PERFORMANCE MANAGEMENT AND MEASUREMENT FOR AIR NAVIGATION SERVICES PROVIDERS

Submitted by the ICAO Secretariat

1. INTRODUCTION

1.1 The 35th Session of the ICAO Assembly in 2004 stressed the importance of developing a performance framework for the future global air traffic management (ATM) system and concurred that ICAO, at an appropriate time, would convene, in co-operation with other organizations, a global meeting to agree on performance objectives and monitoring requirements. In June 2005 the Council noted that there was general agreement on the importance of the concept of a Worldwide Air Navigation and Air Transport Conference on the Performance of the Air Navigation System. It was, however, considered premature to convene a Conference at the present time as there was a requirement for further development of relevant subject matter to full maturity. The Secretariat would continue to monitor, over the long-term, the need for convening a future such Conference. In noting that the Secretariat would continue to explore ways of increasing awareness and improving knowledge of performance issues, the Council indicated that serious consideration should be given to convening a symposium on the performance of the air navigation system.

1.2 For discussion by the Symposium, and as part of an overall performance framework, this background material on performance measurement and management systems for air navigation services providers (ANSPs) has been developed. It is intended as clarification to existing policy and guidance material contained in ICAO's *Policies and Charges for Airports and Air Navigation Services* (Doc 9082/7) and in the *Manual on Air Navigation Services Economics* (Doc 9161/4) with respect to performance measurement and management systems. For longer term considerations, it also takes into account the *Global Air Traffic Management Operational Concept* (Doc 9854), hereinafter denoted as the "Operational Concept", as well as Performance Based Transition Guidelines based on the Operational Concept.

1.3 Section 2 of this background material suggests guidelines for ICAO Contracting States regarding the use of performance measurement and management systems for ANSPs, and describes key system characteristics.

1.4 The remainder of this material describes considerations and methods for implementing performance management and measurement systems by ANSPs. Section 3 stresses that, at present, consultation with users is imperative for successful performance management and that in the longer term collaborative processes with other members of the ATM community will increasingly gain importance. Sections 4 through 7 focus on the mechanics of performance management and measurement – determining objectives and targets; identifying key cost drivers; adopting performance indicators; and ANSP assessment. Section 8 discusses the role of incentives in achieving performance goals[1], objectives and targets. Finally, Section 9 deals with information disclosure and performance reports.

[1] In this background material the term "goal" is used to denote a general statement of purpose or expectation regarding long term ANSP performance related to the realization of the Operational Concept. The term "objective" is used to indicate specific outcomes required to achieve the long term goals envisaged. Several objectives may be adopted for any one goal. See Section 4 of this guide for further discussion.

2. SUGGESTED GUIDELINES

2.1 The purpose of an ANSP is to provide air navigation services that contribute to the safety of flights in an efficient and cost-effective way. Individual ANSPs must work in partnership with airports, airlines, regional planning entities and other members of the air traffic management community to provide an efficient air traffic management system. The performance of any community member can have an important impact on the whole system. Thus, the development and operation of a safe and efficient air traffic management system requires the involvement and co-operation of the entire ATM community. Successful implementation requires complementary action by airports and users of air navigation services. In order to facilitate the design, implementation, and operation of an integrated and collaborative air traffic management system to meet aviation's needs in the 21st century, ICAO Contracting States should ensure that performance measurement and management systems are implemented by ANSPs. Within an overall performance framework, these systems need to be developed in collaboration by the entire ATM community, and community members ought to adopt complementary performance objectives. Specifically, States should ensure that:

a) effective governance structures exist to define and monitor ANSP performance taking into account the regulatory circumstances concerned; and

b) ANSPs have a performance management process in place that includes the implementation of a performance plan.

2.2 Performance management is a systematic approach to improvement within an organization that consists of the definition of strategy and its execution through the alignment of resources and behaviours. It is an effective way of helping an organization understand how it can improve. Performance management should promote a culture of co-operation and collaboration, and help communicate a unified vision of an organization's general strategy.

2.3 The need for a comprehensive, effective performance measurement system is independent of the type of organization (government department, an autonomous public sector organization, or a private sector organization) that provides air navigation services. A discussion of the nature and characteristics of these organizational forms is provided in the *Manual on Air Navigation Services Economics* (Doc 9161/4, Chapter 2, Organizational Structures at the National Level). Each organizational form has its own strengths and weaknesses. It is the responsibility of the State to decide which form best suits its circumstances. A performance management process is desirable regardless of the form of ANSP governance.

2.4 The performance management process should define and document ANSPs' objectives. These need to focus on continuously improving the safety, productivity, quality and cost-effectiveness of ANSP services. ANSPs may also select additional performance areas. In formulating objectives, ANSPs ought to consult with stakeholders. In the context of the Operational Concept, formulation of goals will in the future take place collaboratively within the ATM community.

2.5 At present, the performance management process for ANSPs should:

a) define objectives of ANSPs;

b) identify main ANSP cost drivers;

c) select ANSP performance indicators and supporting metrics and measurement methods;

d) in consultation with users establish performance improvement targets that are supported by compatible user performance management commitments;

