

APPENDIX

SCENARIOS FOR THE GLOBAL AIR TRAFFIC MANAGEMENT CONCEPT

1. PREFACE

1.1 Scenarios have been developed by the Air Traffic Management Operational Concept Panel (ATMCP), to be read in conjunction with the ATM operational concept, to aid in understanding the operation of the future ATM system, as foreseen in the operational concept. Specifically, an attempt has been made to present representative cases concerning all types of users as well as the air traffic management (ATM) community members, as seen from the cockpit of airlines on international and regional flights, general aviation aircraft or military flights, as well as from the operations room of an ATM unit or an airline operational unit, before and during the time of flight.

1.2 The scenario illustrations reflect the basic principles of the operational concept as follows:

- a) scenarios do not identify specific technology;
- b) information management supports a collaborative decision-making process by providing relevant information at the appropriate times;
- c) contracts between airspace users and ATM ground service providers are based on four-dimensional (4-D) trajectory from gate-to-gate;
- d) the term “trajectory contract” introduced by these scenarios, specifies agreed trajectory performance criteria between the airspace user and the ATM service provider. The criteria allow changes to user trajectory without compromising the contracted performance, thus not requiring contract renegotiation; and
- e) the scenarios imply that the landside activities of aerodrome operations are consistent.

1.3 Although there will be differences between the way that flights are managed today and in the future, the degree of change at the tactical level will not be as significant as might generally be assumed. A considerable change at the tactical level would, in fact, contradict the intent of the operational concept, which is focused on increasing strategic intervention in ATM management, rather than at the tactical level. To illustrate, take a typical example of a flight from aerodrome A to aerodrome B in 2025.

1.4 A scenario of a nominal case, i.e. a case that meets the user’s (in this case an airline) preferred trajectory, is provided in paragraph 2, while examples of how exceptions may be handled are given in paragraphs 3 and 4 of this Appendix.

2. THE NOMINAL CASE

2.1 This scenario demonstrates the requirement for a significant shift in ATM applications, to be brought about by the year 2025, in accordance with the operational concept. It highlights, in particular, the departure from today's "just-in-time" air traffic control, to pre-planned ATM, supported by a "just-in-case", ATM application.

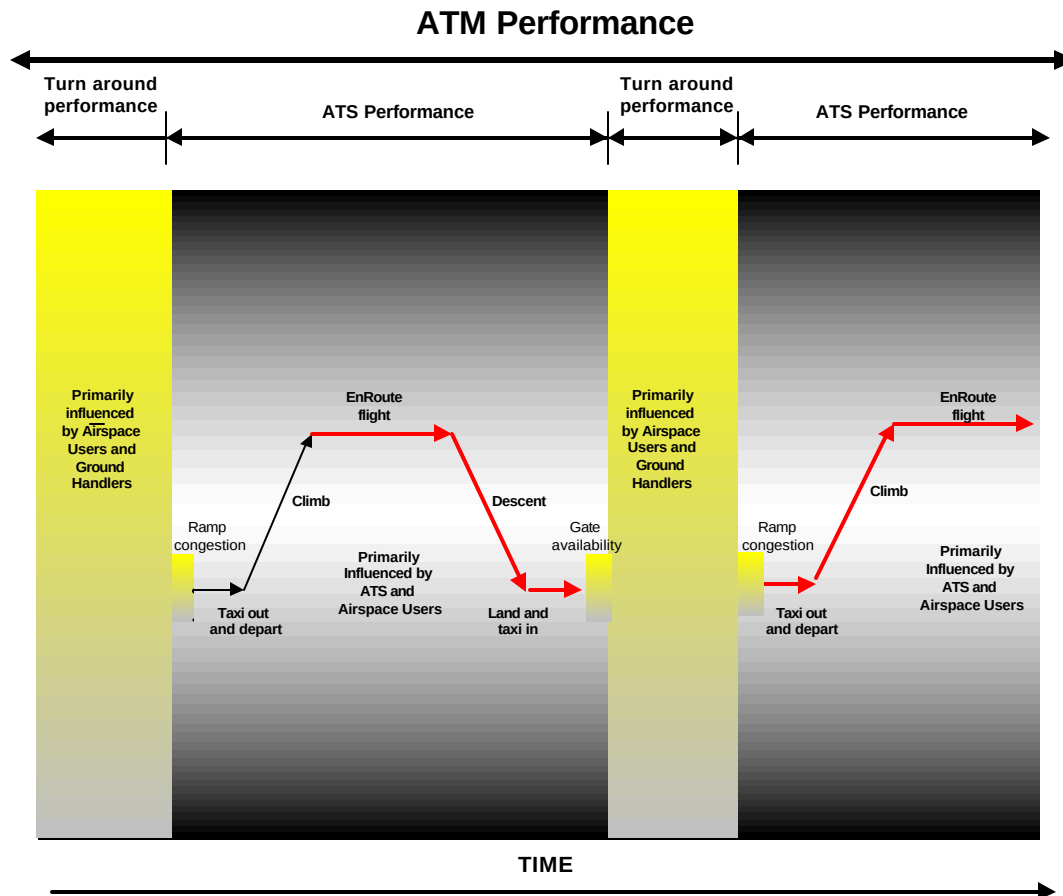
Example 1: Expectations of airspace user perspective

An aircraft requests push-back at the assigned push-back time. The aircraft taxis to the holding point and arrives there at the pre-determined departure time. Although there are aircraft ahead, there are no conflicts and consequently there is no delay for departure. The aircraft receives an optimum departure path and clearance to climb to cruising level. The aircraft cruises at optimum level, on a user-preferred track. The aircraft requests a deviation around weather. This is granted; a new trajectory is calculated and assigned and speed is adjusted to meet the pre-assigned arrival time. The aircraft descends on an optimum approach path to the runway. The aircraft exits the runway at the agreed turn off point consistent with the surface movement planning. Ground support facilities are aware of the arrival time and appropriate resources are made available.

