PBN Airspace Concept

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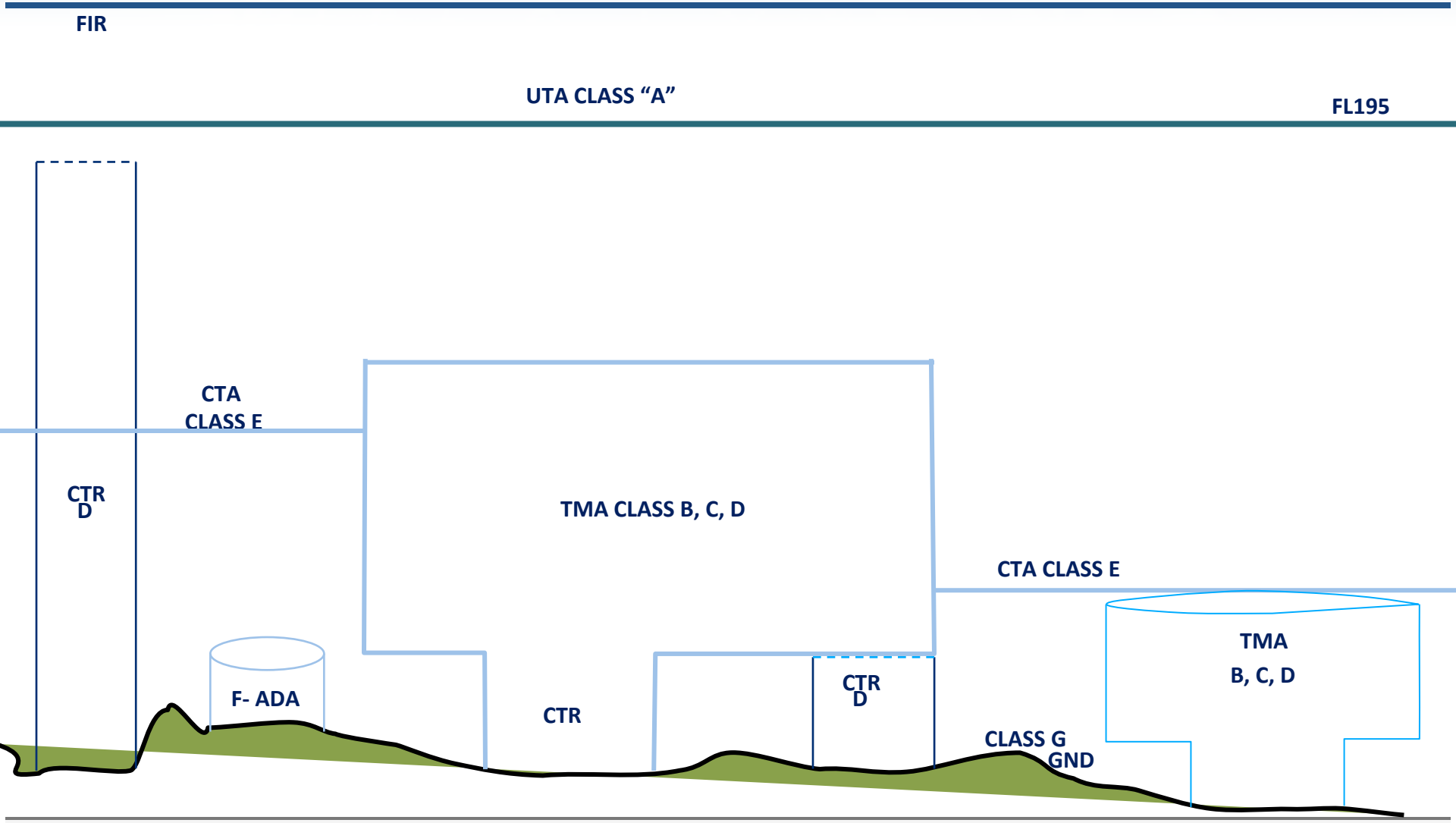
Annex 11, ATS Airspace Requirements



Annex 11, ATS Airspace Classes
Services provided and flight requirements

Class	Type of flight	Separation provided	Service provided	Speed limitation*	Radio communication requirement	Subject to an ATC clearance
A	IFR only	All aircraft	Air traffic control service	Not applicable	Continuous two-way	Yes
B	IFR	All aircraft	Air traffic control service	Not applicable	Continuous two-way	Yes
	VFR	All aircraft	Air traffic control service	Not applicable	Continuous two-way	Yes
C	IFR	IFR from IFR IFR from VFR	Air traffic control service	Not applicable	Continuous two-way	Yes
	VFR	VFR from IFR	1) Air traffic control service for separation from IFR; 2) VFR/VFR traffic information (and traffic avoidance advice on request)	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
D	IFR	IFR from IFR	Air traffic control service, traffic information about VFR flights (and traffic avoidance advice on request)	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	IFR/IFR and VFR/VFR traffic information (and traffic avoidance advice on request)	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
E	IFR	IFR from IFR	Air traffic control service and, as far as practical, traffic information about VFR flights	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	Traffic information as far as practical	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No
F	IFR	IFR from IFR as far as practical	Air traffic advisory service; flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	No
	VFR	Nil	Flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No
G	IFR	Nil	Flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	No
	VFR	Nil	Flight information service	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No

* **When the height of the transition altitude is lower than 3 050 m (10 000 ft) AMSL, FL 100 should be used in lieu of 10 000 ft.**

Misconceptions on PBN

- PBN, it looks complicated but it is not:
  - It does not add new navigation philosophy, but just is a pragmatic tool to implement navigation procedures for aircraft capability that exists for more than 30 years!
  - It does not require States to completely overhaul navigation infrastructure, but can be implemented step-by-step
  - It does not require States to implement the most advanced navspec, only needs to accommodate operational needs

ATM Planning…

- Main Traffic Flows between City Pairs / en-route airspace
  - Concentration of significant volumes of air traffic on the same or proximate flight trajectories
  - Major traffic flows may cross several homogeneous ATM areas
  - Basic is the number of aircraft movements that must be provided with ATM services.
  - Estimates and forecasts of annual aircraft movements
  - Capabilities of the aircraft population
  - Forecasts of aircraft movements in peak periods, such as during a particularly busy hour, are needed for detailed planning
  - Civil/military coordination and special use airspace (SUA)

- Homogenous areas
  - An airspace with a common ATM interest, based on similar characteristics of traffic density, complexity, air navigation system infrastructure requirements or other specified considerations / level of sophistication

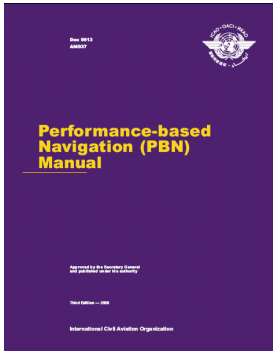
Commitment from States
2010 37th ICAO General Assembly

- Resolution A37-11 supersedes A36-23
- A37-11 urges all States to complete a national PBN implementation plan as a matter of urgency to achieve:
  - PBN for en route and terminal areas
    - According to established timelines and intermediate milestones;
  - PBN approach procedures with vertical guidance (APV) for all instrument runway ends (as primary or back-up for precision approach) by 2016 - 30% by 2010, 70% by 2014

How is PBN going worldwide?

- Global agreement on PBN
- ICAO complete tool box

Annexes



Doc 9613 PBN Manual
Volume I
Part A - Airspace Concept
Part B – Implementation Processes

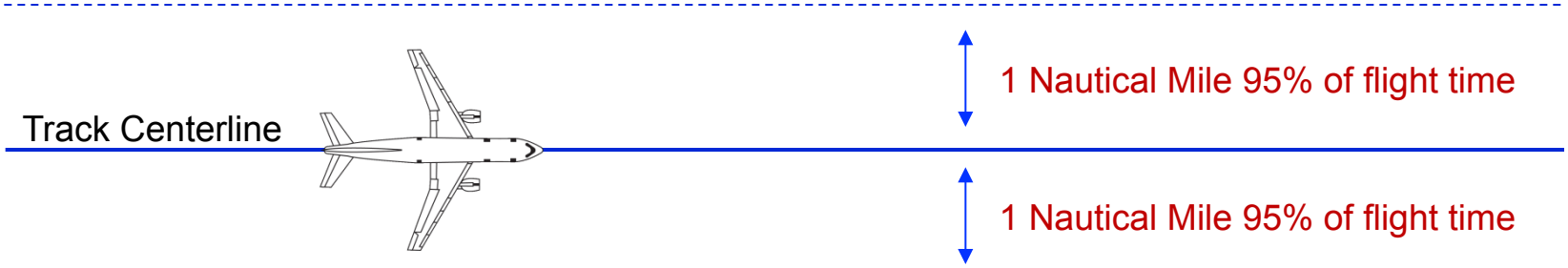
Volume II – Navigation Specifications

Supporting Guidance

- ICAO Doc 8168, PANS-OPS Vol II
- Doc 9906, Vol I, FPD QA System
  - Vol 2, FDP Training
  - Vol 3, FPD Software validation
  - Vol 5, Validation of FPD
  - Vol 6, Flight validation, Pilot Training and evaluation
- Doc 9905, RNP AR Procedure Design Manual
- Doc 9902, PBN in Airspace Design
- Doc 9933, CCO Manual
- Doc 9931, CDO Manual