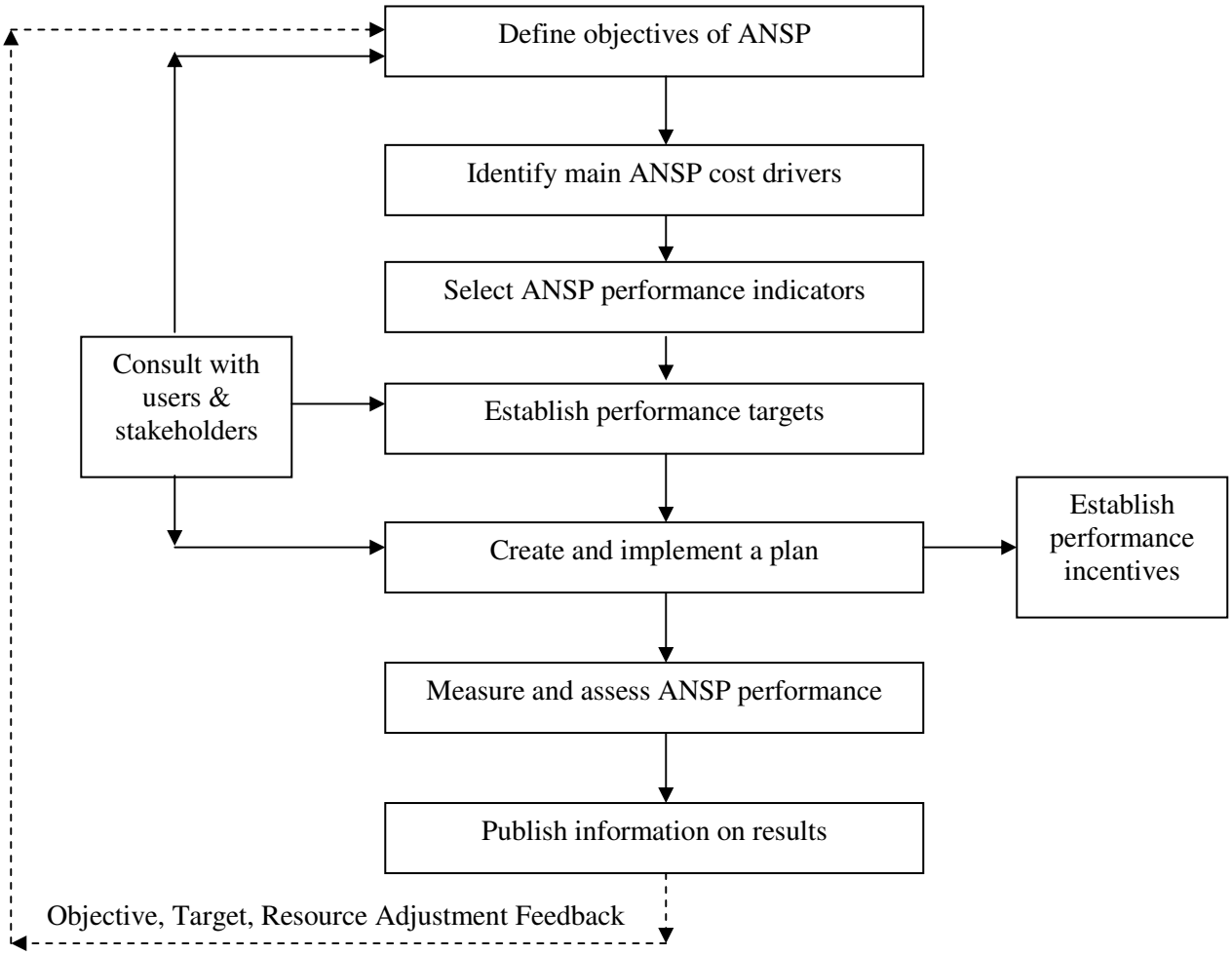
e) create and implement a plan in co-operation with other members of the ATM community, to achieve performance targets;

f) consider, and where appropriate, establish performance incentives; and

g) periodically measure and assess actual ANSP performance using benchmarking as appropriate, and publish information on results achieved.

2.6 Figure 2.1 illustrates the suggested performance management process for an ANSP at present. As indicated by the feedback loop in the flow diagram, the performance management process uses the results of assessments of actual performance to periodically adjust performance goals, objectives, targets and plans to results achieved, as appropriate.

Figure 2.1
Performance Management Process Flow Diagram
for periodical economic performance management of ANSPs



2.7 The starting point for any performance management system at present is the adoption of goals that define success. These should be selected by the ANSP management and focus on continuously improving safety, productivity, quality of service, and cost-effectiveness of the organization in a measurable manner. In formulating goals and objectives, ANSPs should consult with users and other stakeholders of the ATM community, in accordance with the governance arrangements specific to their State, so as to ensure continuous improvement. A gradual evolution towards full collaboration with the rest of the ATM community is foreseen in the Operational Concept.

2.8 Performance measurement areas should be selected so that they relate to the ANSP's goals and objectives. Presently, the areas of performance measurement should at least include safety, quality of service, productivity and cost-effectiveness. For each goal, there should be specific objectives and associated performance targets. ANSPs ought to use one or more measures as appropriate for each of the selected performance targets. As part of the realization of the Operational Concept, all eleven Key Performance Areas based on the ATM community expectations should be included: access and equity, capacity, cost-effectiveness, efficiency, environment, flexibility, global interoperability, participation by the ATM community, predictability, safety and security.

2.9 Performance measurements need to be made at regular time intervals, at least annually, using a consistent, transparent methodology to determine progress in meeting performance objectives and targets. ANSPs should publish a performance plan for interested parties that describes the targets they have selected, the performance indicators established, and the results achieved on a periodic basis. Public reporting can energize staff and encourage on-going thinking about what works and what does not. Performance information should be both motivational and informational. Appropriate dissemination of performance information can build public confidence and lead to significant improvement in the provision of services.

2.10 The performance management process is an iterative process. If an organization is not achieving its performance targets, managers need to determine the reasons for this, and how performance could be improved accordingly. After the assessment of performance reports, actions may be taken by an ANSP to re-allocate resources so as to achieve or, in collaboration with other members of the ATM community, re-define goals (the "learning and adjustment" stage). The potential use of information on actual performance to adjust resources and goals is denoted in Figure 2.1 by the loop labeled "Goal, Objective, Target, Resource Adjustment Feedback".

2.11 Good quality information is a most valuable asset to the whole performance management process and hence insufficient or poor quality data can constitute a serious problem. Information systems for economic and management performance must provide all the relevant information for targets, performance indicators and actions. However, ANSPs should take care that the benefits of collecting information justify the cost of collection. Potential weaknesses in economic and management information systems may include too much detail in some areas, inconsistencies, and information not directly relevant for management purposes.

