EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

THE PRC'S EUROPEAN ATM PERFORMANCE MEASUREMENT SYSTEM

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Abstract

One task of the EUROCONTROL's Performance Review Commission (PRC) is to measure the performance of Air Traffic Management (ATM) in Europe.
This document proposes a top-level structure of Key Performance Areas (KPAs) and a first set of Key Performance Indicators (KPIs) to this effect.
This version also incorporates comments received at a consultation meeting held on 15 January 1999 and in writing.

Keywords

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Air Traffic Management	ATM		

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1.0	24.09.1998	Initial ICON document	
1.1	10.11.1998	Introduction of comments from PRC/2, stakeholders, commissioners and other sources.	All
1.2	08.12.1998	Internal and PRC KPI TF meeting comments	all
1.3	22.12.1998	PRC members comments, internal review	all
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1.5	4.3.1999	Further PRC members comments	all
1.6	22.03.1999	Input from SRU Annex 1 rearranged	Chapter 4.1 Annex 1
1.7	01.06.1999	PRC/4 corrections	Title page Annex 1

TABLE OF CONTENTS

TABLE OF FIGURES

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EXECUTIVE SUMMARY

FOREWORD

This document proposes a top-level structure of Key Performance Areas (KPAs) and associated performance indicators to measure the performance of Air Traffic Management (ATM). It is intended to be a living document that will improve as experience is gained.

It is intended to select indicators to be used in Performance Review Reports of the EUROCONTROL Performance Review Commission from successive versions of this document, based on potential impact and data availability.

This document aims to be comprehensive because ignoring one important performance area may lead to wrong performance compromises. It does not aim to be exhaustive in that it does not discuss all possible options, but focuses on those that could be achievable and could have a significant influence on ATM performance.

Input has been taken from work progressing in parallel, particularly within the EUROCONTROL Organisation (ATM 2000+ Strategy, Agency), in the USA, and in some organisations (IATA, CANSO, CNS/ATM Focused Team, and others). The document also integrates comments received after consultation with stakeholders, PRC members and Agency experts.

THE KEY PERFORMANCE AREAS AND INDICATORS

This document identifies ten “Outcome” KPAs and suggests one or more Key Performance Indicators (KPI) for each KPA. The generally agreed order of priority of the ten KPAs is:

1) *Safety, delays and cost-effectiveness,*

2) Predictability, access, flexibility, flight efficiency, availability, environment and,

3) Equity.

Some KPAs are constrained by minimum standards or regulatory limits which are imposed by external parties (e.g. safety), while others allow tradeoffs (e.g. delays and cost-effectiveness). The ATM system may be optimised provided that the constraints are adhered to at all times.

A summary of the KPAs, their associated indicators and feasibility in time is set out in Annex 1.

In addition to quantitative measures, there may be a need to evaluate qualitative measures of performance, e.g. users’ satisfaction, by means of surveys carried out at regular intervals.

The ten KPAs generally take an outsider’s view, and tend to measure “Outcomes”. “Process” KPAs addressing the effectiveness of processes themselves, and meant to understand how performance can be delivered will have to be added in later stages.

AGGREGATION OF INDICATORS

Several breakdowns of performance items may be needed to apprehend complex ATM performance issues, e.g. ECAC-wide, by State, by ACC, by ATS provider, by airport, by sector, by time-series, by phases of flight, by city pair, by airspace user. Some views will be more relevant to some indicators than others.

It is intended to report on indicators at an appropriate level for each indicator. For example, the preferred level at which to measure service cost would be the ATS provider level, which, in most cases, corresponds to the present reporting level, i.e. the State. There are however cases such as the Maastricht UAC where costs would have to be disaggregated.

The indicators have been designed so that they can be applied in a “gate-to-gate” perspective. It is apparent that data are currently available on a Europe-wide basis mostly for en-route, and less so for terminal areas and airports. Much development work will be required to prioritise such collection, to obtain data automatically from existing and future systems, and to convert it into usable indicators.

OVERVIEW

Although the many indicators identified are necessary for the measurement of the whole and parts of the ATM system, there are too many to provide a simple “overview”. Also, it would not be clear how trade-offs between conflicting indicators should be handled.

The overview should be consistent with objectives defined in the ATM 2000+ Strategy, and should make it clear whether these objectives are being met. In line with those objectives, it is proposed to assess the total number of accidents/risk bearing incidents (and not ratios par flight hour), and total costs, direct as well as indirect.

Total costs would be computed as the sum of economic impacts of under-performance in all KPAs, within minimum standards or regulatory limits as imposed by external parties (e.g. safety). Using a common unit of measurement should allow those areas which are most critical to be identified, and should enable good trade-offs to be found. This should lead to critical areas of the system being better understood, providing better direction for management actions.

1. INTRODUCTION

The EUROCONTROL Revised Convention contains a provision to establish an independent and transparent performance review system to address and set targets for all aspects of air traffic management (ATM), including the financial and economic aspects of services rendered. The Performance Review Commission (PRC), consisting of representatives nominated by Member States, supported by the Performance Review Unit (PRU), has been set up and has been given the responsibility for developing the system and setting the targets. PRC and PRU terms of reference can be found in Annex 2.

The first version of this document was produced by ICON Consulting as part of a study for the PRU to propose a top level structure of key performance areas (KPAs) and key performance indicators (KPIs) to measure the performance of ATM in the European Civil Aviation Conference (ECAC) area. Subsequently the document was further developed by the PRU and sent to a large number of stakeholders in Europe as part of a consultation process. Comments were received in writing or were made verbally at a consultation meeting held at EUROCONTROL headquarters on 15 January 1999. This version of the document reflects the comments made. It is intended to be a living document that will improve as experience is gained. Taking data availability into account, KPAs have been split into two groups: those that can be measured in the short term and those which will be measured later, as data becomes available. The short-term KPAs are Safety, Delay and Cost Effectiveness and only these will be covered in the 1998 Performance Review Report. It was confirmed at the consultation meeting that these KPAs cover the most important concerns of users and that they should be given the highest priority.

The other KPAs will continue to be developed after the publication of the 1998 Report. It was agreed at the consultation meeting that Access, Availability, Environment, Flexibility, Flight Efficiency and Predictability should be considered next and that Equity, together with any other new KPAs, will be addressed fully at a later stage.

It should be noted that aircraft operator is used throughout the document as a generic term for all types of airspace user including commercial airlines, general aviation and the military.

2. APPROACH

The performance measurement structure has been designed on the basis of the following principles:

- the set of performance measures should measure whether user requirements are being met,
- each indicator should be a measure of current performance that is amenable to management action to change its value in the future,
- the set of indicators should encourage the necessary behaviour and decisions in the short and long term to bring about significant and continuous improvement,
- the performance indicators should be predictive, in order to evaluate if present plans are able to meet the agreed levels of performance in the future and to support management decisions,
- each indicator must be operationally and economically feasible to measure,
- a set of indicators should be defined so that all major actions within the ATM system will affect an indicator and hence be subject to measurement and adjustment, and
- indicators should be developed to allow comparisons, when possible.

An iterative approach has been taken to developing the performance measurement structure consisting of the following stages:

a) Top down formulation of key performance areas (KPAs) based on a user's perspective of the requirements of ATM.

b) Identification of the elements of each KPA which need to be measured to provide a comprehensive view of the performance of all aspects of ATM.

c) Consideration of some performance indicators (PIs) which could be used to measure each element of the framework.

d) Validity and completeness checks to ensure that all aspects of ATM are covered.

e) Meetings with stakeholders (Representative Organisations, Aircraft Operators and ATSPs) to obtain feedback on the acceptability and completeness of the performance measurement structure.

Much work is conducted in developing ATM related performance measures both in EUROCONTROL and globally in various organisations. This work has been used as source material in developing the initial structure and, in particular, the associated indicators. References are included at the end of this document.

Only broad definitions of indicators to be used by the PRC are given at this stage. It is envisaged that the set of indicators and their detailed definitions will evolve progressively.

3. THE PROPOSED PERFORMANCE MEASUREMENT STRUCTURE

In order to develop a customer responsive system, performance measurement should be driven by the needs of the users of ATM. The KPAs have, therefore, been structured according to a user-oriented view. Each KPA has been considered in turn and those aspects of ATM which have a direct impact on the KPA have been identified. The KPAs and the indicators that support them can then be used by each stakeholder (EUROCONTROL, ATS Provider, Airport Authority, Aircraft Operator) to measure the outcome of activities which are under the control of ATM.

To assess ATM performance in its entirety and improve performance for the benefit of the user, it is recognised that performance indicators that are oriented towards ATS providers and airport authorities are necessary. The majority of indicators proposed in this report measure the performance of ATS providers, as there is less data available at present on airports. As this data becomes available further indicators on airport performance will be added. In addition indicators will be required to measure the performance of the EUROCONTROL Agency and these will be developed later.

It is also recognised that poor performance by an aircraft operator can have an adverse affect on the service provided by an ATS provider or an airport. Indicators relating to the performance of an aircraft operator will be added later to measure this effect.

The indicators defined measure the outcome of ATM. The effectiveness of the processes which are used in the management of ATM in Europe should also be measured and indicators will be identified later. CIP objectives may be important inputs in this respect.

Definitions for each KPA are shown in Table 1, as follows:

Key Performance Area (KPA)	Definition
Safety	The conformance of air transport to specified safety targets.
Delay	The time in excess of the optimum time that it takes a user to complete an operation.
Cost Effectiveness	The value for money that users receive from the supply of air traffic services.
Predictability	The ability of a user to predict variation and to build and maintain optimum flight schedules.
Access	The accessibility of airspace, ATM services and airport facilities under controllable conditions.
Flexibility	The ability of ATM to accommodate changing user needs in real time and without penalty.
Flight Efficiency	The ability of the ATM system to allow a user to adopt the preferred flight profile in terms of flight level and route.
Availability	The availability of critical ATM resources and of the ATM services provided to users.
Environment	The conformance of air transport to environmental regulations.
Equity	Equity of treatment of flights by all aircraft operators within and between specific classes of users.