2.2 Considering the expectations of airspace users for the future ATM system, it would appear obvious that the underlying system will have to be able to optimize conflict-free trajectories for all aircraft and that, more specifically, it has to ensure that, *inter alia*:

- a) the aircraft would request a push back at a certain time;
- b) there would be no delay if the pilot asked to depart at a certain pre-determined time;
- c) a component of the ATM system would ascertain that, for any given runway configuration or weather condition, there would be no delay for departure, if the pilot taxied at a predetermined time;
- d) a component of the ATM system would calculate and offer a conflict-free trajectory;
- e) a component of the ATM system would be able to respond adequately to an unplanned excursion from track; and
- f) a component of the ATM system would ascertain that adequate ground facilities expected the aircraft's arrival.

2.3 Although the ATM system will be able to manage unscheduled departures, the above and all further scenarios assume that the airspace users are ready to depart on time.



3. ATM SYSTEM PERFORMANCE

3.1 General

3.1.1 One of the key strategies in the operational concept is that it is based on performance. Accepting that safety is the essential performance characteristic, all other performance measures are based around optimizing the ATM system as a whole.

3.1.2 Strategic planning is related to ascertaining, with reasonable certainty, the “end-to-end” system capacity and where there is a constraint, strategic planning either circumvents or seeks to eliminate it. This mechanism sets the framework for matching demand to capacity. More specifically, the ATM system based on the operational concept must ensure that:

- a) having accepted a “contract”, aircraft will actually meet their trajectory contract;
- b) the ATM system can actually deliver its part of the contract; and
- c) a “lost trajectory contract” can be re-assigned tactically.

3.2 Scheduled operation

3.2.1 The following five examples describe the planning and progress of a scheduled flight through various stages of its contract in the year 2025, showing how a future ATM system might react to changes of varying complexities to the flights initial trajectory contract. What can be seen from these examples is that a performance-based system requires all relevant members of the ATM community, e.g. users and providers, to be a part of the performance contract: ATC must meet the pre-agreed trajectory contract and route expectations, pilots must, within safety parameters, adhere to the flight performance contract; ground service providers must adhere to turn-around contracts for the benefit of the ATM system as a whole, etc.

Example 2a: Scheduled operation — Strategic planning phase

Six months in advance, through a strategic collaborative decision-making process, an airline — Airline A — negotiates a series of departure trajectory contracts for one of its aircraft on a multi-stage flight. The trajectory contracts are allocated on the basis of the known (historical) performance of all components of the system. Detailed en-route significant weather forecasts for that day have been available for five days already and have been refined in the course of the week. The aerodrome all-weather capacity is known for each departure and destination aerodrome, and a capacity ($\pm x\%$) is published. Route capacity and sector capacities are also known, but a factor for improving performance over the next 6 months is added. Average taxi times ($\pm x\%$) have been determined for each runway, hence, a push-back time can be calculated. Average route segment times are also known ($\pm x\%$). The airline has already negotiated ground turn-around contracts with ground handlers. ATM performance contracts for the day are set, i.e. airline to ground handlers, airline to ATM providers, ATM providers to airlines, etc.

Example 2b: Scheduled operation — Pre-tactical phase

One week before the flights, minor adjustments are made to trajectory contract times, to take into account planned runway maintenance, predicted available resources, changed aircraft with changed performance characteristics, etc. System demands and capacity as well as optimal routing according to the refined significant weather forecast for that day are reassessed, and balanced, and ATM performance contracts are adjusted accordingly.

Example 2c: Scheduled operation — Tactical phase without contract change

On the day of the flight, the pilot-in-command (PIC) receives a briefing and accepts responsibility for the flight crew's part of the ATM performance contract. Push-back at the first aerodrome is set for 0100 hours, for a departure at 0107 hours. The PIC ensures that the doors are closed in adequate time to accommodate push back at 0100 hours. The PIC taxis to the holding point. A conflict-free trajectory is assigned to the aircraft, which the PIC accepts. At 0107 hours, the aircraft rolls for take-off. The

negotiated flight time is 45 minutes, with landing time assigned of 0152 hours, and on-gate time of 0159 hours. The aircraft lands at 0152 hours, and parks at 0159 hours. Ground turn-around contracts for this flight are 90 minutes. The next negotiated departure time is 0340 hours, with push-back required by 0332 hours. The ground handlers finish their turn-around at 0315 hours. The PIC closes doors at 0320 hours, and pushes back at 0331 hours. An unexpected delay of 2 minutes will occur, which could lead to a tactical change to the flight trajectory. This eventuality will be addressed by the collaborative decision-making process which will provide information and options leading to a possible revised contract. The aircraft arrives at the holding point at 0338 hours and takes-off at the designated departure time. The aircraft is airborne at 0340 hours, on a 65 minute flight leg. The planned landing time is 0445 hours, and next departure time is 0630 hours, including 8 minutes inbound and 7 minutes outbound taxiing .

Example 2d: Scheduled operation —Tactical phase with minor contract modification not caused by the ATM system

The flight encounters storms and the PIC requests a re-routing. For this flight the ATM ground service provider is requested to facilitate such re-routing, which would add 4 minutes to the flight. The ATM system now attempts to compensate. The PIC is asked by the ATM ground service provider to increase speed from M0.81 to M0.83. This will regain 2 minutes. The airline renegotiates the ground turn-around for next departure from 90 minutes to 85 minutes. This ensures that the next departure trajectory contract is not missed. The flight of Airline B originally holding a landing trajectory contract of 0447 hours is expedited and lands 2 minutes early. Airline A flight lands at 0447 hours, and is on gate at 0455 hours . The ground handlers complete the turn-around in 65 minutes. The ATM system met its performance contract. The airline B flight that was expedited was within the agreed 2% fuel burn contract and so again the ATM system met its performance.

