



INTERNATIONAL CIVIL AVIATION ORGANIZATION

A United Nations Specialized Agency

PBN AIRSPACE CONCEPT

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CONTENT

Background

Planning

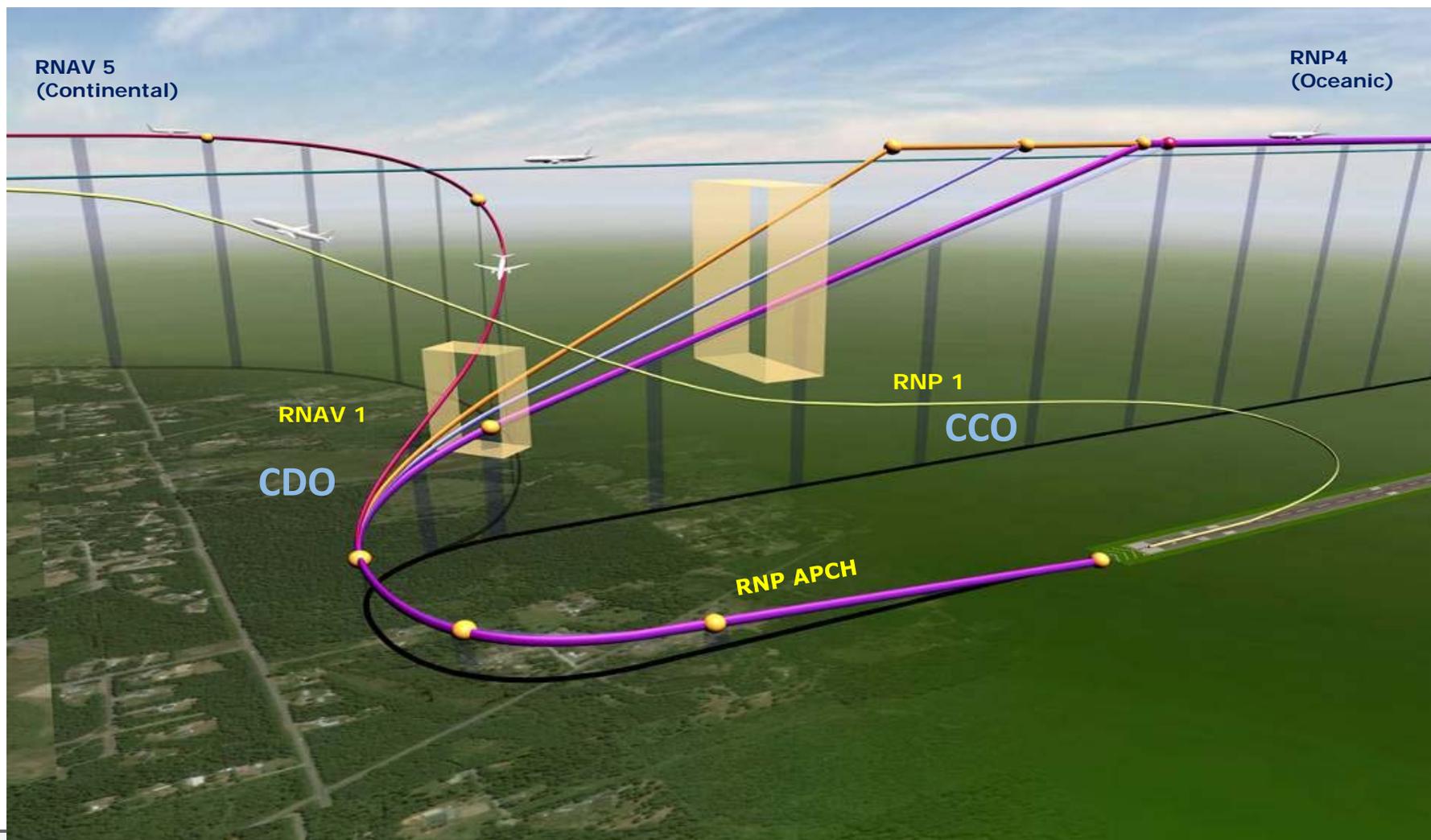
Airspace Concept Validation

Implementation

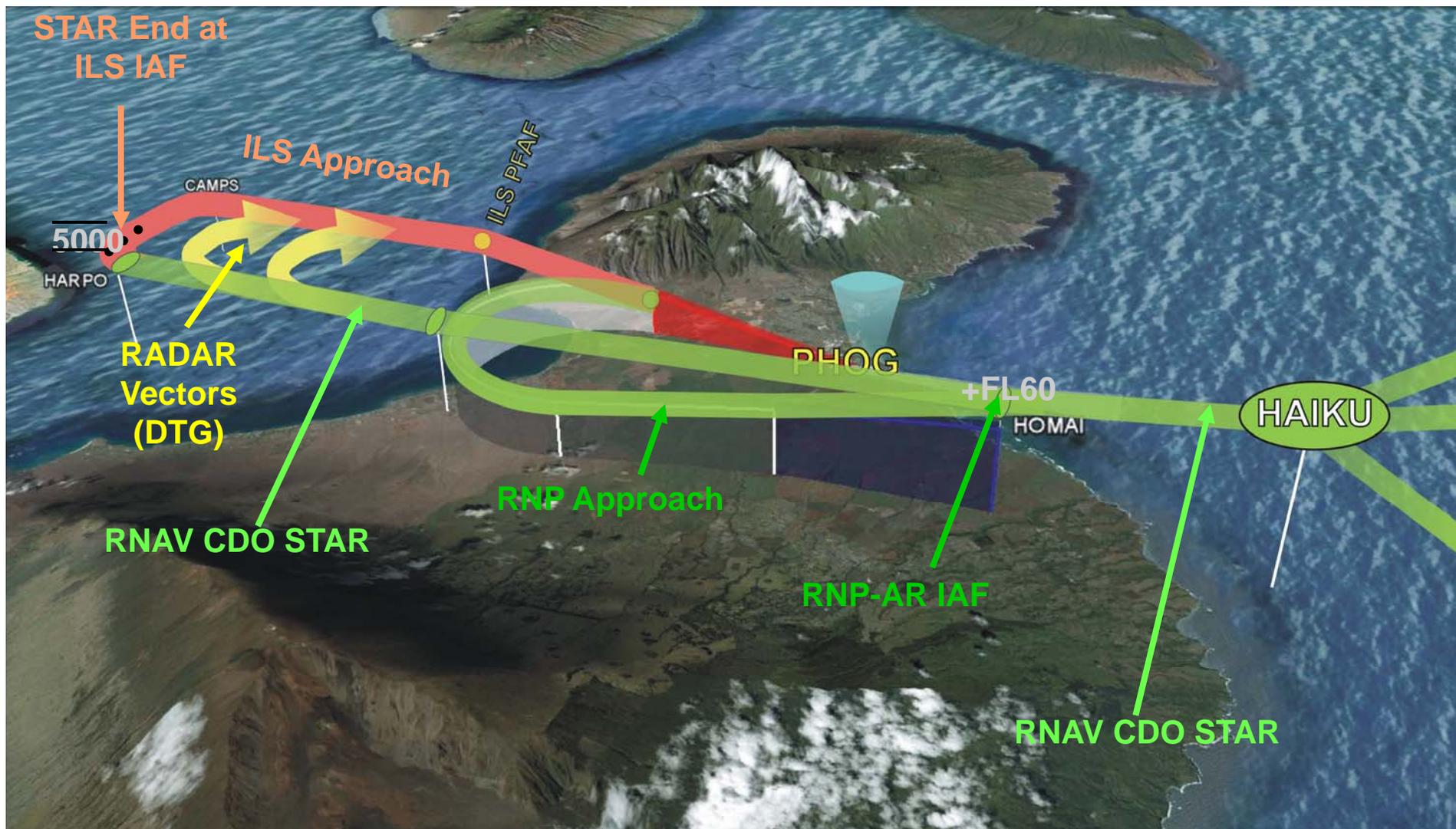
Lessons Learned



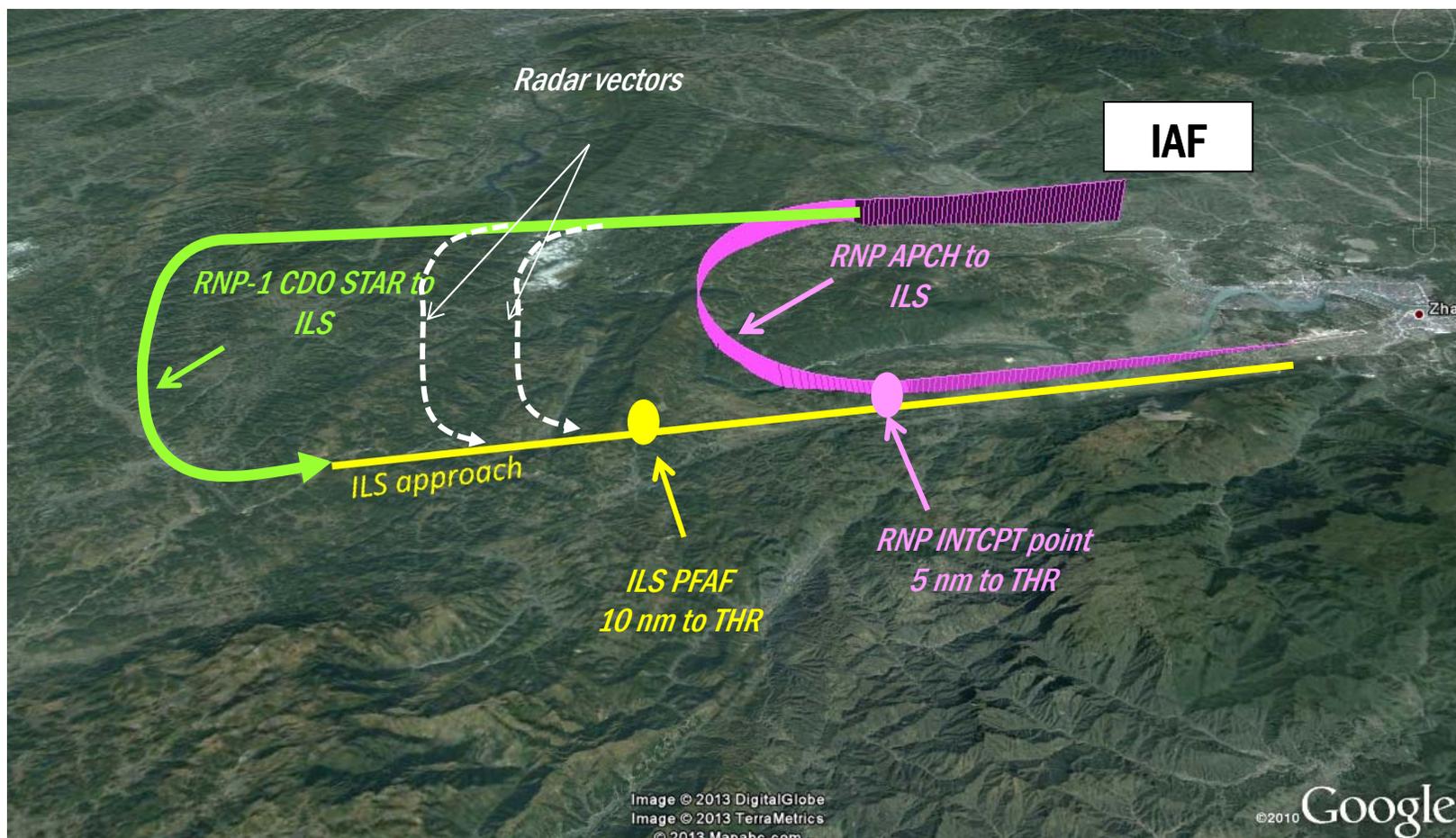
Background

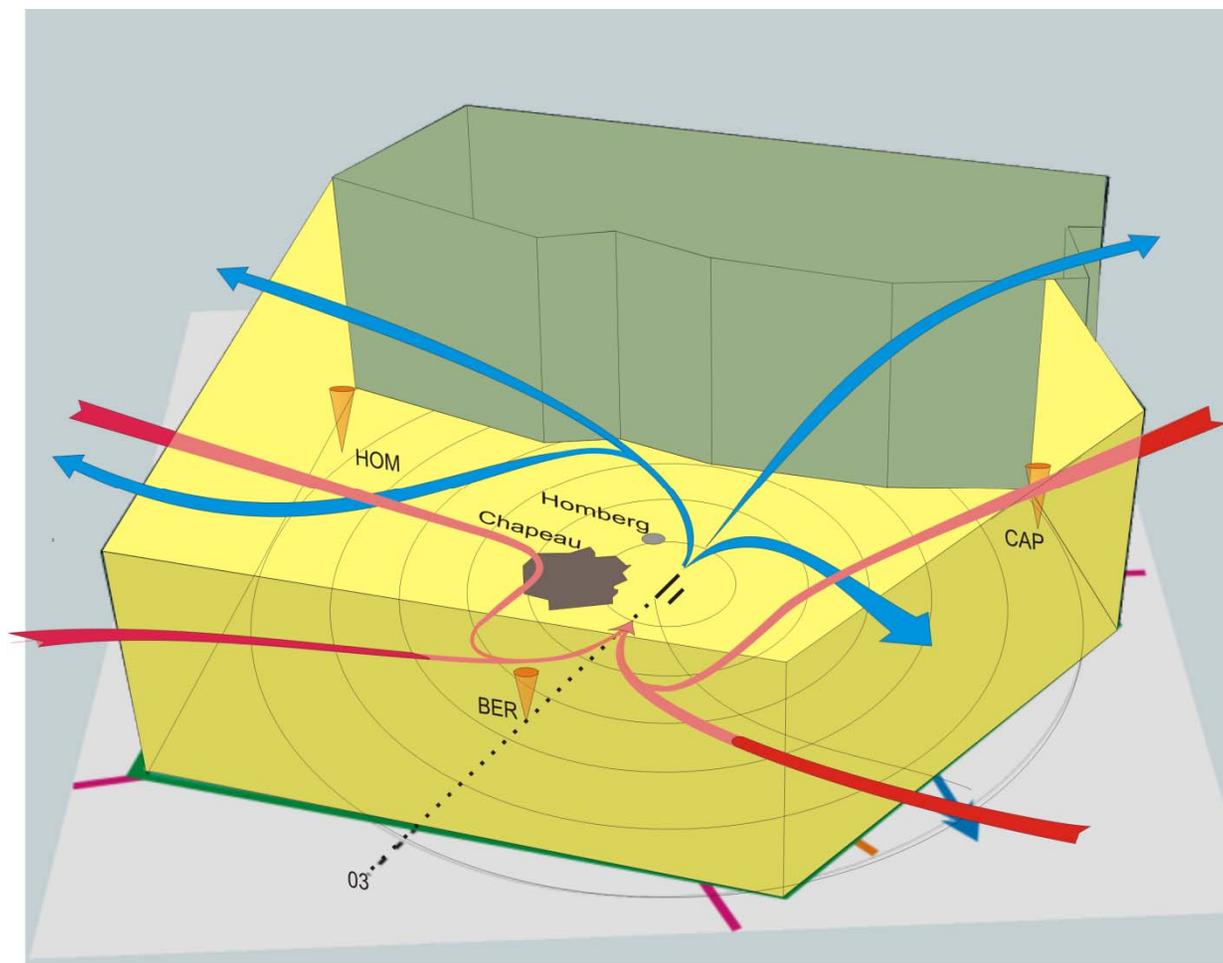


Integrating RNAV, RNP, & Conventional Capabilities

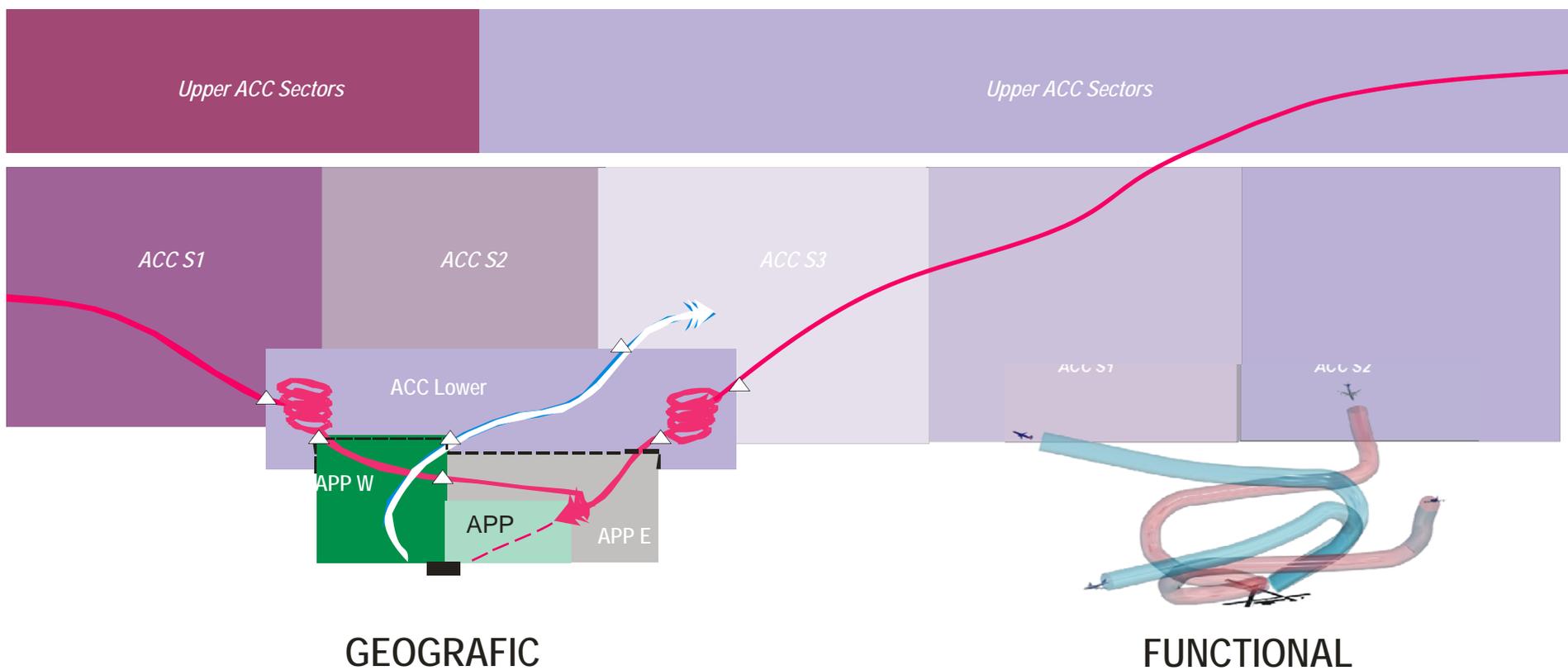


Good Design Integrates PBN, CDO, & Conventional Capabilities

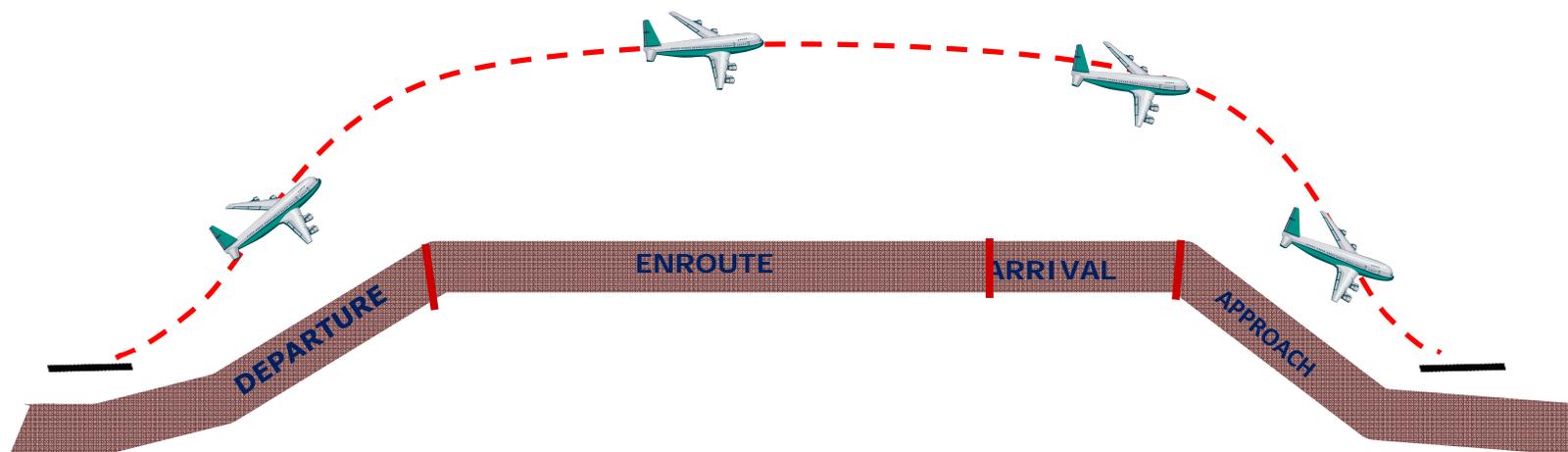




ATC Sectorization



Gate-to-Gate





ICAO PBN Manual Doc 9613

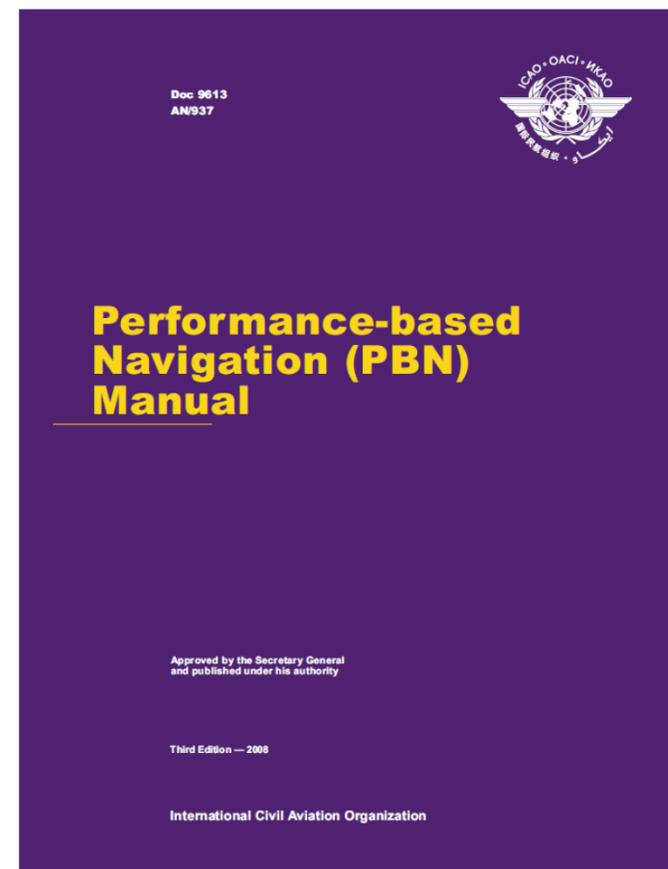
Volume I

 *Airspace Concept*