RNAV and RNP

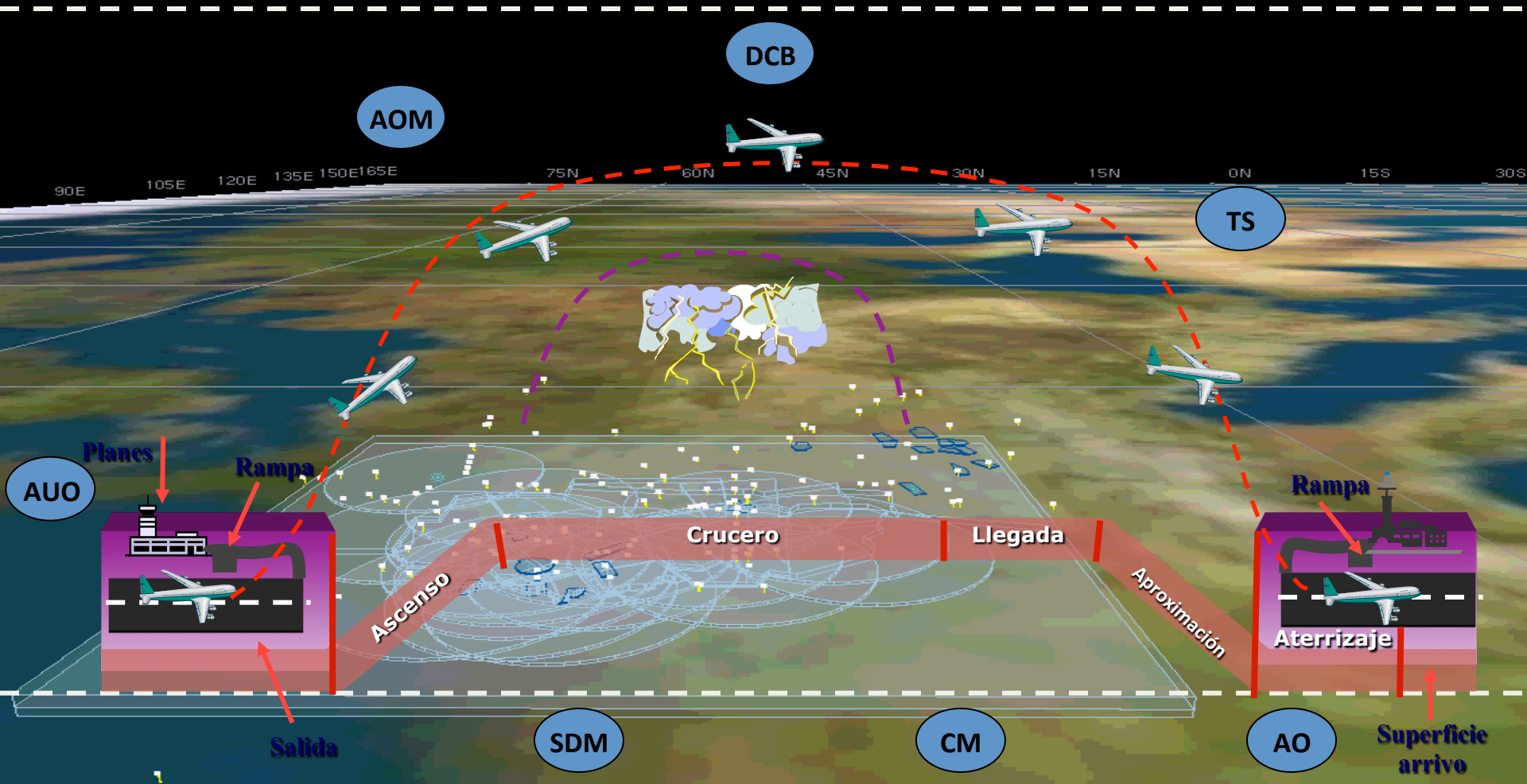
RNAV 1	RNP 1 2*RNP Alert to Pilot



RNP isn't "fundamentally different" from RNAV:
RNP is ***MORE*** Than RNAV

The Key Difference:
On-Board Performance Monitoring and Alerting

Gate-to-Gate Concept



COMMUNICATION (COM) - NAVIGATION (NAV) - SURVEILLANCE (SUR)

Navigation Specification

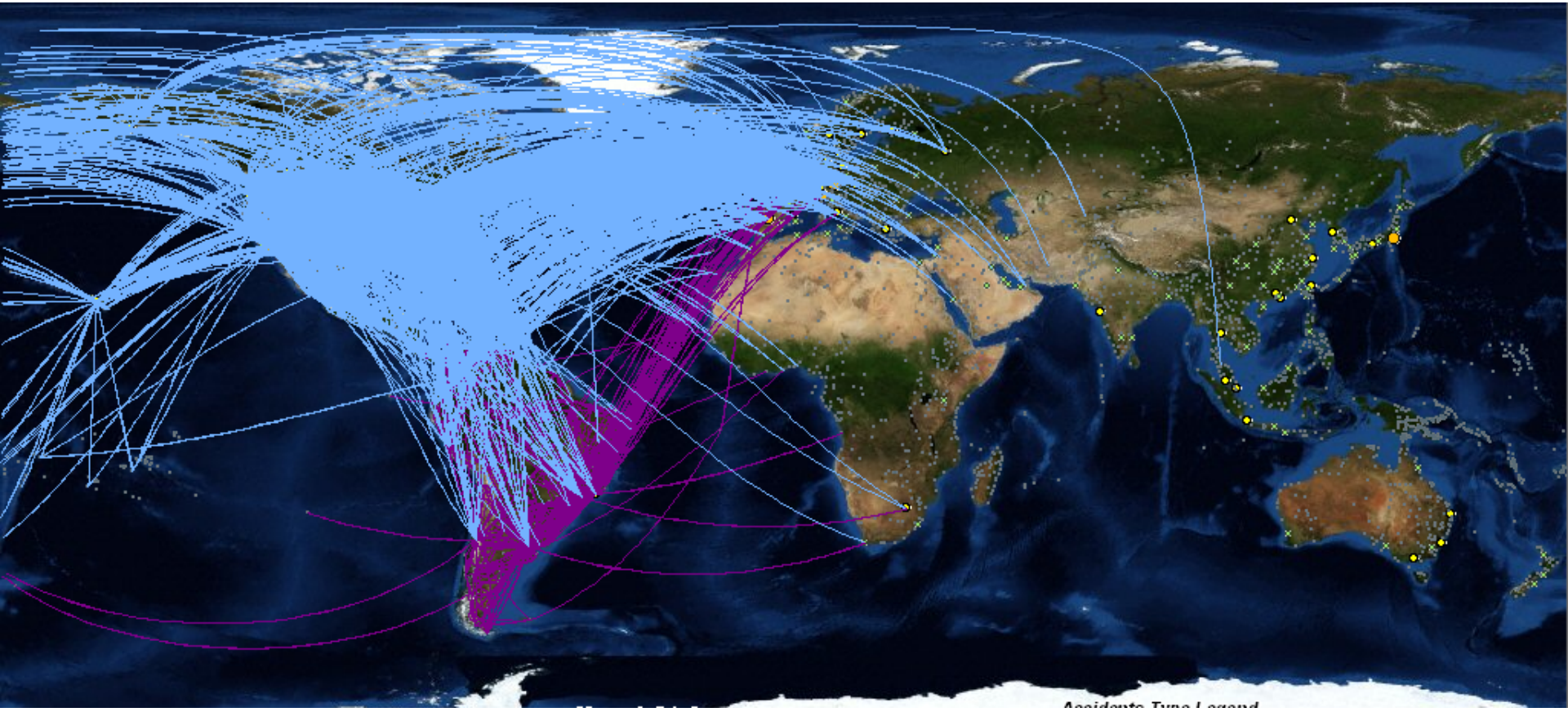
8. The RNP 0.3 specification is primarily intended for helicopter operations.

Navigation Specification	Flight phase							
	En-route oceanic/remote	En-route Continental	Arrival	Approach				Departure
				Initial	Intermediate	Final	Missed [1]	
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

Regional PBN Airspace Concept

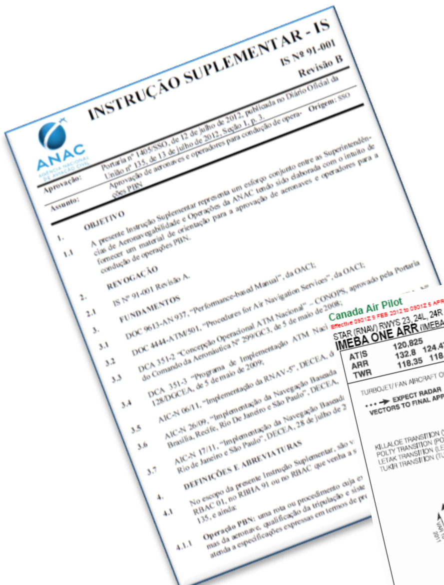
STAGE	ATM OPERATIONAL IMPROVEMENT
Stage I (2010 2011)	<u>Review of ATS route network in the CAR Region</u> • Gathering data on aircraft PBN capacity • Review of CNS infrastructure • Realignment and implementation of new RNAV routes in the upper airspace based on RNAV 5 • Implementation of RNAV routes in the lower airspace based on RNAV 1, RNAV 2 and RNP 1, as required • Implementation of PBN approach procedures in accordance with Assembly Resolution A37-11
Stage II (2011 2012)	<u>Review and interface of the ATS routes network in the CAR/SAM Regions</u> • Realignment and implementation of new RNAV routes in the interface of the upper airspace between the CAR and SAM Regions, based on RNAV 5 or RNAV 2, as applicable • Implementation of CDO in international airports, as required
Stage III (2012 2014)	• Elimination of conventional ATS routes in the upper and lower airspace, as required • Implementation of random routes, by airspace altitude stratum • Review of the upper airspace configuration • Review of the lower airspace configuration • Implementation of flexible use of airspace (FUA) • Implementation of dynamic ATS route management

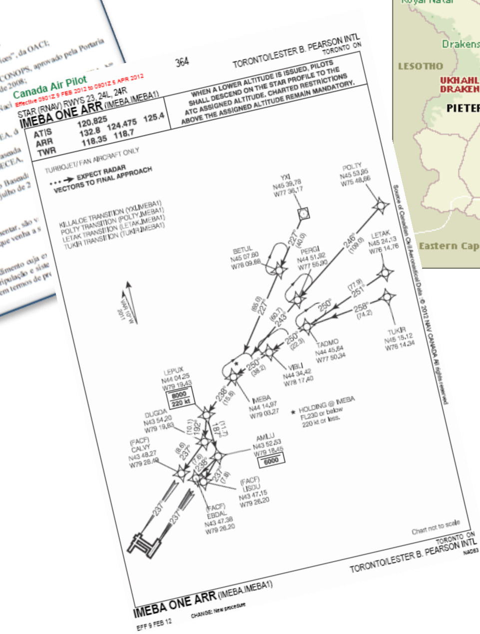
Main Traffic Flows in NAM/CAR/SAM Regions