Table 1: Key Performance Areas and their Definitions

While it is the aim that ATM performance in general should improve over time, an aircraft operator or service provider may be able to trade-off certain KPAs against others to optimise system performance. A choice may cause one KPA to improve at the expense of another. For example, an aircraft operator may choose to reduce delay on a flight between city pairs by accepting a re-route or sub-optimal flight level. This will improve the delay at the expense of the flight efficiency. However, there are a number of external factors that will limit the extent to which the KPAs are tradable. For example, external parties such as government or the safety regulator will impose constraints in the form of minimum standards or regulatory limits that must be adhered to.

The focus of the Performance Measurement System is to ensure or encourage ATS Providers and aircraft operators to make the best use of the system subject to those constraints. ATS Providers, individually or collectively, are likely to give their input to the establishment of key standards. Equally, ATS Providers will, as a matter of course, implement changed policies and procedures that offer “win, win” outcomes for external and internal KPAs.

KPAs can be measured at a number of different levels, such as ECAC, Member State, ATS Provider, Air Traffic Control Centre, Airport or City Pair, and for different phases of the flight. Monitoring a KPA at a high level may hide the fact that some entities at a lower level are improving while others are deteriorating. Some consideration is given to the level at which a performance indicator should be measured in Section 6.

Wherever possible KPAs should be measured in economic terms, so as to present a consolidated view of performance, and to identify which areas are most critical. These areas will be further broken down in a tree-like structure, with variable depth depending on the criticality of the branches to ATM performance.

4. KEY PERFORMANCE AREAS

This chapter discusses each of the KPAs and associated KPIs, providing complete coverage of the ATM system from a user perspective. They are summarised in Annex 1.

There are a number of features of the ATM system which have constraints imposed by external bodies. These constraints reduce the ability of the ATS Provider to make a full trade off between the KPAs. The requirements imposed by the external agencies must be adhered to and performance must be optimised subject to those requirements.

Subsections 4.1, 4.9 and 4.10 discuss the KPAs which have external constraints imposed by parties outside the ATM system.

Over and above these constraints, there are trade-offs that can be made. An ATSP may, for example, choose to implement a higher level of safety than imposed by the regulator if it believes this reflects the users' preferences. This choice would be made in the full knowledge that there would be trade-offs with other KPAs e.g. delays may increase or costs would be higher. It is possible that the regulatory process may facilitate this type of information exchange between users and ATS Providers by establishing a formal means of consultation.

Since trade-offs between the key performance areas are inevitable, it is necessary to ensure that the trade-offs that will be made are done in such a way as to increase the overall benefits of the system to users. To assist the process of assessing the costs and benefits of the trade-offs it is necessary to have an over-arching objective for the ATM system. An appropriate objective is:

"to give users over the long term safe services and the levels of capacity and quality they require, and for which they are prepared to pay, with price being based on the costs of efficient operations."

With a focus on this objective, ATS Providers and users can decide how changes to the current system will increase the benefits over and above the status quo and how this will be monitored by the indicators. For example, if demand for ATS is expected to grow beyond the present capacity of the system there are two possible outcomes. If capacity does not expand to meet the demand then indirect costs will increase due to, for example, additional delays. If capacity is increased to cope with the additional demand, the direct cost of providing ATS will increase. There is a direct conflict between indicators measuring delays and indicators measuring cost. The decision to go ahead with the capacity increase will depend on the relative value users place on increased delays that will occur when current capacity is fully utilised and the increased cost of ATS necessary to fund the extra capacity. The desired response is for additional capacity to be provided up to the point where the additional benefits cover the extra costs.

4.1 Safety

The Safety Regulation Commission (SRC) has been established to ensure consistent high levels of safety in ATM within the ECAC area. One of its functions is to assess the overall safety performance of the system in order to promote safety improvement, while still preserving appropriate confidentiality to encourage a good level of reporting.

Measurement of safety is understood in this report as being an assessment of the results, i.e. the level of safety that is being achieved by the in-service ATM system, rather than by an assessment of the level of adherence to good working practices, processes or safety requirements that ATM providers are expected or required to implement as means to better manage safety. It should however be noted that the development of harmonised safety regulatory requirements for ATM is being addressed as part of another area of the SRC work programme: that of setting safety objectives, requirements and standards for ATM. SRC is currently ensuring overall consistency between:

- the a priori identification, assessment and mitigation of potential hazards related to the introduction of any operational/technical change to the ATM system; and

- the a posteriori measurement of actual hazards that occurred during in- service operations.

Improvement in ATM system performance must not degrade safety, which is fundamental to keeping public confidence in aviation and is the number one priority of the business. The main safety performance indicators in use by the SRC will therefore be made available to the PRC so that changes in ATM system performance can be seen within the context of changes in safety performance.

4.1.1 Safety framework

Accident occurrences only provide a limited insight into flight operations safety, in part because they represent a very narrow range from which to draw conclusions. Traditional accident or serious incident reports may only reveal the tip of the pyramid. Therefore, as illustrated in Figure 1, the SRC intends to adopt progressively a more thorough approach to safety performance measurement.

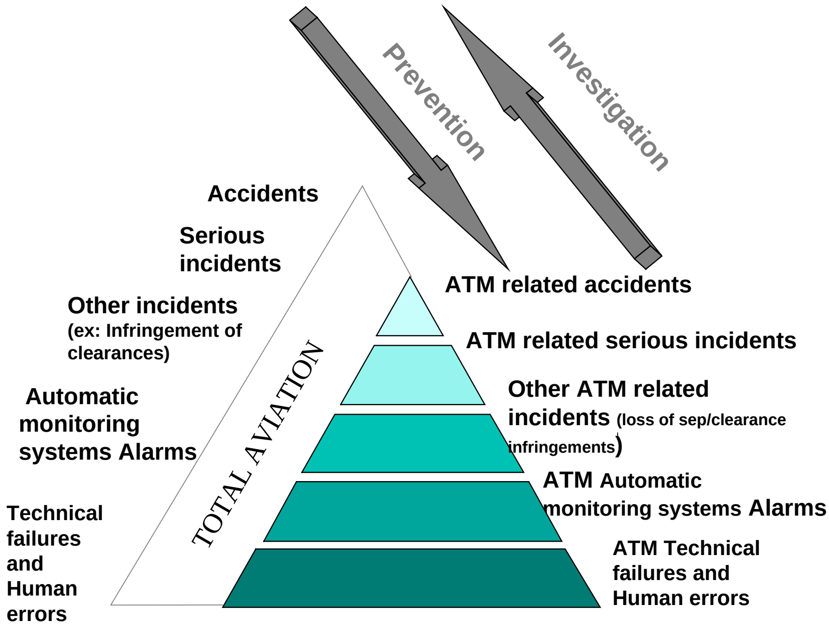

Figure 1: Safety iceberg

The role of ATM safety is to ensure adequate separation of aircraft from one another, from other objects and from the ground. The principal basis of the SRC assessment of safety performance therefore reflects this role, and mainly consists of measurement of the ATM contribution to aircraft accidents and incidents, for all types of operations occurring in all classes of airspace, categorised according to the level of risk and expressed in terms of air to air, air to ground or ground to ground safety occurrences[*].

4.1.2 PRC Safety Indicators

As outlined in Table 2, the safety indicators for the ECAC area being considered so far by the SRC[†] as safety performance inputs to the PRC are defined according to three high level categories[‡] and to three different levels of risk[§].

However, it must be noted that existing data collection schemes are not presently capable of providing ECAC-wide safety data within these categories, and therefore of populating the safety indicators.

- The total number of accidents[**], and its categorisation into air-air, air-ground, and ground-ground accidents;
- The actual ratio of ATM contribution[††] to aircraft accidents;
- The total number of serious incidents[‡‡] and its breakdown into categories of air-air, air-ground and ground-ground;

[*] To be further developed and potentially mapped to ´phases of flights´ (To Be Confirmed)
[†] Compatible but broader than those identified within the Eurocontrol EATMP Safety Group.
[‡] Air-Air, Air-Ground and Ground-Ground
[§] Accident, serious incident and other incidents
[**] Defined as per ICAO Annex 13
[††] ATM direct and indirect causes, (causes as defined by ICAO Doc 4444)
[‡‡] Defined as per ICAO Annex 13

- The actual ratio of ATM contribution to aircraft serious incidents;

- The total number of other incidents (i.e., incidents affecting the safety of operations or incidents having the potential to be an accident or a serious incident, such as clearance infringements, if the risk can not be managed within safety margins, of if another aircraft is in the vicinity) and its breakdown into categories of air-air, air-ground and ground-ground;

- The actual ratio of ATM contribution to other types of aircraft incidents.

Each of these occurrences will be further classified into types of occurrences (e.g. Level bust, Control Flight Into Terrain Incident, Runway Incursion).

Taking into account the Safety objective as stated in the ATM2000+ Strategy:

> *"To improve safety levels by ensuring that the number of ATM induced accidents and serious or risk bearing incidents do not increase and where possible decrease",*

the performance will be assessed at ECAC level in absolute figures.

This will ensure that the objective of not exceeding a fixed number of risk-bearing incidents and/or accidents is achieved as traffic grows.

In addition, the absolute traffic volume will be provided so that relative safety indicators and trends[*] **over time** can also be identified, with regard to actual traffic increases. The relative safety indicators will be expressed in terms of "per 100000 movements", the air-air types of occurrences being also expressed in terms of "per 100000 flying hours".

Table 2 below presents the PRC key performance indicators for ATM safety based upon the above approach.

[*] In order to encourage safety reporting, no geographical comparison between States shall be allowed and only ECAC aggregated data will be made available to the PRC

	TOTAL	ATM ratio	AIR-AIR	AIR-GROUND	GROUND-GROUND*	OTHERS
ACCIDENTS	Total number of accidents	Number of accidents where ATM contributed, as direct or indirect causes	Number of mid-air collisions	Number of collisions with the ground	Number of collisions on the ground	Number of other types of accidents
SERIOUS INCIDENTS	Total number of serious incidents	Number of serious incidents where ATM contributed, as direct or indirect causes	Number of critical near mid-air collisions	Number of critical near collisions with the ground	Number of critical near collisions on the ground	Number of other types of serious incidents
OTHER INCIDENTS	Total number of other incidents	Number of other incidents where ATM contributed, as direct or indirect causes	Number of other air-air incidents (e.g. loss of separations, deviations from clearance, airspace infringements)	Number of other air-ground incidents (e.g. CFIT incident, deviations from clearance)	Number of other ground-ground incidents (e.g. RWY/TWY/APRON incursions)	Number of other types other incidents

Table 2: Key Performance Indicators for Safety

Notes for Table 2:

1. In order to increase the consistency of data provided to PRC to populate their ECAC safety indicators, further safety performance measurement will include to collect data about occurrences as triggered and collected in a systematic manner by standardised automatic monitoring systems (e.g., Safety nets, STCA, ACAS, GPWS, MSAW) with related data retrieval.

