Cir 335
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# Air Traffic Management Service Delivery Management (ATM SDM)

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# FOREWORD

This circular provides a more detailed view of the air traffic management service delivery management (ATM SDM) component of the *Global Air Traffic Management Operational Concept* (GATMOC, Doc 9854) — a component that is of chief importance because of its coordinating role. Even if more detailed, this view is still at the same conceptual level as the GATMOC itself and hence an integral part of it. It is foreseen that the material in this circular will be incorporated into Doc 9854 in the future.

Readers may recall that the GATMOC is a "vision statement" — an ideal to be pursued through coordinated planning and implementation activities that are focused on satisfying the eleven ATM community expectations (otherwise known as the eleven key performance areas (KPAs)). KPAs are based on following the *Manual on Global Performance of the Air Navigation System* (Doc 9883) and are managed by the relevant national, regional and global plans.

The GATMOC is based on seven interdependent components, the operation of which should be integrated. However, ATM SDM plays a singular, coordinating role across the other components. Indeed, "The ATM service delivery management component will address the balance and consolidation of the decisions of the various other processes/ services, as well as the time horizon at which, and the conditions under which, these decisions are made" (GATMOC, 2.1.9).

Because of its vital importance, it became necessary to provide a more detailed view of ATM SDM, albeit a view that is still at the same conceptual level as the GATMOC.

The task was allocated to the Air Traffic Management Requirements and Performance Panel (ATMRPP), which continues the work of the Air Traffic Management Operational Concept Panel (ATMCP) that developed the GATMOC. This circular is the result of the work on expanding the concept of ATM SDM.

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# BACKGROUND

The *Global Air Traffic Management Operational Concept* (Doc 9854) highlights that the ATM system will be based on the provision of integrated services. However, to better describe how these integrated services will be delivered, seven concept components, together with their expected key conceptual changes, are first described in capsule form (Doc 9854, paragraph 2.1) and then further elaborated upon. In addition to the seven concept components, Section 2.9 on information services describes the exchange and management of information used by the different processes and services. The ATM system needs to be disaggregated to understand the sometimes complex interrelationships between its components. The ATM system cannot, however, function without all of its components, which must be integrated. The separate components form one system.

One of the components of the GATMOC is ATM service delivery management (SDM). ATM SDM will operate seamlessly from gate to gate for all phases of flight and across all service providers. It will address the balance and consolidation of the decisions of the various other processes/services, as well as the time horizon at which, and the conditions under which, these decisions are made. Flight trajectories, intent and agreements will be important components in delivering a balance of decisions. Key conceptual changes include:

a) services to be delivered by the ATM SDM component will be established on an as-required basis subject to ATM system design. Once established, they will be provided on an on-request basis;

b) ATM system design will be determined by collaborative decision-making (CDM) and system-wide safety and business cases;

c) services delivered by the ATM SDM component will, through CDM, balance and optimize user-requested trajectories to achieve the ATM community's expectations; and

d) management by trajectory will involve the development of an agreement that extends through all the physical phases of the flight.

As the reader will learn below, ATM SDM means analysing and deciding what assets need to be deployed to deliver what required services, to obtain what expected performance, and to do so while thinking:

a) across and within global concept components — airspace organization, aerodrome operations, user operations, etc.;

b) across and within time horizons — from long-term planning through to tactical decisions; and

c) end to end — whether seen as gate to gate or en route to en route.

———————————

# OBJECTIVE

The objective of this circular is to clarify and expand upon the air traffic management service delivery management (ATM SDM) component described in Chapter 2 of the *Global Air Traffic Management Operational Concept* (Doc 9854) and in the *Manual on Air Traffic Management System Requirements* (Doc 9882), in order to foster a better understanding of its application and facilitate a common interpretation for the development of future ATM systems.

ATM SDM is not an actor or an organization or an authority, but a process or a function that can be discharged through different organizational arrangements, across time and geographical jurisdictions, for example, by arrangements that can be more or less centralized or distributed. The ATM SDM description provided in this circular notes the existence of the different organizational arrangements but does describe them in any detail.

The *Manual on Global Performance of the Air Navigation System* (Doc 9883) focuses on performance of the system, while the *Manual on Collaborative Air Traffic Flow Management* (Doc 9971), Part 1, *Collaborative Decision-Making (CDM)* focuses on collaboration as a supporting process. Taking these two guidelines on the collaborative pursuit of performance improvements as a given, the focus of this ATM SDM description is different.

> ATM SDM addresses the decisions on what assets need to be deployed to deliver what required services, to obtain what expected performance, while thinking across and within global concept components, across and within time horizons and end to end (whether seen as gate to gate or en route to en route).

Doc 9883 focuses on a performance-based approach (PBA) to strategic planning that is informed by CDM supporting processes. Doc 9971 addresses all other CDM activities not covered in Doc 9883 and defines CDM as an explicit supporting process in pursuit of articulated objectives between two or more ATM community members. Additionally, since the planning and conduct of system-wide information management (SWIM) will take place through ATM SDM, the SWIM concept will provide consolidated guidance on how SWIM will ensure the cohesion and linkage between the concept components to support the needs established through the ATM SDM process.

The scenarios in this circular attempt to bring ATM SDM to the fore. In order to do that, the scenarios generally contrast today's world with an ideal, although in some instances the ideal may have already been implemented. The scenarios also focus on the ATM SDM aspects addressed in the immediately preceding text and are given as soon as there is a sufficient enough message to illustrate. The scenarios do not describe the entire ATM SDM function at once, for example, by repeated reference to all time horizons, participants or services, but attempt to avoid unnecessary repetition of concepts that are extensively addressed elsewhere (e.g. CDM, SWIM and PBA).

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AO | Aerodrome operations |
| AOM | Airspace organization and management |
| ATC | Air traffic control |
| ATFM | Air traffic flow management |
| ATM | Air traffic management |
| ATMCP | Air Traffic Management Operational Concept Panel |
| ATMRPP | Air Traffic Management Requirements and Performance Panel |
| AUO | Airspace user operations |
| CDM | Collaborative decision-making |
| CM | Conflict management |
| DCB | Demand and capacity balancing |
| FUA | Flexible use of airspace |
| GATMOC | Global ATM operational concept |
| IM | Information management |
| KPA | Key performance areas |
| PBA | Performance-based approach |
| PSAP | Performance, services and assets package |
| SDM | Service delivery management |
| SWIM | System-wide information management |
| TS | Traffic synchronization |

# Chapter 1

# THE ATM SDM CONCEPT COMPONENT

## 1.1 INTRODUCTION

1.1.1 Air traffic management service delivery management (ATM SDM) is one of the seven components of the Global ATM Operational Concept (GATMOC). It is about balancing and consolidating decisions across the other six concept components and their ATM processes and services, as well as the time horizon at which, and the conditions under which, these decisions are made (Doc 9854, Chapter 2, paragraphs 2.1.9 and 2.8.1).