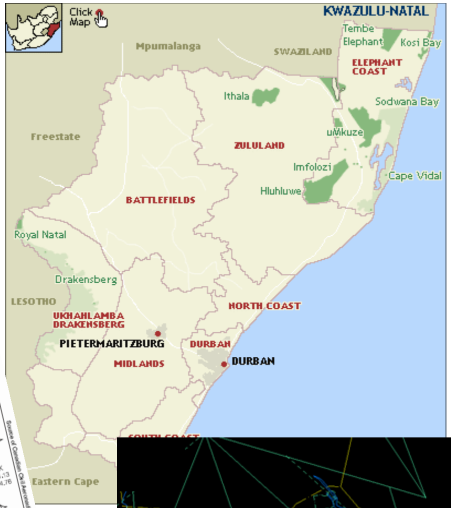


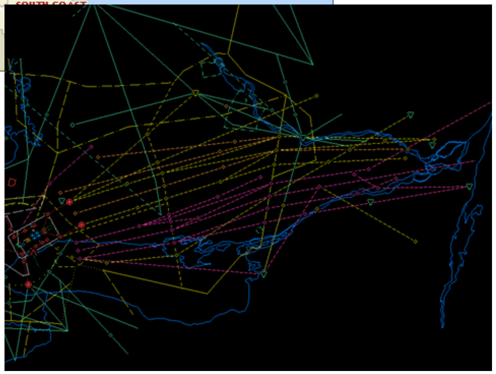
Regional ATS route Network

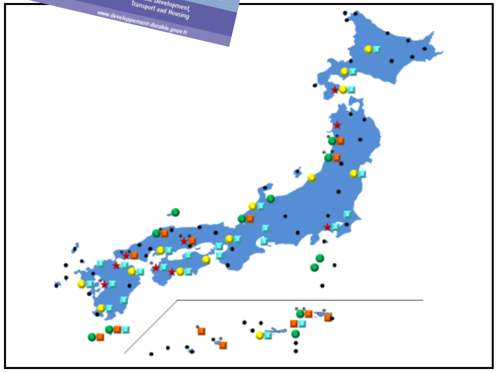
Good Examples



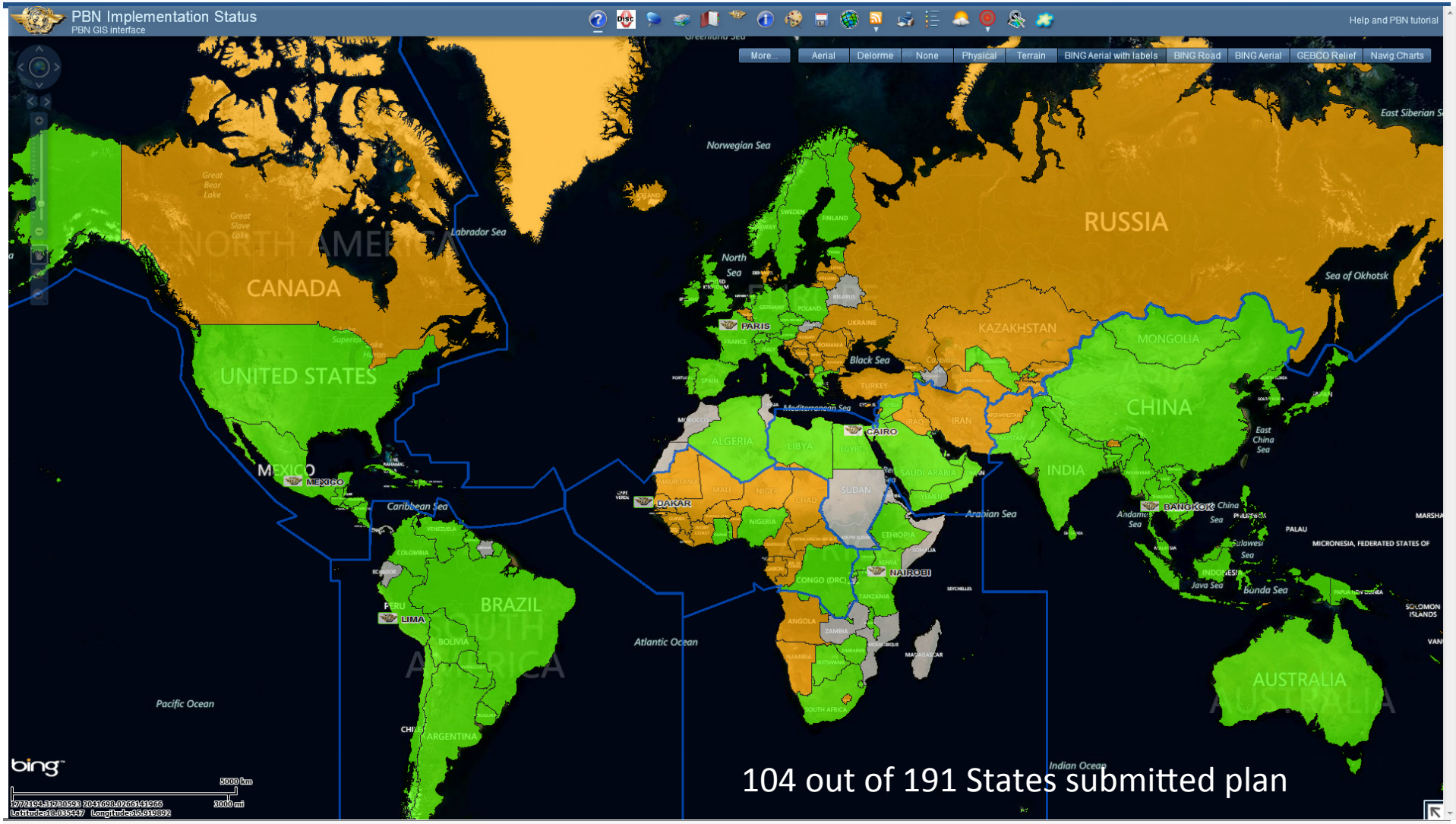






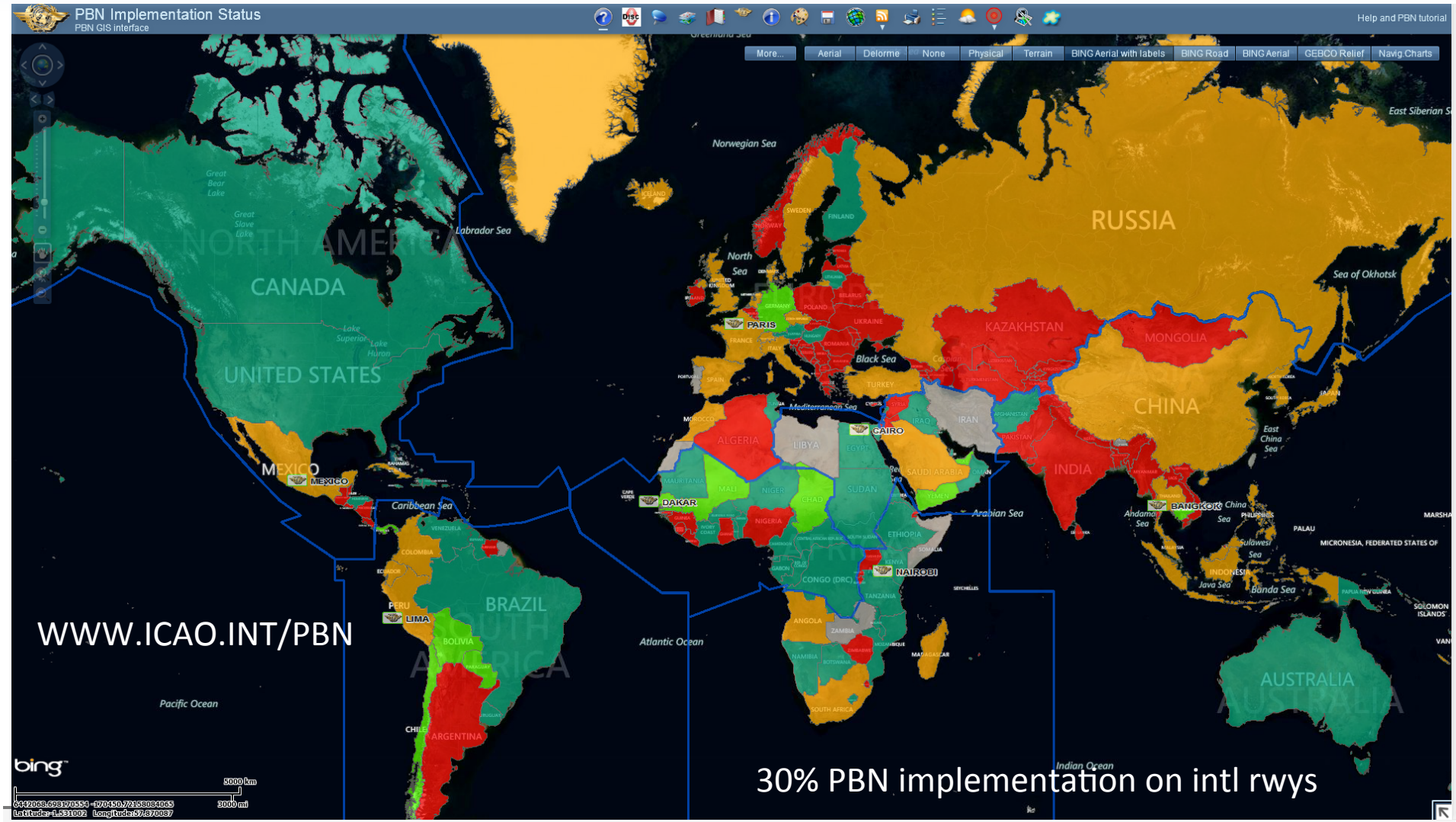


Implementation plans

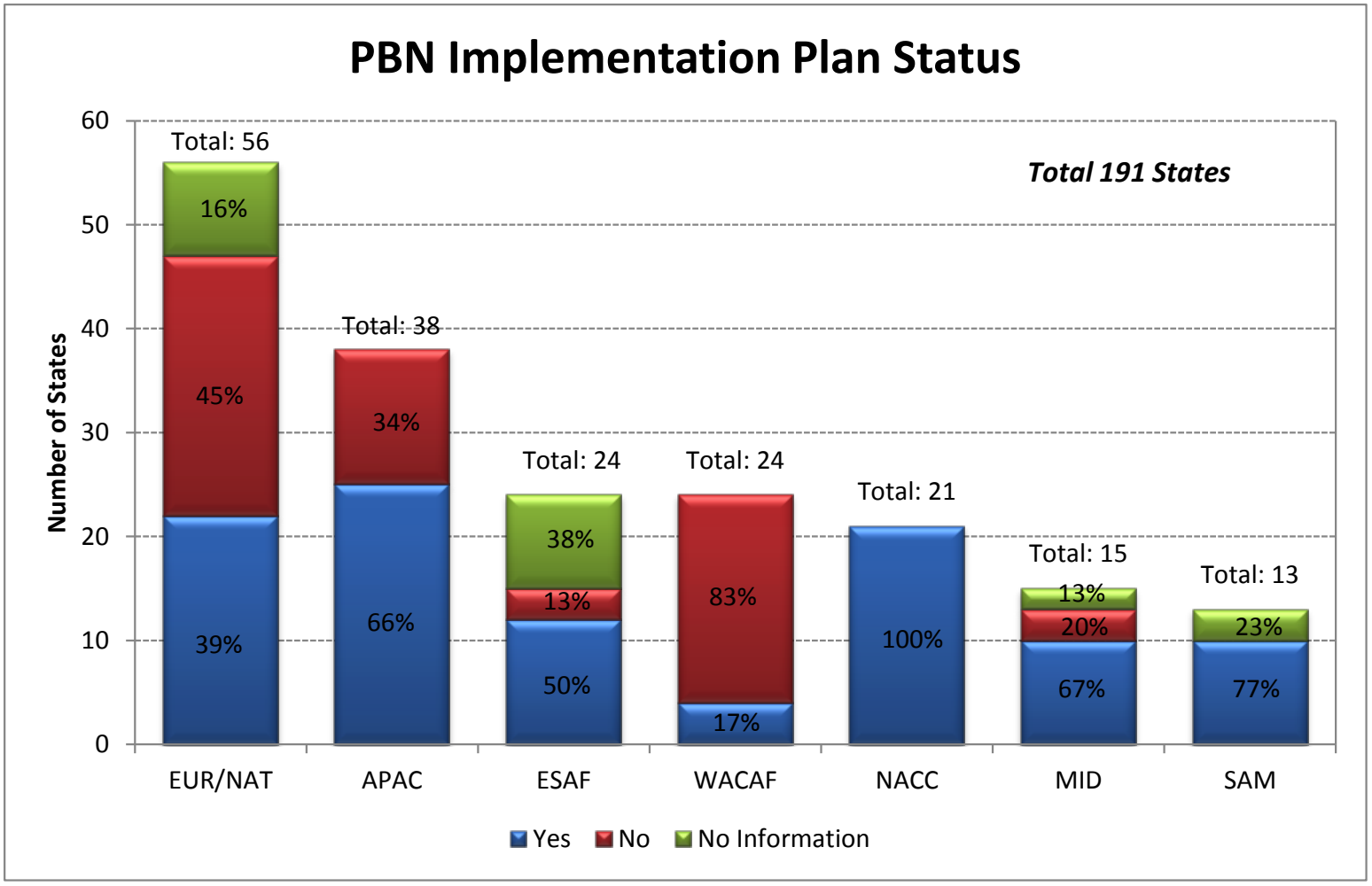


