

# **PERFORMANCE-BASED APPROACH FOR GLOBAL AIR NAVIGATION SYSTEMS**

***Developed on the basis of the ICAO Manual  
on Global Performance of the Air  
Navigation System (Doc 9883)***

# PERFORMANCE BASED APPROACH

- Notion of Performance Based Approach (PBA) emanated from good industry practices and evolution of aviation industry into a less regulated and more corporatized environment, with greater accountability.
- ICAO Supports and encourages the global adoption of performance management techniques as a step towards a performance based Global Air Navigation System as envisaged in the *Global Air Traffic Management Operational Concept* (Doc 9854) and related *ATM System Requirements Supporting the Global Air Traffic Management Operational Concept* (Doc 9882)

# PRINCIPLES

- **PBA is based on following three principles**
  - Strong focus on desired/required results: In stead of prescribing *solutions*, desired/required *performance* is specified. It implies finding what the current situation is, what the most appropriate result should be, as well as clarifying who is accountable for achieving those results
  - Informed decision making, driven by desired/required results: Means working backwards from the “what (result)” – the primary focus – to decisions about “how”.
  - Reliance on facts and data for decision making: Desired/required results, drivers, constraints, shortcomings, options expressed in quantitative terms (not in qualitative terms). Rationale *‘if you can’t measure it, you can’t manage it’*.