Example 2e: Scheduled operation — Tactical phase with contract change caused by the ATM system

The Airline A aircraft now pushes back for the third leg. It arrives at the runway at the scheduled time of 0630 hours. An unexpected delay occurs in an en-route sector resulting in the departing aircraft being delayed for 5 minutes — it departs at 0635 hours on a 60-minute flight leg. Its planned arrival time was 0730 hours. The ATM ground service provider has now rescheduled this to 0739 hours. The aircraft is slowed down en-route from M0.81 to M0.79 to absorb 2 minutes delay. The arrival path is extended to absorb 2 additional minutes. The next departure time was scheduled as 0915 hours. To meet this, the ground handling needs to be accomplished in 80 minutes. As the delay was ATM ground service provider induced, the ATM system will not have met its performance contract.

3.3 Aerodrome operations

3.3.1 Aerodrome operations have a significant impact on overall ATM system capacity and performance. The ATM community will use collaborative decision-making techniques, from strategic to tactical, to minimize any constraints on airspace user operations.

Example 3: The role of aerodrome operations

Consider a busy aerodrome that has implemented all economically justifiable improvements. It has a multiple-runway configuration, with precision approach guidance serving all runways, high lighting capability, all-weather operations and multiple high-speed exits to a parallel taxiway system. All traffic on the aerodrome surface is known and monitored. The domestic and international terminals are situated between the runways allowing easy access to the predominant, into wind, runway configuration.

The runway capacity, which is pre-tactically and tactically refined through collaborative decision-making processes, will be determined after consideration of engineered runway capacity, predominant configuration, least optimal runway configuration, environmental concerns and aircraft traffic mix. The agreed runway capacity is based on examination of the performance of the aerodrome over the previous few years, examining both what had been used for planning and what was actually achieved.

The flexibility incorporated into ATM system design (including trajectory contracts) will enable safe exploitation of capacity opportunities, as well as adjustment to unplanned decreases in capacity.

Additional advantages are gained in advances in aircraft design and performance, including reduced wake turbulence vulnerability as well as predictable and optimized runway occupancy times, both for departures and arrivals.

3.4 Non-scheduled operation

3.4.1 The ATM system must be able to support the differing operating requirements of all airspace users. One such case is identified in the following example.

Example 4: Non-scheduled operations

A charter operator, who has been hired on short notice to carry out an aerial photography flight over a city near Airport A, wishes to operate for one hour over the city at an altitude of 5 500 feet. At least half the operation will take the aircraft within the managed airspace associated with Airport A. The operator, when requesting a trajectory contract for the activity from the ATM operations unit for the area concerned, is advised that the request will be processed within 30 minutes.

Because the planned departure time is only 3 hours away, the ATM operations unit refers the request to the pre-tactical unit. The flight will affect several arrival routes and one departure route. Ten aircraft are already en-route to Airport A, but the tactical managers currently responsible for these aircraft can uplink amended inbound trajectories as soon as they have been devised by the pre-tactical unit. All other inbound flights are still outside the trajectory issue time and their arrival trajectories can be amended prior to issuing their contracts. Altering the departure path is difficult to negotiate due to environmental constraints. However, a window of opportunity can be created if the departure path is affected by the planned operation for less than 20 minutes. An airspace reservation is created, to guarantee the operation airspace for the required time, with a set of constraints issued to the aerial work aircraft in order to mitigate the affect on the departure path.

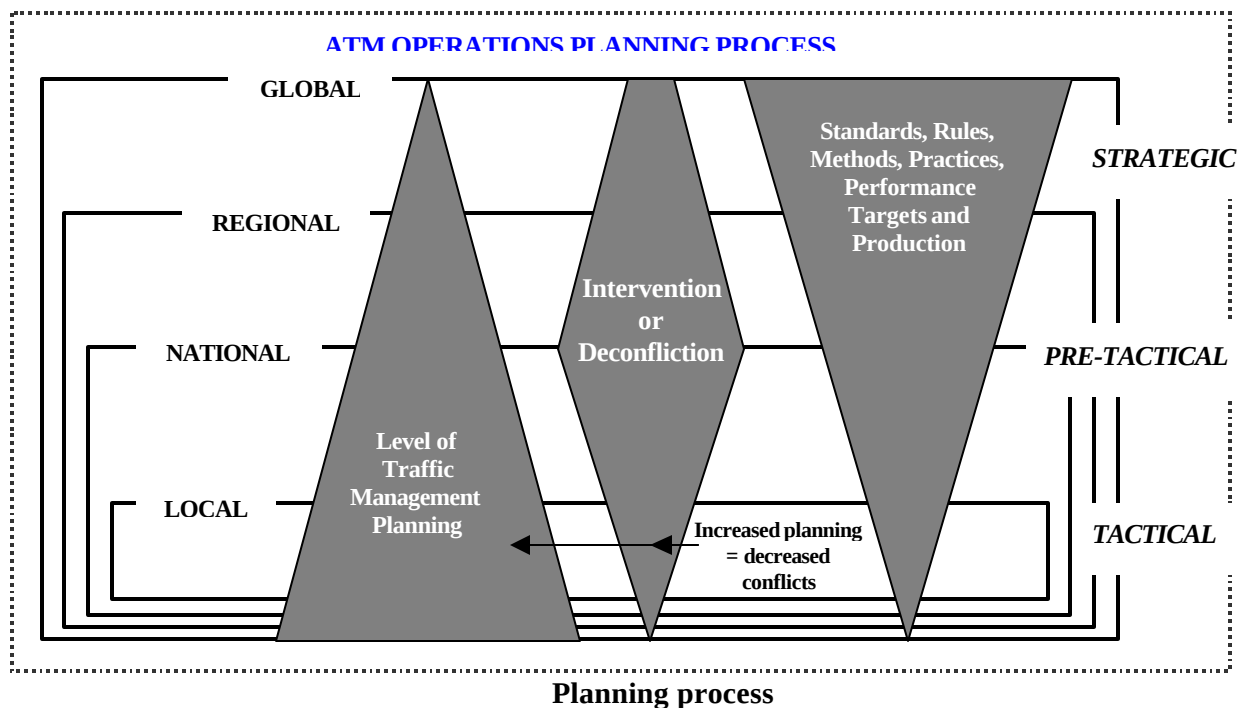
As promised, the trajectory contract is delivered to the charter operator within 30 minutes, including all relevant communication and surveillance requirements, as well as strict start and complete time requirements, which must be met to ± 5 minutes. The charter operator accepts the contract.