104 out of 191 States submitted plan

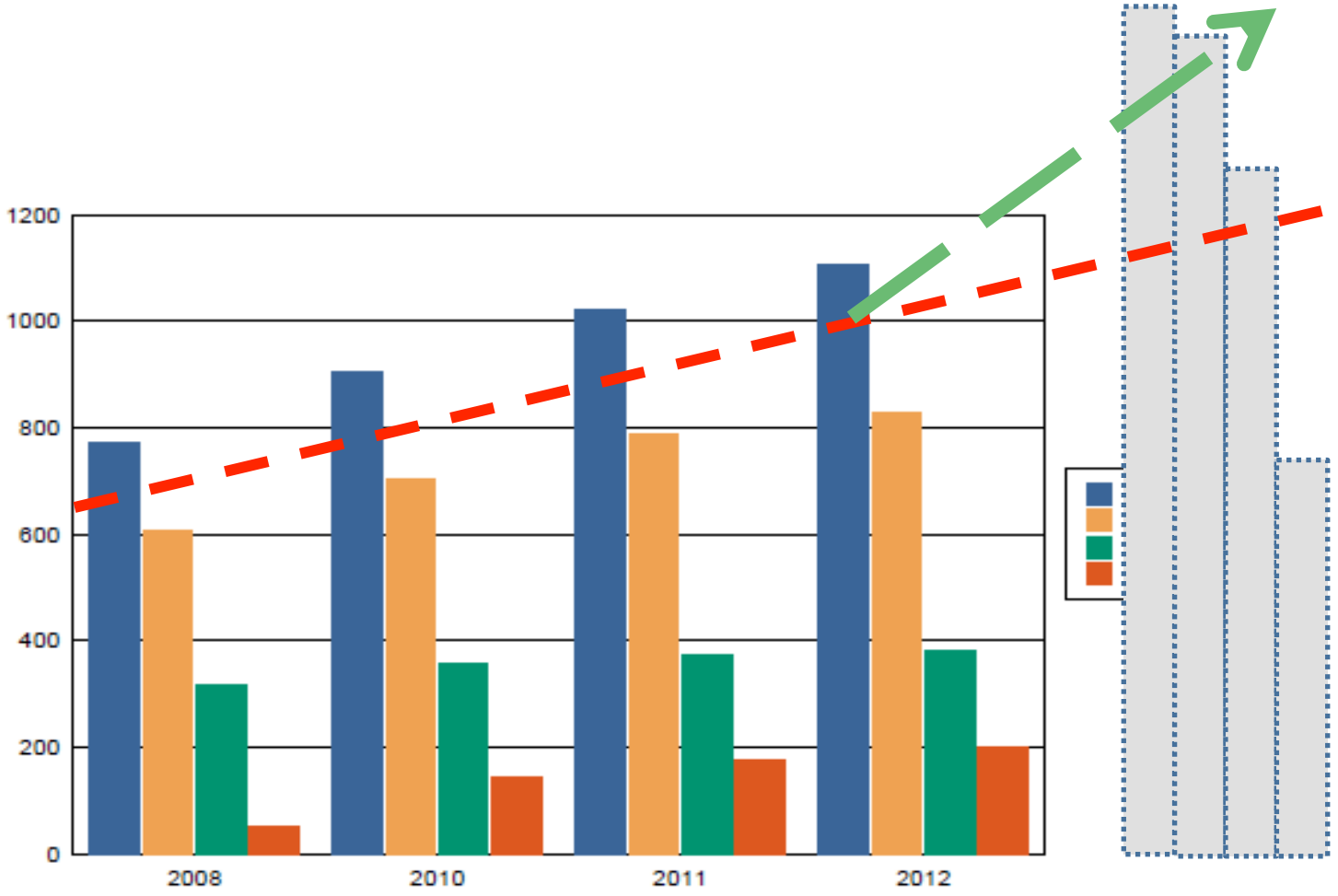
Actual implementation of PBN approaches (LNAV, LNAV/VNAV, LPV, RNP AR)



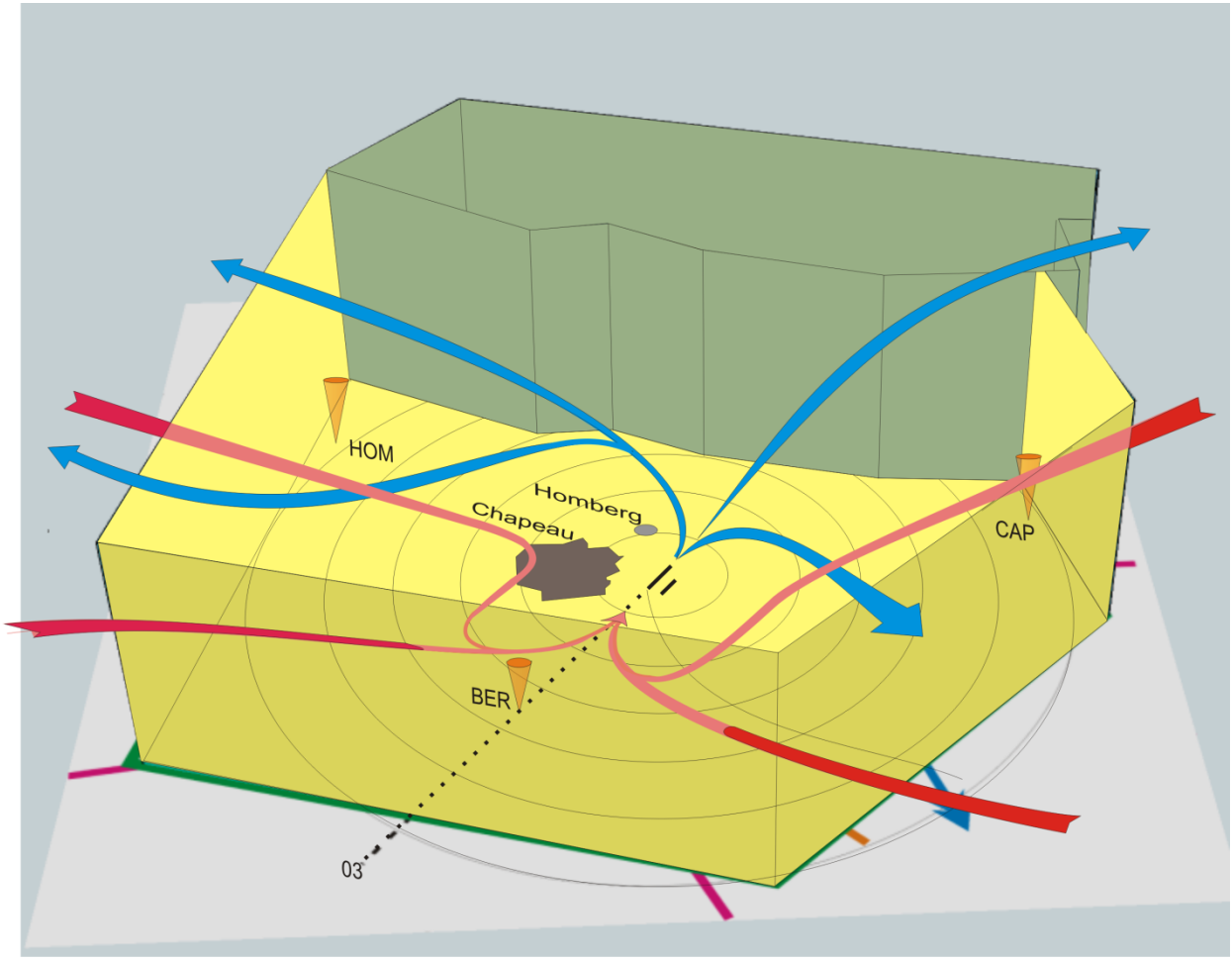
PBN Implementation Plan Submitted



PBN Implementation
International airports



Next?



