Global ATM System

~ Performance framework ~

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International Civil Aviation Organization

Seventh Central Caribbean

Working Group Meeting
(Mexico City, 13-16 July 2009)

Overview

- History and Back ground
- ICAO planning process
- ATM Operational Concept
- Global Air Navigation plan
- Performance Based Approach
- Air Navigation Projects
- Way forward

History and Background

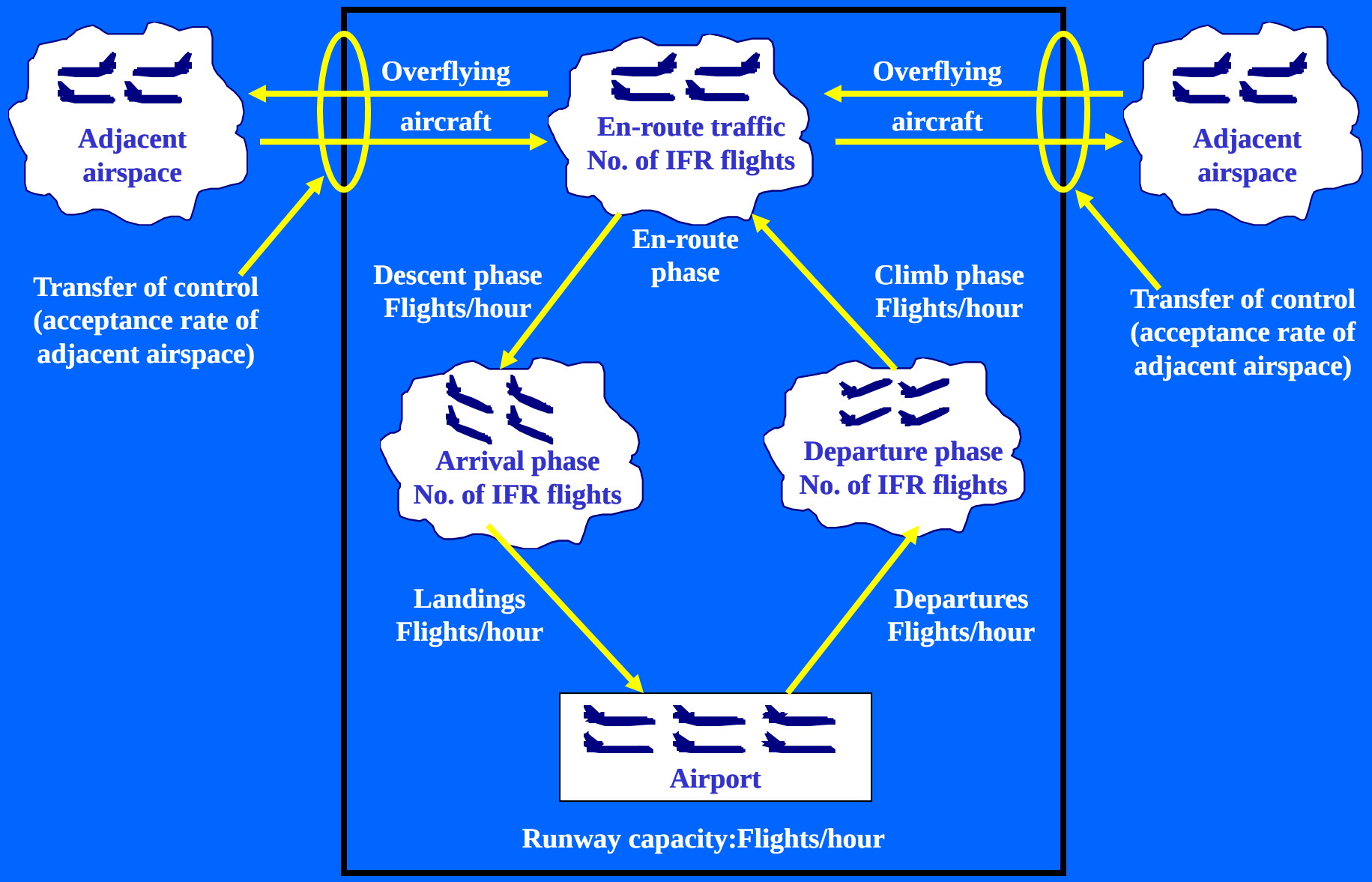
ATM Community

~ Strategic vision ~

To foster the implementation of an global air traffic management system for all users during all phases of flight that:

- **meets agreed levels of safety**
- **provides for optimum economic operations**
- **is environmentally sustainable**
- **meets national security requirements**

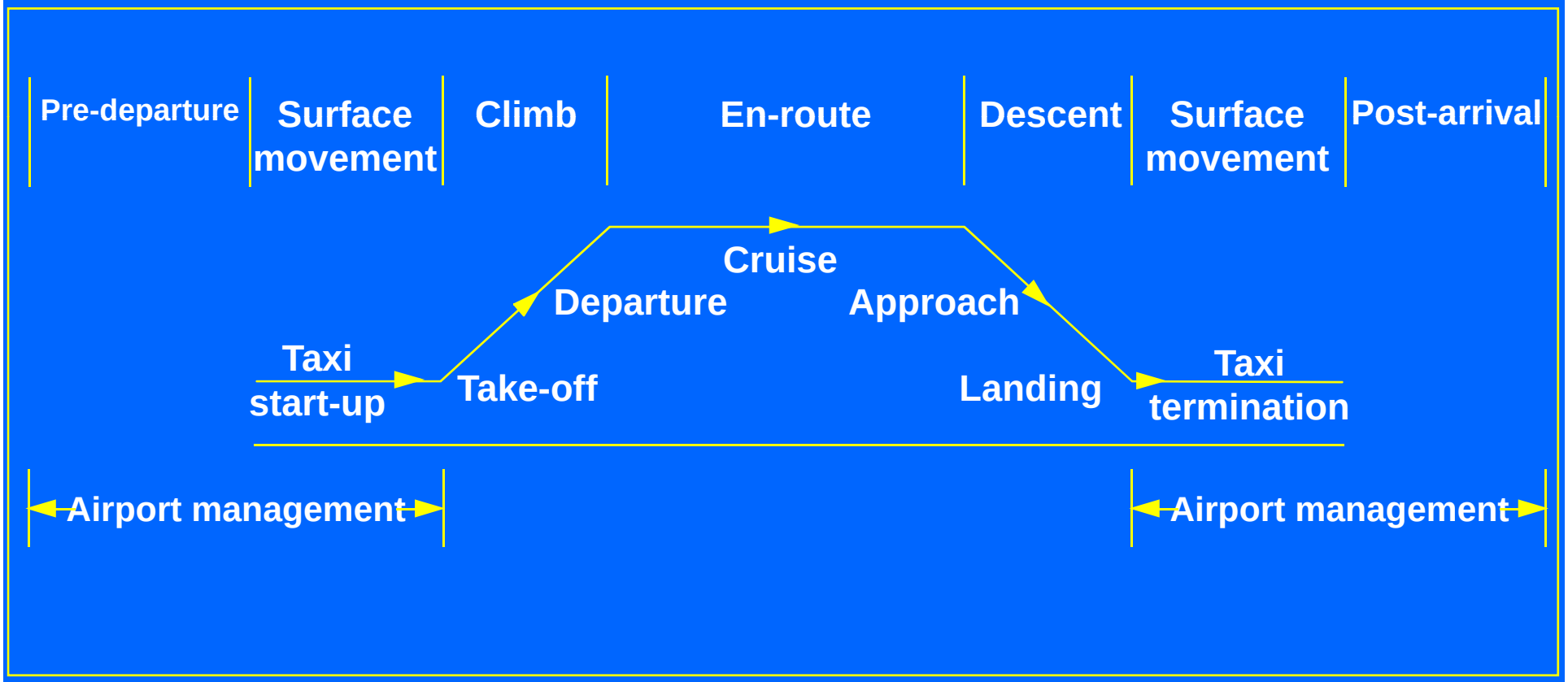
AREA OF RESPONSIBILITY OF A STATE



Capacity assessment for ATM

Phases of flight

Gate to Gate Operation

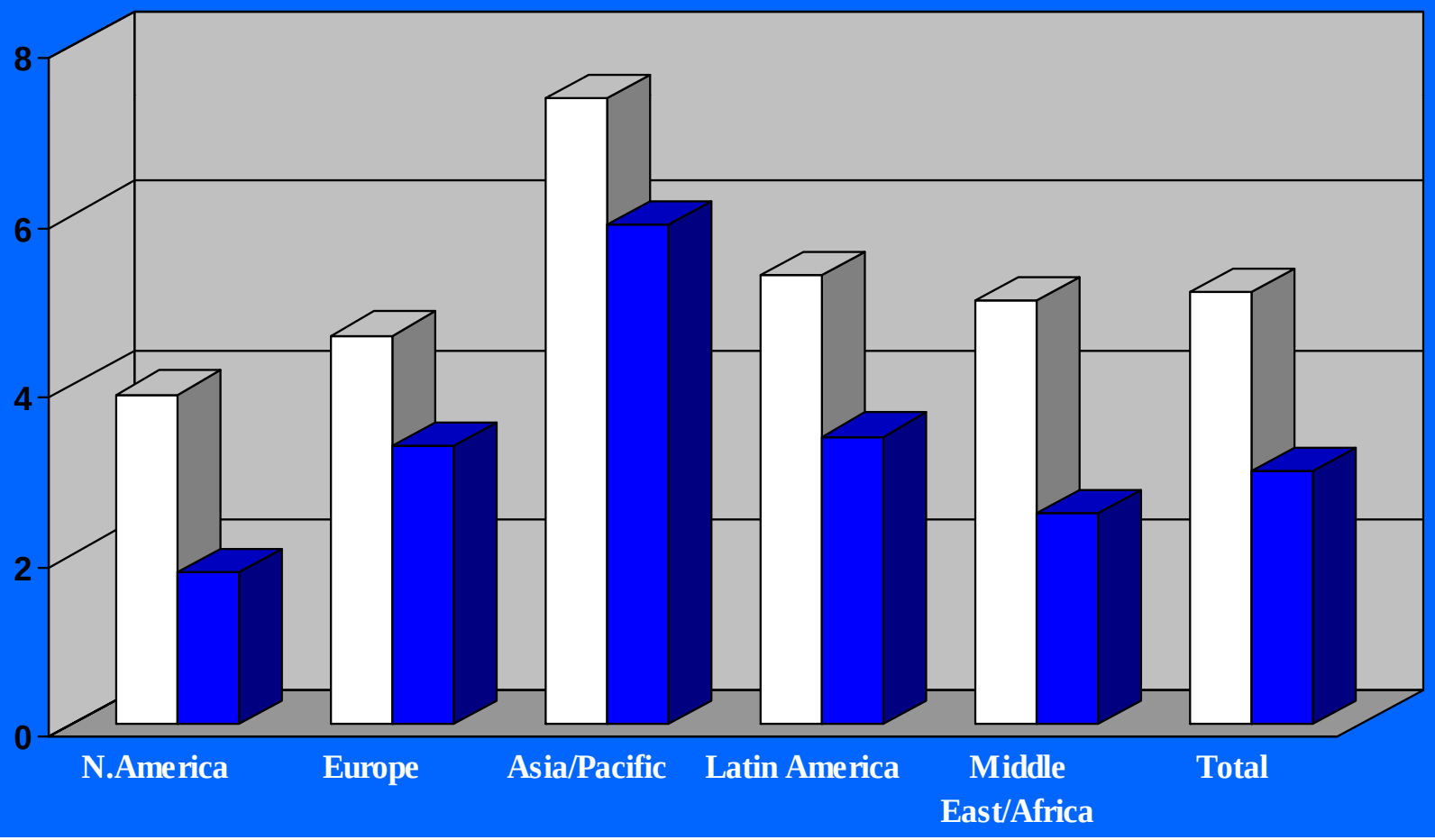


Air Navigation System Limitations

- Line-of-sight propagation of ground based CNS facilities
- Difficulty in the implementation of ground based CNS facilities in large parts of the world
- Lack of Digital Air Ground Data interchange Systems

Projected Growth in Air Traffic Demand

Average Annual Increases in Traffic Movements 1992 – 2010



Need for change

- Increased growth in air traffic
- Limitations of ground based CNS systems
- New technologies provide solutions
- Requirement for global consistency

↓

- FANS (Future Air Navigation Systems) Committee was established to address the above issues

CNS/ATM System concept

- **ICAO Assembly endorses FANS concept:** **Sept. 92**
- **ICAO CNS/ATM systems implementation task force addressed funding, cost recovery & promotion of the concept:** **Dec. 94**

CNS/ATM distinct features …

a) have a mix of satellite and ground-based systems

b) provides global coverage

c) uses interoperable systems

(1/2)

CNS/ATM distinct features

d) **provides seamlessness**

e) **employs air/ground data link**

f) **employs digital technologies**

g) **comprises various levels of automation**

(2/2)

Global ATM system

It is a worldwide system which:

- **Facilitates interoperability of different technologies;**
- **accommodates different procedures;**
- **covers all elements of AN systems (ATM, CNS, AGA, AIM and MET); and**
- **provides harmonization**

thus leading to seamlessness across regions

This is achieved through progressive, cost effective and cooperative implementation of air navigation systems worldwide

Eleventh Air Navigation Conference (22 September - 2 October 2003)

- Endorsed the global ATM operational concept
- Noted that corporatization and a more structured regulatory environment were placing increasing pressure on accountability
- Urged ICAO to develop a performance framework for Air Navigation Systems

35th Session of the Assembly September 2004

- Called upon States, PIRGs and the aviation industry to use the ICAO Global ATM Operational Concept as the common framework
- Requested ICAO to develop the transition strategies, ATM requirements and SARPs necessary to support implementation of a global ATM system
- Urged ICAO to ensure that the future global ATM system is performance based and that the performance objectives and targets for the future system are developed in a timely manner

Documentation developed for Performance Planning …

Document	Description	Objective	Role	Guidance
ATM Operational Concept (Doc 9854) (Available on ICAONET)	The ATM Operational Concept (ATMOC) presents the ICAO vision of an integrated, harmonized global air traffic management system. The planning horizon is up to and beyond 2025.	To achieve an interoperable global air navigation system, for all users during all phases of flight, that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable and meets national security requirements.	Vision	**ATM System Requirements** document (Doc 9882) (Available on ICAONET), will ensure that all ATM related standards making and industry work will be in support of the operational concept

1/3

Documentation developed for Performance Planning ...

