ICAO/CANSO Regional PBN Workshop
Ciudad de México
25 - 29 Nov, 2013

Designs with CDO / CCO

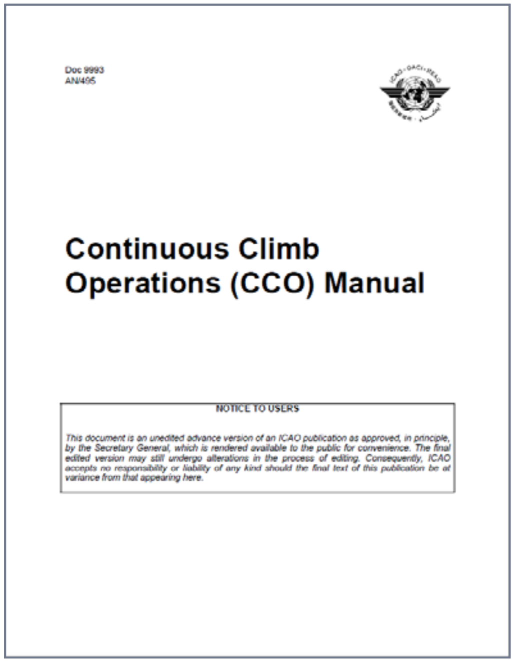
AGENDA

- CCO and CDO Documentation
- Continuous Climb Operations
- Continuous Descent Operations
- CCO and CDO Design Thoughts

ICAO Manuals for CCO/CDO

CCO and CDO are documented in ICAO Manuals

Doc 9993 – Continuous Climb Operations Manual



Doc 9993
AN/495

Continuous Climb Operations (CCO) Manual

NOTICE TO USERS

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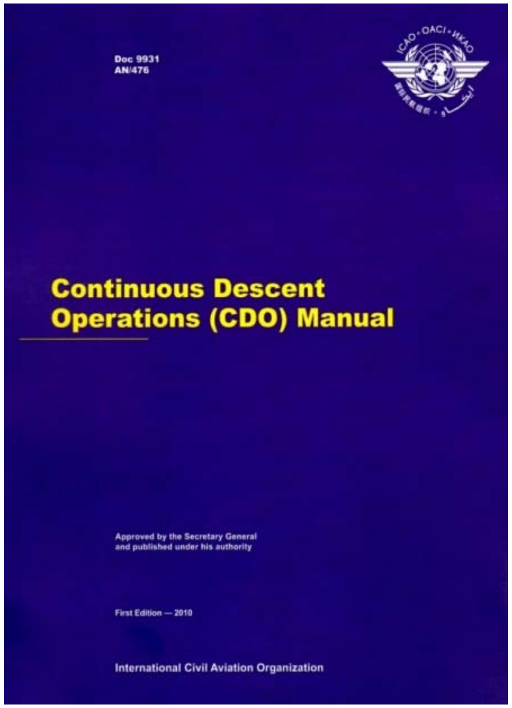
Doc 9931 - Continuous Descent Operations Manual



Doc 9931
AN/476

Continuous Descent Operations (CDO) Manual

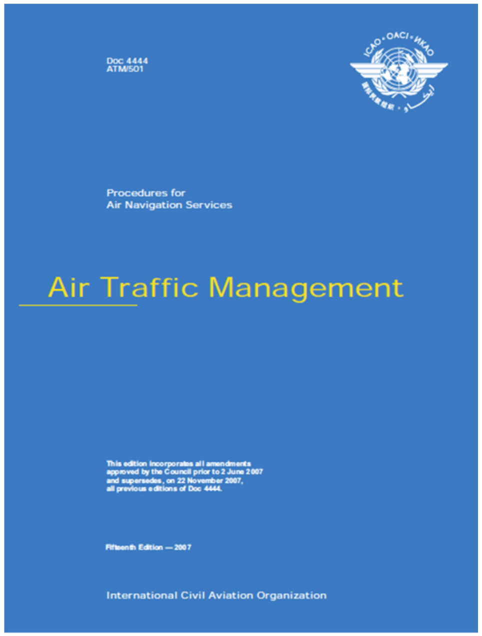
Approved by the Secretary General and published under his authority

First Edition — 2010

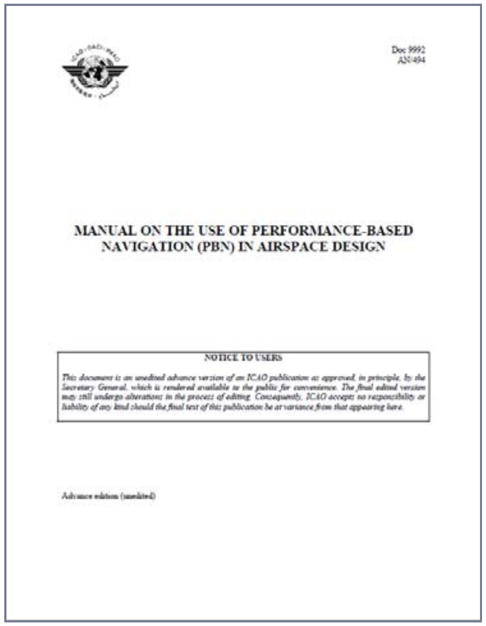
International Civil Aviation Organization

