (using the relevant KPAs) that will result from the operation of CDM. It is important that the results of the performance case are 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 prior 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 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 provide insufficient 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 is insufficient time remaining to continue collaborating.

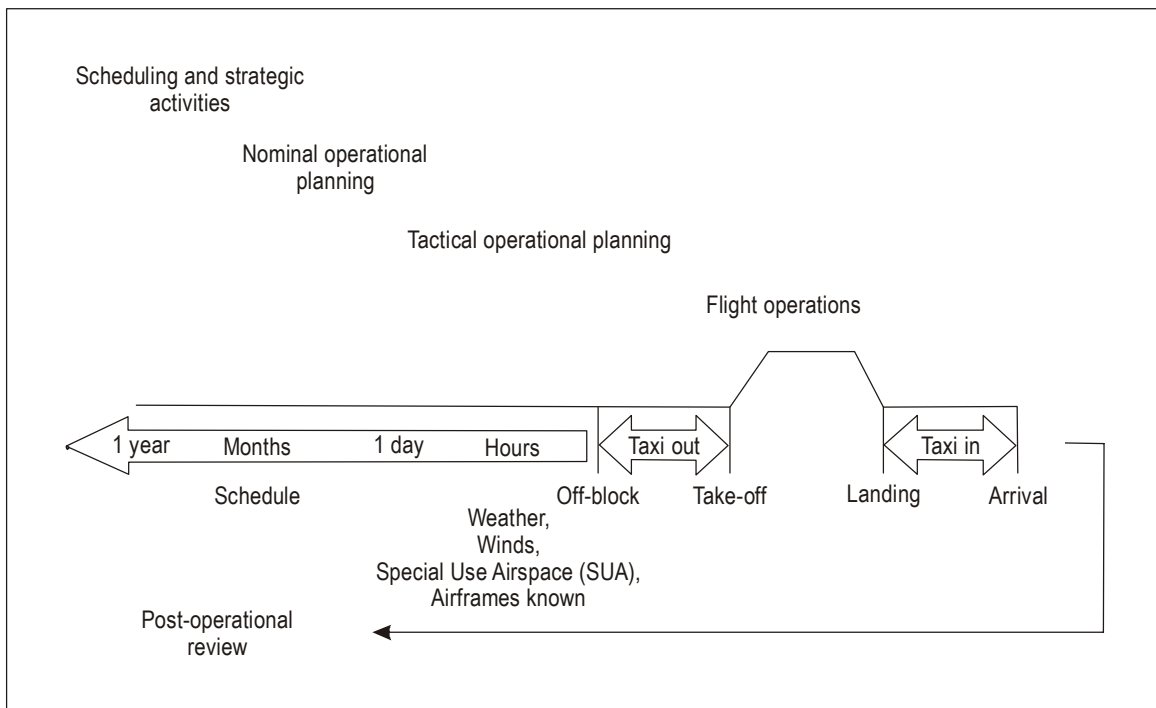


Figure I-2-1. Timeline of information provision (extracted from FF-ICE concept)

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, AOM – 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 competitive 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 (pre-departure) to manage the turn-around 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 a subset of CDM as defined below:

- a) CDM applied to any concept component;
- b) 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) 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.

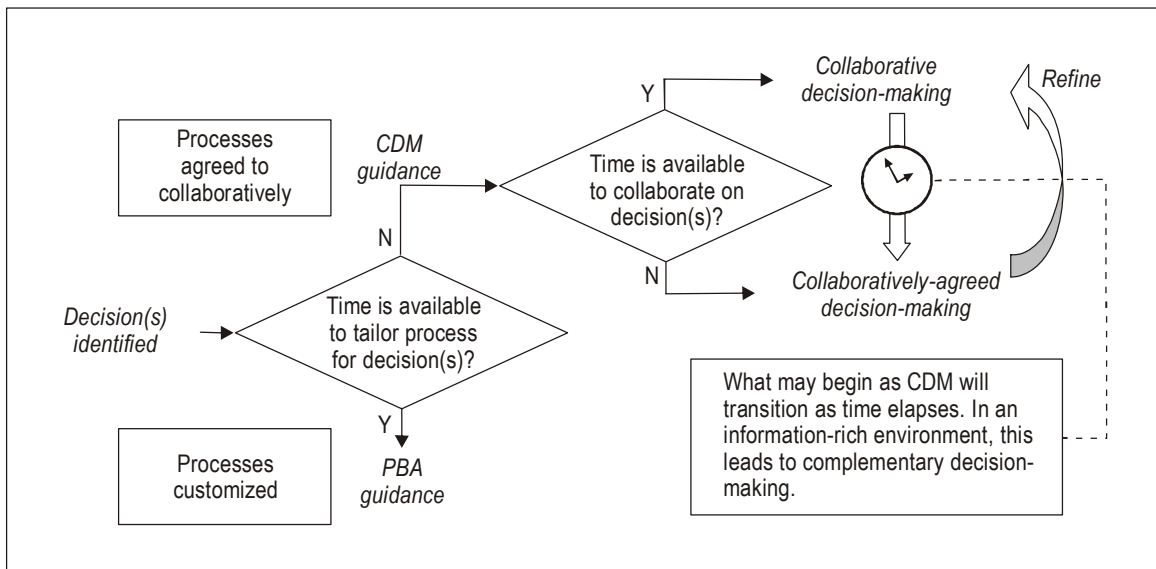


Figure I-2-2. Selection of applicable guidance material

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 both uncertain and subject to changing objectives and decisions as a consequence. 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 interest. As the situation unfolds and becomes more certain, decisions respond to this more certain information, with changing decisions contributing to the dynamism.

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.

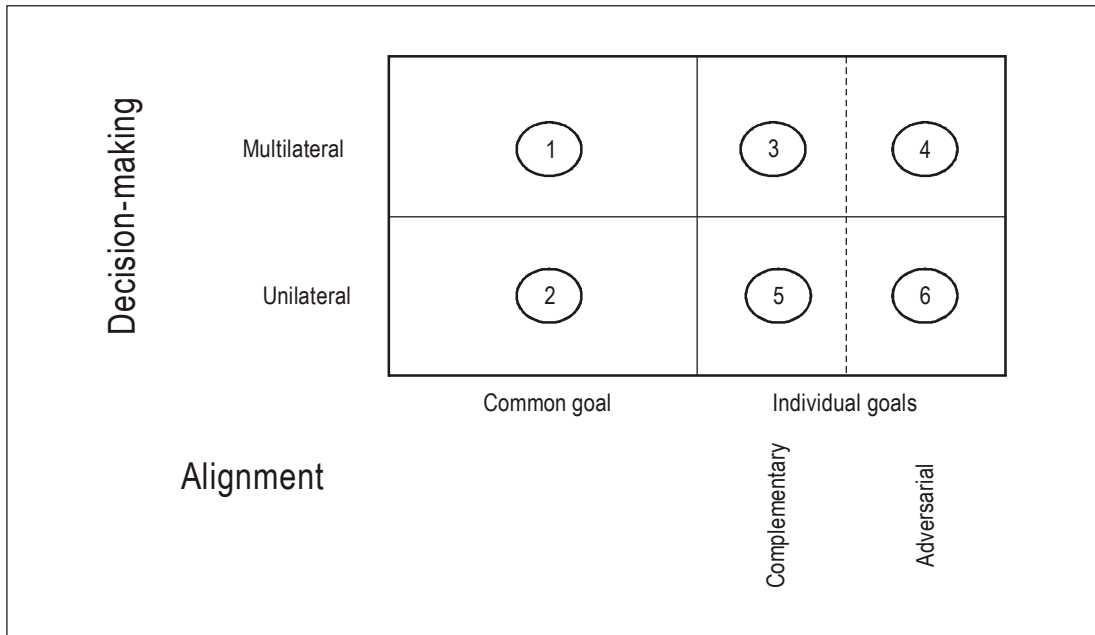


Figure I-2-3. Classification of types of CDM

2.4.2 As has already been mentioned in the prior 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 close the problem, additional goals, including individual goals, may be applied to close the problem. If these are adversarial, these need to be considered.

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 provided 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 are 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 impact;
- 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 location, 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 is frequent 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 prior 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 that are 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 across these multiple ASPs and other participating ATM community members of these constraints may lead to inefficient flight profiles (and potentially infeasible profiles in an extreme case);

- b) having different objectives across locations applying CDM processes may lead to both objectives not 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, a detailed end-to-end analysis 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, there is a set of decision variables that 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-maker will seek to meet their 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 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 sought objectives. 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., and so on 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 including:

- 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 their 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, 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 the:

- a) ATM service provider (ASP);
- b) airport operator (AOP);
- c) AU;
- d) airspace provider (AP); and
- e) emergency service provider (ESP).

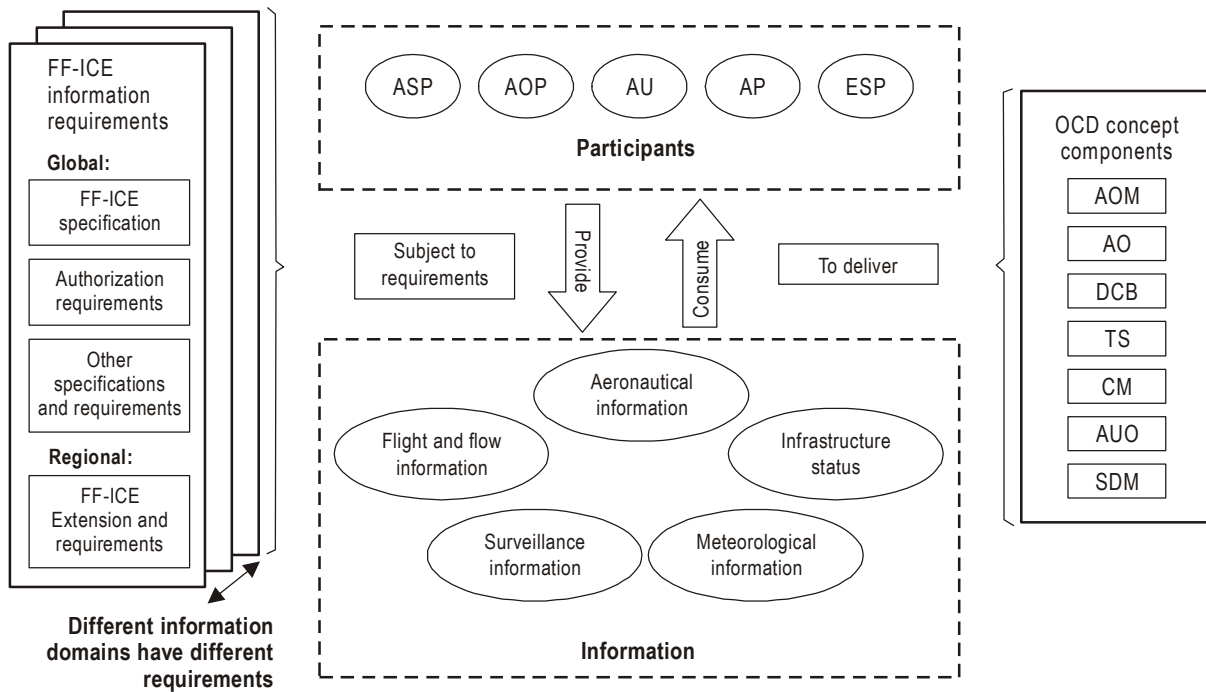


Figure I-3-1. Example information in a collaborative environment

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 other AUs' flights. 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, equipment 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 that information exchange in this collaborative environment is expected to comply with, 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 Paragraph 2.7 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 pertains to CDM, data standardization is pertinent to several areas within which we would expect decisions to be made through collaboration, such as:

- a) areas (e.g. agreement on performance outcomes, operational improvement deployment, airspace redesign, projections and post-operational analysis) falling under the purview of the performance-based approach. 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. Paragraph 2.8 discussed 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 their 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

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.

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 is the exchange of information 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?

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 what the objective is 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 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. pushback 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 3.2, 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.

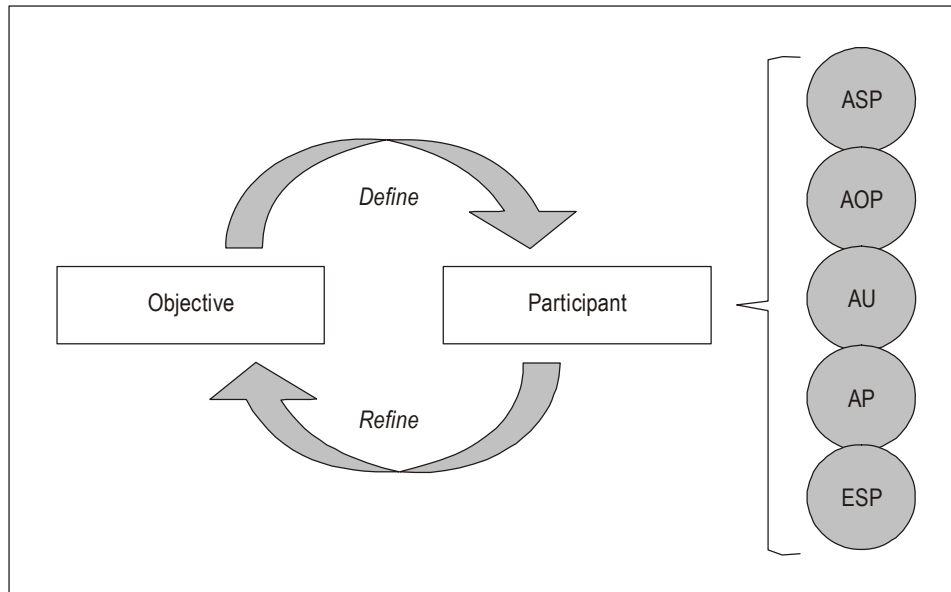


Figure I-4-1. Iterative process identifying participants and objective(s)

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) making a decision and sharing the result of that decision;
- d) executing on a decision that has been made. The executing participant may or may not be the participant that made the decision; and
- e) providing 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 pushback 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 ASP on the allocation of capacity to AUs);
- c) once decisions have been taken, it is expected that execution of those decisions will follow by the responsible parties.

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 2.4). When the CDM process is first defined, the allocation of decisions into sub-problems with the best decision-maker responsible for their 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 2.9.

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

4.6 RULES AND ACCOUNTABILITY

4.6.1 Rules and the 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.

Appendix

CDM EXAMPLES

This appendix contains a collection of examples of CDM applied across the globe. These examples are taken from present-day operations at the time of publishing of this document. It is fully expected that as the global ATM community adopts the global ATM operational concept, these processes would become more interoperable and harmonized.

1. AIRPORT AND SURFACE CDM

This section describes a collection of CDM examples applicable to the airport and airport surface movement.

1.1 Airport CDM (Example: Europe)

1.1.1 The specific application of CDM to airports is known as airport-CDM (A-CDM). Experience gained with A-CDM in Europe is provided in this example, which is based on conditions defined in the European Community Specification (CS) EN 303212.

1.1.2 A-CDM is about improving the way operational partners at airports and European air traffic flow and capacity management (ATFCM), air traffic control, airlines, ground-handling agents/units and airports work together at an operational level. Transparency and predictability are improved leading to better planning and efficient allocation of airport and network resources.

1.2 A-CDM — concept description

A-CDM aims to improve the sharing of information between A-CDM partners and to pre-define procedures and rules for collaboration. It is an enabler for ATFCM at airports, reducing delays, improving the predictability of events and optimizing the utilization of resources. Implementation of A-CDM allows all A-CDM partners to optimize their operations and decisions in collaboration with each other, knowing their preferences, their constraints and the actual and predicted situation. The decision-making by the A-CDM partners is facilitated by the sharing of accurate and timely information and by adapted procedures, mechanisms and tools. An essential feature of all CDM processes, is that there should be pre-defined procedures and rules for collaboration which is agreed between the partners before the start of operations. These procedures and rules describe how the CDM partners will cooperate, and how decisions will be taken in order to assure efficient operations and equity between the interests of the partners.

1.3 A-CDM elements

The A-CDM concept includes the following elements:

- a) information-sharing;
- b) milestone approach;

- c) variable taxi time calculation;
- d) collaborative pre-departure sequencing;
- e) CDM in adverse conditions; and
- f) collaborative management of flight updates.

1.4 Information-sharing

1.4.1 Transparency and information-sharing serves as a basis for the A-CDM process. Information-sharing is in fact the connecting element that ties the partners together in their aim to efficiently coordinate airport activities, and forms the foundation for other A-CDM concept elements.

1.4.2 A-CDM information-sharing supports local decision-making for each of the partners and facilitates implementation of A-CDM elements by connecting A-CDM partners' data processing systems and providing a single, common set of data describing the status and intentions of a flight, serving as a platform for information-sharing between partners.

1.5 A-CDM — milestone approach

The milestone approach element describes the progress of a flight from the initial planning to the take-off by defining milestones to enable close monitoring of significant events. The A-CDM procedure fits all milestones together and is the basis for the description of alerts, publication and necessary IT-system adaptations. The milestone approach combined with the information-sharing element is the foundation for all other concept elements.

1.6 Variable taxi time calculation

At complex airports, the layout of runways and parking stands can result in a large difference in taxi time. Instead of using a standard default value, a calculation of the different permutations based upon historic data, operational experience and/or integrated toll will provide a set of more realistic individual taxi times. The variable taxi time calculation will ensure highly accurate target times for arriving and departing aircraft.

1.7 Collaborative pre-departure sequencing

The A-CDM collaborative pre-departure sequence has a favourable effect on start-up and pushback procedures. The basis for pre-departure sequencing calculations are the target times as target off-block time (TOBT) and target start-up approval time (TSAT). TSAT calculation takes into consideration TOBT, calculated take-off time (CTOT), the operational capacity and possible local restrictions. Based on aircraft progress by using the TOBT, as well as the operational traffic situation on the aprons, taxiways and near runways, ATC can provide a TSAT which places each aircraft in an efficient pre-departure sequence from off-block. This results in regulated, steadier, traffic flows towards the runways, with less queuing at the runway holding point.

1.8 CDM in adverse conditions

Many different events, both planned and unplanned, can disrupt the normal operations of an airport and reduce its capacity to levels substantially below that of normal operations. There are adverse conditions which can be foreseen

with more or less accuracy and both their scope and likely effects are predictable. Snowy conditions, industrial action allowing the maintenance of elementary services, etc. would fall in this category. A fire or aircraft incident/accident is more difficult to prepare for in terms of procedures. In fact, too detailed, pre-arranged procedures may even be more of a hindrance than a help. The adverse conditions element aims to enable the management of reduced capacity in the most optimal manner possible and to facilitate a swift return to normal capacity once adverse conditions no longer prevail, by using the improved information-sharing results from the previous elements. The CDM cell or coordinator who is fully familiar with the A-CDM principles may facilitate operations during adverse conditions.

1.9 Collaborative management of flight updates

The coordination between ATFCM and A-CDM during the turn-around process by constant exchange of flight messages is called A-CDM collaborative management of flight updates. The exchange includes flight update messages (FUM) for arriving flights sent by the network to the CDM airport, as well as departure planning information (DPI) messages for departing flights sent from the airport to the network. The slot allocation process is improved, CTOTs better match the target off-block times (TOBT), resulting in reduced delays, less wasted slots and better management of network resources.

1.10 Relevant documents

The following documents provide additional background on airport-CDM:

- a) *European Airport CDM* <http://www.euro-cdm.org/>
- b) *European Community Specification EN303212*
http://www.euro-cdm.org/library/airports/a-cdm_community_spec_doc_etsi.pdf
- c) *Airport CDM Implementation "The Manual"*
http://www.euro-cdm.org/library/cdm_implementation_manual.pdf
- d) *Example airports* http://www.euro-cdm.org/airports_cdg.php
- e) *Flight Crew Briefing and Brief Description Document Frankfurt*
[http://www.cdm.frankfurt-airport.com \(library\)](http://www.cdm.frankfurt-airport.com (library))

1.11 Gate/spot allocation meeting (Example: Republic of Korea)

1.11.1 To effectively manage the airport capacity, every airport has its own gate/spot allocation meeting which is hosted by the airport corporation and participating airlines, ground-handling agencies, etc. Before holding the meeting, each airline submits its seasonal schedule which contains aircraft disposition message (ADM) information and airport corporation input ADM information to the gate/spot allocation system which is called the integrated Flight Information System (iFIS). Upon completion of ADM information input, iFIS assigns gates/spots for all flights automatically. Based on this information, the meeting arranges gates/spots and finalizes the gate/spot allocation plan; the plan is then used as a basic ramp operation reference during the season.

Ex) Example of ADM Message;

Message) HL7240 1002 1209 1210 1851 1852

Description) HL7240 (Registration Number) will be connected as KAL1002, KAL1209, KAL1210, KAL1851, KAL1852

1.11.2 Once the gate/spot allocation plan is confirmed, each airline establishes its own gate/spot allocation plan and submits it to airport corporation one day before operations. This information goes into the iFIS again to fix the gate/spot for each flight. The finalized gate/spot information is forwarded to air traffic control units and flight information services stations through the dedicated flight operation information system (FOIS).