The flight departs to operate in the designated area, but arrives there 2 minutes late. The flight is affected by cloud and the pilot requires an additional 10 minutes in the area. The tactical manager of the Airport A area is at peak capacity and cannot, therefore, issue tactical trajectory changes; therefore, the aerial photography flight must be terminated at the previously agreed time.

4. ATM OPERATIONS PLANNING

4.1 General

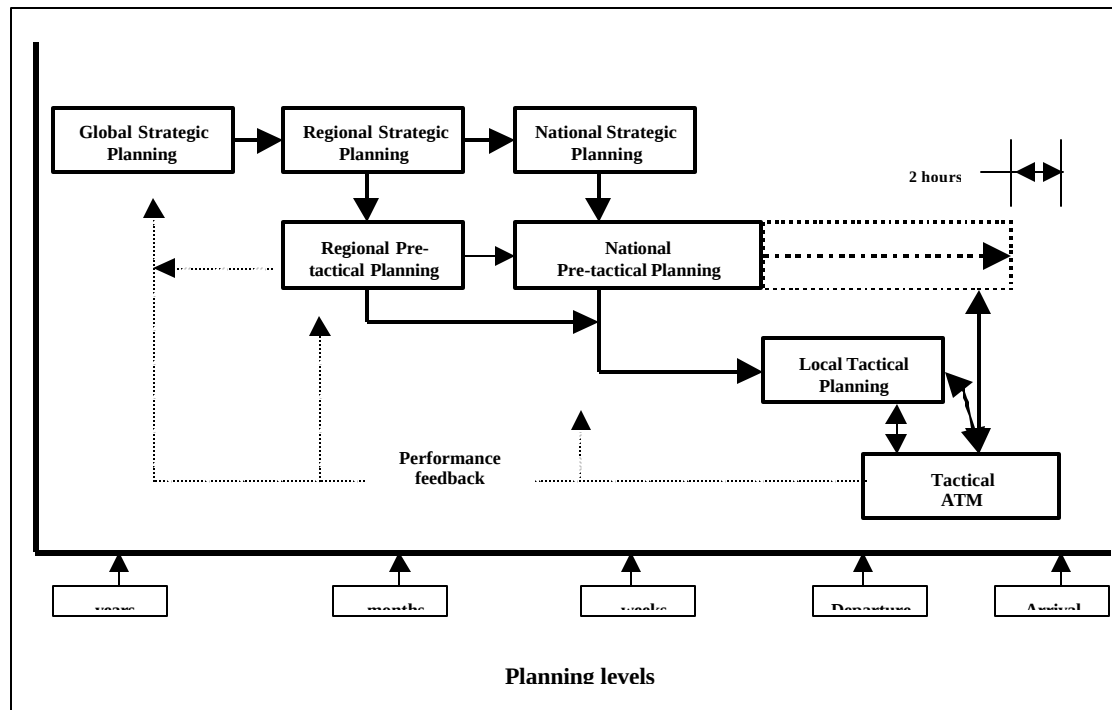
4.1.1 The future ATM system will differentiate between tactical, pre-tactical and strategic planning levels; global, regional, national and local planning levels, as well as between the level of intervention or management that occurs at each of these levels. The diagram below attempts to illustrate the changing levels of intervention in the ATM system.



4.1.2 In this context, the following time frames apply:

- a) strategic planning: any time prior to 2-3 days before a flight;
- b) pre-tactical planning: any time between strategic planning and 2-3 hours before a flight; and
- c) tactical planning: after 2-3 hours before a flight.

4.1.3 The pre-tactical planning period may overlap a portion of the flight, to the extent that the 4-D trajectory included in the contract for the flight can be amended. The diagram below approximately illustrates the different planning levels.



4.2 Global ATM strategic planning process

4.2.1 Implemented through ICAO on the basis of a pro-active global collaborative process involving the highest level representatives of all stakeholders, the following functions would be performed, as indicated in the example below:

- setting and amending of standards;
- setting and changing of business rules;
- addressing of funding principles;
- monitoring, assessing and addressing global performance;
- arbitration and harmonization of interface and global issues;
- monitoring and enforcing global safety; and
- monitoring of seamlessness and interoperability.

Example 5: ATM strategic planning — Global

This week, senior representatives from ICAO and other global representative bodies have been holding their bi-annual meeting to review global aviation safety and system performance and to make recommendations aimed at enhancing system safety.

Accident trends are relatively stable, with a slight downward trend in the last 12 months. Incident trends are upwards, however, mainly due to a spike in one region. This is thought to be associated with the last minute cancellation of a proposed regional demand and capacity balancing system, due to non-readiness of several States. It has been decided that a formal audit of the regional implementation process should be initiated immediately, to provide assurance that such changes will be better managed in future.

One international airline has had an increase in safety related incidents in the last 6 months. The IATA representative states that this may be attributed to a rapid fleet build-up and an IATA safety management assistance team is working with the airline to alleviate these problems.

A number of service providers have indicated that runway separation standards are inadequate for their operations and are requesting a review of global standards to see if it is possible to reflect enhanced runway occupancy infrastructure in new standards. The meeting has agreed that this is a priority task and a project will be established immediately, to report back to the group in 18 months.

