ICAO Doc 9992

Manual On The Use of Performance Based Navigation (PBN) in Airspace Design

Overview

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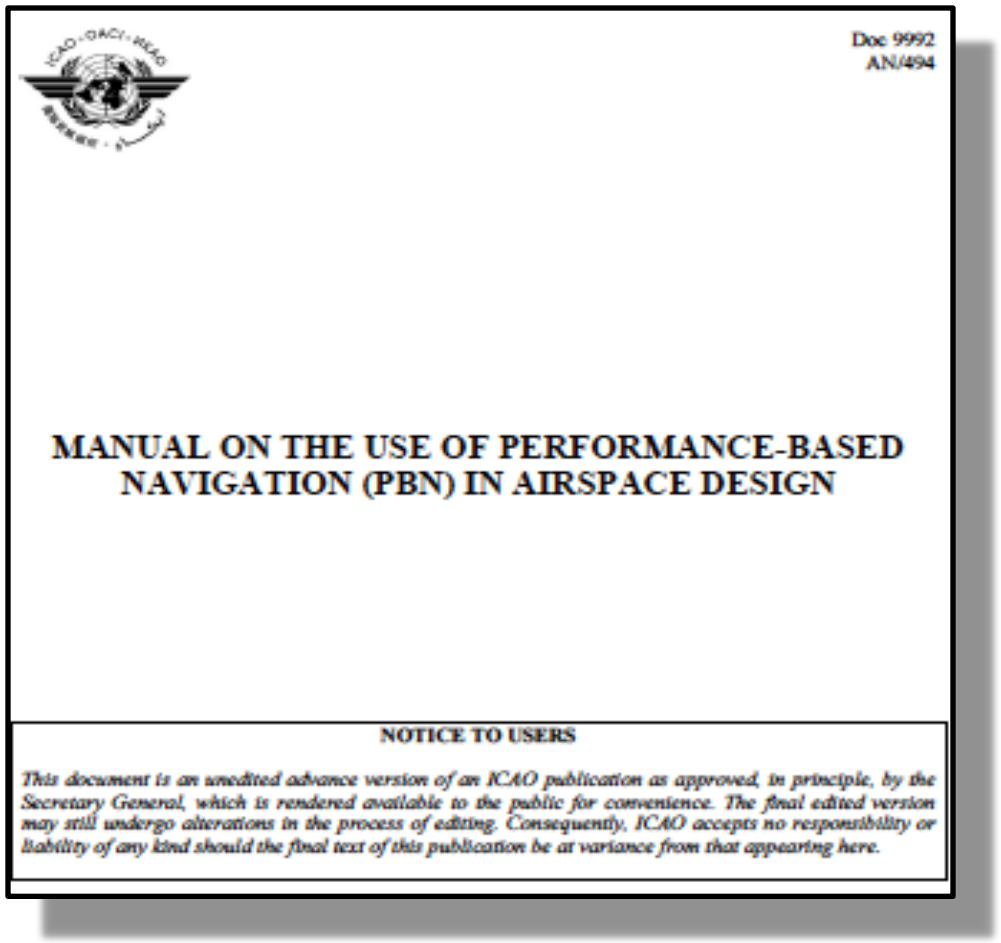

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AN/494

MANUAL ON THE USE OF PERFORMANCE-BASED NAVIGATION (PBN) IN AIRSPACE DESIGN

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Online Course:

Airspace Concept

PBN Implementation Processes

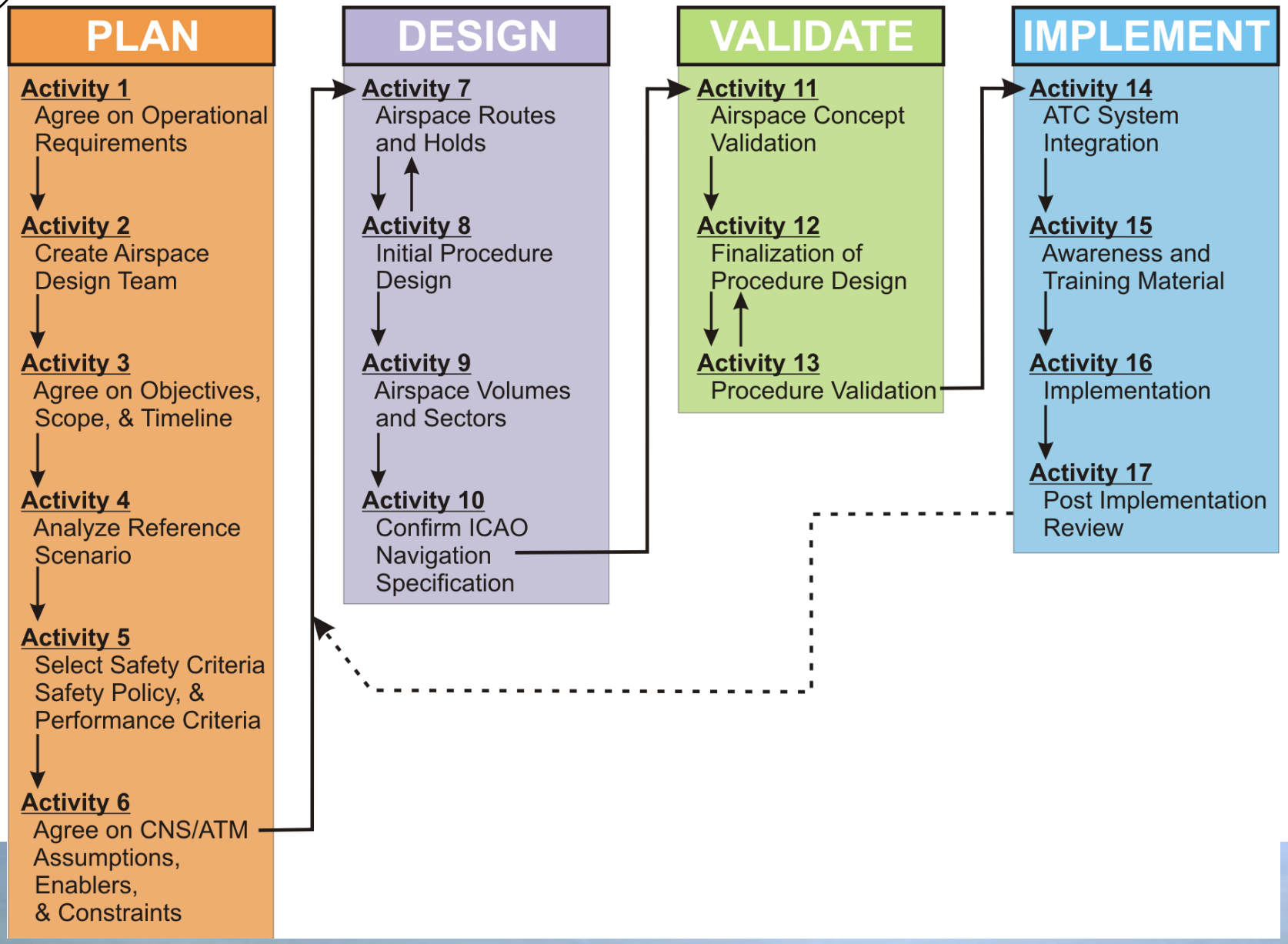
PLAN

DESIGN

VALIDATE

IMPLEMENT

Airspace Concept Activity Overview



Activity 1

PLAN

1 - Agree on Operational Requirements

- Safety
- Capacity
- Efficiency
- Environment
- Accessibility

Objectives ➲ Implementation Example

PLAN

Safety	Capacity	Efficiency	Environment	Access
Reduce Controlled Flight Into Terrain via lateral & vertical course guidance to runway	Increase number of air traffic routes to reduce congestion; accommodate projected growth	Reduce delays that result from excessive "levelling off" flight profiles by implementing CCO/CDO	Reduce noise over sensitive area	Improve airport and airspace access in all weather conditions
RNP approach (LNAV/VNAV) to replace circling approach	Parallel RNAV-2 ATS routes between cities	RNAV-1 SID that allows continuous climb to enroute	Use of RF in intermediate or missed approach segment	RNP approach allowing lower minima

Who develops an Airspace Concept?

- A *team effort* by representatives of various organizations and technical specialties
- Composition of the team depends on the scale and nature of the project
  - A simple airspace concept (e.g. a SID, STAR and IAP) would have experts from
    - ANSP (including PANS OPS procedure designer)
    - civil aviation regulator
    - airport operator
    - operators' representative
  - A more extensive Airspace Concept (e.g. new runway, plan for terminal and enroute airspace) could also include
    - safety management system experts
    - simulation studies experts
    - additional operator representatives
    - environmental personnel
- *Team lead* - usually an airspace planner or knowledgeable ANSP air traffic manager- *Not a hard and fast rule.* The fundamental requirement is for a knowledgeable, proactive and dedicated individual with a sound understanding of air traffic management and airspace organization.

Activity 2

PLAN

2 – Create Airspace Design Team

- Lead by ATM/airspace specialist
- ATC (Approach and Area controllers)
- ATM & CNS specialist
- Procedure designers
- Technical pilots
- ……

Activity 3

PLAN

3 – Project objectives, scope and timescales

- Objective derived from Ops requirements
- Scope !! (sets the limit of the project)
  - Time
  - Resources
- Timescales

Activity 3

3 – Project objectives

PLAN

Safety? | Capacity | Efficiency | Environment | Access?

- Capacity → Improve SID/ STAR design to accommodate projected traffic growth
- Efficiency → Provide shorter and more predictable routes to/from Kapitali
- Environment → Reduce noise over sensitive areas

→ Airspace Concept

Objectives ➲ Implementation Additional Considerations

PLAN

Example:

Although GNSS is associated primarily with navigation, GNSS is also the backbone of ADS-B surveillance applications.

As such, GNSS positioning and track-keeping functions are no longer “confined” to being a navigation enabler to an airspace concept. GNSS, in this case, is also an ATS surveillance enabler.

The same is true of data-link communications: data are used by an ATS surveillance system (for example, in ADS-B and navigation).

What is needed to develop an Airspace Concept?

PLAN

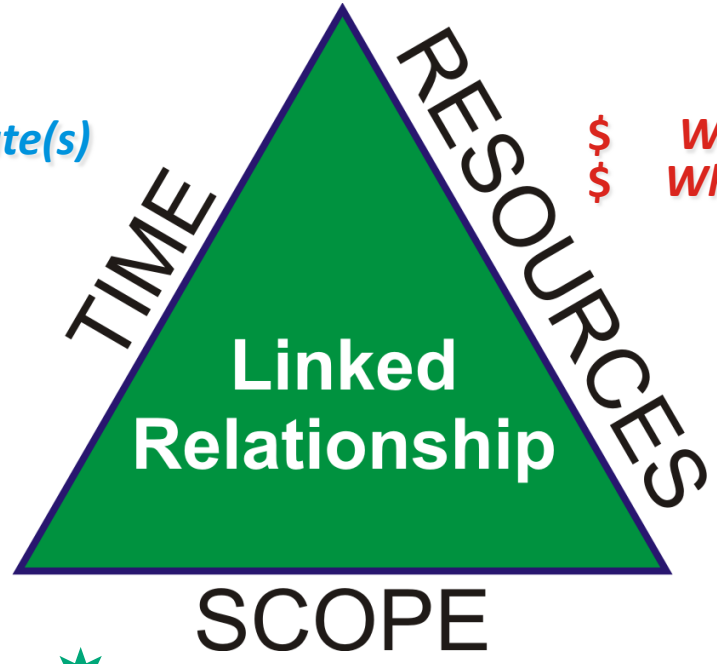
- TIME – to explore the needs of the various stakeholders, reach agreement on goals, identify current ground and airborne equipment limitations, conduct traffic flow analyses, etc
- RESOURCES – Costs may include (but are not limited to)
  - education and training (regulators, operators, ATC, procedure designers, etc),
  - establishment and sustainment of robust airworthiness, operations approvals, data quality techniques,
  - changes to ATC automation, flight validation, possibly new NAVAIDS (DMEs), etc
- TOOLS - design and modeling tools to support the design, validation and assessment of the present ("reference scenario") and planned Airspace Concept