1.11.3 If an abnormal situation causes a change of gate/spot, i.e. cancellation of a flight, long delay, diversion, each airline informs its intention to the airport corporation using a dedicated system or telephone. Upon receiving the information, related parties, i.e. other airport corporations, airlines, and ground-handling agencies, discuss the rearrangement of gates/spots and reassign a gate/spot.

1.12 Surface collaborative decision-making (S-CDM) operations (Example: United States)

1.12.1 In today's complex air traffic system, a holistic approach to the totality of surface operations and not individual phases of flight may provide solutions to synchronizing all surface components to one another. The principal objective of S-CDM is to improve demand predictions, thereby enabling stakeholders to efficiently manage aircraft movement and make optimum use of available airport capacity.

1.12.2 Traditionally, ATC airport surface operations have been modelled on a "first come, first served" basis. Barring some exceptions, today's surface operations are tactically oriented and reactive in moving aircraft from "pushback to take-off" and from "landing to taxi-in to the gate". This is further exacerbated by traffic management initiatives (TMI) and weather events, which inevitably create long queues and delays on the airport surface and adversely affect the en-route stream. Furthermore, there is minimal linkage between surface operations and the en-route and terminal domains as well as limited situational awareness between ramp operations and the ATC facility. The residual effect is extra fuel consumption, emissions and on-board passenger delays.

1.12.3 S-CDM is the sharing of flight movement and related operational information among airport/flight operators, flight plan service providers and stakeholders to improve demand predictions and to maximize the use of available airport and airspace capacity, thus minimizing adverse effects on stakeholders, passengers and the environment. Collaborative S-CDM provides the basis for the safe and efficient management of traffic flows on the surface (movement and non-movement areas) of an airport. It is founded on the premise that access to aircraft surface surveillance data, coupled with the timely sharing of accurate operational data among participants affords the opportunity to better understand and manage "real" demand on the airport surface.

1.12.4 When departure metering procedures are in effect at a specific airport, the focal point for coordination and entry into the movement area for the purposes of this document will be referred to as the "metering point". Surface operations in the non-movement area continue to remain under the control of the ramp tower or flight operator, as appropriate. The objective is to maintain a sufficient amount of aircraft at the end of the runway to allow the tower controller to efficiently sequence and clear flights for departure. Due to the complex sequencing and spacing constraints that controllers must meet, it is important to provide a reservoir of flights with different characteristics, i.e., departure fix, aircraft type, weight class, engine type, runway requirements, etc., which will allow the controller's to select the best sequence for the given conditions. Departure metering procedures focus on establishing a flexible queue in regard to queue length and other characteristics as determined by the local S-CDM stakeholders group at the given airport. This ability to adjust the target queue length in real time in accordance with the preferences of the local S-CDM stakeholders is a high-value attribute. In recognition of the variances in surface operations at United States airports, S-CDM provides stakeholders with two options; time-based or count-based departure metering procedures.

1.12.5 In the time-based metering model, the procedures involve the assignment of an entry time to each flight operator to the designated metering point at the airport. These assigned entry times are not single points in time, but rather a time window; a specified amount of time before and after the indicated time is within the acceptable range. This provides the operator flexibility and control over the final assignment of flights subject to operational needs and constraints.

1.12.6 In the count-based metering model, in lieu of assigning a specific time to flight operators, the operators receive an allocated total number of flights that can enter the metering point during a specified time bin. A separate count is provided to each flight operator for each metering time bin. The time bin is expected to be relatively short in duration — approximately 10 minutes. The departure metering time bin must be long enough to allow multiple flights to enter the movement area and also permit the flight operator to exchange flights within this period.

1.12.7 The S-CDM concept is scheduled for integration into United States airports with the procedures reflecting the basic tenets of the United States National Airspace System. Although tailored to address the regulatory requirements, it is founded on the very same principles as other A-CDM programmes, such as the European airport CDM programme. While the tactical procedures are likely to vary from one programme to another, the goal is to achieve continuity and consistency across programmes. The interoperability of airport CDM “programmes” are essential to long-term global harmonization of all S-CDM stakeholders.

2. NETWORK OPERATIONS

2.1 Network operations plan (Example: Europe)

2.1.1 The network operations plan (NOP) was originally a regional concept to oversee European ATM using a network perspective, where it is fundamental to maintain an overview of the ATM resources availability required to manage the traffic demand, to support the ATM partners on CDM. It provides visibility of the network demand and capacity situation, the agreements reached, detailed aircraft trajectory information, and resource planning information, as well as access to simulation tools for scenario modelling, to assist in managing diverse events that may threaten the network in order to restore stability of operations as quickly as possible.

2.1.2 The NOP is continually accessible to ATM partners and evolves during the planning and execution phases through iterative and collaborative processes, enabling the achievement of an agreed upon network, stable demand and capacity situation.

2.1.3 The NOP is still evolving and currently works using web media (portal technology) to present ATM information within European areas, increasing a mutual knowledge of the air traffic flow situation in the aviation community from the strategic phase to the real-time operations which contribute to the anticipation or reaction to events.

2.1.4 The NOP portal was launched in February 2009 and as it exists today is a recognized major step on simplifying the ATM partners’ access to ATM information. It evolved from a situation where information was disseminated via multiple websites and using several applications, towards fully integrated access, with a single entry point to the European ATM information, for improving decision-making at all levels.

2.1.5 The NOP portal through one application provides one single view for all partners of several relevant ATM information, such as:

- a) a map displaying the air traffic flow information, including the status of the congested areas in Europe and a corresponding forecast for the next three hours;

- b) scenarios and events enriched with context and cross-reference information;
- c) the collaborative process for building the season operations plan; and
- d) the summary information of the preceding day with access to archive reports.

2.1.6 ATM partners, while waiting for further NOP portal developments are already using it to monitor the ATFM situation, to follow the ATFM situation in unexpected critical circumstances, get online user support, validate flights before filing, to view regulations and airspace restrictions, to evaluate the most efficient routes, to accede to pre-tactical forecasts (daily plan, scenarios, etc.), plan events, post-event analysis, forecast next season, view network forecast and agreed upon adaptations, evaluate performance at the network level and for each particular unit, conferencing for CDM.

2.2 CDM Conference and provision of the ATM operations plan (Example: Japan)

2.2.1 Understanding the impact that adverse weather has on traffic flow is one of the important factors in traffic flow management (TFM). Since an imbalance between demand and capacity seriously diminishes flight efficiency, it is necessary to improve demand prediction and maximize the use of available capacity of airspace and the airport after due consideration of the weather impact. To achieve high accuracy capacity prediction, weather products dedicated to Japanese ATM operations are provided to ATM personnel by weather specialists, for instance, air traffic meteorological category forecast with respect to each airspace or airport provides four coloured levels of indicators according to the severity of the weather impact and six hours of forecasts in tabular and graphic forms, and air traffic meteorological summaries containing interactive radar graphs and time-series forecasts of wind components for airports. Furthermore, ATM personnel work in close proximity to the meteorological specialists thereby facilitating communication.

2.2.2 Collaborative web conferences using the Internet (CDM conference) are conducted on a regular basis twice each operational day by CDM partners actively involved not only to share the information, which includes weather conditions and forecasts, operational conditions of sectors and airports, air traffic situation, traffic demand predictions, plan of TFM and ASM and flight operation plan of airline operators, but also to exchange their intents, such as runway operation plan, estimation or possibility of flow control and flight priority or cancellation. If necessary, there are opportunities of ad hoc CDM conferences throughout the operational day in case of pronounced or unexpected decrease in ATC capacity affected by significant weather conditions, such as severe thunderstorm, gale force winds, typhoon and heavy snow.

2.2.3 The ATM operations plan (OP) is distributed to the CDM community, which reflects the contents of the CDM conference. It contains capacity and constraints of airspace and the airport, traffic management initiatives and other adequate information. The CDM conference and OP contributes to facilitating the common situational awareness and to achieving more collaborative ATM operations for the related CDM partners. Furthermore, sharing real-time operational data through the ATM workstation encourages mutual understanding. Each CDM partner conducts themselves in a manner fully consistent with the OP to maintain efficient and effective ATM operations.

2.2.4 Through these processes, the Japanese community has tried to minimize the impact on traffic flow. These activities are continuously improved upon by CDM partners during post-evaluation intervals.

3. COORDINATION AND MANAGEMENT OF AIRSPACE USE (Example: Japan)

3.1 In order to efficiently use airspace, the JCAB Air Traffic Management Center (ATMC) established a coordination procedure between ATM personnel and the military liaison officers for military training and testing areas. ATM personnel use these areas based on the schedule provided by the military liaison officers and then coordinate available time periods and altitudes. Consequently, with this coordination process, civil IFR flights are able to fly through the area under ATC instructions. When civil IFR flights enter the area for avoiding adverse weather, while taking into account the requirements process, ATM personnel coordinate with military liaison officers for temporarily using military training and testing areas.

3.2 ATMC also manages the civil training and testing areas which are often established at lower altitudes in the vicinity of airports. At these areas, ATMC usually keeps VFR flights separate from IFR flights laterally or using time slots. Meanwhile, under adverse weather conditions, IFR flights are enabled to use these areas according to instructions by ATC who recognize activities of VFR training/testing aircraft.

4. CDM UNDER ADVERSE WEATHER

4.1 Air Traffic Coordination Committee (Example: Republic of Korea)

4.1.1 To cope with abnormal air traffic situations and traffic congestion, Incheon ACC established the Air Traffic Coordination Committee in 2006. This Committee is comprised of ATC units, a meteorology agency, airport corporations and airlines. The committee usually uses a dedicated teleconference system to discuss urgent matters, such as weather deviation, flow control, airspace restriction, aircraft/ATC contingency, to solve any problems. Flow control, especially, is in effect from either China or Japan, and this information is disseminated to the committee members through the teleconference system. If the committee cannot reach an agreement, Incheon ACC decides on a solution based on the discussion.

4.1.2 In addition, Incheon ACC exchanges air traffic flow information with China and Japan to maintain efficient and orderly traffic flow. Also, Incheon ACC uses AIDC with Fukuoka ACC to reduce operational errors between ATC units and to expedite the exchange of flight information.

4.1.3 In terms of civil/military cooperation, Incheon ACC has been sending two liaison officers to the Air Force Master Control Reporting Centre (MCRC) which controls VFR military aircraft and combat training aircraft. At the same time, Incheon ACC assigns one control position to the air force stationed in Incheon ACC to facilitate civil/military coordination. The result is such that the change of airspace is immediately shared with the committee members through the dedicated system.

4.2 Collaborative convective weather forecast (Example: United States)

4.2.1 Since the inception of air travel in the United States, thunderstorm activity (or “convection”) has been the single most disruptive weather factor to air traffic control (ATC) operations. By the 1990s, government, airline industry, and private sector organizations alike employed meteorology departments to produce weather forecast information to support ATC. While these convective forecasts had the potential to aid both tactical and strategic ATC planning, they often described different thunderstorm duration, movement, and intensity expectations for the same geographical areas. The resulting confusion often produced less than desirable results.

4.2.2 As ATFM became more precise and refined, the aviation community realized the numerous forecasting tools available and the importance of having a single source reference which industry could accept as the main forecasting product. The stage was set for a collaborative forecasting product which was developed by expert subject matter meteorologists for ATFM personnel to utilize in their daily strategic planning.

4.2.3 The purpose of the collaborative convection forecast product (CCFP) is to aid in the reduction of air traffic delays, re-routes, and cancellations influenced by significant convective events. From a system user's perspective, CCFP is designed for strategic planning of ATFM particularly during the en-route phase of flight. It is not intended to be used for ATFM oversight in the airport terminal environment, nor for tactical traffic flow management decisions. From a producer's perspective, CCFP itself is designed to address two major purposes:

- a) an accurate representation of the convection of most significance for strategic planning decisions of ATFM; and
- b) a common forecast baseline, as consistent as possible, shared among all meteorological organizations responsible for providing forecasts of convection to traffic flow managers within the FAA and/or commercial aviation organizations.

4.2.4 The primary users of CCFP are ATFM personnel which include both FAA and industry partners. CCFP is the primary convective weather forecast product for collaboratively developing a strategic plan of operations (SPO). The SPO is finalized during the collaborative TELCONS hosted by the Strategic Planning Team and conducted approximately every two hours immediately after the issuance of the CCFP.

4.2.5 CCFP, a strategic planning tool for a two- to six-hour time frame, is available via the National Weather Service Telecommunications Gateway circuit in an ASCII coded text format. It is a graphical representation of expected convective occurrence at two, four and six hours after issuance. Convection for the purposes of the CCFP forecast is defined as a polygon of at least 3 000 square miles that contain:

- a) a coverage of at least 25% with echoes of at least 40 dBZ composite reflectivity; and
- b) a coverage of at least 25% with echo tops of FL 250, or greater; and
- c) a forecaster confidence of at least 25%.

4.2.6 All three of these threshold criteria combined are required for any area of convection of 3 000 square miles or greater to be included in a CCFP forecast. This is defined as the "minimum CCFP criteria". Any area of convection which is forecasted "not" to meet all three of these criteria will not be included in a CCFP forecast.

4.2.7 With the recent development of radar-based tactical decision aids and an increasing need to have convective initiation forecasts as early as possible in the operational day, CCFP coverage must be moved to a four- to eight-hour time frame. In addition, an extended CCFP, known as the ECFP, was created last year to address the growing need for longer-term planning in the 24-36-hour period. The ECFP is an automated version of the CCFP, based on an ensemble of short-term model information. Both the ECFP and CCFP create common situational awareness, improve teleconference planning coordination, promote harmony and cooperation among planners, and is the official weather forecast product for ATC convective planning. It has been embraced by the FAA and the United States airline industry as the cornerstone of severe weather planning for United States airspace operations.

4.3 Coordination of re-routing to avoid adverse weather (Example: Japan)

4.3.1 Adverse weather conditions have a major impact on traffic flow for Japanese ATM operations due to an excessive concentration of traffic demand within a small airspace. Under these severe circumstances, re-routing procedures are absolutely essential.

4.3.2 During re-routing for avoidance of airspace capacity saturation, CDM partners coordinate from a few months before the operational day to the moment before departures based on a flight plan. To improve efficiency, the various parties involved, such as the JCAB Air Traffic Management Center (ATMC), re-rating ATC facility(s) and airline operators must complete their coordination within a limited amount of time. Therefore, they share preliminary “re-routing” lists of the flight routes between city-pairs, which have been established and updated after coordination among CDM partners. Using the re-routing lists simplifies coordination.

4.3.3 CDM partners coordinate their re-routing via ATM workstations which provide traffic demand, detailed data and position information on each flight. Re-routing in this process exerts a positive effect on decreasing the demand on congested airspace and identifying the variations in air traffic flow.

5. SPECIAL TRAFFIC MANAGEMENT PROGRAMMES AND SECURITY (Example: United States)

5.1 Special traffic management programmes (STMPs) are particular events attracting thousands of people and aircraft to participating airports. These events have the potential of creating additional demand for air traffic controllers handling this traffic. In order to safely manage aircraft during these events, an STMP requires pilots to make arrival and/or departure reservations prior to their flights to or from these airports. Pilots can make reservations via the telephone to a toll-free number or, if more convenient, utilize a web-based interface that is available to anyone with Internet connection and a web browser. This electronic web-based application is commonly referred to as an eSTMP. This collaborative tool is a good representation of how the CDM organization has been able to tap into the collective intellect of its constituency to create, construct and modify ATFM tools and technologies as conditions warrant.

5.2 The ANSP may typically use this STMP at high-density locations that host high-profile sporting events, business conventions, air shows, and international global events such as the World Cup and Olympics. A recent event where STMP was successfully implemented was the Vancouver 2010 Winter Olympics and the South Africa 2010 World Cup Finals. These examples typify the amount of pre-planning that occurs among stakeholders prior to the event taking place in order to harmonize the needs of the various aviation community participants.

5.3 STMPs are generally managed by the overseeing national command centre or the regional area control centre (ACC) where the event is taking place. The ATC governing facility shall transmit an advisory that contains the reason for the programme, airport(s)/sector(s) involved, dates and times the programme will be in effect, telephone numbers to be used, and any special instructions, as appropriate. The affected ACC shall be responsible for monitoring the special traffic management programmes to ensure that the demand to the centre/terminal facilities does not exceed the declared capacity. Aircraft are expected to arrive within +/-15 minutes of their slot reservation time. If a reservation requires change or cancellation, pilots must do so as early as possible in order to release the slot reservation for another flight.

5.4 The end results are mutually beneficial since they serve both the ANSP and the system user, by providing predictability, minimizing delays and contributing efficiency to the airspace system.

5.5 In today's dynamic, complex and volatile aviation industry, maintaining the continuity of a robust and redundant flow management system requires more than balancing demand with capacity issues. Information exchange,

real-time communication and a teamwork approach is essential in confronting potential threats to vital resources which provide support to both domestic and global ATFM assets. Establishing a central focal point that can provide subject matter expertise as to how the ATFM system functions is essential to the vitality and security of the air traffic system. In an effort to meet these challenges, the FAA command centre has established a designated position that serves in this capacity and more importantly functions as a liaison to the civilian and military security organizations. Whether it's a common daily occurrence, such as a radio or transponder outage, or a singular or plural event that has the implications to threaten national security, the command centre is prepared to successfully navigate through these challenging events.

6. COLLABORATIVE WORKING GROUPS AND TOOLS

(Example: United States)

6.1 CDM has evolved into a collaborative methodology with respect to traffic flow management operations. It has brought together operators, governments, air navigation service providers, private industry, military and academia with a shared vision that improves decision-making. As a result of this evolved environment, the greater aviation community will ultimately benefit from information-exchange, data-sharing and development of sophisticated tools and technologies.

6.2 This evolution has led to the creation of an eclectic, collaborative environment which is capable of dynamically addressing systemic issues through highly specialized working groups that are tasked to specifically address problematic issues impacting the TFM community.

6.3 The success of these working groups stems from a variety of reasons. First and foremost is the capability to collaborate with subject matter experts across a wide spectrum of stakeholders. Their contributions and personal commitment is reflective of the core values shared by the organizations. Empowerment, transparency, and trust are just some of the characteristics that promote a collaborative culture of ingenuity among members. This model of soliciting input from the experts and end users of tools, technologies and procedural guidelines then becomes the cornerstone of its own success.

6.4 The organizational hierarchy is composed of a high-level oversight committee consisting of both ANSP and industry stakeholders. They provide oversight, tasking and prioritization of projects for the various focused working groups. The working groups are then tasked to generate solutions by incorporating innovative technologies for cutting edge tools that flow managers can use in the airport, terminal or en-route domain. This degree of fluidity is complementary and quite instrumental in addressing the complex issues which confront the aviation industry on a daily basis.

6.5 Examples include "ground delay programmes" to balance demand and capacity issues at specific airports by delaying assignments for departing aircraft in order to arrive at destinations within a specified time slot. Another example is using "flow evaluation area, flow constraint area" tools which can measure the throughput of a specific sector or geographical area. These examples have migrated into more sophisticated enhancements, such as airspace flow programmes which assess and manipulate en-route volume to achieve the optimum equilibrium that the system can safely manage.

6.6 This constant assessment of the needs of the system coupled with the pairing of the end users of these tools is the cornerstone of the CDM organization.

7. ADDITIONAL INFORMATION

Additional information on CDM in the United States may be found through:

<http://www.flycdm.org/>

Topics covered on this website include:

- CDM Leadership Guide
- CDM MOA 2009
- CDM membership process
- CDM training documents
- Points of Contact

PART II

AIR TRAFFIC FLOW MANAGEMENT (ATFM)

FOREWORD

This guidance material contains information on how air traffic flow management (ATFM) should be implemented and applied by using collaborative decision-making (CDM) processes in order to balance capacity and demand within different volumes of airspace and airport environments. It highlights the need for close cooperation among different stakeholders by providing flexibility in the use of the airspace and airport resources.

This guidance material is intended for the following stakeholders:

- a) air navigation service providers;
- b) airspace users;
- c) airline operation centres;
- d) airport operators;
- e) airport ground handlers;
- f) airport slot coordinators;
- g) regulators;
- h) military authorities;
- i) security authorities;
- j) meteorological agencies; and
- k) industries related to aviation.

Key objectives of this guidance material are to:

- a) establish globally consistent ATFM planning and operating practices;
- b) encourage a collaborative and harmonized approach to ATFM between States and regions; and
- c) encourage a systemic approach to ATFM, including all ATM community members.