A new draft standard, developed as a result of a project initiative 12 months ago, is being considered by the meeting. It allows the use of infra-red optical devices to be used by pilots to “see” the runway through fog when approaching to land, effectively creating a pseudo-visual approach condition. The meeting concludes that this will enhance safety and capacity and requests ICAO to expedite its adoption and implementation.

The meeting has been presented with performance statistics for regional ATM and has noted the overall reduction in delay despite an increase in capacity and demand. One State, however, is still not able to meet the demand and the inability to match the capacity available in adjacent States is causing concern. The meeting has agreed to offer the State concerned technical assistance and access to infrastructure support, aimed at balancing regional capacity. The target for increasing capacity is two years.

4.3 Regional ATM strategic planning process

4.3.1 At the regional level, rule-making options are less significant, but strategic and pre-tactical planning — both infrastructure and traffic management — are becoming more dominant. The following functions are therefore envisaged:

- a) monitoring, assessing and addressing of intra-regional and inter-regional performance;
- b) review of conformance with standards and business rules;
- c) infrastructure planning, system architecture and system design;
- d) proposing of changes to standards;
- e) assessment of capacity;
- f) setting of implementation time lines and rules;
- g) collaborative decision-making at regional level;
- h) comparison and matching of regional demand and capacity;
- i) setting of performance targets;
- j) consideration of seasonal variations and demand;
- k) development of international and intra-national strategic planning processes;
- l) negotiation of intra-regional, international performance agreements;
- m) determination of flexible use of airspace (FUA) rules; and
- n) assessment of resource requirements as part of a discussion on demand versus capacity.

4.4 National ATM strategic planning process

4.4.1 It is recognized that, in some areas, there is both a regional and a national planning function; therefore, elements of ATM management and planning need to be represented in the related scenarios. In some cases, however, a State may be sufficiently large that it assumes the notional “regional” role as well. At the national level, the following functions are envisaged:

- a) monitoring, assessment and treatment of intra-national performance;
- b) review of conformance to standards and rules;

- c) establishment of capacity and demand in a collaborative process;
- d) balancing of demand and capacity in a collaborative process;
- e) data and information management and dissemination;
- f) setting of implementation time lines and rules;
- g) negotiation of schedules;
- h) negotiation of trajectories;
- i) setting of performance targets;
- j) issuance of first level of trajectory (e.g. city pair and time);
- k) planning of military exercises and training;
- l) development of national airspace organization and management strategies;
- m) planning of special requirement and event activities;
- n) negotiation and implementation of flexible use of airspace;
- o) planning of resources; and
- p) setting of performance targets.

4.4.2 Unless exceptional circumstances would prevail, local level ATM would not be engaged in strategic ATM activities beyond those detailed above. In the same way, the pre-tactical phase functions would not extend to the global environment, other than through interchange of information between regions.

4.4.3 The following two examples provide different scenarios related to strategic planning at regional and national levels in the year 2025:

Example 6: Strategic planning — Regional/national level (1)

This region comprises 47 States. There are significant North/South regional traffic flows, as well as from this region to its northern neighbour. There is also a convergence area from a region to the east. There is some instability in a number of States, resulting in frequent airspace closures at short notice.

A recent annual traffic flow survey across the region has been completed and lessons learned are being evaluated. Planning for next year's flow has already begun and past performance and experience will be discussed with operators at a planned meeting. The annual performance review is being collated for dissemination to

governments and other ATM community members. Whilst this is a national requirement, the actual evaluation is automatically monitored on a daily basis by the regional monitoring agency.

Demand forecasts for the next 5 years are indicating that capacity may be exceeded at a number of aerodromes in the region. The aerodrome operators are presenting plans for capacity enhancement to the next bi-monthly collaborative decision-making meeting.

The convergence area airspace capacity may also be exceeded. Furthermore, the Region to the east is considering the introduction of a greater autonomy for the airspace users in a certain volume of airspace (e.g. where ground separation provision service is not provided and full self separation is applied), which may complicate trajectory management at the convergence area. This will be a major agenda topic at the next cross-regional meeting.

The data submitted for the upcoming 12 month flight schedule have been loaded into the computer and will be assessed over the next month, with specific conflicts being flagged for discussion with users.

A request for a two-week combined military exercise for September 2026 has been received. The exercise will affect significant portions of regional airspace. Early indications are that traffic will be moderately affected.

Commissioning of a new ATM tactical unit is planned for June next year and management, resource and contingency plans will need to be developed prior to service activation.

The six month schedules negotiation for this week are progressing, with initial 2-D (city pair and time) trajectories being issued. Most of this work is fully automated, with computer systems accessing system performance information, airport performance, airline performance and other relevant information. Some manual intervention is still required, particularly in relation to airspace organization and management in the region concerned, where airspace closures are once again occurring on a regular basis.

Example 7: Strategic planning — Regional/national level (2)

This region is a continent of a large number of States. There are significant traffic flows in all directions within the region and also with its neighbouring regions. The air transport system is closely connected to the ground transport system and in most cases airport and railway stations share the same facilities. The road network is closely connected to the airports and often major intersections coincide with airports. The northern part of the region represents areas with heavy domestic and international

traffic flows, proportional to its major geographical position in the region, as well as with a major traffic flow in and out of the central region.

Major aerodrome operators, three main airlines and the region's central flow management unit share the same facility and therefore represent one of the five main ATM operational units on this continent. The system-wide business case has proven that, since this facility started its operations, the total overall costs have been reasonable. Moreover, as the system wide safety case has established, safety has also improved for the whole region.

Based on a collaborative process, a common strategic plan for the region was developed to renew the region's infrastructure and airline fleet. This plan was implemented 2 years ago and the system wide business and safety cases have shown increased safety and lower cost per flying hour. Moreover, last year's performance and revenue figures from the different ATM community members have validated the model business and safety cases.

