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AMENDMENTS

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FOREWORD

This manual was produced by the ICAO Air Traffic Management (ATM) Requirements and Performance Panel within the context of a performance-based global air navigation system.

The notion of a performance-based air navigation system emanated from sound industry practices external to the aviation industry. As the aviation industry has evolved into a less regulated and more corporate environment, the advantages of implementing a performance-based air navigation system are becoming increasingly apparent.

The performance-based approach (PBA) is based on the following principles:

- strong focus on desired/required results through adoption of performance objectives and targets;
- informed decision-making, driven by the desired/required results; and
- reliance on facts and data for decision-making.

Assessment of achievements is periodically checked through performance reviews, which in turn requires adequate performance measurement and data collection capabilities.

Establishing a PBA requires knowledge-sharing, training and other specific expertise.

The expected result is a more efficient system through identified cost savings, reduction in the waste of resources, more equitable charging practices, and more efficient provision of services. As the work effort is challenging and requires a globally coordinated effort, the aviation community should be encouraged to follow a common approach toward the development and implementation of a performance-based air navigation system.

The PBA can be applied in economic management, transition management, safety management, security management, communications, etc. This manual is not replacing any existing ICAO guidance material in these areas, rather it is to be seen as overarching and complementary guidance, introducing a set of performance management terminology and techniques to assist the aviation community members in converging towards a globally harmonized and agreed upon approach.

One of the objectives of this manual is to promote the use of harmonized terminology among ATM community members applying the performance-based approach in their area of interest. This terminology is introduced progressively, throughout the various chapters and sections of the document. Because some readers may not read the document in its entirety or in sequential order, they may experience difficulty locating certain terminology definitions. Consequently, an abbreviations and terminology list has been provided for quick-reference purposes in the preliminary pages of this manual.

ABBREVIATIONS AND TERMINOLOGY

1. ABBREVIATIONS

ACC	Area control centre
ADS-B	Automatic dependent surveillance — broadcast
AIRAC	Aeronautical information regulation and control
ANS	Air navigation system
ANSP	Air navigation service provider
ATC	Air traffic control
ATCO	Air traffic controller
ATM	Air traffic management
ATMRPP	Air Traffic Management Requirements and Performance Panel
CFIT	Controlled flight into terrain
CNS	Communications, navigation and surveillance
DM	Data mart
DW	Data warehouse
ETL	Extract, transform and load
FIR	Flight information region
GANP	Global air navigation plan
GPM	Global Performance Manual
IATA	International Air Transport Association
IFR	Instrument flight rules
IMC	Instrument meteorological conditions
ISO	International Organization for Standardization
IT	Information technology

KPA	Key performance area
KPI	Key performance indicator
MCDA	Multi-criteria decision analysis
MDM	Master data management
Mode S	Mode select
OCD	Operational Concept Document
OPS	Operations
PBA	Performance-based approach
PBN	Performance-based navigation
PBTG	Performance-based transition guidelines
PCA	Process capability area
PIAC	Peak instantaneous aircraft count
PIRG	Planning and Implementation Regional Group
QoS	Quality of Service
RASP	Required air navigation system performance
RCP	Required communication performance
RNP	Required navigation performance
RSP	Required surveillance performance
RTSP	Required total system performance
SARPS	Standards and Recommended Practices
SLA	Service level agreement
SMART	Specific, measurable, achievable, relevant and time-bound
SSR	Secondary surveillance radar
SWOT	Strengths, weaknesses, opportunities and threats
TFM	Traffic flow management
TMA	Terminal control area

VFR	Visual flight rules
VHF	Very high frequency
VMC	Visual meteorological conditions

2. TERMINOLOGY

Aggregation hierarchy. Aggregation hierarchies define how detailed (granular) performance data will be aggregated into summary data, and vice versa, how to break down the summary data into details. The following is an example of a sequence of aggregation levels: runway > airport > State > region > world (Chapter 2, 2.4.2, Appendix C, 4.3.4 and 4.3.8, and Appendix D, 3.1 refer).

ATM community. The ATM community is defined in Appendix A of the *Global Air Traffic Management Operational Concept* (Doc 9854). It comprises (in alphabetical order) the aerodrome community, the airspace providers, the airspace users, the ATM service providers, the ATM support industry, the International Civil Aviation Organization (ICAO), the regulatory authorities and States (Chapter 1, 1.3.2 refers).

Baseline performance. The term baseline performance refers to the performance, as described by a collection of defined indicators, in a given set of years. This performance may be the planned baseline performance (incorporating planned improvements), the measured baseline performance (based on historical data) or a projected baseline performance (without planned improvements, sometimes referred to as a “do-nothing” scenario). The projected baseline performance is expected to be used when analysing the need for planned improvements (Chapter 2, 2.4.3 refers).

Classification scheme. A classification scheme defines how general object types and event types can be more specifically characterized in terms of subtypes. For example: air vehicle < aircraft < aircraft category < aircraft class < aircraft type < aircraft model < aircraft series < airframe.

Classification schemes allow the breakdown of summary data into details, and vice-versa, they can be used to aggregate detailed (granular) performance data into summary data (Chapter 2, 2.4.2, Appendix C, 4.3.4 and 4.3.8, and Appendix D, 3.1 refer). See also: aggregation hierarchy.

Core data warehouse. The function of a core data warehouse is to facilitate data loading, integration and quality assurance. So, the function of a core data warehouse is **not** to make the data available to its users. Instead, for the users' purposes, i.e. for performance data analysis and dissemination, separate data marts should be built (Appendix C, 4.3.6 refers). See also: Data warehouse, Data mart.

Data management. Data management is the process of data collection, processing (including quality assurance), storage and reporting in support of the performance-based approach.

In practical terms, it is about: how to set up the data acquisition process needed for performance monitoring; how to aggregate performance data and exchange the data between planning groups; how groups can best manage their information base in which performance data are stored; and how to organize performance evaluations. Other subjects under this heading include global harmonization of such work, including definitions, standards for reporting requirements, and information disclosure (Chapter 1, 1.4.6, Chapter 2, 2.7, Appendix A, 3.8 and Appendix B refer).

Data mart (DM). A data mart is a specialized version of a data warehouse. The key difference is that the creation of a data mart is predicated on a specific, predefined need for a certain grouping and configuration of select data

from a core data warehouse. The primary function of data marts is to make data available to users, i.e. to support performance data analysis and dissemination (Appendix C, 4.3.7 refers).

Data profiling. Data profiling is a technique used to support performance data quality assurance. It creates a “profile” or picture of the composition of the whole set of data from different perspectives. Its role is to identify anomalies in large quantities of incoming performance data, while it is still being held in the staging area (Appendix C, 4.3.11 refers).

Data set. A data set is a group of records in a fact table which logically belong together. By including a data set dimension, performance data managers can load data for different versions, realities, assumptions or scenarios in the same table. Likewise, data sets can be used to distinguish between measured values (indicators) and targets.

Data cannot and should not be aggregated over data sets, but the data sets can be compared against each other: for example, different forecast scenarios, or different forecast editions, or measured values against targets. The data set dimension is an important instrument for performance evaluation (Appendix C, 4.3.9 refers). See also: Dimension table.

Data warehouse (DW). A data warehouse contains data which is built out of separate internal and/or external data sources where the data is integrated in a consistent manner. The database design of a data warehouse favours data analysis and reporting in order to gain strategic insight and to facilitate decision-making. A data warehouse contains “fact tables” and “dimension tables” which may be arranged as a “star schema” or a “snowflake schema” (Appendix C, 4.3.2 and 4.3.5 refer).

Dimension table. In data warehousing, the possible values for each of the dimensions used in the various fact tables are stored in separate tables, called the dimension tables. Dimension tables contain a list of items called dimension objects. These can be physical objects (e.g. airframes, airports, countries, regions), but also intangible objects such as classes and categories (e.g. aircraft types, flight rules, wake turbulence categories, months, severity classifications) (Appendix C, 4.3.4, 4.3.5 and 4.3.8 refer).

Extract, transform and load (ETL). The loading of data into a data warehouse is usually referred to by the term ETL process (extract, transform and load). This is a process in data warehousing that involves extracting data from outside sources, transforming it to fit performance monitoring needs, and ultimately loading it into the data warehouse. ETL is how data actually gets loaded into the warehouse (Appendix C, 4.3.10 refers).

Fact table. Within a data warehouse, all performance data (e.g. the values of supporting metrics, performance indicators and performance targets) are stored in fact tables. Each fact (described by a set of metrics and/or indicator values) has a dimensional context which defines the scope covered by the value of the metrics/indicators (Appendix C, 4.3.3 and 4.3.5 refer). See also: Dimension table.

Focus area. Within each KPA or PCA, a number of more specific areas — focus areas — are identified in which there are potential intentions to establish performance management. Focus areas are typically needed where performance issues have been identified. For example, within the capacity KPA one can identify airport capacity, runway capacity and apron capacity as focus areas. Within the safety KPA, the list of focus areas might include: accidents, incidents, runway incursions, safety management system maturity, etc. There may be a need to define hierarchical groupings of focus areas (Chapter 2, 2.3.3 and Appendix A, Figure I-A-2 and 3.4 refer).

Global ATM performance hierarchy. This is a construct which is useful for illustrating (and reminding the reader) that the performance-based approach can be applied at different levels, ranging from high-level socio-political issues to lower-level technology. The hierarchy distinguishes between five levels: 1) political and socio-economic requirements; 2) required air navigation system performance (RASP); 3) required total system

performance (RTSP) at the level of ATM component functionality; 4) system performance requirements (e.g. RNP, RCP); 5) technology performance (including standards, specifications) (Appendix A, 2 refers).

Indicator. See: Performance indicator.

Influence diagram. Influence diagrams are used to depict a chain of (assumed validated) cause-effect relationships. They can be used in a simple way to depict a high-level, qualitative understanding of performance. When such diagrams are used in a more complex way (supported by influence modelling tools), they follow precise conventions which serve to document relationships between (supporting) metrics (via processes and mechanisms), and to link these to well-defined performance indicators. Influence diagrams are useful as a tool to develop and document an initial understanding of the performance behaviour of the system. They can also serve as a communication tool to explain performance behaviour to a non-technical audience (Appendix D, 3.2.3 refers).

