PERFORMANCE REVIEW UNIT

Working Paper

"Cost Effectiveness and Productivity KPIs"

Prepared by the KPI DRAFTING GROUP

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EXECUTIVE SUMMARY

A Validation Phase of the Pilot Project on Information Disclosure was launched on 28 March 2001 with a meeting of the participating air navigation service providers (ANSPs) from Phase 1, together with representatives from six additional ANSPs. The airspace users' community was also represented by participants from IATA, British Airways, and KLM.

At this meeting it was decided that the previous participants and the representatives of the new participating ANSPs would form the Steering Group for the Validation Phase on Information Disclosure and that they should put forward nominees to form a KPI Drafting Group (KPIDG) which would work at a more detailed level. The objectives of the KPIDG were to develop a performance framework for the measurement of cost effectiveness and productivity, and to identify a set of high level KPIs that could be used to measure different aspects of performance within this framework.

The KPIDG has met five times between 23 April and 12 September 2001 and has been attended by participants from 17 organisations representing ANSPs, Civil Aviation Authorities (CAAs) and airspace users. Each meeting has been a working session, led and facilitated by the Performance Review Unit (PRU). A major output has been this working paper which identifies a selection of KPIs at the gate-to-gate, en-route, terminal and ACC levels. To ensure consistency in both the collection of data and the interpretation of indicators, a standard set of definitions relating to inputs, outputs and operations has been prepared. Existing definitions have been used where possible, but novel definitions have been necessary in certain areas. Care has been taken to harmonise these definitions with those being developed by CANSO.

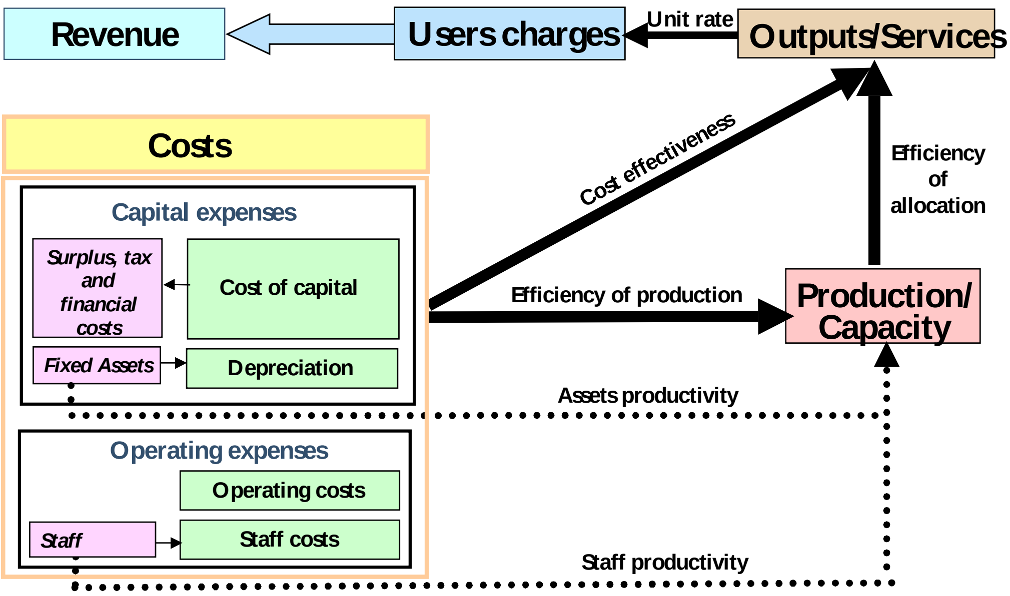
The scope of the work of the KPIDG has been limited to the development of precise KPIs for cost effectiveness, productivity and efficiency. The KPIDG has not considered other important, but indirect components of value-for-money such as the cost of ATM delay and the cost of inefficient flight profiles.

Some sample indicators that have been prepared using the 2000 data display considerable variation in performance between ANSPs. In this working paper, the KPIDG draw attention to the many and various exogenous factors that contribute to the variation and create difficulty in making fair comparisons between ANSPs unless they can be quantified. These exogenous factors are related to the institutional and operational environment in which the ANSP operates and are mainly outside an ANSP's control. Some of these factors, such as complexity, are difficult to measure and will clearly require further work and modelling before agreement is reached on a satisfactory definition that takes into account the various dimensions involved. Since many of the exogenous factors that affect the performance of a particular ANSP will remain fairly constant from year to year, KPIs are particularly relevant to track the evolution of performance of a given ANSP.

The KPIDG has recognised that complementary benchmarking tools such as multivariate regression analysis and total factor productivity should also be used to provide a richer and fairer picture of performance and give further insight, but such tools will require further study. In this context, full information disclosure should be encouraged in order to throw light on some of the factors that can cause differences.

The KPIDG has identified several situations where care is needed when measuring performance. Difficulties can arise when one state/ANSP delegates air navigation services to another state/ANSP, when civil and military OAT are partially or fully integrated, and when different outsourcing (contracting out) policies are used. In all cases it is necessary to ensure that consistency is maintained between the measurement of inputs and the measurement of outputs.

The following figure illustrates a framework that has been identified by the KPIDG for the measurement of cost effectiveness and productivity. The framework includes the principle metrics that are required to measure performance and the arrows show the way in which the metrics can be connected to measure different aspects of performance.



The working paper provides an in depth discussion of each part of the framework, explores different metrics that could be used to measure output, production and capacity, and suggests indicators for each aspect of en-route, terminal and gate-to-gate performance. High level indicators are summarised in a table on the following page.

The working paper has been approved by the Steering Group who have also prepared of a Specification for Information Disclosure (Version 2) which will provide all the necessary data to populate the indicators and will provide additional information to enable analysis of these indicators to be undertaken.

Both the KPIDG and the Steering Group recognise that while historical indicators are interesting, they are insufficient on their own to predict future performance. Information disclosure will, therefore, require specific forward-looking information to be provided covering the key inputs, outputs and capacity.

The working paper concludes that similar indicators can and should be used at the level of an operational unit (ACC, TWR, etc.) where benchmarking is more meaningful and appropriate because operational units operating within a similar environment can be grouped together and compared. It also concludes that since the majority of costs fall under the heading of ATM/CNS, they should be further split into the major service components (Communications, Navigation, Surveillance, MET, AIS, etc.) so that the cost effectiveness of significant services can be compared.

	En-route ANS	Terminal ANS	Other	Gate-to-Gate
COST EFFECTIVENESS				
Total cost / Km controlled (or flight hours)	✓			✓
Operating expenses / Km controlled (or flight hours)	✓			✓
Total terminal cost / Total airport movements		✓		
Terminal operating expenses / Total airport movements		✓		
EFFICIENCY OF PRODUCTION				
Total cost / Sector hours (or Number of sectors)	✓			
Operating expenses / Sector hours (or Number of sectors)	✓			
Total cost (or operating expenses) / Flight hours controllable	✓			
EFFICIENCY OF ALLOCATION				
Flight hours controlled / Flight hours controllable	✓			
STAFF PRODUCTIVITY				
Total ATCOs hours on duty in OPS / Number of ATCOs in OPS	✓	✓		✓
Sector hours / Number of en-route ATCOs in OPS	✓			
Total airport movements / Number of terminal ATCOs in OPS		✓		
Flight hours controlled / Number of ATCOs in OPS	✓			✓
ASSET PRODUCTIVITY				
Sector hours (or number of sectors) / NBV fixed assets in operation	✓			
Km controlled (or Flight hours controlled) / NBV fixed assets in operation	✓			✓
Number of movements / NBV fixed assets in operation		✓		

Table: Summary of Key Performance Indicators

1. INTRODUCTION

As part of the work undertaken in 2001 during the Validation Phase of Information Disclosure, a Key Performance Indicator (KPI) Drafting Group (KPIDG) was set up to establish a link between performance measurement and economic information disclosure. More specifically, the KPIDG has been formed to carry out the following tasks:

(i) To develop a performance framework for measuring cost effectiveness and productivity;

(ii) To use the performance framework to identify suitable high level indicators to measure different aspects of cost effectiveness and productivity;

(iii) To identify exogenous factors influencing performance;

(iv) To propose a set of KPIs of cost effectiveness, productivity and efficiency to the Steering Group on Information Disclosure Requirements.

The KPIDG consists of representatives from a number of European Air Navigation Service Providers (ANSPs) and airspace users, and is led and facilitated by the Performance Review Unit (PRU). By working together in a collaborative manner the KPIDG have been able to develop a mutual understanding of how best to measure performance and have also been able to identify joint solutions to problems in defining and collecting data in a consistent manner.

The KPIDG met five times and attendance lists are provided in Annex 1.

2. BACKGROUND

In 1997 the Member States of EUROCONTROL jointly took the decision to "establish an independent performance review system that will address all aspects of air traffic management, including policy and planning, safety management at and around airports and in the airspace, as well as financial and economic aspects of services rendered, and set targets that will address these aspects"[1].

The Member States also decided "to study and promote measures for improving cost effectiveness and efficiency in the field of air navigation"[2].

As a result of these decisions the Performance Review Commission (PRC) was established to ensure the effective management of the European air traffic management system through a strong, transparent and independent performance review and target setting system.

At the request of the ECAC Transport Ministers, a comprehensive, gate-to-gate oriented ATM Strategy for 2000+ has been developed. The high level objectives of this strategy were taken into account when identifying ten key performance areas (KPAs) to measure each aspect of ATM performance. Figure 1 puts the work of the KPIDG into the context of the complete set of KPAs and summarises several high level objectives of the ATM strategy relating to cost effectiveness.