2. As a complement, SRC will also assess but for its own purpose safety as perceived and reported by ATS operational staff and crews (e.g., AIRPROX†);

3. As a complement, SRC will also assess but for its own purpose occurrences that impact the ability to provide safe ATM services;

4. The SRC will look also for its own purpose to the underlying causes to the occurrences (e.g; Equipment failures, human errors, regulatory problems, management issues) increasing the scope and depth of the PRC safety indicators and enabling to identify where and how ATM contributed to the occurrences and helped (or could have helped) in reducing the risks; and

* Ground-Ground would include both ‘aircraft-aircraft’ related events and ‘aircraft-other objects’ ones
† Defined as per ICAO

5. The indicators will be developed further for SRC use to allow additional characterisation of types of occurrences (e.g. Types of traffic involved in occurrences).

The evolution of the safety indicators over time will also be represented whenever possible so that trend can be assessed. This will show if safety is becoming a major concern or if it is well managed. Given the fact that, at present, only limited data are available, the trend will be the main indication arising from the first set of Performance Reports. However, during the first years, a rise could be explained by an increased reporting level.

A measure of aircraft operators' and/or ATSPs' perception of safety could also be useful to compare with the hard measures above. This could be collected by means of a customer service questionnaire issued perhaps annually, to monitor the performance of some of the more qualitative indicators for which numerical data do not exist. Such soft measures are useful because they allow comparison between what the hard measures are indicating and what the users perceive about certain aspects of the ATM system performance.

The proposed indicator is:

Aircraft operators' perception of the safety of the ATM system

ATS providers' perception of safety

Although assessing the perception of safety can prove to be very useful, a great deal of care needs to be taken in the interpretation of the data gathered. For example, a survey carried out shortly after an accident might show a degraded perception of safety, affected by the recent event.

4.2 Delay

Consistent with the ATM system objective defined in the introduction to section 4, the aim of the delay KPA is to ensure that ATS Providers have the right level of ATC capacity in relation to expected demand for ATC services so that delays are maintained at an acceptable level from the user perspective.

A number of indicators of delay are well established and currently reported by CODA and the CFMU. All current delay analyses are based on departure delays. Airborne and arrival punctuality should be considered as well as a breakdown of different types of delay.*

It should be noted that in the final delay assessment only ATM related constraints (and delays) will be analysed.

There are a number of attributes to delay which are important. These are summarised schematically in Figure 2 below.

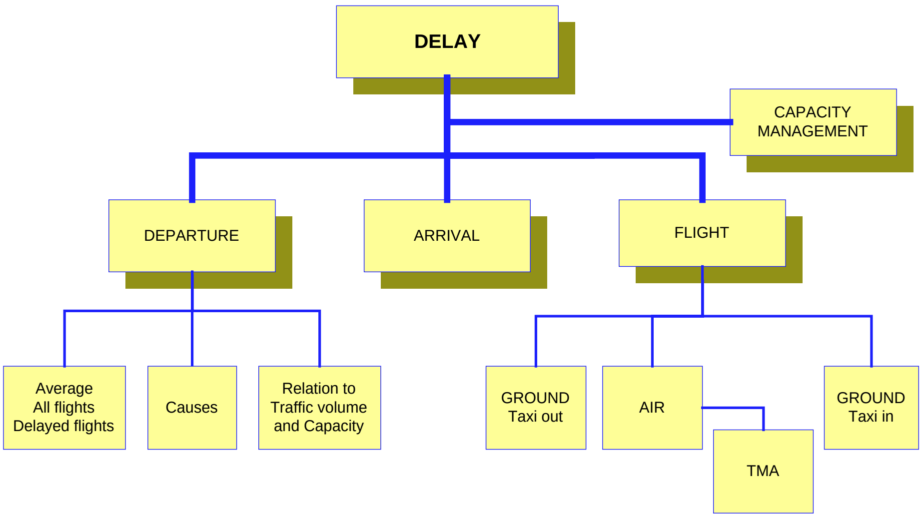

Figure 2: Delay KPA Attributes

The delay definitions used are those described in the ECAC Guidelines on monitoring delays at airports.

The different times present in the theoretical and in the real flight plans will be considered when the breakdown into the different contributors of total delay is assessed. However, the total delay is an indirect cost contributing to the final total cost of the system and is not affected by the various definitions of particular times.

These are generated by the different concepts of the flight plan:

- optimum will mean the time taken on the direct path between the two ends of the flight (great circle);
- preferred will be the time taken on the best route, according to the existing route structure;
- planned will be the time calculated by the flight plan processing system, on the accepted flight plan;
- scheduled will be the time published by the aircraft operator in its timetables;
- actual is the time the aircraft actually flies due to all ATM and non-ATM constraints.

4.2.1 Departure Delay

Departure delay is the difference between actual off-blocks time and the scheduled departure time. Departure delay may have many possible causes and is only partly under the control of ATM. The main causes relevant to ATM are air traffic control flow restriction (ATFM delay) and those related to ground ATC (approval delay). The proposed indicator is:

Total minutes of departure delay / Total number of flights

where total minutes of departure delay is accumulated over all flights.

An important indicator for the general severity of the delays for different ATM systems is the balance between the total traffic and the delayed traffic. The proposed indicator is:

Total number of delayed flights / Total number of flights

Departure delay in relation to the number of flights that are delayed is a measure of the seriousness of delay to an aircraft operator and its passengers. Short delays can be absorbed quite easily but as the delay grows disruption will increase.

The proposed indicator is:

Total minutes of departure delay / Number of delayed flights

Each of these indicators should be calculated for departure delays arising from any cause and for departure delays caused by ATM. This will allow ATM related delay to be put into perspective.

4.2.2 Flight Delay

Once a flight has left the departure gate, delay can occur during several different flight phases; on the ground before take-off, in the air, and on the ground after landing. In each phase there will be an optimum time which is dependent on factors such as the location of a gate in relation to the runway in use, the performance characteristics of the aircraft, etc. Individual phases might be considered at the next level down in the performance indicator hierarchy.

The proposed indicator is:

Total minutes of gate to gate delay / Total number of flights

where total minutes of gate to gate delay is the difference between actual and planned gate to gate time accumulated over all flights.

To separate out delay on the ground from delay in the air it is recommended that the use by aircraft operators of the OOOI (Out, Off, On, In) measurement scheme is encouraged.

4.2.3 TMA Delay

An important element of flight delay is the time spent in the arrival holding pattern and/or during extended radar vectoring between the arrival fix and the touchdown. If automatic means of recording time over specified boundary crossing points or over the arrival fix can be developed it would be possible to measure the total time of delay from both causes. Time of touchdown would be derived from OOOI data.

The proposed indicator is:

Total minutes of TMA delay / Total number of flights

where total minutes of TMA delay is the difference between the actual and optimum time from boundary (or arrival fix) to touchdown accumulated over all flights.

4.2.4 Arrival Delay

Arrival delay is a function of departure delay, flight delay and the amount of buffer time an aircraft operator puts into its flight schedules. It can give a major indication about the performance of the system as a whole since air travellers expect to arrive at their destinations safely and on time and this is what ultimately they perceive as flight delay. This type of delay is also recommended by the ECAC Guidelines for delay monitoring. The proposed indicator is:

Total minutes of arrival delay / Total number of flights

where total minutes of arrival delay is the difference between the actual and scheduled arrival time accumulated over all flights.

4.2.5 Causes of Delay

Delay can be caused by ATM, an aircraft operator, an airport and external circumstances such as the weather. ATM delay should be put into the context of all other delays. This is already done by CODA and the corresponding graph on the causes of delay at individual airports will be used as a performance indicator. It should be noted that a delay apparently caused by one stakeholder may have as its root cause an operational problem incurred by another. This is particularly true of ‘reactionary’ delay which is a major factor in departure delay at most airports and is due to the "ripple effects" of late arrivals. The root causes of ‘reactionary’ delay are currently being investigated by CODA.

The proposed indicator is:

Proportion of total delay arising from each identified cause

4.2.6 Relationship between Delay, Traffic Volume and Capacity

Network capacity is dependent on traffic patterns. Capacity variation for similar traffic patterns can be shown by plotting total delays against traffic volume. The shift of the delay/traffic curve can be interpreted as a measure of capacity variation as shown in Figure 3.