2.12 When initiating a performance management process, ANSPs ought to develop or update existing appropriate management systems. Periodic reviews should be conducted of the performance management process itself and appropriate remedial actions taken. The following practices relate to ANSPs:

a) *a quality management system*: It is desirable that ANSPs comply with ISO 9000 or a similar certification programme. This standard establishes quality requirements for business-to-

business dealings and is supported by national standards bodies from more than 120 countries;

b) *a safety management system*: It is essential that ANSPs comply with the safety management Standards of Annex 11, including the definition of lines of safety accountability throughout the air traffic services provider, with direct accountability for safety on the part of senior management. Detailed guidance on safety management is provided in the *Safety Management Manual* (Doc 9859), which is freely available on the ICAO public website at: http://www.icao.int/anb/safetymanagement/Documents.html; and

c) *a security management process*: ANSPs should comply with specific security requirements (in access to computer and communication systems, for instance) in order to guarantee the provision of secure air navigation services.

2.13 Special attention needs to be paid to management accounting systems used in budgeting and to monitoring of cost-effectiveness and allocation. International compatibility problems can arise if ANSPs follow generally accepted accounting principles (GAAP) that can differ across frontiers. In order to avoid such a situation, it is highly recommended that, whenever possible, international financial reporting standards (IFRS) and international accounting standards (IAS) be adopted. However, some States may require that ANSPs use other financial standards.

2.14 Performance of the ATM system as a whole can be measured and influenced at national, regional and global levels. Performance indicators applied at these levels can help the ANSPs improve system performance and manage costs while ensuring safety:

a) at national level, performance indicators demonstrate the quantity, quality and cost-effectiveness of services provided to aircraft operators. They identify areas for improvement and may justify potential new investment and associated benefits and costs to users. Performance information assists national authorities in assuring safe and efficient air navigation services through ANSP accountability and can build public confidence about the ANSP. Performance results can be used to forecast needed capital investments and air traffic controller staffing requirements to meet near, medium and long term demand;

b) at regional level, performance indicators can be used to define benchmarks to compare the quantity, efficiency, or quality level of different service providers within a region. Through regional benchmarking, it is possible to identify more efficient regional facilities as well as processes that may be commonly adopted to improve regional performance as a whole. Performance management can support more effective regional co-ordination and planning by rationalization and avoidance of duplication of effort; and

c) at global level, international performance guidelines could be issued (for instance, through ICAO) containing a set of practices to be observed by ANSPs when adopting performance indicators. By adhering to these guidelines, ANSPs would be assured of effective and credible performance indicators. Because ANSPs confront differing business circumstances and are not at the same point of development and sophistication, the guidelines should recognize potential differences and set out a broad spectrum of possible performance indicators, data sources, and compilation and estimation procedures. A common set of minimum reporting requirements should be considered, as recommended by the Eleventh Air Navigation Conference in 2003.

3. CONSULTATION WITH USERS AND COLLABORATIVE DECISION MAKING

3.1 Other members of the ATM community (such as States, regulatory authorities, airspace users and airports) need to be consulted as an integral part of the performance management process of an ANSP.

3.2 As individual users tend to have different opinions and priorities, the ANSP needs to adopt a process that seeks to reconcile these differences. The process should allow input to the consultation exercise from technical and economics specialists representing the various parties. In the event that the initial consultation process fails to result in common understanding, there needs to be a pre-designed process that outlines who takes final decisions, and how. Such processes may differ between States, depending on the regulations and governance systems pertinent to individual ANSPs.

3.3 Common understanding is key to good consultation. The ANSP needs to put sufficient information at users' disposal to allow them to participate fully in the consultation process.

3.4 At present, the following best practices are suggested for stakeholder consultation:

a) effective consultation should ensure that interested parties have the opportunity to have their say and know that their interests have been considered in policy decisions;

b) those who may be affected by a policy proposal should be engaged from an early stage, and then throughout its development;

c) issues should be discussed informally with interested parties to establish an agenda and focus the formal consultation process;

d) consultations should make clear the nature of proposals; parties most likely to be affected; business case for proposals; specific questions on which feedback is requested; and time schedule for responses;

e) consultations should use methods appropriate for the subject matter including seminars, working groups and oral briefings as well as standard written consultation exercises;

f) consultation documents should be concise, clearly laid out and should make use of simple language wherever possible;

g) enough time should be allowed for organizations to consult their members and interested parties;

h) reasoned responses should be provided by interested parties;

i) responses should be acknowledged and all respondents should automatically receive copies of the final decision document; and

j) decision documents should contain clear reasons for the chosen outcome(s), and should show how responses have been taken into account.

3.5 In the future, the ATM system, as outlined in the Operational Concept, will be characterized by strategic and tactical collaboration in which the different members of the ATM community will participate in the definition of the types and levels of service. Equally important, the ATM community

will collaborate to maximize system efficiency by sharing information, leading to dynamic and flexible decision making. ANSPs, airspace users and other members of the ATM community will need to take part in this collaborative decision making process as an integral part of the performance management system.

4. GOALS, OBJECTIVES, AND TARGETS

4.1 The first step in the performance management process is to understand the ATM community expectations and the contribution of ANSP performance to overall system performance. Thereafter objectives should be formulated.

4.2 Objectives that focus on outcomes rather than on outputs, activities or inputs are more likely to improve performance. “Increase runway safety” is a goal focusing on an outcome rather than specifying required inputs (e.g. the number of air traffic controllers) or outputs (e.g. the number of aircraft contacts). The potential associated objective “reduce runway incursions” also is an outcome.

4.3 Because success for an organization frequently depends on factors that are not completely under its control, communicating goals and objectives can invite and motivate cooperation from external partners. Different forms of cooperation between service providers, users, and other external stakeholders are often possible. The result should be a partnership that clarifies key operational targets. Consultation with customers should be considered a critical, necessary part of the business planning process. At present, this includes discussions with customers and other stakeholders of high-level goals, related objectives and performance targets, e.g. concerning safety, quality of service, productivity and cost-effectiveness. In the future, performance objectives and targets for ANSPs will be determined collaboratively between the members of the ATM community, as indicated in the Operational Concept.

4.4 The number of goals and objectives should be limited to a few key ones for any one manager. If too many are pursued, efforts will be spread too widely with the likely result that goals and objectives will not be achieved. Selecting a few key, realistic objectives (five or less) is a good rule to follow.