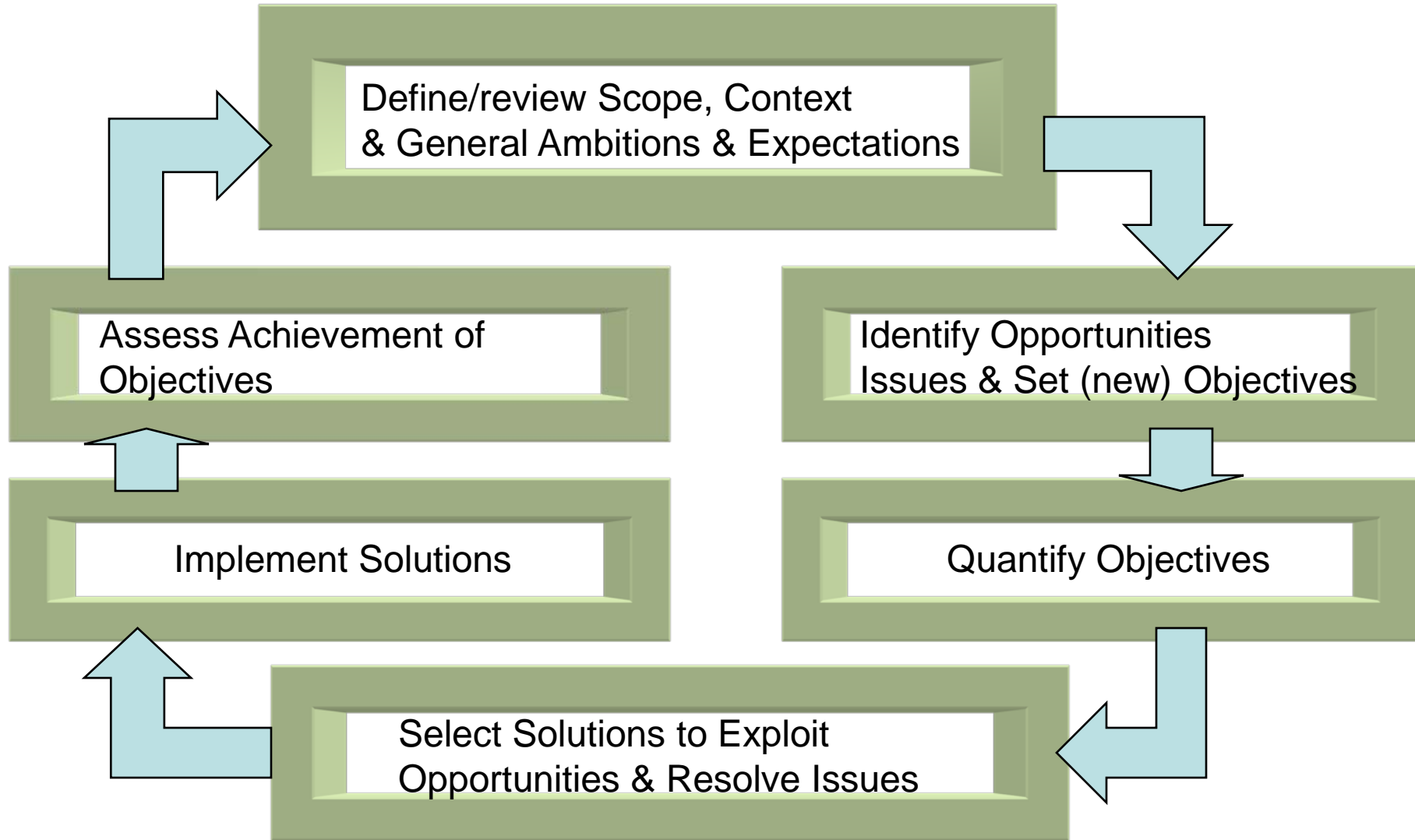
# ADVANTAGES

- **PBA is expected to provide following advantages:**
  - It is result oriented, allows customer focus and promotes accountability
  - Policy making becomes much more transparent when the goals to be reached are publicly stated in terms of performance outcome (rather than solutions)
  - Shift from *prescribing solutions* to *specifying desired/required performance* gives more freedom and flexibility in selecting suitable solutions.
  - “Technology driven approach” and “Solutions searching for a problem to solve” can be avoided
  - Stress on rigorous scientific approach in place of anecdotal evidence
  - Focus on desired/required results helps decision makers to set right priorities, make most appropriate trade offs, choose optimum solution and resource allocation
  - Provides more predictability of benefits
  - Typically results in cost savings, which often is much more than the investment made in applying the approach

# ESSENTIAL REQUIREMENTS

- Once an organization (or State, region etc.) has decided to adopt the PBA approach, it must acknowledge that following ingredients are essential for success:
  - Commitment (*at the top*)
  - Agreement on goals (*desired results*)
  - Organization (*who is responsible/accountable for various functions*)
  - 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*)

# PERFORMANCE MANAGEMENT PROCESS



# PROCESS STEPS

PROCESS	PRINCIPLE
<b>Step 1</b> Define/Review Scope, Context & General Ambitions & Expectations	<b>Strong Focus on Desired/Required Results</b>
<b>Step 2</b> Identify Opportunities, Issues, & Set (new) Objectives	
<b>Step 3</b> Quantify Objectives	<b>Reliance on facts &amp; data for decision making</b>
<b>Step 4</b> Select Solutions to Exploit Opportunities & Resolve Issues	<b>Informed decision making, driven by desired/required results</b>
<b>Step 5</b> Implement Solutions	
<b>Step 6</b> Assess Achievement of Objectives	<b>Reliance on facts &amp; data for decision making</b>

# Step 1

## DEFINING SCOPE

- To avoid misunderstandings, in particular about the performance (improvement) which can be expected within the given scope

### *Example – Part 1*

*Organization X is the Air Navigation Service Provider in FIR YYYY. X will be establishing a capacity management process as part of PBA. The initial scope could be defined as follows:*

- *Time Period:* Planning period will be initially limited to 5 year horizon based on traffic forecast for 15 years.
- *Key Performance Areas:* Focus on planning of ATM capacity (we are not considering other issues like environment etc.)
- *Geographical limits:* FIR YYYY, only en-route airspace (we are not considering TMA, Airport capacity etc.)
- *Traffic:* Includes domestic, international and overflying traffic. Planning process is limited to IFR traffic.

# Step 1

## DEFINING CONTEXT

- Once the scope is defined, it is necessary to clarify assumptions on what is “surrounding” the performance management activity like with whom to coordinate & collaborate, external drivers, constraints etc.