Key performance area (KPA). KPAs are a way of categorizing performance subjects related to high-level ambitions and expectations. ICAO has defined 11 KPAs: safety, security, environmental impact, cost effectiveness, capacity, flight efficiency, flexibility, predictability, access and equity, participation and collaboration, interoperability (Chapter 2, 2.2.4, Appendix A, Figure I-A-2 and 3.3 refer).

Key performance indicator (KPI). See: Performance indicator.

Master data management (MDM). The function of maintaining a common framework of dimensions throughout disparate IT systems and among a variety of stakeholders is called master data management (MDM) (Appendix C, 4.3.8 refers).

Metric. See: Supporting metric.

Multi-criteria decision analysis (MCDA). Multi-criteria decision analysis is a discipline aimed at supporting decision-makers who are faced with making numerous and conflicting evaluations. MCDA aims at highlighting these conflicts and deriving how to arrive at a compromise in a transparent process (Chapter 2, 2.5.5 and Appendix B, 4.5 refer).

Performance-based approach (PBA). The performance-based approach is a decision-making method based on three principles: strong focus on desired/required results; informed decision-making driven by those desired/required results; and reliance on facts and data for decision-making. The PBA is a way of organizing the performance management process (Chapter 1, 1.2.1 and Chapter 2, 2.1 refer). See also: Performance management process.

Performance case. The term performance case is used to denote the documentation that contains all the reasoning and arguments used to demonstrate that the performance objectives (and performance targets) will be met. A performance case can be seen as the combination of the various cases that together address and balance all areas in which the ATM community has expectations, e.g. the safety case, together with the business case, together with the environment case (Chapter 1, 1.4, Chapter 2, 2.5.3 and 2.5.5 and Appendix D, 3.2.7 refer).

Performance framework. A performance framework is the set of definitions and terminology describing the building blocks used by a group of ATM community members to collaborate on performance management activities. This set of definitions includes the levels in the global ATM performance hierarchy, the eleven key performance areas, a set of process capability areas, focus areas, performance objectives, indicators, targets, supporting metrics, lists of dimension objects, their aggregation hierarchies and classification schemes (Appendix A refers).

Performance gap. The difference between the baseline performance and the target performance is referred to as the “performance gap” (Chapter 2, 2.4.3 and Appendix A, 3.7 refer). See also: Baseline performance, Target performance.

Performance indicator. Current/past performance, expected future performance (estimated as part of forecasting and performance modelling), as well as actual progress in achieving performance objectives is quantitatively expressed by means of indicators (sometimes called key performance indicators, or KPIs).

To be relevant, indicators need to correctly express the intention of the associated performance objective. Since indicators support objectives, they should be defined having a specific performance objective in mind.

Indicators are not often directly measured. They are calculated from supporting metrics according to clearly defined formulas, e.g. cost-per-flight-indicator = $\text{Sum}(\text{cost})/\text{Sum}(\text{flights})$. Performance measurement is therefore done through the collection of data for the supporting metrics (Chapter 1, 1.4.6, Chapter 2, 2.4.2, Appendix A, Figure I-A-2 and 3.7, Appendix C, 4.3.3 and Appendix D refer).

Performance management process. This term refers to a repetitive or continuous process which applies the principles of the performance-based approach to manage (generally improve) selected performance aspects of an organization or system (i.e. the air navigation system). The process is executed through a sequence of well-defined steps, which are described in Chapter 2, Figure I-2-1.

Examples of performance management processes are safety management, security management, and capacity management.

Performance modelling. Within the context of the performance-based approach, the objective of modelling is not to explain how the air navigation system works in terms of data flows, messages etc., but to construct ATM performance models which help to — qualitatively and/or quantitatively — understand the cause-effect relationships between performance variables, showing how individual performance objectives can be achieved and how they interact (enhance or interfere) with each other. This enables understanding of how performance levels can be achieved by operational improvements and what the trade-offs are.

Because performance is measured in terms of metrics and indicators, it follows that the variables in performance models should include all metrics from which the indicators are derived, as well the indicators defined in the performance framework (Appendix D, 3.1 refers).

Performance monitoring. Performance monitoring is the act of collecting performance data in support of the performance review (Chapter 2, 2.7 refers). See also: Performance review.

Performance objective. Within focus areas, the potential intention to establish performance management is “activated” by defining one or more performance objectives. These define — in a qualitative and focused way — a desired trend from today's performance (e.g. improvement). A distinction is made between **generic objectives** and **instantiated objectives**.

Generic objectives specifically focus on what has to be achieved, but do not make statements about the when, where, who or how much. For example “improve safety” is not specific enough to be an objective, whereas “reduce the total number of accidents” and even more specifically “reduce the number of CFIT accidents” would qualify as performance objectives. Because at the level of generic objectives no mention is made about the when, where and who, it does not make sense to try to associate numbers (indicator values or targets) with this level.

Instantiated objectives add the when, where, who and how much to the generic objectives. Instantiated objectives can have indicator values and associated targets (Chapter 2, 2.3.3, Appendix A, Figure I-A-2, 3.5 and 3.6 refer).

Performance review. Performance review is the act of analysing performance data in support of performance management (Chapter 2, 2.7 refers).

Performance target. Performance targets are closely associated with performance indicators: they represent the values of performance indicators that need to be reached or exceeded to consider a performance objective as being fully achieved (Chapter 2, 2.4.3, Appendix A, Figure I-A-2 and 3.6 refer).

Priority. The notion of priorities is used to ensure that the performance-based approach is applied at opportune moments when and where it will bring desired benefits, and to maintain acceptable performance levels in KPAs, which are critical for meeting general expectations and realizing strategic ambitions (Appendix B, 3 refers).

Process capability area (PCA). Whereas KPAs zoom in on a particular type of performance outcome (e.g. safety, capacity, etc.), PCAs slice the performance subject from a different angle, focussing on the quality, maturity and completeness of the performance management processes that ATM community members have put in place. The process-oriented perspective helps to diagnose weaknesses in the existing performance management processes, after which specific initiatives can be taken (performance based, i.e. with appropriate objectives, indicators and targets) to improve these processes and/or their deployment across the ATM community (Appendix A, 5 and Appendix D, 3.2.2 refer).

Risk management. The systematic application of management policies, procedures and practices to the tasks of: establishing the context of, identifying, analysing, evaluating and treating risks; monitoring the implementation of treatments; and communicating about risk.

Staging area. A staging area is a part of a data warehouse where raw source data is placed, prior to quality checking, transformation and subsequent loading into fact tables and dimension tables (Appendix C, 4.3.10 and 4.3.11 refer).

Stakeholder. In this document, a stakeholder is any ATM community member who has an interest in, or is involved in, ATM performance management.

Supporting metric. Supporting metrics are used to calculate the values of performance indicators. For example, cost-per-flight-indicator = $\text{Sum}(\text{cost})/\text{Sum}(\text{flights})$. Performance measurement is done through the collection of data for the supporting metrics (e.g. this leads to a requirement for cost data collection and flight data collection) (Chapter 2, 2.4.2, Appendix A, Figure I-A-2, 3.8, Appendix B, 3, Appendix C, 4.3.3 and Appendix D refer).

SWOT analysis. SWOT analysis is a business management term used to denote the analysis of a system or organization with the aim of developing an inventory of present and future **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats that may require performance management attention (Chapter 2, 2.3.2 and Appendix D, 3.2.7 refer).

Target performance. See: Performance target.

Taxonomy. See: Classification scheme.

Trade-off. The role of trade-offs is explained as an instrument for choosing the appropriate — that is, the most balanced — solution within a given set of priorities, when different options are available, but each option has different advantages and disadvantages in terms of performance impact (Chapter 2, 2.5.5 and Appendix B, 4 refer).

PART I

GLOBAL PERFORMANCE



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Chapter 1

INTRODUCTION

1.1 ABOUT THIS DOCUMENT

1.1.1 Context

1.1.1.1 Organizations in many industries have long since discovered the value of a performance-based approach (PBA) for:

- improving the effectiveness of the day-to-day economic management of their business;
- channelling efforts towards meeting stakeholder expectations and improving customer satisfaction; and
- managing change in a dynamic environment.

Likewise, the air traffic management (ATM) industry can reap significant benefits from adopting a performance-based approach.

1.1.1.2 For the best results, ATM community members need to cooperate in a performance-based manner. For this reason, ICAO supports and encourages the global adoption of performance management techniques, which is part of the transition towards a performance-based global air navigation system (ANS) as envisaged in the *Global Air Traffic Management Operational Concept*¹ (Doc 9854) and the related *Manual on Air Traffic Management (ATM) System Requirements*² (Doc 9882).

1.1.1.3 As illustrated in Figure I-1-1, one can distinguish between basic (common) performance management terminology and techniques, and their application in economic management, transition management, safety management, and other applications.

1.1.1.4 This manual addresses the basic performance management terminology and techniques that are the “common denominator” between all performance planning/management applications. The specifics of each application are addressed in other related documents, including but not limited to the:

- *Manual on Air Navigation Services Economics* (Doc 9161)
- *Global Air Navigation Plan* (Doc 9750)
- *Safety Management Manual (SMM)* (Doc 9859)

-
1. The global ATM operational concept presents a vision for an integrated, harmonized, and globally interoperable air navigation system planned up to 2025 and beyond.
 2. This manual identifies requirements where a significant change to operating practices will be required to transition to the global ATM operational concept.