Document	Description	Objective	Role	Guidance
Global Air Navigation Plan (Doc 9750) (Available on ICAONET)	Strategic document that describes the methodology for global air navigation harmonization.	Establishes the focus for near and medium term activities	Strategy	**Manual on Global Performance** of the Air Navigation System (Doc 9883) (available on ICAONET). **Part I provides a comprehensive understanding** of the intent, expected benefits and delivery mechanisms of the performance-based air navigation system and provides guidance on measuring and evaluating ATM performance; **Part II provides transition strategies** and supports the Global Plan as a transition planning document.
Global Plan Initiatives (Part of Global Plan)	A set of implementation methodologies derived from operational environment	Measurable progress towards the implementation of the ATMOC	Tactical	

Documentation developed for Performance Planning

Document	Description	Objective	Role	Guidance
Regional Plans (Available on ICAONET)	Regional work programmes including the planning and monitoring of the detailed activities and their timelines which, inter alia, lead to the realization of a global air traffic management system as envisaged in the operational concept.	Contains the performance directives and associated requirements for facilities and services, established through regional air navigation agreements, in support of the global air navigation infrastructure.	Action	**ICAO Business Plan** ICAO Strategic Objectives (Available on ICAONET)

Summary
Evolution from Ground based AN systems to Performance based Global ATM system

Performance based Global ATM system (2008)

↑

Global ATM system (2006)

↑

CNS/ATM systems (1994)

↑

Future AN systems (1992)

↑

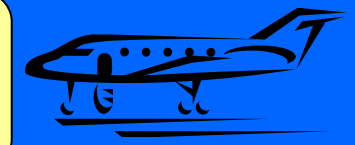
Ground based AN systems (Before 1992)

A PERFORMANCE BASED GLOBAL ATM SYSTEM

ICAO Planning process

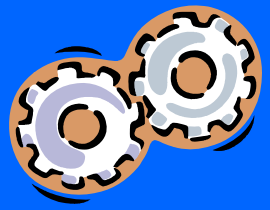
The ICAO Planning Process

Vision



The concepts to implement the safety and efficiency strategic objectives

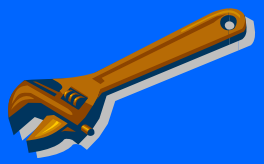
Strategy



Global Air Navigation Plan

Global Aviation Safety Plan

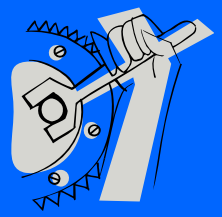
Tactics



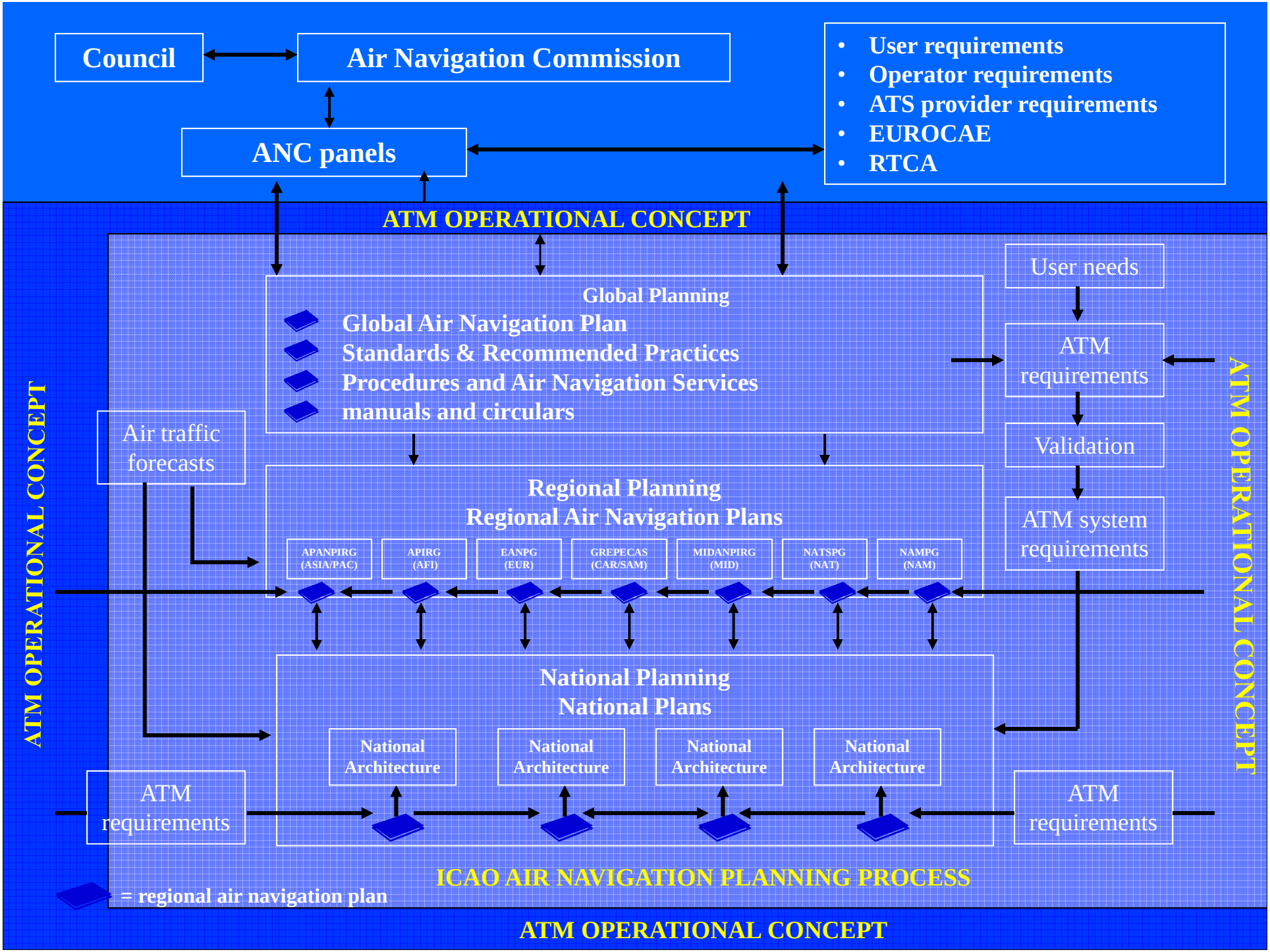
Global Performance Initiatives (GPI)

Global Safety Initiatives (GSI)

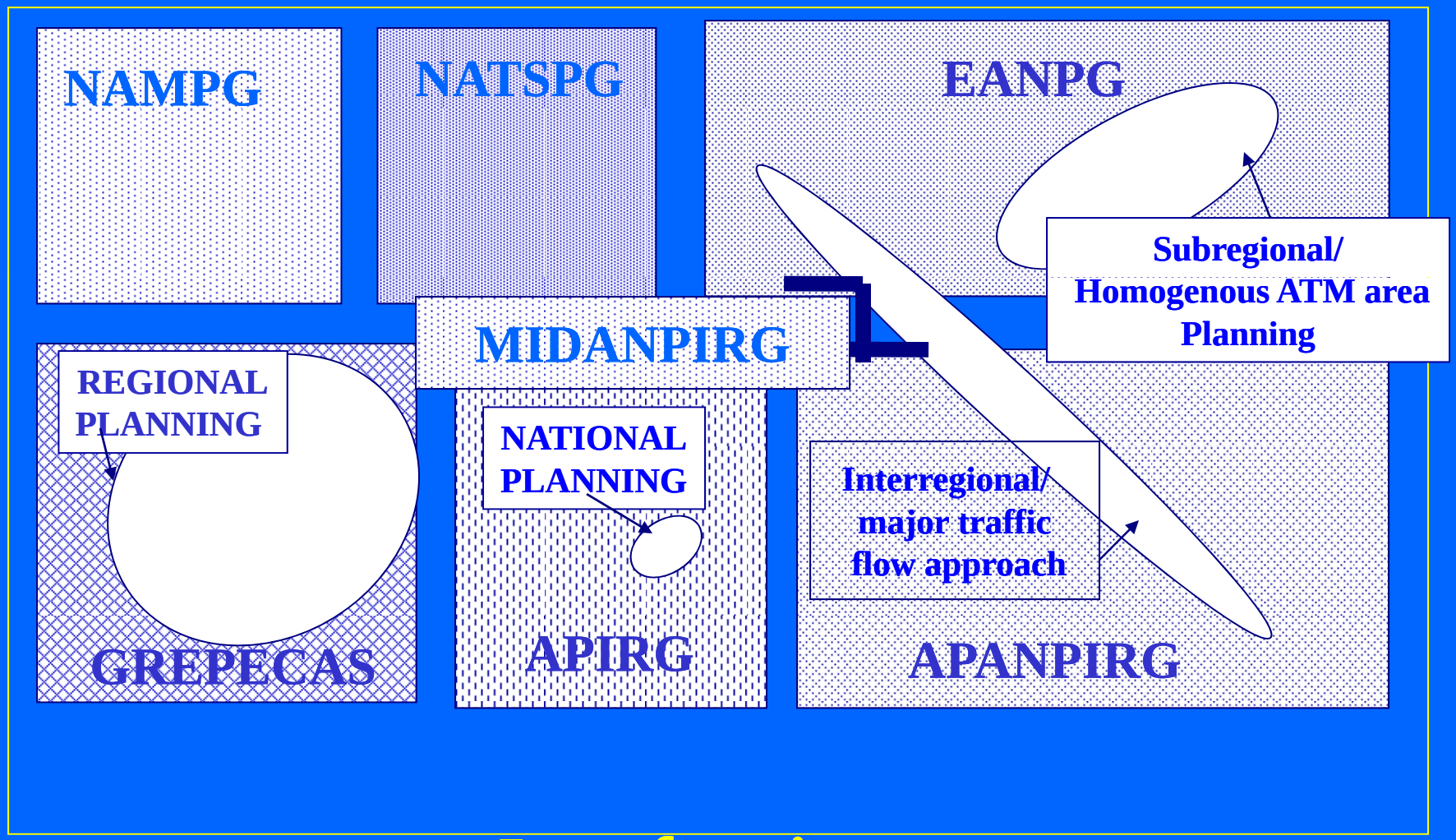
Action



Regional and National plans


Council
Air Navigation Commission
ANC panels
User requirements
Operator requirements
ATS provider requirements
EUROCAE
RTCA
ATM OPERATIONAL CONCEPT
Global Planning
Global Air Navigation Plan
Standards & Recommended Practices
Procedures and Air Navigation Services
manuals and circulars
User needs
ATM requirements
Validation
ATM system requirements
Air traffic forecasts
Regional Planning
Regional Air Navigation Plans
APANPIRG (ASIA/PAC)
APIRG (AFI)
EANPG (EUR)
GREPECAS (CAR/SAM)
MIDANPIRG (MID)
NATSPG (NAT)
NAMPG (NAM)
National Planning
National Plans
National Architecture
National Architecture
National Architecture
National Architecture
ATM requirements
ATM requirements
ICAO AIR NAVIGATION PLANNING PROCESS
= regional air navigation plan
ATM OPERATIONAL CONCEPT
ATM OPERATIONAL CONCEPT
ATM OPERATIONAL CONCEPT

Major traffic flows

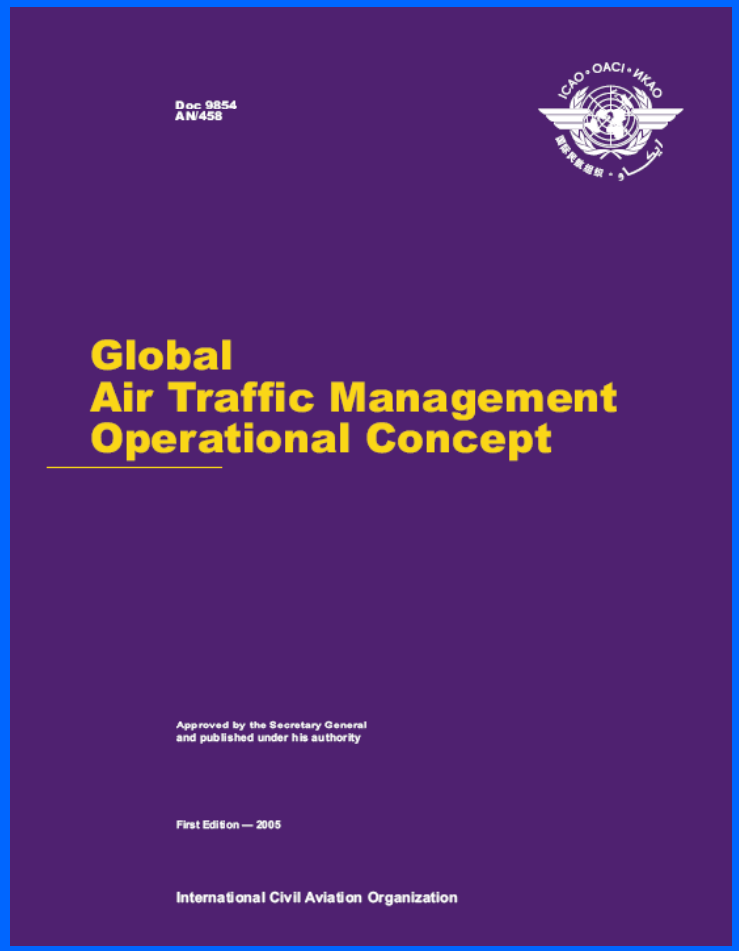


Interface issues

AIR TRAFFIC MANAGEMENT OPERATIONAL CONCEPT

Global ATM - Operational Concept

- describes how an integrated global ATM system should operate
- discusses how the services form an integrated system
- utilizes an information rich environment, that solves most problems strategically, through a collaborative process
- provides States and industry with clearer objectives for the design and implementation of air navigation systems
- ATM user expectations are drivers for change, requiring:
  - Safety case
  - Business case