This material is designed to provide answers to the following questions:

- a) What is the starting point regarding the development of an ATFM service? (Chapter 1);
- b) What are the foundational objectives and principles of ATFM? (Chapter 1);
- c) What are the benefits of implementing an ATFM service? (Chapter 1);
- d) How does an ATFM service operate? (Chapter 2);

- e) How is an ATFM service structured and organized? (Chapter 3);
 - f) What are the roles and responsibilities of the stakeholders in an ATFM service? (Chapter 3);
 - g) How is the capacity of an airspace sector and airport determined? (Chapter 4);
 - h) How are ATFM processes applied in order to balance the demand and capacity within its area of responsibility? (Chapter 4);
 - i) How is an ATFM service implemented? (Chapter 5);
 - j) What are ATFM measures and how are they established and applied? (Chapter 6);
 - k) What data is exchanged in an ATFM service? (Chapter 7);
 - l) What terminology/phraseology is used in ATFM? (Chapter 8); and
 - m) What resources are available to States regarding the various aspects of ATFM? (Appendices).
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Chapter 1

INTRODUCTION

1.1 AIR TRAFFIC FLOW MANAGEMENT (ATFM) PHILOSOPHY

1.1.1 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 of 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.

1.1.2 What is the starting point regarding the development of an ATFM service?

1.1.2.1 The level of an ATFM service required in a given setting will depend on a number of factors that will be addressed in this manual. An ATFM service may be simple or complex, depending on the environment and its requirements. It is however important to note that even relatively simple ATFM services can be, when properly designed and implemented, as effective as complex ATFM services and thus enable air navigation services providers (ANSPs) to effectively provide the required service.

1.1.2.2 One key to the successful implementation of an effective ATFM service is achieving robust coordination between aviation stakeholders. It is envisioned that ATFM is performed as a collaborative decision-making (CDM) process where airports, ANSPs, airspace users (AUs), military entities, 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 regions.

Note.— For the purpose of this guidance material, the term airspace user includes, but is not limited to, airline, air taxi, charter, general aviation, and military operators.

1.1.2.3 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, a multilateral agreement.

1.2 ATFM OBJECTIVES AND PRINCIPLES

1.2.1 What are the foundational objectives and principles of ATFM?

1.2.1.1 The objectives of ATFM are to:

- a) enhance the safety of the ATM system by ensuring the delivery of safe traffic densities and minimizing traffic surges;
- b) ensure an optimum flow of air traffic throughout all phases of the operation of a flight by balancing demand and capacity;
- c) facilitate collaboration between 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) balance the legitimate, but sometimes conflicting, requirements of all AUs, thus promoting equitable treatment;
- e) reconcile ATM system resource constraints with economic and environmental priorities;
- f) facilitate, by means of collaboration among 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) facilitate the achievement of a seamless and harmonized ATM system while ensuring compatibility with international developments.

1.2.1.2 The principles of ATFM are to:

- a) optimize available airport and airspace capacity without compromising safety;
- b) maximize operational benefits and global efficiency while maintaining agreed safety levels;
- c) promote timely and effective coordination with all affected parties;
- d) foster international collaboration leading to an optimal, seamless ATM environment;
- e) recognize that airspace is a common resource for all users and ensure equity and transparency, while taking into account security and defence needs;
- f) support the introduction of new technologies and procedures that enhance system capacity and efficiency;
- g) enhance system predictability, help to maximize aviation economic efficiencies and returns, and support other economic sectors such as business, tourism and cargo; and
- h) evolve constantly to support an ever-changing aviation environment.

1.3 ATFM BENEFITS

1.3.1 What are the benefits of implementing an ATFM service?

1.3.1.1 The benefits of ATFM lie in 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) reduced fuel burn and operating costs; and
 - 6) effective management of irregular operations and effective mitigation of system constraints and consequences of unforeseen events;
- b) societal:
- 1) improved quality of air travel;
 - 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 along with coordinating effective and rapid solutions to recover from them.
-

Chapter 2

THE ATFM SERVICE

2.1 HOW DOES AN ATFM SERVICE OPERATE?

2.1.1 It is essential to understand that, from a systemic perspective, ATFM concerns every stakeholder involved in ATM.

2.1.2 The guiding principles of “first come, first served” and “equitable access to airspace” have traditionally been very important to the ATM system. The global ATM system is however evolving to incorporate in its guiding principles, net results in terms of overall system efficiency, the environment, and operating costs. To support this evolution, ATFM service may have to evolve and to integrate other priorities such as “most capable aircraft” in order to achieve optimum ATM system performance. Likewise, equitable access to airspace may be viewed on a longer time scale than the short-term first come, first served model.

2.1.3 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. Some elements to be considered to operate an ATFM service are:

- a) ATM resources: ATFM recognizes that airspace and airports are common resources shared by all AUs and that equity and transparency must be maintained to the highest standard;
- b) traffic demand: a timely, accurate depiction of predicted flight activity for all flights utilizing an ATM resource (e.g. airport, en-route sector). Data should be aggregated from all available operational data sources (e.g. airline schedules, flight plan data, airport slot management systems, ATM operational systems, and AU intentions);
- c) the tactical, dynamic traffic situation: accurate data derived from surveillance 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 draw from a variety of databases to accurately display meteorological and air traffic information; and
- g) institutional arrangements: formalized agreements between all ATFM stakeholders in the relevant area and appropriate arrangements with adjacent ATFM units.

2.1.4 Whenever measures to control the flows of air traffic have to be applied in the form of delays, AUs should be notified by ATC while the aircraft are on the ground rather than in flight. A strategy should collaboratively be agreed upon in advance by the ATFM units, the affected air traffic services (ATS) facilities and AUs. Its aim should be to safely and efficiently balance ground and airborne delays.

2.1.5 AUs should be informed as early as possible of the nature and location of ATM constraints. This will allow them to integrate that information into their operational flight planning.

2.1.6 In addition to airborne holding, the management of airborne delays can be accomplished by slowing aircraft well before top of descent (TOD) and making use of required time of arrival (RTA) aircraft capabilities in order to reduce operating costs, environmental impact, and ATC workload.

2.1.7 When ATFM measures are necessary to manage a constraint, they should be applied in a timely manner and 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.

2.1.8 Information on anticipated overload situations should be provided to affected AUs as soon as possible.

2.1.9 ATFM measures should be established and coordinated so as to avoid, if at all possible, having cumulative or contradictory effects on the same flights.

2.1.10 Automated tools should be implemented and utilized to allow for effective collaboration and dissemination of ATFM information.

2.1.11 CDM should be utilized to manage flows of traffic through all components of the ATM system. CDM should also occur within and between regions where significant traffic flows force them to interact with each other.

2.1.12 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 planning stage. Moreover, ATFM planning should, as much as possible, focus on regional ATFM and be prioritized for the appropriate major traffic flows.

2.1.13 ATFM traffic data analysis can yield significant strategic benefits, especially when used in conjunction with airspace and ATS route planning, in terms of future ATM systems and procedure improvements. This is part of a continuous safety and service improvement loop (see Figure II-2-1).

2.1.14 States may choose to prioritize or exempt certain classes of flight from ATFM measures. Examples of such flights include but are not limited to:

- a) flights experiencing an emergency, including aircraft subjected to unlawful interference;
- b) flights on search and rescue or fire fighting missions;
- c) urgent medical evacuation flights specifically declared by medical authorities;
- 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 ATFM measures. Scheduled passenger transfer flights are, by their nature, non-urgent and should not be given priority under normal operational situation. Notwithstanding any exemption from ATFM measures, exempted aircraft are included in the airport/airspace demand estimation.

2.1.15 Appropriate automated tools can be used to enable and enhance the effective application of ATFM.

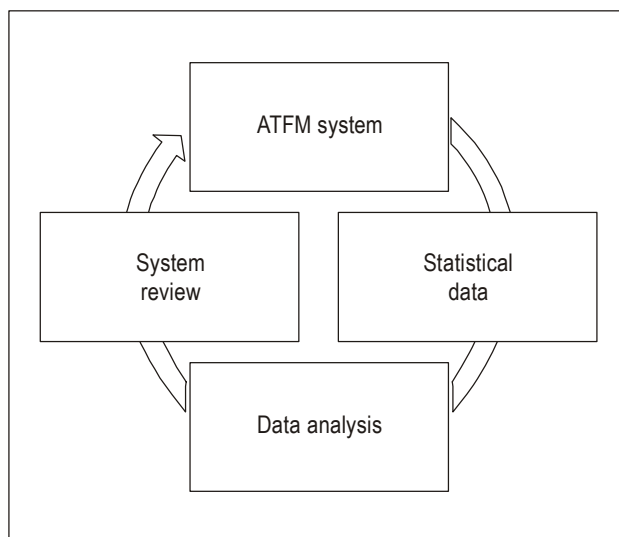


Figure II-2-1. ATFM cycle of review and improvement

2.2 CDM IN THE CONTEXT OF ATFM

2.2.1 CDM is the process which allows decisions to be taken by amalgamating all pertinent and accurate sources of information, ensuring that the data best reflects the situation as known, and ensuring that all concerned stakeholders are given the opportunity to influence the decision. This in turn enables decisions to best meet the operational requirements of all concerned.

2.2.2 The CDM process is a key enabler of an ATFM strategy allowing the sharing of all relevant information between the parties involved in making decisions and supporting an on-going dialogue between the various stakeholders throughout all phases of flight. This enables the various organizations to update each other continuously on events from the strategic level to real time.

2.2.3 CDM is a supporting process applied to activities such as airspace management (ASM) and demand/capacity balancing and can be applied at any time from strategic planning to tactical operations. CDM is not an objective in itself, but rather a way to reach the performance objectives of the processes it supports. These performance objectives are expected to be agreed upon collaboratively.

2.2.4 Although information-sharing is an important enabler for CDM, it is insufficient to realize CDM and its objectives. Successful CDM also requires agreed-upon procedures and rules to ensure that collaborative decisions will be taken expeditiously and fairly.

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

2.3 CDM ORGANIZATION AND STRUCTURE

2.3.1 The organization and structure of the CDM process depends on the complexity of the ATFM system in place. The structure must be designed to ensure that the affected stakeholders, service providers and AUs alike, can discuss airspace, capacity and demand issues through regular meeting sessions and formulate plans that take all pertinent aspects and points of view into account.

2.3.2 Frequent tactical briefings and conferences can be used to provide an overview of the current ATM situation, discuss any issues and provide an outlook on operations for the coming period. Traffic patterns and the severity of the envisaged ATFM events will dictate the frequency of those meetings. They should occur at least daily but may also be scheduled more frequently depending on the traffic and capacity situation (e.g. an evolving meteorological event may require that the briefing frequency be increased). Participants should include involved ATFM and ATS units, chief or senior dispatchers, affected military authorities and airport authorities, as applicable.

2.3.3 The output of these daily conferences should be the publication of an ATFM daily plan (ADP) and should include subsequent updates. The ADP should be a proposed set of tactical ATFM measures (e.g. activation of routing scenarios, miles-in-trail (MIT)) prepared by the ATFM unit and agreed upon by all partners concerned during the planning phase. The ADP should evolve throughout the day and be periodically updated and published.

2.3.4 Feedback and review of the ADP received from ANSPs, AUs, and from the ATFM unit itself represent very important input for further improvement of the pre-tactical planning. This feedback helps the ATFM unit identify the reason(s) for ATFM measures and determine corrective actions to avoid reoccurrence. Systematic feedback from AUs should be gathered via specifically established links.

2.3.5 In addition to the daily conferences, the ATFM unit should consider holding periodic and event-specific CDM conferences, with an agenda based on experience. The objective should be to ensure that the chosen ATFM measures are decided through a CDM process and agreed to by all affected stakeholders.

2.4 CDM REQUIREMENTS AND BENEFITS

2.4.1 Through the application of a transparent CDM process, the involved stakeholders will gain the necessary situational awareness which will ensure that the optimum measures are applied in any given situation. CDM will also create an environment where stakeholders better understand the issues of all concerned.

2.4.2 Regular CDM conferences provide stakeholders with the opportunity to propose enhancements from which they could benefit, to follow up on any issue, and to monitor the equity of the flow management process.

2.5 ATFM, CDM AND CIVIL/MILITARY COORDINATION

2.5.1 ATFM principles are equally applicable to both civil and military flights operated in accordance with civil rules. Civil/military coordination will provide more flexibility to AUs, thanks to the greater availability of both information and airspace. It is however essential to realize that some missions, such as military operations, operations conducted in support of security requirements, live weapons firing, space operations or others, will remain incompatible with civil

aviation. National policies will establish the degree of civil/military coordination in terms of ATM within each State. Military participation in a regulated aeronautical information infrastructure will therefore remain subject to national considerations.

2.5.2 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.

2.5.3 Benefits of civil/military coordination 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 sectoring, which enable ATC capacity increases and reduced delays;
- c) more efficient air traffic flow separation procedures;
- d) reduced ATC workload through a reduction of airspace congestion and the number of choke points;
- e) real-time provision of capacity in line with AUs' operational requirements; and
- f) definition and use of temporary airspace reservations designed to bring an optimal response to military operational requirements.

2.5.4 It is recommended that 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.

2.5.5 When applicable, such agreements and procedures should be established on the basis of a regional air navigation agreement. 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) units or authorities responsible for the airspace;
 - d) conditions for transfer of the airspace to/from the ATS unit concerned;
 - e) 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.
-

Chapter 3

ATFM STRUCTURE AND ORGANIZATION

3.1 HOW IS AN ATFM SERVICE STRUCTURED AND ORGANIZED?

3.1.1 It is understood that different levels of ATFM oversight will exist. The main concept however relies on the fact that States assign responsibilities for oversight and execution of ATFM services. Each State shall therefore assign responsibility for the collection and dissemination of ATFM-related information, as well as for the monitoring and surveillance of ATFM activities within its respective FIR(s). This will ensure that all stakeholders have timely and efficient access to applicable ATFM information.

3.1.2 Each State will ensure that an ATFM organizational structure that meets the needs of the aviation community is developed. This structure should, at least, allow the management and oversight of:

- a) the ATFM service; and
- b) the coordination and exchange of information, both internally and externally; and

should also ensure:

- c) the existence of a line of authority for the implementation of decisions (see Figure II-3-1); and
- d) compliance with the mission requirements that have been assigned to the ATFM services.

3.1.3 A line of authority to support the ATFM service is therefore required and may include the following:

- a) a manager of the ATFM service;
- 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.

3.1.4 An ATFM service could be designed considering the following:

- a) an aerodrome control tower (TWR) can be served by an FMP. This duty can be assigned to an existing position or it may require a dedicated position. The control tower FMP coordinates with the FMP at the approach control unit;
- 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 FMP at an area control centre (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 and its subordinate units. The following functions at an ACC FMU may require dedicated staff, depending on the workload induced by:
- 1) approach control coordination;
 - 2) departure control coordination;
 - 3) en-route coordination;
 - 4) meteorological briefing/forecasting coordination;
 - 5) AU 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;

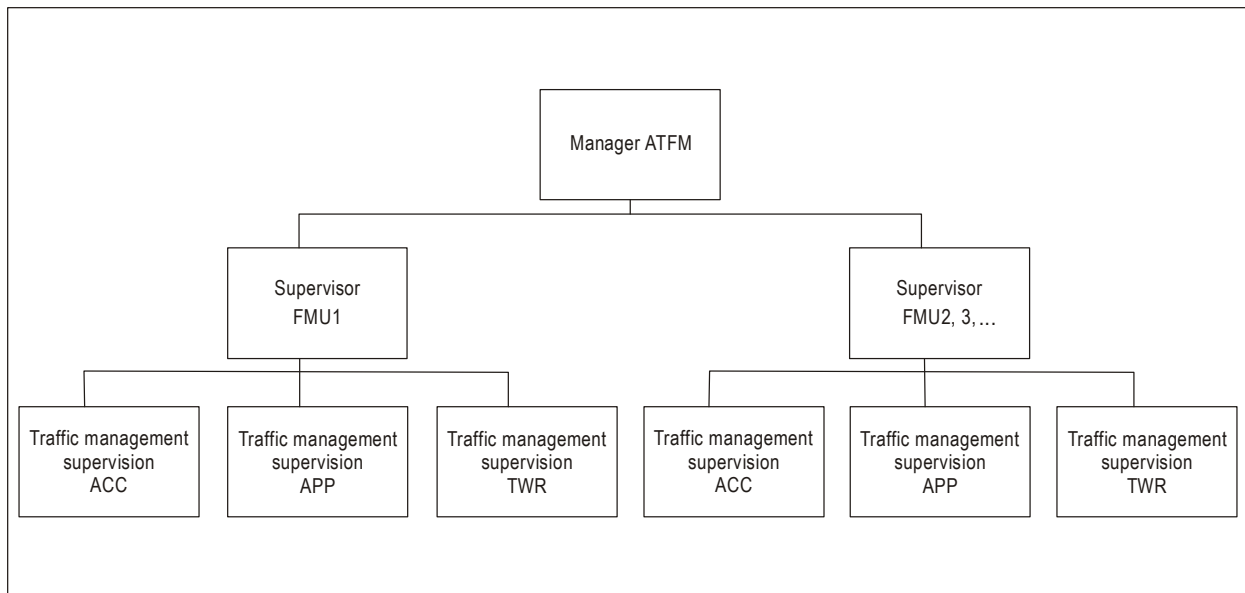


Figure II-3-1. Sample ATFM line of authority

- d) a group of ACCs can be served by a national or an international ATFM centre. This is one of the most complex ATFM structures and includes multiple functions. Each function may be combined or may require dedicated staff, depending on the workload, and may include:

- 1) traffic management coordination;
- 2) traffic planning;
- 3) meteorological briefing/forecasting coordination;
- 4) NOTAM/messaging coordination;
- 5) flight calibration/flight check coordination;
- 6) AU liaison;
- 7) military liaison;
- 8) information technology coordination and operational data management;
- 9) technical operations coordination (concerning infrastructure and systems such as NAVAIDs, radar, VHF communication sites);
- 10) crisis management coordination; and
- 11) operations analysis; and

Note.— Depending on the unit's size and traffic density encountered in the ACC, some of the above functions may be combined.

- e) the national or international ATFM centre is responsible for the dissemination of information and coordination among the facilities located in its area of responsibility, i.e. national, intra-regional and interregional coordination.

3.1.5 The purpose of the coordination methodology implemented in ATFM is to establish a protocol to ensure that each level of the organization is informed of ATFM in a timely and accurate manner. This method was extracted from a generic organizational model that can be modified to meet the needs of each specific environment.

3.1.6 Letters of agreement or other appropriate documentation should be developed in order to ensure the necessary standardization.

3.2 WHAT ARE THE ROLES AND RESPONSIBILITIES OF THE STAKEHOLDERS IN AN ATFM SERVICE?

3.2.1 FMU/FMP

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 3.1.1, their operations are overseen by the appropriate authority. FMU/FMP duties may include:

- a) creating and distributing the ADP based on prior consultation and collaboration with the designated facilities and stakeholders;

- 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, email, internet and automated data gathering;
- c) analysing and distributing all relevant information;
- d) documenting a complete description of all ATFM measures (e.g. ground delay programmes (GDPs), MIT) in a designated log. It should include, among other data, for each measure, the start and end times, the affected stakeholders and flights, and its justification;
- e) coordinating procedures with the affected stakeholders;
- f) creating a structure for information dissemination (such as a website);
- g) conducting daily telephone and/or web conferences, as required; and
- h) continuously monitoring the ATM system, making service delivery adjustments where necessary, managing ATFM measures and cancelling them when no longer required.

3.2.2 AUs

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 in user-driven prioritization processes). The participation of AUs in the ATFM process will be supported by CDM telephone conferences and/or web-based interfaces.

3.3 TRAINING REQUIREMENTS FOR THE STAKEHOLDERS IN AN ATFM SERVICE

3.3.1 FMU/FMP personnel

Personnel performing ATFM functions will require standardized and recurrent training in order to maintain their competency level in a constantly changing environment. A detailed ATFM training plan will ensure that personnel maintain an optimized level of operational efficiency in their respective FMU/FMP. This will allow ATFM personnel to successfully face the important changes in their operational environments and provide the highest level of service.

3.3.2 Other ATFM stakeholders

All stakeholders involved in the ATFM system must be given the training required to enable the provision of an efficient ATFM service. ATS personnel, as well as AUs, must have the knowledge required to carry out their respective responsibilities.

Chapter 4

CAPACITY, DEMAND AND ATFM PHASES

4.1 HOW IS THE CAPACITY OF AN AIRSPACE SECTOR AND AIRPORT DETERMINED?

4.1.1 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, weather-related factors, and controller equipment and workload. Every effort should be made to provide sufficient capacity to cater to both normal and peak traffic levels; however, in taking any actions to increase capacity, the responsible ATS authority shall ensure that safety levels are not jeopardized.

4.1.2 The number of aircraft provided with air traffic control service shall not exceed that which can be safely handled by the ATS unit concerned under the prevailing circumstances. In order to define the maximum number of flights which can be safely managed, the appropriate ATS authority should assess and declare the ATC capacity for control sectors (en-route and terminal control area) and for airports.

4.1.3 ATC capacity should be expressed as the maximum number of aircraft that can be accepted over a given period of time at an ATM resource (airspace sector, waypoint, airport, etc.).