[1] EUROCONTROL Revised Convention Article 2.1(i)

[2] EUROCONTROL Revised Convention Article 2.1(j)

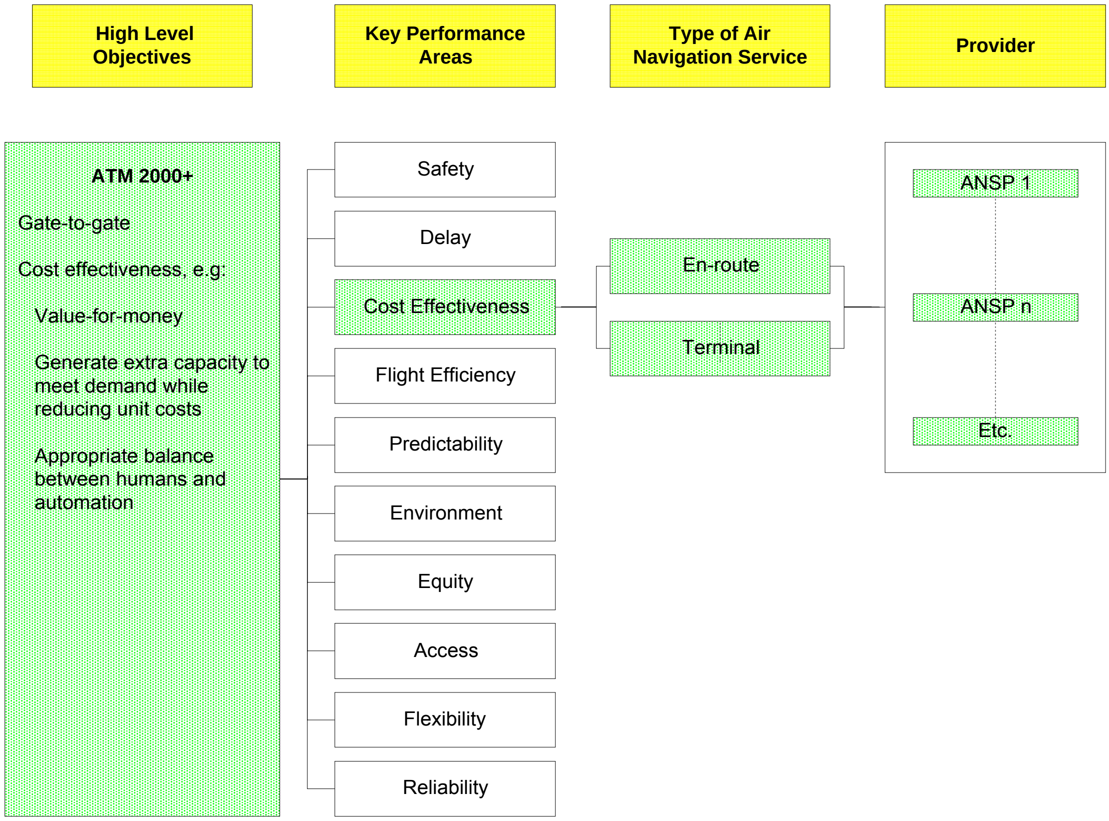


Figure 1: Context of Work

The early work of the PRC has focussed on the three areas of safety, delay and cost effectiveness using readily available data from the CFMU and CRCO. However, in its first Performance Review Report (PRR1) issued in June 1999 the PRC identified the lack of economic information as a major impediment in assessing cost effectiveness. The pilot project on economic information disclosure is intended to fill this gap and enable a better understanding to be gained of the economics of air navigation services (ANS) provision, and the causes and drivers of performance. This will permit the PRC to achieve two further objectives, which are to identify and promote best practice and to foster a safe, performance-oriented culture in the ANSP community.

According to ICAO definitions, ANS can be decomposed into the following components: air traffic management/communications, navigation and surveillance (ATM/CNS), aeronautical information services (AIS), meteorological services for air navigation (MET) and search and rescue services (SAR). Furthermore, ATM/CNS comprises air traffic services (ATS), air traffic flow management (ATFM) and airspace management (ASM).

Because the ATM system is being viewed on a gate-to-gate basis, it is necessary to identify and understand the cost of providing ANS during the different phases of a flight. This approach has the advantage of being consistent with the ANS revenues, which are typically obtained separately for the en-route and terminal phases of a flight (see ICAO Annex 11, Chapter 2, 6th Edition).

En-route navigation services comprise those services defined by ICAO in Document 9082/5 (“Statements by the Council to Contracting States on Charges for Route Air Navigation Facilities”) and Document 9161 – AR/724, 3rd edition, 1997 (“Manual on Air Navigation Services Economics”).

Terminal navigation services comprise those navigation services provided to arriving or departing traffic at or on the approaches to a country's aerodromes not included in en-route services.

Other air navigation services comprise services provided to airspace users that are not included in the above categories and are charged separately, but nevertheless form part of the organisation's statutory monopoly of ANS. Examples include oceanic ANS, services provided to military OAT and other ancillary activities such as consulting and training.

The boundaries between the various classes of ANS, and in particular the boundary between en-route and terminal ANS, are not defined precisely, and different ANSPs' operating and charging practices may make different boundaries appropriate or convenient. In the context of this paper, it is expected that each ANSP will use definitions of ANS that are consistent with its own cost allocation and charging.

3. SCOPE

The scope of the work of the KPIDG is limited to the identification of KPIs for cost effectiveness, productivity and efficiency in relation to the costs that an ANSP incurs and the resources it uses in providing outputs and capacity. The scope does not include other important, but **indirect**, components of value-for-money such as the cost of delay resulting from air traffic control restrictions or the additional cost of routing a flight on a less than optimum trajectory.

The PRC/PRU recognises that concepts such as the indirect cost of poor service quality are important and should be taken into account in the overall performance assessment of an ANSP. The Validation Phase of Information Disclosure is, therefore, the first step of an ongoing process. The PRC/PRU intends to set up similar focus groups consisting of representatives from ANSP and user organisations to consider these concepts and to develop KPIs in other key performance areas.

It should be noted that tools such as multivariate regression analysis and data envelopment analysis could also assist in the analysis of performance. These tools are complementary to and not a replacement for KPIs and can provide insights into the comprehensive benchmarking of ANSPs and the identification of best practice. However the use of sophisticated tools such as these is outside the scope of the KPIDG.

4. MEASUREMENT OF ATM PERFORMANCE

There are a number of conditions to satisfy if performance is to be measured in a fair and consistent way so that ANSPs can be compared.

- The approach for measuring performance should be agreed and shared among all the stakeholders. Airspace users need to be satisfied that the aspects of performance that are being measured will encourage improvement in those areas that are of most concern to them. ANSPs need to understand and be comfortable with the rationale behind the approach.

- High level KPIs should be simple to compute, easy to understand and bring visibility to the important aspects of performance.

- Precise definitions should be provided for the components of each KPI to ensure that the data used in constructing the indicator for each ANSP is consistent.

- The factors that are outside an ANSP's control (the exogenous factors), and which will influence the value that a KPI takes, need to be recognised and measured by suitable metrics.

- Because a KPI can only capture one aspect of performance, it should be interpreted in the light of other performance dimensions. A range of KPIs should therefore be used to ensure that all key aspects of cost effectiveness, productivity and efficiency are taken into account.

For the time being, an interesting indicator that is supported by the KPIDG will be retained in this document, even though the data required to compute it is not currently available. The feasibility of collecting this data and any confidentiality issues will be addressed later.

5. A PERFORMANCE FRAMEWORK

Before identifying appropriate KPIs for cost effectiveness, productivity and efficiency it is helpful to develop a conceptual framework for the measurement of performance. Figure 2 shows such a high-level performance framework. It provides an overview of the inputs, process and outputs of providing air traffic services and attempts to break down a highly complex system into a reasonably comprehensible form. It can be used to consider both financial and operational measures.

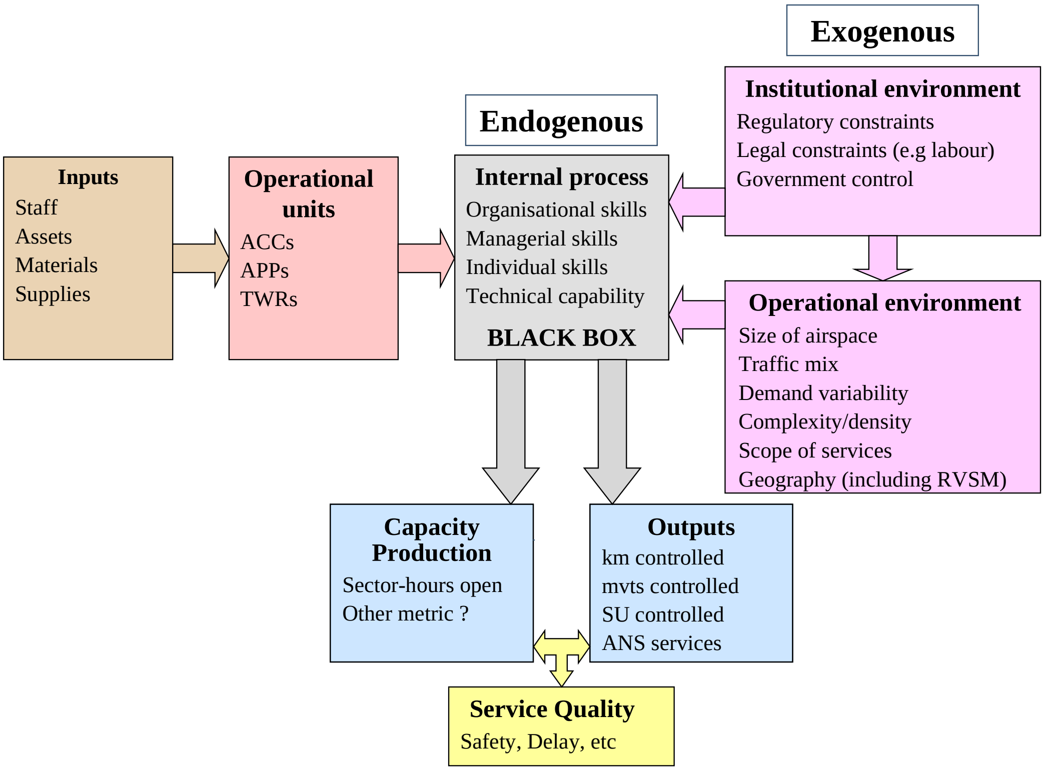


Figure 2: A Performance Framework

Several broad categories of economic variables are shown as inputs to the system and these consist of all the resources that are available to an ANSP to provide services to airspace users. When an ANSP has more than one operational unit, each of these units will receive some part of each resource. In principle, the total cost of each resource can be allocated to each operational unit so that the cost of operating individual units can be established.