 *Implementation Processes*

Volume II

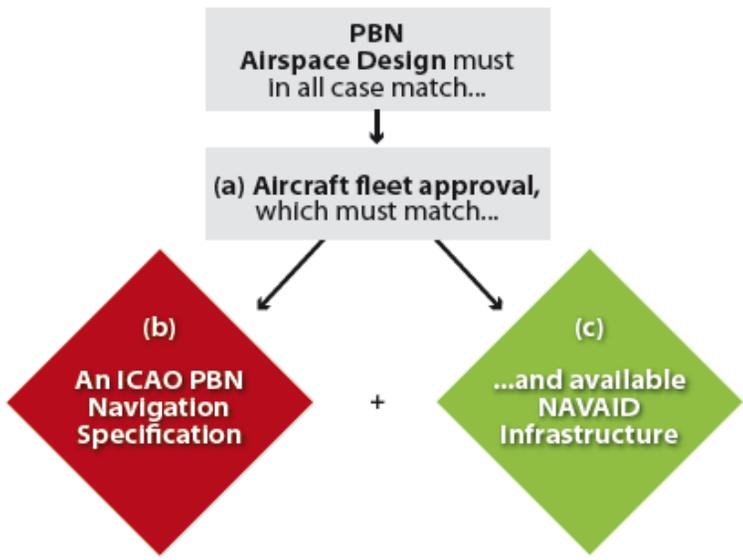
 *Navigation Specifications*



PBN



<p>Conventional Navigation Airspace design based on assumptions that all aircraft equipped with NDB/VOR and/or DME and airspace designed on those assumptions.</p>	<p>RNAV (pre-PBN) Airspace design based on assumptions that 'RNAV equipped' aircraft can use RNAV routes. Exceptionally, Nav Spec required e.g. RNP4.</p>
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8. *The RNP 0.3 specification is primarily intended for helicopter operations.*

Navigation Specification	Flight phase							
	En-route oceanic/remote	En-route Continental	Arrival	Approach			Missed ¹	Departure
				Initial	Intermediate	Final		
RNAV 10	10							