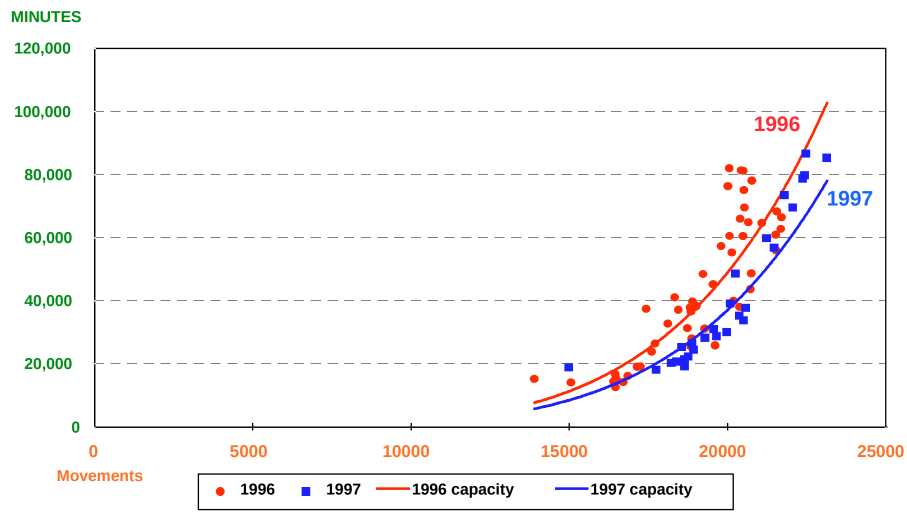

Figure 3: Weekly Minutes of ATFM Delay by Volume of Traffic

This is a powerful overall indicator which can be used to determine the inherent variability of the system in terms of the relationship between volume, delay and capacity. The proposed indicator is:

Weekly minutes of ATFM delay by volume of traffic

4.2.7 Capacity Management

A capacity index with base 100 on a given year could be derived from the above. It could be defined as the number of movements possible for a given number of minutes delay referenced to the number of movements in the base year. This index could be compared with a traffic index (past or predicted traffic with base 100 on the same year as above) and with an ATM cost index to observe how well capacity is provided and managed in the face of growing demand. The proposed indicator is:

Capacity index

The Provisional Council have urged the Agency and the States to develop a global action plan for the provision of capacity for Summer 1999. In response, capacity plans have been prepared based on the FAP method. This process is likely to continue. Comparing the actual traffic variation, target capacity variation and actual capacity variation would enable the performance of capacity management to be measured. This can be done at an ACC and at a sector level. The proposed indicators are:

Actual capacity variation / target capacity variation (%);

Actual capacity variation / actual traffic variation (%)

4.3 Cost Effectiveness

Consistent with the ATM system objective defined in the introduction to section 4, the over-arching objective in relation to cost-effectiveness is to ensure that ATS Providers supply ATC services at the least-cost over the long term, given safety and environmental constraints.

Aircraft operators pay for the use of the ATM system through route, terminal and airport charges. These charges are calculated by the service providers from their projected costs and the expected volume of traffic using their services. The result is a unit charge that is used to calculate the total charge. Given the current cost-recovery focus of the EUROCONTROL system, the Cost Effectiveness KPA will not be concerned with charges, but rather the costs that are built into the charges paid by users.

As well as en-route costs, terminal and ATM related airport costs should also be reported and analysed. While CRCO can provide cost information for those States where route charges are collected centrally, other sources will be needed for costs which form the basis of charges made by other bodies. Costs are accounted for in different ways by different States and precise definitions are necessary to ensure consistency. The cost base should be audited to ensure that it is a fair and accurate reflection of reality, and in conformity with agreed principles.

Since staff and capital expenditure are major ATM cost drivers, their level and effectiveness should also be assessed. Planned expenditure should be examined for consistency with agreed levels of forecast demand as well as with planned capacity profiles for ACCs.

Productivity ratios provide one means of measuring cost effectiveness and are of particular interest to aircraft operators. Although they are at a lower level than cost in the hierarchy of indicators they are included for completeness.

A summary of the proposed Cost Effectiveness KPA structure is shown schematically in Figure 4.

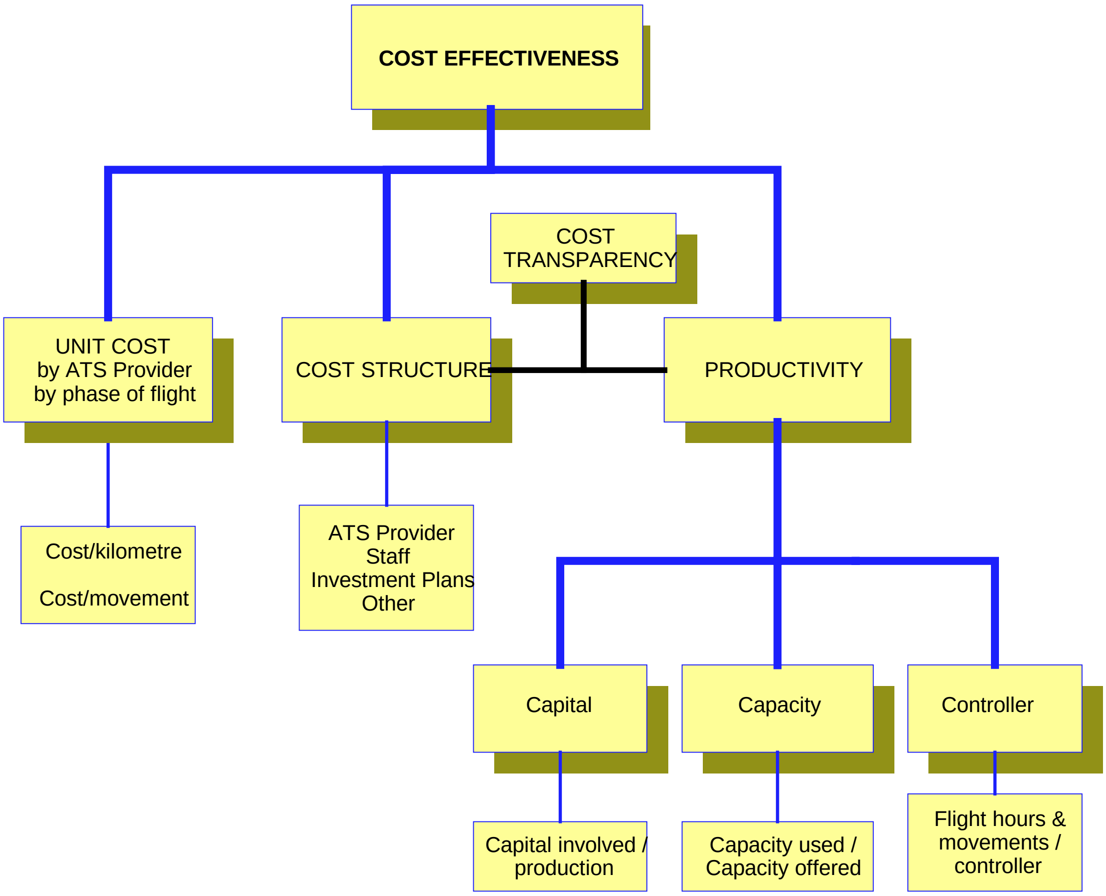

Figure 4: Cost effectiveness KPA Structure

4.3.1 Cost of ATM Services

Total service costs are not valuable performance indicators on their own without knowledge of the demand being made on the service and the capacity being provided in response to the demand. The performance indicators proposed are therefore based on unit cost.

Unit costs are useful when making comparisons between different ATS providers, both within and outside Europe. However, cost should be viewed in the context of output from the services provided. Further work is needed to develop useful output metrics.

In constructing unit costs, the total cost can be broken down into the different phases of flight and into the different types of service provided (e.g. flow management, central charging). A further breakdown can be made to show the proportion of the total cost attributable to different elements. The proposed indicators are:

Total cost per movement

Total cost per kilometre flown

The first of these indicators is in common use in the United States and other parts of the world and will enable comparisons to be undertaken provided a common unit of currency such as the EURO is used. It should be noted, however, that the indicator does not take into account the size and complexity of the area of responsibility, so comparisons between service providers for a particular year could be misleading. Nevertheless it is valid to compare year on year trends for different service providers as long as complexity remains similar for an individual provider from year to year. When comparing trends an index should also be provided based on local currency units to avoid the effect of changes in the rate of exchange.

The second of these indicators is probably more relevant for en-route services. The distance from the entry point to the exit point shall be used, according to CRCO procedures.

Forecast costs for the next five years are provided by some States to the CRCO. This data, together with future annual traffic forecasts, will be used to show the expected evolution of unit costs.

4.3.2 Productivity

Users consistently request that unit rates decrease. This could be achieved by cost efficiency increases, through economies of scale, or by a combination of both. Productivity indicators are important in demonstrating to the user community that improvements are taking place to increase value for money. Initially they will cover the two main constituents of capacity provided; the number of controllers employed and the value of the fixed asset base. The latter will indicate the use which is being made of the capital invested in infrastructure.

The proposed indicators for the productivity of controllers are:

Number of movements / Number of controllers employed

Total flight hours handled / Total hours worked by controllers

Standard definitions are required to ensure that the number of controllers is calculated in the same way by all control centres. It is proposed that figures from the route charging reporting tables as available in CRCO should be used.

Proposed indicators for the productivity of the fixed asset base are:

Value of fixed assets / Number of movements

Value of fixed assets / Total kilometres flown

Productivity measures can be difficult to interpret due to the wide variation in the complexity of sectors, skill mix of controllers etc. As a minimum, categories relating to airspace complexity would be necessary in order to be able to make a fair comparison between ACCs. However, a year-on-year trend analysis for each ACC would be valid despite these reservations.

Single measures of productivity are rarely sufficient to judge performance. For example, a labour intensive or a capital intensive strategy could deliver the same level of service at equivalent costs. Controller productivity and productivity of the fixed asset base should therefore be analysed in conjunction.

Another important aspect of productivity is the utilisation of available capacity. This will identify the ability of a centre to adapt its capacity to the demand. Over utilisation will materialise through delays.

The proposed indicator is:

Sector Capacity used / Declared sector Capacity

4.3.3 Cost transparency

The degree to which aircraft operators are involved with ATS providers in ensuring that expenditure is made in areas which will benefit the users is also important. This is related to the transparency of the cost base and the openness with which ATS providers are willing to discuss their multiyear business plans.

The PRC should assess what processes are in place to ensure that the cost base is correct and that costs are allocated according to agreed principles. A simple indicator could be whether or not the cost statement has been independently audited.

A qualitative measure could also be used to determine the aircraft operators' perception of the transparency of the cost base and could be collected by means of the customer service questionnaire as described in section 4.1 on Safety.

4.3.4 Investment Plans

Delays are a symptom of lack of capacity. Because of the long timescales, the return on investment made in additional capacity, and the cost of that investment, will not be manifest for many years. However, when new capacity becomes available, benefits will be quickly visible to aircraft operators in terms of a reduction in delay costs. Since traffic demand is increasing year by year, investment is necessary in additional capacity, consistent with forecast demand, to ensure that delays in the future are reduced. Investment should be monitored by the PRC.

Indicators will be developed in later phases.

4.4 Predictability

If delay was entirely predictable at different times of the day, and did not vary from its predicted value, an aircraft operator would be able to build anticipated delays into its schedule and always arrive on time. As delay variability grows, more and more disruption will be caused to an aircraft operator's schedule and flight connectivity will be damaged.