1.1.2 The respective foci of the ATM processes and services under the other six concept components are as follows:

a) airspace organization and management (AOM): selecting and establishing airspace structures;

b) aerodrome operations (AO): providing the ground infrastructure that supports the provision of services by ATM;

c) demand and capacity balancing (DCB): the strategic evaluation of traffic demand and system capacities;

d) traffic synchronization (TS): the establishment of an orderly flow;

e) airspace user operations (AUO): sharing with the ATM system operational information that would improve performance; and

f) conflict management (CM): the use of three layers to reduce the risk of collision:

   1) strategic (AOM, DCB, TS);

   2) separation (by whichever mode); and

   3) collision avoidance.

1.1.3 The ATM SDM processes attempt to optimize, at any one point in time, the decisions being made by the ATM community as it pursues tangible performance improvements across the eleven key performance areas (KPAs), guided by the ideal of the GATMOC.

## 1.2 MAIN FUNCTIONS

1.2.1 ATM SDM encompasses three main functions executed in a collaborative manner:

a) managing ATM performance;

b) managing ATM services; and

c) managing ATM assets (including human resources).

1.2.2 Achieving an expected performance requires services, which in turn need assets. Conversely, assets are deployed so that services can be delivered and performance achieved; from a third point of view, the delivery of services requires assets in order to achieve desired performance.

1.2.3 The three main functions of ATM SDM are closely intertwined throughout the life cycle of the ATM system, from planning through commissioning, operation and decommissioning. There is no management of performance in complete isolation from managing services or in complete isolation from managing assets. ATM SDM is about managing the performance, services and assets package (PSAP) as a whole and getting the balance right.

1.2.4 Assets, services and performance each have their own specific management techniques. Assets range from airspace assets to infrastructure assets, which include airborne, space- and ground-based assets, to human assets, which include human resources, technology and know-how. Services encompass those provided while managing airspace, aerodromes, capacity, flow and actual separation. Services are established (implemented) as required but provided (deployed, delivered) on request. Services can be required during the strategic and scheduling activities and during nominal or tactical operations planning, but they are requested only during flight operations. Performance encompasses the eleven KPAs (Doc 9883) corresponding to the eleven ATM community expectations (Doc 9854, Appendix D).

1.2.5 While assets, services and performance have their own specific management techniques, ATM SDM focuses on optimizing the PSAP balance, with a system-wide performance case (as per Doc 9883) providing the argument and supporting evidence.

1.2.6 Broader ATM SDM decisions are taken during the planning phases, during what Doc 9971, Part 1, refers to as strategic and scheduling activities, and nominal and tactical operations planning. Progressive temporal ATM SDM decisions are made tactically during what Doc 9971, Part 1, refers to as flight operations, a time when actors manage the situation based on earlier ATM SDM decisions, as reflected in their various operations manuals, to optimize the outcomes.

**Scenario**

The objective of this scenario is to describe the interplay between the three main ATM SDM functions and to note the existence of subfunctions which are specific, respectively, to the management of performance, the management of services and the management of assets.

*Planning today:* Aircraft capabilities evolve early and without structured, timely reference to the co-evolution of the necessary supporting capabilities across other members of the ATM community, such as aerodromes, air traffic management service providers, regulators and States. As a result the potential performance benefits are not realized or are delayed more than necessary.

*Planning under the ATM SDM ideal:* The ATM community establishes a shared planning method that seeks to better synchronize the co-evolution of capabilities and thus optimize the delivery of performance improvements. The method applies the performance-based approach (PBA) described in Doc 9883 and Doc 9971, Part 1, and consequently justifies its case by way of a system-wide performance case.

*Commissioning today:* It is not unusual for new services or assets to be implemented too early or too late with respect to the number of airspace users who are equipped and ready to benefit from them.

*Commissioning under the ATM SDM ideal:* The planning of new services and assets commissioning results from collaborative decision-making in order to pursue performance improvements through the timely deployment of harmonized airborne and ground assets and to have the support of timely regulations and standards.

*Operations today:* The full range of services and assets may be available during long periods of zero, or extremely low, demand (for example, control tower services in remote locations or low traffic demand control sectors).

*Operations under the ATM SDM ideal:* Technology permits the availability of services and assets to more closely follow demand. For example, aerodrome services can be turned on and off on demand by way of remote provision; air traffic control (ATC) sectors can be dynamically reconfigured to follow demand across time and airspace. While these decisions are actually made tactically according to operational circumstances, the possibility of making such decisions is established at the planning phase.

*Specific subfunctions:* Performance, service and asset management each have their own specific aspects, which make no direct or immediate reference to the other two. For example, gathering performance information does not involve making a decision about assets or services; turning services on and off during the day, week or month according to an agreed level-of-service plan need not have an effect on the agreed level of performance and asset base; regular asset maintenance need not have an impact on the agreed level of service and performance; and regular, short- and long-term management of staff rosters need not have an impact on the agreed level of service.

## 1.3 RULES, STATIC/DYNAMIC PRINCIPLES AND SERVICE TIMING

1.3.1 ATM SDM operates in a more dynamic way than the more static operations with codified procedures. It establishes both static (strategic) and dynamic principles — with the latter providing variation over the former but within previously established bounds.

1.3.2 ATM SDM uses collaboration based on shared, system-wide information to establish the said principles and determines where and when different principles and service delivery decisions are to be applied.

1.3.3 ATM SDM operates seamlessly across all phases of flight and services. It manages the different time lines and takes place in different temporal forms.

1.3.3.1 Long-term ATM SDM relates to managing the evolution of the ATM system as described in Doc 9883, defining the static principles and planning for ATM services provision, ATM system design and asset deployment. Long-term refers to strategic planning, i.e. one year and beyond.

1.3.3.2 In the medium and short term, ATM SDM adapts the plan taking into account the assets implemented, the traffic demand and the services required. Medium and short term refer to scheduling, nominal operations planning and tactical operations planning.

1.3.3.3 Tactically, ATM SDM manages the requests for and access to ATM services to satisfy the individual needs and the user trajectory request while not compromising global performance. Tactically means during flight operations.

1.3.4 Figure 1-1 illustrates the balancing function that ATM SDM performs across the other six concept components and across the full time horizon. It also shows that CDM is not a concept component, but a supporting process.