RNAV 5 ²		5	5					
RNAV 2		2	2					2
RNAV 1		1	1	1	1		1	1
RNP 4	4							
RNP 2	2	2						
RNP 1 ³			1	1	1		1	1
Advanced RNP ⁴	2 ⁵	2 or 1	1	1	1	0.3	1	1
RNP APCH ⁶				1	1	0.3 ⁷	1	
RNP AR APCH				1-0.1	1-0.1	0.3-0.1	1-0.1	
RNP 0.3 ⁸		0.3	0.3	0.3	0.3		0.3	0.3





Doc 9613
AN/937



Performance-based Navigation (PBN) Manual

Approved by the Secretary General
and published under his authority

Fourth Edition — 2013

International Civil Aviation Organization

Doc 9992
AN/494



Manual on the Use of Performance-based Navigation (PBN) in Airspace Design

Approved by the Secretary General
and published under his authority

First Edition — 2013

International Civil Aviation Organization

AIRSPA

AIRSPACE CONCEPT

Assumptions: CNS/ATM/Traffic/RWY/MET

Airspace Design
Routes;
Volumes;
Sectors.

Inter-centre letters of Agreement

Traffic assignment
[incl. regulation]

Special techniques
CDA; Point Merge

Flexible Use of Airspace
Airspace Classification



1 PLANNING

Activity 1

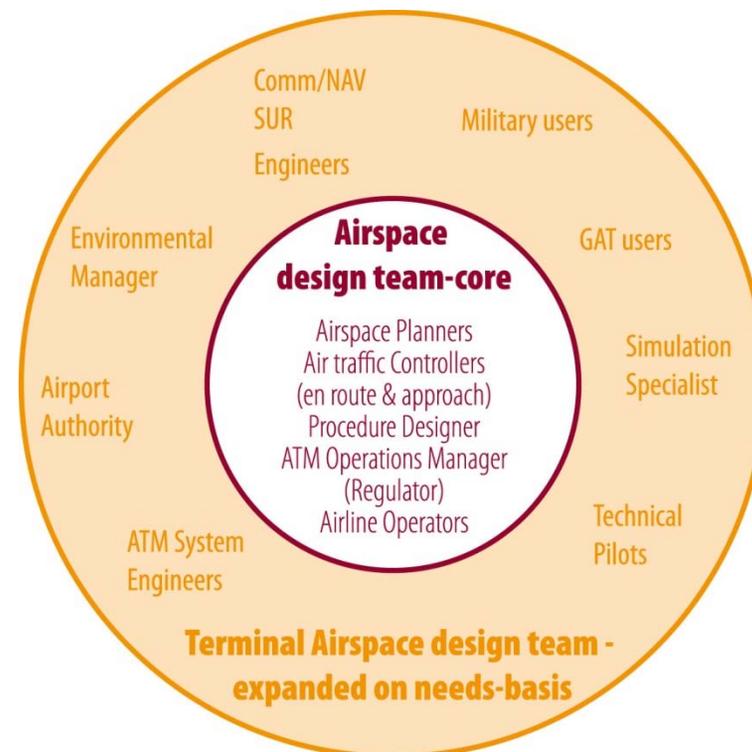
1 - Agree on Operational Requirements

-  Capacity
-  Environment
-  Accessibility
-  Safety
-  Efficiency

Activity 2

2 – Create Airspace Design Team

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



Activity 3

3 – Project objectives, scope and timescales

✈️ Objective derived from Ops requirements

✈️ Scope !! (sets the limit of the project)

✈️ Time

✈️ Resources

✈️ Timescales

Sometimes the most difficult task

3 - Project objectives

Safety?

Capacity

Efficiency

Environment

Access?