An annual traffic flow survey across the region has been completed recently and performance data as well as tactical and pre-tactical analysis reports are being collated for dissemination to governments and other ATM community members. At a collaborative process annual ATM planning conference with the ATM community members next week, the planning of traffic for the next five years and anticipated traffic flows will be adjusted with emphasis on the next 12-month period. The conference will also consider any needs for a change in strategy or management procedures, as well as proposals for change of rules at the global level. The week after the conference, the results will be discussed and decided in a collaborative process management meeting with the Chief Executive Officers (CEO) of the airlines and heads of the ATM community members in the region and the neighbouring regions.

The demand for capacity seems to suggest that next year there will be a lack of aerodrome capacity during a period of three months at three of the region's major aerodromes, while there is capacity available at aerodromes in the close vicinity which can assist during this period. Plans for capacity enhancement and solutions on how to solve the problem will be presented by the aerodrome operators at the next collaborative process meeting.

Plans for a number of major civil/military exercises during the next five-year period involving unmanned aerial vehicles (UAV) and self-separating aircraft are presented for planning and draft allocation of resources. The civil/military operations unit has already produced methods of operations to this end. Indications so far suggest that other traffic will not be affected, but for safety and efficiency reasons, extra resources will be needed for ground-based ATM assistance.

During the upcoming six-year period, the region's ATM Research and Development (R&D) programmes require a number of live trial exercises concerning a large number of airlines as well as a general aviation (GA) aircraft. This means that extra ground

service provision in certain areas is needed for safety reasons, as well as a number of operations personnel for monitoring in the ATM ground service provider units.

A number of airlines announce plans for changes in the current fleet as well as in their strategies and management of the fleet. Draft plans of consequences have been developed and will be presented at the next collaborative process meeting.

The neighbouring region, which carries a major inter-regional traffic flow on one particular route, has announced that they will close that route for a period of three months during next year due to environmental constraints. This will adversely affect the south-easterly flow of traffic and, therefore, also the traffic flow of the neighbouring and next neighbouring regions. A cross-regional collaborative process conference in December will present alternative solutions with accompanying safety and business cases. Decisions on how to make progress will be taken before the end of the year.

In order to reduce to three the currently five ATM units within 15 months, a new ATM tactical unit will have to be commissioned and management, resource and contingency plans will need to be developed.

One of the region's major airlines is undergoing investigations due to a safety audit showing major deficiencies in their safety and security measures. This has affected negatively the airline's revenue for the past six months, resulting in a reduction of their route network. The probable result of this is that two or three aerodrome operators heavily dependant on the operations of this airline will be adversely affected. This topic is therefore on the agenda of the next collaborative process planning conference in order to evaluate the consequences to the ATM system as a whole.

Investments in ground and avionics infrastructure for complementing the current navigational systems have been delayed and the strategies for the future planning of capacity will be adjusted at the next annual collaborative process conference.

Several major airlines have announced their requirement for a reduction of their turn-around times to a maximum of 15 minutes at five of the region's major airports. This, in turn, will require a major change in the demand and capacity plan for the whole region and its neighbours. The time frame for the implementation has been set for three months from now, i.e. in the middle of the current scheduling. A conference for the region will be held by the end of next week to announce initial and intermediate steps for solving that problem.

4.5 Regional ATM pre-tactical planning process

4.5.1 The following pre-tactical functions are envisaged at the regional level, wherever the many States of that region coordinate closely their civil aviation policies:

- a) monitoring of system configuration, e.g. for runway availability and scheduled works;

- b) management of data, creation of operational information and dissemination of information;
- c) allocation of trajectories (3-D);
- d) establishment of a collaborative processes to balance demand and capacity;
- e) management and dissemination of data and information;
- f) negotiation of schedules;
- g) planning of packet (groups of aircraft) flows;
- h) examination of regional traffic flows;
- i) negotiation of system maintenance; and
- j) planning of resources.

4.6 **National ATM pre-tactical planning process**

4.6.1 At the national level, the following pre-tactical functions are envisaged:

- a) monitoring of system configuration, e.g. for runway availability and scheduled works;
- b) management of data, creation of operational information and dissemination of information;
- c) trajectory negotiation and allocation;
- d) establishment of a collaborative process to balance demand and capacity;
- e) management and dissemination of data and information;
- f) negotiation of schedules;
- g) planning of packet (groups of aircraft) flows;
- h) allocation of resources;
- i) allocation of facility maintenance;
- j) planning of military exercises and training;
- k) planning of special requirement/event activity;

- l) negotiation of flexible use of airspace; and
- m) development of national airspace organization and management strategies;

4.6.2 It is envisaged that the local level would not engage directly in pre-tactical planning processes, but would delegate responsibility to the national process which, in fact, may be a series of sub-national functional areas. In addition, the national level would not get involved directly in tactical ATM, but would liaise downwards where the pre-tactical planning overlaps with the tactical.

Example 8: Pre-tactical planning scenario — Regional/national level

The region comprises 28 nations with responsibility areas of varying size. All responsibility areas have been integrated for strategic and pre-tactical planning purposes. Some individual States have also implemented their own strategic and pre-tactical planning processes to deal with domestic operations as well as international integration.

A review of all flight requests for December is being undertaken, to compare with the initial strategic schedules and to establish initial demand forecasts. The airspace organization is being assessed. A conference has been scheduled for December, which is likely to result in priority requests at short notice by States. Two States within the region, because of a political commitment, will be insisting during the conference that a third State implement ground-based separation provision. This requirement will be communicated to the affected State for assessment and action. Regionally-agreed business rules will be applicable in order to enhance predictability regarding the timely implementation of this provision.

Several requests for military exercises and other special activities have been received. Long range weather forecasts are being compared with statistical data. Capacity estimates from nations are being evaluated against the estimated demand. They are also being validated against past capacity performance. From this, preliminary resource requirements are being determined. These will be communicated to States for them to determine annual leave schedules and other resource management issues. On the basis of this analysis, initial 3-D trajectories will be developed and input to the ATM information network.