### *Example – Part 2*

*Capacity planning of FIR YYYY fits within the regional planning process, so that it should not become a capacity bottleneck. Regional planning is also responsible for VHF frequency management.*

*Geographical limits include neighboring airspace, TMAs and airports within FIR YYYY*

*Main external driver for capacity planning is expected traffic growth. Magnitude of growth and expected changes in traffic pattern are documented in ‘Traffic Forecast’. Physical airport capacity is a potential external constraint.*

## Step 1

# AMBITIONS & EXPECTATIONS

- ‘Expectations’ refer to desired results from an external perspective, ‘ambition’ indicates that desired result refer to an internal initiative. Ambitions and expectations could include safety, security, environmental impact, cost effectiveness, capacity, efficiency, flexibility, predictability, access and equity, participation and collaboration & interoperability the eleven Key Performance Areas (KPA) identified in the *Global Air Traffic Management Operational Concept* (Doc 9854)

### *Example – Part 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 while minimizing restrictions on traffic flow. The capacity should increase along with efficiency, flexibility and predictability while ensuring that there are no adverse impacts on safety giving due consideration to environment.*

## Step 2

# IDENTIFY OPPORTUNITIES

- Step 2 is aimed at identifying opportunities and to decide which specific performance aspects are essential for meeting expectations
- Based on the scope, context and general ambitions/expectations (Step 1), inventory of opportunities and issues (weaknesses & threats) should be developed using SWOT analysis. Strength are helpful internal attributes, Weaknesses are harmful internal attributes, Opportunities are helpful external conditions and Threats are harmful external conditions.

### *Example – Part 4*

*Organization X conducted SWOT analysis on the Air Navigation System in FIR YYYY and came to following conclusions:*

*Strength: No shortage of staff*

*Weaknesses: No radar coverage in part of FIR (for present traffic sufficient)*

*In another part, controller workload may be a handicap. Density already high, channel loaded. SSR capacity exceeded.*

*Opportunities: ADS-B technology has matured, may be cost effective where no surveillance is available on date*

*Threats: May be fall of traffic due to external conditions*

## Step 2

# PRIORITISING PERFORMANCE OBJECTIVES

- Expectations are required to be translated into specific performance objectives.
- Even within a Key Performance Area, focus sometimes needs to be concentrated on a smaller area
- Performance objectives are defined only in those focus areas, where a real need for action is identified (through analysis of historical/projected performance data)

### *Example – Part 5*

*Focus of Performance Management: Focus area could be ‘en-route ATM capacity for IFR flights’ within the Key Performance Area – ‘Capacity’*

*Specific Improvements: Considering the results of SWOT analysis, the service provider may decide that there is a need for two separate Performance Objectives:*

*Objective 1: Increase en-route throughput which can be handled during typical busy hour*

*Objective 2: Increase number of aircraft that can be simultaneously accommodated in en-route airspace*

## Step 3

# QUANTIFY OBJECTIVES

- Reliance on facts and data for decision making implies that **“objectives should be specific, measurable, achievable, relevant and time-bound (SMART).”**
- In PBA, Indicators, metrics underpinning those indicators and common definitions for data aggregation and event classification need to be defined.
- Indicators are often not measured directly, but are calculated from data collected.
- Indicators need to be defined carefully to be relevant, supported by data and should convey some useful meaning.
- Where many stakeholders are involved, the definition and aggregation and classification of indicators should be harmonized.

### *Example – Part 6*

→ *Following indicators were chosen by the service provider:*

*To measure Objective 1 (Increase en-route throughput):*

*Throughput demand* as number of IFR movements/hour requiring entry to FIR.

*Throughput capacity* as number of IFR movements/hour without causing excessive ATC Workload

*Number of Sectors:* defined as number of sectors that are open in an

## Step 3

# QUANTITY OBJECTIVES (Contd.)

- *Example – Part 6 (Contd.)*
- *To measure Objective 2:*
- *PIAC demand as Peak Instantaneous Aircraft Count (PIAC). Defined as the number of IFR flights simultaneously present in the airspace*
- *PIAC capacity defined as number of IFR flights, which can be simultaneously present in the airspace volume without causing system overload*
  
- ➔ *To calculate mentioned indicators, data will have to be collected for each flight. Following supporting metrics need to be created:*
- *Entry time: date and time at which flight enters airspace*
- *Exit time: date and time at which flight leaves airspace*
  
- ➔ *Calculation of Indicators*
- *Throughput demand: count of flights with entry time within one hour period for which the indicator is calculate*
- *PIAC demand time T1: demand at time T0 plus the count of flights with an entry time within the T0 – T1 period minus the count of flights with an exit time within T0 – T1 period.*
  