Improve SID/STAR
design to
accommodate
projected traffic
growth

Provide shorter
and more
predictable
routes to/from
Kapitali

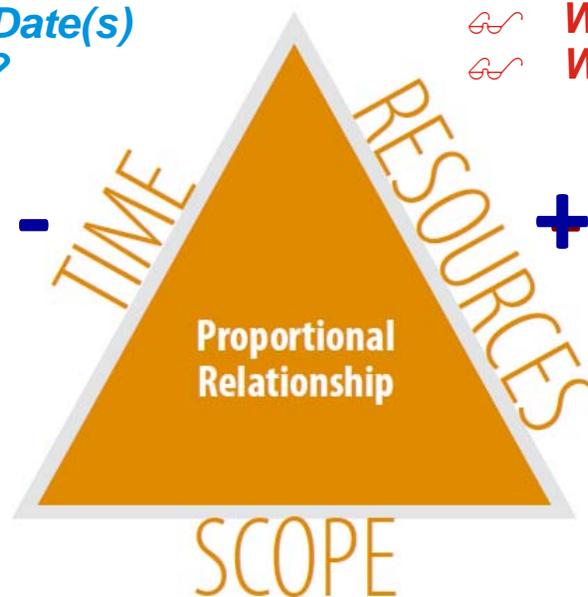
Reduce noise
over sensitive
areas

Airspace Concept

3 – Project objectives, scope and timescales

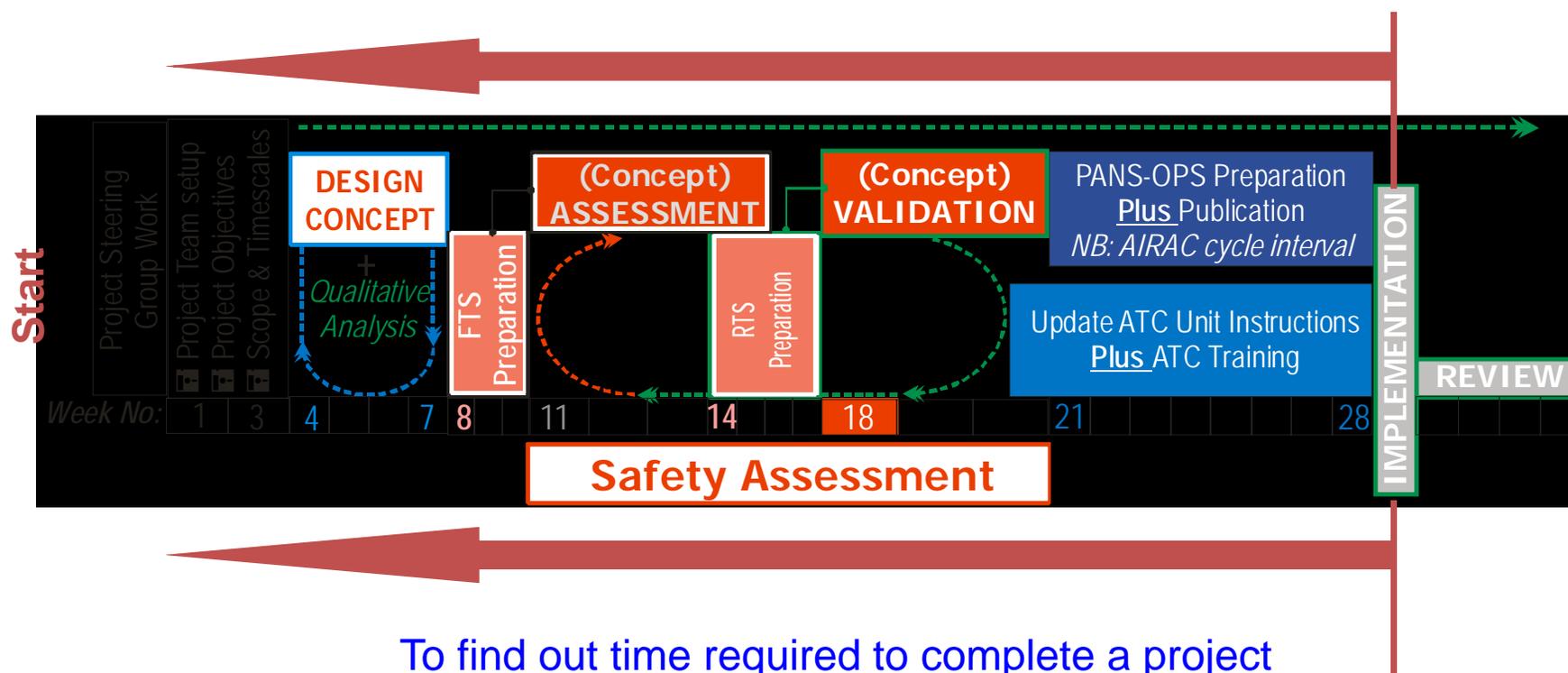
👁 *Implementation Date(s)*
👁 *Phases of Work?*

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



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

3 – Project timescales



AIRSPACE CONCEPT HANDBOOK ACTIVITIES 1 TO 15: PROJECT PLANNING SAMPLE

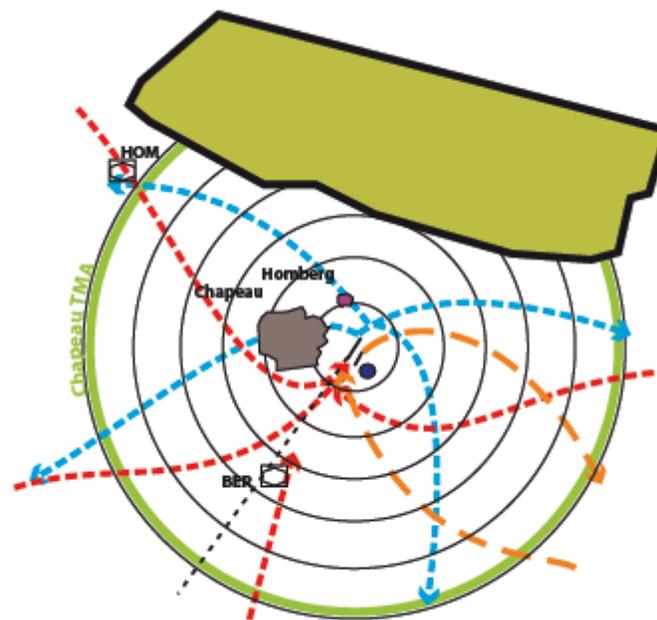
ACT	<i>(to be read from bottom-up)</i>	No of Days	Key Dates (latest)	
15	Implementation of Airspace Change (Match Airac Cycle date)	0	06/02/2014	<< Enter INTENDED Implementation Date here (Must match Airac Cycle Date)
14	Implementation Planning - Write up LoAs - ATC System Changes	56	12/12/2013	
	Additional working day buffer to allow for un-foreseen delays	60	13/10/2013	
12+13	Procedure Design and Validation + 56 day AIRAC cycle - ATC Training ‡	90	15/07/2013	
11	Airspace Concept Validation by Real-Time Simulation (Preparation and Runs)	100	06/04/2013	
11	Airspace Concept Validation by Fast-Time Simulation (Preparation and runs)	70	26/01/2013	
10	Selection of ICAO Navigation Specification	2	24/01/2013	
7-9	Finalise Airspace Design - iteration	5	19/01/2013	
9	Airspace Design: Structures and Sectors	5	14/01/2013	
7	2nd Iteration: Airspace Design - Routes and Holds	5	09/01/2013	
8	Navigation Analysis of Airspace Design	5	04/01/2013	
7	1st Iteration: Airspace Design - Routes and Holds	10	25/12/2012	
6	Data collection and agreement on CNS/ATM assumptions incl. Fleet capability; traffic sample etc.	5	20/12/2012	
5	Select Safety Criteria; Determine Performance Criteria and understand Safety Policy Considerations	10	10/12/2012	
4	Analyse Reference Scenario (incl. Data collection of full ATM operations and critical review of current operations)	20	20/11/2012	
1-3	Agree Operational Requirement; Project Planning; Create Airspace Design Team; Agree Project Objectives and Scope	10	10/11/2012	<< This is the latest project start date
	Total number of working days required	453		
Notes				
†	Assumes availability of FTS or RTS simulator slots, available of required specialists & ATCs/pseudo pilots			
‡	Separate no of days not calculated for ATC Training; Above shows that this would occur at the same time as PANS-OPS procedure design or during 56 day final AIRAC cycle			