Link between airspace design & PBN

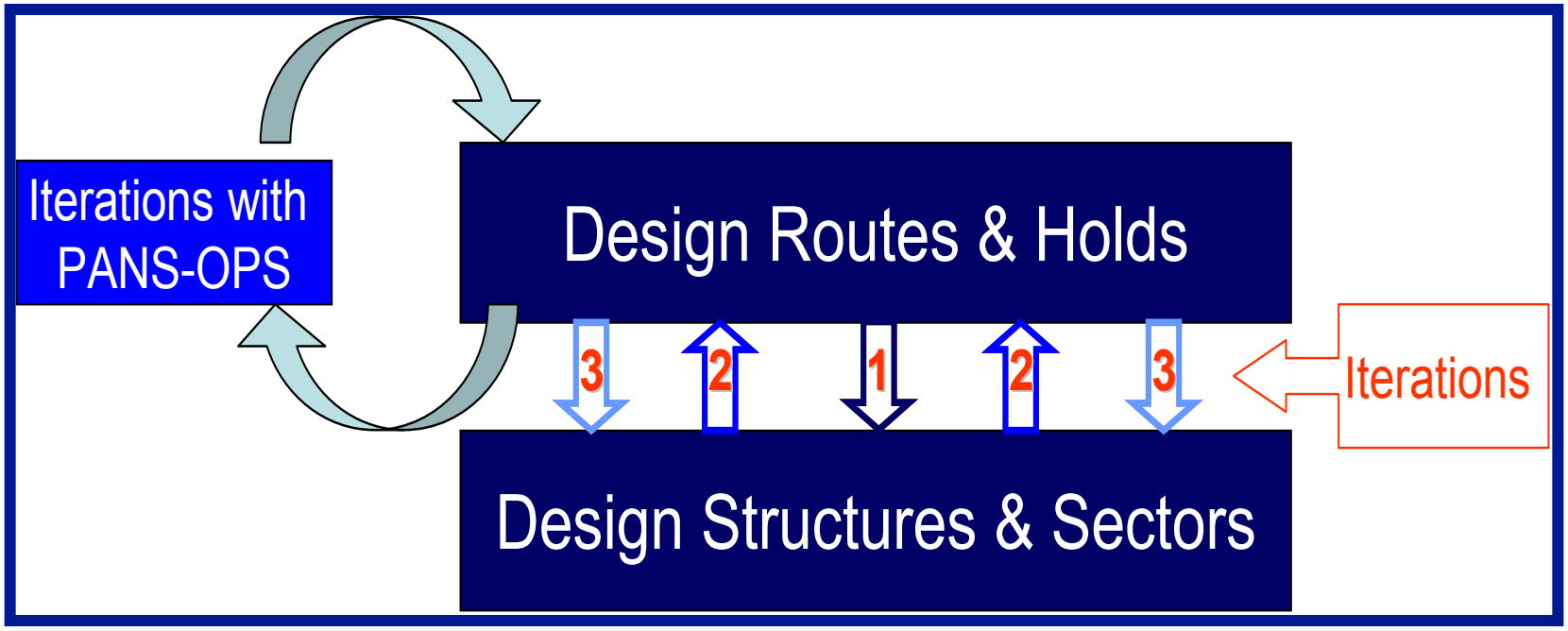
* **Separation minima**

* **Configuration/proximity of ATS Routes** (including SIDs, STARs and IFP) for an airspace organisation.

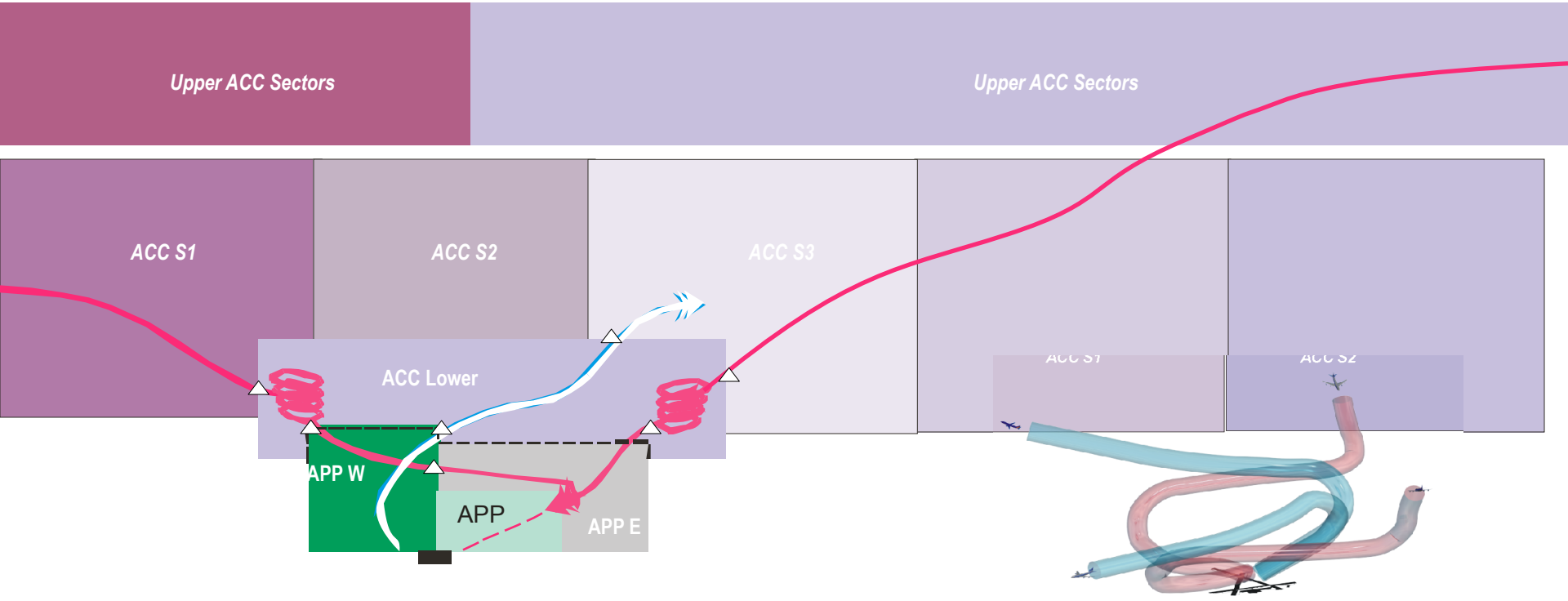
* Determined, *but not exclusively,* by
  - **area navigation system performance** stipulated in the **Navigation Specification** (required for operation in an airspace).