4.1.4 ATC capacity for an airspace sector is normally defined as an entry count (maximum number of aircraft **entering** an airspace sector in a given period of time). A complementary measure is occupancy count (maximum number of aircraft **within** an airspace sector in a given period of time) as well as other possible units. Studies have shown that occupancy count can be used to complement entry counts and allow higher values for such entry counts, where accurate and frequent live surveillance data updates are included in the ATFM system, and that these are available well in advance of flight entry into the given airspace sector and are constantly updated. In certain cases, occupancy count capacity can be described in terms of number of aircraft in a given airspace sector at an instance or number of aircraft in a given airspace sector over the average time a typical aircraft spends in a sector as well as other possible representations.

4.1.5 ATC capacities are not static values but vary with traffic complexity and other factors. Consideration should be given to tolerance thresholds around standard capacity values that may vary in either direction. Figure II-4-1 illustrates the various elements that are usually taken into account when defining airspace capacities. Figure II-4-2 illustrates the main factors affecting airport capacity.

4.1.6 Capacity measurement and calculation methodologies should be developed according to the requirements and conditions of their operational environment. Calculation methodologies, with different levels of complexity, have already been established by States in various ICAO regions (see examples in Appendices C, D and E).

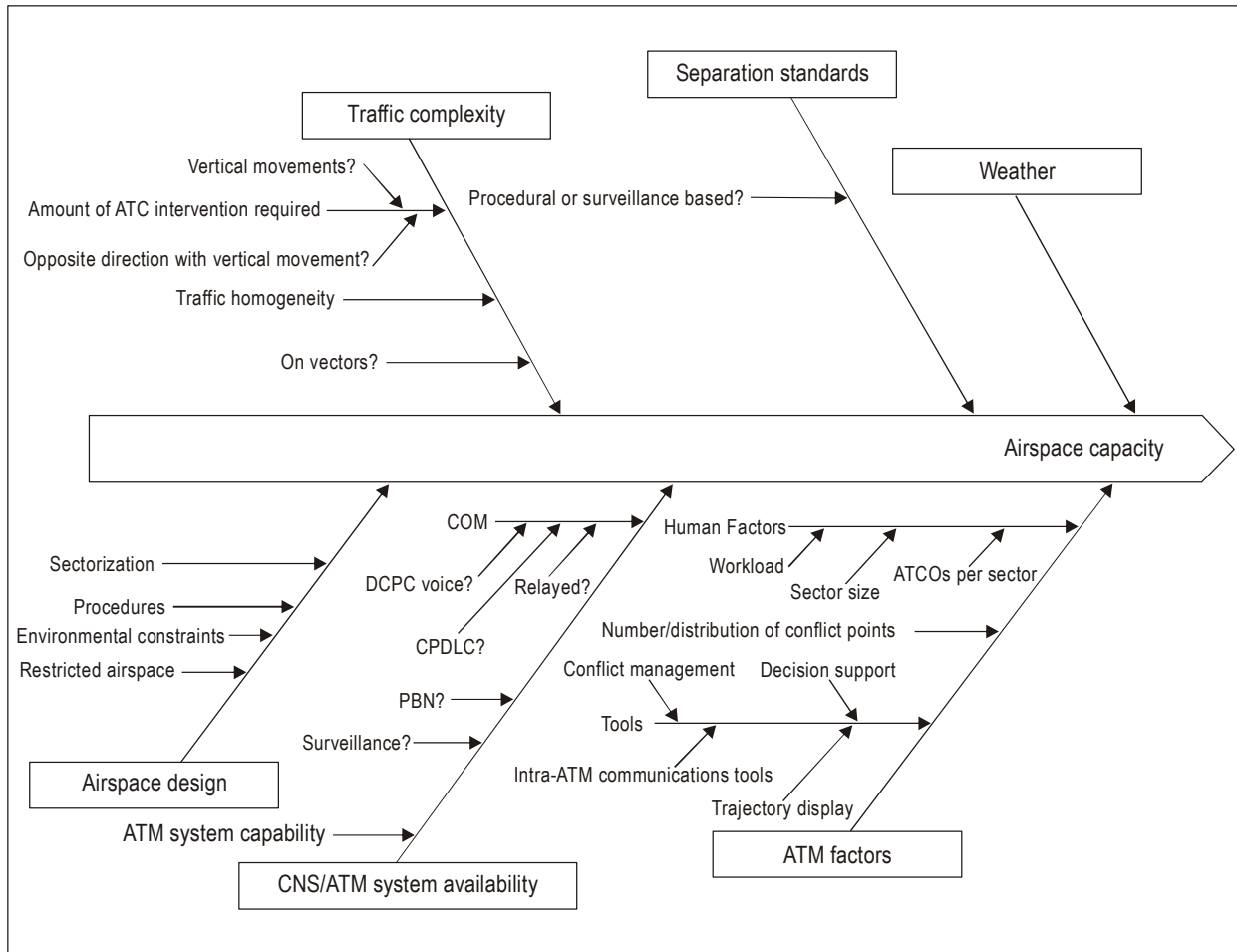


Figure II-4-1. Factors to be considered when defining airspace capacity

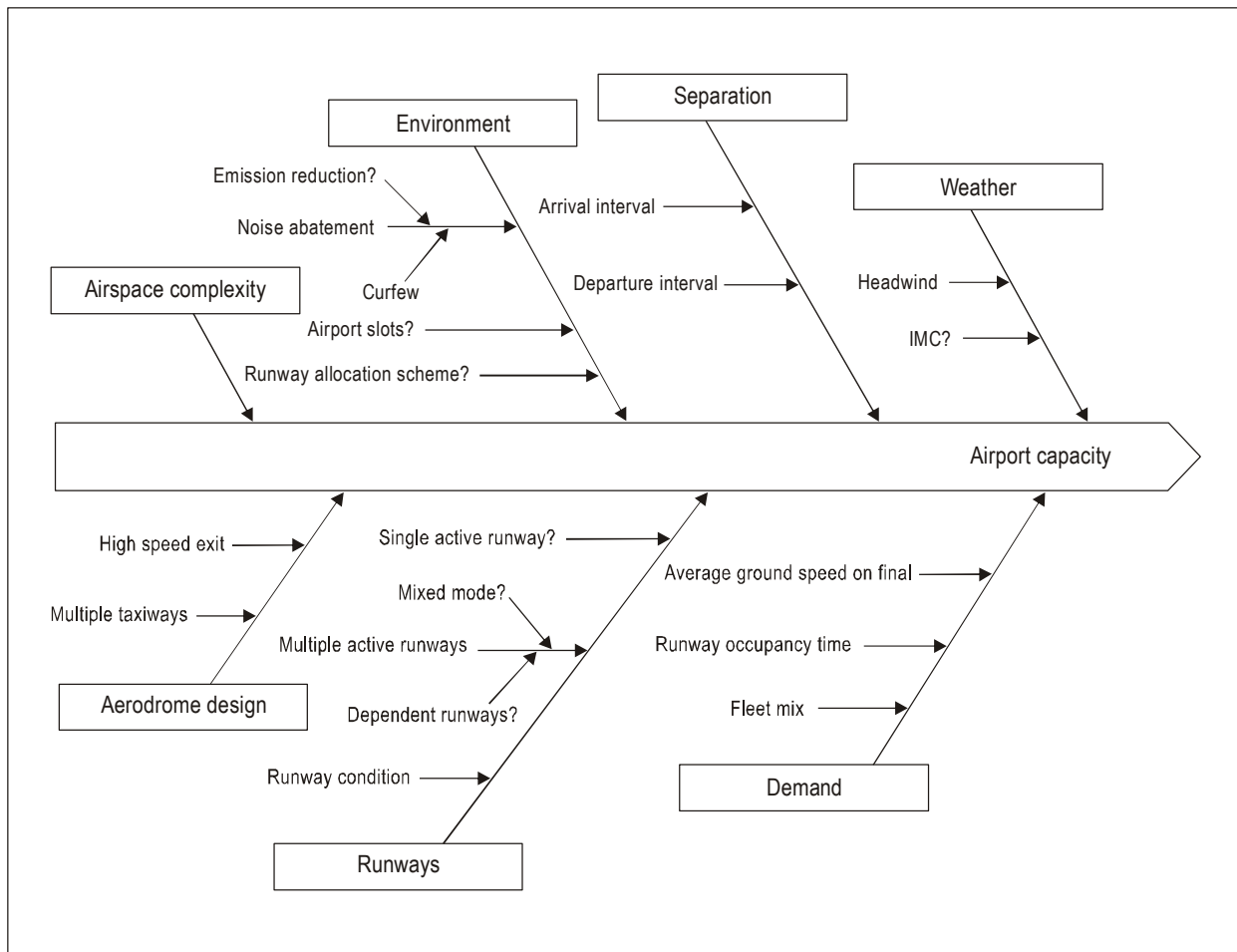


Figure II-4-2. Factors affecting airport capacity

4.2 BALANCING DEMAND AND CAPACITY

4.2.1 How are ATFM processes applied in order to balance the demand and capacity within a given area?

4.2.1.1 In order to minimize the effects of ATM system constraints, a methodology to balance demand and capacity should be developed. This can be accomplished through the application of an “ATFM planning and management” process, which is a collaborative, interactive capacity and airspace planning process, where airport operators, ANSPs, AUs, military authorities, and other stakeholders work together to improve the performance of the ATM system (see Figure II-4-3).

4.2.1.2 This CDM process allows AUs to optimize their participation in the ATM system 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, ASM and ATFM. The process contains three equally important phases: ATM planning, ATFM execution and post-operations analysis.

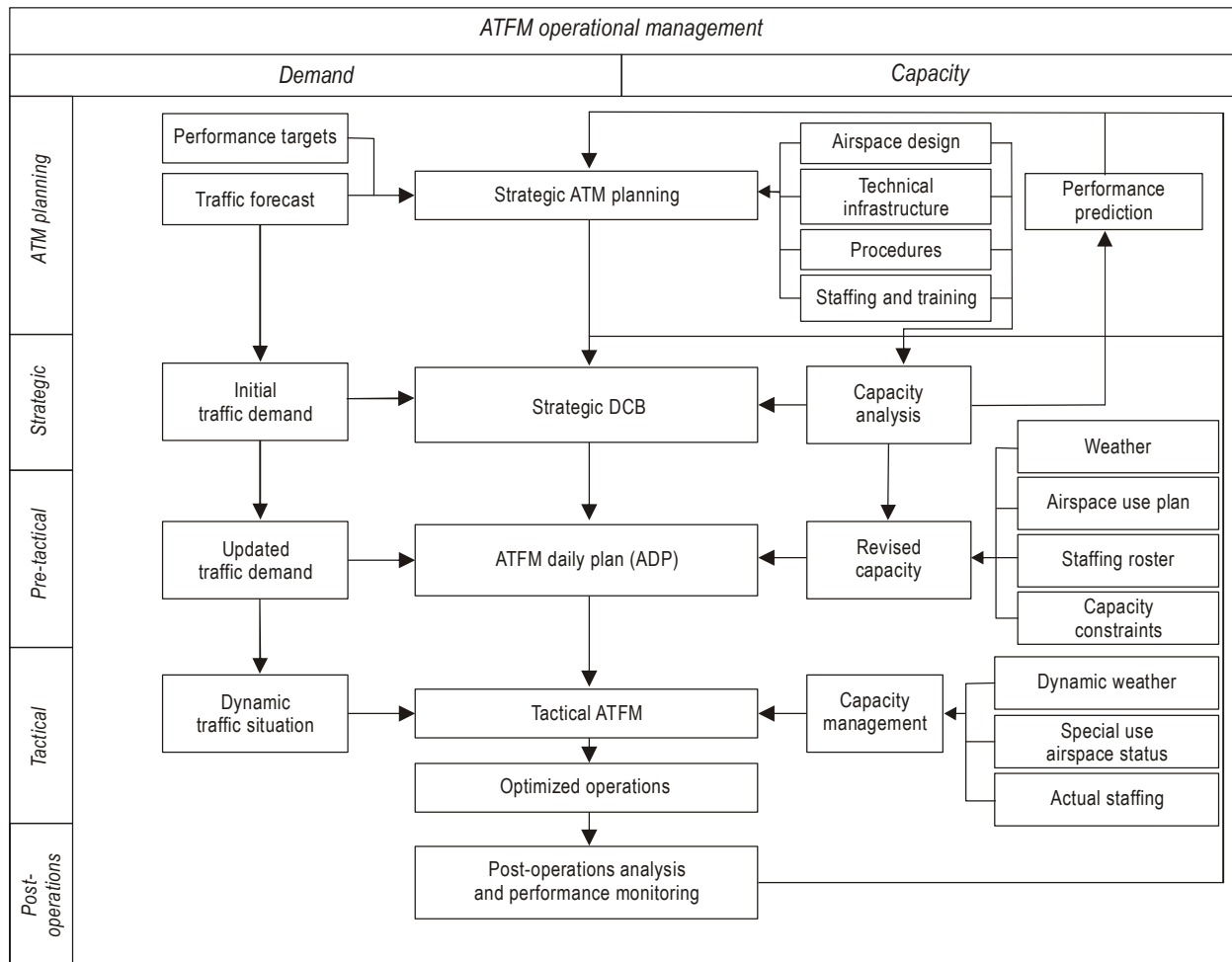


Figure II-4-3. ATFM operational management

ATM planning

4.2.1.3 In order to optimize ATM system performance in the ATM planning phase, available capacity is established and then compared to the forecasted demand and to the established performance targets. 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, communications 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.

4.2.1.4 Such an analysis will quantify the magnitude of any possible imbalance between demand and capacity. Mitigating actions may then be needed to correct that imbalance. However, before they are implemented, it is very important to:

- 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 airports and airspaces in order to quantify excessive demand and significant changes in:
 - i) forecast demand; and
 - ii) ATM system performance targets;
 - 2) obtain demand data from different sources such as:
 - i) comparison of recent traffic history (e.g. comparing the same day of the previous week or comparing seasonal high-demand periods);
 - ii) traffic trends provided by national authorities, user organizations (e.g. International Air Transport Association (IATA)); and
 - iii) other related information (e.g. air shows, major sports events, large-scale military manoeuvres); and
- b) take into account 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-effectiveness) perspective.

4.2.1.5 The next phase, ATFM execution, is built on declared ATC capacity. It aims at facilitating the delivery of optimal ATM services.

ATFM execution

4.2.1.6 ATFM execution consists of three phases: strategic, pre-tactical, and tactical. These phases should not be considered as discrete steps but rather as a continuous planning, action and review cycle that is fully integrated with the ATM planning and post-operations processes. It is important that operational stakeholders be fully involved in each phase.

Strategic

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

4.2.1.6.1.1 This phase applies the outcomes of the ATM planning activities and 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 may be adjusted according to the demand foreseen in this phase.

4.2.1.6.1.2 The strategic phase includes:

- a) a continuous data collection and interpretation process that involves 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 at maximizing and optimizing the available capacity in order to cope with projected demand and, consequently, at achieving performance targets.

4.2.1.6.1.3 The main output of this phase is the creation of a plan, composed of a list of hypotheses and resulting capacity forecasts and contingency measures. Some elements of the plan will be disseminated in aeronautical information publications. Planners will use them to resolve anticipated congestion in problematic areas. This will, in turn, enhance ATFM as a whole as solutions to potential issues are disseminated well in advance.

Pre-tactical

4.2.1.7 The ATFM pre-tactical phase encompasses measures taken one day prior to operations.

4.2.1.7.1 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 adapted and adjusted accordingly.

4.2.1.7.2 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).

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

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

- a) determine the capacity available in the various areas, based on the particular situation that day;
- b) determine or estimate the demand;
- c) study the airspace or the flows expected to be affected and the airports expected to be saturated, calculating the acceptance rates to be applied according to system capacity;
- d) conduct a comparative demand/capacity analysis;
- e) prepare a summary of ATFM measures to be proposed and submit them to the ATFM community for collaborative analysis and discussion; and
- f) at an agreed-upon number of hours before operations, conduct 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.

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

4.2.1.7.6 The ADP must be developed collaboratively and aims at optimizing the efficiency of the ATM system and 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.

4.2.1.7.7 It is recommended that the ADP should cover, as a minimum, a 24-hour period. The plan may however cover a shorter period, provided mechanisms are in place to update the plan regularly.

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

4.2.1.7.9 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 communications networks or any other suitable means of communication, such as internet and email.

Tactical

4.2.1.8 During the ATFM tactical phase, 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.

4.2.1.8.1 The tactical phase aims at ensuring 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 that unnecessary measures be avoided;
- c) capacity is maximized without jeopardizing safety; and
- d) the measures are applied taking due account of equity and overall system optimization.

4.2.1.8.2 During this phase, any opportunity to mitigate disturbances shall 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.

4.2.1.8.3 The provision of 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.

4.2.1.8.4 Proactive planning and tactical management require the use of all information available. 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.

Post-operations analysis

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

4.2.1.9.1 During this phase, an analytical process is carried out to measure, investigate and report on operational processes and activities. This process is the cornerstone of the development of best practices and/or lessons learned that will further improve the operational processes and activities. It shall 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 an impact, and can be repeated. A lesson learned documents the experience gained during an event and provides valuable insight with respect to identifying method, process, or activity that should be used or, to the contrary, avoided in specific situations.

4.2.1.9.2 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.

4.2.1.9.3 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.

4.2.1.9.4 Post-operations analysis shall include analysis of items such as anticipated and unanticipated events, ATFM measures and delays, the use of predefined scenarios, flight planning and airspace data issues. They should compare the anticipated outcome (where assessed) with the actual measured outcome, generally in terms of delay and route extension, while taking into account performance targets.

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

4.2.1.9.6 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.

4.2.1.9.7 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 assist 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 on-going events;
- d) perform 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.

4.2.1.9.8 It is important to ensure that the relevant ATFM stakeholders are made aware of the results (see Figure II-4-4). The following process is therefore recommended:

- a) collection and assessment of data including comparison with targets;

- b) broad review and further information gathering at a daily briefing;
- c) weekly operations management meeting to assess results and recommend procedural, training and system changes where necessary to improve performance; and
- d) periodic operations review meetings with stakeholders.

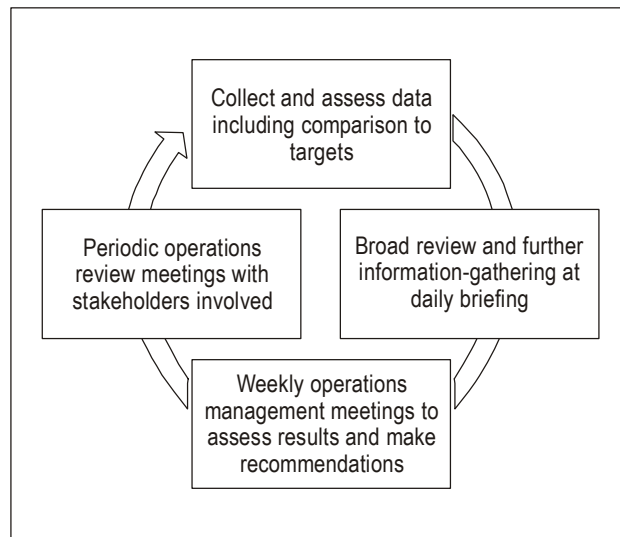


Figure II-4-4. Post-operations analysis cycle

Chapter 5

ATFM IMPLEMENTATION

Note.— This chapter details, in a sequence, the different steps that should be undertaken to establish an ATFM structure. 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). Section 5.2 focuses on the steps necessary to set up an international structure.

5.1 HOW IS AN ATFM SERVICE IMPLEMENTED?

5.1.1 The ATFM implementation strategy should be developed in phases in order to ensure maximum utilization of the available capacity and to enable all concerned parties to gain sufficient knowledge and experience.

5.1.2 Over time, and in order to maximize the operational efficiency of airspaces and airports, consideration should be given to the establishment of international ATFM centres to centralize ATFM service provision and/or oversee/coordinate the activities of local ATFM centres (ACC or airport). Further guidance on implementing an international ATFM unit can be found in section 5.2.

5.1.3 ANSPs can however introduce basic ATFM processes without the immediate need for a national or international centre.

5.1.4 In its initial application, ATFM need not involve complicated 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.

5.1.5 In its initial applications, ATFM can be performed via person-to-person telephone calls designed to exchange information of operational significance and to relay information on factors affecting capacity, system constraints and significant meteorological conditions. The information could, for example, include: planned runway closures, equipment serviceability or maintenance, staffing issues, volcanic activity, airspace constraints and any mitigation measures. This basic level of ATFM provides an opportunity to discuss and coordinate operations and allows significant benefits to be achieved very rapidly.

5.1.6 In any case, it is important that the procedures applied during the implementation process be developed in a harmonized manner among the various States to avoid risks to operational safety and efficiency. This entails defining a national and international strategy to facilitate and harmonize the implementation process.

5.1.7 Any ATFM system must be supported by formal international and national agreements (letters of agreement, etc.). The aeronautical information related to ATFM must be published in accordance with Annex 15 — *Aeronautical Information Services*. ATFM procedures must be consistent with *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444).