PLANNING TOOL EXAMPLE

Activity 4

4 – Analysis of the reference scenario

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



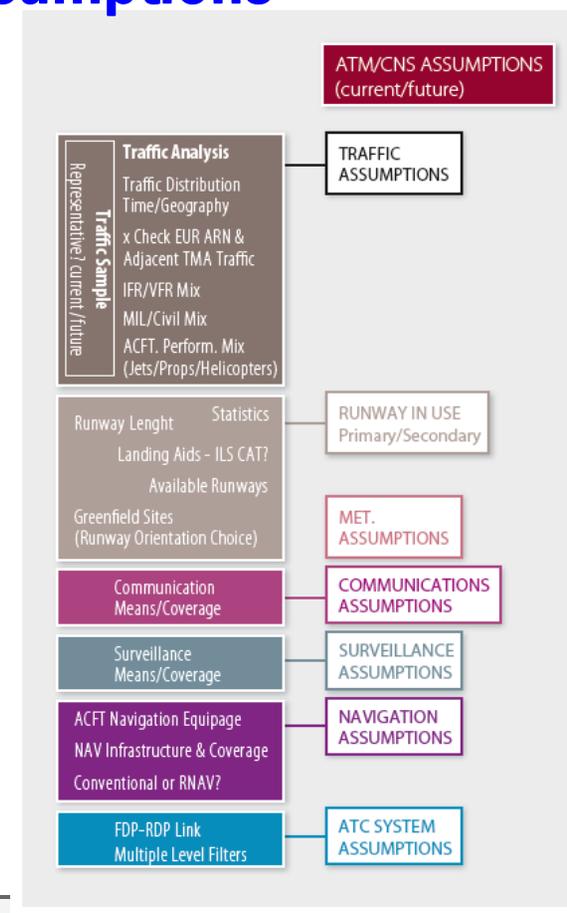
Activity 5

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

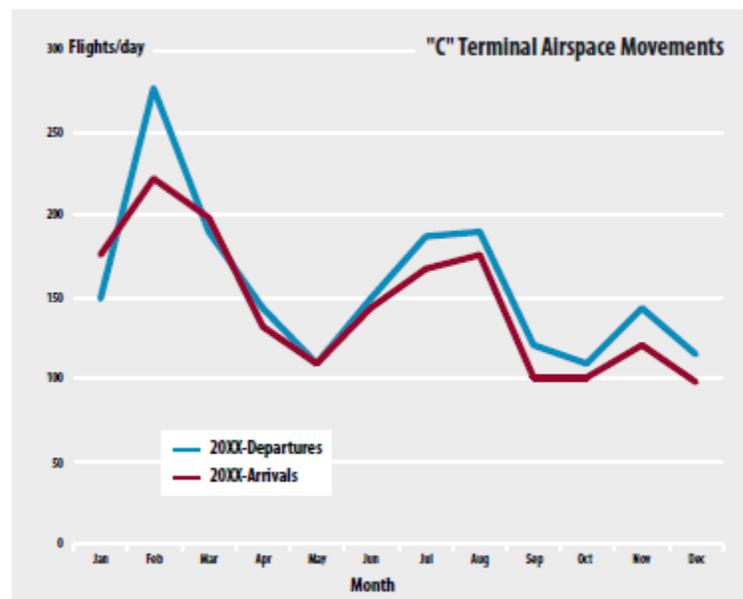
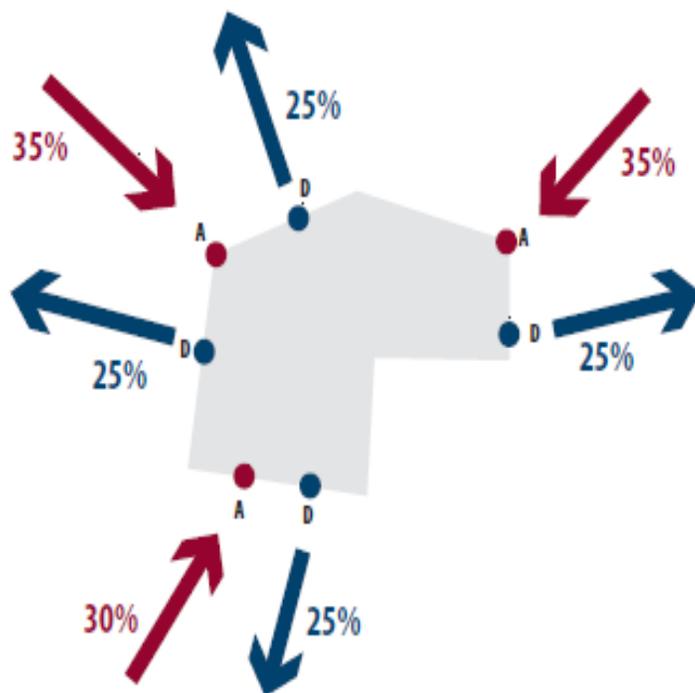
Activity 6

6 – Agree on ATM assumptions

- ✈️ Fleet capability
- ✈️ Traffic sample (distribution & assignment)
- ✈️ Rwy in use
- ✈️ Met assumptions
- ✈️ CNS assumptions



6 – Agree on ATM assumptions - traffic flows

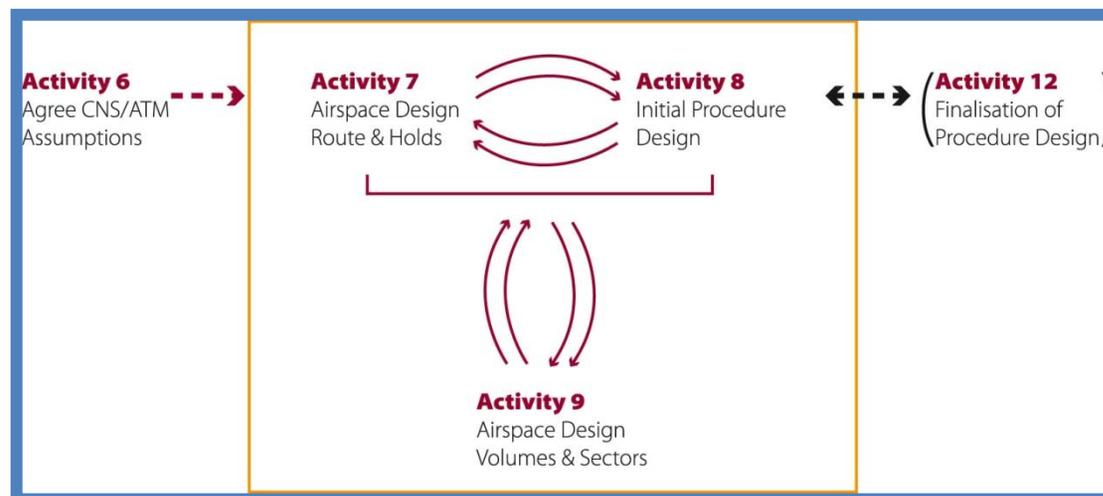


2 DESIGN

Activity 7

7 – Design the Airspace

- 🌱 1st Design Routes
- 🌱 2nd Undertake a Navigation Analysis of the route design
- 🌱 3rd Define the airspace volumes and sectorise these, if needed