Accuracy
Integrity
Continuity

MANUAL ON THE USE OF PBN IN AIRSPACE DESIGN Doc 9992



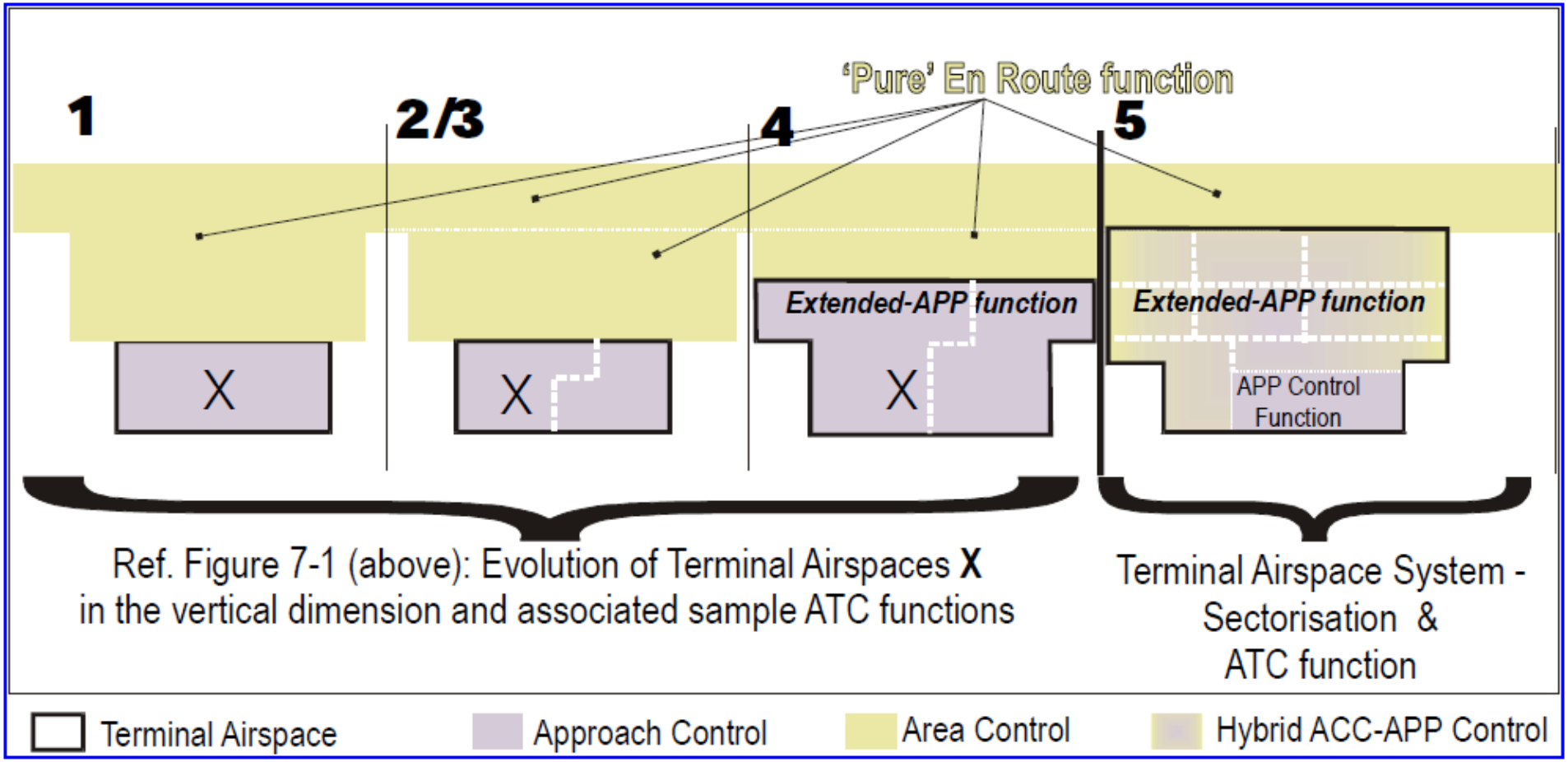
ATC Sectorisation



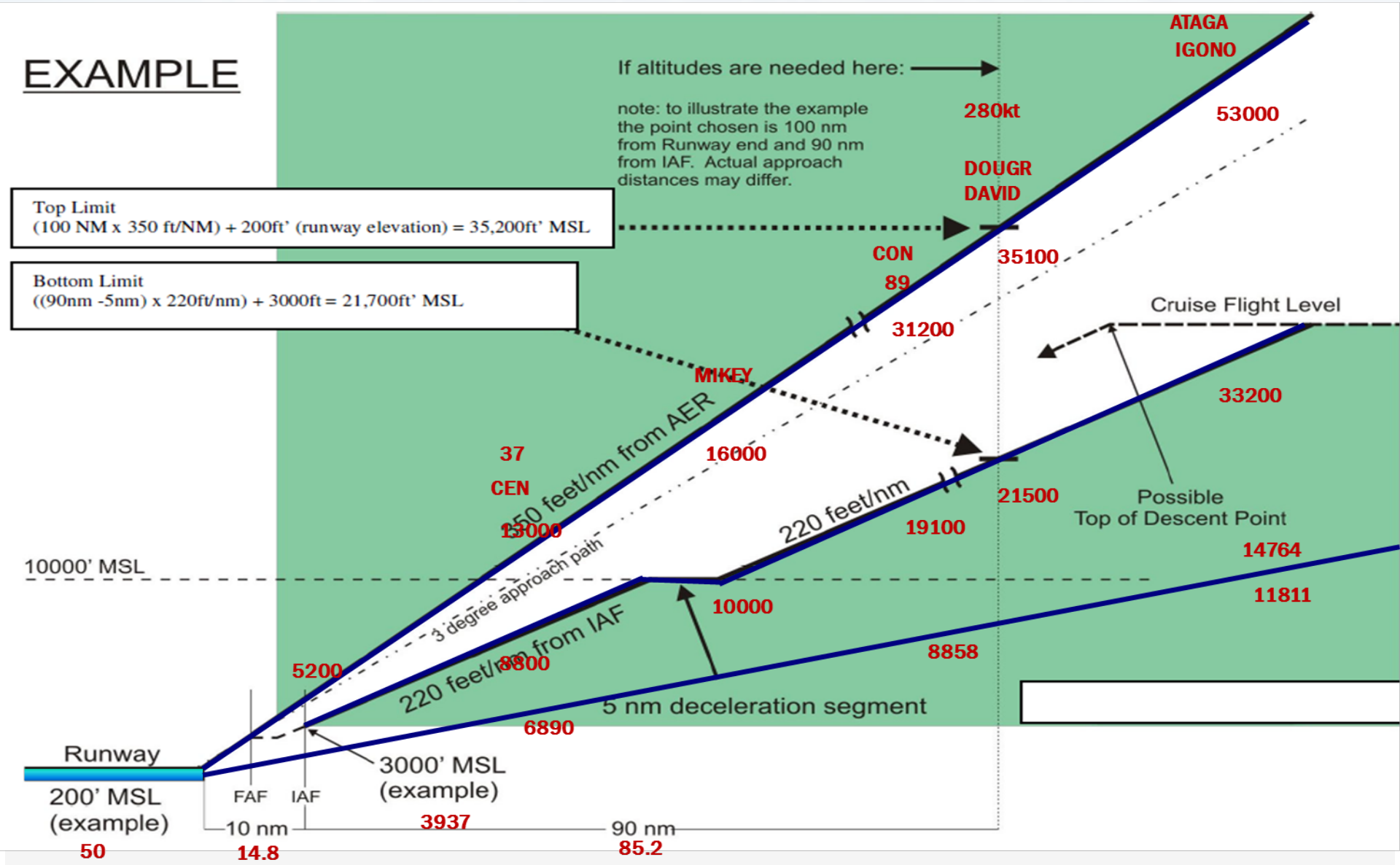
GEOGRAPHIC

FUNCTIONAL

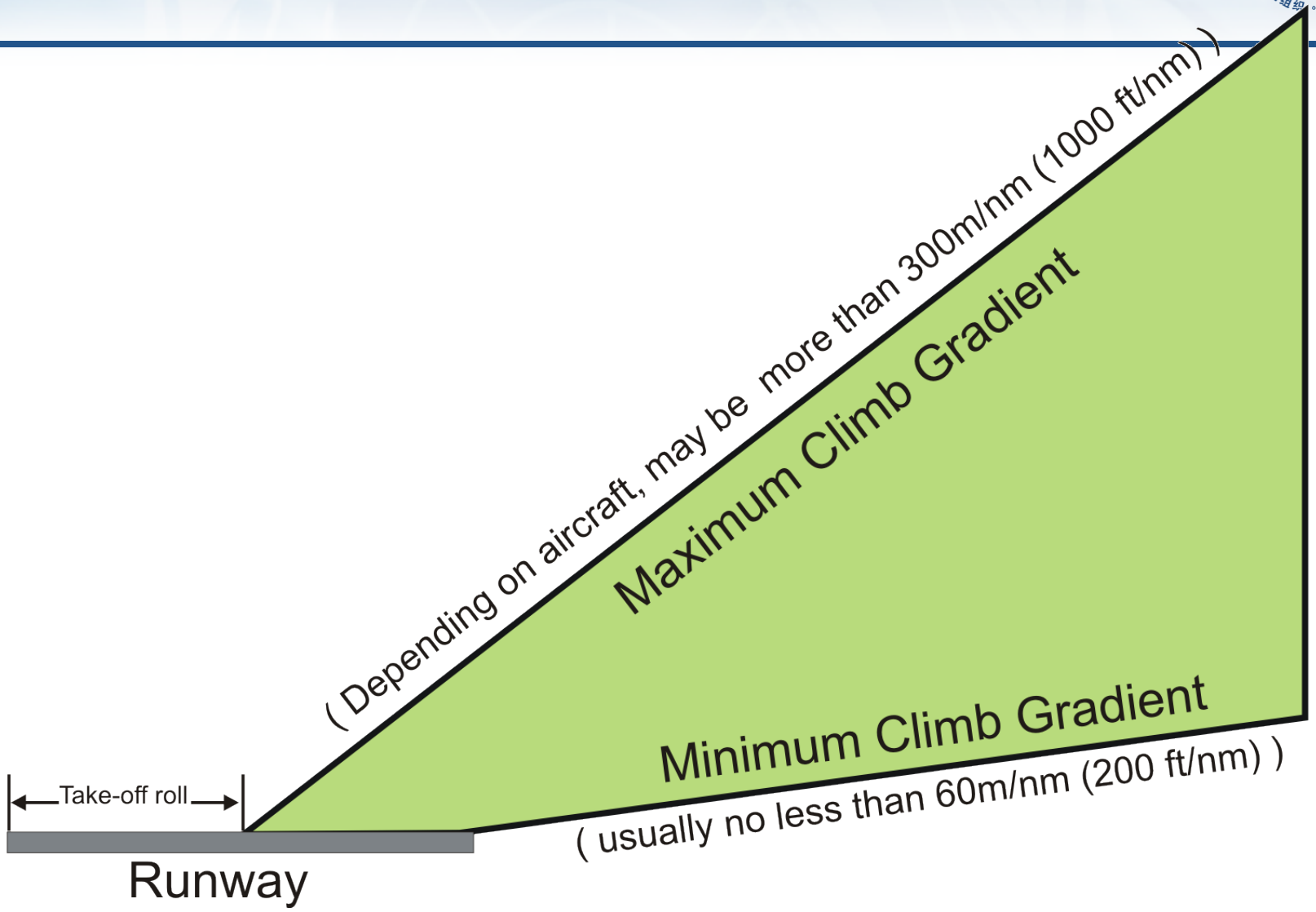
ATS Airspace Evolution



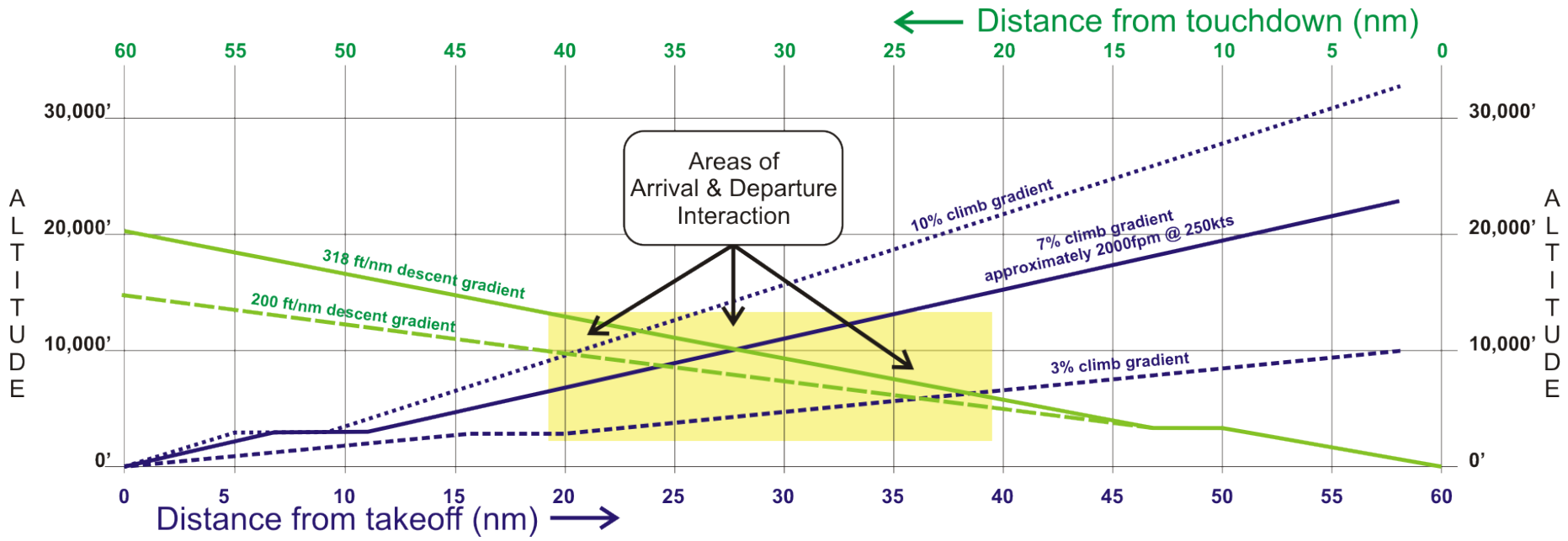
CDO


EXAMPLE
If altitudes are needed here:
note: to illustrate the example the point chosen is 100 nm from Runway end and 90 nm from IAF. Actual approach distances may differ.
Top Limit
(100 NM x 350 ft/NM) + 200ft' (runway elevation) = 35,200ft' MSL
Bottom Limit
((90nm -5nm) x 220ft/nm) + 3000ft = 21,700ft' MSL
ATAGA
IGONO
280kt
53000
DOUGR
DAVID
CON
89
35100
31200
Cruise Flight Level
MIKEY
33200
37
CEN
16000
350 feet/nm from AER
220 feet/nm
21500
Possible
Top of Descent Point
13000
19100
14764
10000' MSL
3 degree approach path