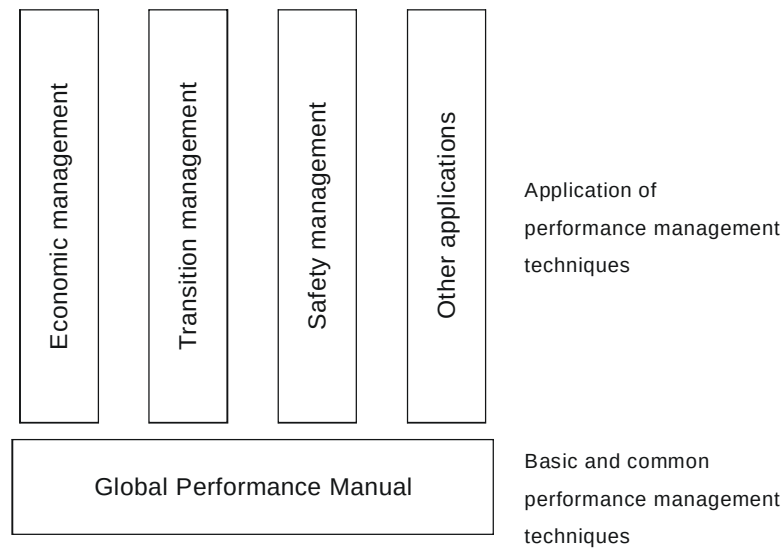


Figure I-1-1. Role of the global performance manual

1.1.2 Using this manual

1.1.2.1 The methods and procedures described in this manual have been compiled from experience gained in the successful development and management of performance management activities in various sectors of both the aviation and non-aviation industries.

1.1.2.2 This manual targets a wide audience ranging from ICAO experts, Planning and Implementation Groups (PIRGs), State aviation regulators, operators and service providers. It also aims to address all levels of personnel from senior management to front-line workers.

1.1.2.3 The manual also covers a wide range of subjects; therefore, users are encouraged to first read Chapters 1 to 5 before focusing on their specific areas of interest. It is possible that more specific ICAO guidance material is available in your area of interest. If that is the case, you are invited to use this manual to ensure that the performance-based perspective is duly taken into account.

1.1.2.4 This manual is aimed at those personnel who are responsible for designing, implementing and managing effective performance management activities. Users should find sufficient information herein for the justification, initiation and operation of a viable performance management process in their organization. The manual is not prescriptive. However, based on an understanding of the philosophy, principles and practices discussed herein, organizations should be able to develop an approach to performance management suited to their local conditions.

1.1.3 Content and structure

1.1.3.1 This manual contains guidance material intended to:

- provide “getting started” assistance to those ATM community members who are (relatively) inexperienced in this subject; and
- assist the experienced ATM community members in converging towards a globally harmonized and agreed upon approach.

1.1.3.2 The **main body** of the document summarizes the three most frequently asked questions about the performance-based approach:

- **What is it for?** The basic principles, advantages, purpose, applicability and success factors are explained in **Chapter 1** (Introduction). This chapter should help you in deciding where and when to implement (or modify) the performance-based approach in your organization.
- **What is it really?** The performance-based approach is a decision-making method. **Chapter 2** (The performance-based approach) provides a step-by-step description with an example. The purpose of this chapter is to show that the approach can be broken down into manageable, easy-to-understand steps. By following these steps, ATM community members should gain confidence in their ability to apply the approach in a successful manner, and benefit from participating in a globally harmonized approach.
- **How do I start?** Some guidelines on how to get yourself (your PBA “project”) organized are offered in **Chapter 3** (Getting Started).

1.1.3.3 **Appendices** provide more specific or technical guidance on selected subjects. **Chapter 4** provides an overview (abstract) of the contents of these appendices.

1.2 THE PERFORMANCE-BASED APPROACH AND ITS ADVANTAGES

1.2.1 Principles

In general terms, the performance-based approach is based on the following three principles:

- Strong focus on desired/required results. Instead of prescribing solutions, desired/required performance is specified. The attention of management is shifted from a resource and solution-centric view (How will we do it?) towards a primary focus on desired/required performance results (What is the outcome we are expected to achieve?). This implies determining the current performance situation, what the most appropriate results should be, and clarifying who is accountable for achieving those results.
- Informed decision-making, driven by the desired/required results. This means working “backwards” from the “what”—the primary focus—to decisions about the “how”. “Informed decision-making” requires that those making the decisions (decision-makers) develop a good understanding of the mechanisms which explain how drivers, constraints, shortcomings, options and opportunities influence (i.e. contribute to, or prevent) the achievement of the desired/required results. Only then can decisions — in terms of priorities, trade-offs, selection of solutions and resource allocation — be optimized to maximize the achievement of the desired/required (performance) results.
- Reliance on facts and data for decision-making. In the performance-based approach the desired/required results, as well as the drivers, constraints, shortcomings and options, are expressed in quantitative terms and in a qualitative way. The rationale for this is that “if you can’t measure it, you can’t manage it”, i.e. unless you measure something, you don’t know if it is getting better or worse. When facts and data are used, they should be relevant and reflect reality. This requires the adoption of a performance measurement culture. It also necessitates associated investments in data collection and management.

1.2.2 Advantages

The advantages of the performance-based approach are:

- it is result-oriented, allows customer focus and promotes accountability;
- policy-making becomes transparent when the goals are publicly stated in terms of performance outcome rather than solutions;
- the shift from prescribing solutions to specifying desired/required performance also gives more freedom and flexibility in selecting suitable solutions, which in turn is a catalyst for more cost-effectiveness. Furthermore, solutions can be easily adapted in a diverse and changing environment.
- exclusive bottom-up approaches (“technology-driven approach” and “solutions searching for a problem to solve”) are easier to avoid;
- reliance on anecdotal evidence can be replaced by a rigorous scientific approach employing quantitative and qualitative methods;
- the focus on desired/required results helps decision-makers set priorities, make the most appropriate trade-offs, choose the right solutions and perform optimum resource allocation;
- organizations are successful in reaching goals, i.e. the general effect of the approach is that it ensures improved predictability of benefits;
- it is worth the investment: the adoption of a performance-based approach typically results in cost-savings (cost avoidance) significantly higher, by comparison, than the cost of applying the approach.

1.3 PURPOSE AND APPLICABILITY OF THE PERFORMANCE-BASED APPROACH

1.3.1 Purpose

1.3.1.1 The performance-based approach is a pragmatic tool for ATM community members involved in:

- policy-making;
- regulation;
- transition planning (planning changes to the system);
- system design and validation (developing changes to the system);
- management (economic and operational); and
- continuous improvement (optimizing the system).

1.3.1.2 The basic terminology, methods and techniques explained in this manual are intended to effect better collaboration between the above activities and audiences, resulting in a “balanced total system approach”.

1.3.1.3 This “balanced total system approach” enables the ATM community to better work together across all disciplines to:

- develop a consensus on “the direction to follow” with the air navigation system;
- manage the required change in a dynamic environment; and
- improve the effectiveness of the day-to-day operational and economic management, thereby meeting long-term and short-term stakeholder expectations and improving customer satisfaction.

1.3.2 Applicability

The performance-based approach (PBA) provides benefits in almost every subject area and can be applied by almost every audience at any level of detail. The list below gives an overview of the applicability from a variety of perspectives. It also delineates the applicability and target audience for this manual.

- The PBA can and should be used in subject areas such as:
 - safety, security, environmental impact of air transport and ATM;
 - economic performance of airspace users, airports and air navigation service providers;
 - operational performance (including quality of service) of flight operations, airport operations and the provision of air navigation services;
 - human performance and social factors within the air navigation system; and
 - performance of technical systems within the air navigation system.
- It can and should be used in all of the following planning and management activities:
 - policymaking;
 - planning;
 - research, development and validation;
 - economic management; and
 - operational management.
- It can and should be used by all ATM community members:
 - air navigation service providers (ANSPs);
 - airports;
 - airspace users;
 - manufacturers;
 - regulators;
 - States; and

- ICAO (including panels and planning groups).
- It applies to the management of performance at a wide variety of levels of detail or aggregation:
- from a geographical perspective: at the level of local performance (States), regional performance, or global performance;
 - from a time period perspective: at the level of momentary performance (real time), or more aggregated, i.e. hourly, daily, weekly, monthly, quarterly, seasonal, annual, or multi-year performance results;
 - from an operational perspective: at the level of parts of operations (e.g. performance of individual flight phases), individual operations (e.g. gate-to-gate performance of individual flights), or the aggregate of operations (e.g. for optimizing the collective performance of groups of flights);
 - from a stakeholder aggregation perspective: at the level of individual operational units/entities (e.g. specific ACCs), individual stakeholder organizations (e.g. specific ANSPs), or stakeholder segments (e.g. collective performance of ANSP groups or all ANSPs).

1.3.3 Interdependencies and the need for collaboration

1.3.3.1 There are interdependencies between all of the above perspectives. In the past, these interdependencies have not always been recognized, resulting in non-optimum performance of the air navigation system as a whole. For example:

- subject areas have developed into distinct performance-based approaches resulting in different terminology and other variations; this makes it difficult to detect the commonalities and to manage interdependencies and integrate results;
- insufficient coordination between policymaking, planning, research/development/validation, economic management, and operational management;
- where insufficient coordination between ANSPs, airports, airspace users, manufacturers, regulators and ICAO takes place, the result is a fragmented air navigation system;
- insufficient coordination at the local level, regional level, and global level leads to less than ideal interoperability and to geographic differences in terms of performance and maturity;
- a fragmented approach from an operational perspective (no gate-to-gate and en-route to en-route) leads to less than optimum flight efficiency and airport operations efficiency.

1.3.3.2 To resolve such issues and achieve better results, all ATM community members need to cooperate in a performance-based manner across geographic boundaries, across operational (e.g. flight phase) boundaries, across subject areas and across planning and management activity boundaries.

1.3.4 Performance management application examples

There are many areas in which the migration to a performance-based approach has already started. Examples include:

- transition planning at global, regional and local levels;

- economic performance management for ANSPs;
- performance-based navigation (PBN); and
- safety management.

1.4 THE WAY TO SUCCESS

1.4.1 Once an organization (or State, region, etc.) decides to adopt the performance-based approach in a particular subject area, it must acknowledge that a number of elements are essential to the successful application of the approach. These elements are:

- commitment;
- agreement on goals;
- organization;
- human resources and knowledge/expertise;
- data collection, processing, storage and reporting;
- collaboration and coordination; and
- cost implications.