Activity 3

PLAN

3 – Project objectives, scope and timescales

$ *Implementation Date(s)*
$ *Phases of Work?*



$ *Which Human Resources?*
$ *What about the budget?*

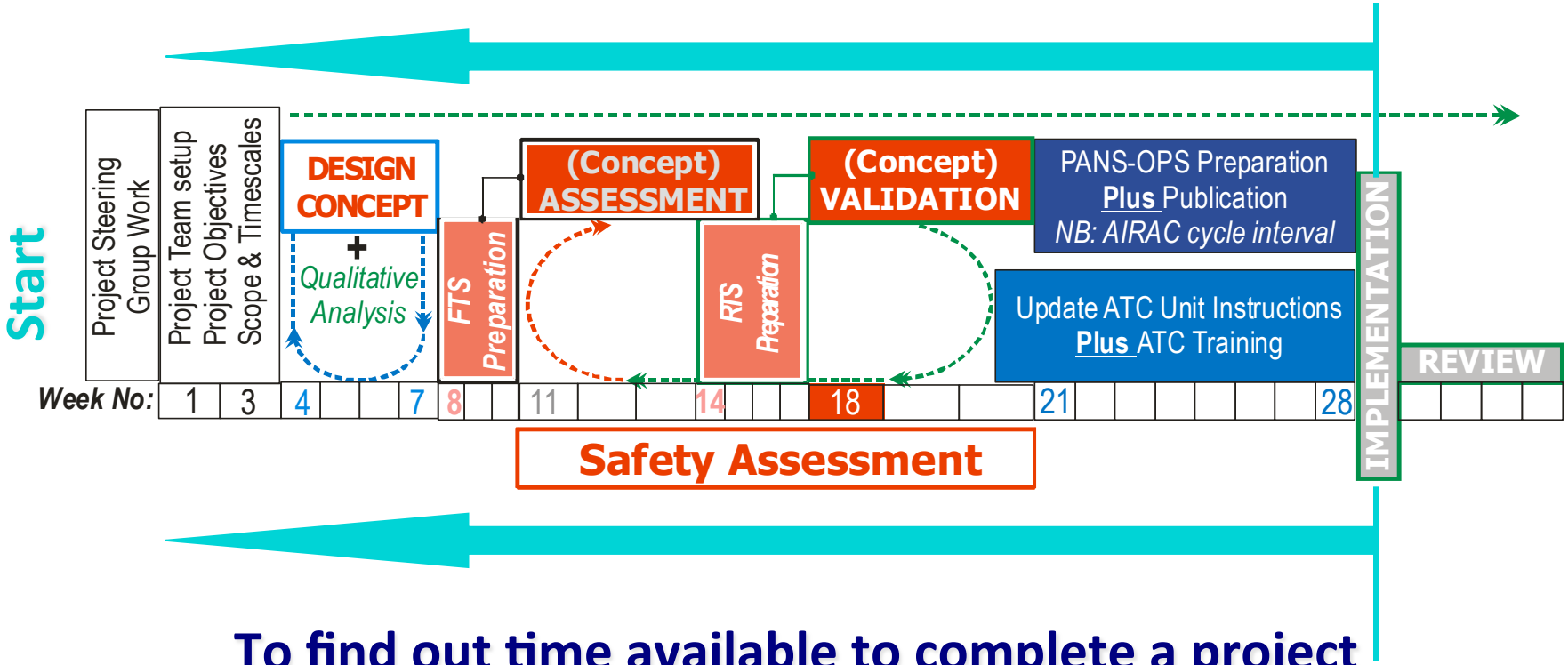
- *What is the Objective ?*
- *How much can be done?*
- *What cannot be done?*

Beware of Project Creep!

Activity 3

PLAN

3 – Project timescales



To find out time available to complete a project – calculate backward from Implementation date

PLANNING EXAMPLE

PLAN

EXAMPLE PROJECT PLAN

		ACTIVITY	Number of Days
PLAN	1	Agree on Operational Requirements	10
	2	Create Airspace Design Team	5
	3	Agree on Objectives, Scope & Timeline	15
	4	Analyze Reference Scenario	15
	5	Select Safety Criteria, Safety Policy, & Performance Criteria	10
	6	Agree on CBS/ATM Assumptions	12
DESIGN	7	Design Airspace Routes and Holds	14
	8	Initial Procedure Design	20
	9	Design Airspace Volumes and Sectors	20
	10	Confirm ICAO Navigation Specification	5
VALIDATE	11	Airspace Concept Validation	20
	12	Finalize Procedure Design	22
	13	Procedure Validation	20
IMPLEMENT	14	ATC System Integration	30
	15	Awareness and Training Material	30
	16	Implementation	1
	17	Post Implementation Review	30
		TOTAL DAYS REQUIRED	279

PLANNING EXAMPLE

PLAN

EXAMPLE PROJECT PLAN

		ACTIVITY	Timeline Number of WorkDays	Parallel Days	Total Work Days	Start Date	Completion Date
PLAN	1	Agree on Operational Requirements	10	0	10	**9-Feb-2013**	22-Feb-2013
	2	Create Airspace Design Team	5	0	5	22-Feb-2013	1-Mar-2013
	3	Agree on Objectives, Scope & Timeline	15	0	15	1-Mar-2013	22-Mar-2013
	4	Analyze Reference Scenario	15	0	15	22-Mar-2013	12-Apr-2013
	5	Select Safety Criteria, Safety Policy, & Performance Criteria	10	0	10	12-Apr-2013	26-Apr-2013
	6	Agree on CBS/ATM Assumptions	12	0	12	26-Apr-2013	14-May-2013
DESIGN	7	Design Airspace Routes and Holds	14	0	14	14-May-2013	3-Jun-2013
	8	Initial Procedure Design	20	0	20	3-Jun-2013	1-Jul-2013
	9	Design Airspace Volumes and Sectors	20	0	20	1-Jul-2013	29-Jul-2013
	10	Confirm ICAO Navigation Specification	5	0	5	29-Jul-2013	5-Aug-2013
VALIDATE	11	Airspace Concept Validation	20	0	20	5-Aug-2013	2-Sep-2013
	12	Finalize Procedure Design	22	0	22	2-Sep-2013	2-Oct-2013
	13	Procedure Validation	20	0	20	2-Oct-2013	30-Oct-2013
IMPLEMENT	14	ATC System Integration	20	10	30	16-Oct-2013	27-Nov-2013
	15	Awareness and Training Material	0	30	30	16-Oct-2013	27-Nov-2013
	16	Implementation	1	0	1	27-Nov-2013	28-Nov-2013
	17	Post Implementation Review	30	0	30	28-Nov-2013	9-Jan-2014
		TIMELINE DAYS REQUIRED	239		279	total workdays	**END DATE 9-Jan-2014**