1.3.4.1 *State's service delivery needs.* The broad societal context sets the boundaries within which ATM SDM takes place, as well as the top level ATM community expectations in the eleven KPAs. There are many interests that influence the priority and way in which a State or region "buys and builds" its aviation assets and services. These interests shape the boundaries and expectations.

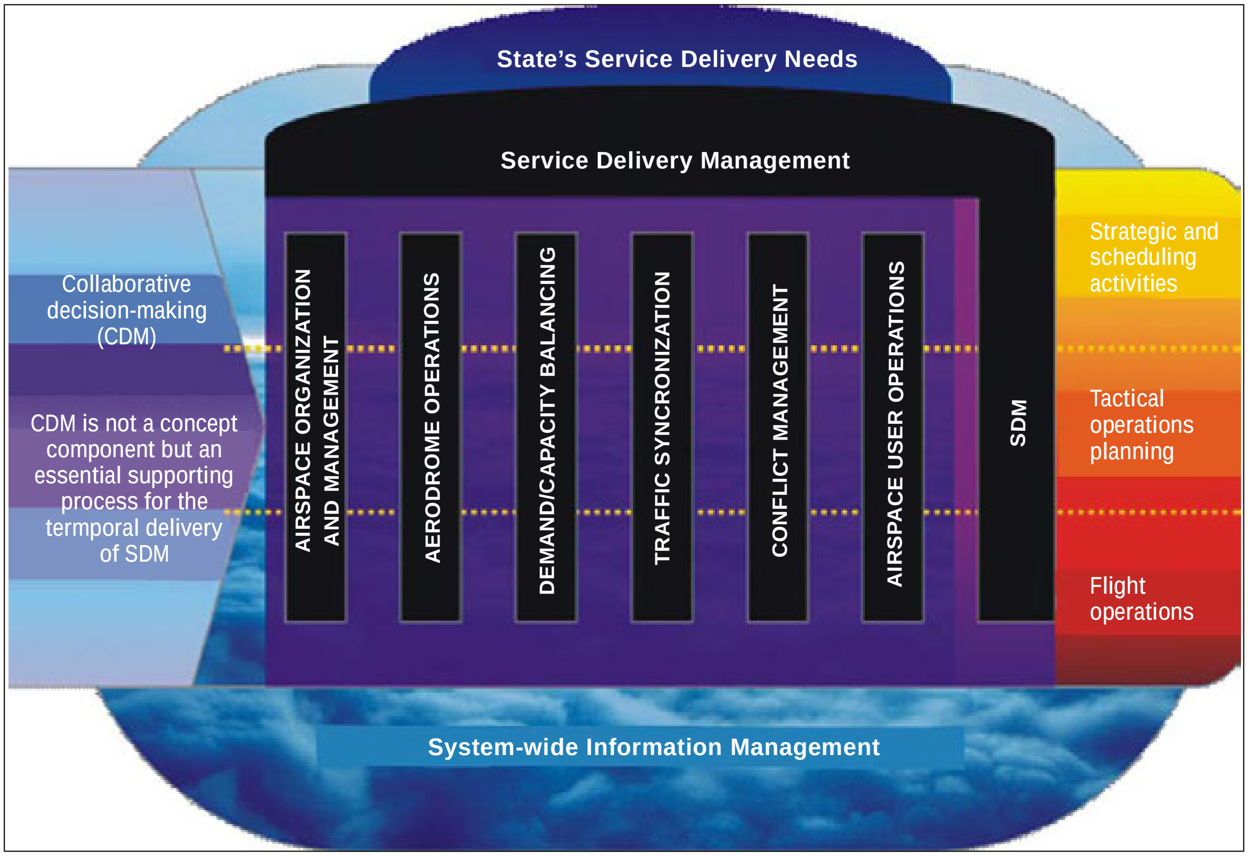


**Figure 1-1. The relationship between ATM SDM,CDM, the six concept components and SWIM**

1.3.4.2 *ATM service delivery management.* This is the process that addresses the above needs in a balanced way by:

a) agreeing on more detailed performance measures and analysing and deciding what services and assets are required (PSAP);

b) taking simultaneously into account all concept components (horizontal axis); and

c) planning for the long, medium and short term and operating tactically (vertical axis).

1.3.4.3 *Collaborative decision-making (CDM).* CDM is not a concept component but an essential supporting process. It allows all members of the ATM community, especially airspace users, to participate in the ATM decision-making that affects them. It applies to all concept components and all decision layers — from long-term planning by way of the performance-based approach, to real-time operations, providing guidance on the prioritization of services and access (Doc 9854, Appendix I, Section 10; Doc 9883; Doc 9971, Part 1).

1.3.4.4 *Information management.* Information is available and shared throughout and within all components to adequately and appropriately inform the decision-making at any given time (Doc 9854, Chapter 2, paragraphs 2.9.2 to 2.9.11).

**Scenario**

The objective of this scenario is to show the difference between static (strategic) and dynamic principles. Since these types of principles exist today, this scenario does not contrast the world of today with an ideal one.

*Long term:*

a) deciding to use Doc 9883 is a strategic/static principle; selecting the specific, more detailed methods to be used when following the manual is a dynamic principle;

b) deciding that there is a minimum acceptable level of safety is a static principle; adjusting such level according to time, place and type of operation is a dynamic principle; and

c) deciding to use a plan to outline the possible long-term evolution of the ATM system is a static principle; that the actual content varies with time and circumstances is a dynamic principle.

*Medium/short term:* The implementation of the long-term plan deploys a number of assets and makes the consequent delivery of services possible. But that does not mean that all of these are necessarily made available all the time; adjustments can still be made in the medium and short term.

a) *Static principle.* A medium-term plan forecasts the performance demanded and determines which of the implemented assets and services are to be made available to satisfy such demand, e.g. a monthly demand forecast establishes the services and assets to be provided.

b) *Dynamic principle.* The time horizon of the medium-term plan is not fixed, and there is latitude in the calculation of assets and services to be made available; for example, the time horizon can be six months or one year with a monthly or fortnightly breakdown. The assets and services can be over-budgeted by a certain amount, or different assets and services configurations can be pre-arranged for different contingencies which may arise at short notice.

*Tactical:* With a range of assets and services already implemented as per the long-, medium- and short-term plans, tactical ATM SDM is about balancing performance, services and assets on a daily basis as the service requests demand. In this case, the dynamic principle is to optimize the application of the variations allowed for within the established plans in order to apply those plans as best as possible. Situations include:

a) redirection of traffic through different airspace, which implies the use of a different asset;

b) temporary delegation of separation — implies a change of service;

c) reconfiguration of the approaches in use according to actual weather patterns — implies using different assets in order to obtain performance; and

d) daily reconfiguration of manpower to fine-tune the medium-term plan.