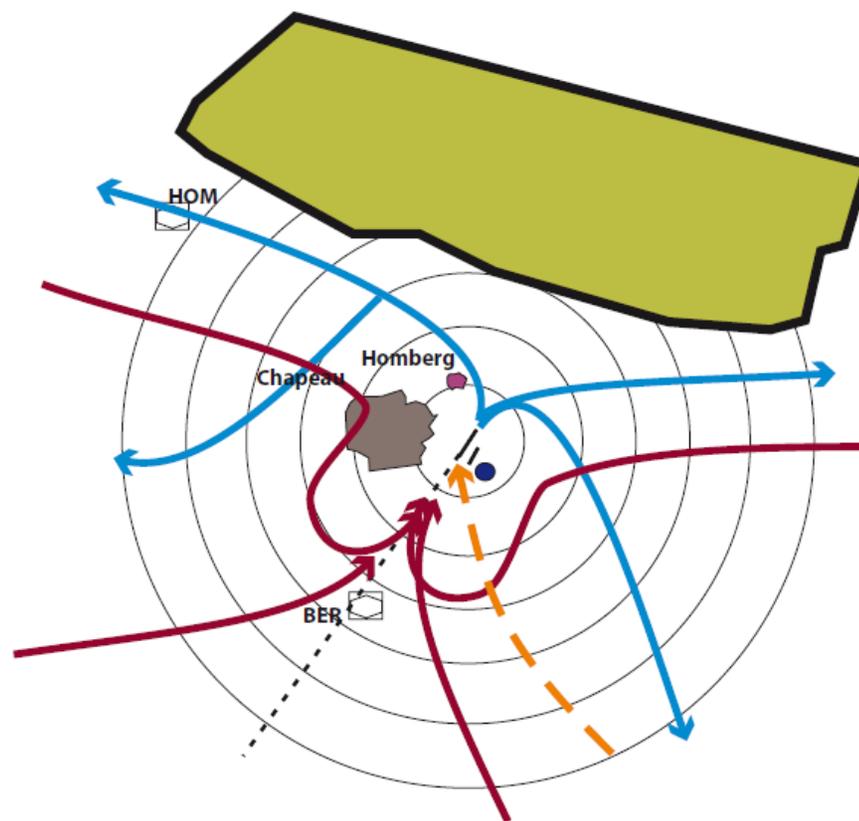


Iterations necessary

7 - Design the Airspace

- ✈ Arrivals
- ✈ Departures
- ✈ Transit
- ✈ VFR
- ✈ Military

NEVER try and fit the routes into the existing airspace volumes



Activity 8

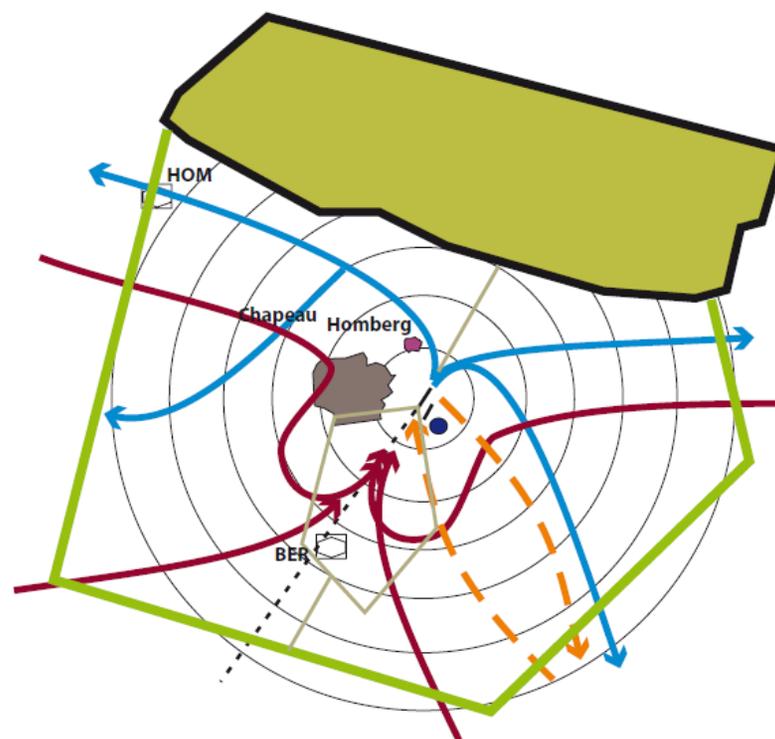
8 - Initial Procedural Design

- ✈️ What capability is needed?
- ✈️ Fleet capability
- ✈️ Available Navaid infrastructure?