4.5 As a minimum, the goals of an ANSP should focus on continuously improving the safety, productivity, quality and cost-effectiveness of air navigation services. Gradually, an evolution will take place towards considering all eleven Key Performance Areas based on the ATM community expectations from the Operational Concept in the definition of performance objectives. Objectives can be defined with varying degrees of quantification. Some areas lend themselves more easily to measurement than others. Policy-related objectives (e.g. develop an adequate level of service) are more difficult to quantify than those related to operations (e.g. reduction of delays) or costs (e.g. reduce costs by a certain amount). However, it should be kept in mind that if one cannot measure something, it cannot be managed. Quantifiable and achievable targets should therefore support goals and objectives.

4.6 Setting of objectives is fundamentally performance-oriented. In selecting an objective, it is therefore important to determine how it will be measured. Within each Key Performance Area, measures are established and results reported. ANSPs should use one or more measures as appropriate for each of the performance targets that they have selected.

4.7 Objectives are often interrelated and therefore there might be some trade-offs among them. Performance indicators may provide a better understanding about those trade-offs. When interrelationships are identified, priorities can be established to resolve conflicts between targets. It is then necessary to determine the relative value of each target. Good targets should be challenging as well as realistic. The goals at the different levels of the organization need to be linked, to ensure overall

coherence and focus on priorities throughout the organization. This will also foster teamwork and facilitate effective communication.

4.8 Having identified objectives, it is necessary to establish performance indicators and targets related to achievement of the goals and objectives. An organization should use a set of performance indicators aligned with the objectives that define success for the organization. Target setting depends on the nature of the goal and other circumstances. In some cases, the performance target may be dictated by external circumstances, e.g. a cost reduction of a specified amount or percent in response to an industry downturn, or a budget cut imposed on a government-operated ANSP. More typically, though, objectives should relate to the ANSP's on-going efforts to improve over time. In this case, targets may be more nuanced. For example, a cost control related target could be established as "meeting", "exceeding" or "far exceeding" the objective if a budget saving of 1, 2 or 3 per cent, respectively, is achieved. The level of achievement would be reflected in performance pay and evaluation. Targets may be set using internal performance indicators or indicators representing a comparison among ANSPs. Targets need to be realistic and achievable. They should be developed in consultation with the managers concerned. This process also helps to ensure a common understanding of what is expected.

4.9 Once objectives and related performance targets have been established, progress to reach them should be monitored on a regular basis. This will allow any problems to be identified in a timely manner and appropriate corrective action to be taken.

5. IDENTIFICATION OF KEY COST DRIVERS

5.1 Cost drivers for the provision of air navigation services are ultimately a function of the level and type of outputs needed by an ANSP's customers. These are generally measured by the quantity of traffic controlled in a given airspace/flight information region (FIR). Creation of the outputs by the service providers requires resource inputs - cost drivers consisting of staff, services and supplies, and capital. In addition, there may be a number of external cost drivers related to both output and input. Examples of external cost drivers are airspace complexity, which directly relates to the number of sectors required and therefore to the cost of the service, traffic flow distribution including peak distribution, regulatory and environmental obligations, and military utilization and requirements.

5.2 ANSPs' output is the provision of infrastructure and information for all air traffic and of the required ATC capacity to handle the demand for controlled air traffic in a safe, expeditious, efficient and cost-effective way in the airspace under their control. This output can be measured in the first instance in terms of the quantity of traffic controlled. Key areas of output and measures thereof include en-route flights, flight hours handled, distance traveled, and number of en-route and terminal aircraft movements.

5.3 These outputs generate input costs (internal cost drivers) that include staff costs (salary, social security costs and pension obligations), other operating costs (purchased services and materials, repairs and maintenance), depreciation and cost of capital.

5.4 Cost inputs will be affected by the general economic conditions of the State/Region the ANSP operates in. These conditions include cost of living, taxation policy, cost of borrowing, scarcity of services and infrastructure, and stage in the investment cycle. Costs also are influenced by availability of operational staff and type of organization structure (ownership). Other important cost determinants are airspace complexity and regulation. Airspace complexity is a cost driver that may affect the number of sectors required for a given level of traffic. Three generally recognized measures of traffic complexity are vertical distance, number of proximate pairs per kilometer flown, and density adjusted to reflect the

concentration of traffic that takes into account airspace congestion. Regulatory requirements, whether they are safety, economic or environmental, often generate costs for both the regulator and the ANSP.

6. PERFORMANCE INDICATORS

6.1 There are several considerations in selecting performance indicators for an ANSP. First, the indicators should be meaningful: they should provide an accurate reflection of performance. Second, the indicators should be useful: indicators should only be developed if they have value as a tool in helping to assess and improve air navigation services. Third, in developing performance indicators, a gradual approach is helpful (start with a small set of basic indicators). Finally, clear definitions of services and units of measurements should be established.

6.2 Performance indicators should relate to the goals and objectives of service. For ANSPs these are to ensure the safe and efficient movement of aircraft. Areas of performance measurement would therefore include, as a minimum, safety, quality of service, productivity and cost-effectiveness. In line with the realization of the Operational Concept, performance measurement will gradually take place within all the Key Performance Areas derived from the ATM community expectations in the Operational Concept.

6.3 Safety indicators generally focus on actual or potential safety events, risk categories and event causality. Potential measures include:

a) ATC-related accidents (accidents per million flights);

b) ATC-related fatal accidents (fatal accidents per million flights);

c) mid-air collisions (mid-air collisions per million flights);

d) controlled flight into terrain (occurrences of controlled flight into terrain per million flights);

e) separation minima violations (separation minima violations per million flights);

f) runway incursions (runway incursions per million operations);

g) MET forecast accuracy (per cent of forecasts verified as accurate); and

h) aeronautical information services (AIS) chart accuracy (average number of reported errors per chart).

Alternative or additional measures may include:

i) ICAO Category A & B incidents (risk bearing) per 1,000 flights; and

j) ICAO Category C & D incidents (non–risk bearing) per 1,000 flights.