## 1.4 ATM SDM, GEOGRAPHICAL JURISDICTION AND THE RELATIONSHIP WITH CDM

1.4.1 Some elements of ATM SDM are already available. They evolved during the past century, in different organizational and process arrangements around the world, as a consequence of and in reaction to the expanding infrastructure built to accommodate growing aviation activity. Aircraft were constructed, airspace users emerged, airspace was organized, aerodromes were built, and ATM services were developed and delivered, all with varying degrees of focus on performance, service and assets, as well as planning, integration and coordination across concept components, the ATM community and geographical jurisdictions.

1.4.2 As ATM SDM continues to evolve, it may still be organized differently across different geographical areas of responsibility (global, regional, subregional, FIR, State or one or multiple ANSPs).

1.4.3 Whatever the future evolution is:

a) the ATM SDM process acts as a first point of contact for ATM service users who require that services be planned for and implemented or who request their provision on the actual day;

b) neighbouring ATM SDM functions/actors need to be coordinated within and across geographical jurisdictions;

c) CDM principles described in Doc 9883 and 9971, Part 1, apply to the significant coordination that is needed between users and with neighbours managing service delivery.

1.4.4 Figure 1-2 illustrates the many ways in which the ATM SDM processes may be organized within and across geographical jurisdictions and the challenge of coordinating them. The figure depicts ATM SDM (in yellow) as that function encompassing the other six concept components (in blue) both within jurisdictions (vertical) and, in part, across jurisdictions (horizontal). The absence of a vertical or horizontal line within or across jurisdictions indicates full integration of those components by SDM. For example, a jurisdiction may manage each concept component separately or integrate the management of some or all of them. In other cases the management of a concept component may be integrated across jurisdictions.

1.4.5 In summary, each jurisdiction has an ATM SDM implementation that needs to interact with the implementation of the concept components within the jurisdiction, and coordination between ATM SDM implementation across jurisdiction boundaries is needed to ensure a globally harmonized and seamless delivery of services.

**Scenario**

The objective of this scenario is to demonstrate global ATM SDM and illustrate some of its possible implementation and transition paths.

*ATM SDM today:* Optimization of the PSAP is hindered by insufficient and/or insufficiently strong coordination across concept components, ATM community members and jurisdictions. For example, the management of airspace may not be sufficiently flexible to accommodate the needs of all airspace users, and the current base of ATM assets may not be sufficiently dynamic to accommodate the increasing capabilities of a sizable portion of the aircraft fleet. Additionally, the development of products, standards and services may not be sufficiently integrated in time, functionality, target need, or usefulness and take-up.

*The ATM SDM ideal:* Global ATM SDM means adopting suitable arrangements to allow optimization of the PSAP worldwide, however this is achieved. For example, within its sovereign territory, a State may perform the ATM SDM function completely, or it may delegate it to some kind of working arrangement between airspace users, service providers, etc. A region may perform the ATM SDM function by creating regional cooperative arrangements between the relevant parts, from the strategic to the tactical level. Similarly, States may use ICAO as a platform to discuss strategic ATM SDM.

The form taken by ATM SDM emerges as the various actors find suitable management arrangements to optimize the PSAP.

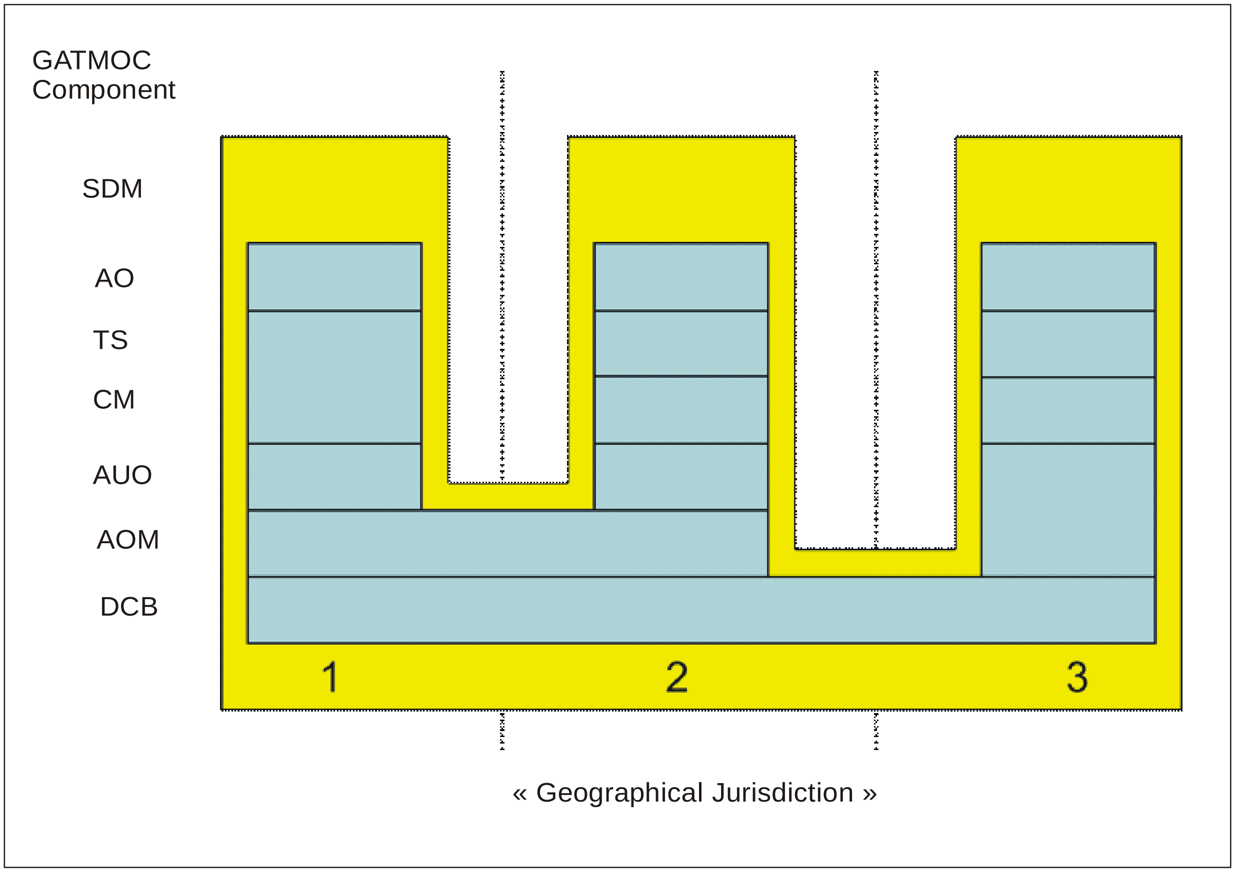


**Figure 1-2. Illustration of the SDM process within and across geographical jurisdictions**

## 1.5 SDM AND MANAGEMENT BY TRAJECTORY

1.5.1 The focus of ATM SDM and its balancing of the PSAP is to facilitate optimized, user-requested flight trajectories and achieve the ATM community's expectations.