5.1.8 ATFM development: initial steps

5.1.8.1 This section focuses on the sequence of steps that should be taken to implement an ATFM service (see Chapter 3 for detailed guidelines on ATFM structure and organization):

- a) establish the objectives, project management plan, and oversight of ATFM, bearing in mind that:
 - 1) a project management approach is required to define clear tasks for each stakeholder and contain milestones; and
 - 2) the oversight of the implementation process should be carried out by the ANSP in collaboration with the relevant oversight authorities;
- b) identify the personnel who will lead the development of ATFM bearing in mind that:
 - 1) best practices indicate that the ANSP usually takes the lead; and
 - 2) key stakeholders from the AUs, airport operators, and military authority should be involved in the planning, development and implementation of ATFM;
- c) identify the stakeholders among the following (see Figure II-5-1):
 - 1) en-route centre supervisors and controllers;
 - 2) approach control supervisors and controllers;
 - 3) control tower supervisors and controllers;
 - 4) ATM planning and procedure experts;
 - 5) airline operations centre supervisors and dispatchers;
 - 6) meteorological office supervisors and specialists;
 - 7) appropriate military authorities;
 - 8) general aviation operations centre managers;
 - 9) airport operations centre managers;
 - 10) airline chief pilots;
 - 11) regulators; and
 - 12) others as identified;

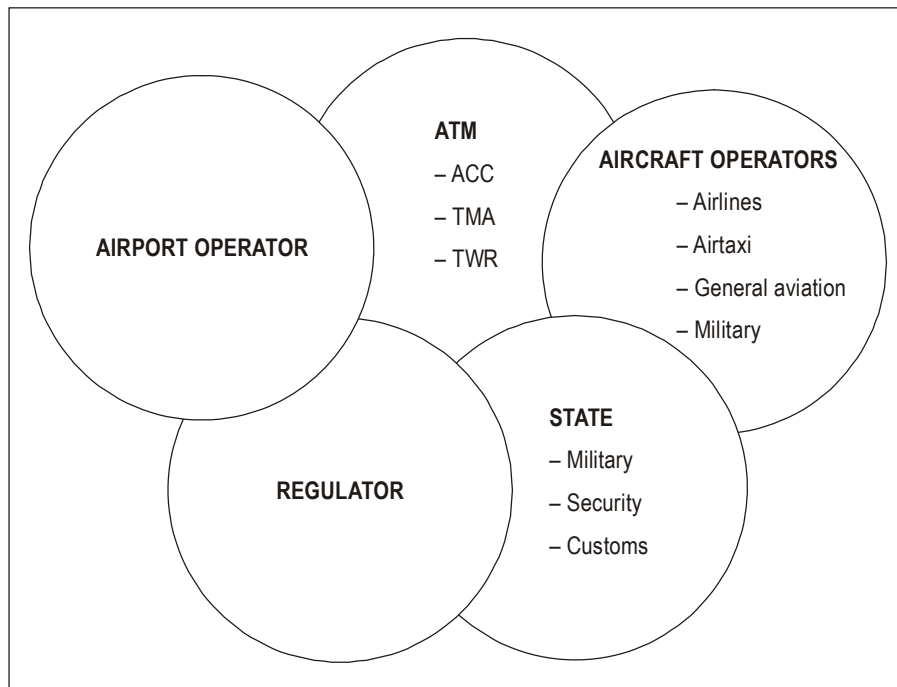


Figure II-5-1. Sample set of ATFM stakeholders per sector of activity

- d) brief the stakeholders on:
- 1) the project's purpose and objectives;
 - 2) the important terms and definitions used in the project;
 - 3) the plan for developing the ATFM service; and
 - 4) their respective roles and responsibilities;
- e) define the ATFM structure that is needed; it usually involves the following stakeholders:
- 1) manager of the ATFM organization;
 - 2) supervisor of the FMU;
 - 3) traffic management supervisors, from en-route centre, terminal and control tower;
 - 4) airline operations centre supervisors and/or dispatchers;
 - 5) meteorological office supervisors and specialists;
 - 6) military flight operations centre commanders;
 - 7) general aviation operations managers; and

- 8) airport operations managers;
- f) establish the CDM processes that will be used in ATFM (for guidelines on CDM, see Part I, 2.6);
- g) develop or adopt and apply a model for establishing the airport acceptance rate (AAR) at the relevant airports (see sample method in Appendix C);
- h) develop or adopt and apply a model for establishing en-route sector and terminal sector capacity (see sample models in Appendices D and E);
- i) identify the appropriate locations for FMUs and FMPs;
- j) identify the personnel in charge, the means of contact and the operational phone numbers for each stakeholder identified in the ATFM management structure;
- k) define the elements of common situational awareness (see Figure II-5-2):

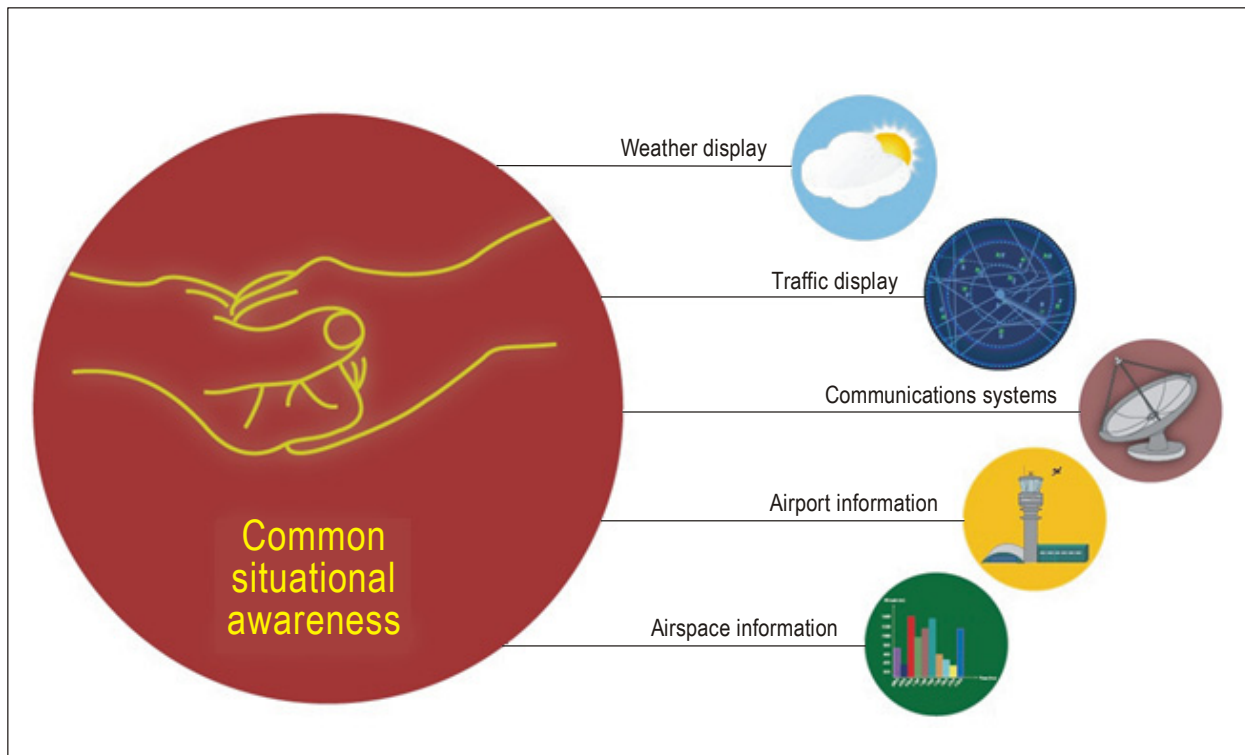


Figure II-5-2. Elements of common situational awareness

- 1) identify the type and format of the information related to airport situation and airspace capability;
- 2) identify the meteorological information that can be used collaboratively to assess the impact of weather on capacity. This information could come from:

-
- i) aerodrome routine meteorological reports (METAR in meteorological code form) and aerodrome forecasts (TAF in meteorological code form);
 - ii) forecast websites and charts;
 - iii) satellite websites and charts; and
 - iv) meteorological radar;
- 3) identify and use the tools that can be used collaboratively to display traffic and geographical information;
- l) identify the appropriate means of communication that will be used for ATFM:
- 1) telephone conferencing systems;
 - 2) web-based conferencing systems;
 - 3) web-based information dissemination and discussion portal similar to a blog format;
 - 4) electronic chat to support tactical discussion;
 - 5) operational information web pages; and
 - 6) any other appropriate means;
- m) develop the applicable ATFM operational letter of agreement (LoA) (see Appendices F and G for an LoA template between an FMU and an ACC, and between ANSPs, respectively);
- n) develop the procedures and training materials for FMUs, FMPs and stakeholders;
- o) develop the procedures and training materials for stakeholders;
- p) evaluate the need to apply safety management system processes when new ATFM tools and procedures induce a significant change to existing procedures, in line with existing provisions in PANS-ATM, 2.6.1.1;
- q) discuss and develop the ATFM measures that will be applied in order to balance air traffic demand and capacity;
- r) establish an implementation date for the ATFM service;
- s) train the appropriate personnel with regard to the processes and procedures necessary for ATFM implementation;
- t) implement the processes and procedures; and
- u) evaluate the results and coordinate changes as necessary, through a collaborative working arrangement that will ensure periodic review and provide feedback from users and stakeholders.

5.2 HOW CAN AN INTERNATIONAL ATFM SERVICE BE IMPLEMENTED?

5.2.1 What is an international ATFM service?

5.2.1.1 International ATFM aims at maximizing 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 defined in Chapter 1. More specifically, it aims at achieving, over a region or subregion, the seamless ATM environment that would exist if the entire ATFM service were served by a single ATFM centre, such as is envisaged in Chapter 3, 3.1.4 d). International ATFM contributes to enhancing the safety, efficiency, cost-effectiveness, and environmental sustainability of ATM. It is also a major enabler of the global interoperability of the air transport industry.

5.2.1.2 The main objectives of international ATFM are those outlined in Chapter 1, 1.2.1.1. However, the specifically 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.

5.2.1.3 ATFM centres collaborate with their stakeholders to provide their own service. However, there are circumstances where one single ATFM centre may not be effective in providing optimum ATFM service. In those cases, international ATFM becomes necessary. Such cases include, but are not limited to :

- a) airports or airspaces which handle large proportions of international flights; and
- b) airports or airspaces located in small-sized States or regions.

5.2.2 How can international ATFM be developed and implemented?

5.2.2.1 It is challenging to achieve the ideal international ATFM set-up right from the beginning. International ATFM can however be the shortest path to achieving an efficient ATFM environment, provided it is designed with this final goal in mind at all times. Staying focused on the final objective will also prevent wasteful investments. The ideal international ATFM is described in 5.2.3, with step-by-step implementation in 5.2.4.

5.2.2.2 The sequence of ATFM implementation described in 5.1 remains valid, but, as described in this section, the whole process must simply be envisaged in a larger set-up, induced by coordination between many air traffic services units located in several countries.

5.2.3 The ideal international ATFM

5.2.3.1 The ultimate goal of international ATFM is to achieve, over a region or a subregion, the creation of a seamless ATM service.

5.2.3.2 An essential aspect of the ideal end stage of international ATFM is the exchange of real-time ATFM information. The systems of all local ATFM centres must therefore be connected to each other, as well as to the systems of the relevant stakeholders. To spread awareness of the present situation, and to be able to predict future situations, the information that should be exchanged includes but is not limited to:

- a) ATC capacity, specified by airport or airspace volume;
- b) meteorological information and forecasts impacting capacity;

- c) traffic demand, i.e. flight schedules, flight plans, surveillance updates; and
- d) other information impacting ATC capacity such as military activities and route availability.

5.2.3.3 While each local ATFM centre could retain the authority to decide on the kind of measures it would like to implement when demand exceeds capacity, it is paramount that the ATFM centres possess a common view of the situation, and that the impact of each measure, required by a local ATFM centre, is collectively assessed at the level of the region or subregion. In the ideal set-up, all centres involve, through CDM, the relevant stakeholders and collaboratively decide to implement the ATFM measures that are needed over their subregion.

5.2.3.4 ATFM centres must continuously monitor the situation. Through that constant monitoring, a global supervision is established to oversee the effects of ATFM measures and to measure their efficiency and effectiveness. The global difference between the actual and predicted situations is monitored in order to balance demand and capacity at the international level.

5.2.3.5 In the framework of that permanent monitoring, should an ATFM centre detect a discrepancy between the predicted and the actual situation, it should take the appropriate actions to mitigate the effect of that difference on traffic. It shall however also take due account of the necessary reaction time of each stakeholder.

5.2.3.6 In the ideal international set-up, the ATFM service is therefore similar to the one that would be delivered by a single international unit. While that may not always be possible, it is however paramount that each ATFM centre considers the impact of the ATFM measures it envisages on the operations of other ATFM centres. It shall do so with equity, transparency, and with the aim of achieving the greatest overall efficiency.

5.2.4 Implementation of international ATFM in a phased manner

5.2.4.1 Step 1 — Recognition of the need for international ATFM

5.2.4.1.1 Should data show, for example, frequent delays recorded in a specific airport or indicate that interval separation has increased for in-bound traffic in a specific airspace block, a State should start to investigate the cause of those delays and increased separation. Meanwhile, it should start to prepare for ATFM by identifying the following:

- a) ATC capacity;
- b) air traffic demand and main traffic patterns and features, including city-pairs;
- c) ATFM systems and procedures in adjacent states or regions; and
- d) any other reason that could explain why the delay or the spacing interval increased:
 - 1) weather impact;
 - 2) increased demand;
 - 3) reduced capacity; and
 - 4) operational procedures.

5.2.4.1.2 The State shall then determine whether actions limited to the scope of an ATFM centre can resolve the issue. However, if, for example, much of the traffic originates from outside the area of responsibility of one of its ATFM centres, or if the investigation shows that the remedial actions go beyond the area of responsibility of a single ATFM centre, then it is time to consider regional ATFM.

5.2.4.2 **Step 2 — Sharing of information**

5.2.4.2.1 Once the investigation has highlighted that cooperation with adjacent States and regions is necessary to tackle the problem generating congestion and delays, the States concerned shall initiate cooperation with adjacent States, regions or subregions.

5.2.4.2.2 The first action is to implement mechanisms to share information, such as by email, person-to-person telephone calls, fax, teleconference, or any appropriate means of communication. Various communications protocols should be established, such as:

- a) a framework detailing the ATFM information to be exchanged in case of exceptional disruptions or unexpected difficulties;
- b) a framework detailing the ATFM information that should be exchanged regularly; and
- c) a framework detailing the ATFM data that should be exchanged for periodic post-operational analysis.

5.2.4.2.3 The following items are examples of data elements (the list is non-exhaustive) that would be relevant for international ATFM:

- a) conditions or capabilities of the main airports;
- b) actual and forecast weather conditions and anticipated impact on ATC capacity;
- c) expected runway closures;
- d) airspace or route closures, relevant military activity; and
- e) ATM system or communications, navigation and surveillance (CNS) disruptions having an impact on capacity.

5.2.4.2.4 When establishing international ATFM, one of the main elements to be recognized is the early notice that must 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 cases of overload. That measure has however a very significant impact over the ACC and the local ATFM centre that has to implement it. For that specific measure, and for any other ATFM measures, the first notion to integrate, when establishing international ATFM, is that of advanced notice to neighbouring facilities. It must be integrated in the coordination procedures set up between adjacent facilities. It should be noted, at this point, that the appropriate CDM processes will also spread the benefits of that advance notice to the operators as well as to all the relevant stakeholders.

5.2.4.2.5 In Step 2, all the ATFM units of a subregion therefore share data and maintain a common regional awareness. Every ATFM unit informs the other units and various stakeholders of the ATFM measures that will be used in its area of responsibility. AUs are involved in the decision-making process due to ongoing CDM processes.

5.2.4.3 **Step 3 — Notification of expected ATM measures in advance**

5.2.4.3.1 In the second phase of international ATFM implementation, if an ATFM centre plans to implement ATM measures, it must coordinate them with the other units and relevant stakeholders of its region or subregion before actually implementing them. 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.

5.2.4.3.2 Once the appropriate coordination has been conducted at the international level, with the appropriate stakeholders, each ATFM centre then publishes its ADP. (See Part II, 2.3.3 for further guidance on ADP.)

5.2.4.3.3 This coordinated and cooperative approach ensures that the solutions that are chosen are understood and implemented in the most effective manner.

5.2.4.3.4 Automated information exchange is an important enabler of international ATFM. Automated exchange systems ensure constant updates and contribute to maintaining the situational awareness of all the relevant stakeholders. It should be pointed out that the existence of those systems, involving a wide range of stakeholders, further emphasizes the importance of standardizing the format of the messages exchanged in the ATFM processes.

5.2.4.3.5 Step 2 of international ATFM is a phase where all the ATFM units of a region or subregion pool their resources to collectively agree on and implement a common ATFM action plan, therefore providing a seamless ATFM service for their region or subregion.

5.2.4.4 **Key elements of international ATFM**

5.2.4.4.1 International ATFM ensures that all the relevant stakeholders gain the adequate awareness of ATFM planning during strategic, tactical and pre-tactical phases.

5.2.4.4.2 International ATFM contributes to ensuring transparency of all ATFM activity for all stakeholders.

5.2.4.4.3 Post-operational analysis is a key element to improving ATFM in general. It is even more important in international ATFM because the collected data and lessons learned can be rapidly shared throughout the entire region or subregion in order to further enhance ATFM provision and its related policies.

Chapter 6

ATFM MEASURES

6.1 WHAT ARE ATFM MEASURES AND HOW ARE THEY ESTABLISHED AND APPLIED?

6.1.1 ATFM measures are techniques used to manage air traffic demand according to system capacity. Some ATFM measures must be considered as control instructions or procedures.

6.1.2 ATFM measures are also important initiatives for managing the flow of air traffic and, as stated in 6.1.1, should be used to manage traffic demand. However, these measures have an impact on AUs. Therefore, it is essential to implement only those measures necessary to maintain the safety and efficiency of the system. In other words, ATM personnel should employ the least restrictive methods available in order to minimize, as much as possible, the impact on flight operations.

6.1.3 The ANSPs and the AUs should, using ATFM strategy conferences, collaborate in the identification and selection of the ATFM measures applicable to any given area. All the stakeholders would therefore understand, from the outset, the application parameters, processes and procedures, and this would mitigate misunderstandings and prevent induced dysfunctions during operations. Such conferences could also allow discussions on foreseeable capacity reductions (due to, for example, scheduled runway maintenance) or ways to address a significant demand increase in periods of limited capacity (especially in the case of special and/or unforeseen events).

6.1.4 ATFM measures may only be required during periods when demand exceeds capacity.

6.2 TYPES OF ATFM MEASURES

6.2.1 There are many types of ATFM measures. Their lifetime typically spans the pre-tactical and tactical phases of the ATFM timeline. The list below is not exhaustive and provides guidance on where the various measures fall on the ATFM timeline (see Figure II-6-1).

6.2.1.1 *Miles-in-trail (MIT)*. A tactical ATFM measure expressed as the number of miles required between aircraft (in addition to the minimum longitudinal requirements) to meet a specific criterion which may be separation, airport, fix, altitude, sector or route specific. MIT is used to organize traffic into manageable flows as well as to provide space to accommodate additional traffic (merging or departing) in the existing traffic flows.

6.2.1.2 *Minutes-in-trail (MINIT)*. A tactical ATFM measure expressed as the number of minutes required between successive aircraft. It is normally used in airspace without air traffic surveillance or when transitioning from surveillance to non-surveillance airspace, or even when the spacing interval is such that it would be difficult for a sector controller to measure it in terms of miles.

6.2.1.3 *Fix balancing*. A tactical ATFM measure aiming at distributing demand and avoiding delays. The aircraft is assigned a different arrival or departure fix than the one indicated in the flight plan. This can also be used during periods of convective weather where a standard instrument arrival (STAR) or a standard instrument departure (SID) is unusable.

ATFM measures			
	Strategic	Pre-tactical	Tactical
Vertical			Re-routing (level capping scenarios)
Lateral	Collaborative trajectory options	Collaborative trajectory options	Fix balancing Re-routing (mandatory or alternative) Level capping scenarios Collaborative trajectory options
Longitudinal			Miles-in-trail Minutes-in-trail Minimum departure intervals
Time	Ground delay programme Airborne holding	Ground delay programme	Slot swapping Ground delay programme Ground stop Airborne holding

Figure II-6-1. ATFM measures

6.2.1.4 *Re-routing.* A tactical ATFM measure consisting of an ATC-assigned routing different from the one indicated in the filed flight plan. Re-routing can take a variety of forms, depending on the tactical situation.

6.2.1.4.1 *Mandatory re-routing scenarios.* Mandatory diversion of flows to offload traffic from constrained areas.

6.2.1.4.2 *Level capping scenarios.* A measure carried out by means of flight level restrictions (e.g. flights from London to Paris TMA shall file below FL285, with departures limited to FL245 until they exit the TMA).