Endogenous and exogenous factors influence the system.

An **endogenous factor** is one that is under the control of an ANSP. These factors relate to the skills and expertise that exist within the ANSP at an organisational, managerial, individual and technical level, and determine the efficiency and effectiveness with which the ANSP is able to convert the input resources into outputs and the provision of capacity.

An **exogenous factor** is one that is external to an ANSP and over which the ANSP has little or no control. These factors arise from the institutional and operational environments within which the ANSP has to provide a service. Exogenous factors constraint an ANSPs freedom to act and may be due to safety and economic regulation, legislation such as employment law, and government control that may restrict the range of services that an ANSP is allowed to provide. Other exogenous factors are related to the physical environment in which the ANSP operates and are due to the volume of airspace that the provider is required to control and the density, complexity and mix of traffic passing through it.

6. EXOGENOUS FACTORS

Since no two ANSPs are the same, to compare performance and understand the reasons for differences between ANSPs' apparent performance, it is necessary to understand the context in which a particular ANSP operates. It is particularly necessary to understand the nature of the factors outside an ANSPs control (the exogenous factors). These factors need to be identified for both en-route and terminal services.

6.1 INSTITUTIONAL ENVIRONMENT

The institutional environment gives rise to several constraints that an ANSP must work within and which will effect performance. It is often difficult to define metrics for factors that arise due to the institutional environment but they can and should be described in qualitative terms.

Regulatory constraints

For example, an economic regulator will exert an influence on the charges that can be made for services provided and will restrict the rate at which these charges can be raised. The regulator may also place constraints on the operations that can be carried out or on how business is conducted that might ultimately affect performance.

Legal constraints

Labour laws may have a direct effect on the cost of employment by, for example, prescribing the contractual number of hours that should be worked each week and the minimum leave entitlement.

Government control

Performance will also be affected where the provision of ANS is shared between more than one ANSP. Performance might be good if the providers are in direct competition and cost is driven down. Similarly, performance might be reduced when there are non-commercial objectives that an ANSP is obliged to follow (e.g. when an ANSP is forced by a Government to provide services in the least attractive areas where, for example, traffic is lighter).

6.2 OPERATIONAL ENVIRONMENT

Some of the factors relating to the operational environment are straightforward to measure whereas others, such as airspace complexity, are more difficult. They are discussed below.

Size of airspace

Both the area and volume of airspace controlled are important factors. Area is generally straightforward to measure, although it may not be the same at all flight levels. Volume is more difficult. It could be computed as the sum of the areas controlled at each flight level.

When ANSPs provide Oceanic ANS, oceanic airspace should be measured and handled separately as the density of traffic and the handling constraints are different from en-route airspace.

Demand variability

Demand variability is a measure of how traffic volume fluctuates during a day (peak/off-peak), during a week (weekday/weekend) and during a year (seasonality). High variability may make it difficult for ANSPs to provide resources efficiently. It may be difficult to roster for flat demand if the demand period is not a multiple of an ATCOs duty period.

Demand variability could be measured by the standard deviation of hourly demand during a day, daily demand during a week and weekly demand during a year. Alternatively, an indication could be provided of the average, maximum and minimum hourly demands.

Complexity

The complexity of the airspace controlled by an ANSP can vary considerably. Complexity has a major impact on performance but is difficult to measure because it is multidimensional. Important components of airspace complexity are the traffic volume at a particular time (density), the number of climbing and descending flights, the number of crossing flights, and the number of overtaking flights. Some aspects of complexity are influenced by the number and location of airports. Other aspects are influenced by military traffic and its special requirements, particularly for ANSPs with civil/military integration. Other relevant elements are traffic flows and peaks (see demand variability above), traffic mix (see below), the airspace organisation (route network), and the transition from a radar environment to a non-radar environment.

The level of complexity will affect ATCO workload, which increases at a higher rate than the rate of increase in traffic. Clearly, the density of traffic and the complexity of the sector that is being controlled are significant components in the number of flights that a single ATCO can handle. It will therefore be important to take these factors into account in an appropriate way when assessing cost-effectiveness and productivity KPIs.

For terminal services, the number of airports controlled by a single operational unit and the configuration of the runways will be important in the measurement of complexity.

Nature of traffic/Traffic mix

Traffic mix is relevant when a sector is frequently used by aircraft travelling at different speeds. Sometimes these aircraft will be separated on different flight levels so as to avoid a significant number of overtaking manoeuvres.

Scope of services

It is important to understand the extent of the scope of services provided by an ANSP as this can affect cost-effectiveness and productivity KPIs. A limited range of services might reduce the scope to share joint costs (overhead, fixed assets, etc.). For example, the provision of both en-route and terminal ANS across several facilities may allow for a greater exploitation of economies of scope. Conversely, some ANSPs provide SAR services, for which there is an associated cost but not necessarily a well identified measure of capacity or output.

Account should also be taken of the regulatory tasks (and associated costs) performed to a greater or lesser extent by the ANSP.

Having a list of all the different services provided by an ANSP for which in-house or outsourced resources are required will assist performance assessment.

7. MEASUREMENT DIFFICULTIES

A difficulty arises in performance measurement when one State or ANSP contracts out part of its services to another State or ANSP. For example, around 20% of the business of Skyguide is carried out in French airspace for which it receives payment from France under a fixed contract. The total cost of the services provided by Skyguide includes the cost of controlling the area of French airspace, but the CRCO charging mechanism operates on a state by state basis and the kilometres measured by the CRCO in collecting revenue for Skyguide will only include those flown over Switzerland. There is, therefore, an inconsistency between the basis on which costs are incurred and the basis on which revenue is received.

A similar situation exists for Maastricht UAC which controls traffic in part of the upper airspace over Belgium, the Netherlands and Germany. Revenue arising from this traffic is collected by the CRCO and distributed to the three States.

When a significant part of a state's airspace is delegated, care will need to be taken to be consistent in the computation of KPIs. For example, when computing productivity indicators it will be important to relate the resources used to the relevant measures of output produced by these resources.

A second difficulty arises when the control of civil and military OAT traffic is fully integrated within one ANSP and separated out in another. To be consistent, military traffic should be separated out in both the input and output measures (from an en-route charges point of view, military GAT is usually treated as a civil flight). The cost of providing services for military OAT traffic could be higher than for civil traffic and may be difficult to break out on a consistent basis. This should be taken into account by an exogenous factor when comparing ANSPs that provide purely civil services with those that provide an integrated civil/military service.

A third difficulty arises when one ANSP provides a service using in-house resources and another contracts the service in from a third party. The provision of such a service will be included in the charges recovered from users and so, to be consistent, the cost of providing the service should be included as part of the input cost.

ANSPs do not necessarily offer the same range or the same level of services and this will affect the total cost of service provision. Comparisons between ANSPs can be meaningful only if the same services are taken as a basis for all providers. It is intended at a later stage of the project to break costs down by individual service categories which are yet to be decided. In the meantime, it could be envisaged that the focus would be put on costs associated with the provision of ATM/CNS (i.e. omitting MET, AIS & SAR and EUROCONTROL costs).

8. METRICS FOR COST EFFECTIVENESS AND PRODUCTIVITY KPIS

Figure 3 examines the performance framework in greater depth by focussing on those parts of the framework (shown in rectangular boxes and discussed in this chapter) where metrics are required to measure performance. Categories of indicators are shown by the arrows linking the boxes and are discussed in Chapter 9.

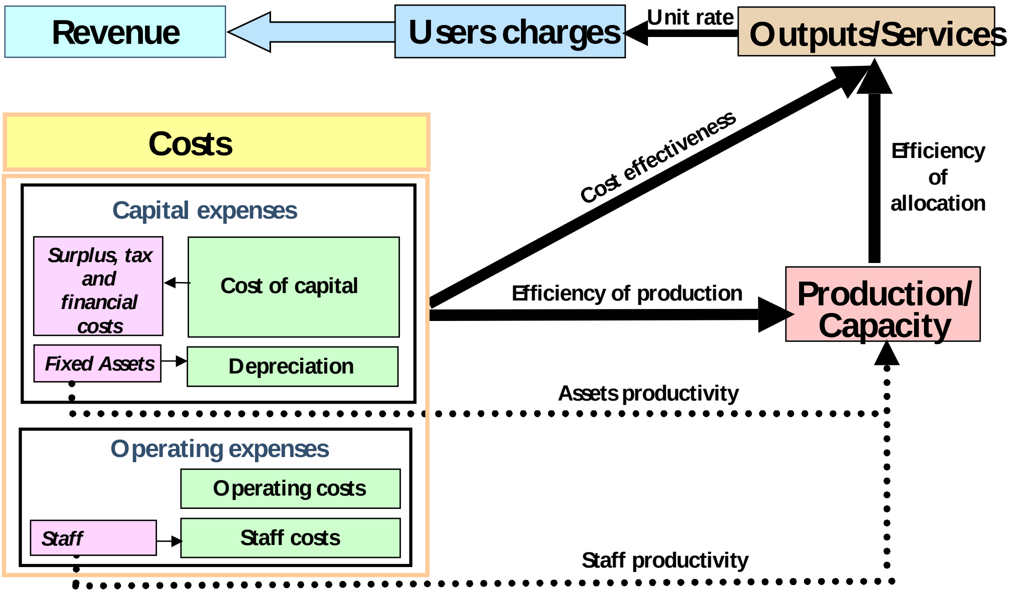


Figure 3: Metrics for Cost Effectiveness and Productivity KPIs

Once defined, the metrics can be combined in different ways to produce performance indicators. For example, an indicator for cost effectiveness would be a metric that measured cost divided by a metric that measured output.