1.5.2 Preferred and agreed flight trajectories are the main information elements in delivering a balance of decisions. Management by trajectory means the development of an agreement on a trajectory that extends through all phases of flight.

1.5.3 When there is a request for ATM services, the process facilitates the building of an agreement on a flight trajectory that is based on user needs and preferences, the constraints and opportunities related to all or some of the ATM services, and the information available on the operational situation. The agreement is then subject to conformance monitoring. A significant deviation from the agreement, as observed or inferred from information available, triggers a revision to the agreement or a warning to draw attention to the need to revert to the agreement.

**Scenario**

This scenario focuses on facilitation, building an agreement and monitoring its conformance, since optimization and performance orientation have been documented in other examples.

*ATM SDM today:* Users are constrained by air routes that are fixed and do not reflect their changing preferences (e.g. it is difficult to accommodate point-to-point area navigation). They are also constrained by inefficient integration of decisions involving two-dimensional routes, altitude and time from gate to gate, and by a tendency towards management by control rather than by assurance or exception.

*The ATM SDM ideal:* Flight trajectories will be specified in four dimensions that will be managed concurrently end to end (gate to gate, en route to en route), will be pre-agreed and managed by assurance or exception.

Facilitation does not require that the trajectory be specified with the same accuracy all along the strategic/tactical time axis, but it does require that the same specification format be used at any single point in time and that it be useful for the purposes at hand, which include optimizing flight trajectories, monitoring conformance and exchanging consequent messages.

## 1.6 ATM SDM AND SWIM

1.6.1 The GATMOC equates information management (IM) with system-wide information management (SWIM). This circular uses the latter term to avoid any confusion. Planning and conduct of SWIM will take place through ATM SDM. ATM SDM defines the rules and means for safe and secure information-sharing between all the actors. It acts as a focal point for coordination between the different service providers (Letters of Agreement, Service Level Agreements, information-sharing, delegation of services).

1.6.2 ATM SDM requires that accredited, quality-assured, timely information be shared by decision-makers on a system-wide basis to ensure the cohesion of and linkage between concept components and to build an integrated picture. Therefore, the needs established through ATM SDM set the overall requirements for SWIM. Taking these needs into account, the SWIM concept provides consolidated guidance, addressing topics such as SWIM's scope (e.g. models, infrastructure, applications), principles (e.g. open standards, service-oriented architecture) and governance (e.g. approval and evolution of standards, allocation of functions/infrastructure to stakeholders, definition of roles and responsibilities).

**Scenario**

The objective of this scenario is to illustrate the central role that ATM SDM plays in the management of information.

*ATM SDM today:* Information is managed in a partially integrated manner. Information discontinuities exist between strategic and tactical time, between one geographical jurisdiction and another, and between different stakeholders, thus hindering proper problem formulation and optimal solutions. Improvements can be made by making available the right amount of information, of the right quality, at the right time, to the right user.

*The ATM SDM ideal:* The decisions made by SDM are only as good as the quality of the information they are based on. Hence, ATM SDM defines the standards for information content as well as exchange, and for quality which is in tune with that of the decision tools being used. ATM SDM defines the quality needed from forecasts and tools to support a successful decision-making process. For example, the quality of the traffic synchronization tools needs to correspond to that of the input they use (e.g. whether it be a flight management system or other) and to the problem they address. Similarly, the quality of the demand and capacity-building tool need not be far better than that of the input being fed.

# CHAPTER 2

# THE MAIN FUNCTIONS OF ATM SDM

## 2.1 ATM SDM DECOMPOSITION

Figure 2-1 depicts the functional decomposition of ATM SDM discussed in subsequent paragraphs.