Lateness causes an increase in operating costs for an aircraft operator due to the inefficient use of resources and support facilities. Earliness can be considered as a lost opportunity for fleet and crew usage. If consistent, an aircraft operator could remove some block time from its next schedule and increase the number of rotations of an aircraft.

4.4.1 Anticipated Delay

Building anticipated delay into the schedule increases cost for aircraft operators, since the number of achievable rotations per aircraft is reduced. An indicator is proposed to measure aircraft operators' perception of how much delay there is likely to be in the system. A reducing indicator implies that aircraft operators have more confidence that delays will be reduced during the next scheduling period.

Difference between scheduled and optimum gate to gate time

4.4.2 Variability in arrival delay

Even if the average anticipated delay is correct, an aircraft operator will still experience disruption to its services if there is variability in the arrival delay. As variability increases, the disruption will grow. The variation in arrival delay should therefore be measured and the proposed indicator is:

Standard deviation of arrival delay

It is important to establish the causes of variation so that action can be taken to reduce them. Data to enable an analysis of the variation caused by each element of gate-to-gate should be collected. This would be available if a statistically representative sample of equipped aircraft were to report OOOI times. The proposed indicators are:

Standard deviation of each delay component

Causes of delay in each delay component

4.4.3 Taxi Time Variability

The greatest variability normally occurs in taxi times. The proposed indicators are in use in the USA, and they require OOOI data:

Taxi in variation time

Taxi out variation time

4.5 Access

An aircraft operator's business is dependent on its ability to gain access to airspace, air traffic services and airport facilities. The effect of lack of access will be access denial and the inability to satisfy users' requirements.

Airspace access may be denied because air traffic services are unavailable or because insufficient capacity is available to meet the demand. When access is denied, a flight will either have to follow a non-optimal route, which will have an impact on the Flight Efficiency KPA, or it will be delayed, which will have an impact on the Delay KPA. Traffic bottlenecks may arise from circumnavigating denied areas, which will create additional delay. The element of airspace access which should be measured is the availability of routes and access to sectors.

Access to airports may be restricted because of a shortage of slots and the few available, if any, may be at times of the day when there is little demand. Restricted access acts as a barrier for new entrants and prevents established aircraft operators from operating new routes. The element of airport access which should be measured is the available, unused capacity.

A summary of the Access KPA is shown schematically in Figure 5 below.

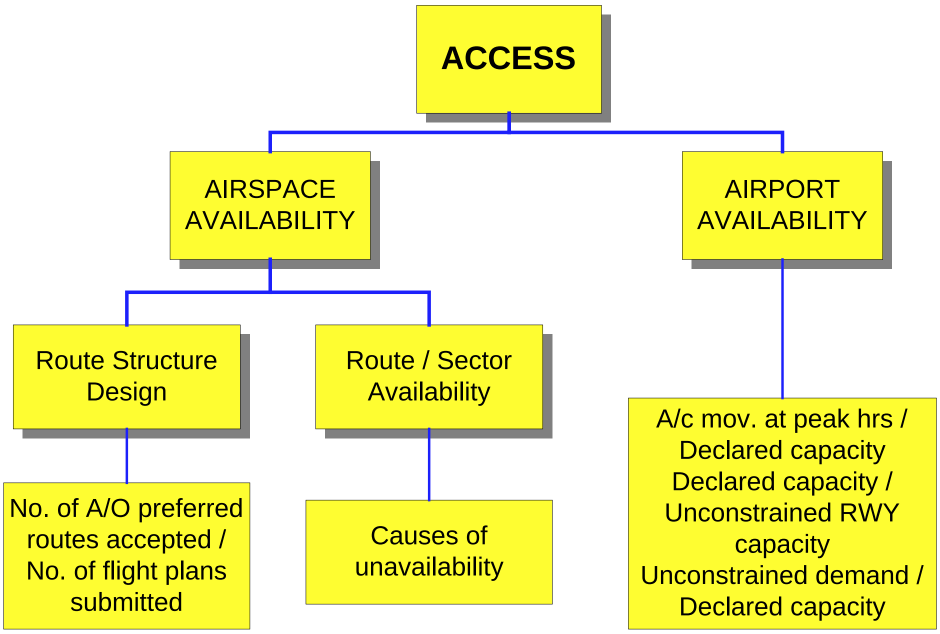

Figure 5: Access KPA Structure

4.5.1 Availability of Airspace

Until the advent of free routes, an aircraft operator is restricted to the existing route structure, which is continually being developed. For the time being, access should not be measured against the optimal route between two points, although this might be a useful measure of flight efficiency, but should be measured against the aircraft operator preferred route. This is because the theoretical optimum route based on, for example, the great circle distance, assumes that there are no route structure restrictions which is not a realistic reference point for Access. A surrogate for the aircraft operator preferred route is the shortest horizontal route within the constraints of the existing route structure. An aircraft operator may choose not to fly the shortest route because of adverse weather or to minimise route charges incurred.

Access to sectors, and therefore routes, can be denied because a sector is closed totally or partially due to military use or downtime of the service, or because a sector is congested. Sector restrictions caused by non-controllable elements such as weather are outside the definition of access and are measured in terms of the cause of delay. An aircraft may also only be able to gain access to a sector if it is carrying certain specified equipment. In this case there may be a financial incentive for an aircraft operator to invest in the necessary equipment.

The proposed indicator is:

Number of aircraft operator preferred routes accepted / Number of flight plans submitted

4.5.2 Causes of Preferred Routes being Unavailable

If access to airspace is to be improved it is necessary to know the reasons why customer preferred routes are unavailable, and the frequency and duration of the cause. Part of this information would relate to the location of a sector which made a preferred route unavailable.

No indicator is suggested for the time being.

4.5.3 Availability of Airport Capacity

Access to an airport will be denied when all slots have been allocated or when there are no slots available at times of the day when demand is high. Any measure of slot availability is only meaningful for a particular airport. When slot availability is very low, the only way of increasing the number of slots will be for an airport authority to increase the capacity of the airport.

Declared airport capacity is the maximum sustainable capacity during periods of normal weather, taking into account all the various limiting parameters. There is a trade-off between declared airport capacity and delay, and the declared capacity should be set at a level which does not lead to unacceptable delay in any of the component parts of the capacity chain. Not all European airports use the same methodology for defining the declared capacity.

The potential for increasing declared capacity, and therefore making additional slots available at a congested airport, is related to the difference between declared capacity and unconstrained runway capacity, assuming that runway capacity is the most constraining facility. Unconstrained runway capacity is defined as the maximum movements per hour attainable from the configuration of runways.

The proposed indicators are:

Aircraft movements at peak hours / Declared capacity

This indicator will help to determine the airports where congestion occurs during peak hours and additional capacity is the most urgent.

Declared capacity / Unconstrained runway capacity

This indicator will measure the scope for increasing the declared capacity when congestion occurs during peak hours.

Peak hour demand realised / Scheduled peak hour capacity

This indicator will measure the ability of an airport to handle the number of take-offs and landings which have been scheduled during peak hours.

4.5.4 Availability of airspace for military purposes

Military users need access to airspace to conduct their missions. However, disruption to civil air traffic should be minimised. Adherence to FUA principles should be measured.

Two indicators are proposed to measure both sides of this question:

% time a given restricted airspace is not available for planned missions

% time a given restricted airspace is reserved and not used

4.6 Flexibility

Flexibility in the ATM system enables aircraft operators to adapt their operations to changing conditions. For example, an aircraft operator may wish to delay departure to wait for passengers from a connecting flight, or put a different aircraft type on to a service at short notice. Flexibility gives them the freedom to make their own operating decisions and trade-offs using all relevant data, which may not be available to them at present, so that short term action can be taken to recover flight schedules and adjust flight profiles to optimise flight duration, fuel consumption or distance flown. The ATM Strategy for 2000+ states that "Lack of flexibility translates into a 'substitution penalty' measurable via delay data, and into a number of denials". Delays caused by lack of flexibility are covered by the Delay KPA, and denials are covered by the Access KPA.

Flexibility is required both on the ground and in the air. The elements to measure of flexibility on the ground are the ability of an aircraft operator to change departure time or planned route without penalty, to exchange slots between flights, and to identify its own re-routes. The element to measure of flexibility in the air is the ability of an aircraft operator to change his flight profile during a flight.

A summary of the Flexibility KPA structure is shown schematically in Figure 5 below.

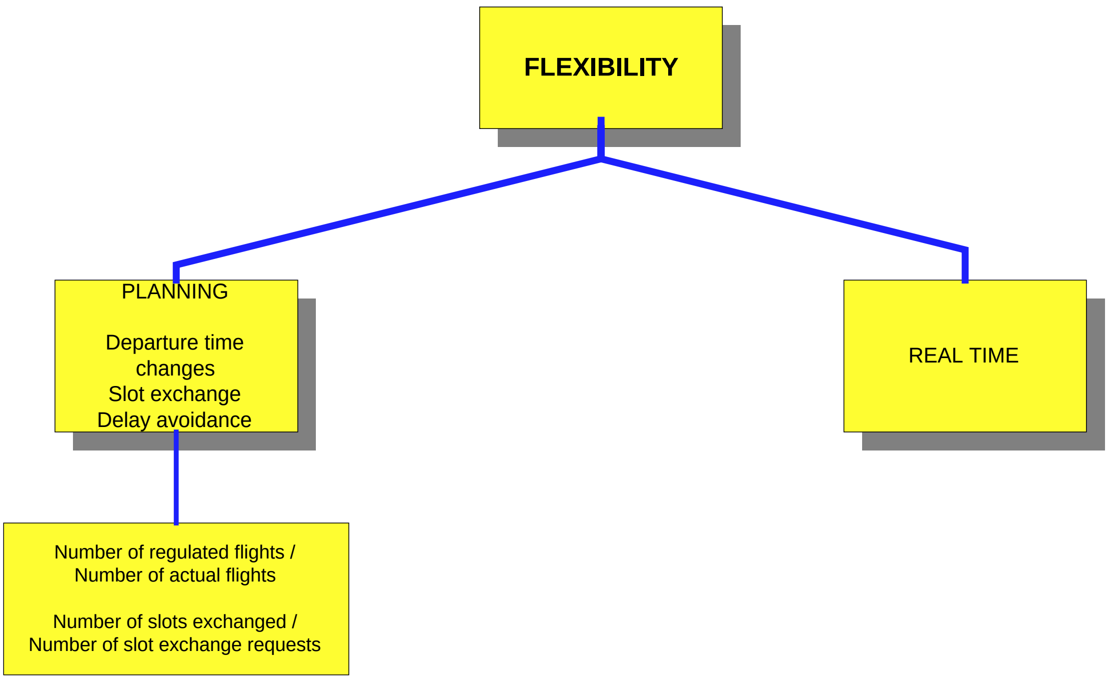

Figure 6: Flexibility KPA Structure

4.6.1 Freedom to Change Departure Time or Planned Route at Short Notice

An aircraft operator has the freedom to delay or bring forward departure at short notice or change the planned route unless flow management restrictions are in place at some point on the requested route. In this case the flight will be given a departure slot by the Central Flow Management Unit (CFMU). The slot is normally issued 2 hours before estimated off block time (EOBT) and is allocated on a “first planned, first served” basis. If an aircraft operator wishes to change the departure time of a flight at short notice it will need to request another slot and, if less than two hours notice is given, the slot will not be issued using the normal slot allocation rule because all the slots will have been fixed. The slot offered will, therefore, be the first available one. This is likely to incur more delay than the original slot that was issued. Any flight which is affected by ATFM restrictions and given a departure slot has, therefore lost some flexibility.