6.2.1.4.3 *Alternative or advisory routing scenarios.* Routes which are made available to AUs on an optional basis to offload traffic from certain areas.

6.2.1.4.4 A re-routing is normally issued to:

- a) ensure that aircraft operate along with a required flow of traffic;
- b) remain clear of airspace under restrictions or reservations;
- c) avoid excessively congested airspace; and
- d) avoid areas of known meteorological conditions of such nature that aircraft have to circumvent it.

6.2.1.5 *Minimum departure intervals (MDIs)*. A tactical ATFM measure carried out when ATC sets a departure flow rate of, for example, 3 minutes between successive departures. MDIs are typically applied for no more than 30 minutes at a time and are typically applied when a departure sector becomes excessively busy or when capacity is suddenly reduced (e.g. equipment failure, meteorological conditions).

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

6.2.1.7 *Collaborative trajectory options*. A strategic, pre-tactical or tactical ATFM measure 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 to be held during periods of system constraint.

6.2.1.8 *Ground delay programme (GDP)*. A strategic, pre-tactical, or tactical ATFM measure. A GDP is 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 airport. In the process departure times are assigned and correspond to available entry slots into the constrained airspace or arrival slots into the constrained airport. Among others, a GDP aims at minimizing airborne holding. It is a flexible programme and its forms may vary depending on the needs of the ATM system. GDPs are developed in a collaborative manner and typically administered by an FMU or national/international ATFM centre. When a GDP is scheduled to last for several hours, slots might have to be revised due to changing conditions. There must therefore be a system in place to advise pilots of departure slots and any changes to the GDP.

6.2.1.9 *Ground stop (GS)*. A tactical ATFM measure where some selected aircraft remain on the ground. Due to the impact of a GS on an AU, alternative ATFM measures should be explored and implemented prior to a GS, time and circumstances permitting. The GS is typically used:

- a) in cases where capacity has been severely reduced at airports due to significant meteorological conditions or aircraft accidents/incidents;
- b) to preclude extended periods of in-flight holding, sector/centre reaching near saturation levels or airport gridlock;
- c) when a facility is unable or partially unable to provide ATS due to unforeseen circumstances; and
- d) when routings are unavailable due to severe meteorological conditions or catastrophic events.

6.2.1.10 *Airborne holding*. A tactical ATFM measure that has been designed strategically. It is a process that requires aircraft to hold at a waypoint in a predefined standard holding pattern. It is generally used to cope with short notice demand and capacity imbalances. It can also allow the establishment of an aircraft inventory that would be able to take advantage of temporary increases in capacity given at short notice, such as those that occur during certain types of meteorological events.

6.2.1.10.1 During the strategic planning phase, stakeholders collaborate to determine suitable locations for the holding patterns. Analysis has shown that the optimal flight levels for airborne holding, from a fuel efficiency perspective, are FL200–FL280. These flight levels strike the right balance between lesser fuel consumption for turbine-powered aircraft and the size of the holding area. Although inefficient holds at low altitudes should be avoided, there are cases where lower altitude holding areas can be designed to provide for a small ready supply of holding aircraft on short notice. In any case, holding altitudes should be compatible with normal descent profiles in order to avoid excessive rates of descent and airspeeds.

6.2.1.10.2 Airborne holding is complementary to a GDP and a GS. Airlines may, in collaboration with the ANSP, choose to use it 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.

6.2.1.10.3 Airborne holding generates a high workload for air traffic controllers (ATCOs) and pilots. Every effort must therefore be made to simplify the procedures and minimize communications during the process. Consideration must also be given to reducing sector capacity during airborne holding periods.

6.3 ATFM MEASURE APPROVAL AUTHORITY

The coordination and approval of ATFM measures must be conducted in accordance with the CDM process established for the provision of ATFM service. Publication in national AIPs and/or regional supplementary procedures is recommended.

6.4 ATFM MEASURES PROCESSING

Prior to implementation, the designated authority responsible for ATFM must identify the need for an ATFM measure, examine alternative options, and develop a justification for the ATFM measure. The ATFM authority will:

- a) discuss and coordinate the proposed ATFM measure with the receiving facility and stakeholders prior to implementation;
- b) notify affected facilities and stakeholders of the implementation in a timely and appropriate manner;
- c) continuously monitor and assess the ATFM measures to ensure they are producing the desired results;
- d) make any necessary adjustments, including the development of an exit strategy; and
- e) coordinate with and notify affected facilities and stakeholders of modifications and cancellations in a timely and appropriate manner.

6.5 APPLICATION OF ATFM SOLUTIONS

6.5.1 ATFM continuously and proactively considers all possible ATFM solutions through an iterative process that spans from the strategic planning phase to the execution of operations. Any new information can therefore be integrated immediately. Anticipating events makes it possible to minimize their impact on the ATM system and provides an opportunity to refine the plan further.

6.5.2 A variety of ATFM solutions may have to be considered to resolve capacity shortfalls and improve system management while minimizing constraints (see Figure II-6-2 for examples).

6.5.3 Once the declared and available capacities have been established, air traffic demand can be monitored and assessed, and ATFM measures can then be coordinated and implemented to strike a balance in the system.

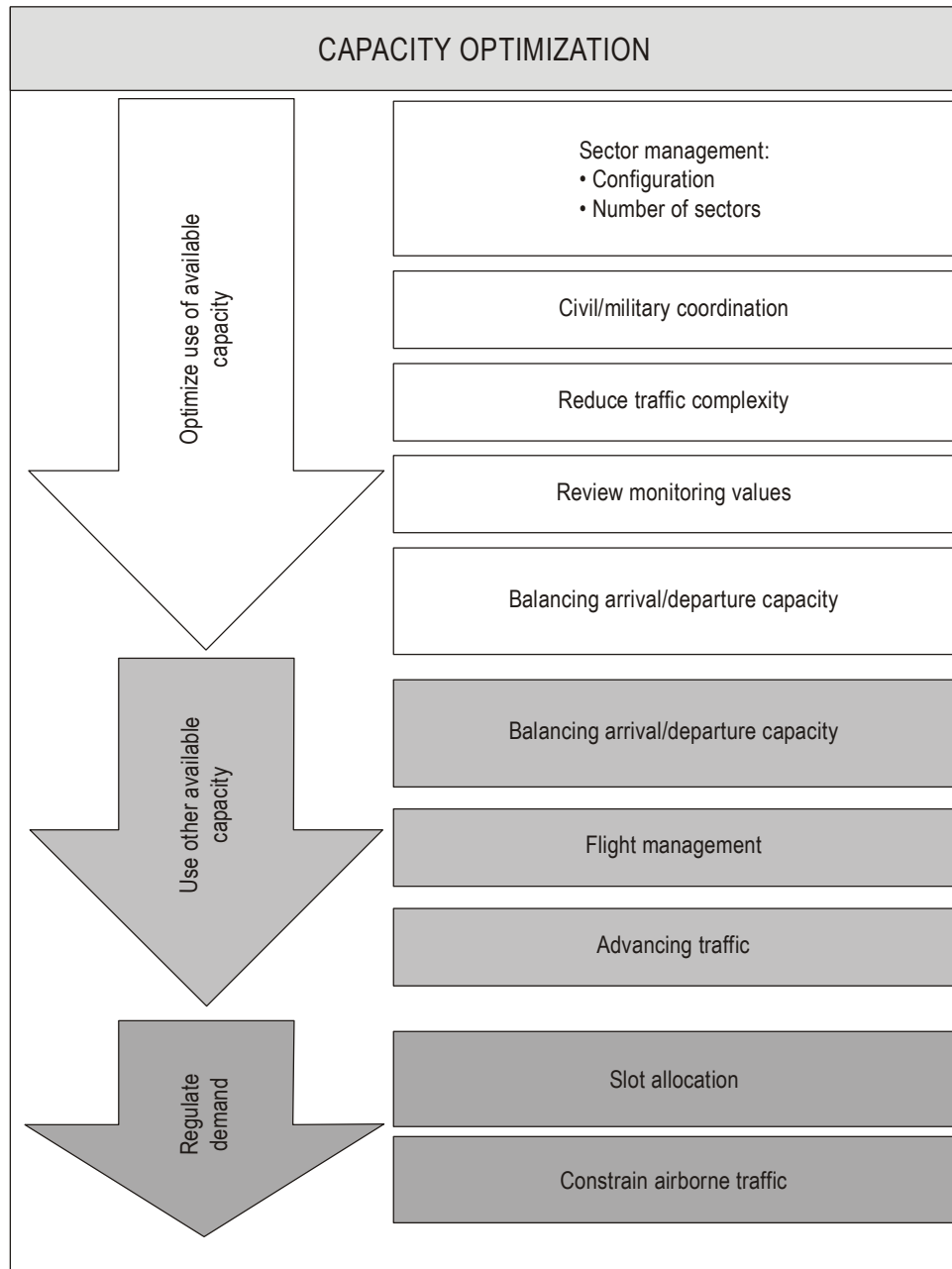


Figure II-6-2. Capacity optimization

6.5.4 The following example provides a general outline of the steps involved in the actions/analyses to optimize the use of the ATM system:

- a) determine capacities: review/assess airport/airspace sector capacities for accuracy;
- b) assess demand: determine forecasted demand for a specific time frame, e.g. 15-minute periods, hour(s);

- c) analyse and compare: demand and capacity levels shall be analysed and compared, focusing 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/parties involved through the means available, using the CDM processes;
- e) determine the action required for mitigating a demand/capacity imbalance: after requesting and collecting information, determine the ATFM measures that are appropriate for the situation;
- f) disseminate information: using the means of communication established to that end, inform the parties involved about the ATFM measures that will be applied;
- g) monitor the situation: examine the situation periodically, as necessary, to ensure that the ATFM measures mitigate the consequences of the imbalance. If necessary, reassess and make the corresponding adjustments; and
- h) conduct a post-event analysis: following the event, conduct an analysis by reviewing the weekly or monthly report of the FMU/FMP to evaluate the effectiveness of the ATFM measure and catalogue the best work practices.

6.6 ATFM EFFICIENCY CALCULATION

6.6.1 ATFM measures should be based on the principles set down in this guidance material. All parties of the ATFM system should abide by the same rules. They ensure that the ATM system capacity is optimized, to the greatest possible extent, in the safest and most efficient manner. For ATFM, efficiency encompasses fuel consumption and time factors. It should however be noted that, efficiency notwithstanding, there are cases where actions from ATFM units to balance capacity and demand will generate delays.

6.6.2 Delays have a great impact on AUs. Their route networks and schedules are built upon connections. The reliability of these connections enables passengers to board connecting flights, ensures that aircraft are available for the next leg of flight and impact 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.

6.6.3 As of yet, standardized ATFM delay calculation metrics across ANSPs have not been developed. This is due, on the one hand, to the difficulties of defining what constitutes a delay and, on the other hand, to the difficulty of determining which party (ANSPs, airport authorities and 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 of the ANSPs, airports, AUs and other stakeholders that form part of the ATFM process in the concerned area.

6.7 PRINCIPLES OF DELAY ANALYSIS

- 6.7.1 For practical reasons, the following considerations should be taken into account with regard to delays:
- a) common definitions must be agreed upon by ANSPs and other stakeholders;
 - b) some ANSPs and airport authorities measure airlines on-time departure performance, which then makes that metric important; and
 - c) delays should be calculated for each phase of flight.
- 6.7.1.1 Departure:
- a) all time in airline ramp/gate area should be measured;
 - b) taxi time should be measured including taxi-out duration, when it exceeds normal taxi-out time;
 - c) all time in penalty box, de-icing pads, etc., should be measured; and
 - d) all movement area delays should be measured.
- 6.7.1.2 En route:
- a) all airborne holding delays should be measured;
 - b) linear hold (route extensions, use of RTA, etc.) delays need to be measured; and
 - c) suboptimal routes imposed due to ATM infrastructure should be measured at a macro level and discussed during strategic CDM conferences.
- 6.7.1.3 Arrival:
- a) on time arrival should be measured (it is, financially speaking, more relevant to airlines than on time departure);
 - b) if consequential delays caused by cascading effects can be determined, they should only be measured once (e.g. if flight 2 has a delayed departure due to the aircraft being delayed on the inbound leg, it should not count as an additional delay); and
 - c) all movement area delays should be measured, including taxi-in duration exceeding normal taxi-in time.

6.8 ATTRIBUTION AND ACCOUNTABILITY FOR ATFM MEASURES

- 6.8.1 All ATFM entities must understand the reasons for ATFM measures and the entity that should be held accountable for them, as shown in 6.8.1.1 to 6.8.1.4. Appropriate and agreed definitions should be contained in local ATFM procedures.

6.8.1.1 Factors under ANSP control:

- a) flight calibration/flight check;
- b) equipment maintenance or failure;
- c) ANSP staffing;
- d) availability of strategies to mitigate the impact of capacity reductions due to abnormal meteorological conditions;
- e) flight arrival and departure sequencing; and
- f) non-optimization of capacity and configurations.

6.8.1.2 Factors under State control:

- a) activation of restrictions or reservations of airspace that affect capacity;
- b) special events: airshow, VIP activity, special sports events; and
- c) availability of special use airspace during periods of adverse meteorological conditions or other constraints.

6.8.1.3 Factors under airport control:

- a) airport infrastructure and configuration;
- b) airport construction affecting capacity;
- c) runway closure;
- d) taxiway closure;
- e) de-icing delays (exceeding unimpeded normal processing time);
- f) runway decontamination (sweeping, plowing);
- g) runway capacity reduction caused by the airport operator'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.).

6.8.1.4 Factors under AU control:

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

- b) inability to depart at a controlled departure (slot) time that is at or later than ETD.
- 6.8.1.5 Additional reasons for ATFM measures are:
- a) uncontrollable situations, e.g. capacity reductions due to significant meteorological conditions or unforeseen events;
 - b) delay classifications:
 - 1) departure delay (actual versus planned departure time), e.g. ATOT minus estimated take-off time (ETOT) or actual off-block time (AOBT) minus estimated off-block time (EOBT);
 - 2) ATFM delay, e.g. first calculated take-off time (CTOT) minus EOBT;
 - 3) airline scheduling practices;
 - 4) time spent waiting in queue for take-off;
 - 5) total airborne holding minutes;
 - 6) route extension in time and distance by flight phase; and
 - 7) arrival delay (actual versus planned arrival time).

6.9 REPORTING

6.9.1 For reporting purposes, stakeholders should report delays on a monthly basis, at least, and include trend analyses. Delays should be broken down by reason and geographically to support analysis. ANSPs are encouraged to provide the data electronically in a format that would support further processing by stakeholders.

6.9.2 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.

6.9.3 Studies have shown that there is roughly a 4:1 difference in cost between applying ground delays versus applying delays via airborne holding.

Chapter 7

DATA EXCHANGE

7.1 WHAT DATA IS EXCHANGED IN AN ATFM SERVICE?

7.1.1 As a key enabler to support the global development and further harmonization of ATFM, cooperation as well as coordination of ATFM activities between States must be enhanced. Therefore, States should ensure that operational data from ANSPs (e.g. traffic and flight data information, capacity information, delay and meteorological information, which have to be derived from a valid and authoritative source) is exchanged not only within their ICAO regions but also across ICAO regional boundaries, so that more efficient traffic flows can be achieved.

7.1.2 Data exchange is the sharing of information required for the effective provision of ATFM services. As depicted in Figure II-7-1, the data to be shared includes information related to the flight plan, capacity, demand, and ATFM measures.

7.1.3 The requirement for data sharing covers many different areas. As described in Part II, section 2.1, there is a requirement for the ATFM function to be constantly updated with information on the overall ATM resource (e.g. airspace status and airport infrastructure).

7.1.3.1 Many established ATFM units rely on databases that contain comprehensive details of the ATS organization in their areas of responsibility. These databases contain essential information to ATFM planning and daily operations including ATS routes and routing systems, airports, SIDs, STARs, aids to air navigation (NAVAIDs), ATC sectorization, etc.

7.1.3.2 Where such databases are available, the effectiveness of the ATFM service depends, to a large extent, on the completeness and accuracy of the associated information and on the timely exchange of data.

7.1.4 The ATFM unit also needs access to accurate and timely data with regard to ATC demand. Throughout the various stages of the ATFM planning horizon (strategic, pre-tactical, 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 be able to correctly assess the impact of various operations.

7.1.5 It is critical that the ATFM unit be provided with current information on the dynamic airport and airspace traffic demand and capacity situation in order to increase the accuracy of the tactical prediction.

7.1.6 Data exchanged between stakeholders is applied to facilitate:

- a) strategic planning:
 - 1) evaluate air traffic flow patterns;
 - 2) evaluate capacity and demand problems and patterns;
 - 3) collaborate and communicate with operational stakeholders; and
 - 4) validate and implement strategic ATFM measures for future events;

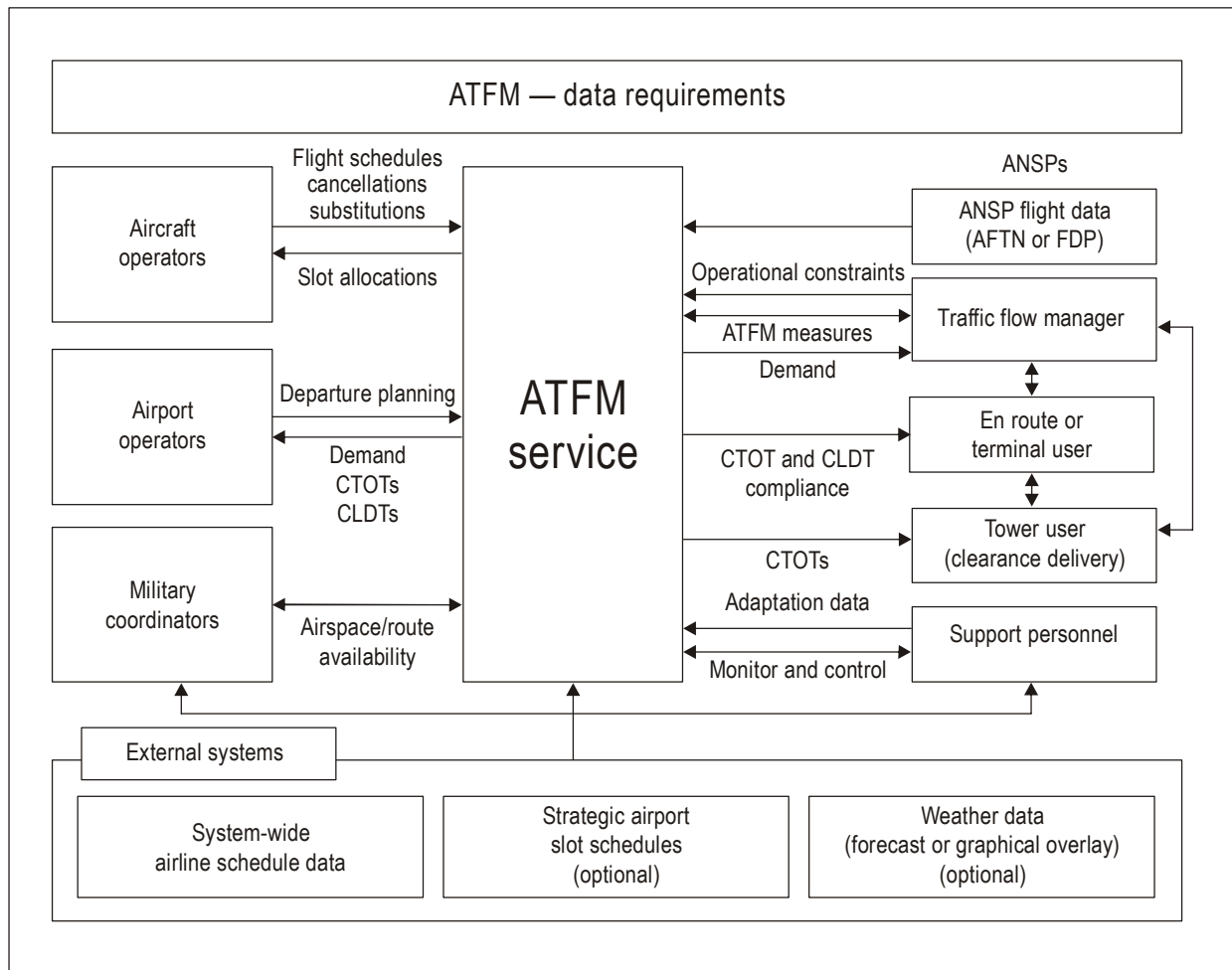


Figure II-7-1. Data requirements

b) pre-tactical planning:

- 1) monitor air traffic flows;
- 2) evaluate changing capacity and demand situations;
- 3) collaborate and communicate with operational stakeholders; and
- 4) implement, revise or cancel ATFM measures;

c) tactical planning:

- 1) monitor air traffic flows;
- 2) evaluate changing capacity and demand situations;
- 3) collaborate and communicate with operational stakeholders; and

- 4) implement, revise, or cancel ATFM measures;
- d) post-operational analysis:
 - 1) review and analyse operations from the previous days or hours; and
 - 2) support and improve future planning functions and processes.