Although depreciation might appear as an operating expense in an organisation's profit and loss account, it has been decided to treat it as a capital expense for performance measurement purposes. This is because depreciation is related to capital expenditure and its treatment may vary from state to state.

8.1 INPUTS

Inputs can be broadly defined to cover staff (human capital); land, buildings, systems, machinery and equipment (physical capital, shown as fixed assets in Figure 3); and electricity, fuel, etc. (raw materials and energy).

As ANS provision is mainly a labour and capital intensive activity there is a need to focus on the first two categories of input (i.e. staff and physical capital).

8.1.1 Staff

From an economic point of view, the input of human effort and skills is called labour.

Number of Staff

The number of staff and the breakdown of staff categories will be key to the development of relevant productivity KPIs. For pragmatic reasons, it was decided to co-ordinate the staff categories used with CANSO and these are shown in the following table. In all cases the number of "full-time equivalent" (FTE) staff should be used. Definitions related to the staff categories and the counting of staff are provided in a Glossary of Definitions at the end of the working paper.

STAFF (FTE)	En-route ANS	Terminal ANS	Other	Total
ATCOs:				
ATCOs in OPS				= ∑
ATCOs on other duties				= ∑
ATCO trainees:				
Ab initio trainees				= ∑
OJT trainees				= ∑
Other staff:				
Air traffic control assistants				= ∑
Technical support staff (e.g. technicians, engineers, R&D)				= ∑
Administration				= ∑
Other				= ∑

Whenever possible, staff should be split between en-route, terminal and other categories. For some ANSPs a large part of the theoretical training is general to both en-route and terminal ANS and an *ab initio* trainee does not specialise in one or the other until the later stages of training. In this case, and before specialisation, an *ab initio* trainee should be accounted for in the "Total" column only.

The "Other" column should be used for staff who do not fall into en-route or terminal ANS.

ATCOs working in an Area Control Unit (ACC) should be assigned to the en-route column and ATCOs working in a Tower Control Unit (TWR) should be assigned to the terminal column. ATCOs working in an Approach Control Unit (APP) could be assigned to either the en-route column or the terminal column, depending on where approach services are located and the way in which the cost and operational data has been collected. Data consistency should be maintained throughout and an ANSP should state in which column approach services have been assigned. Definitions of the three types of control unit are provided in the Glossary.

Ideally, the number of FTE staff counted in each category for the year should be a weighted average of the monthly counts for that year. However, if this information is not available, an acceptable substitute would be a simple average of the number of FTE staff at the start and end of the year.

The computation of labour productivity indicators will be influenced by the extent of staff outsourcing that might occur for certain staff categories. Indeed, in some cases outsourcing may be used as an alternative to employing staff on the payroll. In order to capture such a feature, a breakdown of total staff numbers is required, as shown in the table below.

STAFF NUMBERS (FTE)	En-route ANS	Terminal ANS	Other	Total
Total staff on payroll				= ∑
Total external staff under contract				= ∑

The breakdown should be consistent with staff costs (see the discussion in Section 8.2.1 on staff costs). Total external staff under contract should not include those working on special projects (such as consultants undertaking short-term assignments) whose costs will normally appear as operating costs.

Because ATCOs are, in principle, employed directly by an ANSP, the outsourcing of staff will have no implications on the computed value of ATCO productivity.

Hours worked

The number of hours worked is a better measure of staff input than a count of the number of staff employed since it takes into account the different employment practices used by ANSPs. Contractual working hours (see Glossary) will vary from state to state as they are usually dictated by national labour laws.

Of particular interest as an input metric for ATCO productivity is the number of hours an ATCO in OPS spends **on duty** in OPS, including any overtime worked. An ATCO productivity indicator based on this metric (e.g. number of movements controlled per hour on duty in OPS) will allow a better comparison to be made between ANSPs than an indicator based on the number of ATCOs in OPS (e.g. number of movements controlled per FTE ATCO in OPS).

The relationship between the different classifications of ATCO working hours is shown in Figure 4.

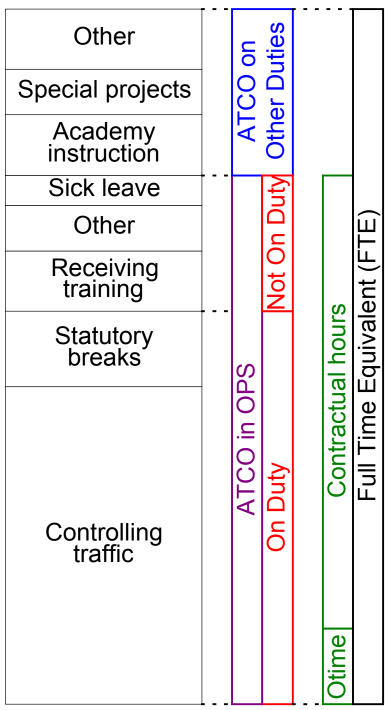


Figure 4: ATCO Hours Worked Per Annum

The required information on **hours on duty in OPS** could be captured in several ways: it could be available from a time recording system if an ATCO clocks in at the start of a duty period and clocks out at the end of a duty period; it could be computed from the roster plan; or it could be calculated by adding the average overtime worked in OPS to the contractual working hours and subtracting the average time an ATCO is not on duty in OPS (See Glossary).

An ATCO giving on-the-job training instruction in the OPS room should be considered as being on duty in OPS since an output is being produced.

8.1.2 Physical Capital

The physical capital of an organisation consists of **tangible fixed assets (**land, buildings, systems, machinery and equipment) and **intangible fixed assets** (software, etc.). The physical capital combined with human capital and other inputs will generate a certain amount of capacity/production.

Fixed assets are permanent in nature and are generally held for a period of more than one year (see Section 8.3.1 on depreciation and amortisation costs). They are resources from which future economic benefits are expected to flow over a number of years to the ANSP that owns or controls them.

Assets can be valued in two ways: at their year end historic cost (i.e. monetary value at the time of purchase less accumulated depreciation) or at their year end current cost (i.e. monetary value in present day terms). Historic values are easier to compute and should be used by all ANSPs.

Some fixed assets are en-route ANS specific (e.g. an ACC OPS room) and some are terminal ANS specific (e.g. ILS). Others are used jointly for the different phases of a flight. The gross book value of assets is usually known because it is used in the computation of depreciation costs. The CRCO charging system forces ANSPs to identify depreciation costs for en-route services, and it is normal practice to allocate individual assets to different activities, including en-route and terminal ANS, by means of cost centres and repartition keys. Hence, it should be possible to establish both depreciation costs and (net) asset values for each type of service.

Although ANSPs are obliged to allocate all their costs to different services according to EUROCONTROL Principles in the calculation of unit rates, some providers believe that it would be difficult, in the short term, to split their fixed assets in this way. Nevertheless, until this split is made, assets could be allocated to services by using depreciation costs as the allocation key.

Asset productivity should relate **fixed assets in operation** with the capacity/production generated for each activity. Clearly, **fixed assets under construction** are, by definition, not yet part of the production process. To provide a meaningful indicator of asset productivity it will be necessary to split fixed assets between those in operation and those under construction as shown in the following table.

FIXED ASSETS	**En-route ANS**	**Terminal ANS**	**Other**	**Total**
Fixed assets in operation: Land & buildings Systems & equipment				= ∑
Fixed assets under construction: Land & buildings Systems & equipment				= ∑
Total fixed assets	= ∑	= ∑	= ∑	= ∑

Asset productivity will be distorted if a significant part of the asset value does not appear in the balance sheet because the assets are leased or owned by another organisation such as an airport. In this case, the value of the fixed assets in operation contributing to the capacity produced will be understated. Accounting convention is often to capitalise assets held under financial leases as tangible fixed assets and to depreciate them over the term of the lease. The issue of leased assets will be addressed later but, in the meantime, ANSPs should provide a description of those assets that are owned and those that are leased.

8.2 OPERATING EXPENSES

As indicated in Figure 3, operating expenses comprise staff costs and operating costs.

8.2.1 Staff Costs

Staff costs should be considered in relation to Section 8.1.1 on Staff.

On average, staff costs account for around 55% of the total en-route costs in the EUROCONTROL states. This indicates that provision of the service is labour intensive.

A useful breakdown of staff costs is to split out gross wages and salaries from state social security scheme contributions, employers' pension contributions and other benefits.

A further useful breakdown is to split staff costs into the staff categories shown in the first table of Section 8.1.1. A particular short-term need is to be able to identify the employment costs of ATCOs in OPS.

When staff are outsourced, their costs may appear as a direct operating cost rather than as a staff cost. In this case, it is expected that the outsourced staff will not be included in the number on the staff payroll. The magnitude of the number of outsourced staff might have an impact on the value of an overall staff productivity KPI, and special caution will be needed in this area (see also Sections 8.1.1 and 8.2.2). It could be envisaged that both the cost and number of external (outsourced) staff might be identified and added to the (internal) staff cost and total number of (internal) staff.

Since ATCOs are normally employees of the ANSP, a cost-effectiveness or productivity KPI focused only on ATCOs should not be distorted by outsourced staff.

8.2.2 Operating Costs

On average, operating costs account for approximately 25% of the total en-route costs in the EUROCONTROL states.