The proposed indicator is:

Number of regulated flights / Number of actual flights

4.6.2 Freedom to Exchange Slots

An aircraft operator may be able to benefit tactically from being able to exchange the queue positions, or slots, of two of its own flights or flights in the same alliance which are subjected to the same regulation. This may be because one of the flights is carrying passengers or crew who will be making connections with other flights at the destination airport and the aircraft operator would like to give it a higher priority to avoid some of the knock-on effects of delay. No other aircraft operator would be affected by such an exchange and the total delay in the system would be unaltered. The internal priorities of an aircraft operator are not known to the CFMU so an exchange can only be made with the co-operation of both parties.

The proposed indicator is:

Number of slots exchanged / Number of slot exchange requests

4.6.3 Freedom to Identify Re-routes

The automatic “what-if” re-route tool is scheduled to be available in March 1999.

An indicator is not proposed at this time but one should be considered in the future related to the transparency of information provided by the CFMU and thereby the degree of collaboration between the CFMU and aircraft operators.

4.6.4 Freedom to Alter Route or Speed during Flight

Once airborne an aircraft operator may wish to optimise the trajectory of a flight and its speed to take advantage of any unused capacity which may have arisen and to take advantage of, or avoid, weather conditions en-route. This is achieved through collaboration between the pilot, aircraft operator, air traffic control and airport operations. Ideally the various organisations should be continuously updating each other on relevant events in real time to provide a sound basis for more efficient decision making.

The level to which collaborative decision making is being achieved could be monitored by measuring the number of interactions which are taking place between the service supplier and aircraft operator and the frequency with which requests are granted. Consideration needs to be made of the quality and feasibility of the requests submitted. The main issue, however, is the ability to record such interactions without imposing additional workload on controllers and/or pilots.

No indicator is proposed at this time.

4.7 Flight Efficiency

Flight Efficiency can be measured in terms of the deviation from the customer preferred four dimensional trajectory. Deviation can take several forms and includes excess route length, non-optimum vertical profile, speed differences from the optimum, excess taxi time and time in stack.

A measure of efficiency could be based on engine burn, although fuel consumption varies markedly by phase of flight. Total fuel burn for a given journey compared to the optimum for the aircraft type in service, and its load, might be a better measure.

Alternative high level indicators of flight efficiency could be based on time or route length. Gate to gate time is attractive because it is related to differences from the planned flight profile. However it is more related to delay and is picked up in the Delay KPA.

The indicators proposed are based, therefore, on route length. The meaning of a given indicator will depend on the route types that are being compared.

A summary of the Flight Efficiency KPA structure is shown schematically in Figure 7 below.

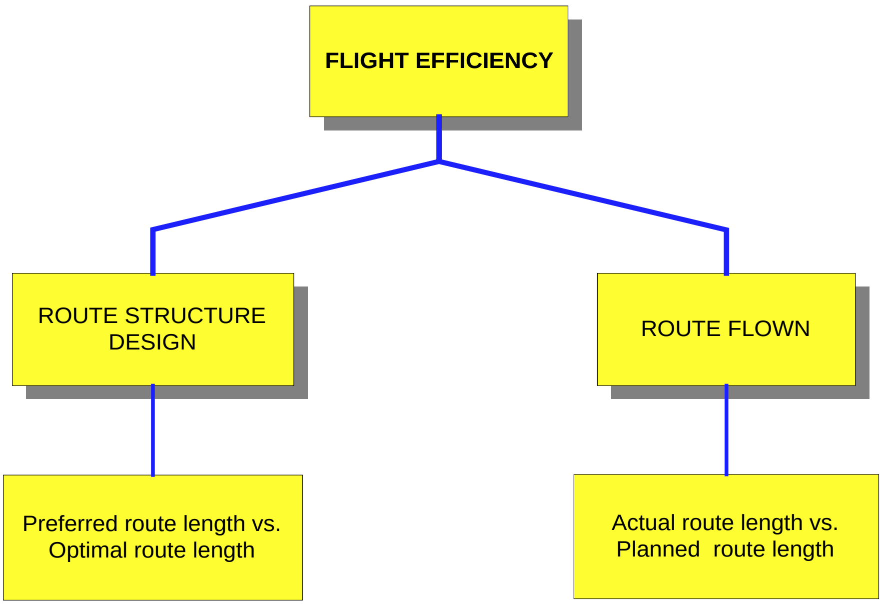

Figure 7: Flight Efficiency KPA Structure

4.7.1 Efficiency of the Route Structure

If free flight was available, an aircraft operator would be able to take the optimal route between two city pairs and, for short and medium haul flights, this approximates to the great circle route. However an aircraft operator is restricted to using the route structure in place and a useful measure of efficiency is the difference between an aircraft operator's preferred route and the optimal route. This measures the efficiency of the route structure.

The proposed indicator is:

1- (Preferred route length – Optimal route length) / Optimal Route Length

Free flight will produce a value of 1 for the indicator. Any constraint on the route that may be flown will result in a value of less than 1.

The performance indicator may be developed in the future to include height.

4.7.2 Efficiency of the Actual Route Flown

There are many reasons why the actual route flown will be different from an aircraft operator's planned route. Some of the reasons are described under the Access KPA and an aircraft operator may have accepted a re-route to avoid or reduce a delay on its preferred route. The second efficiency measure looks at the difference in length between the actual route flown and the planned route, and measures any further efficiency lost in the actual flight. In some cases the actual route flown will be shorter than the planned route because clearance is given to take the direct route between two points once the flight is airborne. In this case the indicator will measure efficiency gained.

The proposed indicator is:

1 - (Actual route length – Planned route length) / Planned route length

The value of the indicator will be greater than 1 if a shorter route was flown than the one planned and less than 1 if the route flown was longer.

The performance indicator may be developed in the future to include height.

4.8 Availability

This performance area relates to unplanned disruption of the services due to the unavailability of resources used for ATM. The resources may be people working in air traffic control, hardware used for communication and navigation, or software used for critical computer systems. The emphasis is on unplanned disruption, as allowances will be made in the ATM planning cycle for routine resource interruptions such as equipment maintenance, staff holidays and sickness.

Downtime from any cause in any part of the system will lead to the curtailment of capacity and the consequence will be severe congestion, delay, re-routing, flight diversions and flight cancellations. When flights are cancelled or diverted the aircraft operators are faced with a potentially large cost from undertaking additional non revenue earning flights to position aircraft in the right place to continue operating their schedules.

The elements of availability to measure are the downtime of critical resources and the disruption caused by these resources not being available. At the top level of the performance indicator hierarchy it may be sufficient to measure the total downtime and disruption caused with the breakdown of cause at lower levels.

A summary of the availability KPA structure is given schematically in Figure 8 below.

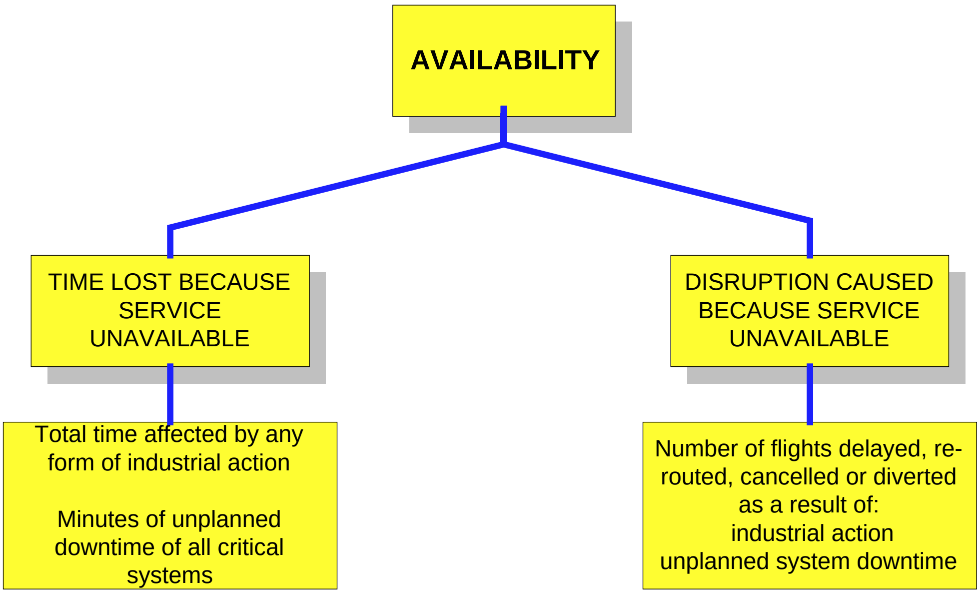

Figure 8: Availability KPA Structure

4.8.1 Time Lost due to any Component of the ATM System being Unavailable

From time to time, industrial action is taken by operational personnel of different ATS providers. The proposed indicator to measure the magnitude of the problem is:

Total time affected by any form of industrial action

A critical system is one which is essential to maintaining capacity and functionality at a given level. In other words, if a critical system goes down some capacity will be lost until the system is restored. The scope of the systems to be covered is any critical system used in gate-to-gate ATM.