11811
10000
220 feet/nm from IAF
8858
5200
8800
5 nm deceleration segment
6890
Runway
200' MSL
(example)
FAF
IAF
3000' MSL
(example)
10 nm
3937
90 nm
50
14.8
85.2

CCO


(Depending on aircraft, may be more than 300m/nm (1000 ft/nm))
Maximum Climb Gradient
Minimum Climb Gradient
(usually no less than 60m/nm (200 ft/nm))
Take-off roll
Runway

Profile Interaction



ATC Impacts on a CDO

- Crossing traffic impacts sequencing/issuing descent clearance
- Departure traffic frequently uses the same fixes as arrivals
- Intra-facility sector point-outs for coordination of high and low airspace
- Inter-facility coordination requires voice coordination

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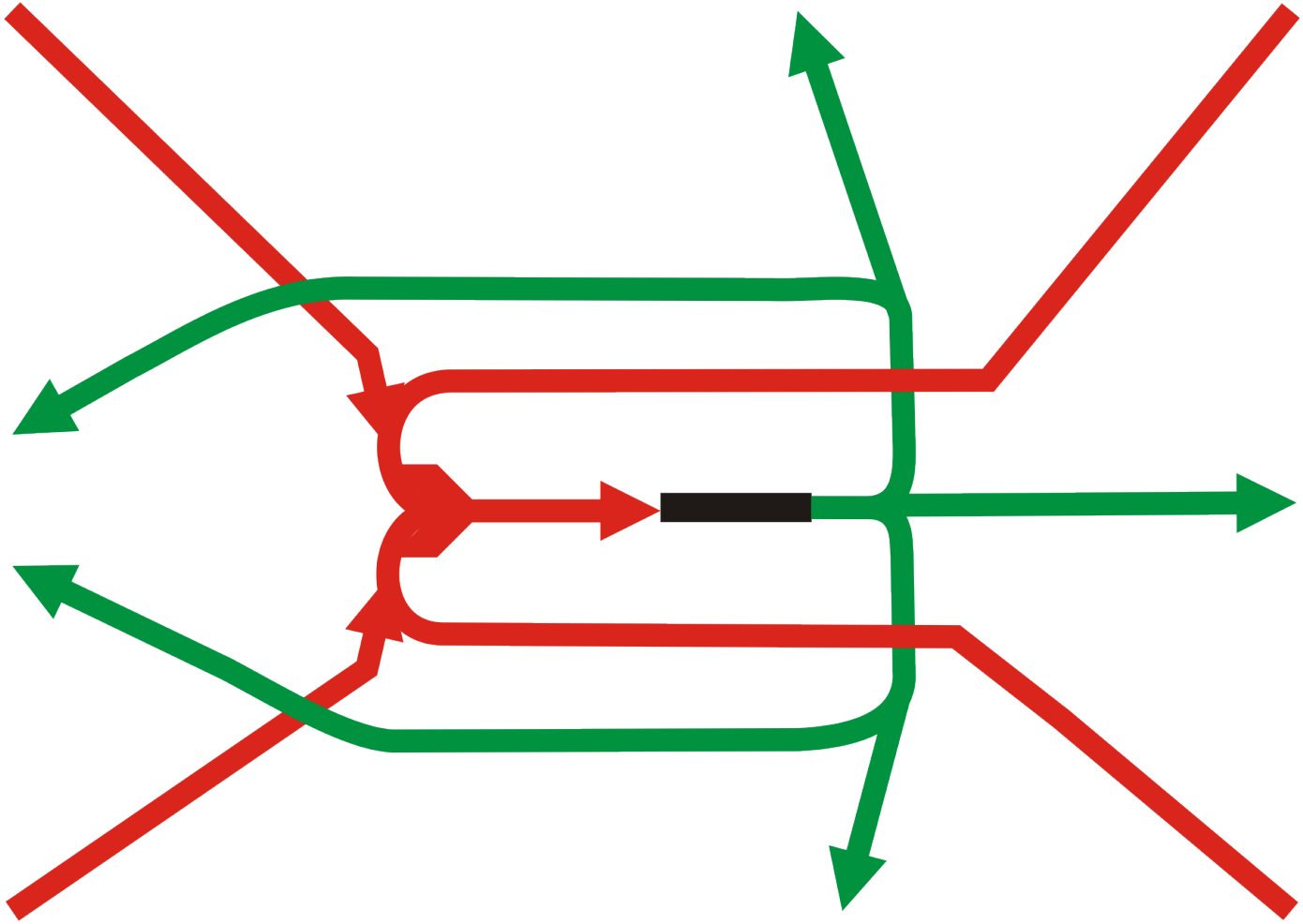
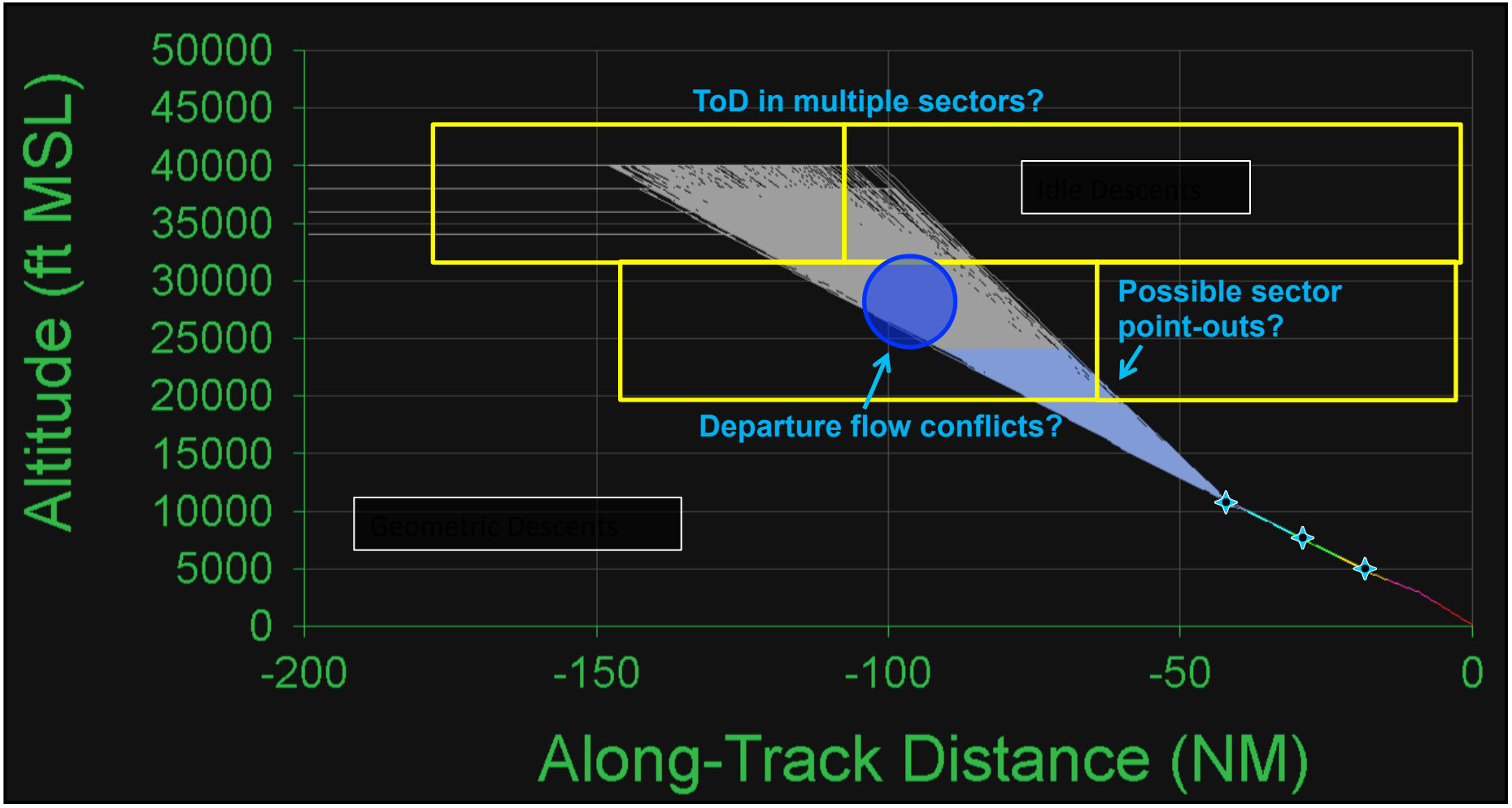
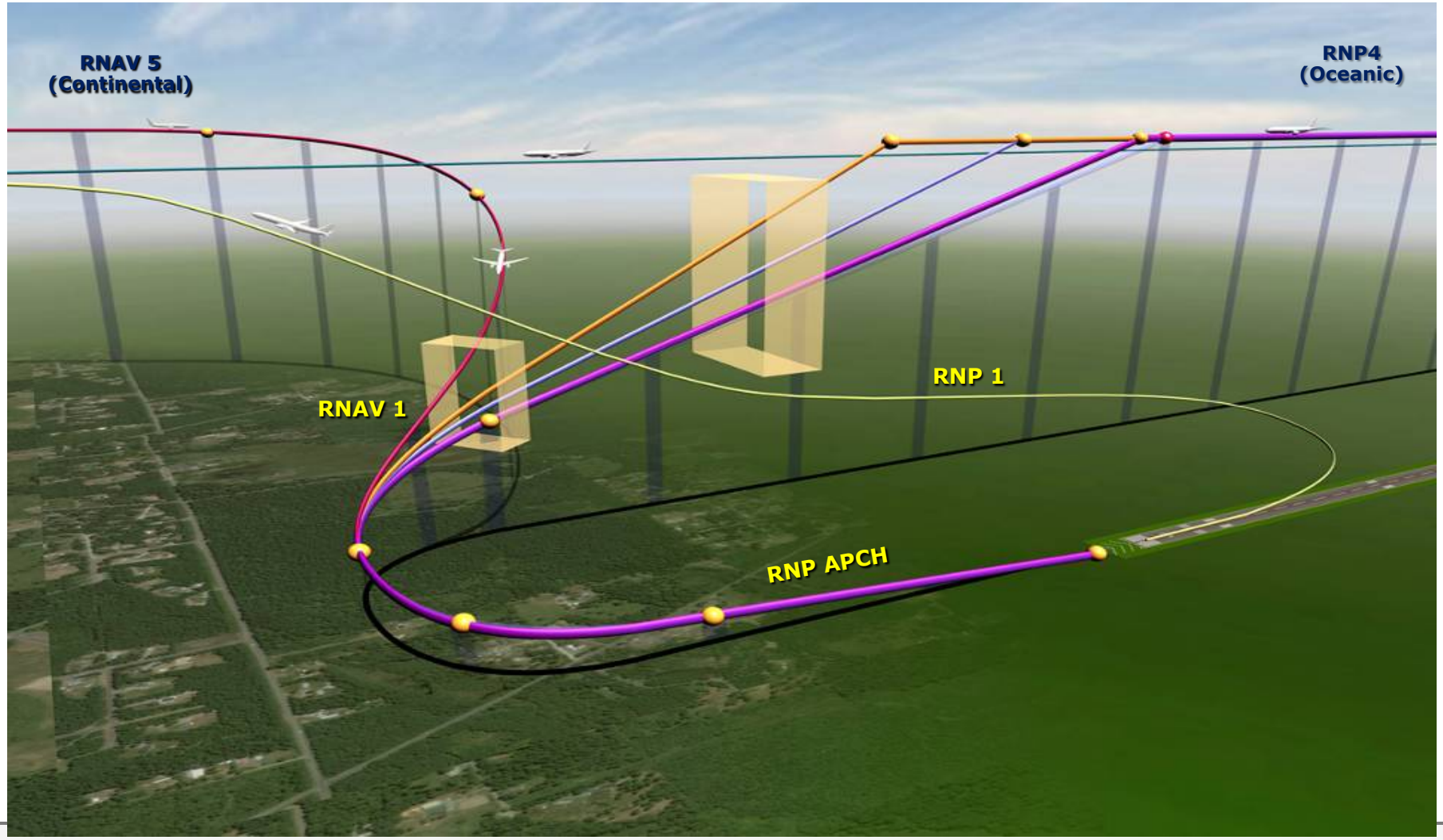
Profile Interaction