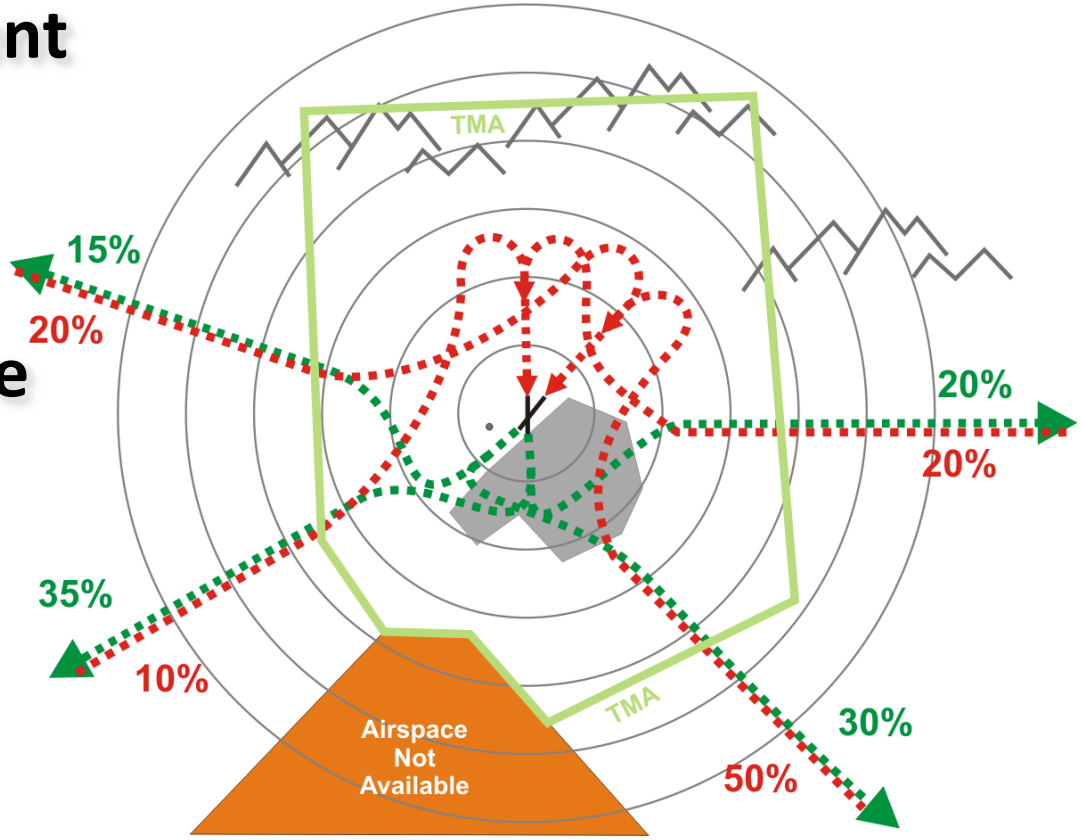
*note: Uses WORKDAY function to exclude weekend and holiday days

Activity 4

PLAN

4 – Analysis of the reference scenario

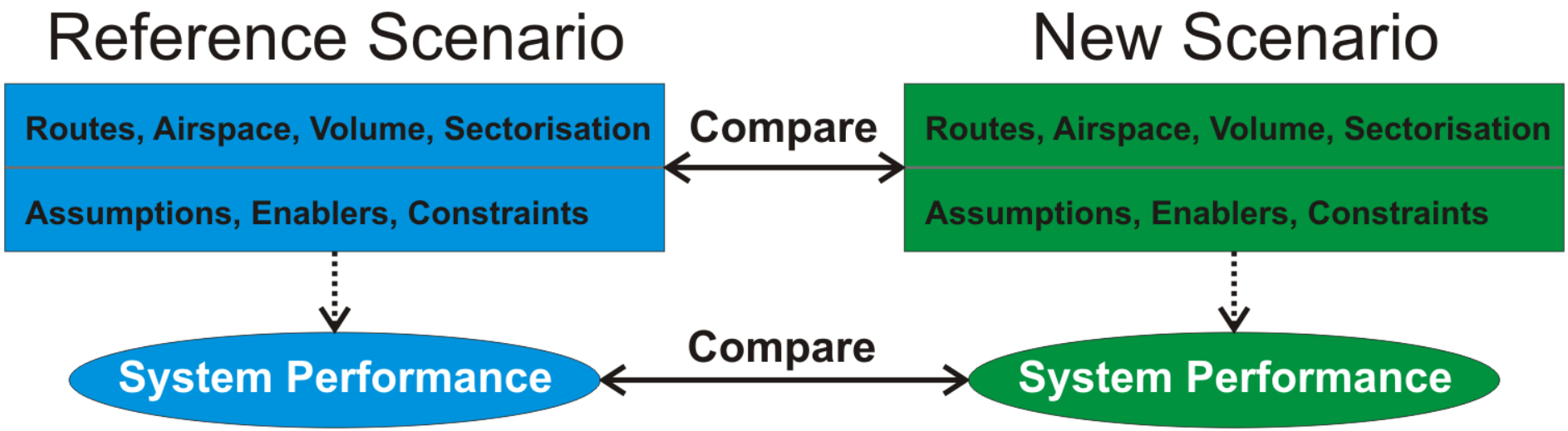
- Assessment of present operations
- Identification of positive and negative
- Benchmark
- Avoids repeats of design flaws



Activity 4

PLAN

4 – Analysis of the reference scenario



Activity 5

PLAN

5 – Select Safety Criteria, Safety Policy and Performance Criteria

- Select Safety Management system
- Select Safety Assessment Methodology
- What evidence is needed to prove safety of design
- Set success criteria

Activity 6

PLAN

6 – Agree on ATM/CNS assumptions

ATM/CNS ASSUMPTIONS (current and future)

Traffic Analysis

- Representative Traffic Sample
- Distribution - Time/Geography
- Cross check adjacent facility traffic
- IFR/VFR mix
- Civil/Military mix
- Acft performance mix (jet/prop/helo)