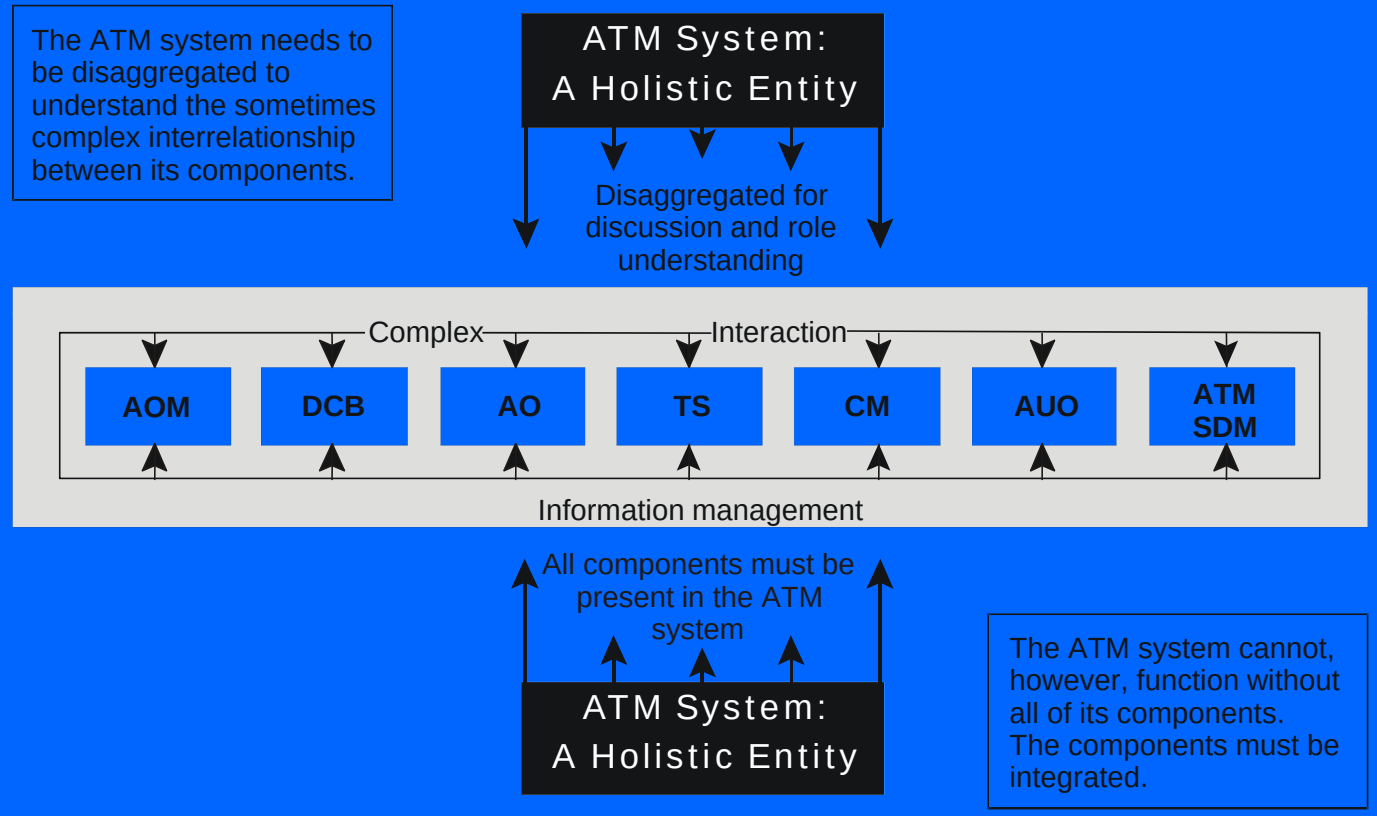


Six Guiding Principles

- Safety
- Humans
- Technology
- Information
- Collaboration
- Continuity

The ATM concept components

The ATM system needs to be disaggregated to understand the sometimes complex interrelationship between its components.



The ATM system cannot, however, function without all of its components. The components must be integrated.

AOM — Airspace organization and management
DCB — Demand/capacity balancing
AO — Aerodrome operations
TS — Traffic synchronization
CM — Conflict management
AUO — Airspace user operations
ATM SDM — ATM service delivery management

Seven Concept Components

- Airspace organization and management (AOM)
- Aerodrome operations (AO)
- Demand and capacity balancing (DCB)
- Traffic synchronization (TS)
- Airspace user operations (AUO)
- Conflict management (CM)
- ATM service delivery management (SDM)

Airspace Organization and Management (AOM)

- All airspace will be the concern of ATM and will be a useable resource
- Any restriction on the use of any particular volume of airspace will be considered transitory
- Airspace management will be dynamic and flexible

Aerodrome Operations (AO)

- Runway occupancy time will be reduced
- The ability to safely manoeuvre in all weather conditions
- Precise surface guidance to and from a runway
- The position and intent of all vehicles and aircraft operating on the manoeuvring and movement areas will be known

Demand and Capacity Balancing (DCB)

- Through CDM at the strategic stage, assets will be optimized
- Through CDM at the pre-tactical stage, adjustments will be made to assets, resource allocations, projected trajectories, airspace organization, and allocation of entry/exit times
- At the tactical stage, dynamic adjustments to the organization of airspace to balance capacity; dynamic changes to the entry/exit times

Traffic Synchronization (TS)

- Dynamic 4-D trajectory control and negotiated conflict-free trajectories
- Choke points will be eliminated
- Optimisation of traffic sequencing will achieve maximization of runway throughput.

Airspace User Operations (AUO)

- ATM data will be fused for an airspace user's situational awareness and conflict management
- Airspace user operational information will be made available to the ATM system
- Individual aircraft performance, flight conditions, and available ATM resources will allow dynamically-optimised 4-D trajectory planning

Conflict Management (CM)

- Collaborative decision making
- Aircraft should be designed with the ATM system as a key consideration

ATM Service Delivery Management (SDM)

Principles include:

- **Trajectory, profile, and aircraft or flight intent**
- **Management by trajectory**
- **Clearance**

8 Members of ATM Community

- Aerodrome operators
- Airspace providers
- Airspace users
- ATM service providers
- ATM support industry
- ICAO
- Regulatory authorities
- States

Eleven Expectations

- Access and Equity
- Capacity
- Cost-effectiveness
- Efficiency
- Environment
- Flexibility
- Global interoperability
- Participation by the air navigation system community
- Predictability
- Safety
- Security

Access and Equity

- A global air navigation system should provide an operating environment that ensures that **all airspace users have right of access** to the air navigation system resources needed to meet their specific operational requirements and that the shared use of airspace by different users can be achieved safely.
- The **global air navigation system system should ensure equity for all users** that have access to a given airspace or service.

Capacity

- **The global air navigation system should exploit the inherent capacity to meet airspace user demands at peak times and locations while minimizing restrictions on traffic flow.**
- **To enable future growth, capacity must increase, while ensuring that there are no adverse impacts on safety, and giving due consideration to the environment.**

Cost-effectiveness

- The air navigation system **should be cost-effective**, while balancing the varied interests of the air navigation system community
- The **cost of service to airspace users should always be considered** when evaluating any proposal to improve ATM service quality or performance.
- ICAO policies and principles regarding **user charges should be followed.**

Efficiency

- Efficiency **addresses the operational and economic cost-effectiveness** of gate-to-gate flight operations from a single-flight perspective.
- In all phases of flight, **airspace users** want to depart and arrive at the times they select and **fly the trajectory they determine to be optimum.**

Environment

- **The air navigation system should contribute to the protection of the environment by considering noise, gaseous emissions and other environmental issues in the implementation and operation of the global air navigation system.**

Flexibility

- **Flexibility addresses the ability of all airspace users to modify flight trajectories dynamically and adjust departure and arrival times, thereby permitting them to exploit operational opportunities as they occur.**

Global interoperability

- **The air navigation system should be based on global standards and uniform principles to ensure the technical and operational interoperability of ATM systems and facilitate homogeneous and non-discriminatory global and regional traffic flows.**

Participation by the Air Navigation System community

- The air navigation system community should have a continuous involvement in the planning, implementation and operation of the system to ensure that the evolution of the global ATM system meets the expectations of the community.

Predictability

- **Predictability refers to the ability of airspace users and ATM service providers to provide consistent and dependable levels of performance.**
- **Predictability is essential to airspace users as they develop and operate their schedules.**

Safety

- **Safety is the highest priority in aviation**
- **ATM plays an important part in ensuring overall aviation safety**
- **Uniform safety standards and risk and safety management practices should be applied systematically to the air navigation system**
- **Safety needs to be assessed in accordance with appropriate and globally standardized safety management processes and practices**

Security

- **Adequate security is a major expectation of the air navigation system community and of citizens. The air navigation system should therefore contribute to security, and ATM as well as ATM-related information should be protected against security threats.**

GLOBAL PLAN FOR AIR NAVIGATION SYSTEMS

Global Plan

- **Global Plan developed on the basis of**
  - Recommendations of AN-Conf/11
  - Global ATM Operational Concept
  - Industry Roadmap, which provides the near and medium industry requirements

- **In addition Global Plan provides guidance on environment, business case, costs, human resources, etc.**

Global Plan Initiatives (GPI)

- Options for ATM improvements
- Relate to ATM objectives
- Result in direct performance enhancements
- Based on Industry Roadmaps and current regional activities
- Bring near- and medium-term benefits to aircraft operators

Global Plan initiatives & their relationships to the major groupings … *(1/3)*

GPI		En-route	Terminal Area	Aerodrome	Supporting Infrastructure	Related Operational Concept Components
GPI-1	Flexible use of airspace	X	X			AOM, AUO
GPI-2	Reduced vertical separation minima	X				AOM, CM
GPI-3	Harmonization of level systems	X				AOM, CM, AUO
GPI-4	Alignment of upper airspace classifications	X				AOM, CM, AUO
GPI-5	RNAV and RNP (Performance-based navigation)	X	X	X		AOM, AO, TS, CM, AUO
GPI-6	Air traffic flow management	X	X	X		AOM, AO, DCB, TS, CM, AUO
GPI-7	Dynamic and flexible ATS route management	X	X			AOM, AUO
GPI-8	Collaborative airspace design and management	X	X			AOM, AUO

Global Plan initiatives & their relationships to the major groupings … *(2/3)*

GPI		En-route	Terminal Area	Aerodrome	Supporting Infrastructure	Related Operational Concept Components
GPI-9	Situational awareness	X	X	X	X	AO, TS, CM, AUO
GPI-10	Terminal area design and management		X			AOM, AO, TS, CM, AUO
GPI-11	RNP and RNAV SIDs and STARs		X			AOM, AO, TS, CM, AUO
GPI-12	Functional integration of ground systems with airborne systems		X		X	AOM, AO, TS, CM, AUO
GPI-13	Aerodrome design and management			X		AO, CM, AUO
GPI-14	Runway operations			X		AO, TS, CM, AUO
GPI-15	Match IMC and VMC operating capacity		X	X	X	AO, CM, AUO
GPI-16	Decision support systems and alerting systems	X	X	X	X	DCB, TS, CM, AUO

Global Plan initiatives & their relationships to the major groupings *(3/3)*

GPI		En-route	Terminal Area	Aerodrome	Supporting Infrastructure	Related Operational Concept Components
GPI-17	Data link applications	X	X	X	X	DCB, AO, TS, CM, AUO, ATMSDM
GPI-18	Aeronautical information	X	X	X	X	AOM, DCB, AO, TS, CM, AUO, ATMSDM
GPI-19	Meteorological systems	X	X	X	X	AOM, DCB, AO, AUO
GPI-20	WGS-84	X	X	X	X	AO, CM, AUO
GPI-21	Navigation systems	X	X	X	X	AO, TS, CM, AUO
GPI-22	Communication infrastructure	X	X	X	X	AO, TS, CM, AUO
GPI-23	Aeronautical radio spectrum	X	X	X	X	AO, TS, CM, AUO, ATMSDM

Performance based approach (PBA)

Introduction

PBA Principles

- Focus on results through adoption of performance objectives and targets
- Collaborative decision making driven by the results
- Reliance on facts and data for decision making
- Assessment of achievements is checked through a performance review, which in turn requires adequate performance measurement and data collection capabilities

PBA Advantages

- Result oriented, transparent and promotes accountability
- Shift from prescribing solutions to specifying desired performance
- Employs quantitative and qualitative methods
- Avoids a technology driven approach
- helps decision makers to set priorities, makes the most appropriate trade-offs, and allows optimum resource allocation

PBA Requirements

- **Once an organization (or State, region etc.) has decided to adopt the PBA approach, it must acknowledge the following :**
  - **Commitment *(at the top)***
  - **Agreement on goals *(desired results)***
  - **Organization *(who is accountable)***
  - **Human resources and know-how *(Culture & Skills)***
  - **Data collection, processing, storage and reporting**
  - **Collaboration and coordination *(with other subject areas and stakeholders)***
  - **Cost implication *(dedicated data management & IT infrastructure)***

PBA
Terminology (1/3)

- **Expectation or Key Performance Area**
  - **11 high level expectations are defined in the OCD (Access/ Equity, Capacity, Cost-effectiveness, Efficiency, Environment, Flexibility, Global interoperability, Participation by the air navigation system community, Predictability, Safety and Security)**
- **Focus Area**
  - **Focus areas may be defined as areas where performance must be addressed in a any given KPA. For example, in the safety KPA, focus may be in such areas as CFIT accidents, runway incursions, or mid-air collisions for general aviation aircraft.**
  - **Sometimes expectation itself is referred to as a KPA**