Impacts on ATC



PBN Airspace Concept



PBN airspace concept

- Airspace concept is developed to satisfy explicit strategic objectives
  - improved or maintained SAFETY
  - increased ATS CAPACITY
  - improved EFFICIENCY to allow more accurate flight paths
  - mitigation of ENVIRONMENTAL impact

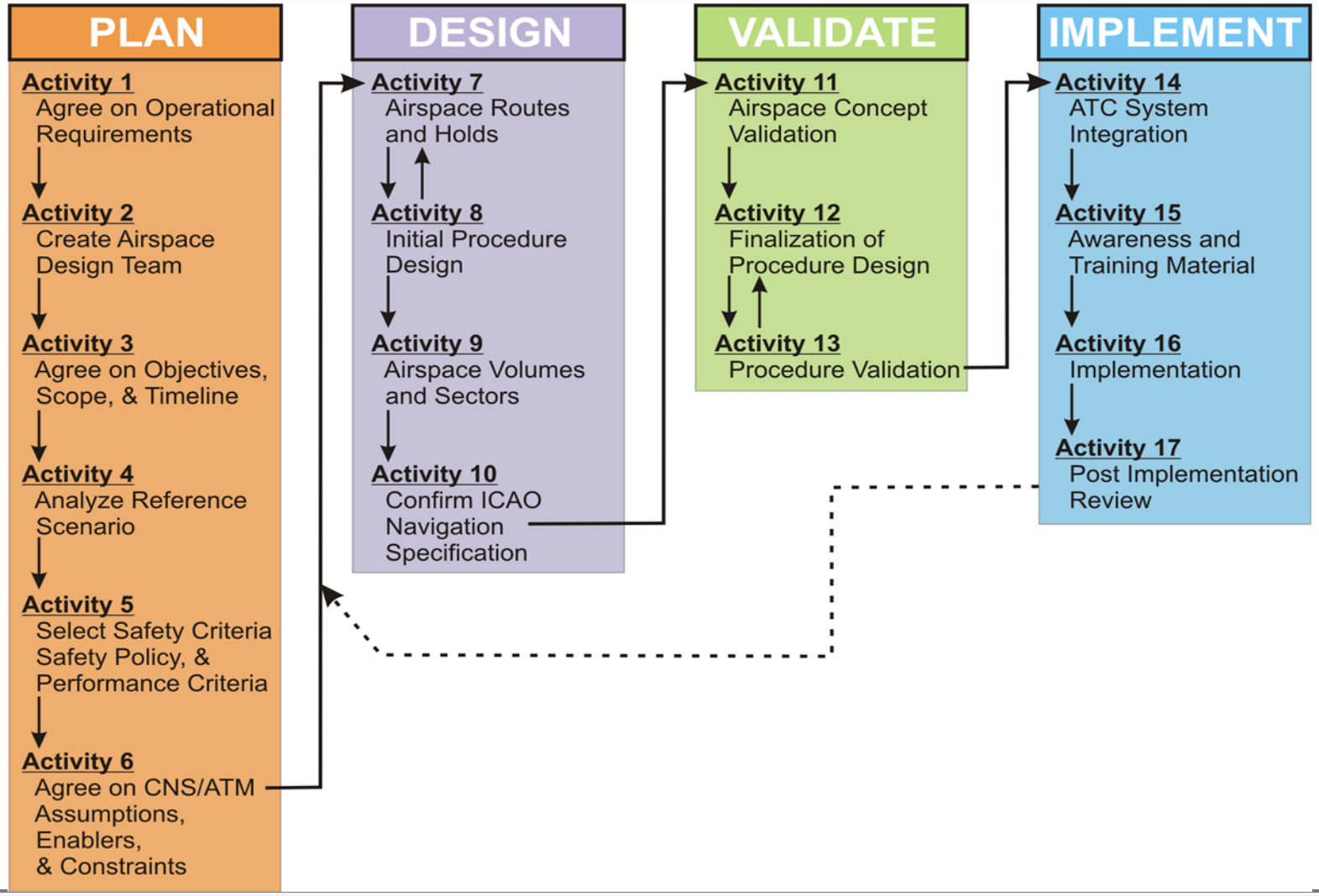
- These objectives are identified by airspace users, air traffic management (ATM), airports as well as environmental and government policy.

PBN airspace concept = Design

- Describes the intended operations within an airspace.

- Detailed practical organization of the airspace and its users based on particular CNS/ATM requirements,
  - ATS route structure,
  - separation minima,
  - route spacing and obstacle clearance.

PBN Airspace Design



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

PBN Airspace Concept, Lessons

- Collaboration for comprehensive implementation in the lower and higher airspace

- Airspace redesign due to complex airspaces, traffic grow and enhanced aircraft capabilities
  - (Multidisciplinary team: airspace planners, approach procedure design, pilots, controllers, regulators, etc.)
  - Several working months – years

- Apply Airspace Organization and Management (AOM) principles to ensure benefits for all stakeholders
  - improve airspace classification & sectorisation
  - ATM separations, procedures, vectoring, etc.

- Reinforce PBN Training
  - phraseology, procedures
  - Especially for pilots and ATCOs (lack or not qualified staff)
  - Day by day operational application
  - FMS use in operational environment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