Navigation

- ACFT Navigation Equipage
- NAV Infrastructure and Coverage
- PBN Conventional Mix

Runway in use (primary/secondary)

- Available runways/length
- Meteorological assumptions
- Landing Aids
- Greenfield Site? Orientation choice?
- Runway usage statistics

ATC System

- Sectors/Personnel/Equipment
- Traffic Sequencing and Management

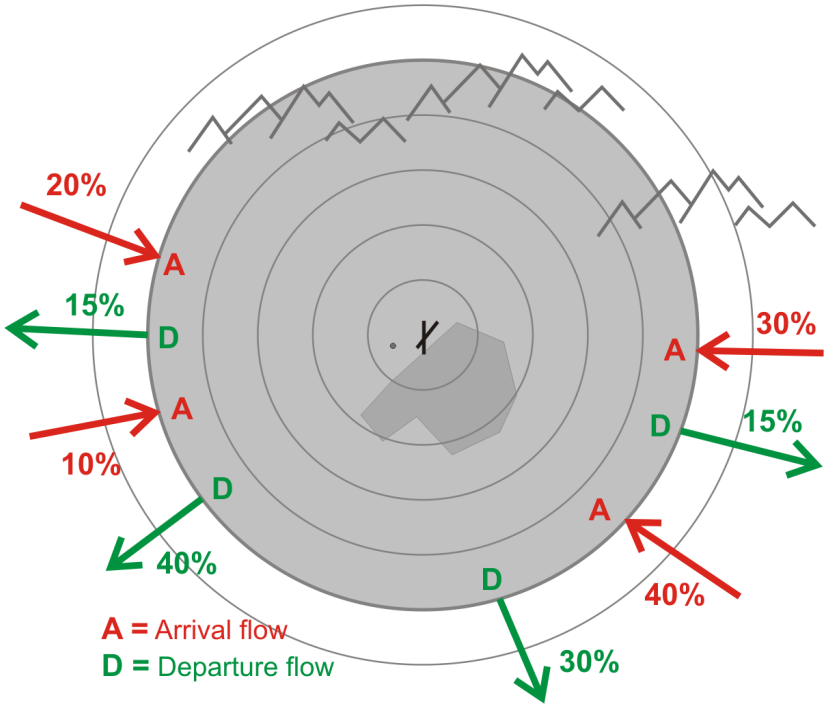
Surveillance Means/Coverage

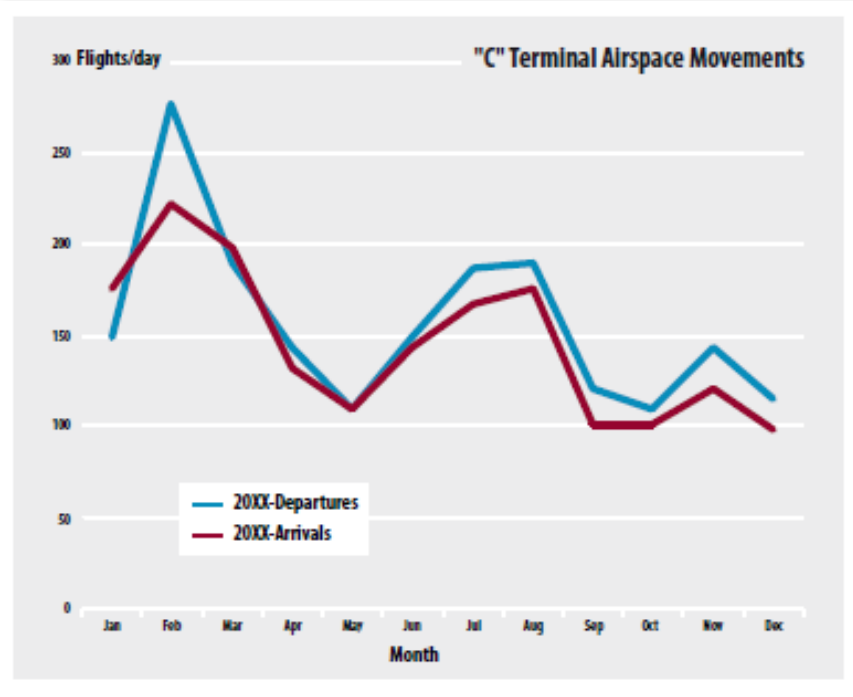
Communications Means/Coverage

Activity 6

PLAN

6 – Agree on ATM/CNS assumptions





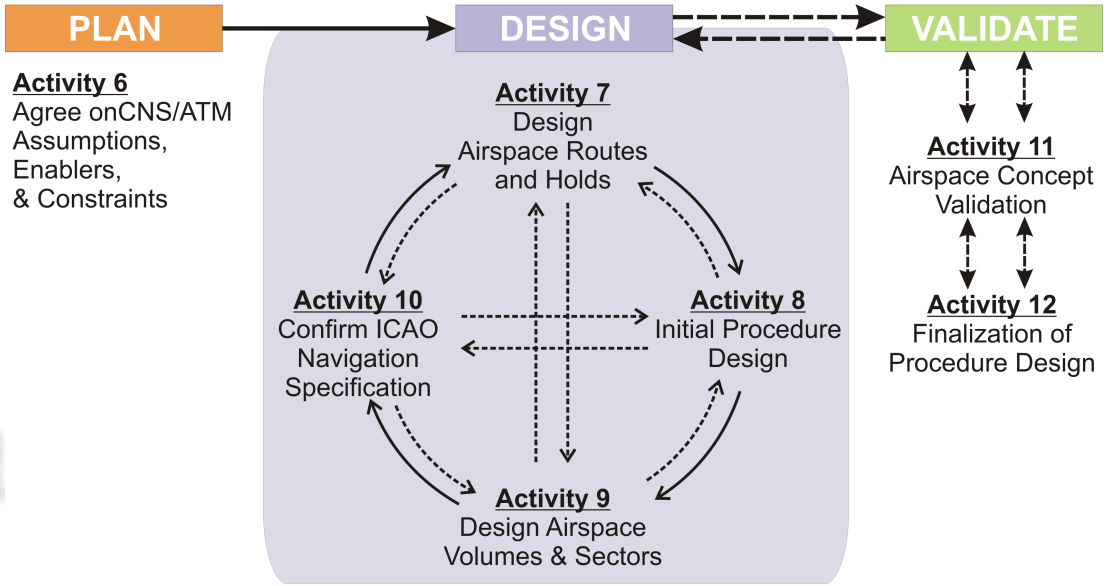
Activity 7

DESIGN

7 – Design the Airspace, Routes and Holds

- 1st Design Routes
- 2nd Initial Procedure Design Analysis
- 3rd Define the airspace volumes and sectorise these, if needed

Iterations necessary!