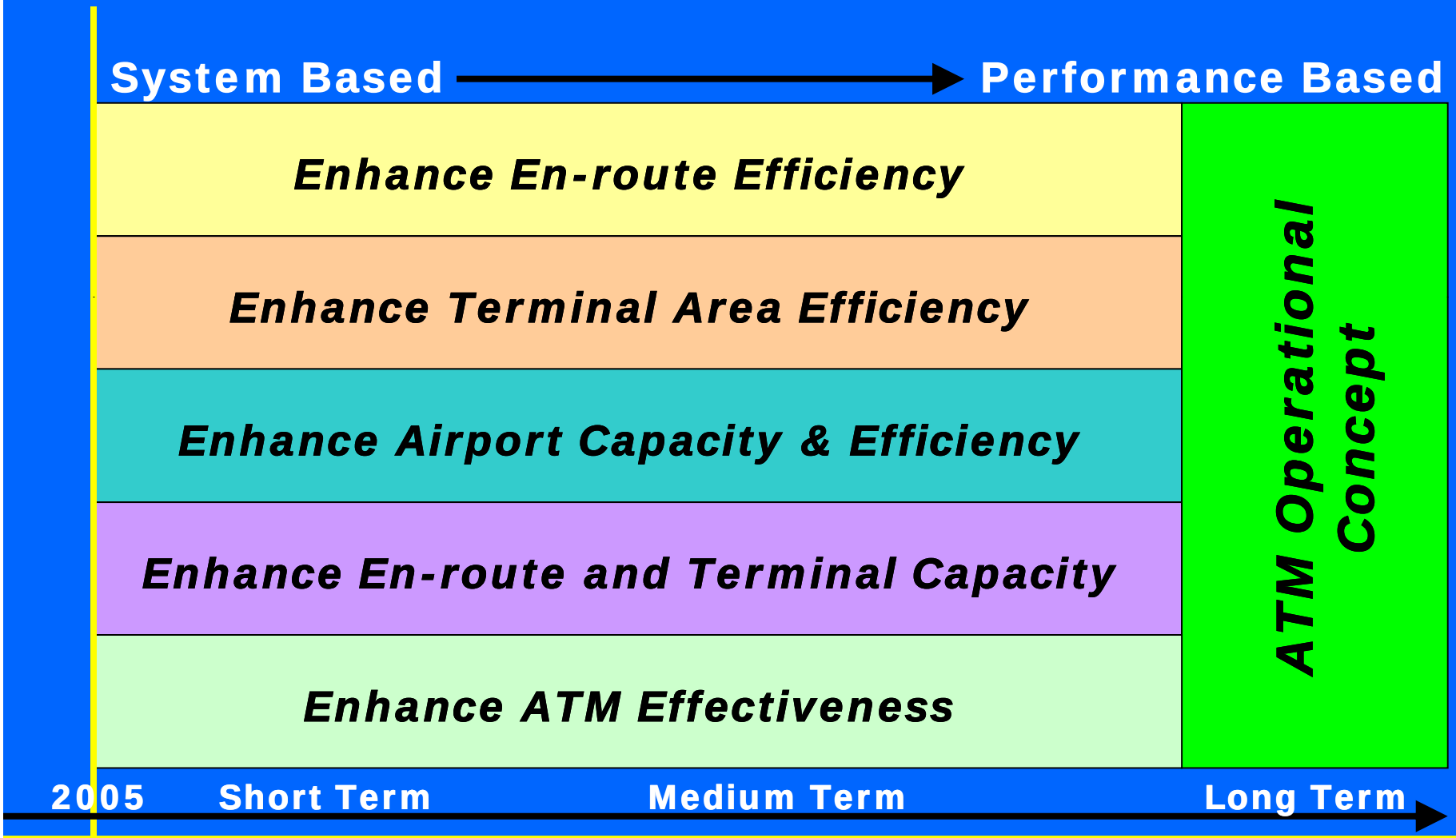
PBA
Terminology (2/3)

- **Performance Objective**
  - ***Each expectation should be reached through a set of specific, measurable, achievable, relevant and timely (SMART) performance objectives.***
  - ***Performance Objectives define – in a qualitative way - a desired trend from today's performance (eg improvement), within a well specified ATM planning environment. In other words it is*** **high level statement of outcome that satisfies ATM community expectations. Example : Enhance terminal airspace capacity**
- **Performance Indicator**
  - **Indicators are defined when there is a need to numerically document current performance levels and progress in achieving an objective. It is measure of achievement of performance objective. Ex: Number of additional flights in a defined terminal airspace**

PBA
Terminology (3/3)

- **Performance Target**
  - **A set of agreed numerical values of related performance indicators, representing the minimum performance levels at which an objective is considered to be 'achieved'. Performance targets can only be specified after indicators have been defined. Example: Y number of additional flights in terminal airspace.**
- **Performance Metric**
  - **A generic definition of what can be measured, how it can be measured and in which context and scope this should be done. Defines also the units in which the measurement is to be expressed. Metrics are quantitative measure of system performance – how well the system is functioning The data needs to be collected to calculate values of performance indicators .Ex: Traffic density, number of city pair flights**

Performance objectives – examples



Performance objectives – examples

Flexible Airspace Management

- Flexible Use Airspace
- Align Upper Airspace Classifications
- Collaborative Airspace Design
- Simplify Airspace Classifications

Dynamic Airspace Management

- Integrated Decision Making
- Demand Based Capacity
- User Preferred Routes

Enhanced Route Flexibility

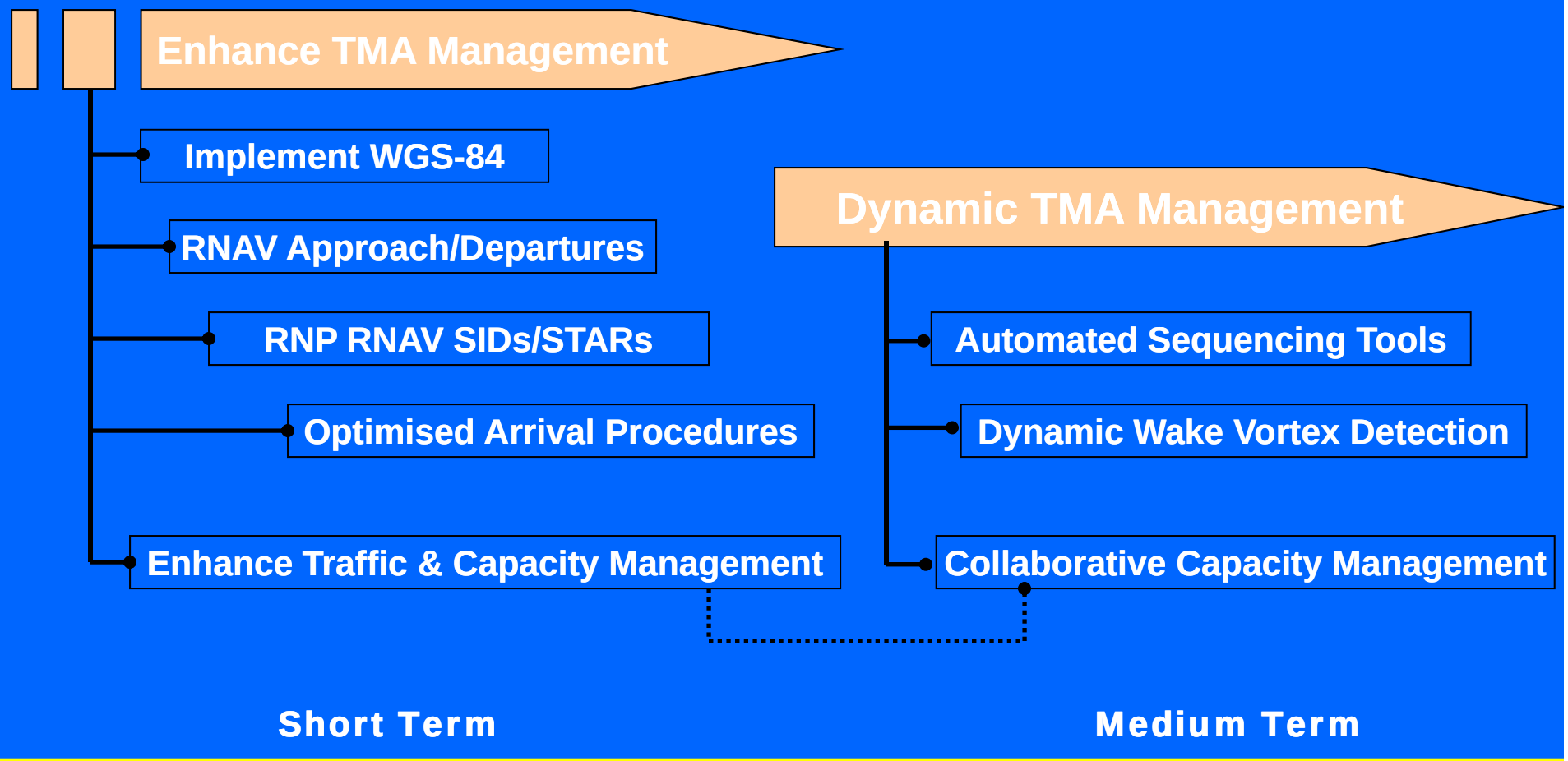
- Dynamic Route Management
- Capability Based Navigation
- Area Navigation