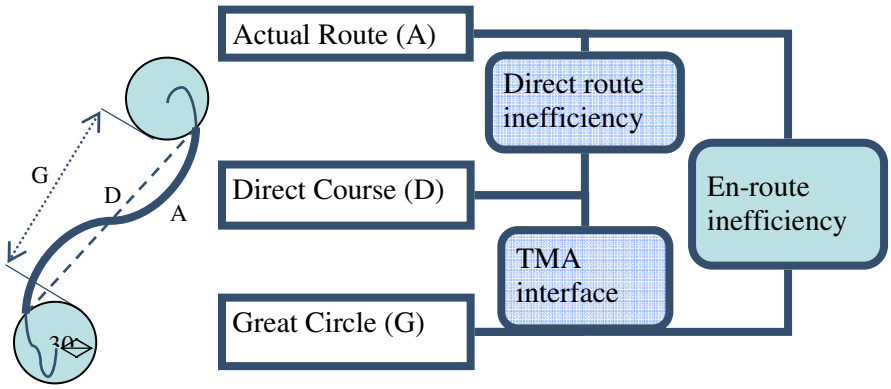
6.4 Quality of service performance indicators should reflect the customers' perspective. The main aspects of service that affect quality include:

a) capacity to meet airspace user demand at peak times and locations while minimizing restrictions on traffic flow. Potential measures are:

- volume of system operations (effective capacity) that can be accommodated with minimal delay (for example one minute per flight);
- volume of sector operations per period of time (hour) that can be accommodated under different weather conditions and procedures;
- volume of airport operations per period of time (hour) that can be accommodated under different runway configurations, weather conditions, and procedures;
- sector (or airport) capacity/demand ratio (percent);
- duration (hours per year) when demand exceeds capacity (capacity shortage);
- magnitude of capacity shortage (movements per hour);
- number of congested facilities (number of facilities);
- number of years that capacity profile leads demand profile (years);
- un-accommodated demand (flights per annum);
- airport average daily capacity (aircraft movements per day); and
- airport annual service volume (aircraft movements per year);

b) flight efficiency may be considered in terms of the frequency and duration of deviations from optimum routes. Efficiency should be compared against a baseline of individual user preferred 4-D trajectories because it is up to individual users to define the criteria which determine their optimum (most efficient) solution. The percentage of flights where the requested flight plan trajectory (i.e. including altitude) is changed by ATC to a less efficient one before or during a flight evidences less than efficient service from the user's perspective. Figure 6.1 illustrates how the en-route horizontal flight efficiency indicator can be computed.

Figure 6.1



Potential measures of efficiency include the number and/or the percentage of:

- vertical deviations from the requested/optimum flight level;
- horizontal deviations from requested/optimum route;
- other ATC-imposed restrictions; and
- the difference between actual aircraft block time compared to the theoretical time associated with published service or requested plans;

c) predictability refers to the ability of the airspace users and the ANSPs to provide consistent and dependable levels of performance and is measured by delay variance against a

dependability target. Predictability is essential to airspace users as they develop and operate their schedules. The dependability target (delay standard) should be decided by the ANSPs in consultation with users. Examples of potential delay measures include:

- number of delays by cause;
- percentage of flights with or without attributable delay;
- number and/or average duration of delays attributable to ATC;
- average delay per flight;
- average delay per delayed flight;
- average delay per ATM delayed flight in en-route;
- average delay per ATM delayed flight in terminal;
- number and/or average duration of departure, en-route and arrival delays;
- delays per region and/or sector;
- time in stack that could be analyzed into per time of day and per airport; and
- number of days with average ATM-related delay > 1 minute;

d) availability as described by the incidence of air navigation equipment outages affecting customers. Incidence may be measured by number of outages, average duration of an outage, and mean-time between equipment failures; and

e) accessibility of services provided to different user groups, e.g. for regional and local services, and for general aviation.

6.5 Productivity performance indicators measure the quantity of output produced by a unit of input. For air navigation services, the output is the traffic served, while the input is the resources (mainly labour and capital assets) engaged in providing the service. Depending on the specific productivity one is trying to measure and the availability of data, both traffic and resources can be quantified in various ways. Typical performance indicators include the average number of:

a) aircraft handled per centre;

b) aircraft handled per sector;

c) aircraft handled per controller;

d) aircraft hours per centre;

e) instrument flight rules (IFR) aircraft hours per sector;

f) IFR aircraft hours per controller;

g) IFR kilometres handled per center;

h) IFR kilometres handled per sector; and

i) IFR kilometres handled per controller.

Alternative or additional measures may include:

j) en-route flight hours (or kilometres flown) per en-route ATCO in operations;

k) IFR aircraft movements per terminal ATCO in operations;

l) total support staff per ATCO in operations; and

m) flight hours (or kilometres controlled) per unit of capital employed.

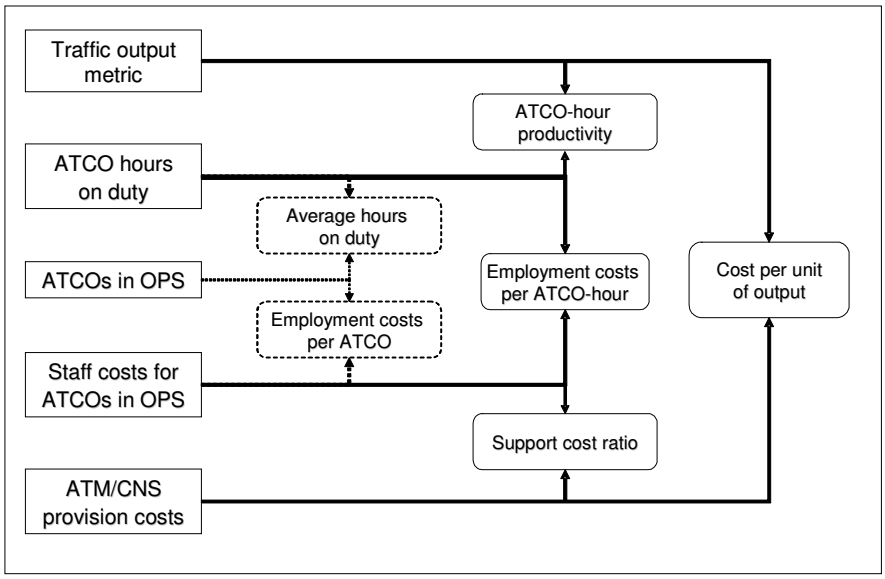
6.6 Cost-effectiveness can be assessed from two perspectives: financial cost-effectiveness and economic cost-effectiveness.