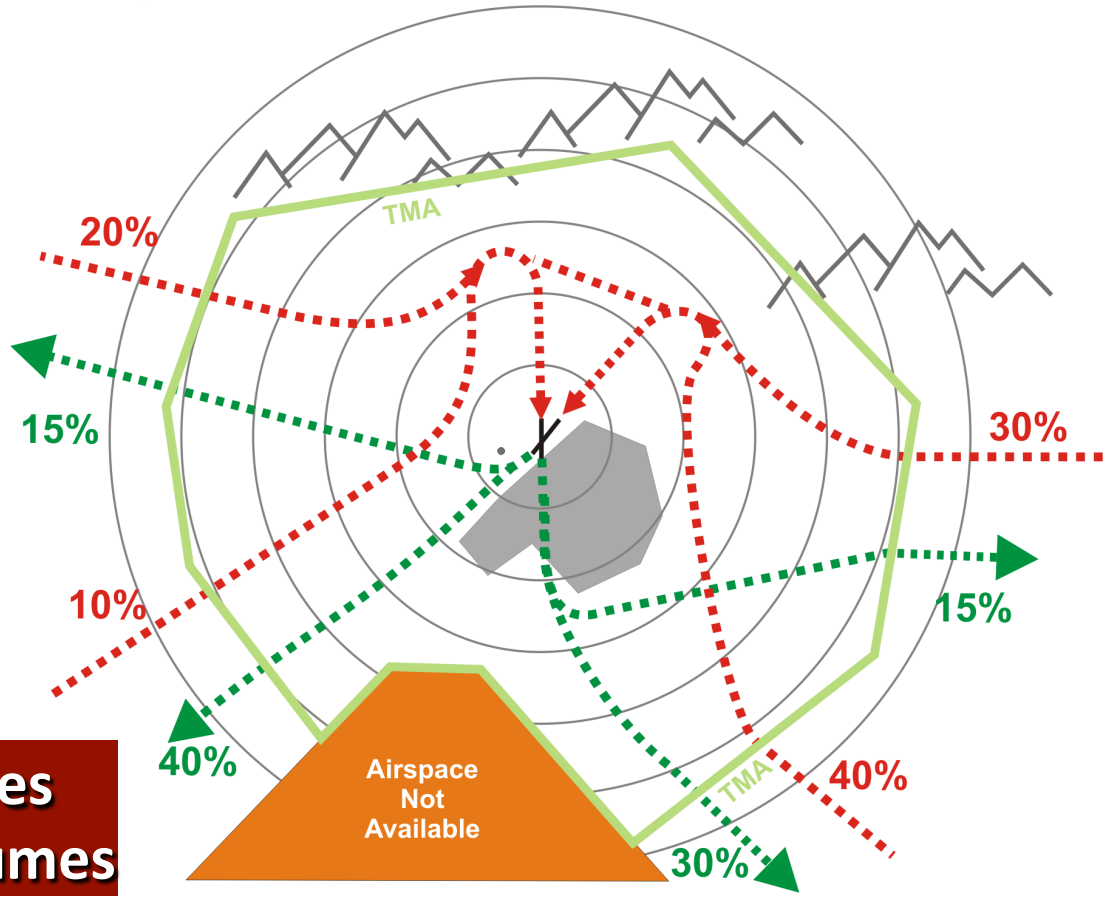


Activity 7

DESIGN

7 – Design the Airspace

- Arrivals
- Departures
- Transit
- VFR
- Military



AVOID trying to fit the routes into the existing airspace volumes

Activity 8

DESIGN

8 – Initial Procedural Design

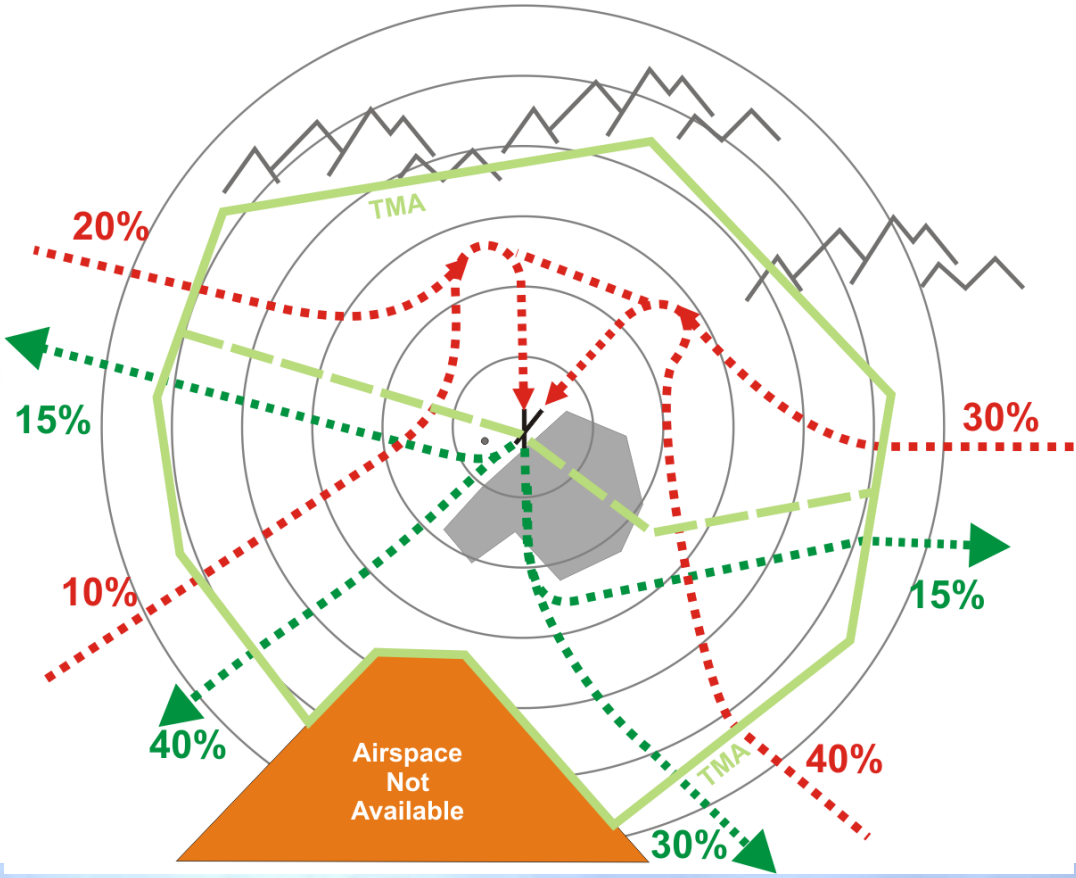
- Capability/functionality needed?
- Fleet capability/functionality available?
- Coverage provided by available Navaid infrastructure?
- Design according to ICAO Doc 8168 and Doc 9905
  - Initiation
  - Collect & Validate Data
  - Create Conceptual Design
  - Review by Stakeholders