Activity 9

9 Design Airspace Volumes and Sectors

- ✈️ Sectorisation
- ✈️ Airspace volume
- ✈️ Iterations possible



Activity 10

10 – Select ICAO Navigation specification

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

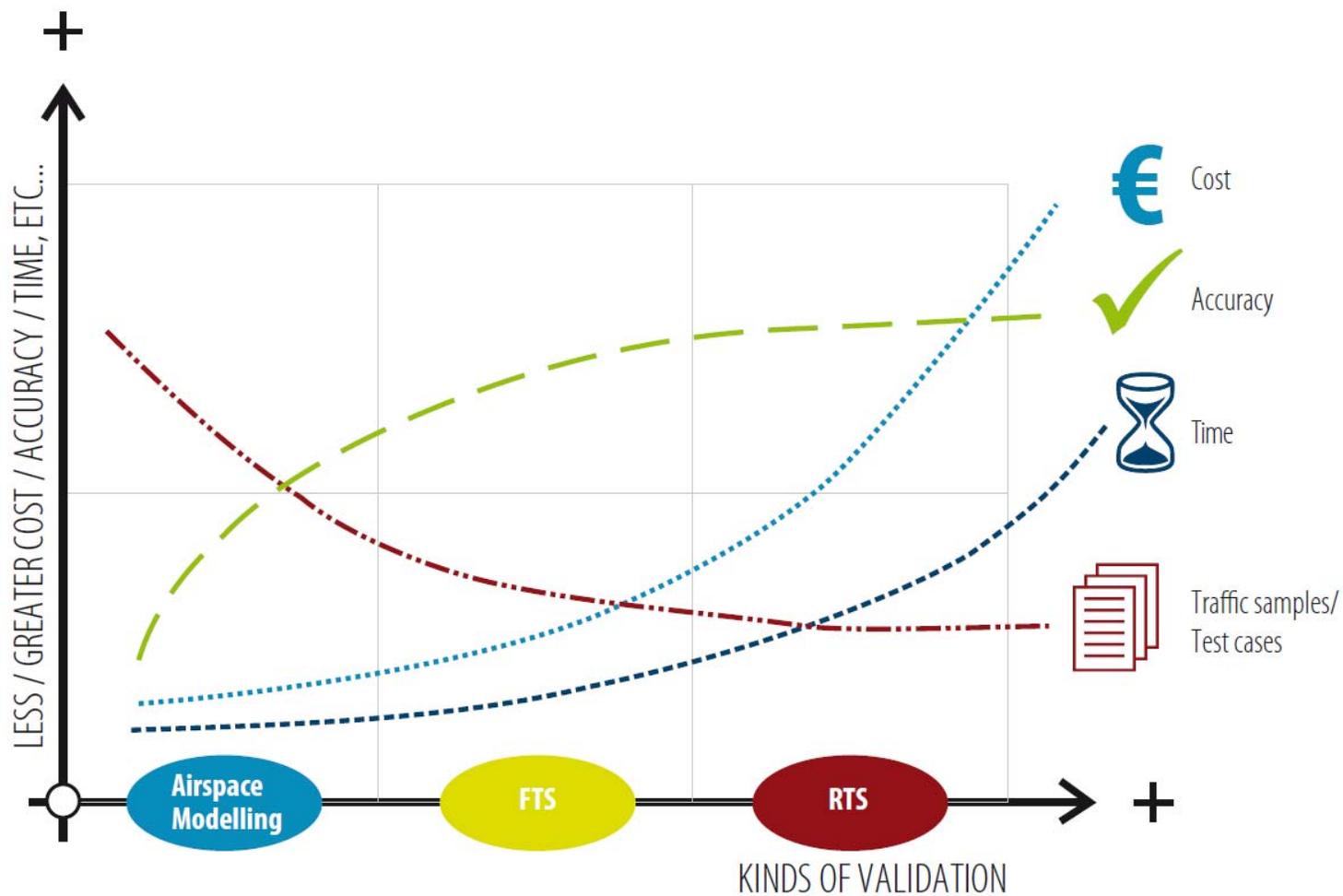
3

VALIDATION

Activity 11

11 – Airspace Concept Validation

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



Activity 12

12- Finalisation of Procedure design

- ✈️ Design according to Doc 8168
- ✈️ Procedure ground validation
 - ✈️ Obstacle
 - ✈️ Data
 - ✈️ Infrastructure
 - ✈️ Fly ability
 - ✈️ Evaluate
- ✈️ Flight inspection
- ✈️ ATC system considerations
- ✈️ Awareness and Training material

Activity 13

13- Procedure validation

 Obstacle clearance

 Data

 Infra structure

 Fly ability

 Charting

 Flight inspection

4

IMPLEMENTATION

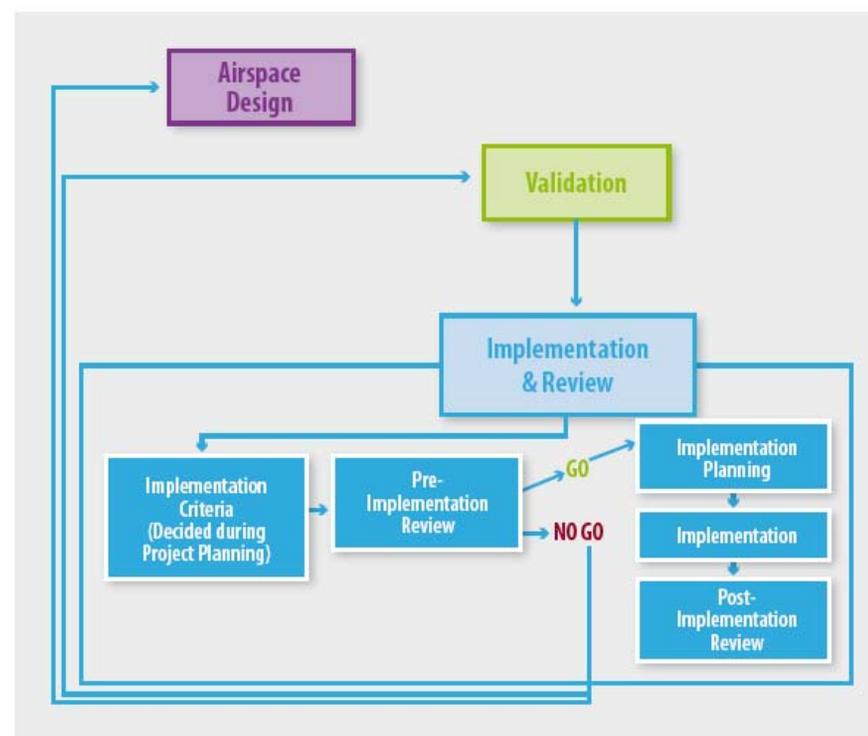
Activity 14

14- Implementation planning

✈️ Pre-implementation review

✈️ Keep design team available

✈️ Monitor process



Activity 15

15 - Implementation

 Monitor process

 Support OPS

 Redundancy or contingency procedures

 Support controllers and pilots

Activity 16

Post Implementation Review

 Keep LOG system Post implementation review

 Assess if objectives are met

 Measure!

 System safety assessment – collect evidence

Lessons Learned

RNAV 5 implementation in en-route airspace

- ✈ Selecting the right Nav Spec can be very difficult ... more older aircraft than you think!
- ✈ Roll out airspace changes over time: never at the same time as the PBN switch on date
- ✈ NEVER 'switch on' PBN in continental en route without 'switching it on' in the Terminal Airspace as well...
- ✈ Aircraft populations do not make 'cleaner' turns because of PBN ... for that you need RF/FRT

RNP implementation in terminal airspace

- 🌱 Implementation without a mandate is counter productive and caused a log jam.
 - 🌱 Without the mandate, aircraft did not equip
 - 🌱 Because aircraft not equipped, ANSPs reluctant to provide procedures
 - 🌱 A bit like walking on glue..
- 🌱 Without a mandate, many RNAV capable aircraft had no RNP approval but wanted to fly the procedures anyway.
- 🌱 In some cases, a great number of SIDs/STARs were designed at one airport which caused severe shortage of data base storage space.

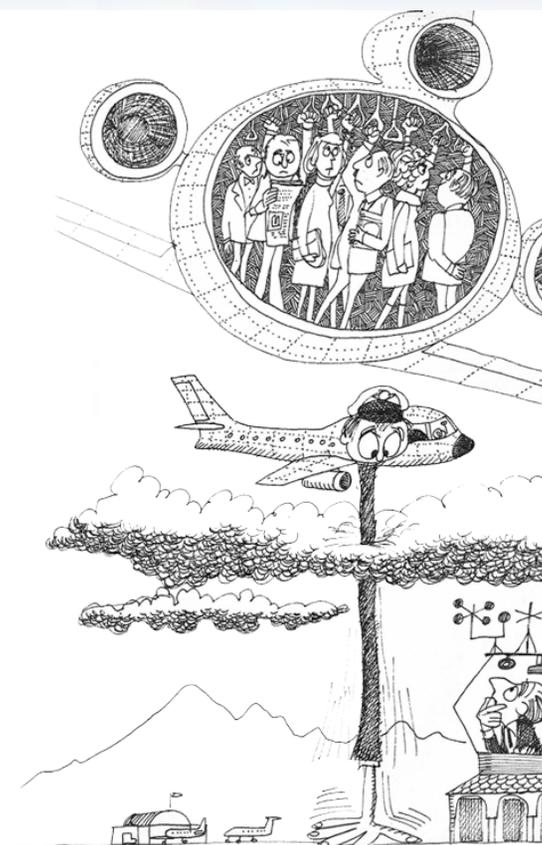
PBN implementation

- ✈️ Co-ordination with stakeholders is a pre-requisite for success
- ✈️ Controllers had unrealistic expectations of aircraft turn performance
- ✈️ Education needed on RNAV and RNP

Mixed Navigation Specifications

- ✈️ Avoid if possible
 - ✈️ Increases workload
 - ✈️ Flight planning implications
- ✈️ ATC prefers uniform applications (no mix)

**Without international rules
air travel would be in chaos.**





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Thank You

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