Short Term

Medium Term

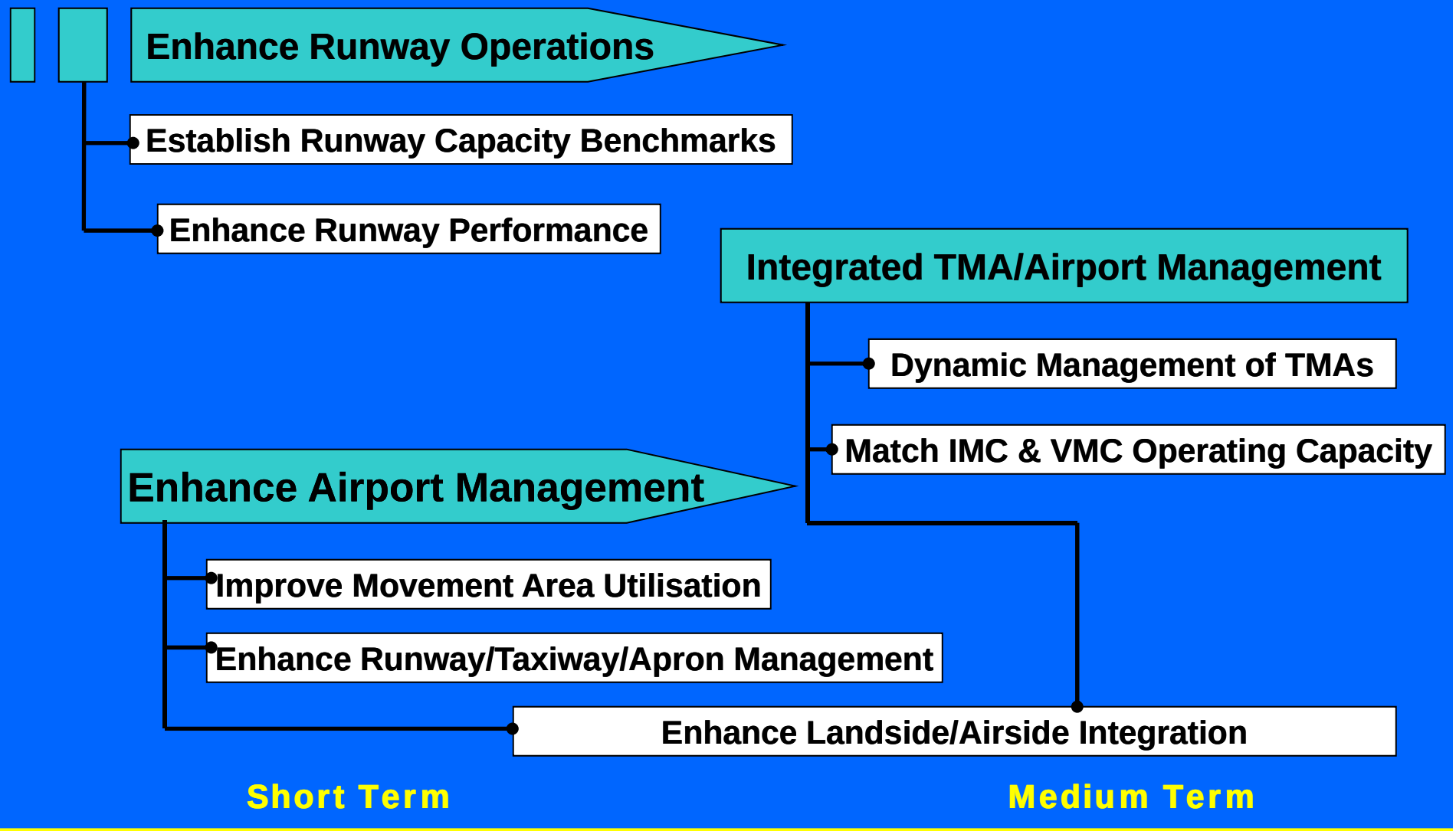
ENROUTE EFFICIENCY

Performance objectives – examples



TMA EFFICIENCY & CAPACITY

Performance objectives – examples



Performance objectives – examples

Increase Vertical Capacity

- Implement RVSM
- Harmonize Level Systems

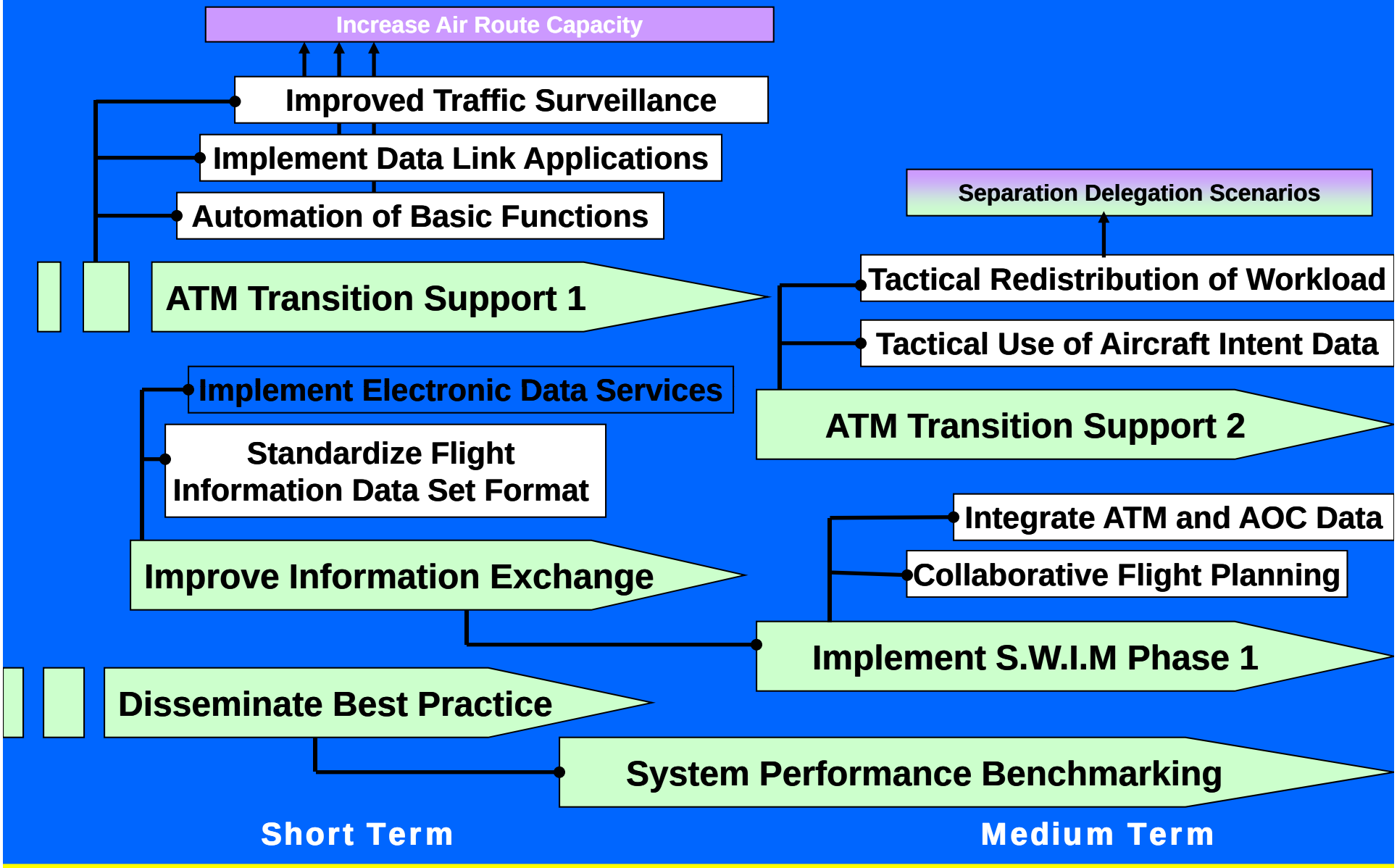
- Implement Capability Based Separation
- Implement RNP 1 Based Separation
- Implement RNP 4 Based Separation

Increase Horizontal Capacity

Short Term

Medium Term

Performance objectives – examples



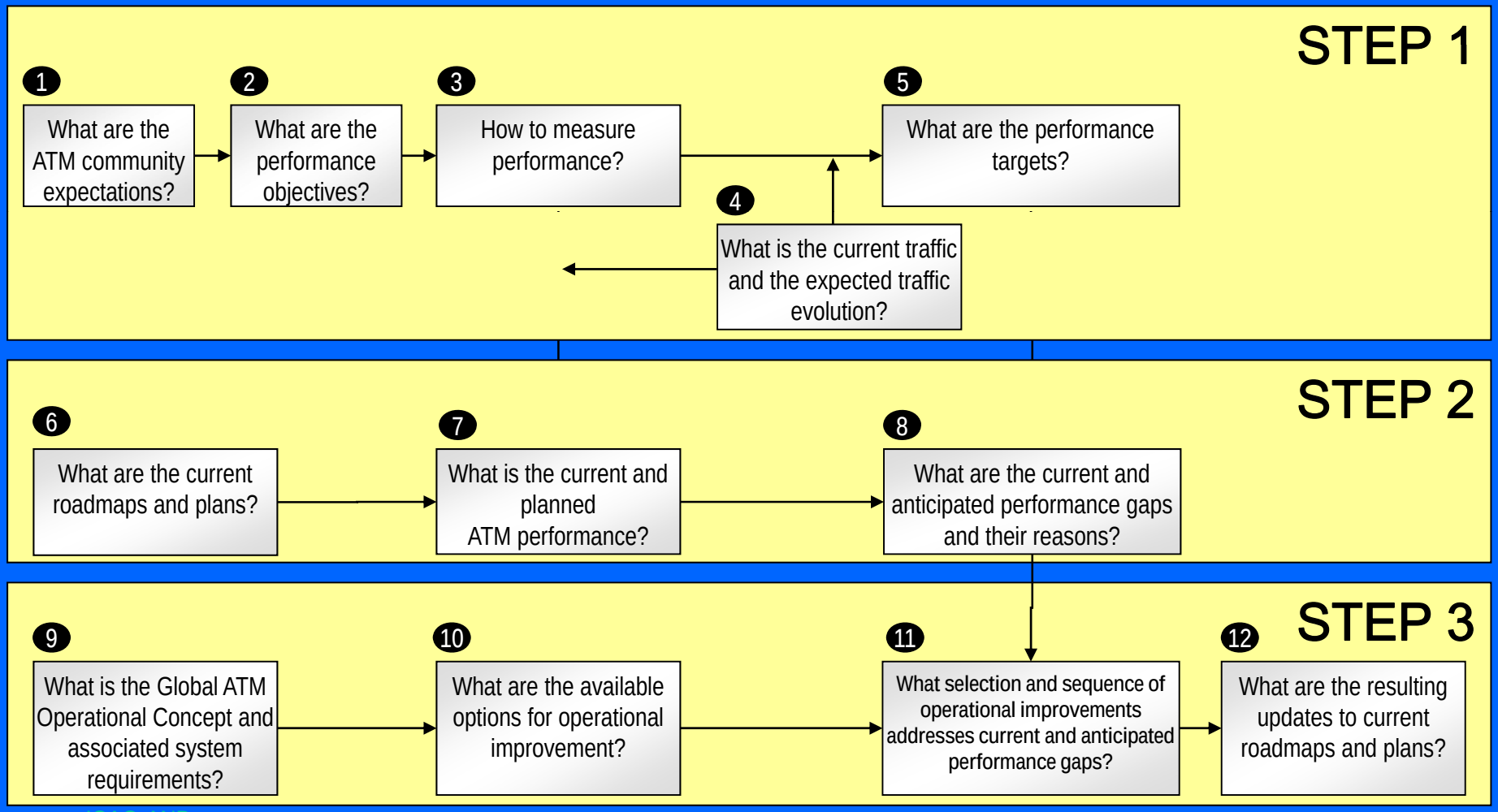
Performance Framework

- The performance based methodology provides decision makers with a consistent approach to apply when implementing changes to the Air Navigation System.
- In essence, a **Performance Framework** is the set of definitions, requirements and terminology describing the building blocks used by a group of ATM community Members to collaborate on performance management of activities.

Performance Based Approach

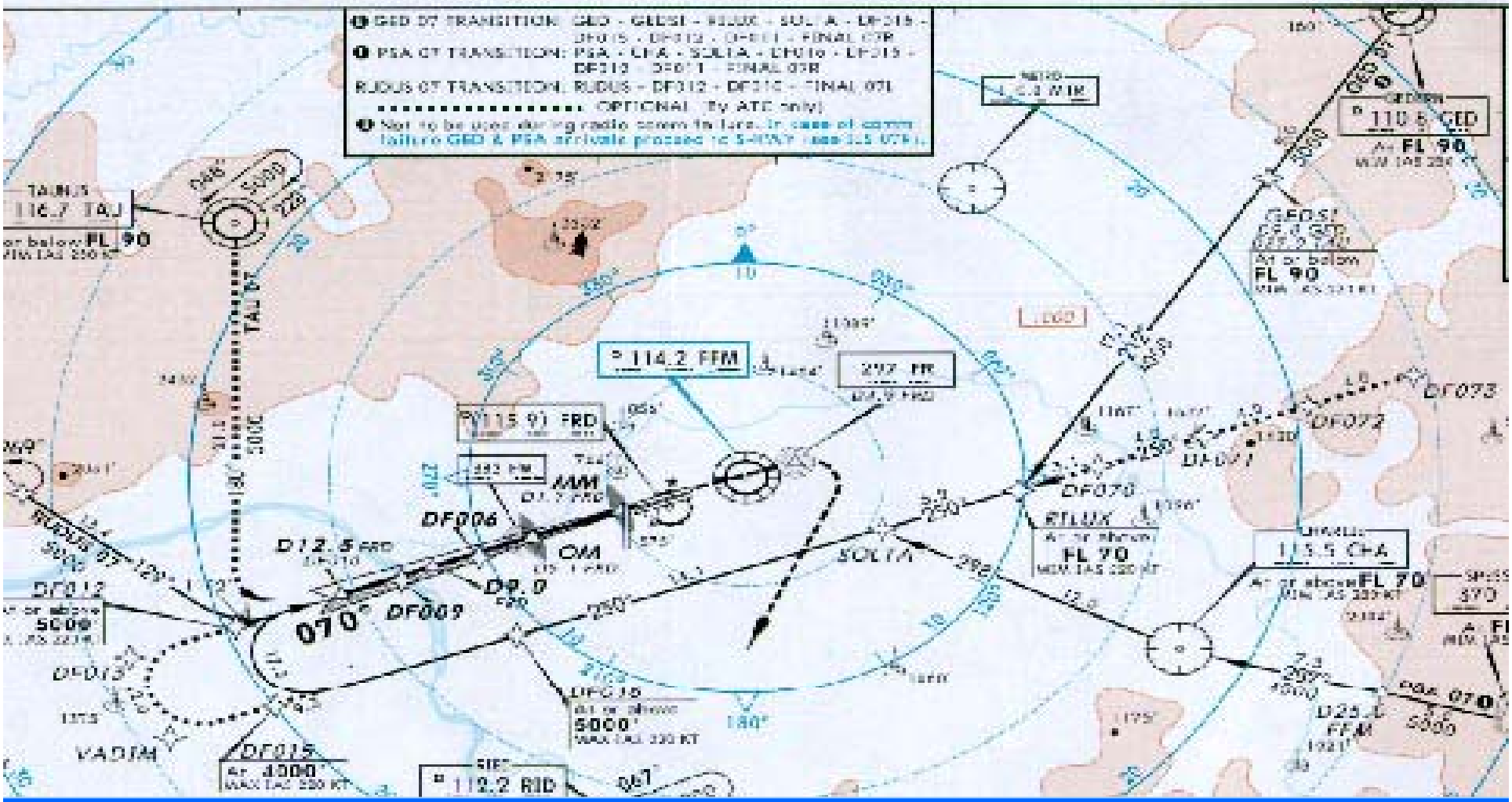
Methodology

Performance Based Approach



ICAO-ANB

An example: - Airport approaches - Environment/Noise



STEP 1

1. What are the ATM community expectations?
2. What are the performance objectives?
3. How to measure performance?
4. What is the current traffic and the expected traffic evolution?
5. What are the performance targets?

e.g. Number of complaints
e.g. Number of noise violations

e.g. Max 20 noise Violations in 2010
Or
-50% complaints in 2010

The ATM system should contribute to the protection of the environment by considering noise, gaseous emissions and other environmental issues in the implementation and operation of the global ATM system

Noise emissions and their impacts are minimised for each flight to the extent possible.