One State has indicated that several of its communications facilities need to be taken out of service for routine maintenance in January. Whilst the January demand and capacity balancing work is yet to be completed, early indications are that the optimum traffic flow would be through the affected State's airspace. The State is therefore urged to complete the work on these facilities in November.

Another State has advised that runway re-surfacing work will need to be completed at a major airport in November. Complicating the matter is the fact that the airport is a major alternate aerodrome for international operations. The November trajectory predictions for international traffic will now be seriously affected by the reduction in

capacity. A meeting involving affected airlines, the airport operator and national ATM providers has been scheduled to discuss options for mitigating the loss in capacity, prior to amending trajectories.

A new regional jet service has notified intent to start international services in February. It is being briefed on the regional collaborative decision-making processes and its proposed schedules are being integrated into the strategic/pre-tactical database. The company's prioritization business rules will be loaded into a secure area in the information management (IM) system. Performance expectations will need to be established over the next 3 months and appropriate business rules set in respect of performance agreement breaches.

The cross nation military exercise planned for next week has been confirmed and military officials are requesting a more flexible approach to hours of operation of the designated training areas. The effect on trajectories is assessed as severe, and in accordance with pre-agreed business and safety rules, the request has to be declined. However, work is in progress to offer alternative exercise areas.

One week before those flights are due, pre-tactical staff are analysing trajectories for cross oceanic transits with a view to offering a number of aircraft with similar performance characteristics that they be assembled into packets that will operate in a self separation mode to station-keeping rules, in order to optimize system capacity. Most of this task is fully automated, with only relatively minor human intervention.

On the day of these flights, the pre-tactical process is involved in re-scheduling and amending the trajectories of flights with more than two hours time en-route. The pre-tactical process is also issuing conflict-free 4-D trajectories to airspace users.

4.7 Tactical ATM management process

4.7.1 At the local level, the following tactical functions are envisaged:

- a) confirmation and approval of trajectory;
- b) allocation and replacement of resources;
- c) management and dissemination of information;
- d) provision of separation;
- e) refinement of demand capacity balancing;
- f) refinement of traffic synchronization;
- g) re-negotiation of trajectories, including pre-tactical planning;

- h) handling of short notice user requests;
- i) handling of emergency flights, management of emergency responses and search and rescue;
- j) allocation and management of 4D trajectories;
- k) activities related to the implementation of works;
- l) handling of tactical maintenance response;
- m) handling of tactical capacity response and tactical demand response;
- n) handling of tactical changes to airspace organization and management; and
- o) handling of the tactical collaborative process, which includes flight re-prioritization, re-allocation of trajectory contracts, etc.

Example 9: Tactical ATM scenario — Issues related to resources

The manager at a busy tactical ATM unit has been advised that all staff for the morning shift are present, that the workstations and infrastructure are performing to specification and that all notified capacity figures can be met, barring emergency. Throughput capacity has been notified as 80 flights per hour, with a maximum of 25 flights at any one time per workstation.

The pre-tactical plan for the morning has been reviewed by all managers and the morning conference with users and the meteorological services has been held. The meteorological section is forecasting that the passage of a warm front predicted for 1200 hours will be about one hour earlier — re-routings due to weather are expected. The manager is negotiating with the pre-tactical section to amend the trajectories of flights in the time window from 1030 hours to 1300 hours and to reduce the throughput in that period to 50 flights per hour, with a maximum of 15 flights at any one time.

Eight workstations are staffed for the morning shift, and the pre-planning now anticipates 2 000 aircraft movements in the 6-hour period from 0700 hours to 1300 hours. A military exercise is scheduled to continue today. Airspace has been reserved for the day, but information has just been received that several flights will be joining the area on an ad-hoc basis from an adjacent military base. The manager is trying to determine the probable transit times and to establish an airspace reservation corridor for the transits. The matter is being dealt with tactically rather than by the pre-tactical ATM process, as arrival and departure paths should not be affected.

One workstation has just received an emergency call (pressurization failure) from an aircraft. The manager is busy transferring aircraft from that workstation's jurisdiction

to two other workstations and a tactical warning has been issued to the pre-tactical unit, advising of a temporary sector restriction for the three sectors affected. The emergency traffic needs to transit the military exercise area on emergency descent and the sector has activated a distress clearance alert to the military operations unit. The military manager initiates an emergency override to clear the path of the descending aircraft. This process is a standard clause within the letters of agreement between the military and civil airspace managers.

Later in the morning, at 1015 hours, two aircraft report moderate-to-severe turbulence ahead of frontal activity. A number of other aircraft report light-to-moderate turbulence. The manager anticipates that separation will change within 30 minutes from self-separation to separation provision provided by the ATM unit and begins the transition. This requires a reduction in per sector capacity from 25 to 15 flights and adjustment of the parameters of the conflict alert and resolution tools. System throughput was already scheduled for reduction from 1030 hours.

A maintenance supervisor has requested permission to carry out routine maintenance on the back-up power supply. The room supervisor denies access to the equipment because duplicated power supplies are required during the forecast period of increased separation provided by the ATM unit and asks that the work be re-scheduled for late evening. The supervisor adds this item to the checklist for the weekly managers' safety and performance meeting, noting that these requests should not be made during busy periods. The maintenance supervisor has already indicated that there are additional costs associated with night-time repair work.

Several aircraft have requested to carry out training in a volume of airspace in a section of the airspace administered by the unit. They do not require services during the training period of two hours. The room supervisor checks that there is no confliction with en-route managed traffic and then designates an area for the training activity. The airspace is reserved for 2½ hours and is designated as requiring full self separation operations.

The morning supervisor is advised that two managers will not be at work in the afternoon due to illness and that replacement staff are unavailable. The afternoon traffic schedule can be managed safely with one manager less. However, the loss of a second manager will require traffic throughput restrictions. To minimize the disruption to traffic, the supervisor negotiates with the pre-tactical supervisor, to see if the traffic can be off-loaded to an adjacent unit. Trajectories will be affected, with several aircraft being required to fly outside optimum trajectories and to exceed the agreed performance parameters. The cost will need to be borne by the tactical unit, which had entered into a performance contract to manage a pre-agreed number of aircraft.