6.6.1 Financial cost-effectiveness of a service is generally measured as the cost per unit of output. For air navigation services, with traffic as the output, the cost-effectiveness indicator would be the cost per unit of traffic. The appropriate cost components (e.g. labour, operations and maintenance, capital costs) and traffic units would vary, depending on the specific cost-effectiveness being measured. It should be noted that cost-effectiveness is related to productivity.

To assess ATM/CNS financial cost-effectiveness, the following high-level framework may be used:

Figure 6.2

Financial cost-effectiveness framework



Cost-effectiveness is determined by the productivity and the unit cost of input. The framework illustrated in Figure 6.2 allows financial cost-effectiveness (measured as a cost per unit of output) to be broken down into a number of contributory factors and cost drivers.

Typical financial cost-effectiveness measures include the following averages:

a) ATC cost per flight;

b) cost per IFR flight hour;

c) cost per kilometre of IFR flight;

d) cost per sector;

e) cost per air traffic centre;

f) operating cost per IFR flight hour;

g) operating cost per kilometre of IFR flight;

h) operating cost per sector;

i) operating cost per air traffic centre;

j) aviation routine weather report (METAR) cost per flight;

k) METAR cost per airport;

l) cost per chart; and

m) cost per notice to airmen (NOTAM).

Alternative or additional measures may include:

n) cost per en route flight hour (or kilometre controlled);

o) cost per IFR airport movement;

p) employment costs per ATCO in Ops. hour; and

q) non-staff related operating costs per ATCO in Ops hour.

Several important cost driver performance ratios associated with the cost per unit of output are:

a) ATCO-hour productivity means the ratio of the output to the hours spent by ATCOs in OPS on operational duty.
All other things being equal, a higher ATCO-hour productivity will improve cost-effectiveness.

b) Employment cost per ATCO hour means the ratio of ATCO employment costs to the number of hours on duty. It represents therefore the average employment cost per hour on duty.
All other things being equal, a lower employment cost per ATCO hour will improve cost-effectiveness.

c) Support cost ratio means the ratio of total ATM/CNS provision costs to the costs for employing ATCOs. In other words, it indicates for each dollar (or any other currency) spent on employing ATCOs what is the additional amount of dollar spent on other costs (comprising other staff costs, non-staff operating costs, and capital-related costs).
All other things being equal, a lower support costs ratio will improve cost-effectiveness.

Furthermore, as depicted in the framework of Figure 6.2 above, employment cost per ATCO hour can be further broken down into the following two elements:

d) Average hours on duty per ATCO in OPS means the contractual working hours, plus the average overtime worked in OPS, minus the average time an ATCO is not on duty in OPS.
All other things being equal, more hours on duty per ATCO improve cost-effectiveness.

e) Employment costs per ATCO means the total employment cost for an ATCO in OPS comprising the gross wages and salaries, payments for overtime, employers' contributions to social security scheme and taxes directly levied on employment, employers' pension contributions and the costs of other benefits.
All other things being equal, lower ATCO employment costs lead to lower ATM/CNS provision costs and so to higher cost-effectiveness.

6.6.2 Economic cost-effectiveness recognizes that airspace users also incur monetary costs when the services provided by an ANSP do not reach an acceptable or desirable level of quality (e.g. when a lack of timely capital investment results in ATM capacity-related delays, or degradation of flight-efficiency). Given that the objective is to minimize the overall economic costs to airspace users, these additional costs need to be taken into consideration for a full economic assessment of ANSP performance. To this end, an indicator of economic cost-effectiveness could comprise, besides the costs for service provision, the cost of delay and the cost of flight inefficiency per unit of output.

6.7 Cost-effectiveness and productivity are related through the unit cost of input. A productivity indicator can be converted into the related cost-effectiveness indicator by multiplying the inverse of the productivity indicator by the unit cost of the input.

7. MEASUREMENT AND ANSP ASSESSMENT

7.1 The measurement and assessment of ANSPs (refer to Figure 2.1) is frequently accomplished by using performance indicators to define a benchmark from which to compare the quantity and quality level of different services provided. Benchmarking is an assessment method that measures performance in providing specified services for a set period of time.

7.2 Internal benchmark measurements may be used by an individual ANSP and conducted by its management. Such benchmarks might be the average performance of facilities of a given type or the performance of a specific facility at a point in time. In the former case, individual facilities are compared to the average level of performance, while in the latter case changes in performance of a single facility over time are compared to its benchmark period. Establishing a benchmark provides an individual ANSP the opportunity to measure performance levels against its own standards.

7.3 Benchmarks may also be used to compare performance of an individual ANSP with the performance of other providers. Great care, however, should be taken when making such external comparisons. It is important that the definitions of services being measured be identical for each ANSP. Also, it is important to measure service areas that have similar characteristics, such as airspace complexity, traffic volumes, weather patterns and physical geography, as these characteristics greatly affect performance and resource requirements.

7.4 A benchmarking process can be used as a simple but effective process to compare performance and assist management in the identification of improvement opportunities. It can highlight "best practices" that may be incorporated by ANSPs. Benchmarking has to be based on data that are

accurate, meaningful and practical to assemble. The outputs must be readily understandable at a senior management level and provide a basis for discussion and awareness across stakeholder groups, including the customers.

7.5 Successful performance measurement, improvement and monitoring of air navigation services uses benchmarking to:

a) improve transparency of air navigation services performance;

b) provide insight into the opportunities for the improvement of individual ANSPs' performance (learning opportunities, setting performance targets);

c) support constructive industry dialogue with all stakeholders;

d) provide customers with visibility of industry cost drivers and set expectations for service delivery; and

e) provide global reach to expand the knowledge base.

7.6 ANSP customers have displayed a keen interest in the use of benchmarking. The development of cost-effectiveness is a key performance criteria for the airlines. There is an increasing sense of urgency to determine and deliver recognizable and sustainable improvements in performance for air navigation services at global level.