An interesting breakdown of operating costs distinguishes between **direct operating costs**[3] for the purchase of goods (e.g. raw materials, energy, small furniture equipment, etc.) and services (e.g. outsourced staff, IT, communications, maintenance, insurance, etc.), and other operating costs that are **institutional costs or transfers**. Costs falling into the latter category include the costs of any service contracted in where there is little scope for negotiation (such as payment for MET, payment to national governments in respect of services provided (e.g. regulation activities), EUROCONTROL costs, and payment for delegation of ANS, etc.). Such a breakdown would not be used directly to derive KPIs related to cost-effectiveness and productivity, but would ensure a better understanding of the different cost items/drivers of ANS, as well as improving the consistency of reporting information between ANSPs.

The information could be captured by the following table.

[3] In the sense that they are directly controllable by the ANSP.

OPERATING COSTS	En-route ANS	Terminal ANS	Other	Total
Direct operating costs				= ∑

Institutional costs or transfers:
• Payment for outsourced MET
• Payment to national government for provision of services
• Payment of EUROCONTROL cost
• Payment for delegation of ANS
  • to other ANSPs/States
  • for Maastricht / CEATS costs
		xxxxxxxx
		xxxxxxxx
			xxxxxxxx
			xxxxxxxx
				= ∑

Total operating costs	= ∑	= ∑	= ∑	= ∑

8.3 CAPITAL EXPENSES

As indicated in Figure 3, **capital expenses** comprise depreciation & amortisation costs and the cost of capital.

It is important to note the distinction between **capital expenses** and **capital expenditure**. Capital expenditure corresponds to capital investment in order to maintain or increase the amount of productive assets.

8.3.1 Depreciation & Amortisation Costs

Each tangible and intangible fixed asset of an ANSP (see Section 8.1.2) generates depreciation (and amortisation) that is spread over the life of the asset.

Depreciation costs are computed only on the fixed assets in operation. The interest payable on fixed assets under construction is normally accumulated as capital until the asset is put into operation when the purchase price of the asset together with any accumulated interest (i.e. its **gross book value**) is depreciated in the normal way.

Net book value is the gross book value less the accumulated depreciation. The ratio *Net book value / Gross book value* provides an indication of the age of the assets. Similarly the ratio *Net book value* / *Depreciation* provides an indication of the remaining asset life.

The net book value of the fixed assets in operation should be used in the computation of a KPI related to asset productivity (see also Section 8.1.2 on Physical Capital).

8.3.2 The Cost of Capital: The Return on Fixed Assets and Working Capital

The full cost-recovery mechanism makes provision for ANSPs to generate sufficient revenues to cover costs or payments related to the assets employed by an organisation[4].

These assets, consisting of **fixed assets** (in operation and under construction) and **working capital** (current assets less current liabilities) constitute the **asset base** of an organisation and are financed by the capital employed, consisting of long-term debt and equity. The capital employed also finances any long term interest-bearing investments unrelated to ANS

[4] This is at least the case for en-route ANS.

provision (such as a pension fund provision). However a rate of return is only allowed on the part of capital employed related to the asset base, since long-term interest-bearing investments should not be additionally remunerated. This financial return is called the return on the asset base or cost of capital.

		En-route ANS	Terminal ANS	Other	Total
ASSET BASE	Total fixed assets Working capital				
CAPITAL EMPLOYED	Equity (share capital & reserves) Long term debt				

The ratio *Return on Asset Base / Asset Base* will indicate the effective (pre-interest and pre-tax) **rate of return** of an ANSP's asset base. It is independent of how an ANSP is financed and therefore makes comparisons more relevant.

The rate of return that is applied will differ from state to state and should be related to the normal market rate for investments with low financial risk. The achievement of a fair return on the asset base is normal practice in any organisation and provides a surplus that can be added to existing reserves. These reserves can then be used for future investment. An organisation that is operating in a competitive market will attempt to maximise this return for the benefit of its shareholders (in reward for the opportunity costs of the capital plus the risk premium). However, in a monopoly situation with very limited business risk (full-cost recovery), the rate of return on the asset base should be considered to be reasonable by all stakeholders. Too high a rate of return will mean that users are paying too much for the service, and too low a rate of return will mean that the organisation is starved of investment capital. An indicator is required to measure the degree of this "reasonableness". Such an indicator could be used to monitor an organisation's "reasonableness" over time.

The rate of return on the asset base can be broken down into two elements as follows:

Rate of return on the asset base

= Return on the asset base / Asset base

= (Return on asset base / Total revenues) × (Total revenues / Asset base)

= **Rate of return on revenues × Asset base turnover**

Both the rate of return on revenues and the asset base turnover are useful ratios. The rate of return on revenues could be used as a measure of 'reasonableness'.

Depending on each ANSP, the return on the asset base will be used to cover:

1. **Financial costs paid on debt capital (i.e. interests charges)**: These costs will mainly depend on how an ANSP's capital is financed (structure of capital). If an ANSP is 100% debt financed, then its financial costs will be greater but this doesn't necessarily mean that it is a bad performer. The financial costs might vary from State to State because of different nominal interest rates that are charged on long-term debt. Interest charges reduce an ANSP's cash flow (i.e. they constitute a payment outside the organisation).

2. **Tax on operating earnings**: Some ANSPs might pay taxes to the government on operating earnings. Payment of such taxes should not imply that the ANSP is less cost-effective than another ANSP which does not have to pay taxes. Tax payments also reduce an ANSP's cash flow.

3. **The return on own capital invested (equity[5])**: This return, which is calculated from the earnings after interest and tax have been paid, will remunerate the owner of the organisation (either the government or private shareholders) and/or contribute to a surplus to be added to the reserves. While financial costs and taxes constitute a payment outside the organisation, the extent to which the return on own capital invested will remain within the organisation, i.e. it will stay within the ANS sector, will depend on the dividend policy of each ANSP.

8.4 REVENUES

8.4.1 En-route

Figure 5 illustrate the different sources of en-route revenues.

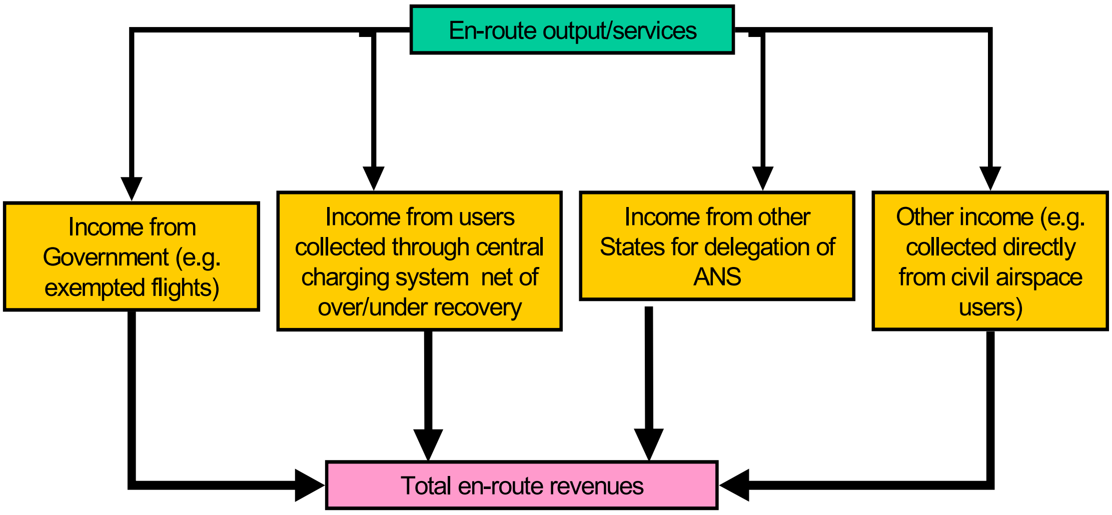


Figure 5: Different Sources of En-route Revenues

User charges, which are the main source of en-route revenues, are collected by the CRCO on a State by State basis. The unit rate is calculated from the cost of services for which each State is responsible by virtue of the ICAO Regional Air Navigation Agreements and the forecast number of chargeable units in a year. Included are all the providers of air navigation facilities and services whose costs are included in the cost base for a State. Revenue received by a State also includes a EUROCONTROL charge which covers the cost of providing essential services such as traffic flow management and traffic forecasting. For the States where the EUROCONTROL charge also covers the costs associated with Maastricht UAC and CEATS, it will be important to have consistent measures of costs/revenues and output/services at both the State level and the ANSP level.

Most ANSPs operate on the basis of full cost recovery, and any over/under recovery is carried forward to the following years. It follows that the amount billed in a particular year is affected by the over/under recovery from previous years. This over/under recovery is more a measure of forecasting accuracy than value for money of the services provided and, in order to have a consistent approach, the income disclosed should be the revenue net of any adjustment for over/under recovery.

[5] Comprising share capital and reserves.

Not all ANSPs are permitted to carry forward any over/under recovery. In the case of the UK, the UKCAA Regulator sets a maximum level for UK en-route charges based on an RPI – X% regime. The regime covers a 5-year period and the carry forward of over or under recovery is not applicable.

The user charges collected by means of the Route Charges System may not cover all the costs incurred by an ANSP with respect to its en-route output, since the ANSP may also collect revenue from other sources. For example, the national government may make a payment for exempted flights, and the government of another State may make a payment for the provision of ANS that it has delegated to the ANSP. Finally, in some other cases, an ANSP might directly collect income from airspace users (e.g. some VFR flights).

8.4.2 Terminal

The collection of revenues for terminal services operates in a similar way to that for en-route services. However, in most cases the majority of revenues are collected by individual States and ANSPs instead of the CRCO. No common formula is used to determine the revenue that will be collected for a particular flight and each State and ANSP has its own method of establishing what the charging rate should be based on the formula that it uses. In addition, some States apply differential charging rates for different airports and give discounts to certain types of flights or aircraft sizes. As a consequence, there is considerably less harmonisation of charging mechanisms for terminal services than is the case for en-route.