- ➔ *Aggregation Hierarchy:*
- *If the FIR is divided into sectors, then indicators are calculated for each sector, sector groups and for the FIR as whole*

## Step 3

# BASELINE & TARGETS

- **Performance Targets:** values of performance indicators that need to be reached or exceeded to consider a performance objective as being fully achieved. It can be set in terms of time or geographical area or a particular stakeholder. Targets can be set to provide guidance and as an instrument for enforcement.
- **Baseline Performance:** The result of assessment under nominal performance.
- **Performance Gap:** The difference between baseline and target. It defines as to how challenging it is to reach the target performance.

### *Example – Part 7*

*In our example, let us say that FIR YYYY can be divided into two regions (North and South) with distinctively different characteristics*

#### *Baseline:*

##### *North part of FIR*

*o Number of Sectors 5*

*o Sector capacity 15 movements/hour, busy hour demand 10 movements/hour*

*o PIAC capacity of sector group is 40 aircraft, busy hour PIAC demand 25 aircraft*

## Step 3

# BASELINE & TARGETS (Contd.)

- *Example – Part 7 (Contd.)*
- *Southern part of FIR*
  - *Number of Sectors: 4*
  - *Sector capacity 30 movements/hour, busy hour demand 25 movements/hour*
  - *PIAC capacity of sector group 100 aircraft, busy hour PIAC demand 80 aircraft*

### *Traffic Growth Forecast*

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

### *Target Setting*

*Based on the Traffic Forecast for future, the targets are set as follows*

#### *Northern part of FIR*

- *Sector capacity:  $10 \times 3 = 30$  movements/hour*
- *PIAC sector group capacity:  $25 \times 3 = 75$  aircraft*

#### *Southern part of FIR*

- *Sector capacity:  $25 \times 2 = 50$  movements/hour*
- *PIAC sector group capacity:  $80 \times 2 = 160$  aircraft*

## Step 3

# BASELINE & TARGETS (Contd.)

- *Example – Part 7 (Contd.)*

### Capacity Gap

#### Northern part of FIR

- o *Sector capacity gap:  $30 - 15 = 15$  movements/hour*
- o *PIAC sector group capacity gap:  $75 - 40 = 35$  aircraft*

#### Southern part of FIR

- o *Sector capacity gap:  $50 - 30 = 20$  movements/hour*
- o *PIAC sector group capacity gap:  $160 - 100 = 60$  aircraft*

### Required capacity increase:

#### Northern part of FIR

- o *Sector capacity:  $15/15 = 100\%$  increase*
- o *PIAC capacity:  $30/40 = 75\%$  increase*

#### Southern part of FIR

- o *Sector capacity:  $20/30 = 66\%$  increase*
- o *PIAC capacity:  $60/100 = 66\%$  increase*

## Step 4

# SELECT SOLUTIONS

- **Performance Gap Analysis:** assess impact of drivers, constraints, blocking factors etc. on the objectives
- The process involves
  - Eliminate/defer issues that do not immediately or significantly affect the achievement of objective(s)
  - Help to maximize effectiveness if resources are constrained
  - Create a 'traceability chain' explaining what will be improved and how much, prior to selection of solutions
  - Progress the decision making to the point where it is appropriate to start thinking in terms of options

### *Example – Part 8*

#### *Short-term strategy*

*Based on the analysis of forecast, available data and coordination with other stake holders, it may be decided that some spare capacity is available so no necessity for increase of capacity for next five years in northern & southern parts.*

- *After that procedural control will be dominant blockage in northern part of FIR*
- *Controller workload may become an issue*

# Step 4

## SELECT SOLUTIONS (Contd.)

### *Example – Part 8 (Contd.)*

#### Priority

- o *The effect of Frequency Shortage and Staff Shortage are given low priority, because their effect will be visible after quite sometime.*

#### Assessment of Risk

- o *Analysis of future demand, route structure and airspace availability in neighboring FIRs seem to indicate that probability of traffic falling is low*
- o *Severity assessment: severity of effect of drop can be lessened by using more cost effective ways of increasing capacity*