The proposed indicator is:

Minutes of unplanned downtime of all critical systems

Also, inappropriate manpower planning or inadequate manning of resources will have to be considered at a later stage.

4.8.2 The Disruption Caused by Unavailability

The disruption caused by unavailability can take many forms. Any flight affected by unavailability should be included in the indicator.

The proposed indicators are:

Number of flights delayed, re-routed, cancelled or diverted as a result of industrial action / Number of planned flights

Number of flights delayed, re-routed, cancelled or diverted as a result of downtime of all critical systems / Number of planned flights

4.9 Environment

The process of determining the appropriate mechanism for dealing with the issue of environmental damage is outside the direct control of the ATS agencies. Governments will set their own policy on such issues and although the ATS agencies can contribute to the debate, the final decision will be taken by those external bodies. Once the mechanisms have been chosen, whether they be tradable emission rights, quantity constraints or other regulatory processes, it is up to the ATM system to maximise outputs subject to those. For example, if the environmental regulations have the effect of increasing the cost of fuel to address global warming concerns, we would expect airlines as ATC users to put even greater emphasis on the importance of making direct routings available to aircraft.

The two environmental impacts resulting from aviation are noise and the effects of emissions.

Noise is related to airports, particularly take-off and approach, except in the case of supersonic aircraft, which are a particular case and should be dealt with separately. ATM does have an effect on the noise impact of aircraft operations through the design and application of designated routes (SIDs and STARs) in and out of notified TMAs. It should be possible, in theory, to devise a performance measure for the effective application of ATM to reduce noise impact. In practice, there are a great variety of other factors involved including the local rules of the airport and Government authorities. Therefore, an ATM performance measure is not thought to be feasible in the near term.

The effect of exhaust emissions is measured in many different ways by different parties, but there is at present no homogeneous data analysis of the impact ATM could have on aviation emissions throughout Europe. This is an area which has to be developed as the sustainable growth of airport operations and air transport is linked to environmental considerations. It is proposed to estimate fuel consumption for optimum and actual flight profiles and to consider taxi time for the ground part. This would require the availability of ETMS data.

The question then arises as to whether operators determine their flight plans to achieve the least environmental impact. Whilst this may be a valid question, it is not related to ATM.

The indicators proposed are:

Estimated fuel consumption/ optimum fuel consumption

Taxi time / optimum taxi time (%)

At this time it is too difficult to measure the conformance of air transport to all environmental regulations and the above indicators are seen as a first set of measurable factors.

4.10 Equity

The flow management slot allocation rule of ‘first planned, first served’ has been designed to ensure equity for all aircraft operators irrespective of the nature of the flight. Their perception, from recent surveys is that it is being achieved.

Equity is a subjective concept which is difficult to measure but it should be monitored to ensure that it continues to be achieved. This could be done by means of the customer service questionnaire suggested in subsection 4.1 on Safety.

An indicator for equity would identify if it was being achieved within and between all classes of aircraft operator including scheduled, charter, regional, business, freight, general aviation and military.

The proposed indicator is:

% of aircraft operators by class who consider that equity is achieved.

Problems such as adherence to CFMU slots, adherence to flow management rules and the equitable treatment of aircraft operators within individual States or at individual airports are also considered to be important by the user community and might also warrant an indicator.

5. OVERVIEW

Many performance indicators have been proposed to give a complete view of the performance of ATM in each of the 10 key performance areas. It is not the intention to report on each indicator in every performance review report, but rather to focus on those indicators which provide the greatest insight into performance. Emphasis will be given to examining the most important ATM issues at the time of publication.

To provide an overview of performance it is helpful to have summary indicators for each performance area. This section suggests some summary indicators and puts them in the context of the objectives contained in the ATM Strategy for 2000+.

5.1 ATM 2000+ objectives

Once agreed, the ATM 2000+ Strategy objectives should be guiding the development of ATM in Europe. These are:

1. ***To improve safety levels by ensuring that the number of ATM induced accidents and serious or risk bearing incidents do not increase and, where possible, decrease.***

2. ***To reduce the direct and indirect ATM-related costs per unit of aircraft operations.***

3. ***To provide sufficient capacity to accommodate the demand in typical busy hour periods without imposing significant operational, economic or environmental penalties under normal circumstances.***

4. ***To enable airports to make the best use of possible capacity, as determined by the infrastructure in place (land-side and air-side), political and environmental restrictions, and the economic handling of the traffic demand.***

5. ***To work with ICAO and its member States to obtain improvements in ATM, in particular the accelerated implementation of CNS/ATM concepts, procedures and systems which help to mitigate the impact of aviation on the environment.***

6. ***To ensure that ATM operations are compliant with ICAO CNS/ATM plans, provide a seamless service to the user at all times, and operate on the basis of uniformity throughout the ECAC area.***

7. ***To determine new mechanisms, criteria and structures to enhance civil-military co-operation and co-ordination.***

8. ***To ensure access to airspace for military purposes through the implementation of special procedures where necessary.***

The PRC approach to ATM performance should be consistent with the agreed ATM 2000+ objectives. It should inform decision makers whether ATM 2000+ objectives are being met and whether credible plans are in place to meet those objectives. High level performance indicators covering at least the first four objectives could be measured, namely:

- Safety (objective 1)

The following indicator is proposed to check that the number of ATM induced accidents and serious or risk bearing incidents do not increase and, where possible, decrease:

Number of losses of planned separation incidents in the ECAC area

The yearly series could be compared against a baseline (e.g. 1997)

- Total cost (objective 2)

The total cost incurred by ATM airspace users is made up of direct costs (e.g. route charges, avionics) and indirect costs (e.g. due to delays, unpredictability, etc.). In keeping with the second objective of the ATM 2000+ strategy, all costs should be taken into account, direct as well as indirect, and the total cost should be minimised.

The total cost of capacity and delays is already used in the FAP methodology to identify optimum capacity target as shown in Figure 9.

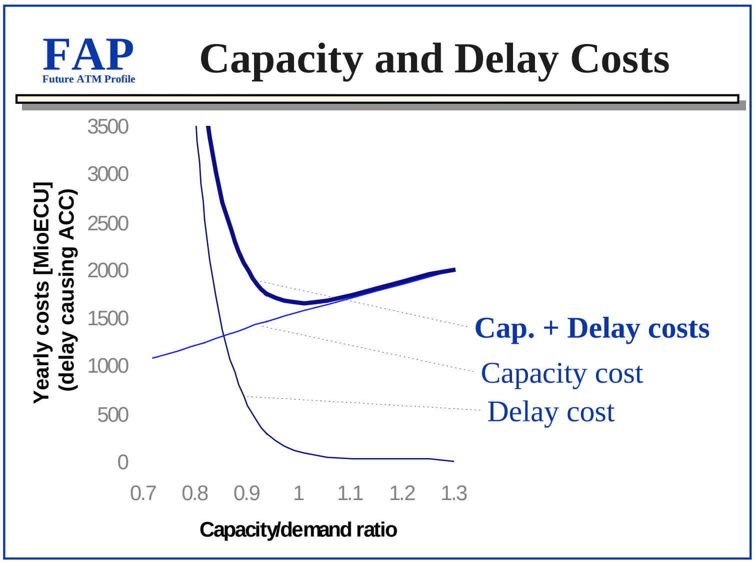

Figure 9: Capacity and Delay Costs

This approach could be generalised to other Key Performance Indicators. Subject to the constraints on certain KPAs, performance indicators will be measured in economic terms wherever possible. For example, poor predictability leads to “schedule padding” and lower fleet usage if on-time arrival is to be ensured, the penalty of which can be estimated in economic terms. Eventually the contribution of each tradable performance area to overall ATM performance can be presented in a consolidated view. This will allow those areas which are most critical to be identified and will permit the best trade-offs among a number of scenarios to be found.

It is intended to define performance indicators such as these which would enable the trade-offs among several scenarios to be understood and would allow the achievement of the second ATM 2000+ objective to be checked.

In the case where economic values are not available, indices, such as those used in illustrating stock exchange performance, may be a valuable presentation mechanism of different KPAs at the summary level.

- Meeting the demand (Objective 3)

It is valid to question whether future demand is likely to be met. It is suggested that yearly series for a traffic index, a capacity index, a delay index and a direct cost index should be superimposed on the same graph. This would show graphically whether capacity is growing as fast as traffic, whether there is a link between underspending and delays, and whether direct costs are growing slower than traffic. This graph could be extrapolated into the future, using informed judgement or modelling. To understand how capacity has been generated in the past, one could use staffing, productivity, investment and capacity indices.

- Airport capacity (objective 4)

Airport capacity will probably be the ultimate limitation to air transport growth. ATM can only help make best use of existing airport capacity provided the constraints imposed by safety, environment and equity are met. Some indicators proposed under “airport access” could be used (see 4.7.3). Airport capacity has so far been much more critical in the USA than in Europe. It is proposed to use US experience as far as possible in this area, and to use US airport performance as a baseline.

In all areas, qualitative indicators obtained from user or provider surveys could be used as well.

5.2 KPA breakdown

Aggregations of indicators are of little value unless it is possible to "drill down" to the detail in order to identify the specific problem areas for action.

It is proposed that a few key performance indicators concerning, for example, cost and delay should be capable of being broken down to the level of ATS provider, ACC, airport (for the most congested airports), and City Pair (for the most congested routes), as appropriate. Similarly a breakdown based on the phase of flight (i.e. gate to take off, climb, en-route, descent, approach, landing to gate) is proposed for relevant indicators. In both cases data would need to be collected at the lowest level so that it can be consolidated at higher levels.

A helpful presentation style is the use of a "Top 20" worst/best performers. This can be added to the summary to highlight the problem areas.

5.3 Top Ten ATM issues

The PRC decided to publish the current “Top Ten ATM issues”. It may prove useful to develop specific performance indicators to check their validity and to identify whether they are being resolved.