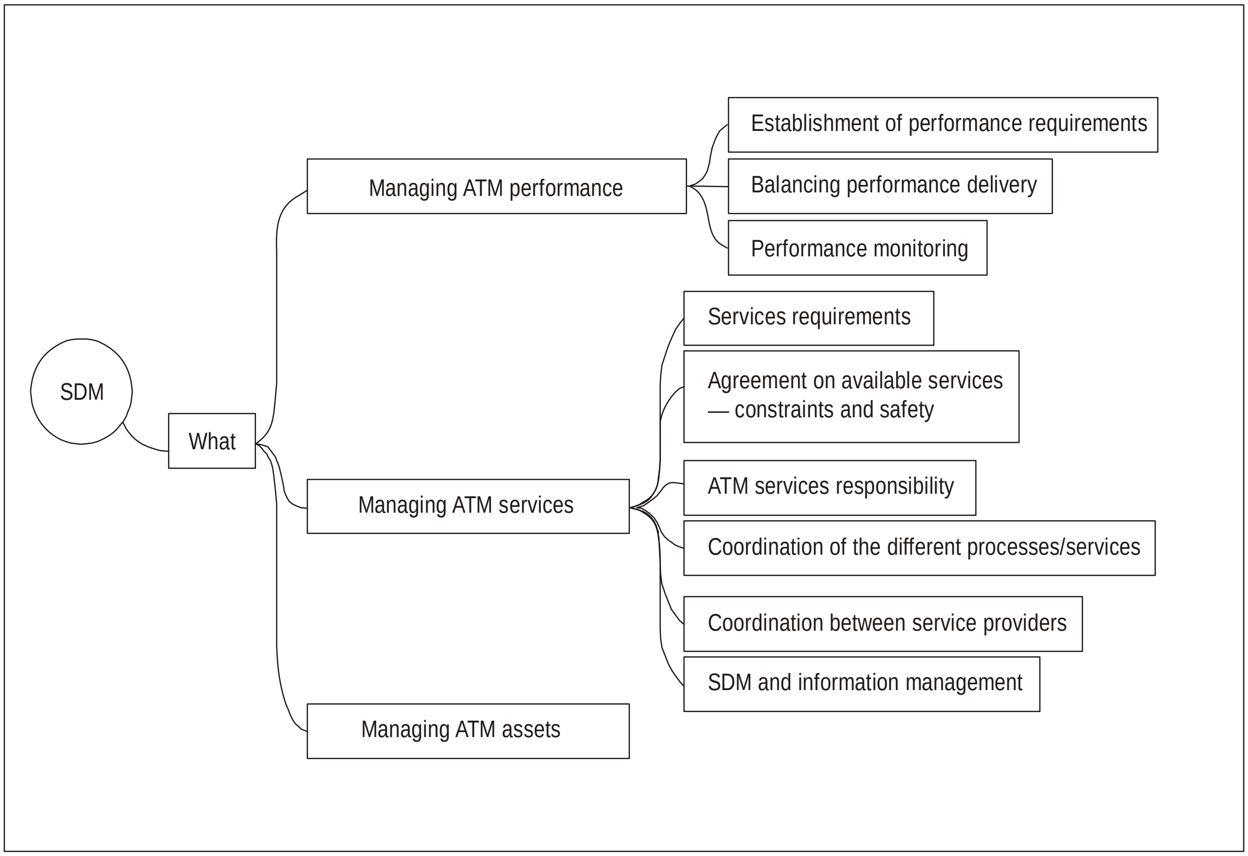


**Figure 2-1. Functional decomposition of ATM SDM**

## 2.2 MANAGING ATM PERFORMANCE

At the strategic level ATM SDM requires collaborative decision-making (CDM) within the ATM community to achieve the best possible PSAP for the members of that community as a whole. This includes balancing the conflicting requirements from different community members. For example, choices are constrained by global safety standards and additional requirements from States and other community members which need to be met.

### 2.2.1 Establishment of performance requirements

2.2.1.1 ATM SDM encompasses all phases of flight, all levels of planning and aggregation and considers the eleven KPAs[1] and all members of the ATM community. ATM SDM implements the principles of performance-based planning as described in Doc 9883. For example, the process for agreeing on the strategic performance targets for ATM system development and deployment is one of the functions of ATM SDM.

2.2.1.2 Using CDM principles, the ATM SDM process is used to establish the performance requirements of the ATM system as a whole, and then for the various operational service environments, which in turn include the performance requirements for specific enablers.

2.2.1.3 ATM SDM channels this collaboration to ensure that system performance requirements, objectives and targets are realistic, achievable and balance performance across time, users and geographical locations.

**Scenario**

The objective of this scenario is to describe the establishment of performance requirements within and across jurisdictions while balancing conflicting requests from different community members and any constraints on choice.

*ATM SDM today:* Strategic management tends to be done by geographical jurisdiction, tends to be reactive and follows problems and technologies rather than proactively looking and planning ahead. It has an unstructured approach to the potential performance benefits and disbenefits in various performance areas and also does not effectively integrate the various community members.

*The ATM SDM ideal:* The following tasks are undertaken within and across geographical jurisdictions:

At this stage, members of the ATM community collaborate on their performance requirements for the applicable KPAs. For example, the government may establish the minimum acceptable level of safety, minimum access rights for certain types of community members, and minimum environmental standards. Large and small national and international airspace users may put forward their own performance requirements in terms of access and cost-effectiveness. This is done not only in qualitative terms, but also by establishing performance objectives and associated quantitative targets.

*ATM SDM at this stage:*

a) analyses the performance requirements in coarse and then finer degrees;

b) identifies points of conflict (e.g. simultaneous access to airspace by users accepting different levels of safety; extreme average cost of service in particular volumes due to lack of demand; significantly reduced flow efficiency in certain volumes, as driven by the mix of traffic; and over-investment over a period; and

c) ranks a limited number of PSAP solutions and proposes them to the appropriate governance bodies to negotiate a suitable decision.

1. "2.2.2 What are the ATM community expectations and key performance areas (KPAs)? The ATM system seeks to meet diverse expectations in terms of service delivery. These expectations are detailed in Appendix D of Doc 9854 and constitute the starting point for ATM performance objectives. For performance management purposes, it is considered that each of these expectations corresponds to a single KPA as shown below" (Doc 9883).

### 2.2.2 Balancing performance delivery

Delivering ATM services in accordance with a performance-based approach entails trade-offs across the various key performance areas (e.g. efficiency for predictability), as well as temporally and spatially. It also entails distributing (allocating) performance targets among the different components and different providers for different areas. Once a set of performance targets is established collaboratively, ATM SDM operates to meet these targets tactically.

**Scenario**

The objective of this scenario is to describe the tactical latitude in deciding how to achieve the agreed strategic targets.

Strategic performance targets, whether minimum, standard or maximum and whether hourly, daily or monthly, are figures which represent averages to be achieved over time, geography, level of activity, user type, type of operation or some other variable. Being averages these targets can be achieved by varying combinations of tactical values.

*ATM SDM today:* An insufficient functional connection between airport CDM nodes, network management nodes, weather/aeronautical information nodes and appropriate analysis tools within and across jurisdictions hinders efforts to understand what tactical trade-offs can be made without hindering the agreed strategic targets.

*The ATM SDM ideal:* The tactical configuration of airspace, airports and surfaces, demand/capacity balancing settings, and traffic synchronization settings (e.g. priority, sequences) is adjusted simultaneously, and in sympathy across jurisdictions, according to circumstances (e.g. weather events, network congestion) in order to obtain best end-to-end performance across jurisdictions and KPAs. Another example is a location that may occasionally and briefly accept higher-than-average noise levels to help reduce the capacity disruptions produced by an upstream weather event.

### 2.2.3 Performance monitoring

2.2.3.1 In order to perform these functions to the required level, ATM SDM is a closed-loop process, performing a conformance-monitoring function on the system performance, analysis and mitigation functions, and non-flight-specific infrastructure and traffic demand information (Doc 9854, paragraph 2.8.4). Conformance monitoring asks: Is the PSAP satisfying the demand optimally? Why not? Is it because demand is different than the short- and long-term forecast? Are assets and services different than the short- and long-term plan? Are analyses correct and are mitigation functions working as expected? If not, what actions are appropriate in the short, medium and long term?

2.2.3.2 During the post-flight phase, performance conformance monitoring:

a) takes place at global, regional and local levels;

b) considers planning decisions taken in the past; and

c) takes place at different levels of flight aggregation, that is, from one to many.

**Scenario**

The objective of this scenario is to demonstrate performance monitoring in action.

*ATM SDM today:* Many jurisdictions do not monitor their own performance and/or consult/coordinate with neighbouring jurisdictions on optimization and identification/correction of systemic difficulties. Of the jurisdictions that do coordinate regularly, most of their communication is constrained to addressing operational matters without further performance considerations.

*The ATM SDM ideal:* For example, three neighbouring jurisdictions coordinate daily to compare the following actual outcomes over the past 24 hours:

a) the availability of services and any associated constraints, and

b) weather and demand conditions,

with those in the relevant configurations (e.g. service availability and constraints 1/2/3, weather 1/2/3, demand 1/2/3, etc.) in the short-term plans (e.g. tactical operations plan for the day, and nominal operations plan for the day).