Activity 9

DESIGN

9- Design Airspace Volumes and Sectors

- ✈Sectorisation
- ✈Airspace volume
- ✈Iterations possible



Activity 10

DESIGN

10 – Confirm ICAO Navigation specification

- Review NAV specs
- Identify appropriate spec
- Go to Validation and Implementation
- If no appropriate spec
  - Apply Trade off

Activity 11

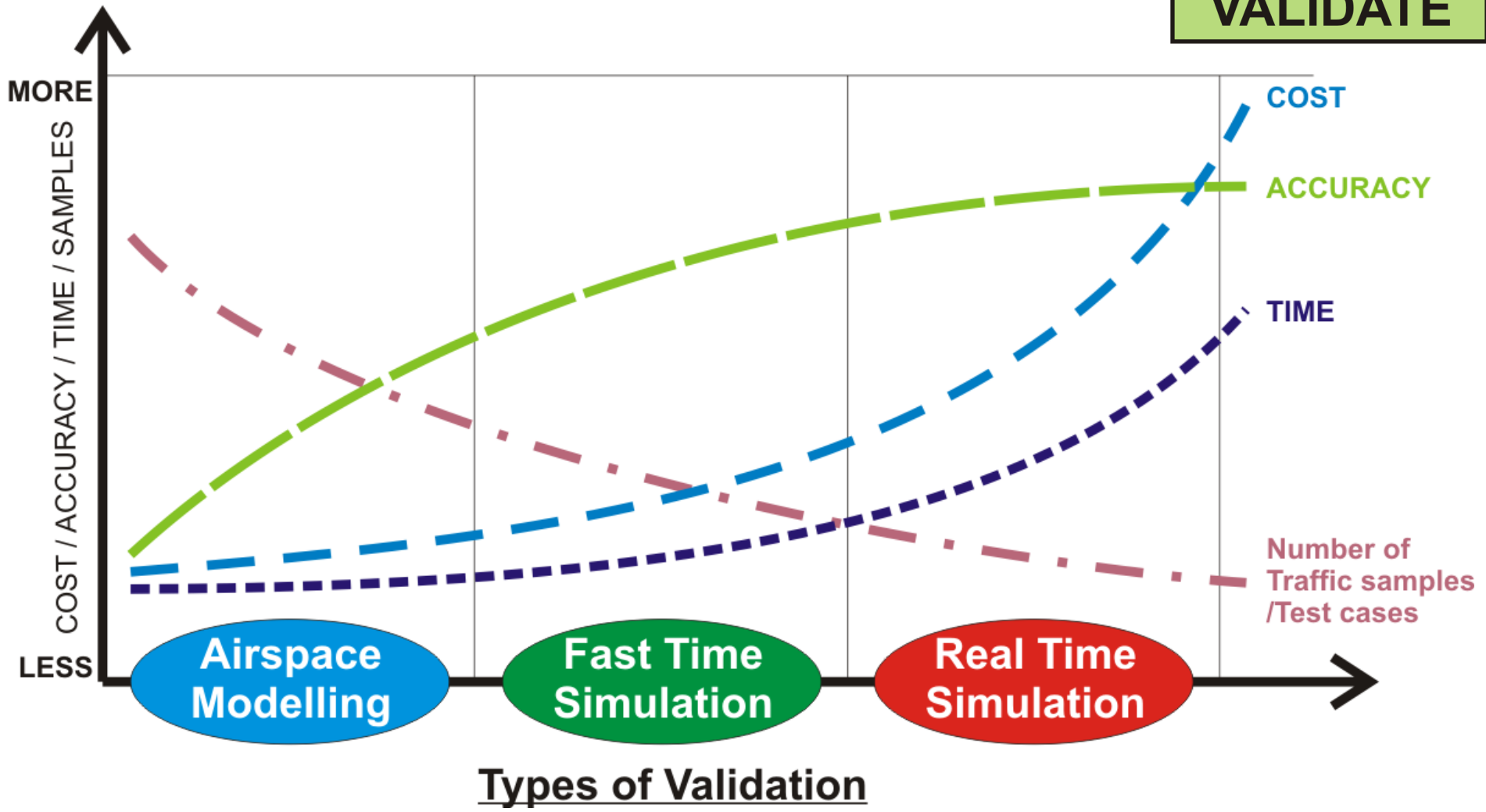
VALIDATE

11 – Airspace Concept Validation

- Prove ATM operability & validity
- Assess objectives
- Indentify possible weak points
- Provide evidence and proof to support Safety Assessment

CONCEPT VALIDATION

VALIDATE



Activity 12

VALIDATE

12- Finalisation of procedure design

- Design according to ICAO Doc 8168 and Doc 9905
  - Apply Criteria
  - Document and Store
  - Support Safety Assessment
- Output:
  - Draft procedure layouts
  - Calculation outputs
  - Textual description of procedure

Activity 13

VALIDATE

13- Procedure validation

- Verification of terrain, obstacle and aeronautical data used to support design
- Validate intended use of procedure (match to conceptual design)
- Validate correct application of criteria
- Validate flyability and human factors (charting)
- Flight Inspection (if required)

Activity 14

IMPLEMENT

14- ATC System Integration

- Changes to ATC system interfaces and displays to ensure controllers have the necessary information on aircraft capabilities and the appropriate displays to support the new routings. Such system changes could include modifications to:
  - Air Traffic Flight Data Processor (FDP)
  - Air Traffic Radar Data Processor (RDP)
  - ATC situation display
  - ATC support tools

Activity 15

IMPLEMENT

15 – Awareness and Training Material

- The introduction of PBN can involve considerable investment in terms of training, education and awareness material for both flight crew and controllers.
  - Printed training packages
  - Computer based training
  - NOTAMS
  - ICAO provides additional training material and seminars.