7.2 BENEFITS OF DATA EXCHANGE

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 system. This leads, in turn, to increased safety and efficiency in air traffic operations, including: increased efficiency for traffic flows, reduced delays, enhanced predictability and reliability of AU schedules, and reduced impacts on the environment from greenhouse gas emissions and noise pollution. It also optimizes contingency responses to unforeseen events and system disruptions.

7.3 DATA EXCHANGE

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

7.3.2 Whereas the widespread sharing of ATFM data is generally of benefit to the ATFM system and its operational stakeholders, appropriate safeguards for its correct use should be put in place. The provision of ATFM data will normally be subject to national freedom of information policies. In the case of international ATFM activities, the ATFM data policy should reflect the data policies of all national entities involved.

7.3.3 ATFM data is normally supplied for operational ATFM purposes. An ATFM data policy should define:

- a) duration and back-up arrangements of data storage for investigation and post-operational purposes;
- b) restrictions on the release of data to the general public and to commercial organizations;
- c) provisions for the release of data to State, judicial and authorized investigative agencies;
- d) restrictions on the use of ATFM data for other than operational ATM purposes;
- e) provisions for cost recovery associated with the retrieval and supply of ATM data; and
- f) restrictions regarding the provision of data on military and other special status flights.

7.4 INTERNATIONAL DATA EXCHANGE SPECIFICATIONS

7.4.1 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.

7.4.2 Flight data is provided to ATFM units and operational stakeholders for the purpose of ATM. Such data should not be released to third parties unless covered by a predefined data policy.

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

7.5 DATA TYPE DESCRIPTION AND HARMONIZATION

Automated ATC information contained in ICAO message types is the foundation for data exchange programmes. Examples of the ICAO message types are:

- a) flight plan;
- b) flight amendment;
- c) flight plan cancellation;
- d) flight departure;
- e) flight coordination; and
- f) flight arrival.

7.6 ATFM TOOLS

Depending on the size and complexity of the ATFM service to be provided, a set of ATFM tools may be implemented to enable partial automation of ATFM. Table II-7-1 provides an overview of ATFM tools to support planning, prediction, execution and analysis of ATFM measures.

Note.— If available, it is recommended to couple ATFM execution tools with ATC sequencing and metering tools, such as arrival and departure management (AMAN/DMAN) systems, to achieve further capacity and efficiency benefits.

Table II-7-1. ATFM tools

<i>ATFM tools</i>				
<i>Planning tools</i>	<i>Prediction and monitoring tools</i>	<i>Execution tools</i>	<i>CDM tools</i>	<i>Analysis tools</i>
Airspace design and ATS route planning tools	Demand and workload prediction tools	Slot allocation tools	Information exchange tools	Data analysis and reporting tools
Capacity analysis and workload modelling tools	Weather prediction tools	Route and fix balancing tools	Collaboration tools	Replay support tools
	Monitoring tools	Flight level balancing tools	Electronic user helpdesks	
		Airspace user slot swapping tools	Crisis management tools	

Chapter 8

ATFM COMMUNICATION

8.1 COMMUNICATION

The communication and exchange of operational information between stakeholders on a real-time basis forms the backbone of ATFM. This exchange may be accomplished by a variety of means including by telephone, web conferences, email, electronic data exchange and web page displays. The purpose of the information exchange is to increase stakeholder situational awareness, to improve operational decision-making, and to enhance the efficiency of the ATM system.

8.2 STAKEHOLDER ATFM COMMUNICATION

8.2.1 An ATFM unit requires several layers of communication. As a basis for the exchange of information, NOTAM and AIP supplements could 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.

8.2.2 As the functionality of an ATFM unit develops, consideration should be given to developing a more ATFM specific communication structure for the notification of ATFM measures. For example, to facilitate AU awareness, the ATFM unit could produce and distribute the ADP on the day prior to the operation in order to provide a summary of the planned operations and ATFM measures in their area of responsibility. It could also allow distribution of any specific instructions or communications requirements associated with those measures and could be updated by ADP amendments.

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

8.2.3 In addition to the production and distribution of ADPs, the ATFM unit could produce ATFM messages to provide information and guidance. These messages could be used for the initial publication of changes in the availability of runways, ATS routes and airspace in the area, and could serve as the vehicle for the initial publication of new and amended ATFM operating procedures, which affect all users.

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

8.2.5 Each national AIP could include ATFM information on specific arrangements for dealing with ATFM issues and coordination matters as well as the telephone numbers of relevant ATFM units to contact for ATFM advice and information.

8.3 ATFM COMMUNICATION OVERSIGHT

8.3.1 For consistency, the appropriate authority should ensure that a single office provides oversight of the dissemination of ATFM information and measures, and is responsible for monitoring, collecting and disseminating that information. This oversight will ensure that applicable information is shared by all ANSPs and operational stakeholders in a timely and efficient manner.

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

- a) current airport runway configurations;
- b) AARs;
- c) airport departure demands;
- d) en-route sector demand and capacity imbalances;
- e) runway closure or airport conditions;
- f) NAVAID outages;
- g) ATM infrastructure; and
- h) activities on airspace under restrictions or reservations.

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

8.3.3 ATFM units should develop an internal operations manual for their respective facilities to address the ATFM measures process. For example, the operations manual could 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 on the constant monitoring and adjusting of ATFM measures; and
- c) disseminate information on the timely cancellation of ATFM measures.

8.4 COMMUNICATING ATFM INFORMATION

8.4.1 There is a requirement for AUs and ATFM units to communicate and exchange information for the purposes of CDM and information dissemination.

8.4.2 Since the involvement of ATFM units and AUs may vary significantly, the tools for exchange of information must be geared to meet the stakeholder's capabilities and requirements.

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

8.4.4 The following communication methods are offered as examples:

- a) scheduled telephone (or web) conferences: these consist of defining times at which the ATFM units will hold daily operational conferences to exchange ATFM information and to meet their operational needs;
- b) tactical telephone conferences: these consist of establishing a procedure to convene non-scheduled ATFM teleconferences, held in real time and at a tactical level, in order to make the necessary operational adjustments; 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) provided to share information about the ATM system in order to develop a common situational awareness and minimize the workload.

8.5 ATFM WEB PAGES

For ATFM units that elect to create web pages with relevant ATFM information, examples could include:

- a) airport operational status information:
 - 1) current and planned active runway configuration;
 - 2) AAR/departure rate;
 - 3) information concerning delays — duration and outlook;
 - 4) meteorological information;
 - 5) scheduled flight inspections/calibrations;
 - 6) ATFM measures;
 - 7) low visibility procedures;
 - 8) de-icing operations; and
 - 9) airport or runway closures;
- b) airspace operational status information:
 - 1) actual and planned capacity by sector;
 - 2) anticipated demand by sector;
 - 3) meteorological conditions likely to affect capacity or demand;
 - 4) special use airspace status; and
 - 5) ATFM measures;

- c) ATFM stakeholder planning teleconferences:
 - 1) schedules; and
 - 2) joining instructions;
- d) ATFM strategic, pre-tactical and tactical plans; and
- e) links to ATFM-related information:
 - 1) weather websites;
 - 2) ACC and APP contact information;
 - 3) letters of agreement;
 - 4) route information;
 - 5) GNSS operational status;
 - 6) ATFM-related NOTAMs; and
 - 7) contingency plans.

8.6 ATFM TERMINOLOGY

8.6.1 What terminology/phraseology is used in ATFM?

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

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

8.6.1.3 Coordination with international stakeholders may impose the use of English language, unless there is consensus to use another common language.

8.6.1.4 The use of standardized terminology as contained in this manual should be employed to guarantee global consistency on how ATFM messages are communicated among ATFM units. This includes the concept of modular and structured ATFM messages and defines the components of the message as who, what, when, where and why.

8.6.1.5 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.

8.6.1.6 Each ATFM coordination message should have five components (who, what, when, where, why) that contain plain language elements and that, when combined, provide a complete ATFM message as follows:

- 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: FROM NOW 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 which aircraft or traffic the restriction will apply to. The modifying clause and the location combination are used to construct the “where” component;

examples: FOR ALL AIRCRAFT LANDING EL DORADO INTERNATIONAL AIRPORT
FOR ALL TRAFFIC LANDING CAIRO INTERNATIONAL AIRPORT
FOR ALL TRAFFIC FILED VIA B881

- e) *Why*: this identifies the reason for the ATFM objective:

examples: DUE TO SEVERE WEATHER OVER
EL DORADO INTERNATIONAL AIRPORT
DUE TO A LONG-RANGE RADAR OUTAGE
DUE TO EXCESS SECTOR DEMAND
DUE TO AN AIRCRAFT INCIDENT

8.6.2 Complete message

The following is an example of a complete message:

CGNA THIS IS COLOMBIA FMU. REQUEST 30 MILES IN TRAIL FOR ALL AIRCRAFT LANDING EL DORADO INTERNATIONAL AIRPORT FROM NOW UNTIL 1700 UTC DUE TO SEVERE WEATHER OVER EL DORADO INTERNATIONAL AIRPORT

8.6.3 Message amendment

8.6.3.1 The amendment of an ATFM message should include similar elements but with additional modifiers, including:

- a) change;
b) amend;

- c) reduce;
- d) increase; and
- e) decrease.

8.6.3.2 The following is an example of a message amendment:

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

8.6.4 Message cancellation

8.6.4.1 The cancellation of an ATFM message should contain a cancelling word or phrase. Cancellation messages should also identify which message is being cancelled because several ATFM measures could be in place at one time. 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.

8.6.4.2 The following is an example of a message cancellation:

CARACAS FMU THIS IS GEORGETOWN FMU, CANCEL THE GROUND STOP FOR CHEDDI JAGAN INTERNATIONAL AIRPORT DUE TO THE RUNWAY NOW OPEN

8.6.5 What resources are available to States regarding the various aspects of ATFM?

The information in Appendices A to G pertains to the implementation of ATFM between 2006 and 2013. It relates to the experiences of some States/international organizations in the planning, implementation and application of ATFM. These appendices provide information that can be used with regard to implementing an ATFM service.

Appendix A

SAMPLE INTERNATIONAL ATFM OPERATIONS PLANNING TELEPHONE CONFERENCE FORMAT

Note.— Appendix A 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

xxxxZ planning telecon
covering the time frame from xxxx UTC to xxxx UTC

Situation

The current situation is: ...

Issues

We will be discussing: ...

Common weather products — working from

- 1) the ICAO area “_” Prog chart, valid xxxx UTC for (date)
- 2) the ICAO area “_” IR satellite photo, 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 and atmospheric conditions

thunderstorm activity
turbulence
volcanic ash plumes

Terminal discussion

For select airports:
airport/sector capacities
projected terminal demand
airport constraints, such as construction projects or NAVAID outages

Anticipated traffic management measures

expanded miles-in-trail
potential airborne holding
potential ground stops

En-route discussion

en-route constraints, such as frequency outages or
NAVAID outages
route discussion and issues

Anticipated traffic management measures

expanded miles-in-trail
potential airborne holding

Additions to the plan, including any pertinent tactical updates.

Stakeholder input, comments and questions.

Next planning telecon: xxxxZ

Appendix B

SAMPLE AIR TRAFFIC MANAGEMENT (ATM) DATA EXCHANGE AGREEMENT

Note.— Appendix B provides a sample format regarding an agreement for the exchange of ATM data between States.

AGREEMENT xxxx BETWEEN (STATE NAME) AND (STATE NAME) FOR THE EXCHANGE OF AIR TRAFFIC FLOW MANAGEMENT (ATFM) DATA

ARTICLE I — PURPOSE

The purpose of this Agreement is to establish the terms and conditions for cooperation between (State name) and (State name) in the exchange of non-critical radar and flight data. The exchange of data will enhance the cooperation and coordination of air traffic management (ATM) activities between (State name) and (State name).

ARTICLE II — SCOPE OF WORK

(State name) and (State name) agree to exchange flight data and other information concerning international and domestic instrument flight rules (IFR) aircraft to enhance the cooperation and coordination of ATM activities. This data will be used by each 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 ATFM activities between (State name) and (State name).

ARTICLE III — PROCEDURES

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.

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 chairpersons in reports of those meetings.
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 (ATS). The data shall be formatted to be usable in each system and exchanged using data communications systems as mutually agreed.
4. *Types of data.* Types of data to exchange include non-critical radar and flight data information concerning international and domestic IFR aircraft, including flight and flight plan modifications, cancellations, amendments and related changes.
5. *Communications protocol.* The information shall be exchanged using agreed data communications protocol. Communications protocol and other necessary requirements shall be arranged as mutually agreed. The Parties agree to provide, at the earliest possible date, notice of proposals for the development of changes to hardware, software and documentation applicable to traffic management data and supporting interfaces.
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

1. Data on State and military aircraft shall not be released to a third Party, unless approved through mutual agreement by both Parties.
2. All data may be released by (State name) or (State name) to aviation stakeholders through programmes under the same terms and conditions found in the agreements entered into between (State name) or (State name). Air navigation service providers, aircraft operators, national security or safety authorities and research and development (R&D) institutes for ATM improvement are defined as aviation stakeholders. (State name) and (State name) shall be responsible for data administration in the provision for those Parties.
3. Each Party shall make every effort to ensure that the other Party's ATFM data is not released or rebroadcast 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

The designated points of contact between xxx and yyy for coordination and management of this Agreement are:

1. For (State name): Manager
 Address, phone, fax, email

2. For (State name): Manager
 Address, phone, fax, email

The designated points of contact between (State name) and (State name) for technical issues under this Agreement are:

1. For (State name): _____

2. For (State name): _____

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 6 months' written notice to the other Party.

ARTICLE VIII — AUTHORITY

The (State name) and (State name) agree to the terms of this Agreement as indicated by the signatures of their duly authorized officers.

(State name): _____	(State name): _____
by: _____	by: _____
Title: _____	Title: _____
Date: _____	Date: _____

Appendix C

DETERMINING AIRPORT ACCEPTANCE RATE (AAR)

Note.— Appendix C 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 for establishing the acceptance rate, as outlined in FAA Order JO 7210.3X, Facility Operation and Administration, Chapter 10, Section 7.

1. DEFINITIONS

- a) *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; and
- b) *airport primary runway configuration*: an airport configuration which handles 3 per cent or more of the annual operations.

2. ADMINISTRATIVE CONSIDERATIONS

- a) identify the organization responsible for the establishment and implementation of AARs at select airports;
- b) establish optimal AARs for the airports identified; and
- c) review and validate the airport 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 weather conditions:

- a) visual meteorological conditions (VMC): weather allows vectoring for visual approaches;
- b) marginal VMC: weather does 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; and
- d) low IMC: weather dictates 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 groundspeed by the spacing interval to determine the optimum AAR;
- 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, as shown in the example below, or use Table II-App C-1.

Example: $130 \text{ kt} / 3.25 \text{ NM} = 40$ Optimum AAR = 40 arrivals per hour

$125 \text{ kt} / 3.0 \text{ NM} = 41.66$ round down to 41

Optimum AAR = 41 arrivals per hour

Table II-App C-1. Optimum AAR

	<i>NM between aircraft at the runway threshold</i>									
	3	3.5	4	4.5	5	6	7	8	9	10
<i>Ground speed at the runway threshold</i>	<i>Potential AAR</i>									
140 kt	46	40	35	31	28	23	20	17	15	14
130 kt	43	37	32	28	26	21	18	16	14	13
120 kt	40	34	30	26	24	20	17	15	13	12
110 kt	36	31	27	24	22	18	15	13	12	11

3.3 Identify any conditions that may reduce the optimum AAR, including:

- 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 factors listed in 3.3 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, including:
 - 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, expressed as shown in Table II-App C-2.

Table II-App C-2. Example of actual AAR

<i>Runway configuration</i>	<i>AAR for VMC</i>	<i>AAR for marginal VMC</i>	<i>AAR for IMC</i>
RWY 13	24	21	19
RWY 31	23	20	17

Appendix D

DETERMINING SECTOR CAPACITY

Note.— Appendix D provides an example of a simplified methodology for determining sector capacity at an ACC. This methodology is based on the scientific process developed by the Federal Aviation Administration for establishing the sector capacity.

1. Sector capacity is determined using the average sector flight time in minutes from 7 a.m. to 7 p.m., Monday through Friday, for any 15-minute time period.

2. The formula used to determine sector capacity is:

$$\frac{(\text{average sector flight time in minutes}) \times (60 \text{ seconds})}{36 \text{ seconds}} = \text{sector capacity value}_{\text{optimum}}$$

3. The steps to follow are:

- a) manually monitor each sector, observe and record the average flight time in minutes;
- b) after that time is determined:
 - 1) multiply that 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) the result is the sector capacity value (optimum).

4. Adjustments: the optimum value for a sector is then adjusted for factors such as:

- a) airway structure;
- b) airspace volume (vertically and laterally);
- c) complexity;
- d) climbing and descending traffic;
- e) terrain, if applicable;
- f) number of adjoining sectors that require interaction;
- g) military operations; or
- h) use Table II-App D-1.

Table II-App D-1. Simplified method

<i>Average sector flight time (in minutes)</i>	<i>Optimum sector capacity value (aircraft count)</i>
3	5
4	7
5	8
6	10
7	12
8	13
9	15
10	17
11	18
12 or more	18

Appendix E

CAPACITY PLANNING AND ASSESSMENT PROCESS

Note.— Appendix E provides information developed by EUROCONTROL to provide information related to the ATFM capacity and planning assessment process. See attachment to this appendix for definitions of terms used.

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, an annual capacity planning and assessment process — 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 using the following indicators:

- a) *average ATFM delay per flight*: the average ATFM delay per flight is the ratio between the total ATFM delay and the number of flights in a defined area over a defined period of time; and
 - 1) 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
- c) *effective capacity*: effective capacity is defined as the 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 requirement for the ATM system. This can be done in different ways, but preferably through the use of a future ATM profile (FAP) involving a combination of different modelling and analysis tools (see Figure II-App E-1).

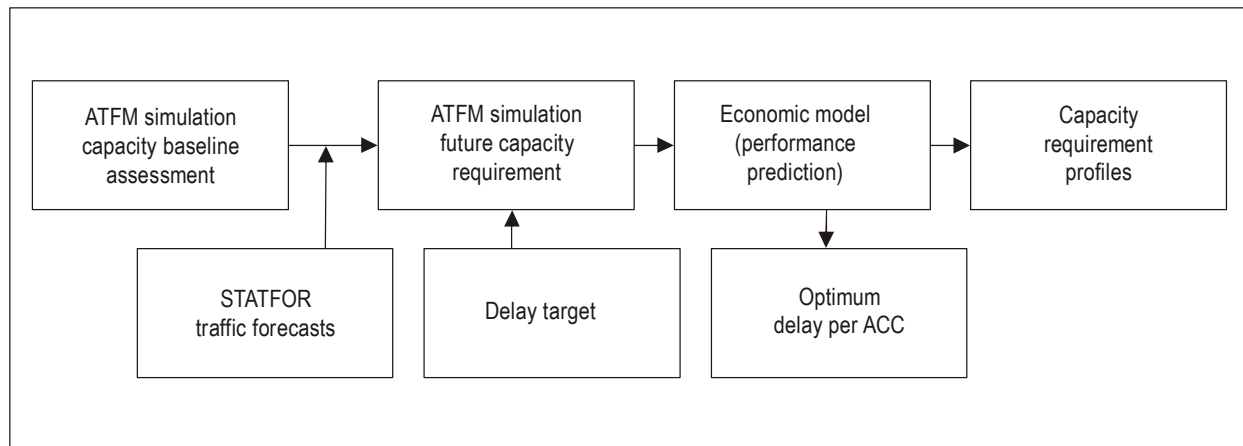


Figure II-App E-1. Key FAP processes

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 ACC and sector group levels. This is done according to the following steps:

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 5 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 **5-year capacity requirement profile**. Percentage increases with respect to the measured capacity baseline are provided.

3. EXPECTED DEMAND ON THE FUTURE ROUTE NETWORK

Medium-term capacity requirements

3.1 Medium-term capacity requirements at the ACC or sector group level can only be assessed once one has an idea of the expected traffic volume and distribution over the future route network in the area concerned. The expected demand at the ACC or sector group level should be assessed by the FAP tool from:

- a) the forecast 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.

Future route network evolution and traffic distribution

3.2 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 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.

3.3 Changes 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.

3.4 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.

3.5 Traffic flows respecting these assumptions should be simulated by the appropriate tools and serve as an input to the FAP simulations. The result of these simulations should be a horizontal and vertical traffic distribution over the future route network, allowing the determination of the 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 larger cost. Both capacity and delay costs are borne by AUs. 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 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 changes 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 in an updated total cost curve for each ACC.

Calculation of the required capacity profiles

4.5 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 E-2).