8.4.3 Other Revenues

Revenues may also arise for services supplied to airspace users that are not linked to the cost of providing en-route and terminal services. Income may be received from the military for the handling of OAT flights, from civil airspace users for the provision of services such as Oceanic ANS, and from domestic government.

8.5 OUTPUTS/SERVICES

Several metrics could be used to measure outputs. They are:

- Number of flights controlled;
- Number of ACC movements;
- Flight hours controlled;
- Kilometres controlled; and
- Number of service units

Any metric used should be compatible with the definition of the cost incurred in producing the output. Different types of service may require different metrics and these will be explored below.

Definitions related to traffic metrics are provided in the Glossary.

8.5.1 En-route

The **number of flights controlled** is one of the simplest and most frequently used measures. However, while it is suitable for following the trend of a single organisation through time, it does not take into account the size of the airspace controlled and therefore cannot be considered as an adequate measure of en-route ATS services when comparing organisations of different sizes. It also has the disadvantage of not being additive (i.e. the number of flights passing through a group of ACCs is not equal to the sum of flights passing through each ACC).

The **number of ACC movements** counts a flight passing though two ACCs as two movements. It has the merit of being readily available and takes into account to some extent the size of the organisation. It could, however, be influenced by changes in the ACC configuration. A reduction in the number of ACCs would result in an apparent reduction in the output.

The **flight hours controlled** is a good candidate since, from a provider's point of view, an aircraft consumes resources for the whole of the time it spends in en-route airspace.

Kilometres controlled is also a good candidate. Different ways of measuring the distance are possible. The distance could be defined as the great circle distance between the entry and exit points, as the distance along the flight plan, or as the actual distance flown. All these distances are relevant and will be useful in deriving measures of flight efficiency. However, the difference between them is generally small (a few %) and any of them could be used as a measure of output as long as it is done in a consistent way. The great circle distance is probably a better measure of the production of ATS seen from the perspective of users of the system. While km-controlled reflects the size of the airspace involved, it does not take into account the nature and characteristics of that airspace (i.e. its complexity), which will influence the value taken by any indicator using the metric. It also has the disadvantage of not being fully additive (i.e. the great circle distance computed for a group of ACCs, is not strictly equal to the sum of the great circle distances within each ACC).

A **service unit** is less useful when looking at cost effectiveness from an ANSP's point of view since it is calculated from a formula that uses a combination of distance flown and maximum take-off weight (MTOW), and MTOW is related to the ability to pay rather than to the cost of providing the services. However, it is the unit by which an airspace user pays for the service provided, so a comparison of the differences between the unit rates of different providers and the trend in the unit rate for a single provider will be of interest to a user. The service unit is used by the CRCO and is already discussed with airspace users in bilateral meetings.

Data is currently being collected on all of these metrics: the number of aircraft movements is collected by the CFMU; the number of minutes a flight spends in a sector is collected by each ANSP; and the kilometres flown is calculated by the CRCO using the great circle distance between the entry and exit points of the most recent flight plan filed.

In conclusion, ***flight hours controlled*** (not including airborne delay) and ***kilometres controlled*** appear to be the two best options for the measurement of en-route ANS output. They are obviously highly correlated, the relationship between the two depending on the average speed of the aircraft controlled.

8.5.2 Terminal

The volume of traffic controlled in the vicinity of an airport will be limited to the number of landings and take-offs that the airport can handle. Both IFR and VFR flights consume runway capacity and contribute to ATCO workload, so both should be counted. However, there are several difficulties associated with VFR flights: there is no harmonised and comprehensive view in EUROCONTROL member states on their number, the workload associated with IFR and VFR flights might be different, and the relationship between workload and the number of VFR flights handled is not straightforward since VFR flights vary in their complexity (e.g. training flights). These issues are not well understood at present and will be considered later.

For the time being, the best metric to use for terminal ANS output is ***total IFR movements***. When the difficulties outlined above have been resolved, the metric should be complemented by ***total VFR movements***.

A large element of the cost of providing ANS at an airport is fixed and is more dependent on the hours that an airport is open than the number of flights handled. Airports handling a small number of flights will therefore bear a much larger proportion of the fixed cost per flight than airports handling a large number of flights. Comparisons of cost effectiveness between airports would therefore be more meaningful if airports were classified according to the volume of traffic handled. Suitable definitions would be required for such a classification system. It should be noted that airport classification is already used by some states. For example, Italy uses four different airport categories depending on the nature and volume of the traffic.

A secondary indicator could be the ***number of airports controlled by an ANSP***. Again, cost effectiveness will be influenced by the mix of airport sizes for which ANS are provided and an airport classification system would make comparisons more meaningful.

When terminal ANS includes the handling of aircraft between en-route and final approach (see Section 8.1.1), the volume of traffic that can be controlled will be constrained by the sector configuration. It is, therefore, more akin to en-route control than final approach. Nevertheless, to maintain consistency, movements should still be used.

8.6 PRODUCTION/CAPACITY

8.6.1 En-route

Capacity is difficult to measure although the relationship between capacity and delay is understood from the use of simulation technology. The capacity that is available at any one time is related to the number of sectors that are open. It will also be affected by the maximum number of flights that can be handled in a sector and the efficiency with which sectorisation has been carried out.

As the traffic builds up during a day, an ACC will open more and more sectors to match the capacity provided with the volume of traffic expected. Similarly sector positions will be closed as the traffic falls off towards the end of a day. The **sector hours** (see Glossary) provided by an ACC over a fixed period of time is, therefore, an indication of the volume of capacity available. Since costs will be disclosed on an annual basis, capacity volume should ideally be measured over a year also.

The greatest capacity is available when the maximum number of sectors are open. Therefore, the number of en-route sectors at maximum configuration is an indication of the peak (instantaneous) capacity that is provided. This is referred to as the **number of sectors** (see Glossary).

Capacity increases according to the law of diminishing returns. As sectors are opened the average sector transit time reduces and more sectors are crossed per flight. Thus the co-ordination workload becomes greater and eventually becomes so great that opening an additional sector would provide no additional capacity benefit.

Capacity should ideally be defined in terms of **flight hours controllable**, as this measure would take into account the different factors affecting capacity. If compared with the flight hours actually controlled, it could provide a useful indication of capacity utilisation. Further work will be needed to develop a metric that measures flight hours controllable.

If simplicity is to be maintained, the most appropriate metric to measure capacity is ***sector hours***. An alternative would be to use ***number of sectors***, although cost could be expected to vary with the number of hours that the number of sectors was maintained.

8.6.2 Terminal

At a facility level, proxies for terminal capacity when related to a particular airport tower include the **peak capacity available** and the **number of hours per day that an airport is kept open**. The former will be affected by the traffic mix and there is a complex relationship between the two. The latter is only meaningful if services are provided to a single airport, in which case it would allow the marginal cost of extending the opening hours of an airport to be determined. Neither of these metrics is suitable at an ANSP level, and further work is necessary to define an appropriate ANSP production metric.

The measurement of terminal capacity is a complex subject and further work is needed. This work is outside the current scope of the KPIDG.

9. CATEGORIES OF INDICATORS

9.1 COST EFFECTIVENESS

Cost effectiveness is a measure of the total cost of providing a service per unit of output provided.

As indicated in Figure 3, the total cost can be split into **operating expenses** and **capital expenses**. As well as looking at total cost effectiveness, it is also interesting to look at cost effectiveness and the efficiency of production in relation to the operating expenses component of total cost. Reasons are that:

- On average, operating expenses account for around 80% of the total en-route costs in the EUROCONTROL states and are not affected by potentially differing accounting practices for depreciation, the treatment of tax and return on capital employed, which might vary greatly between ANSPs/States.

- Capital expenses are linked to the investment cycle and have little direct relationship with the current level of output or the current level of capacity. Significant fluctuations can be expected across time.

- Once an investment has been made there is little scope for altering capital expenses on a year by year basis whereas expenditure on operating expenses is more flexible and could be impacted relatively quickly by, for example, the introduction of a cost reduction programme.

Care is necessary when considering cost effectiveness in relation to operating expenses since, to some extent, the cost structures of ANSPs will vary depending on how they finance their facilities (buildings, equipment, etc). If an ANSP owns its facilities, the financing costs will be picked up as depreciation and the cost of capital, both of which are capital expenses[6]. However, if an ANSP leases part of their facilities, the financing costs will be picked up in the lease payments and might be treated as an operating expense.

[6] It should be noted that maintenance, which is normally treated as an operating cost, may be capitalised in big projects. It will then increase the value of fixed assets on which financing costs are paid.

The treatment of leasing costs as an operating or capital expense is not expected to be a big issue in en-route services, although it might be for terminal services if, for example, all the assets used in terminal control were owned by an airport.

If the treatment of leasing costs is likely to lead to a significant distortion in the compilation of a cost effectiveness indicator then it ought to be possible to identify them separately and treat them as a capital expense. To be consistent one would also need to add the value of the leased asset to the value of the capital employed.

Suggested indicators are presented in Table 1. In this and the following tables the metrics used in the indicator should be consistent with the column heading.

COST EFFECTIVENESS	En-route ANS	Terminal ANS	Other	Gate-to-gate
Total cost / Km controlled (or flight hours)	✓			✓
Operating expenses / Km controlled (or flight hours)	✓			✓
Total terminal cost / Total airport movements		✓		
Terminal operating expenses / Total airport movements		✓		

Table 1: KPIs for Cost Effectiveness

Table 1 proposes two high level KPIs for en-route ANS and two KPIs for terminal ANS. Because it is important to keep a gate-to-gate perspective, the last column of Table 1 proposes two KPIs for the sum of en-route and terminal ANS. Both of these indicators use km controlled (the en-route output measure) rather than movements (the terminal output measure) as the output measure for gate-to-gate. This is because there can be large variations between the km controlled in an en-route movement, whereas there is little variation in the km controlled in a terminal movement if stacking is excluded. It would be possible to construct an index for gate-to-gate output that included km controlled and movements with appropriate weighting factors. However, the benefit and construction of such an index will not be considered for the time being.