1.4.2 Commitment

1.4.2.1 The decision-makers (e.g. senior management) need to be convinced that the approach will bring real value. After all, it is their tool because the approach supports result-oriented management, i.e. helps to achieve real results based on a “performance case” containing solid, quantified arguments, as outlined in Part II of this manual.

1.4.2.2 Commitment from the senior management will ensure that:

- the effort and money spent on the collection and analysis of performance data are actually used to improve the effectiveness of decision-making; and
- decision-making is effectively supported by the availability of trustworthy, meaningful data.

1.4.2.3 In other words, it is the responsibility of senior management to ensure a healthy balanced relationship between performance-based decision-making, and performance data collection and analysis.

1.4.3 Agreement on goals

The main principle of the performance-based approach is a strong focus on desired/required results. The ability to reach consensus on the desired outcome of performance management in terms of performance results to be achieved (i.e. to agree on objectives and targets), is a basic prerequisite for the successful application of the approach.

1.4.4 Organization

1.4.4.1 The process which underlies the performance-based approach is introduced in Chapter 2. The steps of that process require a number of roles and responsibilities. This means that it must be clear who (or which organization) is accountable and responsible for:

- defining (regulatory and management) objectives;
- setting targets (regulatory and management);
- defining indicators;
- gathering performance data;
- managing data quality; and
- performance review.

1.4.4.2 Overlaps and gaps in these responsibilities are to be avoided. Depending on the complexity, the organizational aspects will need to be addressed at different levels:

- in simple cases, this means assigning roles and responsibilities to individuals;
- in more complex situations (application in large organizations), the roles and responsibilities should be reflected in the organizational structure; and
- at State and regional levels, specific institutional arrangements may be required (setting up statistical offices, performance review organizations, governance structures, such as regulatory bodies).

1.4.5 Human resources and knowledge/expertise

1.4.5.1 Applying the performance-based approach requires a certain amount of effort; hence, it is necessary that the organizational structure is sufficiently staffed.

1.4.5.2 In simple cases, performance management roles and responsibilities may be added to the job description of existing staff. With increasing workload, successful application of the approach will require dedicated staff, which is able to spend 100 per cent of their time on the subject. In particular, data collection and management, and also performance review are all labour-intensive.

1.4.5.3 Likewise, it is essential that the required knowledge/expertise is available: successful application of the performance-based approach requires a certain culture and skills which may not be readily available in the organization. It must be ensured that the staff involved has a suitable background and receives additional training as required³.

3. Required knowledge/expertise includes an indepth understanding of ATM performance and the surrounding issues of data collection, information management, performance modelling, performance review, forecasting, etc. The team should include system analysts, statisticians, database specialists, etc.

1.4.6 Data collection, processing, storage and reporting

1.4.6.1 Data collection, processing, storage and reporting are fundamental to the performance-based approach.

1.4.6.2 It should not be assumed that all data needed for applying the performance-based approach are simply available “somewhere” and only needs to be copied. Although re-use of data prepared by others is sometimes possible, the data reporting chain always starts at the “grass-roots level”, and properly setting up and managing the entire chain is an integral part of the approach.

1.4.6.3 Establishing a data reporting chain usually involves participation from many ATM community members. Their willingness to participate requires the establishment of a performance data reporting culture (i.e. to consider the challenges surrounding safety event reporting), a capability to successfully manage disclosure and confidentiality aspects, and deciding on a case-by-case basis which approach works best: mandatory or voluntary (incentive-based) reporting.

1.4.6.4 In the end, data will be condensed into a few indicators which represent the high-level knowledge about the performance of the system, but prior to that, data from a variety of sources will need to be collected, quality-checked and stored. This requires initiatives at the technical level: harmonization and standardization of reporting requirements, and investments in appropriate information technology (IT) infrastructure.

1.4.6.5 The above-mentioned harmonization and standardization of reporting requirements is needed to allow consistent interpretation of data across different reporting sources. This in turn is a prerequisite for meaningful benchmarking (comparison of reporting sources) and aggregation of data (calculation of totals across reporting sources).

1.4.7 Collaboration and coordination

1.4.7.1 The performance-based approach is never applied in isolation. There is always interaction within a context, consisting of other subject areas, other stakeholders, other geographical areas, higher or lower aggregation levels, other planning and management activities, etc.

1.4.7.2 Collaboration and coordination is needed to:

- come to an agreed vision on the expected results;
- ensure that everyone delivers their part of (their contribution to) the required performance;
- ensure that everyone uses a compatible approach, method and terminology; and
- ensure that everyone's data can be integrated and aggregated to calculate overall indicators and assess system performance at a higher aggregation level.

Paragraph 1.3.1.3 gave some examples on what can happen if there is insufficient emphasis on collaboration and coordination.

1.4.8 Cost implications

Many of the above-mentioned success factors have cost implications: in all but the simplest cases, the PBA will require specialized organizations, organizational units or staff working on the subject. In addition, a dedicated IT infrastructure may be required.

Chapter 2

THE PERFORMANCE-BASED APPROACH STEP-BY-STEP

2.1 INTRODUCTION

2.1.1 The performance-based approach is a way of organizing the performance management process. Many variations to this process are in use today. They are all based on a similar philosophy and principles which are covered in more detail in the following paragraphs.

2.1.2 Without intending to be prescriptive, this chapter presents a “generalized” version of this process, together with a step-by-step description and a worked-out (hypothetical) example. Its purpose is to show that — no matter in which subject area it is applied — the approach can be broken down into manageable, easy-to-understand steps. By systematically following these steps, ATM community members will gain confidence in their ability to apply the approach in a successful manner, and benefit from participating in a globally harmonized approach.

2.1.3 Figure I-2-1 outlines the general sequence of steps in the performance management process. It serves as general guidance.

2.1.4 There is a clear relationship between the three principles presented in 1.2.1 and the steps of the process:

- strong focus on desired/required results: is covered by Steps 1 and 2;
- informed decision-making, driven by the desired/required results: is dealt with by Steps 4 and 5;
- reliance on facts and data for decision-making: is enabled by Steps 3 and 6.

2.1.5 The remainder of this chapter explains Figure I-2-1 in more detail. More specifically, the steps cover the following activities:

- Step 1: Define/review scope, context and general ambitions/expectations
 - Step 1.1: Define scope
 - Step 1.2: Define context
 - Step 1.3: Identify ambitions and expectations
- Step 2: Identify opportunities, issues and set (new) objectives
 - Step 2.1: Develop a list of present and future opportunities and issues that require performance management attention
 - Step 2.2: Focus efforts by defining and prioritizing performance objectives as needed

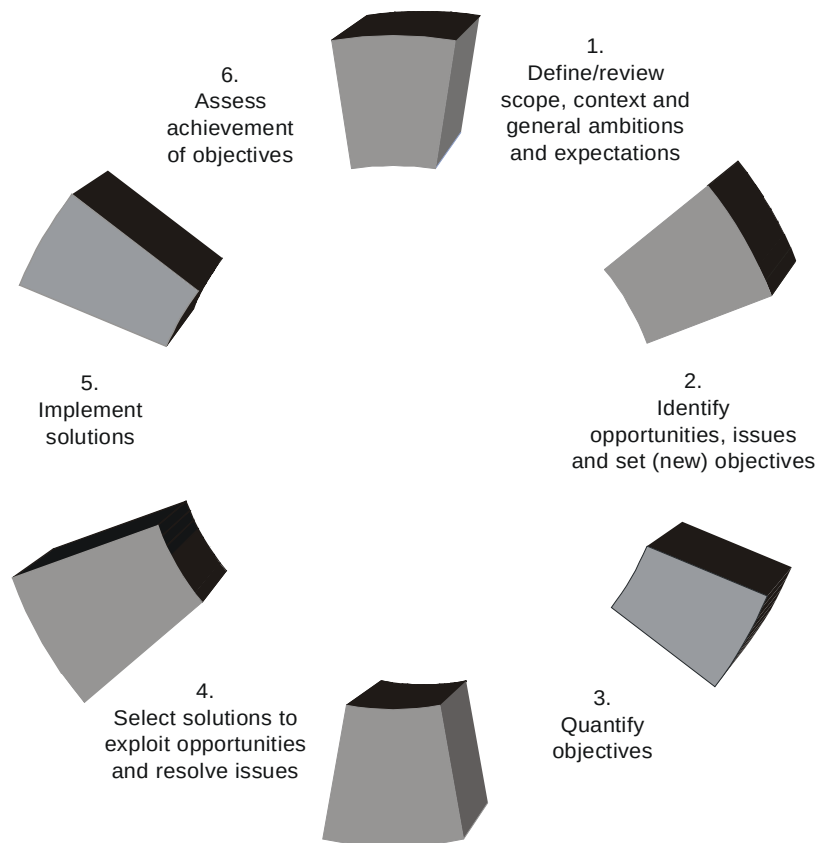


Figure I-2-1. General performance management process

- Step 3: Quantify objectives
 - Step 3.1: Define how progress in achieving performance objectives will be measured and which data are required to do so
 - Step 3.2: Define the desired speed of progress in terms of baseline and target performance
- Step 4: Select solutions to exploit opportunities and resolve issues
 - Step 4.1: Select the decisive factors to reach the target performance
 - Step 4.2: Identify solutions to exploit opportunities and mitigate the effects of the selected drivers and blocking factors
 - Step 4.3: Select a sufficient set of solutions
- Step 5: Implement solutions
- Step 6: Assess achievement of objectives.

2.2 STEP 1: DEFINE/REVIEW SCOPE, CONTEXT AND GENERAL AMBITIONS/EXPECTATIONS

2.2.1 The purpose of Step 1 is to reach a common agreement on the scope and (assumed) context of the “system” on which the performance management process will be applied, as well as a common view on the general nature of the expected performance improvements.