Discrepancies that are beyond previously determined, acceptable bounds are noted, and possible causes are briefly analysed and noted, including observations as to whether they are likely to be systemic or not. In general, systemic causes cannot be fixed in the short term since operations are run within the bounds of short-term plans, themselves bounded by the investments made through long-term plans. Further consideration is postponed until monthly, quarterly and six-monthly performance monitoring coordination activities consider their potential resolution in the context of strategic planning.

## 2.3 MANAGING ATM SERVICES

2.3.1 Using performance as its objective, ATM SDM acts as the component "optimizer" determining:

a) which components are invoked;

b) when they are invoked;

c) which participant is responsible for the component;

d) what information is required either as the input or output of a component;

e) what level of performance is required of the component.

2.3.2 ATM SDM acts as an ATM services optimizer by orchestrating the provision of ATM services.

**Scenario**

This scenario shows how ATM SDM interplays with the other ATM concept components and their related processes and services.

*Planning example*

*ATM SDM today:* Planning coordination is insufficient and/or not sufficiently timely between members of the ATM community (i.e. airspace providers, aerodrome operators, ATM service providers, airspace users, ATM support industry, regulatory authorities and States), between members of the ATM community and socio-demographic and economic forecasters, and between all of them across geographical jurisdictions. This reduces the effectiveness and efficiency of planning and operations.

*The ATM SDM ideal:* Over a region, the ATM SDM process takes the forecast traffic, airspace and aerodrome situations and analyses how different combinations of airspace structure, aerodrome infrastructure, DCB processes, traffic synchronization (TS) and conflict management (CM) processes can potentially deliver different PSAPs.

For example, the ATM SDM process analyses the AOM, DCB, TS and CM capabilities currently implemented and determines that they are sufficient to meet a significant forecast change in the geographical pattern of traffic. However, the analysis warns that aerodrome operations would be a major problem unless urgent action is taken. The aerodrome community then becomes responsible for taking the lead and upgrading the airport infrastructure accordingly.

Or ATM SDM may detect that, should a specific and significant change in the geographical pattern of traffic eventuate and persist, the DCB, TS, CM and AO configurations would be suitable to respond and that, although current airspace structures could not support the change, they could still be modified within a reasonable time frame. ATM SDM would be responsible for monitoring the situation, and the airspace provider would be responsible for taking the necessary action.

*Medium-/short-term example*

*ATM SDM today:* The configuration of airspace and air traffic management services tends to be static, with seasonal adjustments, if applicable, but does not always monitor medium-term forecasts and implement justifiable adjustments.

*The ATM SDM ideal:* Over a region, ATM SDM takes the forecast traffic for, say, the next week or the next month and, within the boundaries that have been cast by design and implementation, reconfigures airspace structures, aerodrome usage patterns, and DCB, TS and CM patterns to optimize the PSAP. For example, low demand may invite the closure of runways, the restructuring of airspace, or the change of separation mode, and their consequent manning changes. Responsibility for the changes would rest respectively with the ATM service provider, the airspace provider and the airspace user.

*Tactical example*

*ATM SDM today:* Airspace users vie for increased peak capacity and there tends to be no significant mechanisms or incentives to consider spreading demand over periods of spare capacity. As a consequence a portion of the investments remains under-utilized.

*The ATM SDM ideal:* ATM SDM determines that although the AOM, AO, TS and CM configurations are generally appropriate, the current PSAP is underperforming because of mismatches between DCB and airspace user operations (AUO) and that the performance that can be obtained by attempting to spread demand to meet unused capacity is by far more acceptable than investing to create new capacity. Airspace users would be responsible for taking the lead in attempting to spread demand.

### 2.3.3 ATM services requirement

2.3.3.1 ATM SDM is normally the first point of contact between a potential airspace user and the ATM services/system. This may occur:

a) directly, through a CDM process about levels of service; or

b) indirectly, through determination by appropriate authorities; or

c) otherwise, for certain services or processes.

2.3.3.2 The airspace user may also contact individual service providers directly for the provision of a particular service; in this case the service provider executes an ATM SDM function.

2.3.3.3 The ability to obtain a specific ATM service can be related to level of performance or capability. ATM SDM uses established performance requirements to dynamically determine whether a particular service can be provided.

**Scenario**

The objective of this scenario is to highlight ATM SDM as the first point of contact when requiring a service.

*ATM SDM today:* Stakeholders have to approach a variety of organizations depending on the apparent nature of their service issue (e.g. type of airspace, air traffic flow management). There is no single, common process to deal with the concept components as a whole and with which stakeholders can interface.

*The ATM SDM ideal:* Stakeholders conclude that a mid- to short-term DCB service is necessary for a particular geographical area and period of the year, since there seems to be long periods where the level of service available far exceeds the actual demand. Through the ATM SDM process the airspace user and service provider collaborate.

### 2.3.4 Agreement on available services — constraints and safety

Although ATM services are available on request, it may not be efficient to supply all ATM services in all airspace all the time. Because of this, the ATM community needs to agree when, how and where each ATM service is to be available subject to the results of performance cases covering the eleven KPAs. ATM SDM assesses the capability and appropriateness of all service providers to provide any and all services. This may include assessing the capabilities of adjacent providers or conducting analysis work in support of safety and business cases for system enhancements.

**Scenario**

The objective of this scenario is to illustrate ATM SDM and its interplay with the ATM community for agreement on services to be provided. See the earlier scenario under "Establishment of performance requirements" in Section 2.2.1.

### 2.3.5 ATM services responsibility

2.3.5.1 ATM SDM manages the distribution of responsibilities for the various ATM services and their seamless performance, including the designation of a pre-determined separator for separation provision. This function is important to ensure that the services determined collaboratively and delivered by the ATM system balance and optimize user-requested trajectories to achieve the ATM community's expectations.

2.3.5.2 Responsibilities for the provision of services are more dynamic than in the past. ATM SDM explicitly identifies the entity or entities responsible for providing services. For the allocation of responsibility, the concept components may or may not be deconstructed into explicit services.

2.3.5.3 Specific service responsibility may be assigned to different actors for different services (e.g. DCB, CM) in parallel, relating to the same or different phases of flight.

**Scenario**

The objective of this scenario is to show stakeholders how, through the ATM SDM process, to formulate performance problems and decide which joint or separate action, by which services and which actors, over which time frames, may lead to their solution.

*ATM SDM today:* In many areas of the world there is no common, collaborative process to formulate performance problems and consider solutions, which takes into account all concept components at once and from long-term planning to operations.