Example 10: Tactical ATM scenario

It is late afternoon in a busy tactical ATM unit. Most of the daytime traffic has been processed and the unit is getting ready to handle the relatively quiet night shift. The unit manager has just finished a link-up with the adjacent unit managers and the pre-tactical manager, and they have agreed, on the basis of forecast traffic levels, to implement full self-separation operations from 2200 hours this evening until 0500 hours the following morning.

During this time, traffic will be managed into and out of controlled airports, but will operate to full self-separation rules in the en-route environment.

Aircraft A operating for Company A taxis at Airport A bound for Airport B at 2200 hours. Aircraft A is provided with a separation service by the ATM ground service provider from departure until transition to full self-separation operations. Prior to transition to full self-separation, Aircraft A is provided with traffic information on traffic known to be operating in proximity to their trajectory while Aircraft A will be self-separating.

Later in the evening, Aircraft B operated by Company B taxis at Airport C, bound for Airport D. Again, the aircraft is provided with a separation service by the ATM ground service provider until transition to full self-separation operations. Prior to transition, Aircraft B is provided traffic information on other flights, including Aircraft A.

Both Aircraft A and B are receiving Decision Support Services directly to the cockpit, enabling them to monitor traffic. Even though they operate in full self-separation mode, the trajectories of the aircraft in the airspace are known to the ATM system and ground-based traffic alerts are generated automatically, when separation minima are infringed.

An alert is provided to Aircraft A about Aircraft B and vice versa. Aircraft A requests a separation service from the ATM ground service provider which, on this occasion, can be provided. Under pre-defined conditions, the ATM ground service provider temporarily overrides the independent manoeuvring of Aircraft B while separating Aircraft A.

The ATM system is anticipating that Aircraft A will cease full self-separation at 0200 hours. A 4-D trajectory for arrival at Airport B is up-linked at 0130 hours and accepted by the pilot. The aircraft receives a separation service from 0200 hours until parked at 0235 hours.

Example 11: Combination of tactical and pre-tactical ATM

0000 hours: *Aircraft F, from a southern part of one region, is cruising at FL366, at Mach 0.85. Upper airspace in the southern and central part of the region has been designated as requiring full self-separation operations, and traffic information from ground and air surveillance systems is being continually up-linked to the cockpit. The*

northern part of the region retains separation provision services and an entry gate time of 0612 hours has been projected and passed to the pre-tactical management unit.

0100 hours: *Aircraft F has become aware of a potentially converging aircraft, not following a system notified trajectory. Attempts to contact the flight have been unsuccessful. Aircraft F has requested a separation service from the ground ATM service provider, but they are unable to provide it, as the traffic is unknown. Aircraft F initiates early cautionary avoidance action.*

0300 hours: *Aircraft F has encountered the adverse weather that had been forecasted and has been forced to reduce speed because of turbulence. This will affect its gate entry time. The pilot is negotiating a new gate entry time of 0620 hours, and is also requesting a trajectory amendment for the section of the trajectory for which a separation provision service is offered, in order to maintain its programmed landing time of 0712 hours at destination.*

0600 hours: *Aircraft F is being transferred to the adjacent region's ATM command unit. Aircraft F has been coordinated to transfer to that region's management at 0628 hours. A programmed landing time of 0712 hours has been confirmed. However, the trajectory is sub-optimal, as the aircraft was delayed by weather in the originating region.*

0800 hours: *At Aircraft F's destination airport, visibility is reduced to 100 m in fog, which is expected to last for 3 hours. Acceptance rates have been maintained at 60 per hour, using the automated landing guidance systems. Only suitably-equipped aircraft are being accepted during the period 0700 hours to 1000 hours. Aircraft F touches down at 0712 hours local.*

4.8 Airspace user operations process

4.8.1 The following functions, at a pre-tactical level, are envisaged for the airlines' operations process:

- a) integration of the airline system;
- b) prioritization for maintenance, business priority, fleet utilization, etc;
- c) sharing of information on aircraft performance, system performance, etc;
- d) attempt of influencing tactical ATM;
- e) dynamic management of other ATM affecting performance; and
- f) assurance that "ATM and ATM affecting contracts" are met.

Example 12: Airspace user operations — Pre-tactical and tactical

The airspace user has already negotiated the preferred schedule for their flights at the strategic stage.

At pre-tactical stage, the ATM ground service provider and the airspace user manage the changes from the initial planning through a collaborative process.

Prior to the departure of each flight, their 4-D trajectory, including estimated departure and arrival times, as calculated by the airspace user, is negotiated with the ATM service provider; then the 4-D trajectory contract will be up-linked to the aircraft.

The tactical stage starts when the aircraft leaves the parking position, after which the trajectory contract will be validated and adjusted, if necessary, with the ATM ground service provider. Thereafter, the 4-D trajectory is updated and refined dynamically with real time information. All real time processes will be synchronized.

Unforeseen events during the flight could lead to, inter alia, the following situations:

- a) a deviation from the current trajectory has only a minor impact on the trajectory contract, for example, a vector around an isolated thunderstorm cloud; and*
- b) a deviation, e.g. an extensive vector around a long line of thunderstorms, requires a new trajectory derived through a collaborative process, which in turn would result in a revision of the trajectory contract and thus will impact on the estimated arrival time.*

Any modification of the current trajectory contract, be it minor or significant, will invoke the conflict management processes necessary to resolve potential conflict without compromising the level of safety.

The 4D trajectories include the user requested (e.g. the most economical) descent profile. The sequence of aircraft to land is based on the estimated arrival time. In order to optimize the landing rate, the taxi time on the runway is negotiated between the airspace user and ATM service provider, taking into account a turn-off point consistent with the taxi plan requested by the user.

— END —