#### Opportunity Analysis:

- o *After analyzing how other regions have implemented ADS-B, the service provider is confident that ADS-B is a viable alternative.*

# Step 4

## CREATING OPTIONS

- Next step is to create the list of options. The decision makers need to gain a good understanding of strategic fit, benefits, cost and feasibility of each option.
  - They must fit with high level strategy and policy orientation
  - They must be on transition path towards operational concept
  - They must take into account the architecture in which the system enablers need to fit (like the CNS system, automation system)
  - They need to be developed from the baseline
  - They depend on feasibility/timing of developing/deployment of enablers
  - Safety and human factor assessment is required to have sufficient confidence that operational improvement is feasible from human factors and safety perspective
  - It should be explicitly specified which issues are expected to be resolved under which circumstances, so as to quantify the resulting performance improvements.
  - All side effects should also be identified. The side effects could include
    - Increased cost
    - Increased resource consumption
    - Unintended performance reduction in other areas.

## Step 4

# CREATING OPTIONS (Contd.)

- *Example – Part 9*

*Issues which were identified and are required to be mitigated on priority:*

- ✓ *Capacity limits associated with procedural control in northern part of FIR*
- ✓ *Controller work load in the southern part of FIR*
- ✓ *The SSR capacity limits in the southern part of FIR*

*Candidate solutions could include the following:*

- ✓ *Moving from procedural control to radar control (enabler: surveillance)*
- ✓ *Sector splitting (horizontal and vertical)*
- ✓ *Replacement of SSR technology by a system with higher PIAC capability*
- ✓ *Choice of surveillance technologies:*
  - ✓ *SSR*
  - ✓ *Mode S MSSR*
  - ✓ *ADS-B*

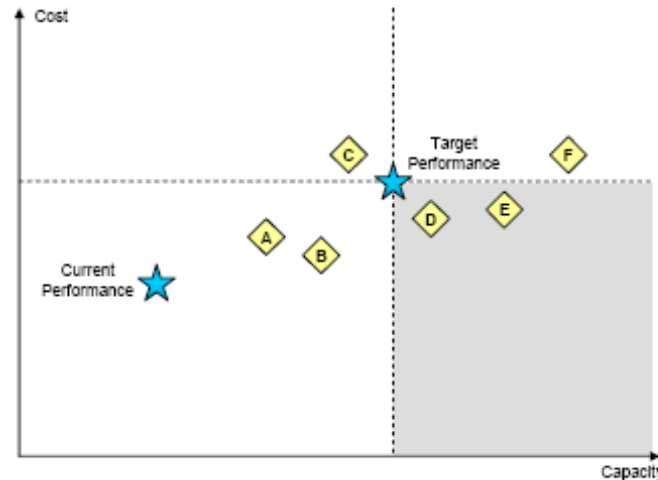
## Step 4

# SELECTION OF OPTIONS

Based on the following information available to support decision making:

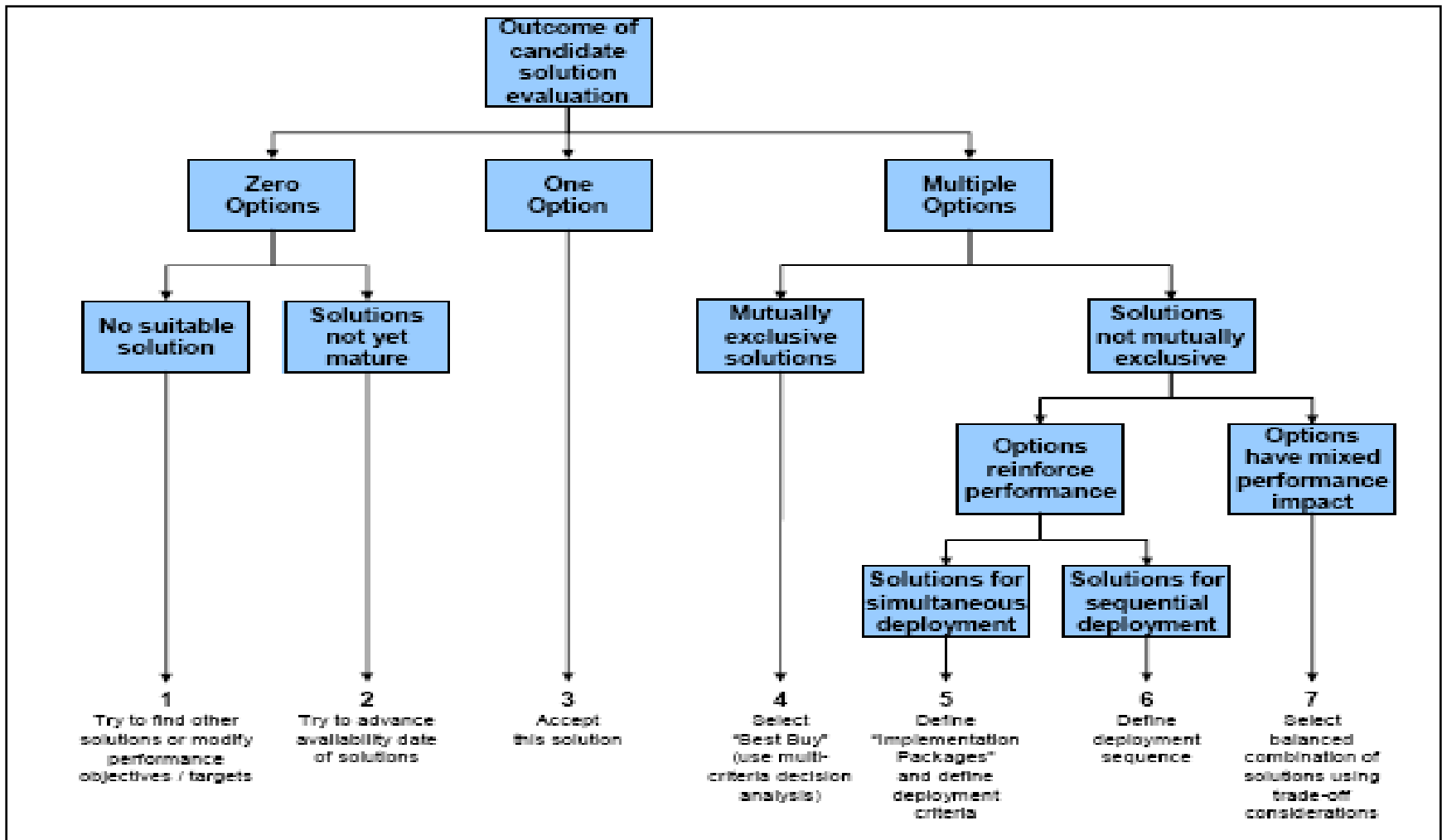
- ❑ Definition of system/expectations scope and context
- ❑ Required results in terms of performance objectives and targets (with dates)
- ❑ Prioritized issues and opportunities
- ❑ Overview of candidate solutions and their capacity to resolve issues
  - ❑ List of operational improvements
  - ❑ Associated enablers (services and procedures, human resources, technology etc.)

The decision process is optimized between various parameters (like capacity & cost in the following case)



## Step 4

# SELECTION OF SOLUTION



## Step 4

# SELECTION OF OPTIONS (Contd.)

### *Example – Part 10*

*Because the Baseline and Targets are different for Northern and Southern part of the FIR, different solutions have to be chosen:*

#### *Operational Improvements*

##### *For northern part of FIR*

*Movement from Procedural control to Radar Control. Sector splitting not considered since, target sector capacity is same as existing sector capacity of southern sector.*

##### *For southern part of the FIR*

*Reorganization of sectors from 4 to 7, with a capacity of 30 movement/hour for each sector.*

#### *Selection of Enablers*

- ❖ *Sector splitting requires installation of three more controller work stations*
- ❖ *Surveillance coverage in northern area. Options Mode-S radar, ADS-B*
- ❖ *Since same Radar can not cover northern region, may be additional Mode S and ADS-B can be considered as options. After cost/benefit analysis, ADS-B is chosen based on lower cost and long term capacity potential*

## Step 5

# IMPLEMENT SOLUTION

Depending upon nature and magnitude of change, it could involve

- o In the case of small-scale change or day-to-day management
  - o Assigning management responsibility for the implementation to an individual
  - o Assigning responsibility and accountability for reaching the performance target to an individual or organization
- o In the case of major or long term changes:
  - o Creating a detailed implementation plan, followed by launching of implementation project
  - o Executing performance management process at the level of individual projects. Each project must inherit scope, context and expectations from overall implementation plan.