2.2.2 Step 1.1: Define scope

2.2.2.1 In practice, there is not just one global, all-encompassing application of the performance management process, but many simultaneous — and often interrelated — applications at more specialized and localized levels. Chapter 1, 1.3.2 provides an indication of the possibilities for reduced scope.

2.2.2.2 Scope definition is important to avoid misunderstandings, in particular about the performance (improvement) which can be expected within the given scope. For example, the possibilities for managing safety or environmental impact vary depending on whether one considers only the role of ATM or approaches the subject at the level of the entire air transport system (which includes, for example, changes in fleet composition, engine technology, etc.).

2.2.2.3 By defining the scope of the performance management activity, the limits of responsibility and accountability are also defined.

Example — Step 1.1

Organization X is the air navigation service provider (ANSP) in flight information region (FIR) YYYY. The organization will be establishing a capacity management process as part of an ongoing performance-based approach. The initial scope is defined as follows:

- Time period: traffic forecasting and issue analysis will be done for a 15-year time horizon. The planning period (selection of solutions) will be initially limited to a 5-year horizon (to support development of the business plan).
- Key performance areas: the main focus of the planning process will be on ATM capacity.
- Geographically: the planning process will plan and implement ATM capacity in FIR YYYY, but only en-route airspace is considered. Terminal control area (TMA) capacity and airport capacity are initially not included. Airport expansion planning (e.g. construction of new airports, runways, terminals) does not fall within the scope.
- Traffic: the scope includes domestic, international and overflying traffic. However, the scope of the planning process is limited to instrument flight rules (IFR) traffic. Capacity management for visual flight rules (VFR) traffic is initially not included.

2.2.3 Step 1.2: Define context

Once the scope is defined, it is necessary to make clear assumptions on what is “surrounding” the performance management activity. This includes clarifying what the strategic fit is within a larger (parent scope) performance management activity, with whom there is a need to coordinate and collaborate, and what the external drivers and constraints are for the scope.

Example — Step 1.2

The capacity planning process for FIR YYYY fits within the regional planning process (ICAO region ZZZ), which looks after the network effect. Organization X is responsible for avoiding that FIR YYYY becomes the capacity bottleneck in region ZZZ. Regional planning is also responsible for managing the VHF frequency allocation plan.

The geographical context includes neighbouring airspace, as well as the TMAs and airports within FIR YYYY (because they were excluded from the scope).

The main external driver for capacity planning is the expected traffic growth. The magnitude of growth and the expected changes in traffic patterns are documented in a medium- and long-term traffic forecast. Physical airport capacity is a potential external constraint.

2.2.4 Step 1.3: Identify ambitions and expectations

2.2.4.1 Within a given scope, the purpose of identifying general ambitions and expectations is to develop a strategic view on the (performance) results that are expected. The term “expectation” refers to desired results from an external perspective. The term “ambition” indicates that the desired results refer to an internal initiative.

2.2.4.2 For example, in ATM, the performance-based approach can be used to better meet society's aviation expectations, as well as improve the business performance of airlines, service providers, etc. To achieve this, one could identify ambitions and expectations with regard to the performance of flight operations, airspace/airport usage and air navigation services in areas such as:

- safety;
- security;
- environmental impact;
- cost effectiveness;
- capacity;
- flight efficiency;
- flexibility;

- predictability;
- access and equity;
- participation and collaboration; and
- interoperability.

These are the eleven key performance areas (KPAs) as identified in the *Global Air Traffic Management Operational Concept* (Doc 9854).

2.2.4.3 Achievable performance in the areas listed in 2.2.4.2 is made possible by the following enabler levels:

- services and procedures;
- human resources;
- physical infrastructure;
- systems and technology; and
- regulation and standardization.

2.2.4.4 The performance-based approach can and should be applied at each of these enabler levels for the purposes of understanding the impact on the eleven KPAs. For example, for the systems and technology level, the focus includes technical performance characteristics such as service/system availability, continuity, reliability, integrity, resilience, maintainability, scalability etc. An important part of the PBA is the development of cause-effect relationships between these technical performance characteristics and the higher level 11 KPAs.

Example — Step 1.3

The general expectation of the ATM community with regard to capacity is that the air navigation system in FIR YYYY will meet airspace user demand at peak times and locations by minimizing restrictions on traffic flow. To respond to future growth, capacity must increase, along with corresponding increases in efficiency, flexibility, and predictability while ensuring that there are no adverse impacts on safety or the environment. The air navigation system must be resilient to service disruption, and the resulting temporary loss of capacity.

2.3 STEP 2: IDENTIFY OPPORTUNITIES, ISSUES AND SET (NEW) OBJECTIVES

2.3.1 The purpose of Step 2 is to develop a detailed understanding of the performance behaviour of the system (this includes producing a list of opportunities and issues), and to decide which specific performance aspects are essential for meeting the general expectations. The essential performance aspects are those which need to be actively managed (and perhaps improved) by setting performance objectives.

2.3.2 Step 2.1: Develop a list of present and future opportunities and issues that require performance management attention

2.3.2.1 Based on the scope, context and general ambitions/expectations which were agreed to during the previous step, the system should be analysed in order to develop an inventory of present and future opportunities and issues (weaknesses, threats) that may require performance management attention.

This part of the process is generally known as the SWOT (strengths, weaknesses, opportunities and threats) analysis.

- **Strengths** are (internal) attributes of a system or an organization that help in the realization of ambitions or in meeting expectations.
- **Weaknesses** are (internal) attributes of a system or an organization that are a detriment to realizing ambitions or meeting expectations.
- **Opportunities** are external conditions that help in the realization of ambitions or in meeting expectations.
- **Threats**¹ are external conditions that are a detriment or harmful to realizing ambitions or meeting expectations.

2.3.2.2 Note that what may represent strengths with respect to one ambition or expectation may be weaknesses for another one. The term “issues” is used in this document to refer to weaknesses as well as threats.

2.3.2.3 A good understanding of the opportunities and issues should be developed early in the process, to provide background information for deciding which performance objectives to set, what to measure and how/where to change the system. When possible (second or later iteration in the process), advantage should be taken of the results of Step 6: Assess achievement of objectives. In general, this activity should take place as part of the forecasting and performance review.

2.3.2.4 Once the strengths, weaknesses, opportunities and threats are identified, action can be taken to target and exploit or remove these factors, thereby leading to performance improvements directly related to meeting the expectations.

Example — Step 2.1

Organization X has conducted a SWOT analysis on the air navigation system in FIR YYYY. The conclusions have been summarized as follows:

- Strengths: currently, there is no staff shortage.
- Weaknesses:
 - In the northern part of the FIR:

1. Term used in the general (business) sense of the word; not just to be seen within the context of security.

- Currently there is no radar coverage. ATC services are provided in that area using procedural control. At present, this is sufficient to handle the traffic levels there, but within a few years procedural control and lack of surveillance will become the blocking factors.
- In the southern part of the FIR the anticipated problems are:
 - controller workload may become a blocking factor.
 - traffic density is already very high, and frequency shortage may ultimately prevent the ANSP from splitting sectors to increase capacity.
 - the high number of aircraft simultaneously present in the airspace will also lead to a degradation of surveillance performance (SSR capacity limits will be exceeded).
 - a wave of controller retirements is expected in ten years, leading to a staff shortage.
- Opportunities: ADS-B technology has matured, and this is potentially a cost-effective solution to the surveillance problem in the northern part of the FIR.
- Threats: in the coming years, various events could take place which could cause traffic patterns of intercontinental flights to change. This could lead to a severe drop in the volume of overflying traffic. There is a risk that this could happen after capacity has been increased. Since the service provider obtains a significant part of the revenue from user charges, this risk creates an unfavourable investment climate.

2.3.3 Step 2.2: Focus efforts by defining and prioritizing performance objectives as needed

2.3.3.1 The purpose of this activity is to focus and prioritize the application of the performance-based approach:

- focus is necessary to aim general expectations into specific performance objectives, which in turn will be the basis for deciding on improvement actions.
- prioritization is required because, even though the scope of the process has already been limited, in practice, not everything can and/or needs to be performance managed.
- prioritization is supported by risk management which helps identify the risks that are most urgent or must be avoided, those that should be transferred or reduced, and those that are reasonable to retain.

2.3.3.2 Focusing the performance-based approach is a two-stage process:

- Within each KPA, identify a number of specific areas — **focus areas** — in which there are potential intentions to establish performance management. Focus areas are typically needed where issues have been identified (see Step 2.1). For example, within the capacity KPA one can identify airport

capacity, runway capacity and apron capacity as focus areas. Within the safety KPA, the list of focus areas might include: accidents, incidents, runway incursions, safety management system maturity, etc. There may be a need to define hierarchical groupings of focus areas.

- Within focus areas, the potential intention to establish performance management is “activated” by defining one or more **performance objectives**. These define — in a qualitative and focused way — a desired trend in today's performance (e.g. improvement); they specifically focus on what has to be achieved, but do not make statements about the when, where, who or how much. These objectives may be developed iteratively with the development of indicators. Significant analysis of historical data, performance modelling or simulation may be required to understand the necessary objectives. For example, “improve safety” is not specific enough to be an objective, but represents a starting point. Further analysis would reveal that “reduce the total number of accidents” and even more specifically “reduce the number of CFIT accidents” would qualify as performance objectives. Because at this level of detail no mention is made about the when, where and who, it does not make sense to try to associate numbers (indicator values or targets) at this level. That is done during the next step of the process.

2.3.3.3 **Prioritizing** the performance-based approach means that performance objectives will only be defined in those focus areas where a real (present or anticipated) need for action and improvement has been identified (preferably through analysis of historical or projected performance data).

Example — Step 2.2

As stated in Step 1.1, the scope of the new performance management process was defined as covering en-route ATM capacity for IFR flights.

Focus of performance management: one focus area is defined within the capacity KPA: en-route ATM capacity for IFR flights.

Specific improvements: traffic growth will lead to higher airspace throughput, but also to a higher number of aircraft simultaneously present in the airspace. Considering the results of the SWOT analysis, the service provider decides that there is a need for two separate performance objectives:

- Objective 1: increase en-route throughput that can be handled during typical heavy traffic time-periods.
- Objective 2: increase the number of aircraft that can be simultaneously accommodated in en-route airspace.