*The ATM SDM ideal:* Airspace users put together the following list of performance problems affecting a region:

a) increased safety concerns in specific areas and at specific times;

b) significant, consistent delays in some other specific areas and at specific times;

c) consistently discontinuous flows in and around certain airports; and

d) the apparent excessive cost of some services in specific areas.

ATM SDM analyses the current PSAP, seeking the root causes of the stated problems. After identifying a number of root causes, ATM SDM explores a number of alternative PSAPs. In all this work ATM SDM pays due attention to the interdependent nature of the various components of the system. The conclusion is that:

a) the safety concerns can be addressed by better traffic synchronization (TS) between three ATM service providers in order to reduce stress over choke points;

b) the consistent delays can be addressed by improved mid to short-term DCB to be conducted between two airport operators and an ATM service provider;

c) the consistently discontinuous flows can be significantly improved by having integrated TS across the boundaries of ATM approach-arrivals, airport airside and ground side, and ATM departures; and

d) the apparent excessive cost of some services is the result of early investment in assets in preparation for an expected upsurge in demand.

### 2.3.6 Coordination of the different processes/services

2.3.6.1 ATM SDM operates seamlessly for all phases of flight and across all service provision areas. ATM SDM addresses the balance and consolidation of the decisions of the various other services, as well as the time horizon at and the conditions under which these decisions are made.

2.3.6.2 The different ATM concept components and their related ATM services have interacting functions overlapping in time. ATM SDM provides mechanisms that are required to determine:

a) when certain functions of the ATM services start and stop; and

b) which ATM concept component and ATM service are applied to address a problem when multiple solutions are potentially available.

**Scenario**

The objective of this scenario is to show seamlessness, interaction, start/stop and component/service selection.

*ATM SDM today:* In many instances operational plans are not sufficiently adaptable to readily accommodate dynamic change and sustain optimum overall performance. For example, airspace structures may not be changeable at short notice, and "what-if" decision support tools may not be comprehensive enough to respond optimally to rapidly developing events.

*The ATM SDM ideal:* Long-haul flights, arriving in five hours, departed nine hours ago and constitute forty per cent of the capacity demand to be satisfied during a period of three hours. A very disruptive, low probability, short duration weather phenomenon has actually materialized, changing significantly the last mid- to short-term PSAP analysis (done every two hours). ATM SDM re-evaluates the situation and concludes that the short- and long-term disruptions could be minimized by applying AOM and TS services. This would result in the airspace structure being adapted (e.g. by sector configuration changes, sector openings/splits) or in the coordination of airspace usage in the framework of flexible use of airspace (FUA) between civil and military partners. The realized (temporary and localized) extra airspace capacity could then be used to accommodate and to re-smooth the remaining 4D trajectories via TS.

ATM SDM has operated across component/service provision (AOM and TS), across time horizons (i.e. tactically restructuring while accounting for mid- to short-term and longer-term needs), determined which components to use and when to start/stop reconfigurations.

### 2.3.7 Coordination between service providers

The role of ATM SDM is to coordinate the delivery of services of all service providers (for concept components and information management), including other ATM SDM providers, in response to an airspace user's request or need for a service. For example, it may be a single, common ATM SDM function or process that coordinates services from a number of different providers located in several regions.

**Scenario**

The objective of this scenario is to demonstrate coordination across service providers.

*ATM SDM today:* Coordination among service providers does exist. However, there is room to make it more wide ranging and more responsive to better react to the overall dynamics of the system.

*The ATM SDM ideal:* A hijacked aeroplane is parked on a major taxiway close to a runway. The conflict is not anticipated to be resolved for another twelve hours. The lead security team interacts with the ATM SDM function. After an initial evaluation of the forecast inbound and outbound traffic for the next twelve hours, and within the bounds established by the security team, ATM SDM commences coordination with other non-security stakeholders to optimally adjust schedules in accordance with the situation. ATM SDM coordination takes places with the AUO function within the various airspace users, relevant ATM SDM functions where they exist, and with relevant service providers where ATM SDM does not yet exist (e.g. whoever provides DCB, CM, TS). As usual, the objective of coordination is to optimize the PSAP. Similar examples can be made with less exceptional situations.

## 2.4 MANAGING ATM ASSETS

2.4.1 Service providers require capabilities to ensure that they are able to accommodate trajectory demand on the day of operation to achieve the agreed service performance targets. These capabilities are supported by assets which include airspace, the need for and deployment of human assets (e.g. staff) and infrastructure.

2.4.2 ATM SDM manages the assets required for the provision of ATM services by using CDM at global, regional or local levels.

2.4.3 An ATM system development and implementation plan steers the development and implementation of assets.

2.4.4 The requirement for and deployment of human assets are defined by the number of staff, their skills and training, and scheduling according to the type of service demand.

2.4.5 Airspace is also the subject of assets management. The main airspace assets are the ATC units and their internal subdivision in airspace sectors of responsibility.

2.4.6 Infrastructure covers all of the airborne, space- or ground-based assets. These are the ground ATM facilities, airborne capabilities requirement and CNS infrastructure.

2.4.7 During operations, assets conformance monitoring allows for the detection of failures or contingencies having an impact on ATM services and appropriate action to minimize this impact.

2.4.8 Conformance monitoring also compares the available assets with evolving situations in order to take corrective action.

**Scenario**

The objective of this scenario is to illustrate asset management in the context of ATM SDM. Some clarifications are needed before contrasting today's world with an ideal one.

Asset management activities are those that affect performance or services. Examples include:

a) unscheduled maintenance of facilities since it could potentially affect services;

b) scheduled maintenance of facilities where it implies a reduction in the level of service or performance;

c) recruiting and/or training staff for new facilities (new; implying a different functionality and/or performance, rather than mere replacement);

d) planning for, or procuring, a new PSAP; and

e) monitoring the performance of assets (facilities, staff) in conformance with planned values, and continually matching the actual services being supported, as well as the overall ATM system performance being supported.

Specific subfunctions are those that do not affect performance or services. Possible examples include:

a) regular maintenance of established facilities, only where it does not affect the level of service or performance (e.g. reducing availability); and

b) regular training of staff for already established facilities and/or services, again only where it does not affect the level of service or performance (e.g. reducing availability).

Essentially the above activities seek to sustain the long-term viability of the PSAP, rather than change its configuration within established bounds, or to change the PSAP altogether.

*ATM SDM today:* Asset management does take place today. However, the linkage between asset management and service and performance management needs to be strengthened all the way along — from planning to operations, from one geographical jurisdiction to the next, from one concept component to the next. The purpose is to optimize the PSAP.

*The ATM SDM ideal:* At any one time the assets deployed match the required services and expected performance; have been planned for, implemented and deployed in a timely manner; and are appropriately balanced among the concept components from gate to gate.

**— END —**

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