Activity 16

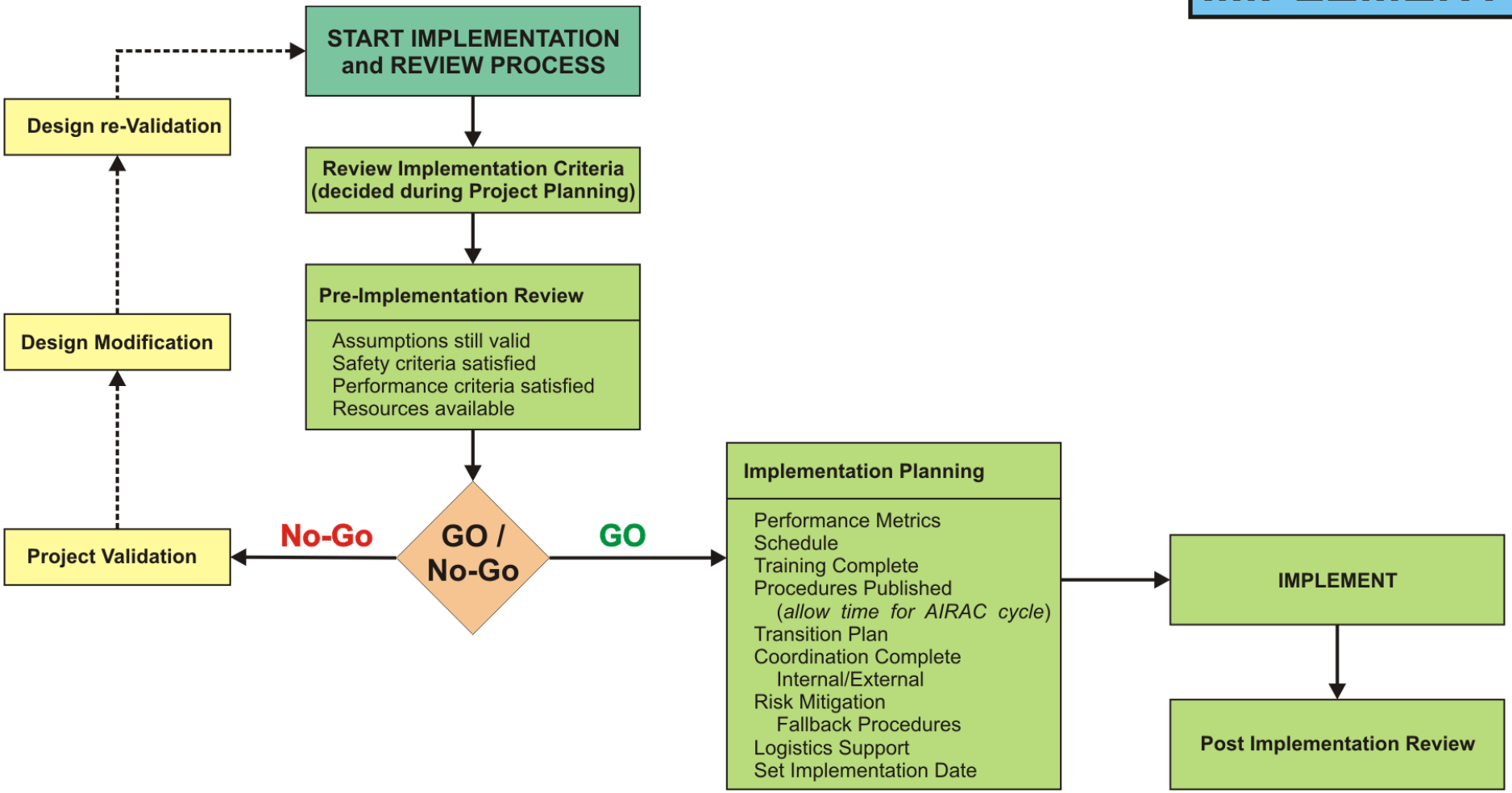
IMPLEMENT

16 – Implementation

- Have the Safety and Performance Criteria been satisfied;
- Have the required changes been made to the ATM system;
- Have the required changes been made to the ground navigation systems;
- Do the assumptions and conditions upon which the Airspace Concept has been developed still pertain. (are traffic flows as forecast, is the fleet suitably equipped and approved etc);
- Are the critical enablers all in place.;
- Have the pilots and controllers received appropriate training.

Activity 16

IMPLEMENT



Activity 16

IMPLEMENT

- Monitor the implementation process;
- Support the Centre supervisor/Approach Chief or Operational Manager should it become necessary to use redundancy or contingency procedures;
- Provide support and information to operational controllers and pilots;
- Maintain a record of implementation-related difficulties for use in future project planning;

Activity 17

IMPLEMENT

- Post Implementation Review
- Keep LOG
  - Assess if objectives are met
  - Measure!
  - System safety assessment – collect evidence

Lessons Learned

- RNAV implementation in some regions over past 15 years has highlighted some issues.
- The following slides list a few of those issues.

RNAV 5 implementation en-route airspace

- Selecting the right Nav Spec can be a challenge… sometimes there are more older aircraft than expected
- Roll out airspace changes over time: avoid multiple airspace changes at the same time as the PBN switch on date
- 'Switch on' PBN in the Terminal Airspace should be matched by 'switch on' in continental en route…

RNAV 1 and 2 implementation

- Aircraft populations may not make ‘cleaner’ turns because of PBN … watch turn angles in design
- Co-ordination with stakeholders is a pre-requisite for success
- The number of SIDs/STARs at some major airports increased significantly which caused problems for operators with limited data base storage space.
- Education needed on RNAV and RNP

THANK YOU