2.4 STEP 3: QUANTIFY OBJECTIVES

2.4.1 The principle of “reliance on facts and data for decision-making” implies that objectives should be specific, measurable, achievable, relevant and time-bound (SMART). The purpose of Step 3 in the process is to ensure that these aspects are properly addressed.

2.4.2 Step 3.1: Define how progress in achieving performance objectives will be measured and which data are required

2.4.2.1 This section explains briefly that as part of the performance-based approach there is a need for defining:

- indicators;
- the metrics underpinning those indicators; and
- common definitions for data aggregation and event classification.

2.4.2.2 It also addresses the measurement granularity and the need for harmonization.

2.4.2.3 Current/past performance, expected future performance (estimated as part of forecasting and performance modelling), as well as actual progress in achieving performance objectives is quantitatively expressed by means of **indicators** (sometimes called Key Performance Indicators, or KPIs).

2.4.2.4 Indicators are not often directly measured. They are calculated from supporting metrics according to clearly defined formulas, e.g. $\text{cost-per-flight-indicator} = \text{Sum}(\text{cost})/\text{Sum}(\text{flights})$. Performance measurement is therefore done through the collection of data for the supporting metrics (e.g. leads to a requirement for cost data collection and flight data collection).

2.4.2.5 Indicators need to be defined carefully:

- To be relevant, they need to correctly express the intention of the performance objective. Since indicators support objectives, they should not be defined without having a specific performance objective in mind.
- They need to be expressed in terms of supporting metrics for which there is adequate data availability.

2.4.2.6 When there is a problem with data availability, there are two possibilities:

- set up the appropriate data reporting flows and/or modelling activities, to ensure all supporting metrics are populated with data as required to calculate the indicator(s) associated with the objective; or
- if this is not possible, aim for a different kind of performance improvement, by choosing a different performance objective, as constrained by data availability.

2.4.2.7 Note that the need for an indicator lasts only as long as the corresponding performance objective exists.

2.4.2.8 Alternatively, the need for supporting metrics (such as the number of flights) lasts much longer because metrics are seldom indicator-specific, i.e. they are typically used to calculate a variety of indicators. When deciding which data to collect, a sufficiently broad spectrum of supporting metrics will have to be considered.

2.4.2.9 Data collection should take place at the most detailed level of granularity that can be afforded because the availability of detailed data greatly increases the effectiveness of the performance-based approach.

2.4.2.10 Common aggregation hierarchies and classification schemes (taxonomies) are then used to condense the detailed supporting metrics into clearly scoped summary indicators.

2.4.2.11 To conclude: in a collaborative environment in which many stakeholders contribute to the achievement of objectives and/or have performance reporting obligations, it is important to harmonize not only the definition of indicators and supporting metrics, but also the scope definitions, e.g. aggregation hierarchies and classification schemes (taxonomies).

Example — Step 3.1

The service provider has chosen to use the following indicators:

- To measure Objective 1:
 - Throughput demand as a number of IFR movements per hour. Defined as the number of IFR flights requiring entry to the airspace volume during a given one hour period.
 - Throughput capacity as a number of IFR movements per hour. Defined as the number of IFR flights which may enter the airspace without causing excessive ATC staff workload, and therefore without impeding safety.
 - Number of sectors. Defined as the number of sectors that are open in an airspace volume (FIR or part thereof) during typical busy hours.
- To measure Objective 2:
 - PIAC demand as a peak instantaneous aircraft count (PIAC). Defined as the number of IFR flights simultaneously present in the airspace at a given moment in time.
 - PIAC capacity as a peak instantaneous aircraft count (PIAC). Defined as the number of IFR flights which can be simultaneously present in the airspace volume at a given moment in time, without causing system overload (e.g. surveillance, flight data processing).

To calculate the above demand indicators, data will have to be collected at the level of individual flights. The following supporting metrics are needed:

- Entry time. Defined as the date and time at which a flight is entering the airspace volume.
- Exit time. Defined as the date and time at which a flight is leaving the airspace volume.

For each flight, entry and exit times will have to be calculated and/or recorded for every airspace volume for which calculation of the indicators is desired.

Calculation of indicators:

- Throughput demand: the number of flights with an entry time within the one-hour period for which the indicator is calculated.

- PIAC demand at time T1: PIAC demand at time T0 plus the number of flights with an entry time within the T0-T1 period minus the number of flights with an exit time within the T0-T1 period.

Aggregation hierarchy:

- The FIR is subdivided into two sector groups (north and south), which in turn consist of ATC sectors.
 - Indicators are calculated for sectors, sector groups and the FIR as a whole.

2.4.3 Step 3.2: Define the desired speed of progress in terms of baseline and target performance

2.4.3.1 The above-mentioned performance indicators are the quantifiers for how well performance objectives have been achieved.

2.4.3.2 **Performance targets** are closely associated with performance indicators: they represent the values of performance indicators that need to be reached or exceeded to consider a performance objective as being fully achieved. Note that performance targets can be set as a function of time (e.g. to plan yearly improvement); they can also vary by geographic area, stakeholder, etc. In addition, targets can be set at different levels: local, regional or global.

2.4.3.3 Once the scope of a target has been agreed, it becomes clear where and at which level performance management will need to be applied, between which stakeholders the achievement of the objective needs to be coordinated, and who will need to be involved in trade-off decisions. The term target is used with different meanings:

- current versus future: when the aim of the objective is to improve current performance over time, the term “target” refers to a future desired or required performance level;
- real versus design specifications: when the aim of the objective is to manage real performance so as to stay within pre-defined limits, the term “target” refers to design specifications.

2.4.3.4 Performance targets may be set with different intentions, for example:

- as a strategic design target, to support transition planning;
- as a recommendation or incentive to promote the need for action and accelerate improvements;
- as a legal requirement;
- as a performance level which needs to be achieved to enable other performance improvements;
- as a mandatory performance requirement which is necessary for safety reasons;
- to gain access to certain airspace or receive certain levels of service, etc.

The above examples are included to illustrate that targets can also be set to provide guidance and should not just be seen as an instrument for enforcement.

2.4.3.5 To understand how challenging it is to reach a target, one should know the **baseline performance**. The difference between the baseline and the target is called the **performance gap**. In a “current versus future” application, the size of the gap is often expressed as a percentage of the baseline performance (e.g. 10 per cent improvement needed to reach the target). For “real versus design specifications” applications, targets are usually expressed as absolute values, without reference to a baseline.

2.4.3.6 The determination of the baseline performance (calculation of baseline indicator values) is done during the previous iteration of the process. It is one of the results of Step 6: Assess achievement of objectives. This is part of the performance review.

2.4.3.7 The time available to achieve performance objectives is always limited. Therefore, targets should always be time-bound.

2.4.3.8 The target and the time available to reach the target determine the **required speed of progress** for the performance objective. Care should be taken to set targets so that the required speed of progress is realistic. Target setting is used as a tool by managers, policymakers, regulatory bodies and standardization organizations. Targets can have far reaching consequences depending on how challenging they are and how serious they are taken.

2.4.3.9 In the air navigation system, appropriate decision-making/policymaking processes need to be in place to collaboratively agree on performance objectives, performance indicators and the values of performance targets at the local, regional and, where required, global levels.

Example — Step 3.2

Baseline: today's performance has been determined to be:

- Northern part of the FIR:
 - Number of sectors: 5
 - The sectors have a capacity of 15 movements/hour, with a typical busy hour demand of 10 movements/hour
 - PIAC capacity of the sector group is 40 aircraft, with a typical busy hour PIAC demand of 25 aircraft
- Southern part of the FIR:
 - Number of sectors: 4
 - Sector capacity is 30 movements/hour, with a typical busy hour demand of 25 movements/hour
 - PIAC capacity of the sector group is 100 aircraft, with a typical busy hour PIAC demand of 80 aircraft

The **traffic growth forecast** for the next 15 years is:

- Northern part of the FIR: traffic density is expected to triple (x3)
- Southern part of the FIR: traffic density is expected to double (x2)

Target setting: it is decided to adopt the future typical busy hour demand as the capacity target. This results in the following capacity targets (absolute values: baseline demand multiplied by growth factor):

- Northern part of the FIR:
 - Sector capacity: $10 \times 3 = 30$ movements/hour
 - PIAC sector group capacity: $25 \times 3 = 75$ aircraft
- Southern part of the FIR:
 - Sector capacity: $25 \times 2 = 50$ movements/hour
 - PIAC sector group capacity: $80 \times 2 = 160$ aircraft

The **capacity gap** (for the “do nothing” scenario) is the difference between the target and the baseline performance:

- Northern part of the FIR:
 - Sector capacity gap: $30 - 15 = 15$ movements/hour
 - PIAC sector group capacity gap: $75 - 40 = 35$ aircraft

In terms of relative values (gap divided by baseline), the required capacity increase is:

- Northern part of the FIR:
 - Sector capacity: $15/15 = 100\%$ increase
 - PIAC capacity: $30/40 = 75\%$ increase
- Southern part of the FIR:
 - Sector capacity: $20/30 = 66\%$ increase
 - PIAC capacity: $60/100 = 60\%$ increase

2.5 STEP 4: SELECT SOLUTIONS TO EXPLOIT OPPORTUNITIES AND RESOLVE ISSUES

2.5.1 The purpose of this step is to apply the principle of “informed decision-making, driven by the desired/required results”.

2.5.2 It combines the knowledge of baseline performance, opportunities and issues with the performance objectives and targets, in order to make decisions in terms of priorities, trade-offs, selection of solutions and resource allocation. The aim is to optimize the decisions to maximize the achievement of the desired/required (performance) results.

2.5.3 Step 4.1: Select the decisive factors to reach the target performance

2.5.3.1 This part of the process is sometimes called performance gap analysis.

2.5.3.2 As a result of Step 2, a qualitative inventory of present and future opportunities and issues that may require performance management attention is already available (see 2.3.2).