Because the boundaries used between en-route and terminal services vary between ANSPs, a cost effectiveness indicator for a particular ANSP might be high for en-route and low for terminal (or vice versa) when compared with other ANSPs. This effect will disappear in a gate-to-gate indicator that uses total km controlled.

9.2 EFFICIENCY

9.2.1 Efficiency of Production

The **efficiency of production** is a measure of the cost per unit of capacity. It is an indicator of how efficiently a provider converts operating expenses and capital expenses into the production of capacity.

Suggested indicators are presented in Table 2.

EFFICIENCY OF PRODUCTION	En-route ANS	Terminal ANS	Other	Gate-to-gate
Total cost / Sector hours (or Number of sectors)	✓			
Operating expenses / Sector hours (or Number of sectors)	✓			
Total cost (or operating expenses) / Flight hours controllable	✓			

Table 2: KPIs for Efficiency of Production

As flight hours controllable is a metric that is not readily available for en-route ANS, the focus should be on sector hours. Therefore, for the time being, indicators will be produced for en-route services only. Further work is necessary to define indicators for terminal ANS.

9.2.2 Efficiency of Allocation

The **efficiency of allocation** is concerned with how efficiently the available capacity has been allocated to match the demand. An efficient ANSP will allocate the right amount of capacity at the right time to service the volume of traffic that wishes to pass through the airspace that it controls.

A suggested indicator is presented in Table 3:

EFFICIENCY OF ALLOCATION	En-route ANS	Terminal ANS	Other	Gate-to-gate
Flight hours controlled / Flight hours controllable	✓			

Table 3: KPIs for Efficiency of Allocation

Flight hours controllable is a metric that is not readily available for en-route ANS, and no alternative KPI exists that is straightforward to calculate. No indicator can therefore be derived at present for the efficiency of allocation. Further work is also necessary to define an indicator for terminal ANS.

9.3 PRODUCTIVITY

9.3.1 Staff Productivity

Staff productivity is a measure of the capacity provided or production output per staff member employed or per hours worked.

Suggested indicators are in Table 4:

STAFF PRODUCTIVITY	En-route ANS	Terminal ANS	Other	Gate-to-gate
Total ATCOs hours on duty in OPS / Number of ATCOs in OPS	✓	✓		✓
Sector hours / Number of en-route ATCOs in OPS[7]	✓			
Total airport movements / Number of terminal ATCOs in OPS		✓		
Flight hours controlled[8] / Number of ATCOs in OPS	✓			✓

Table 4: KPIs for Staff Productivity

The first indicator shows the average hours on duty in OPS per "ATCO in OPS". It is not a productivity indicator per se, but it can be a valuable explanatory factor for productivity.

Staff productivity KPIs for en-route ANS are directly derived from the aggregation of the various ACCs' operational units. Providing this data at an ACC level rather than in aggregated form would be informative for airspace users and would allow a richer analysis to be undertaken. Comparisons could then be made between ACCs with similar characteristics (in terms of complexity, density, size of controlled airspace, etc.) and the evolution over time of staff productivity at an ACC could be considered.

9.3.2 Asset Productivity

Asset productivity is a measure of the capacity provided per unit value of the fixed asset base. It is an indicator of the use that is being made of the capital invested in tangible and intangible assets.

When assets are leased rather than bought, comparisons between ANSPs can only be made if asset value also includes the value of the leased assets. This is discussed in Section 9.1.

Suggested indicators are presented in Table 5:

ASSET PRODUCTIVITY	En-route ANS	Terminal ANS	Other	Gate-to-gate
Sector hours (or number of sectors) / NBV fixed assets in operation	✓			
Km controlled (or Flight hours controlled[9]) / NBV fixed assets in operation	✓			✓
Number of movements / NBV fixed assets in operation		✓		

Table 5: KPIs for Asset Productivity

[7] Alternatively, we could have: **the number of ATCOs in OPS / average number of sectors open**, where the average number of sectors open is equal to the sector hours divided by 8760 (i.e. the number of hours in a year).

[8] *Flight hours controllable* could also be used when available.

[9] *Flight hours controllable* could also be used when available.

9.3.3 Multi-factor Productivity

A measure of performance would be easier to interpret if different outputs and different inputs could be added together to provide a single measure of output per unit of input.

Focussing on measures of partial factor productivity (labour productivity or asset productivity) in isolation might be misleading. For example, an ANSP might have above average staff productivity (see Section 9.3.1) because of its greater overall efficiency compared with other ANSPs, but it could also be due to the higher deployment of capital. Similarly, an ANSP might have above average asset productivity (see Section 9.3.2) because of its greater overall efficiency, but it could also be due to higher staff numbers. It is therefore important to take both labour and capital inputs into account when examining productivity differences between ANSPs.

Multi-factor productivity (also known as Total Factor Productivity) is the ratio of output to the combined inputs of labour and capital (assets) and hence relates outputs to both labour and capital inputs. As a result, MFP provides insights on whether labour productivity gains are driven principally by: a) genuine labour productivity growth (better management, better motivation/effort, better knowledge, etc); or b) capital investments.

As well as using MFP to compare ANSPs, trends over time for individual ANSPs could also be identified. In the short term, this approach could be used to overcome the problem of how to treat capital across countries. However, in the medium to long term, harmonisation of accounting standards combined with full information disclosure should enable direct comparisons to be made. Direct comparisons are potentially very valuable to ANSPs, as they give insight into how inputs are mixed to maximise outputs.

To compile an indicator for MFP, labour and capital would be combined into a single measure of total input, with the aggregation weights determined from the contribution of each type of input to total costs. Further work is necessary to develop such an indicator.

9.4 OTHER INTERESTING INDICATORS

Other indicators could be constructed that would help explain differences in the KPIs between different ANSPs. Suggested indicators are presented in Table 6:

	En-route ANS	Terminal ANS	Other	Gate-to-gate
Total cost of ATCOs in OPS / Number of ATCOs in OPS	✓	✓		✓
Flight hours controlled / Sector hours	✓			
Capital expenditure (n) / NBV fixed assets (n)	✓	✓		✓
Average number of sectors open[10]	✓			

Table 6: Other Interesting Indicators

Given the number of sectors at maximum configuration, the last indicator in this table (the average number of sectors open) provides a proxy for the utilisation of capacity. It provides some indication on the amount of spare capacity in the system, but the extent to which this capacity can be used will depend on the shape of the daily traffic pattern. It might be interesting to compare this indicator with the average daily traffic divided by the peak daily

[10] This is equivalent to Sector hours / 8760.

traffic. Looking at these indicators in the context of delay will provide information on how efficiently capacity is being provided to match demand.

9.5 FORWARD LOOKING KPIS

The KPIs discussed so far deal with historic information. While it is important to assess past performance, forward-looking KPIs that are consistent with historic measurement are perhaps of even greater interest to stakeholders. There is a need, therefore, to project into the future the KPIs that have been discussed in this Chapter. This will require specific forward looking information to be provided covering the key inputs, costs, outputs and capacity for each of three years ahead. This information is summarised in Table 7.

Specific forward looking information	**En-route ANS**	**Terminal ANS**	**Other**	Gate-to-gate
Inputs				
Total number of staff	✓	✓		✓
Number of ATCOs in OPS	✓	✓		✓
NBV of assets in operation	✓	✓		✓
Costs				
Total staff cost	✓	✓		✓
Total cost of ATCOs in OPS	✓	✓		✓
Total operating expenses	✓	✓		✓
Total costs	✓	✓		✓
Capital expenditure	✓	✓		✓
Outputs				
Km controlled	✓	✓		✓
Flight hours controlled	✓			✓
Number of movements		✓		
Capacity				
Sector hours	✓			
Number of sectors	✓			

Table 7: Specific Forward Looking Information

The KPIDG recognised that some forward-looking information for terminal ANS might be sensitive.

9.6 FUTURE WORK

This working paper has been concerned with the development of KPIs at the level of an ANSP and/or State. Similar indicators can be used at an operational level (ACC, airport, etc.) and it is generally true that benchmarking is more meaningful at this level because operational units operating within a similar environment can be grouped together and compared.

ATM/CNS form the bulk of the costs and would need to be broken down further. More work is needed to derive clearer definitions of air navigation services/functions provided and to split ATM/CNS into different components (e.g. Communications, Navigation, Surveillance, MET, AIS, etc.). Eventually, it will be important to compare the cost effectiveness of these services between ANSPs, and appropriate KPIs would need to be developed depending on the nature of each type of service.

Each ANSP participating in the Validation Phase has submitted a template containing 2000 data. Further work is required to interpret and analyse this data and members of the KPIDG have expressed a willingness to share this data with each other, to become involved in the analysis and to refine the metrics where necessary. Such work, facilitated by the PRU, will be carried out in 2001/2002 with the aim to produce a first benchmarking report.