Aerodrome annual traffic volume is expected to be 73% higher in 2020 than in 2005 (measured in flights)

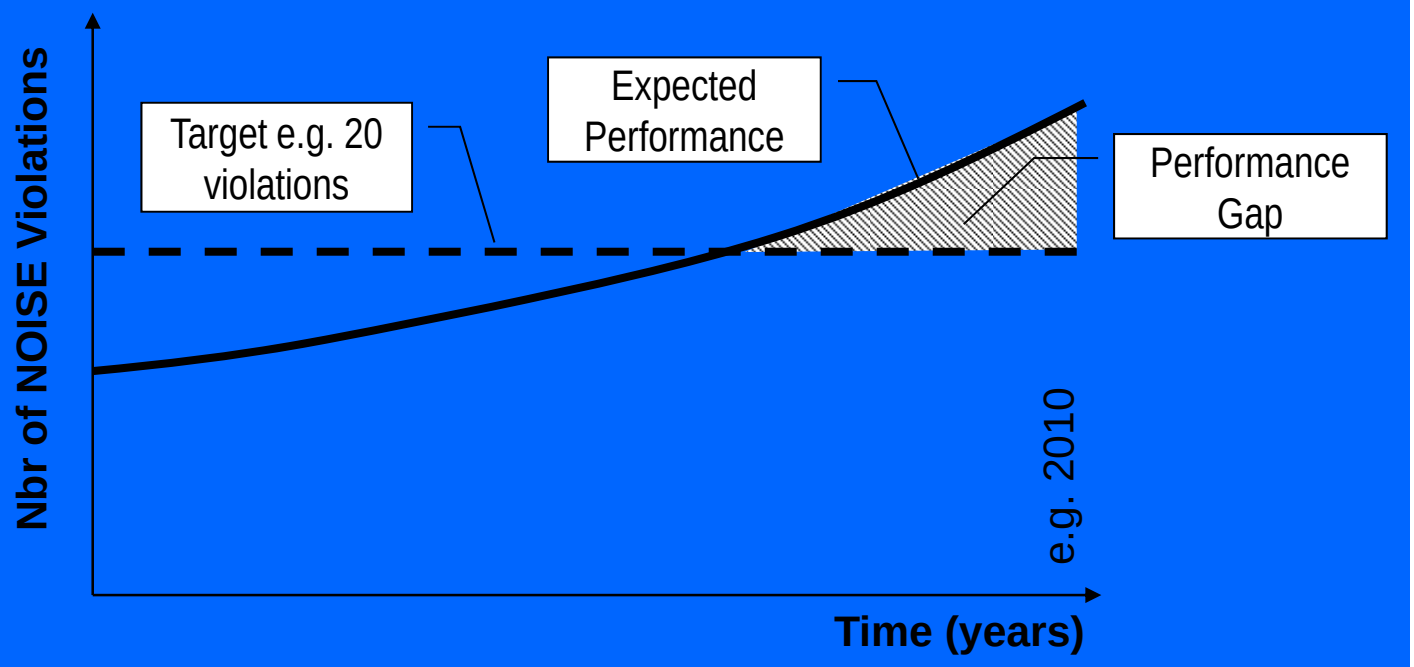
STEP 2

6 What are the current roadmaps and plans?

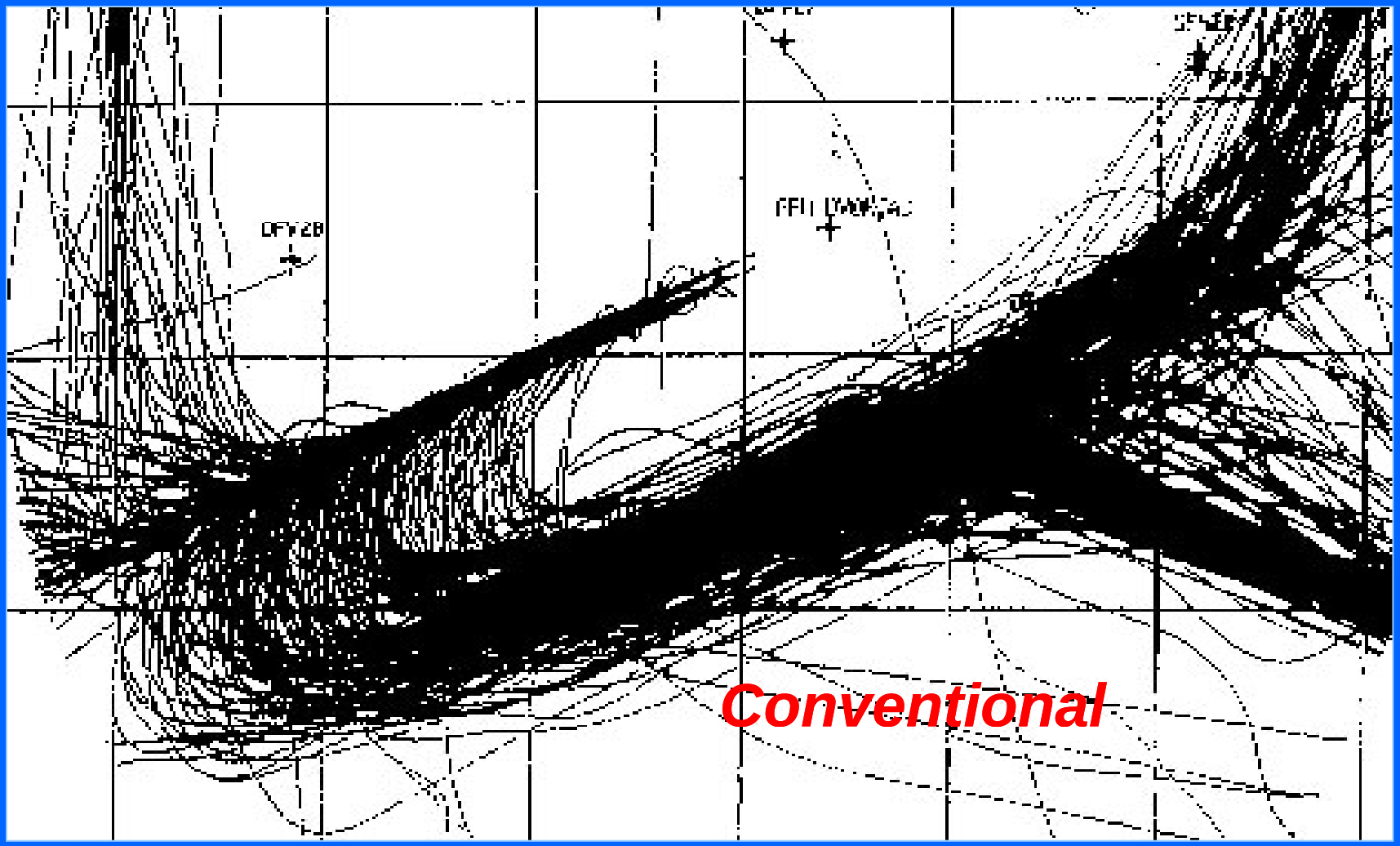
7 What is the current and planned ATM performance?

8 What are the current and anticipated performance gaps and their reasons?

Maintain Conventional Arrivals



Current Roadmap: Conventional Arrivals



Courtesy DFS

STEP 3

9 What is the Global ATM Operational Concept and associated system requirements?

10 What are the available options for operational improvement?

11 What selection and sequence of operational improvements addresses current and anticipated performance gaps?

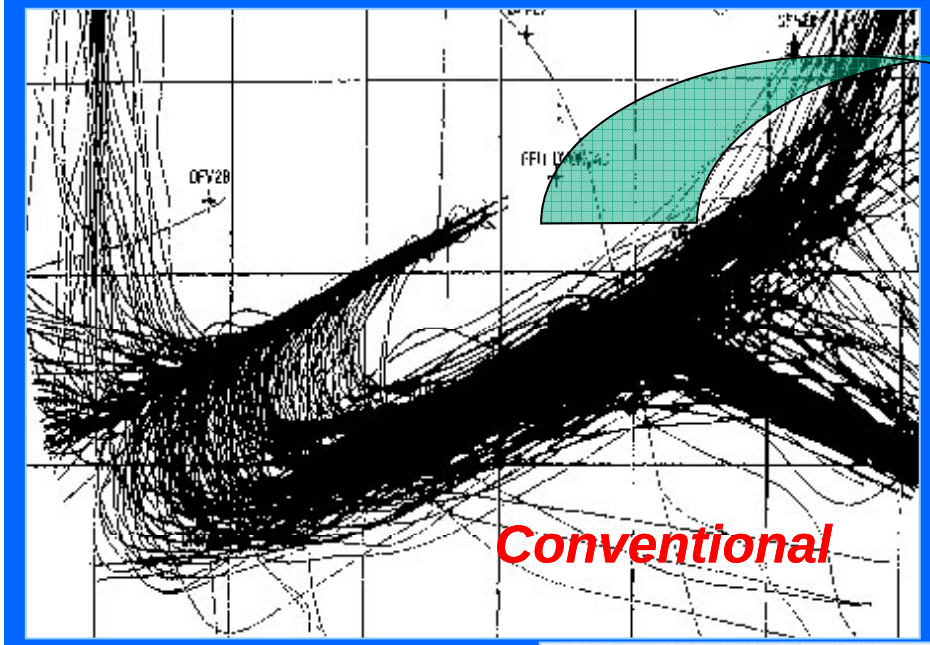
12 What are the resulting updates to current roadmaps and plans?

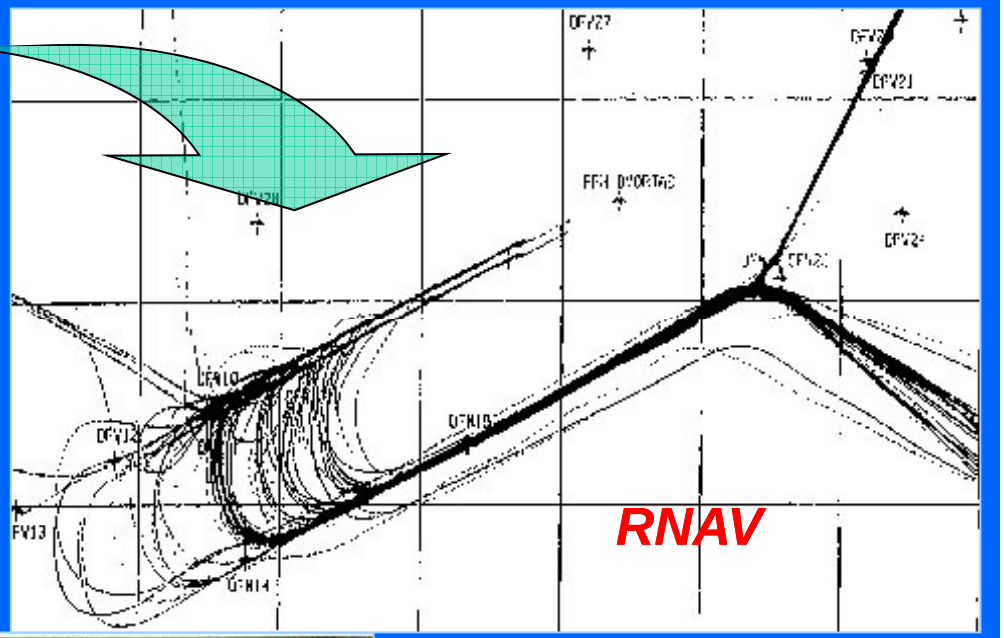
Ensure that environmental issues are considered in the design, development, and operation of all aspects of the ATM system