2.5.3.3 This list now needs to be analysed in a performance oriented way, to assess (i.e. quantify) the impact of drivers, constraints, impediments, etc., on the objective(s) under consideration. In other words: to what extent, when and under which conditions do these contribute to (or prevent) the required performance improvements.

2.5.3.4 When analysing blocking factors for runway capacity improvement for example, it may turn out that for a given airport (example: single runway without parallel taxiway), the dominant blocking factor is runway occupancy time, rather than wake vortex separation minima. Knowing this, it is clear that solutions that reduce runway occupancy time will contribute to runway capacity enhancement, whereas solutions which reduce wake vortex separation minima will not contribute to the achievement of the objective in this particular example. Likewise, at some airports the dominant constraining factor may be runway capacity, but elsewhere it may be gate and apron capacity.

2.5.3.5 In order to make progress in reaching an objective, the dominant factors first need to be undertaken. So the outcome of this activity is a selection and prioritization of opportunities and issues. This can be seen as the development of a “performance strategy” for the achievement of a given objective: working “backwards” from expectation related objectives, it cascades performance requirements down to a selection of subordinate, enabling objectives and targets (e.g. to improve airport capacity, we first need to improve runway capacity, for which we first need to reduce runway occupancy time).

2.5.3.6 This part of the process:

- eliminates/defers issues that do not immediately or significantly affect the achievement of objective(s);
- helps to maximize effectiveness if performance improvements have to be realised with limited resources (e.g. budget, manpower);
- creates a “traceability chain”, and/or a “performance case” which explains what will be improved and how much, prior to the selection of solutions; and
- progresses the decision-making to the point where it is appropriate to start thinking in terms of available solutions (options).

Example — Step 4.1

Analysis of drivers: after collaborative checking of the forecasting assumptions and models, there is a shared belief between the service provider of FIR YYYY, the neighbouring ANSPs and the regional planners that traffic will indeed grow as forecasted.

At present, in both the northern and southern parts of the FIR, there is some spare capacity. After analysis of the data, it is decided that:

- no capacity increases are required for the next five years.

Then:

- procedural control will be the dominant blocking factor in the northern part of the FIR. This will have to be addressed as a matter of priority;
- controller workload may become an issue; and

- degradation of surveillance performance (SSR capacity limits exceeded) will be the next blocking factor affecting capacity in the southern part of the FIR.

The following issues are classified as lower priority, because their limiting effect on capacity enhancements lies much further into the future:

- frequency shortage; and
- staff shortage due to air traffic controller retirements.

Assessment of the investment risk associated with a possible drop in the volume of overflying traffic:

- probability assessment: at present, analyses of future demand, route structures and airspace availability in neighbouring countries seem to indicate that the probability of traffic flow re-routing is rather low for the next ten years; and
- severity assessment: the effect of a drop in the volume of overflying traffic could be lessened by finding more cost-effective ways of increasing capacity.

Opportunity analysis: after analysing how other regions have implemented ADS-B, the service provider is confident that ADS-B is a viable alternative to other surveillance technologies.

2.5.4 Step 4.2: Identify solutions to exploit opportunities and mitigate the effects of the selected drivers and blocking factors

2.5.4.1 At this stage, decision-makers need to know their options for mitigating pre-identified issues and therefore to exploit available opportunities. This part of the process is about establishing the list of options, i.e. defining the “solution space” which is at the disposal of decision-makers for optimizing the achievement of performance objectives.

2.5.4.2 In the above example, for the objective “reducing runway occupancy time”, the list of possible solutions/options may include:

- building extra taxiways to avoid the need for backtracking or to eliminate the need for runway crossings;
- building high speed runway exits to give more options for vacating the runway, thereby reducing runway occupancy time; and
- equipping aircraft with “brake-to-vacate”² technology, which enables pilots to select a runway exit while the aircraft is making its landing approach. This increases the predictability of runway occupancy time, which in turn allows reducing the separation minima on final approach. The latter will lead to increased capacity if runway occupancy time is the dominating blocking factor.

2. Brake-to-vacate uses the auto-flight, flight controls, and auto-brake systems to regulate deceleration after touchdown. This allows the aircraft to reach a specified exit at the correct speed under optimum conditions.

2.5.4.3 The list of solutions relates to the list of issues. In this example, each solution addresses a different issue (which may or may not be present at a given airport), but they all contribute to the same performance objective.

2.5.4.4 When the task is to improve the effectiveness of the day-to-day economic and operational management, the list of options will most likely be populated with off-the-shelf solutions and best practices, i.e. solutions which are readily available.

2.5.4.5 When working with longer time horizons (during transition planning), a number of the options or operational improvements may still be in their research, development and trials phases, meaning that decision-makers will have to work with a “living” list of options, which are still surrounded by a certain degree of uncertainty.

2.5.4.6 In any case, decision-makers need to gain a good understanding of the strategic fit, the benefits, cost and feasibility of each option for operational improvement. Therefore, the description of the operational improvements in the list needs to show that they have been developed from different complementary perspectives. To produce this list of options, the performance-based approach should be applied at each level.

- they must fit within high-level strategy and policy orientations;
- they must be on the transition path towards the operational concept/concept of operation;
- they must take into account the architecture in which the technical system enablers (e.g. flight data processing systems, CNS systems) will need to fit;
- they need to be associated with a baseline (“before” state) from which they can be deployed and will start delivering benefits;
- they depend on the feasibility/timing of developing and deploying the required enablers. Typically this will provide information on earliest availability;
- a safety and human factors assessment is required to have sufficient confidence that the operational improvement is feasible from a human factors and safety perspective, and that a list of issues that first need to be addressed during the development life cycle is raised;
- the expected performance enhancement contribution needs to be known. More specifically, issues that need to be resolved (or opportunities exploited) under which circumstances should be explicitly specified, so as to quantify the resulting performance improvement. The performance improvement is to be shown first in terms of affected supporting metrics, which can then be expressed as performance indicator changes, which in turn are linked to performance objectives, focus areas, expectations and key performance areas. The preferred way of assessing expected performance is through modelling (see Appendix D). If this is for some reason not possible, a pragmatic way forward is through expert judgement with consensus building; and
- the performance assessment should also have identified all relevant side effects. Information on side effects is needed for trade-off decision-making. This covers disadvantages such as:
 - increased cost;
 - increased resource consumption; and
 - unintended performance reduction in other areas.

2.5.4.7 The *Global Air Navigation Plan* (Doc 9750) is a useful source for developing the list of options/operational improvements. Use can also be made of work already developed in other regions.

2.5.4.8 In those cases where a list of options/operational improvements was already developed during a previous planning cycle, the task consists of updating the list to take the latest developments into account. In the case of transition planning — where the process may be executed only once every five years — “updating the list” means significantly “refining the list”.

Example — Step 4.2

The issues which were identified as having to be mitigated as a matter of priority are:

- capacity limits associated with procedural control in the northern part of the FIR;
- controller workload in the southern part of the FIR; and
- the SSR capacity limits in the southern part of the FIR.

Candidate solutions (in terms of operational improvements and enablers) have been identified by the service provider as:

- moving from procedural control to radar control (required enabler: surveillance coverage);
- sector splitting (horizontal and vertical);
- replacement of SSR technology by a system with higher PIAC capability; and
- choice of surveillance technologies:
 - SSR;
 - Mode-S radar; and
 - ADS-B.

2.5.5 Step 4.3: Select a sufficient set of solutions

2.5.5.1 This is the part of the process where decisions are made based on which solution(s) to implement. The following information is available to support decision-making:

- definition of system/expectation scope and context;
- the required results in terms of performance objectives and targets (in some cases, for a certain date, in other cases, as an evolution through time, specifying a “required speed of progress”, e.g. four per cent improvement per year);
- prioritized issues and opportunities, and their impact on performance; and
- an overview of candidate solutions and their capability to resolve issues and exploit opportunities, in terms of:

- list of operational improvements; and
- associated enablers (services and procedures, human resources, systems and technology, and regulation and standardization).

2.5.5.2 It is within this framework that decisions have to be taken. The nature of the decision and the method best applied depend on the situation, as explained below.

2.5.5.3 Assume an example in which one has identified a number of candidate solutions to increase runway capacity. The requirement is to exceed a certain capacity target while staying below a certain cost target. This is illustrated in Figure I-2-2.

2.5.5.4 For each candidate solution, the expected runway capacity and associated cost have been assessed during the previous step. With this information, the various candidate solutions can be positioned in the capacity/cost diagram of Figure I-2-2.

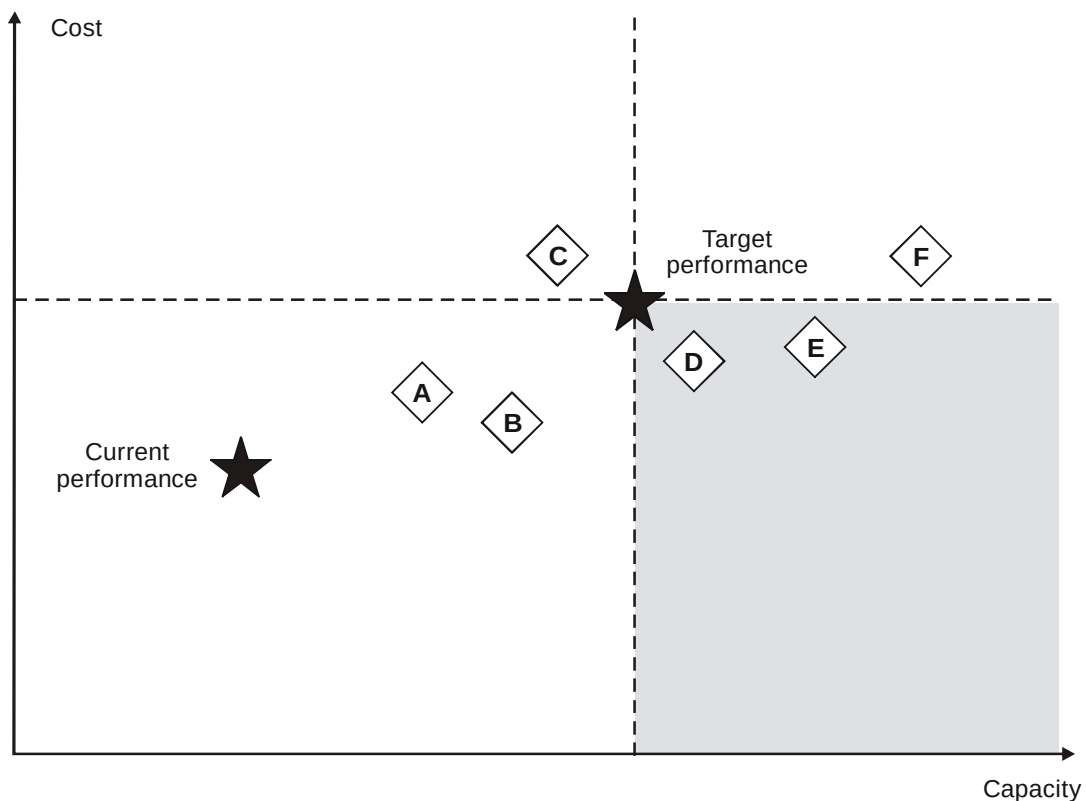


Figure I-2-2. Expected performance of candidate solutions (example)

2.5.5.5 What is the decision to be taken and which method is to be used? Depending on which subset of the solutions is available, the answer will vary. Your project may be faced with any combination of the situations described in Table I-2-1.