ANNEX 1: KPI DRAFTING GROUP ATTENDANCE LISTS

NAME	AFFILIATION	E-mail Address	23/4	14/5	11/6	3/7	12/9
BADSBERG Joren	ANS Denmark	joba@slv.dk	√	√			
BATISTA Joao	NAV Portugal	joao.batista@nav.pt		√	√	√	√
BERENDS Ben	KLM	ben.berernds@klm.nl		√			
BOHREN Marc R.	Skyguide	marc.bohren@skyguide.ch			√		
ENAUD Philippe	PRU	philippe.enaud@eurocontrol.be	√	√	√	√	√
GOUHOT Jean-Claude	DNA France	jean-claude.gouhot@dna.dgac.fr	√	√	√	√	√
GUTIERRES Margarida	NAV Portugal	mgutierres@nav.pt	√				
HENDRIKS Nienke	CAA, UK	hendriksn@caa.erg.co.uk			√	√	
HERLINGER Heinz	Austro control	heinz.herlinger@austrocontrol.at	√	√			
JENSEN Morten R.	CAA Denmark	moro@slv.dk	√	√	√	√	
MEDURI Valentino	ENAV	vmeduri@enav.it		√			
MEGRE PIRES Isabel	NAV Portugal	imegre@nav.pt				√	√
NERO Giovanni	PRU	giovanni.nero@eurocontrol.be	√	√	√	√	√
PAYNTER Joanna	British Airways	joanna.k.paynter@British-Airways.com	√				
PERRY John	UK NATS	john.perry@nats.co.uk	√		√		√
PINTO Ana	NAV Portugal	ana.pinto@nav.pt	√	√	√		
PRETI Francesco	PRU	francesco.preti@eurocontrol.be	√				
REYNAUD Didier	Skyguide	didier.reynaud@skyguide.ch	√	√			
ROLVINK Bert	LVNL Netherlands	l.j.n.rolvink@lvnl.nl	√	√	√	√	√
ROSE Mike	Icon Consulting	mike.rose@icon-consulting.com	√	√	√	√	√
ROSENCRANTZ Asa	Sweden CAA	asa.rosencrantz@lfv.se	√	√	√	√	√
SCHUH Bernd	DFS	bernd.schuh@dfs.de		√	√	√	
TULLETT Peter	UK NATS	peter.tullett@nats.co.uk	√	√	√	√	√
VAN GYSEGEM Frans	MUAC	frans.van-gysegem@eurocontrol.be	√	√	√		√
VERSCHUEREN Raoul	Belgocontrol	raoul_verschueren@belgocontrol.be	√	√		√	√
ZVEGUINTZOFF Nicolas	IATA	Zveguintzn@iata.org	√	√	√	√	

GLOSSARY OF DEFINITIONS

Definitions related to Staff Categories

***Ab Initio* Trainee Controller**: A selected individual, with no previous relevant qualifications, who is given basic instruction and training to enable him or her to obtain theoretical qualifications. The *ab initio* phase ends after institutional training, before entering into on-the-job training (OJT).

Air Traffic Control Assistant: An employee assigned to perform non-control functions in an ATC unit. This includes flight data assistants but excludes technical support staff.

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

> **ATCO in OPS:** 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.
>
> **ATCO on Other Duties**: An ATCO who is participating in an activity outside OPS such as special projects, teaching at a training academy, providing instruction in a simulator, working in a full time management position, etc.

Licence: An ATC licence indicates a controller's qualifications and includes a record of his competence at a particular unit together with his medical classification.

On-the-Job Training (OJT): The integration in practice of previously acquired job related routines and skills under the supervision of a qualified coach in a live traffic situation. The training enables student controllers to check out as operational controllers at a specific operational unit, and/or previously qualified ATCOs coming from another operational unit to acquire a new qualification.

Definitions related to the Counting of Staff and Working Hours

Break: The time in a shift when an individual or group of individuals is not at the workplace. This includes lunch breaks, rest breaks, and relief breaks.

Full Time Equivalent (FTE): The equivalent of a single person carrying out a particular job or activity working on a full time basis during a year. A part time employee working half time would be counted as a 0.5 FTE. A full time ATCO working two third of his time on duty in OPS and one third of his time on teaching at a training academy would be counted as a 0.67 FTE ATCO in OPS and a 0.33 FTE ATCO on Other Duties.

Hours related to ATCOs in OPS:

> **Contractual working hours**: The regular number of hours per year an ATCO in OPS is at work. It excludes public holidays and vacation entitlement. These hours are either on duty in OPS, or not on duty in OPS.
>
> **Hours on duty**: The actual number of hours spent by ATCOs in OPS on duty in OPS, including breaks and including overtime in OPS. The figure could come from direct measurement (clock-in and clock-out times), be computed from the roster plan, or be approximated from contractual working hours after subtracting the average time an

ATCO is not available in OPS (see "Hours not on duty") and adding on the average overtime worked in OPS.

Hours not on duty: The total number of hours an ATCO in OPS is not on duty in OPS (i.e. on sick leave, receiving refresher training, other). The time spent on activities outside OPS (i.e. as an ATCO on Other Duties) should not be reported here but should be computed in the consideration of FTE (e.g. an ATCO working half time on special projects should be considered as a 0.5 FTE in OPS). In the same way, time spent receiving on-the-job training should not be counted here as on-the-job trainees are not counted as ATCOs in OPS.

Overtime: The time during which a person works at a job in addition to the contractual working hours.

Definitions related to Operations

Aeronautical information service (AIS): Aeronautical information services have the objective of ensuring the flow of information necessary for the safety, regularity and efficiency of air navigation. Included are the preparation and dissemination of Aeronautical Information Publications (AIPs), Notices to Airmen (NOTAMs), Aeronautical Information Circulars (AICs) and other relevant information.

AFIS Unit: A unit established to provide a flight information service to aerodrome traffic at an aerodrome designated for use by International General Aviation (IGA) and where the provision of an aerodrome control service is not justified, or is not justified on a 24 hour basis.

Air navigation services (ANS): This term includes five broad categories of facilities and services; i.e. air traffic services (ATS), aeronautical telecommunications services (COM), meteorological services for air navigation (MET), search and rescue (SAR) and aeronautical information services (AIS). These services are provided to air traffic during all phases of operations (en-route, approach and aerodrome control). With the implementation of CNS / ATM systems, ATS and COM will be replaced by respectively ATM and CNS which are broader in scope.

Airspace management (ASM): A planning function with the primary objective of maximising the utilisation of available airspace by dynamic time-sharing and, at times, the segregation of airspace among various categories of users based on short-term needs. In future systems, airspace management will also have a strategic function associated with infrastructure planning.

Airspace sector: A part of airspace controlled by a sector. During a low traffic period, several airspace sectors can be collapsed and controlled by a single sector.

Air traffic control service (ATC): A service provided for the purpose of (1) preventing collisions between aircraft and on the manoeuvring area between aircraft and obstructions; and (2) expediting and maintaining an orderly flow of air traffic.

Air traffic flow management (ATFM): A service of tactical and strategic planning activities with the objective of ensuring an optimum flow of air traffic to or through areas during times when demand exceeds or is expected to exceed the available capacity of the air traffic control system.

Air traffic management (ATM): A systems approach with the objective of enabling aircraft operators to meet their planned times of departure and arrival and adhere to their preferred flight profiles with minimum constraints, without compromising agreed levels of safety. It comprises ground elements and airborne elements which, when functionally integrated, form a total ATM system. The airborne part consists of the elements necessary to allow functional integration with the ground part. The ground part comprises air traffic services (ATS), air traffic flow management (ATFM) and airspace management (ASM), where ATS is the primary component.

Air traffic services (ATS): ATS consists of the air traffic control service (area control service, approach control service, or aerodrome control service), flight information service (including air traffic advisory service), and alerting service.

Approach Control Unit (APP): The ATC unit providing ATC services to arriving, departing and over-flying flights within the airspace in the vicinity of an aerodrome. One APP can provide approach services for several aerodromes. The APP is generally located in the tower building or co-located with an ACC. In both cases the APP should be counted as a separate unit. Small aerodromes, where the approach function is provided from a position within the TWR, do not have a separate APP unit.

Area Control Centre (ACC): The ATC unit providing ATC services to en-route traffic in control areas under its jurisdiction. Part of an ACC may also supply approach services.

FIS Position: Position within an ACC providing services to non controlled flights for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Flow Management Position: Position established within an ACC to ensure the necessary interface with the CFMU on matters concerning the provision of the ATFM Service and the interface with national AMCs on matters concerning the ASM Service.

Number of sectors: This is the number of sectors at maximum configuration. It corresponds to the configuration that has been used during the year in which the greatest number of sectors has been open. To avoid unrepresentative extreme situations this configuration should have been used for a minimum of 50 hours per year.

Position: A one person work area (workstation) equipped for providing ATC services.

Sector: A group of positions required to provide ATC services in airspace sector(s) (typically two positions, one radar and one planning controller).

Sector hours: Measure obtained by adding the number of hours during which each sector has been open during the year.

Tower Control Unit (TWR): The ATC unit at an aerodrome, responsible for the provision of ATC services in respect of flights that are landing and taking off and other traffic that is on the active runway(s). Large airports may have more than one tower building but only one tower control unit.

Definitions related to Traffic

ACC movement: The number of IFR flights that have been controlled over the year by the ACC.

Airport movement: An aircraft take-off or landing at an airport. For airport traffic purposes one arrival and one departure is counted as two movements (Definition ICAO Doc 9713). A touch-and-go is counted as one movement.

Flight: The operation of an aircraft from take-off to its next landing.

Flight hours controlled: The sum of the flight hours controlled over the year by an ANSP or an ACC. For any given flight, the flight hours controlled is derived from CFMU information as the difference between the entry time and the exit time in the controlled airspace based on the last flight plan received.

Flight hours controlled (en-route): The sum of the flight hours controlled over the year by the ACC(s).

General air traffic (GAT): Civil and military air traffic operating in accordance with ICAO rules and regulations, as opposed to Operational Air Traffic (OAT).

Movement: The number of IFR flights that have been controlled over the year by the ANSP. A flight may cross several ACCs; therefore the number of movements controlled by the ANSP can be different from the sum of ACC movements.

Operational air traffic (OAT): Military air traffic, which due to its nature does not comply with the ICAO rules and regulations.