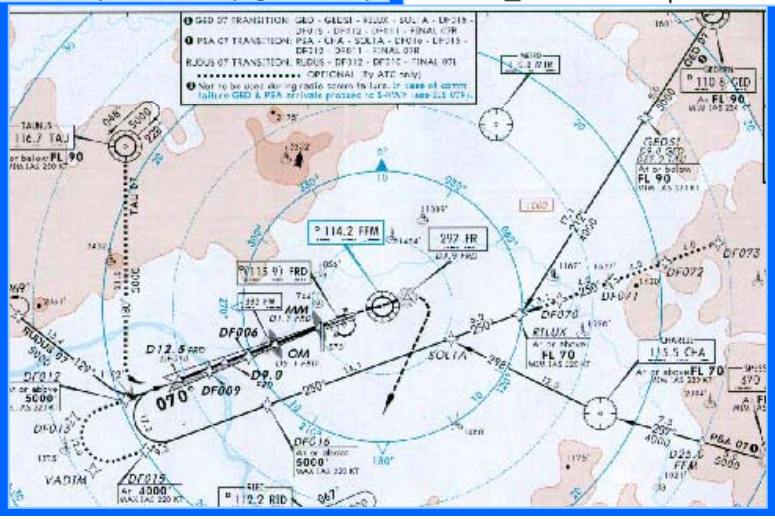
Understanding performance Influence

Trade-offs

From Conventional to RNAV Arrivals
Harmonising aircraft performance







ICAO-ANB

Courtesy DFS

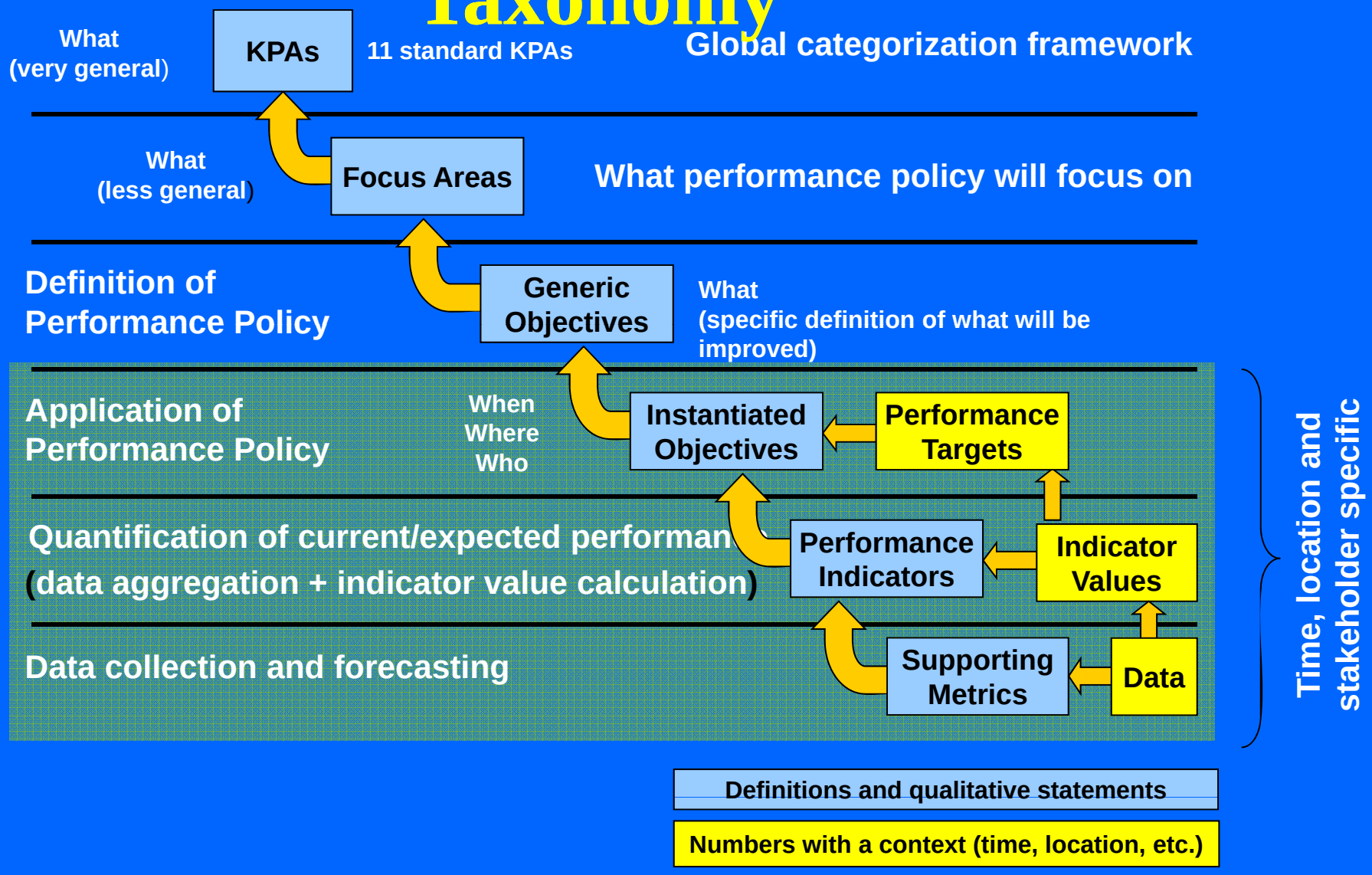
Performance based approach

Measurement

PBA
Identification of Metrics

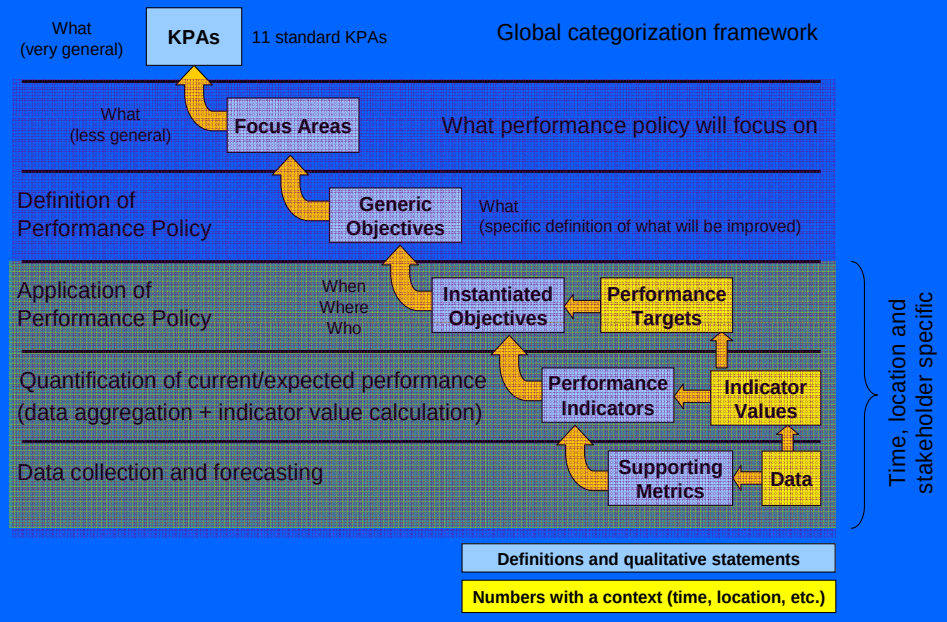
- A performance hierarchy helps to describe how performance changes at one level can influence high-level objectives.
- A measurement taxonomy describes how metrics are defined within each key performance area.

Measurement Taxonomy



Global Categorization

- Access and Equity
- Capacity
- Cost-effectiveness
- Efficiency
- Environment
- Flexibility
- Global Interoperability
- Participation by the ATM Community
- Predictability
- Safety
- Security



Eleven Key Performance Areas are defined, one per ICAO OCD expectation.

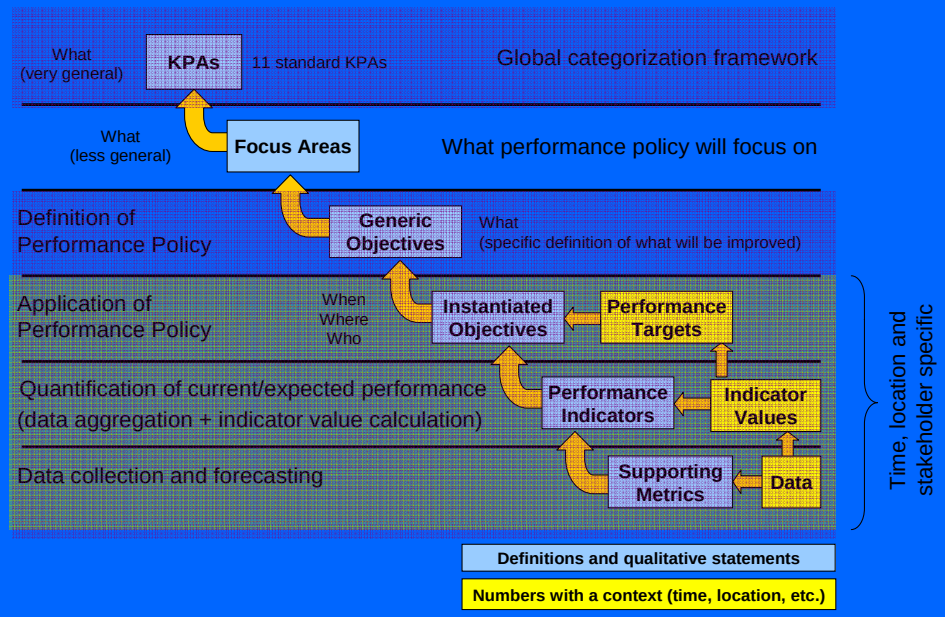
KPAs are named after their corresponding expectation.

KPAs are defined/updated in the Performance Based Approach during:

Step 1.3: Identify Ambitions & Expectations

What Performance Policy Will Focus On

- **Focus areas are defined within each KPA to identify and delineate the broad areas.**
- **Focus areas may be defined as areas where performance must be addressed in any given KPA.**
  - **For example, in the safety KPA, focus may be in such areas as CFIT accidents, runway incursions, or mid-air collisions for general aviation aircraft.**

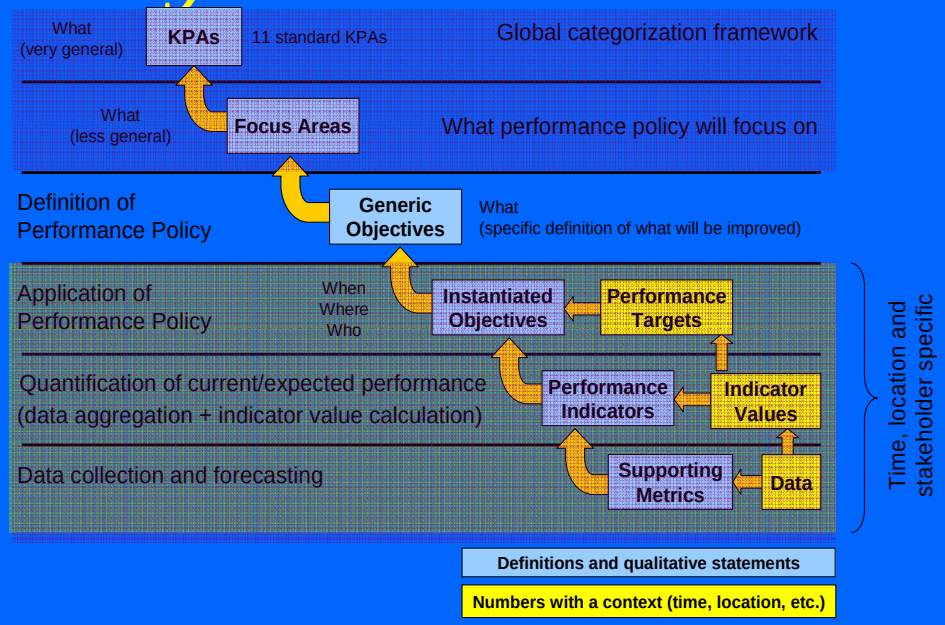


Focus Areas are defined and/or updated in the performance-based approach during:

Step 2.2: Focus Efforts by Defining and Prioritising Performance Objectives as Needed

Definition of Performance Policy

- **Generic Objectives (Performance objective) are an expressed in a qualitative but focused way (e.g. improvement).**
- **They specifically focus on what has to be achieved, but do not make statements about the when, where, or who.**
- **Because at this level 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 point.**
- **Each expectation should be reached through meeting a set of specific, measurable, achievable, relevant and timely (SMART) objectives.**

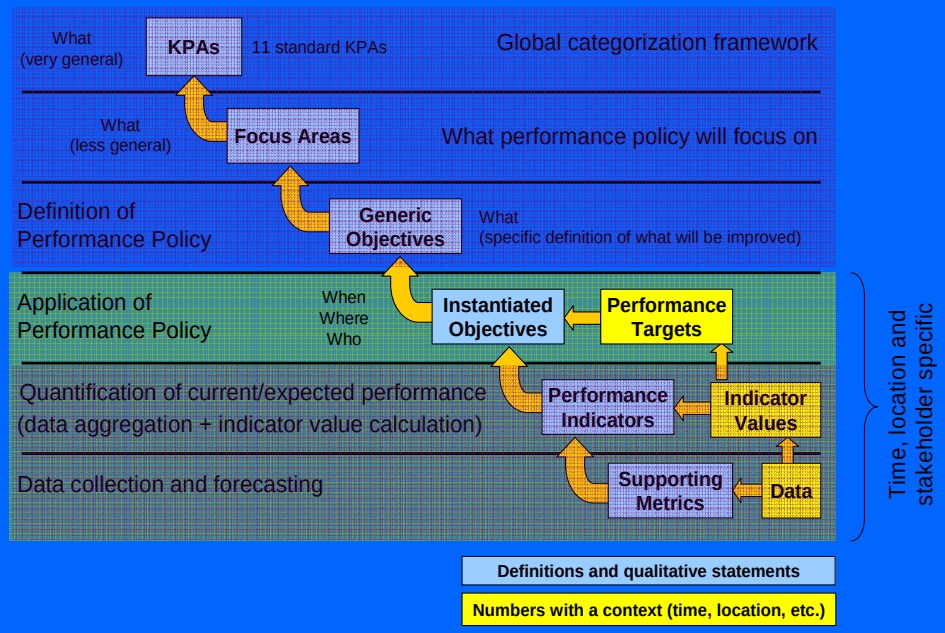


Generic Objectives are defined and/or updated in the performance-based approach during:

Step 2.2: Focus Efforts by Defining and Prioritizing Performance Objectives as Needed

Application of Performance Policy

- Once generic objectives have been described, these must be precisely defined and numerical targets must be set. These precisely defined objectives are labeled "instantiated objectives".
- The instantiated objectives deal with the when, where and who.
- Once instantiated objectives are defined, one requires a means of knowing when the objective has been met.
- This is accomplished through the establishment of a set of targets on numerical performance indicators.



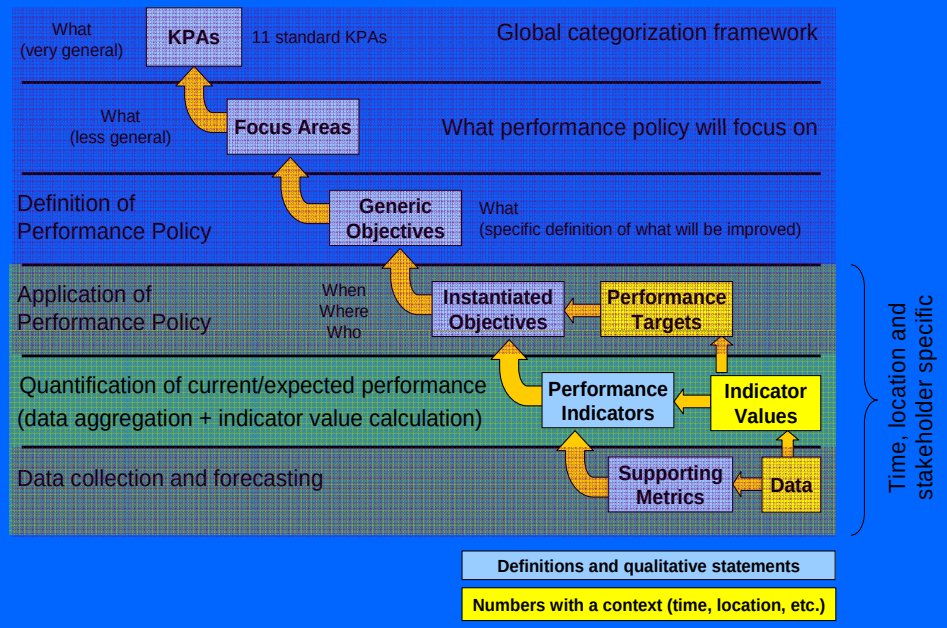
Instantiated objectives and performance targets are defined and/or updated in the performance-based approach during:

Step 2.2: Focus Efforts by Defining and Prioritising Performance Objectives as Needed

Step 3.2: Define the Desired Speed of Progress in Terms of Baseline and Target Performance

Quantification of Performance

- **Instantiated objectives require precisely defined numerical performance indicators.**
- **These serve to establish quantitative measures that collectively will indicate progress towards achieving an objective.**
- **Performance indicators should very precisely describe how the indicators should be derived using supporting metrics. This includes considerations such as limits on scope, statistical derivation, or other mathematical derivation.**



Performance indicators are defined in the performance-based approach during:

Step 3.1: Define how Progress in Achieving Performance Objectives will be measured and which Data are required to do so

Step 4.1: Select the Decisive Factors to Reach the Target Performance

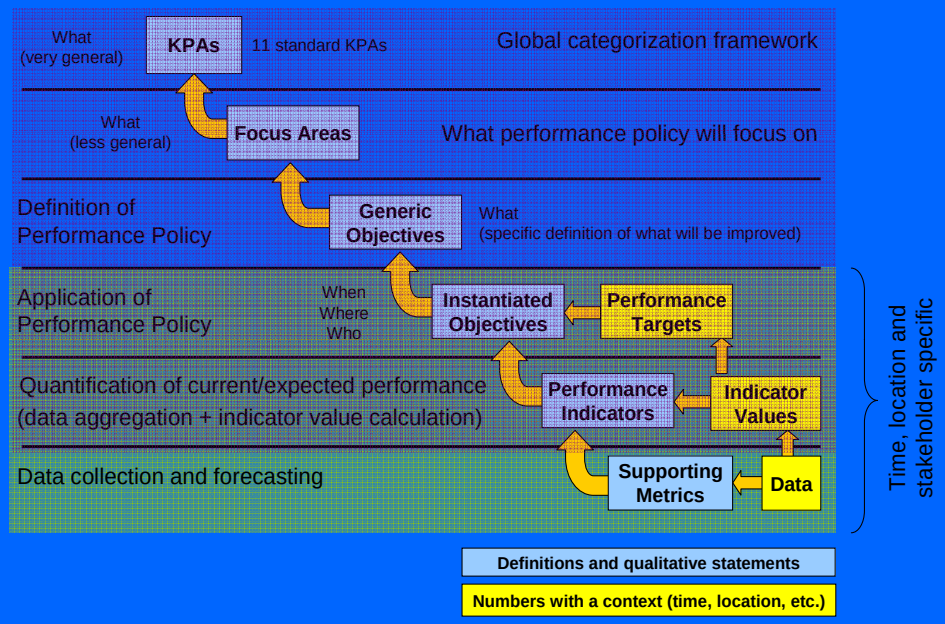
Step 4.2: Identify Solutions to Exploit Opportunities and Mitigate the Effects of the Selected Drivers and Blocking Factors

Step 4.3: Select a Sufficient Set of Solutions

Step 6: Assess Achievement of Objectives

Data Collection and Forecasting

- The **supporting metrics** define which data needs to be collected and/or forecasted to calculate values for the performance indicators.
- Definitions must be sufficiently precise to allow individuals to duplicate the exact measurement without "insider knowledge".
- Supporting metrics are required to compute the performance indicators.
- Associated with each definition is the actual data itself which is used to create the indicator values.