6. OTHER CONSIDERATIONS

6.1 “Outcome” oriented approach

As stated in section 3, an “outcome” oriented approach to ATM performance was chosen to start with. According to EFQM principles a “process” oriented approach will also be needed to understand, for example, how and why performance is delivered. Benchmarking is already used by some ATS providers. It is a powerful tool for measuring and managing performance, e.g. by identifying best practices. To what extent the PRC needs to be involved in a detailed provider oriented approach remains to be seen, and may depend upon the quality of individual providers’ management.

In addition, there may be value in benchmarking against organisations in businesses other than ATM.

6.2 Access to data and production of indicators

This paper has not specifically addressed access to data (which could be confidential or not presently available) or the responsibility for compiling the indicators. In a number of cases, such as delay analysis, data sources are already established (e.g. CODA, CFMU), and it is intended to use what exists. In other cases, it is evident that access to additional data and new information channels will be needed. It is interesting to note that the PRU may not need to process all the information itself as third parties, including the EUROCONTROL Agency, could provide the service, and preserve confidentiality where appropriate.

Some of the proposed performance indicators will require the co-operation of users or providers to undertake measurement responsibilities. This was highlighted in particular for arrival punctuality, reactionary delay analysis and the provision of customer preferred flight profiles. Responsibilities can be identified as part of a more detailed definition of the performance indicators in the next stages.

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ANNEX 1: Summary Table of KPAs, Elements to Measure and Suggested Performance Indicators

KPA	ELEMENTS TO MEASURE	SUGGESTED PERFORMANCE INDICATOR
Safety	The conformance of air transport to specified safety targets	Total number accidents Total number serious incidents Total number of other incidents Aircraft operators' perception of ATM safety ATS providers' perception of ATM safety
Equity	Equity of treatment of all airspace users within and between all classes of user	% of aircraft operators by class who consider that equity is being achieved.
Environment	Effects of Emissions	Estimated fuel consumption/ Optimum fuel consumption Taxi time / Optimum taxi time
Delay	Departure delay	Total minutes of departure delay / Total number of flights Total number of delayed flights / Total number of flights Total minutes of departure delay / Number of delayed flights
	Flight delay	Total minutes of gate to gate delay / Total number of flights
	TMA delay Arrival delay Causes of delay Relationship between delay, traffic volume and capacity Capacity Management	Total minutes of TMA delay / Total number of flights Total minutes of arrival delay / Total number of flights Proportion of total delay arising from each identified cause Weekly minutes of ATFM delay by volume of traffic Capacity index Actual capacity variation / Target capacity variation Actual capacity variation / Actual traffic variation
Predictability	Anticipated delay Variability in arrival delay Taxi Time Variability	Difference between scheduled and optimum gate-to-gate time Standard deviation of arrival delay Standard deviation of each delay component Causes of delay in each delay component Taxi-in variation time Taxi-out variation time

Cost Effectiveness	Cost of ATM services	Total cost per movement Total cost per kilometre flown
	Productivity measures	Number of movements / Number of controllers employed Total flight hours handled / Total hours worked by controllers Value of fixed assets / Number of movements Value of fixed assets / Total kilometres flown Sector capacity used / Declared sector capacity
	Cost Transparency	
	Investment plans	
Access	Availability of Airspace	Number of aircraft operator preferred routes accepted / Number of flight plans submitted
	Causes of Preferred Routes being Unavailable	
	Availability of Airport Capacity	Aircraft movements at peak hours / Declared capacity Declared capacity / Unconstrained runway capacity Peak hour demand realised / Scheduled peak hour capacity
	Availability of Airspace for military purposes	% time a given restricted airspace is not available for planned missions % time a given restricted airspace is reserved and not used
Flexibility	Freedom to Change Departure Time or Planned Route at Short Notice	Number of regulated flights / Number of actual flights
	Freedom to Exchange Slots	Number of slots exchanged / Number of slot exchange requests
	Freedom to Identify Re-Routes	
	Freedom to Alter Route or Speed during Flight	
Flight Efficiency	The efficiency of the route structure	1-(Preferred route length – Optimal route length) / Optimal route length
	The efficiency of the actual route flown	1 - (Actual route length – Planned route length) / Planned route length
Availability	Time Lost due to any Component of the ATM System being Unavailable	Total time affected by any form of industrial action Minutes of unplanned downtime of all critical systems
	The Disruption Caused by Unavailability	Number of flights delayed, re-routed, cancelled or diverted as a result of industrial action / Number of planned flights Number of flights delayed, re-routed, cancelled or diverted as a result of downtime of all critical systems / Number of planned flights

ANNEX 2: TERMS OF REFERENCE

Terms of Reference of the Performance Review Commission (PRC)

1. The Performance Review Commission (PRC) is a Commission established by the Permanent Commission to provide advice in order to ensure the effective management of the European air traffic management system through a strong, transparent and independent performance review and target setting system.
2. The PRC will advise on the development of the performance and target setting system, which will be implemented and enforced by the Member States.
3. The PRC will advise the Permanent Commission through the provisional Council on all matters related to performance review and target setting, including recommendations for the improvement of these functions.

Organisation

4. The Chairman and the Vice-Chairman of the PRC will be appointed by the provisional Council for a non-renewable period of three calendar years. The PRC will be composed of twelve members to be appointed by the provisional Council, according to a selection process developed by the provisional Council, among candidates nominated by Member States. These candidates may include representatives of users' organisations and independent experts.

   Air Traffic Management (ATM) service providers, representative organisations of airspace users and airports, representatives of ECAC government regulatory bodies and of other bodies or international organisations which can contribute to the work of the Performance Review Commission should participate as observers without prejudging the outcome of any discussion between EUROCONTROL and any of the above bodies.
5. The PRC will report through the provisional Council to the Permanent Commission which will approve and may amend its functions.

   The PRC will determine its own rules of procedure, subject to approval by the Permanent Commission.
6. The budget for performance review will be submitted by the Agency through the PRC and the provisional Council to the Permanent Commission .
7. The PRC will be supported by the Performance Review Unit (PRU) operating under the EUROCONTROL Agency with the appropriate level of independence.

Functions

8. In the exercise of its advisory functions, the PRC shall :
   a) propose overall objectives for improvement of the ATM system performance for approval by the Permanent Commission through the provisional Council;
   b) approve performance indicators for monitoring and analysis for adoption by the Permanent Commission through the provisional Council;
   c) approve the format, structure and frequency of performance review reports and the extent of dissemination and ensure these reports are

made available for adoption by the Permanent Commission through the provisional Council;

d) approve targets to be set for ATM system improvements for adoption by the Permanent Commission through the provisional Council;
e) approve guidelines for economic regulation of ATM service providers for adoption by the Permanent Commission through the provisional Council;
f) address the proper functioning of the PRU, its work programme and the quantity and quality of its output and adopt the budget of the PRU for approval by the Permanent Commission through the provisional Council;
g) ensure widespread circulation of the remedial recommendations for ATM system improvements, after their approval by the Permanent Commission through the provisional Council;
h) review, and as appropriate, make recommendations to the Permanent Commission through the provisional Council on ATM performance issues submitted to it by authorised parties: ATM service providers, Airports, Airspace users (civil, military), EUROCONTROL Agency, Government regulatory bodies and other Agencies and International Organisations which can contribute to the work of the PRC;
i) undertake such other functions within the sphere of performance review as the Permanent Commission may specify.

Terms of Reference of the Performance Review Unit (PRU)

1. The Performance Review Unit (PRU) is responsible for monitoring and reviewing the performance of the European ATM System. As part of the EUROCONTROL Agency with the appropriate level of independence, the PRU will support the PRC. It will report, for administrative purposes only, to the EUROCONTROL Director General who will be accountable to the Permanent Commission for the Unit.
2. The PRU shall:
   a) evaluate, monitor and report on ATM System including the Agency, from a gate-to-gate perspective for airspace mentioned in Annex 2 of the revised Convention in regard to agreed and defined parameters which could include productivity (e.g. traffic handled); standards of safety performance; efficiency (e.g. cost per flight); operational performance (e.g. delays, additional route mileage, costs); relevant military requirements; system enhancement (e.g. implementation projects and programmes); and other related factors; a balanced approach is essential;
   b) propose, monitor and report on ATM related performance parameters which could include compliance with ATM procedures, airlines slot wastage (e.g. multiple flight planning); airlines ATM delay inducement (e.g. near simultaneous flight scheduling for same route(s)); airports (e.g. inadequacy of airside facilities); and other related factors;
   c) work with ATM service providers, the Agency, airports, individual users, and representative organisations or airspace users and airports in cases of ATM related activities, in setting targets for achievement in areas under (a), (b) and (c);
   d) develop guidelines for economic regulation of ATM service providers by national administrations, and monitor their application;
   e) make recommendations to the PRC, on the basis of its analyses, for performance improvements of the European ATM System relating to and supporting ATM service provision, the EUROCONTROL Agency and representative organisations of airspace users and airports, or individual users and airports where appropriate.
3. In order to carry out these functions the PRU will develop and maintain working arrangements with service providers, representative organisations of airspace users and airports, and industry, and other appropriate bodies. These arrangements will be submitted through the PRC and the provisional Council to the Permanent Commission.

ANNEX 3: LIST OF ACRONYMS

ACC	Area Control Center
AEA	Association of European Airlines
ATA	Air Transport Association of America
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSP FG	Air Traffic Services Performance Focused Group
C/AFT	CNS/ATM Focused Team
CANSO	Civil Air Navigation Services Organisation
CFIT	Controlled Flight Into Terrain
CFMU	Central Flow Management Unit
CODA	Central Office for Delay Analysis
CRCO	Central Route Charges Office
CTOT	Calculated Take-Off Time
EATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
EOBT	Estimated Off Block Time
FAA	Federal Aviation Administration
IATA	International Air Transport Association
KPA	Key Performance Area
KPI	Key Performance Indicator
OOOI	Out, Off, On, In
PI	Performance Indicator
PRC	Performance Review Commission
PRU	Performance Review Unit
SID	Standard Instrument Departure
SRC	Safety Regulation Commission
STAR	Standard instrument Arrival Route
TMA	Terminal Control Area