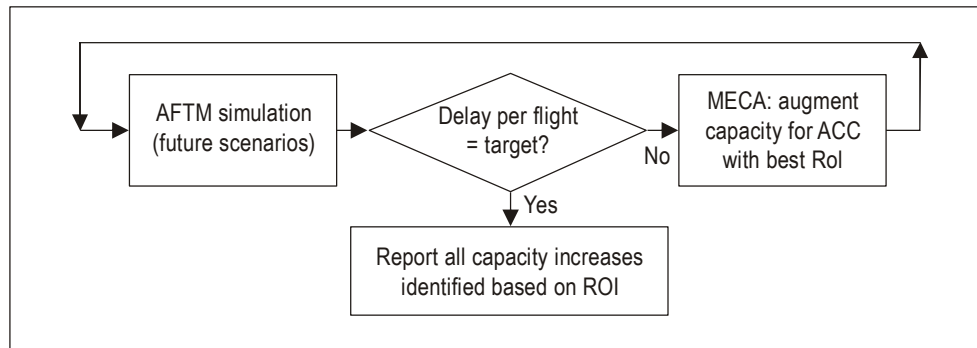


Figure II-App E-2. Iterative ATFM network simulations with best ROI to achieve target delay

4.6 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 that there are changes to ACC or sector group configurations. Capacity levels are interpolated for intermediate years.

4.7 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 section 2 of this appendix).

4.8 Figure II-App E-3 shows an ACC with an optimum capacity (green), an ACC with a capacity shortfall (red) and an ACC with a surplus capacity (blue). For the ACC with optimum capacity, the requirement is only to cover the forecast 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.

4.9 If the network delay is close to the target delay, the optimum delay at ACC level is an effective tool to identify areas that still have a capacity gap.

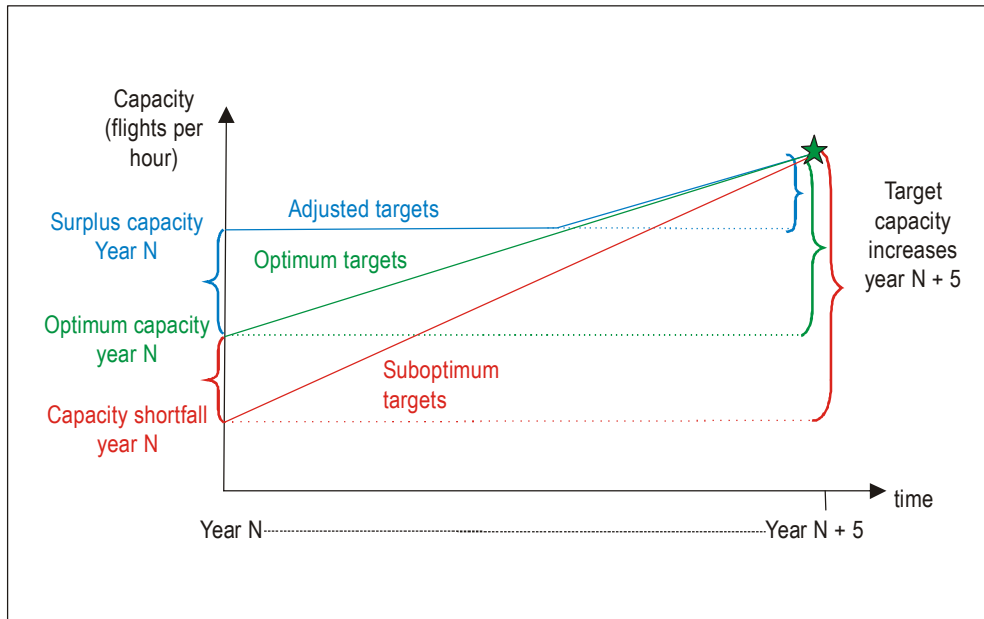


Figure II-App E-3. ACC current versus target capacity

5. THE CAPACITY PLANNING WORK PROGRAMME

5.1 Table II-App E-1 describes the different phases of the annual work programme and lists the required actions and responsibilities.

Table II-E-1. Actions, deadlines and responsibilities

<i>Date/Event</i>	<i>Action ATFM function</i>	<i>Action ANSPs</i>
October–December Capacity planning meetings for the short- and medium-term	Provide all relevant data to enable the ANSP to prepare a first draft of the local capacity plan:	Prepare the draft capacity plan prior to the meeting with capacity enhancement function (CEF).
	<ul style="list-style-type: none"> – as data becomes available; and – at least 2 weeks before the meeting 	Ensure the participation of both planning and operational staff at the meeting.
November–December Completion of the capacity plan	Complete the capacity chapter: <ul style="list-style-type: none"> – by end of December 	Finalize the capacity plan: <ul style="list-style-type: none"> – by end of November
November–February ATFM and capacity report for previous year	Coordinate and agree with ANSPs on the content with respect to the analysis of ACC performance: <ul style="list-style-type: none"> – by end of January 	Review and agree on the ACC performance analysis content provided by ATFM function: <ul style="list-style-type: none"> – by end of January

<i>Date/Event</i>	<i>Action ATFM function</i>	<i>Action ANSPs</i>
	Finalize report: – by end of February	
January Agreement and development of the medium-term capacity profile scenarios	Prepare the airspace scenario data for profile calculation following coordination with ANSPs: – by end of February	Provide ATFM function with details of configuration changes (planned or proposed) during the 5-year planning cycle for ACCs and requested sector groups: – by 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 Provide the new medium-term traffic forecast: – by end of February Merge the short- and the medium-term traffic forecasts.	Attend the user group meetings to ensure that all information relevant to the traffic forecast is provided to the ATFM function: – by the end of December
March Calculation of medium-term capacity profiles (including optimum delay per ACC)	Calculate the optimum delay for each ACC: – by mid-March Calculate the capacity requirement profiles for ACCs and requested sector groups: – by mid-March	Agree on the capacity profiles and optimum delay per ACC for use as a basis for the local capacity plan: – by end of April
March Calculation of the delay forecast for the coming vacation season and next 2 years	Make the delay forecast for the coming vacation season and the next 2 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
March The 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.

<i>Date/Event</i>	<i>Action ATFM function</i>	<i>Action ANSPs</i>
<p>April Publication of the operations plan for the coming vacation season</p>	<p>Incorporate the vacation capacity plans into the plans:</p> <ul style="list-style-type: none"> – by mid-March <p>Release the first version of the vacation plan:</p> <ul style="list-style-type: none"> – by mid-March 	<p>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:</p> <ul style="list-style-type: none"> – by end of February – as they occur, throughout the vacation season
<p>May Coordination and agreement of medium-term capacity profiles</p>	<p>Coordinate bilaterally with ANSPs and agree on the profiles that will be used as the basis for local capacity planning in the medium term:</p> <ul style="list-style-type: none"> – by end of March <p>Present the capacity profiles to the next meeting of the appropriate authorities for approval:</p> <ul style="list-style-type: none"> – May meeting 	
<p>June Publication of the medium-term ATM capacity plan</p>	<p>Collect and consolidate all the local medium-term capacity plans and complete an analysis of the expected situation at network and local levels:</p> <ul style="list-style-type: none"> – by end of April 	
<p>July ACC capacity requirement profiles published</p>	<p>Release document:</p> <ul style="list-style-type: none"> – by end of July 	
<p>July–August ACC/sector group capacity baseline assessment period</p>	<p>Inform ANSPs of the reference dates and request confirmation of data quality:</p> <ul style="list-style-type: none"> – by end of June <p>Calculate the baselines for ACCs and requested sector groups according to the airspace structure scenarios defined for the capacity profiles:</p> <ul style="list-style-type: none"> – by end of August 	<p>Confirm that fully accurate sector capacity and opening scheme data will be provided to the ATFM function:</p> <ul style="list-style-type: none"> – 1 week before the reference period

<i>Date/Event</i>	<i>Action ATFM function</i>	<i>Action ANSPs</i>
	<p>In addition to the baseline assessment, calculate the capacity baselines using appropriate simulation and calculation tools:</p> <ul style="list-style-type: none"> – by end of August 	<p>Ensure that the sector capacity and opening scheme data are sufficiently accurate for the baseline assessment:</p> <ul style="list-style-type: none"> – two AIRAC cycles before the start of the AIRAC containing the measurement period
September–October ACC capacity baselines coordinated with the ANSPs	<p>Communicate the baseline results to ANSPs on a bilateral basis for discussion and agreement:</p> <ul style="list-style-type: none"> – by mid-September <p>Present the agreed ACC baselines to the next meeting of the appropriate authorities</p> <ul style="list-style-type: none"> – at October meeting 	<p>Agree on the capacity baselines for the next planning cycle:</p> <ul style="list-style-type: none"> – prior to meeting of the appropriate authorities

Capacity planning meetings

5.2 Once per year, the ATFM function should visit the majority of ANSPs in the area concerned to collect information on capacity plans for the next 5 years and the coming vacation season. It is essential to the improvement of ATM capacity at the overall network level for each ACC to have a robust capacity planning process and a realistic capacity plan.

5.3 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 airports).

5.4 Prior to each meeting, the ATFM function provides the ANSP with a set of data to enable them to prepare the preliminary capacity plan, tailored to local conditions. The data set should include the following:

- a) a report and analysis of 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 5-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 route scenarios; and
- j) other relevant capacity information.

5.5 ANSPs 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.

5.6 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.

Attachment

DEFINITIONS OF TERMS USED IN APPENDIX E

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. 3 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 ACC/sector group capacity above) for the ACC and defined sector groups.

Capacity profile. The evolution of required capacity over the 5-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 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, weather, 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 ACC at the time.

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 re-triggered 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. 3 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 a 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 F

SAMPLE LETTER OF AGREEMENT (LOA) BETWEEN A FLOW MANAGEMENT UNIT (FMU) AND AN AREA CONTROL CENTRE (ACC)

**LETTER OF AGREEMENT (LOA) BETWEEN
ANSP1 AIR TRAFFIC MANAGEMENT CENTRE (ATMC) AND
ANSP2 AREA CONTROL CENTRE (ACC)**

DOCUMENT MANAGEMENT

Table of Contents

- 1. Overview**
 - 1.1 Introduction
 - 1.2 Objective
 - 1.3 Scope
 - 1.4 Deviation
 - 1.5 Responsibility
 - 1.6 Effective date

- 2. Policy and Definitions**
 - 2.1 Policy
 - 2.2 Definitions

- 3. Coordination Procedures**
 - 3.1 Information-sharing
 - 3.2 Flow control application

- 3.3 Flow control coordination
- 3.4 Alternative route coordination
- 3.5 Communications systems
- 3.6 Evaluation
- 4. Revision
 - 4.1 Revision conditions

Checklist of effective sections

<i>Subject</i>	<i>Issue date</i>
LoA	mm/dd/yyyy
Attachment — Commercial telephone numbers for ATFM coordination	mm/dd/yyyy

1. OVERVIEW

- 1.1 Introduction The following document is an LoA between ANSP1 ATMC and ANSP2 ACC hereinafter referred to as both facilities. The LoA details information-sharing, flow control application and flow control coordination procedures.
- 1.2 Objective Statements of confirmed procedures are applicable between (State name 1) and (State name 2) ATS units in respect of aircraft operating on routes between the ANSP1 and ANSP2 flight information regions (FIRs).
- 1.3 Scope The procedures contained in this operational LoA supplement or detail those prescribed by Annexes 2, 10 and 11, PANS-ATM Doc 4444), *Regional Supplementary Procedures* (Doc 7030) and local AIP and ATS instructions.
- 1.4 Deviation In the event of unusual circumstances, duty watch supervisors of ANSP1 ATMC and ANSP2 ACC, through mutual consent, may modify the LoA for specific periods.
- 1.5 Responsibility This LoA is applicable to ATFM services along the common FIR boundary between ANSP1 FIR and ANSP2 FIR.
- 1.6 Effective date This LoA comes into effect at 0000UTC on mm/dd/yyyy.
- Once effective, this LoA cancels and replaces the LoA between ANSP1 ATMC and ANSP2 ACC dated mm/dd/yyyy.

2. POLICY AND DEFINITIONS

- 2.1 Policy Both facilities recognize the following definitions prescribed in PANS-ATM and introduce procedures according to the policy that flow control should be implemented to a minimum on the condition that available ATC capacity is utilized to the maximum extent.
- 2.2 Definitions *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.

3. COORDINATION PROCEDURES

- 3.1 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 weather; or
 - 3) other adverse effects;
- b) malfunction of ATC systems, such as radar, flight data processing system (FDPS), radar data processing system (RDPS) or communications systems;
- c) flow control restrictions at the responsible facility's request on aircraft destined for other FIRs; or
- d) other adverse effects on international traffic flow.

Paragraph a) above refers to the following airports:

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. Timely provision of information is required when the event is predicted and/or has begun/changed/dissolved.

3.2 Flow control application

Both facilities are able to implement flow control in the events cited in 3.1 a) as well as 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 examples of 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:
 - “50 NM interval at the same altitude over FIX, FIX for AAAA airport.”
 - “15 minutes interval at the same altitude over FIX, FIX for BBBB airport.”
- b) minimum longitudinal interval by time or distance regardless of altitude:
 - “50 NM interval regardless of altitude over FIX, FIX for CCCC airport.”
 - “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
 - “A rate of 5 aircraft per hour from 0200UTC until 0300UTC, over FIX for AAAA airport.”
- d) limitation of acceptable altitude:

“Flight levels 290, 310 and 390 are not available for northbound aircraft passing FIX on AIRWAY.”

“Only FL360 and above are available.”

Minimum separation prescribed in the LoA 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 handover circumstances.

3.3 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 where restrictions are applied to;
- 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; 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 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 some 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;
 - 5) aircraft carrying a patient who needs urgent treatment; and

- b) aircraft to which a transfer control message has been transmitted before the flow control decision 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.

- 3.4 Alternative route coordination When ANSP1 ATMC and/or ANSP2 ACC require changing the route of inflow traffic between FIRs due to the outage of NAVAIDs, temporary airspace restrictions or for 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 time.
- 3.5 Communications systems Use of communications systems for coordination shall be in the following order of priority:
- a) direct speech circuit;
 - b) commercial telephone (commercial telephone numbers are shown in the attachment to this appendix);
 - c) aeronautical fixed telecommunication network (AFTN); and
 - d) any other means of communication 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.
- 3.6 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.

4. REVISION

- 4.1 Revision conditions This agreement shall be revised whenever a modification to ICAO Standards, Recommended Practices and/or regional supplementary procedures, and Japan and Taiwan operating procedures or instructions, which might affect the procedures contained in this agreement occurs, or when new communications facilities, or ATS which might affect these procedures, are commissioned.
- When less than 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 by telephone, followed by a confirmation by fax signed by both parties on the nature of the change, and shall 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 the attachment (Commercial Telephone Numbers for ATFM Coordination),
1 week prior notice meets the revision conditions.

Signed by ANSP1 and ANSP2

Name 1
Director
ANSP1 Air Traffic Management Centre
Organization, State name 1

Name 2
Director
ANSP2 Area Control Centre
Organization, State name 2

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Attachment

COMMERCIAL TELEPHONE NUMBERS FOR ATFM COORDINATION

1. ATMC:

- a) Tel.: xx-xx-xxx-xxxx (primary)
Tel.: xx-xx-xxx-xxxx (secondary)
- b) Fax: xx-xx-xxx-xxxx (operations room)
Fax: xx-xx-xxx-xxxx (office)

2. ACC:

- a) Tel.: xx-xx-xxx-xxxx (primary)
Tel.: xx-xx-xxx-xxxx (secondary)
 - b) Fax: xx-xx-xxx-xxxx (operations room)
Fax: xx-xx-xxx-xxxx (office)
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Appendix G

TEMPLATE FOR LETTER OF AGREEMENT (LOA) BETWEEN AIR NAVIGATION SERVICES PROVIDERS (ANSPs) ON FLOW MANAGEMENT

LETTER OF AGREEMENT (LOA)

Effective date:

Subject: Air traffic flow management (ATFM) collaboration

ANSP1 and ANSP2 enter into this 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 ATFM procedures between the flow management unit 1 (FMU1) in (city/country) and FMU2 in (city/country). This LoA is not intended to replace any local agreements between ANSP1 area control centres (ACCs) and ANSP2 ACCs. This LoA will promote coordination and collaboration between FMU1 and FMU2 regarding traffic management measures and the routing of aircraft into and out of ANSP1 and ANSP2 airspace. FMU1 and FMU2 will be the primary points of contact for coordinating traffic management (TM) measures and operations between ANSP1 and ANSP2.

2. SCOPE

The procedures outlined are for use by FMU1 and FMU2 to provide normal air traffic services (ATS).

3. ACRONYMS

ACC — area control centre
ANSP — air navigation service provider
ATFM — air traffic flow management
FMU1 — actual name of flow management unit 1
FMU2 — actual name of flow management unit 2
OP — operations plan
TM — traffic management

4. BACKGROUND

- a) ANSP1 and ANSP2 have established operational agreements creating cross-border communications and a seamless operational atmosphere. This agreement incorporates FMU1 and FMU2 operational procedures and practices.
- b) traffic flow management continues to evolve as new procedures and technologies are developed. ANSP1 TM measures may include departures from ANSP2 airports. Likewise, ANSP2 TM measures may include departures from ANSP1 airports:
 - 1) the TM measures coordinated by either FMU may include MIT, minutes-in-trail (MINIT), ground delay measures, ground stops and re-route initiatives.

Note.— This list is not all-inclusive and other TM measures may be developed and coordinated to meet operational needs.

5. RESPONSIBILITIES

- a) responsibilities of FMU1 operations:
 - 1) FMU1 is responsible for the flow management of traffic to ANSP1 destinations and through ANSP1 airspace as follows:
 - i) FMU1 will coordinate with FMU2 before implementing TM measures that may impact ANSP2 airports;
 - ii) when ANSP2 airports are included in a TM measure, advise FMU2:
 - before implementing the TM measure;
 - what the TM parameters are; and
 - when the TM measure is cancelled;
 - iii) FMU1 will coordinate with FMU2 before implementing aircraft reroutes affecting departures from ANSP2 airports or airspace;
 - iv) FMU1 must include FMU2 TM measures in the ATFM operations plan (OP) when it is likely that ANSP1 stakeholders will be affected by these measures;
 - 2) FMU1 will ensure FMU2 is informed of situations and conditions in ANSP1 airspace that may require implementing TM measures affecting ANSP2 traffic;
- b) responsibilities for FMU2 operations:
 - 1) FMU2 is responsible for traffic flow management of ANSP2 destinations and through ANSP2 airspace;
 - i) FMU2 will coordinate with FMU1 before implementing TM measures that impact departures from ANSP1 airports;

- ii) when ANSP1 airports are included in a TM measure, advise FMU1:
 - before implementing the TM measure;
 - what the TM parameters are; and
 - when the TM measure is cancelled;
 - iii) FMU2 must include FMU1 TM measures in the ATFM OP when it is likely that ANSP2 stakeholders will be affected by these measures;
 - iv) FMU2 must coordinate with FMU1 before implementing aircraft re-routes impacting departures from ANSP1 airports or airspace;
- 2) FMU2 will ensure FMU1 is informed of situations and conditions, in ANSP2 airspace that may require implementing TM measures affecting ANSP1 traffic;
- c) responsibilities for FMU1 and FMU2:
- 1) to streamline coordination, FMU2 will be FMU1's sole point of contact with ANSP2 and FMU1 will be FMU2's sole point of contact with ANSP1 in regard to cross-border TM measures and routing of aircraft;
 - 2) FMU1 and FMU2 will implement and manage TM measures, as necessary, to relieve congestion and to ensure the orderly flow of air traffic consistent with an equitable distribution of delays;
 - 3) FMU1 and FMU2 will make every effort to limit the impact of TM measures on stakeholders and implement only those measures that will adequately address the system constraint;
 - 4) the principal TM measures to be implemented will consist of MIT, MINIT, re-routes, en-route spacing measures, ground delay measures and ground stops;
- Note.— This list is not all-inclusive, and other TM measures may be developed and coordinated to meet operational needs.*
- 5) FMU1 and FMU2 will collaborate on the design of preferred routes and severe weather avoidance routes that involve the use of both ANSP1 and ANSP2 airspace or resources; and
 - 6) FMU1 and FMU2 will provide feedback and share data on the impact and assessment of joint TM measures, as required.

6. IMPLEMENTATION

The procedures outlined in this LoA will be implemented by operational personnel at FMU1 and at FMU2. The telephone numbers for FMU1 and FMU2 personnel can be found in Attachments 1 and 2, respectively.

7. REVIEW PERIOD

FMU1 and FMU2 agree to participate in a yearly review of this document.

Original signed by:

ANSP1

ANSP2

Date: _____

Date: _____

FMU1

FMU2

Date: _____

Date: _____

Attachment 1

TELEPHONE NUMBERS FOR FMU1

FMU1

Phone number(s): xxx xxx xxx

Attachment 2

TELEPHONE NUMBERS FOR FMU2

FMU2

Phone number(s): xxx xxx xxx

— END —

ISBN 978-92-9249-418-6



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