### *Example – Part 11*

*A plan is developed for the three main projects:*

- *The re-sectorization project*
- *ADS-B implementation project*
- *SSR decommissioning project (since its performance is getting restricted)*

## *Step 6*

# ASSESS ACHIEVEMENT OF OBJECTIVES

- To keep track of performance, and monitor whether performance gaps are being closed.
- First this implies collection of data to calculate the performance indicators. Compare them with the target, to assess achievement and the speed.
- Not only the performance gaps are reassessed but recommendations are given based on the experience to set new objectives.
- For the purpose of *Performance Monitoring & Review*, the task can be broken down into five separate activities:
  - Data collection
  - Data publication
  - Data analysis
  - Formulation of conclusions
  - Formulation of recommendations

## ***Step 6***

# **ASSESS ACHIEVEMENT OF OBJECTIVES (Contd.)**

### ***Data Collection***

There are two categories of data that are required in Performance Monitoring & Review

- Data which is captured by automatic means, and forwarded in electronic form with little or no human intervention. Usually high volume.
- Manual reporting, requires human effort to collect, interpret, analyze, structure and prepare for reporting. Low frequency, complex often processed.

Following steps need to be taken

- ✓ Identify information needs
- ✓ Identify potential suppliers of data
- ✓ Ensure information disclosure by candidate data suppliers
- ✓ Manage the data feeds on an ongoing basis

## ***Step 6***

# **ASSESS ACHIEVEMENT OF OBJECTIVES (Contd.)**

### ***Data Access and Publication***

Data need for the higher level management and expert group which assesses the performance differs. Data can be published for different level of needs.

### ***Data Analysis***

Analysts need to compare *performance indicators* against *performance targets*, identify performance evolution trends, analyze historical evolution of performance, and find relationship between *performance indicators*, *supporting matrices etc.* They need to look at the big picture (annual totals and averages) and also drill down to very detailed levels to find the causes of *performance gaps* and the reasons for trade-offs.

### ***Formulation of Conclusions***

After completing data analysis, analysts are expected to document the insight they have gained by formulating conclusions for each *Key Performance Area (or focus areas)*. Normally these conclusions contain an assessment of the sufficiency of current and expected future performance, for each *performance objective*. Typically conclusions are published in *performance review* reports

## ***Step 6***

# **ASSESS ACHIEVEMENT OF OBJECTIVES (Contd.)**

### ***Formulation of Recommendations***

These are derived from the conclusions, and should also be included in the *performance review* report.

Recommendations should focus on how to meet ATM *community expectations* through agreed *performance objectives*, *performance indicators* and *performance targets*. Recommendations may include need to set or change *performance objectives*, (re-) define *performance indicators* and the need to set or change *performance targets* to align them with ATM *community expectations*.

Recommendations will also fall more typically into following categories:

- o Related to need to improve performance data collection
- o Suggested initiatives aimed at closing identified *performance gaps*
- o Align improvements with the traffic growth
- o Recommendations of organizational nature like setup a task force etc.

## *Step 6*

# REPEAT THE PROCESS

- Performance management is a closed loop process. Step 6 identifies deficiencies, where performance is not as expected, despite implementation of changes designed to achieve the performance improvements. Next iteration process should be started from Step 1.

# PBA APPLICATIONS

- PBA process can be applied under following circumstances
  - During validation of concept
  - During and/or after implementation
  - Legal requirements, rules and regulation
  - Certification and licensing
  - Inspection and oversight
  - Annual performance review (the cycle is annual)
  - Medium term planning process (annual cycles)
  - Strategic planning/seasonal scheduling (seasonal cycle)
  - Pre-tactical planning (e.g. daily cycle)

# CONCLUSION

- In the long run, implementation of PBA is expected to result in
  - Efficient system through identified cost savings
  - Reduction in waste of resources
  - More equitable charging practices
  - More efficient provision of services
- It requires a globally coordinated effort, and a common approach towards developing and implementing a performance-based air navigation system