8. INCENTIVES FOR THE EFFICIENT PROVISION AND USE OF AIR NAVIGATION SERVICES

8.1 Incentives may be incorporated in the performance management process to ensure the efficient provision of air navigation services and encourage collaboration with other members of the air traffic management community and regulators or concerned government agencies as appropriate. Several types of incentive mechanisms could be adopted. Incentives may apply to both ANSPs (performance improvement) and users (behaviour modification). Service providers can benefit since such incentives may help monitor and direct the provision of service to ensure that resources are used efficiently. Users benefit by ensuring that the services they require are provided in a cost-effective manner.

8.2 Traditionally, economic regulation has been the basis for establishing incentives for ANSPs. Economic regulation is designed to prevent potential monopoly abuse from ANSPs where competition is absent or insufficiently strong to provide users with adequate protection from anticompetitive practices such as excessive prices, discrimination in the application of charges, and the absence of an effective dispute resolution mechanism. The following mechanisms could be used for economic regulation purposes:

a) Profit based on meeting performance criteria such as output based price–caps, where charges are set in relation to output performance and adjusted based on the ability of the ANSP to meet specified performance targets.

b) Retention of ANSP licenses.

8.3 However, as noted in Chapter 2 of Doc 9161/4, such mechanisms are not the only tools available to encourage service efficiency. There are a variety of potential incentives or penalties that may

be used to induce and sustain the efficient provision of services. Also, the provision of air navigation services may be the subject of a contract between a service provider and an airport or another authority. In addition, there are a variety of mechanisms that ANSPs can initiate on their own to induce and sustain efficient provision of services. Such incentives include, but are not limited to the following:

a) Performance measurement review and reporting.

b) Compensation of ANSP employees tied to meeting performance targets.

c) Share in cost saving/profit amongst ANSP staff for meeting performance targets.

d) Service level agreements with ANSP users.

8.4 To ensure that such incentives improve performance, an ANSP should adopt a method to measure performance. Reviews of ANSP performance results by economic regulators, users and other interested parties can help ensure that the incentives adopted achieve the desired results.

8.5 Similarly, there are various incentive mechanisms available to influence user behaviour. These incentives would normally exist in a free market, but may be absent in a current air navigation services environment. As is discussed in Chapter 7, Section B of Doc 9161/4, economic pricing can be used to address various circumstances. Arguably, congestion or peak hour pricing of air navigation services may be appropriate when providers face capacity constraints and/or user demand significantly fluctuates between peak and off-peak periods. Congestion pricing may be appropriate to limit consumption to current capacity, shift consumption to alternative under-utilized resources, and provide financial resources for service providers to increase capacity. Pricing may also be appropriate to address inequitable situations where the behaviour of one particular set of users imposes a cost on another set of users.

8.6 At the same time, incentive pricing may be used in other ways to accomplish performance improvement objectives. For instance, equipage of aircraft with specific technology may allow ANSPs to provide a more efficient service or to use existing capacity and facilities more efficiently. Also, reducing the variation of equipment types may reduce ANSP service and maintenance costs. It may therefore be appropriate for ANSPs to encourage rapid aircraft equipage of homogeneous equipment types by offering discounted charges if a user adopts capacity enhancing technology. However, if discounts are offered which do not cover the actual cost of service provided, non-users of the specific service should not be expected to subsidize the new technology.

8.7 If such incentives are used, they should be applied in a transparent manner, facilitating user consultation. Users should have the opportunity to review the process in which all incentives are applied.

9. INFORMATION DISCLOSURE AND PERFORMANCE REPORTS

9.1 Performance data is directly beneficial to ANSPs and their supervisory authorities. It provides useful management information, and best practices can be identified and promoted. Information disclosure is an essential component of a performance review system that promotes efficiency and supports target/objective setting and performance improvement processes. Information disclosure should be a normal obligation imposed on a statutory monopoly as the counterpart of its monopoly rights.

9.2 In developing an information disclosure system, ANSPs should ensure that the information required is readily obtainable and can be made available to customers on a timely basis. Care should be taken that the benefits of collecting information justify the cost of collection.

9.3 Performance reports should compare actual performance with performance objectives adopted in the planning process. Contracting States should ensure that the ANSPs produce performance reports that highlight those measures that are most critical and provide an assessment of the ANSP's performance. Contracting States may also organize the production of performance reports on a regional basis through independent organizations.

9.4 An ANSP should consider placing performance information in the public domain wherever it is possible or practicable to do so. The level of detail of information to be provided will depend on the objectives to be pursued. For example, if it has to be used for the purpose of an incentive-based economic regulation (i.e. price-cap) then the information disclosure can be quite comprehensive.

9.5 The primary purpose of the reports should be to assess performance over time, but they may also be used to compare the performance of an ANSP to other similar ANSPs. Although comparisons between ANSPs can be complicated and must take into account differences such as indicator definitions, organizational structure and airspace complexity, the reader may find such comparisons helpful in understanding the key performance drivers of the ANSP. In addition, the performance reports may also need to consider the performance of ANSPs on a regional or global basis. By addressing both regional and global issues, the report can serve as an important instrument to facilitate co-operation to improve air traffic control on international routes, provide examples and incentives regarding alternate or new ATM techniques and equipment, and ensure that international obligations are addressed. Whether such reports would be subject to an independent audit should be left to the discretion of the Contracting State.

9.6 It is important to recognize that a diverse audience with varied interests will likely be interested in the performance report. To ensure that the report is of sufficient scope and breadth, it is necessary that the ANSP consult with regulators and users during the development phase of the report. To ensure that the report addresses the needs of the various stakeholders, it will also be necessary to periodically re-engage these stakeholders and solicit feedback once the report is published. Performance reports prepared by third parties may be valuable complements to reports produced by ANSPs and assure that stakeholder needs are addressed. However, such reports should not be a substitute for reports prepared by ANSPs.

9.7 Performance reports need not be limited to just a review of the ANSP's past performance. They should, to the extent practical, look forward, anticipating the future needs of the aviation industry. To this end, it may be appropriate for the reports to also include a number of recommendations with respect to how service should be provided in the future. This decision should, however, be left to the discretion of the individual ANSPs.