Table I-2-1. Selection of solutions (example)

Case	Solutions	Decision
1	Only A, B, C, and F are available. None of these solutions meets both targets.	None of the proposed solutions is satisfactory. Decide whether to: — continue searching for solutions which address the selected issues and opportunities and meet all targets; — focus on different issues and opportunities (this assumes that the objectives can be achieved using a different method or by setting different priorities); — relax the target(s) (which makes it easier to achieve the objective(s), but the impact of this would need to be assessed); or — abandon the performance objective(s) altogether (this also requires an impact assessment).
2	D and E are under development and not yet available when needed.	Decide what can be done to advance the availability date of D and E. In many cases, availability constraints are imposed by enabler deployment and this would imply a need to accelerate the deployment of certain enablers.
3	Only D is available and/or meets all targets.	There are no alternatives to choose from. Accept solution D.
4	Only D and E are available. They are mutually exclusive.	Both candidate solutions exceed the targets. Select the “best buy”. Is it worth choosing E instead of D? A commonly used method for making the decision is multi-criteria decision analysis (MCDA).
5	Only D and E are available. They can be applied simultaneously.	D and E may be complementary in delivering performance benefits (improving performance in different places, at different times of the day, under different conditions). Decide whether to combine them into one “implementation package”.
6	Only D and E are available.	It may make sense to first use solution D, and after a while (some years) to replace D by E to achieve better performance. Decide how to include D and E in the “road map” or “deployment sequence”.
7	D is available, but its capacity will suffer if solution G (which improves flexibility, not shown in Figure I-2-2) is also applied.	This is the case where D and G interfere with each other from a performance perspective. Trade-off considerations will need to be part of the decision process. The aim is to take a balanced decision. See Appendix A for more information about trade-offs.
An overview of how the seven cases above relate to each other is given in Figure I-2-3.		

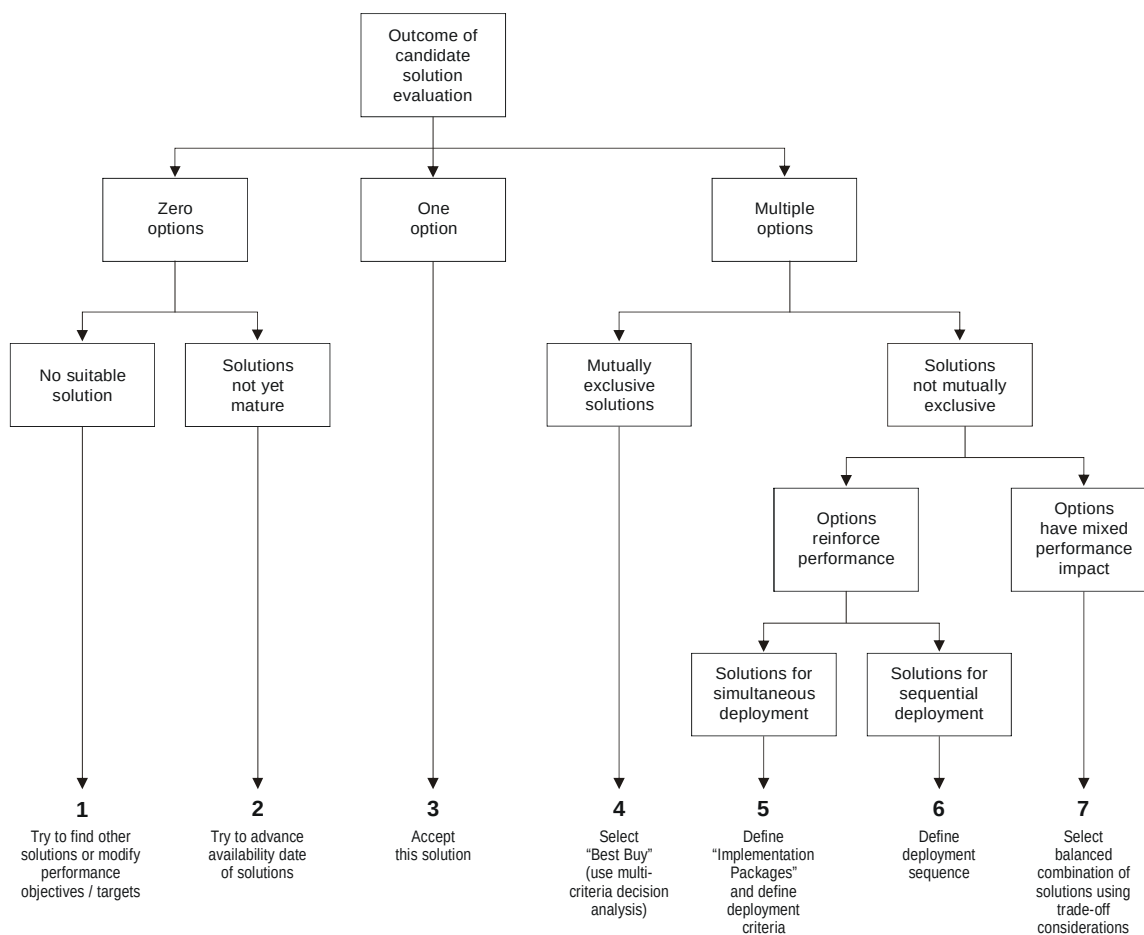


Figure I-2-3. Selection of solutions

2.5.5.6 Depending on the nature of the project, the output of this process step is either a single preferred solution, or a road map of selected solutions (combined into implementation packages and sequenced into a deployment sequence), accompanied by an initial performance case that describes those issues which are resolved and opportunities exploited, together with the expected costs and benefits in terms of performance improvement towards the specified targets.

Example — Step 4.3

Different solutions are chosen for the northern and southern parts of the FIR. This is due to the fact that the targets as well as the baseline system are different. The description below explains the rationale behind the decisions.

Operational improvements selected for the northern part of the FIR:

- Since the target for sector capacity is 30 movements/hour, which is equal to the baseline capacity of the sectors in the southern part of the FIR, sector splitting is not necessary. The number of sectors will remain unchanged, but their capacity will be increased by 100 per cent, and this will be achieved by moving from “procedural” control to “radar” control. The choice of supporting surveillance technology is described in the section “enablers”.

Operational improvements selected for the southern part of the FIR:

- In this example there are no options available that allow sector capacity to be increased beyond today's 30 movements/hour; however, we need a 66 per cent increase. This will be achieved by reorganizing the sectorization in the southern part of the FIR to increase the number of sectors from four to seven, with a capacity of 30 movements/hour each. Independent of that, the problem of degraded surveillance performance under conditions of higher traffic density will still have to be resolved.

Selection of enablers:

- Sector splitting requires the installation of three more controller workstations. Computer system/software changes are not necessary: the flight data processing and tracking systems have sufficient spare capacity.
- There is no need for recruitment of additional controllers: it is determined that the extra human resource requirement can be accommodated through more efficient rostering.
- Surveillance coverage is required in the northern part of the FIR. Options: SSR, Mode-S radar, and ADS-B.
- In the southern part of the FIR, SSR will become inadequate and will have to be replaced. Options: Mode-S radar and ADS-B.

- The service provider has determined that having different surveillance systems in the north and the south is undesirable for various reasons (cost-effectiveness, airspace user equipage, etc.). This rules out SSR as an option for the north.
- Therefore, the shortlist of options for the entire FIR is Mode-S radar and ADS-B. After more detailed evaluation, the service provider decides to select ADS-B. Under the given circumstances, it is a more cost-effective solution with sufficient potential for long-term capacity.

2.6 STEP 5: IMPLEMENT SOLUTIONS

2.6.1 Step 5 is the execution phase of the performance management process. This is where the changes and improvements that were decided upon during the previous step are organized into detailed plans, implemented, and begin delivering benefits.

2.6.2 Depending on the nature and magnitude of the change, this could mean:

— In the case of small-scale changes or day-to-day management:

- assigning management responsibility for the implementation to an individual;
- assigning responsibility and accountability for reaching a performance target to an individual or organization;

— In the case of major or multi-year changes:

- refining the road map of selected solutions into a detailed implementation plan, followed by the launching of implementation projects.
- Ensure that each individual implementation project is operated in accordance with the performance-based approach. This means launching and executing the performance management process at the level of individual projects. Each project derives its scope, context and expectations (see Step 1 of the process) from the overall implementation plan.

Example — Step 5

At this stage of the process, a plan is developed for the three main projects:

- The re-sectorization project
- The ADS-B implementation project (covering both the airspace user and ground segments)
- The SSR decommissioning project