Supporting metrics are defined in the performance-based approach during:

Step 3.1: Define how Progress in Achieving Performance Objectives will be measured and which Data are required to do so

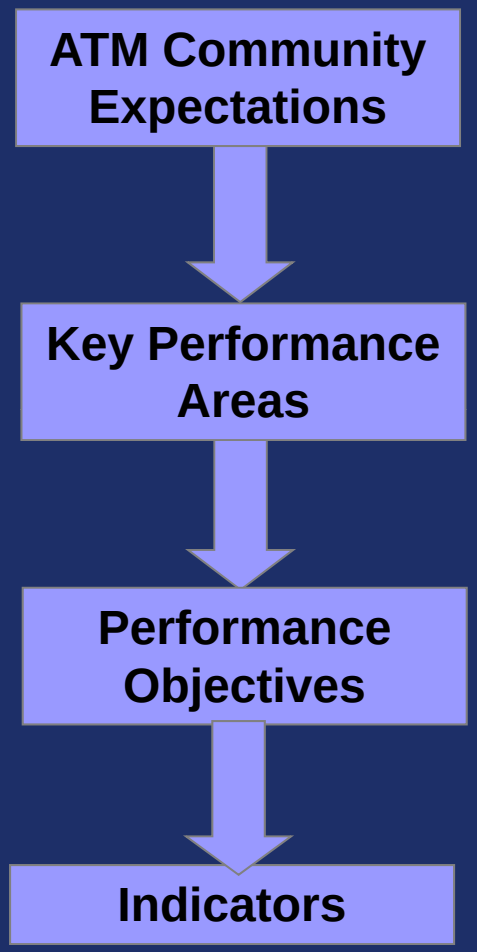
Step 4.1: Select the Decisive Factors to Reach the Target Performance

Step 4.2: Identify Solutions to Exploit Opportunities and Mitigate the Effects of the Selected Drivers and Blocking Factors

Step 6: Assess Achievement of Objectives

Performance Process

- Access and Equity
- Capacity
- Cost-effectiveness
- Efficiency
- Environment
- Flexibility
- Global Interoperability
- Participation by the ATM Community
- Predictability
- Safety
- Security



PBA
Examples of Metrics

- **Capacity**

  - Total number of operations per day
  - Number of aircraft in a specified volume of airspace
  - Number of aircraft able to enter a specified geographical area
  - Number of aircraft per 100nm3
  - Traffic density - number of aircraft per 100 nm3
  - Enroute utilization - number of aircraft per 100nm3

PBA
Examples of Metrics

- **Access**
  - **Civil flights using fixed airspace**
  - **Unusable airspace due to navigation restriction**
  - **Number of access denials**
  - **Number of airports with published approaches**

PBA
Examples of Metrics

- **Flexibility**
  - **Percentage of flights off-on ATC preferred routes**
  - **Number of backups available for emergency**
  - **Flexibility in sequencing**
  - **Number of restrictions**

PBA
Examples of Metrics

- **Efficiency**
  - Average departure time
  - Average departure flight distance
  - Traffic movements
  - Unused capacity
  - Enroute flight distance

PBA
Examples of Metrics

- **Cost**
  - Investment cost
  - Cost per retrofit
  - Out of service cost
  - Operating cost
  - Maintenance cost

- **Environment**
  - Pounds of fuel burn
  - Local noise foot print
  - Number of noise complaints

PBA
Examples of Metrics

- **Safety**
  - **Number of incursions per year**
  - **Number of operational errors per year**
  - **Availability of CNS facilities**
  - **Number of accidents per 100,000 departures**
  - **Number of fatalities per 100, 000 fatalities**

PBA
Transition

Transition Strategy

NEAR-TERM	MEDIUM-TERM	LONG-TERM
Evolution – Phase 1	**Evolution – Phase 2**	**Evolution –Phase 3**
▪ Based on what we HAVE today ▪ Involves application of available procedures, processes and capabilities ▪ Identifies potential "gap" requirements that focus near term work program activities	▪ Based on what we KNOW today ▪ Involves application of emerging procedures, processes and capabilities ▪ Identifies "gap" requirements and drives future R&D	▪ Based on CONCEPT expectations ▪ Involves application of new procedures, processes and capabilities ▪ Fills "gap" requirements and sustains continuous improvement R&D

Overlap Period

Overlap Period

The "Overlap Period" indicates that there is no set date by which the objectives of each transition should be met – other than within a time band of perhaps 2-3 years. It also recognizes that some States or Regions may not have a specific performance requirement that would need the application of changes identified in the transition maps at the same time as another State or Region.

Transition Roadmap

Short-Term

Establish an Inventory of Existing Capabilities

- Current ICAO SARPS
- Current Industry SARPS
- Current Industry Equipage
- Current Technology
- Current Fleet Equipage
- etc

High-Level Performance Gap Analysis

Establish High-Level Performance Objectives

Example:
- Enhance Capacity
- Improve Safety
- Enhance Cost-effectiveness
- etc

Integrate Capabilities with High Level Performance Objectives

Group into Operational Improvements Sets against Performance Objectives

Example:
- Use RVSM to provide additional capacity
- Use datalink and RNP to provide additional capacity
- Use enhanced data reporting and analysis tools to enhance safety
- Standardize cross-boundary coordination procedures to enhance cost effectiveness
- Utilize GNSS capability to fly instrument approaches, enhancing safety [reduced CFIT] and increasing access
- etc

Medium-Term

Establish an Inventory of Planned Capabilities

- Short-term capabilities +
- Emerging ICAO and Industry SARPS
- Emerging Equipage
- Emerging Technology
- etc

High-Level Performance Gap Analysis

Establish High-Level Performance Objectives

Example:
- Reduce Delay
- Enhance Efficiency
- Reduce Environment Effect
- etc

Integrate Capabilities with High Level Performance Objectives

Group into Operational Improvements Sets against Performance Objectives

Example:
- Use datalink and new RNP standards to increase capacity
- Use emerging flow tools and traffic prediction to reduce delay
- Leverage the undertaking by OEMs to improve engine efficiency by 10% by 2010 to develop more environmentally effective route structures.
- etc

Long-Term

Establish an Inventory of Gap Capabilities

- Short- and medium-term capabilities +
- Identified Gap Standards
- Identified Gap Capability
- etc

High-Level Performance Gap Analysis

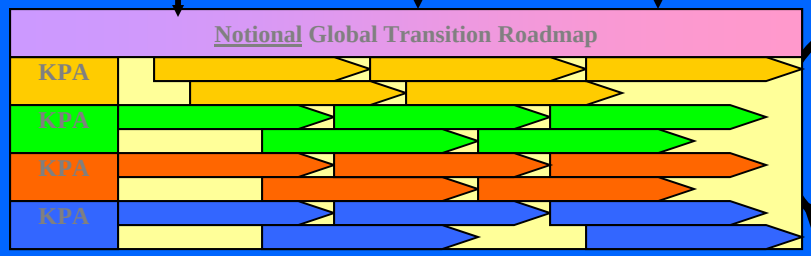
Establish High-Level Performance Objectives

Example:
- Increase Efficiency
- Enhance Capacity
- Improve Safety
- Enhance Cost-Effectiveness
- etc

Integrate Capabilities with High Level Performance Objectives

Group into Operational Improvements Sets against Performance Objectives

Example:
- 4-D Control
- Self Separation
- Traffic Synchronization
- Etc.



On a Regular Basis

Consistency Check Against Regional Plans

Consistency Check Against Local Plans

Performance based approach
Output and Monitoring form

PERFORMANCE FRAMEWORK FORM

- Performance objective:
- Regional performance objective:
- National performance objective:
- Benefits:
- Strategy:
- ATM operational concept components;
- Tasks:
- Timeframe:
- Responsibility:
- Status:
- Linkage to global plan initiatives (GPIs):

REGIONAL PERFORMANCE OBJECTIVES /NATIONAL PERFORMANCE OBJECTIVES — OPTIMIZE THE ATS ROUTE STRUCTURE IN EN-ROUTE AIRSPACE

Benefits

Environment **Efficiency**	• reductions in fuel consumption; • ability of aircraft to conduct flight more closely to preferred trajectories; • increase in airspace capacity; • facilitate utilization of advanced technologies (e.g., FMS based arrivals) and ATC decision support tools (e.g., metering and sequencing), thereby increasing efficiency.

Strategy
Short term (2010)
Medium term (2011 - 20015)

ATM OC COMPONENTS	TASKS	TIMEFRAME START-END	RESPONSIBILITY	STATUS
AOM	*En-route airspace* • analyze the en-route ATS route structure and implement all identifiable improvements; • implement all remaining regional requirements (e.g. RNP 10 routes); and • finalize implementation of WGS-84 • monitor implementation progress • develop a strategy and work programme to design and implement a trunk route network, connecting major city pairs in the upper airspace and for transit to/from aerodromes, on the basis of PBN and, in particular, RNAV/5, taking into account interregional harmonization; • monitor implementation progress	2005-2008		
linkage to GPIs	GPI/5: performance-based navigation, GPI/7: dynamic and fexible ATS route management, GPI/8: collaborative airspace design and management, GPI/11: RNP and RNAV SIDs and STARs and GPI/12: FMS-based arrival procedures.			

Performance based approach

AN Projects

ATM

AOM	ATS	DCB
•ATS Route structure •PBN (RNP and RNAV) •Airspace utilization •FUA	•Air Traffic Control •RHSM and RVSM •Search and Rescue •Decision support systems	• Planning • Coordination •ATS capacity •Collaborative Decision Making

CNS

Communication	Navigation	Surveillance
Data •VHF •HF •Mode S •Satellite •ATN **Voice** •VHF •Satellite • HF • VOIP	**GNSS** • GPS • GLONASS • *GALILEO **Augmentation** • ABAS • GBAS • SBAS **DME/DME**	**SSR** • Modes A/C • Mode S **ADS-C** • VHF • HF • Satellite **ADS-B** **MLAT**

emerging systems

AIM

- WGS-84
- e-TOD
- e-AIP
- Flight Plan
- Digital data exchange
- Digital NOTAMS
- Quality management systems

AGA

- Aerodrome ground lighting
- Rapid exit taxiways
- Non navigation visual aids (PAPI)
- Rescue and fire fighting services
- Use of LEDs for prevention of Runway incursion
- Use of automated FOD detection system
- Emergency planning including pandemic planning
- Availability of RESA

MET

TMA	ENROUTE
(Measuring the weather) Sensors for wind speed and direction; temperature, RVR/visibility, barometric pressure, precipitation and cloud height; Record and broadcast to pilots through ATIS or data link (Forecast the weather) Aerodrome forecast (TAF) Trend forecast (for next 2 hours) Wind shear and aerodrome weather warning	Enroute (Forecast the weather) – useful tool for flight planning, choosing optimum routes and to avoid hazardous weather conditions • WAFS (World Area Forecasting System) •TCAC (Tropical Cyclone Advisory Centre) •VAAC (Volcanic Ash Advisory Centre) •SADIS/ISCS will distribute the above forecasts to all States SIGMET: Ensure that SIGMETs are issued to users for each airspace

Performance based approach

Way forward

Performance framework - Way forward

- **What ICAO is doing:**
  - Based on 11 expectations of ATM community identifying key performance areas (KPAs) such as safety, efficiency, capacity, flexibility, security etc
  - Determining metrics for safety and efficiency, such as number of fatal accidents, tonnes of fuel consumed, Number of PBN routes etc
  - Developing System performance: Communications, Navigation and Surveillance (RCP, PBN, RSP)
- **What Regions and States can do:**
  - Develop Regional/National performance objective and Performance framework forms
  - Identify performance targets and metrics
  - Determine the gaps and implement projects that would meet or exceed performance targets

Summary

- Recalled the background in development of Performance based approach to AN planning
- Noted planning mechanisms
- Reviewed ATM OC and the Global Plan
- Discussed performance framework
- Identified AN projects
- Recognized the way forward

— END —