9.8 To ensure transparency of these reports, each report should describe the derivation of the performance metrics used along with a discussion of how these metrics were applied. This information should be incorporated either directly within the report or by reference to a public document. Such information will assist readers with interpreting the report's findings.

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APPENDIX

GLOSSARY/DEFINITIONS

Air Traffic Management (ATM)[2]: The dynamic, integrated management of air traffic and airspace – safely, economically, and efficiently – through the provision of facilities and seamless services in collaboration with all parties.

Air Traffic Management Community: The aggregate of organizations, agencies or entities that may participate, collaborate and cooperate in the planning, development, use, regulation, operation and maintenance of the air traffic management system.

Air Traffic Management System: A system that provides ATM through the collaborative integration of humans, information, technology, facilities and services, supported by air and ground- and/or space-based communications, navigation and surveillance.

ATCO: The holder of a license, which permits the individual to control traffic in a specific operational unit. Executive controllers, planning controllers and supervisors are also ATCOs.

ATCO in Operations: An ATCO who is participating in an activity that is either directly related to the control of traffic or is a necessary requirement for an ATCO to be able to control traffic. Such activities include manning a position, refresher training and supervising on-the-job trainee controllers, but do not include participating in special projects, teaching at a training academy, or providing instruction in a simulator.

ATM community expectation: What members of the ATM community expect from ATM, in high level qualitative performance terms. These expectations are listed in Doc 9854, Appendix D and have been assigned to Key Performance Areas (KPA).

ATM operational concept: The ATM operational concept is a high-level description of the ATM services necessary to accommodate traffic at a given time horizon; a description of the anticipated level of performance required from, and the interaction between, the ATM services, as well as the objects they affect; and a description of the information to be provided to agents in the ATM system and how that information is to be used for operational purposes. The operational concept is neither a description of the air navigation infrastructure nor a technical system description nor a detailed description of how a particular functionality or technology could be used.

Availability: The ability of a system to perform its required function at the initiation of the intended operation. It is quantified as the proportion of the time the system is available to the time the system is planned to be available.

Benefit: Reduced cost to the user (to the ATM community as a whole) in the form of a saving in time and/or fuel; increased revenue; and/or an improvement to safety.

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[2] This definition is as per the Global ATM Operational Concept (Doc 9854) and is different from the ICAO definition contained in the Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM, Doc 4444).

Capacity: The maximum number of aircraft that can be accommodated in a given time period by the system or one of its components (throughput).

Cost Drivers: Activities or factors which cause costs to be incurred.

Delay: The difference between actual block time and ideal block time.

Demand: The number of aircraft requesting to use the ATM system in a given time period.

Efficiency: The ratio of the cost of ideal flight to the cost of procedurally constrained flight.

Equity: The first aircraft ready to use the ATM resources will receive priority, except where significant overall safety or system operational efficiency would accrue or national interests dictate that priority be provided on a different basis. Equity is ensured for all airspace users that have access to a given airspace or service by the global ATM system.

Governance: The act or process of direction or control of an activity either by State agencies or independent boards.

Key Performance Area (KPA): The ATM community expectations fall into eleven categories, called Key Performance Areas (KPA). These are (in alphabetical order): Access and Equity, Capacity, Cost Effectiveness, Efficiency, Environment, Flexibility, Global Interoperability, Participation by the ATM community, Predictability, Safety, and Security.

Performance: ATM performance is a measure of how well the ATM system satisfies the ATM community expectations. In each of the Key Performance Areas (KPA), performance is measured at the level of individual performance objectives, using performance indicators.

Performance gap: The shortfall between a performance indicator value and its performance target is referred to as a performance gap for a particular performance objective. The existence of (anticipated) performance gaps is the trigger for introducing additional operational improvements via the modification of current transition roadmaps and plans.

Performance Incentives: Rewards, either monetary or privileges, granted for accomplishment of performance targets, or penalties imposed for failure to meet performance targets.

Performance Indicators: Performance indicators are defined in order to quantify the degree to which performance objectives are being and should be met. When describing performance indicators, one must define what and how measurements will be obtained (through supporting metrics) and combined to produce the indicator.

Performance Management: The process of defining performance objectives, performance indicators and performance targets. In addition it includes performance monitoring, and the identification of performance gaps.

Performance monitoring: The process of collecting performance data, as required, for calculating the values of performance indicators. The aim is to monitor how well performance objectives are met.

Performance objectives: The ATM community expectation embodied by each Key Performance Area will be met by pursuing more specific performance objectives. Performance objectives are expressed in qualitative terms, and include a desired or required trend for a performance indicator (e.g. reduce the cost

per kilometre flown) while not yet expressing the performance objective in numeric terms (this is done as part of performance target setting). Care has to be taken to ensure that the agreed performance objectives are "SMART" — (specific, measurable, achievable, relevant and timely).

Performance review: The assessment of past and current performance, using measured data obtained via performance monitoring.

Performance Targets: Performance targets are the values set on performance indicators that need to be reached or exceeded to consider a performance objective as being fully achieved. Note that performance targets can be set as a function of time (e.g. to plan year-on-year improvement); they can also vary by geographic area.

PIRG: Planning and Implementation Regional Group.

Predictability: A measure of delay variance against a performance dependability target. As the variance of expected delay increases, it becomes a very serious concern for airlines when developing and operating their schedules. Conceptually, predictability metrics should be a comparison of the actual flight time to the scheduled flight time, since the scheduled time includes the amount of expected delay at a targeted dependability performance.

Separation minima: The minimum displacements between an aircraft and a hazard which maintain the risk of collision at an acceptable level of safety.

Supporting metric: Supporting metrics determine which data need to be collected to calculate values for the performance indicators.

Traffic volume: The amount of air traffic, usually expressed in terms of number of flights or movements, but sometimes also in terms of distance flown or controlled, or flight hours flown or controlled.

Transition roadmap: The transition roadmap covers a twenty year rolling time period. It contains a sequence of operational improvement deployments, which is suitable for transitioning the current ATM system to the future ATM system envisaged in the Global ATM Operational Concept, while meeting the performance requirements as documented by the performance objectives and performance targets.

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