Additional ICAO Manuals for CCO/CDO

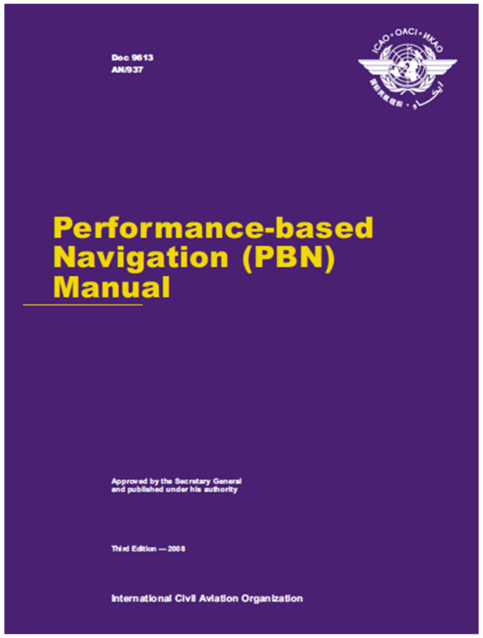
Doc 4444
Air Traffic Management



Doc 9992
Manual on The Use of Performance-Based Navigation(PBN) in Airspace Design



Doc 9613
Performance-based Navigation



AIRBUS PRO SKY

ASBU Block Upgrades

CCO and CDO implementation listed as near term (now thru 2018) steps in the ICAO Aviation System Block Upgrades and Global Air Navigation Capacity & Efficiency Plan

Module	Performance Improvement Area	Module Title	Module Description
B0-05	Efficient Flight Path	Improved Flexibility and Efficiency in Descent Profiles **(CDO)**	To use performance-based airspace and arrival procedures allowing aircraft to fly their optimum profile using continuous descent operations (CDOs). This will optimize throughput, allow fuel efficient descent profiles and increase capacity in terminal areas.
B0-20	Efficient Flight Path	Improved Flexibility and Efficiency in Departure Profiles - Continuous Climb Operations **(CCO)**	To implement continuous climb operations in conjunction with performance-based navigation (PBN) to provide opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb profiles and increase capacity at congested terminal areas.

AGENDA

- CCO and CDO Documentation
- Continuous Climb Operations
- Continuous Descent Operations
- CCO and CDO Design Thoughts

AIRBUS PRO SKY

Definition CCO

Continuous Climb Operations (CCO)

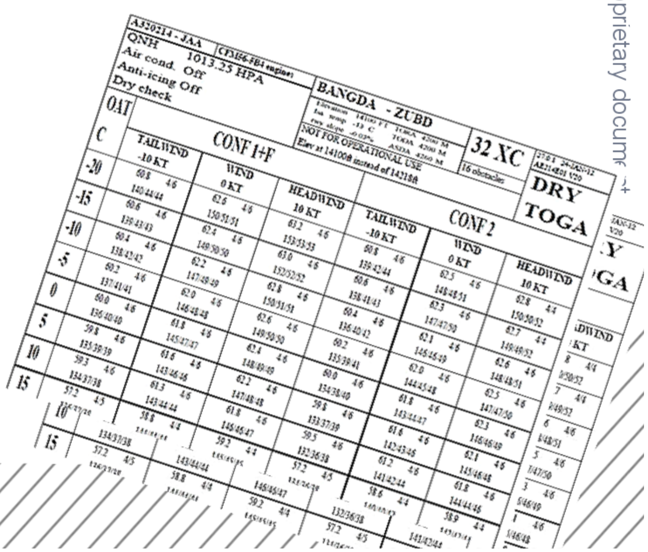
Is a flight operation enabled by:

- ✓ Airspace design,
- ✓ Procedure design, and
- ✓ ATC facilitation.

CCO Continued…

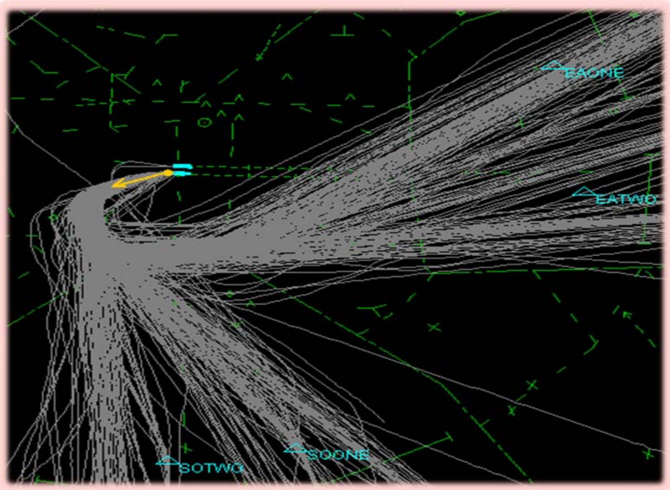
- Where a departing aircraft climbs without interruption to the greatest possible extent.

- By employing optimum climb engine thrust, ideally at optimum climb speeds.

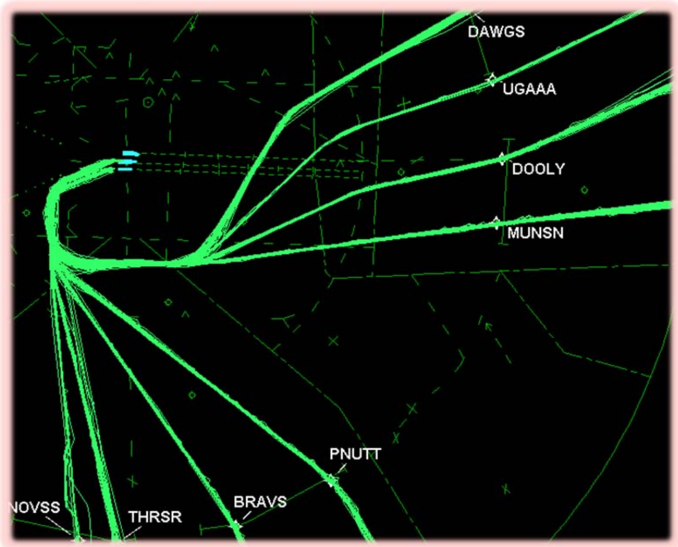


PBN and CCO allow improved capacity and efficiency

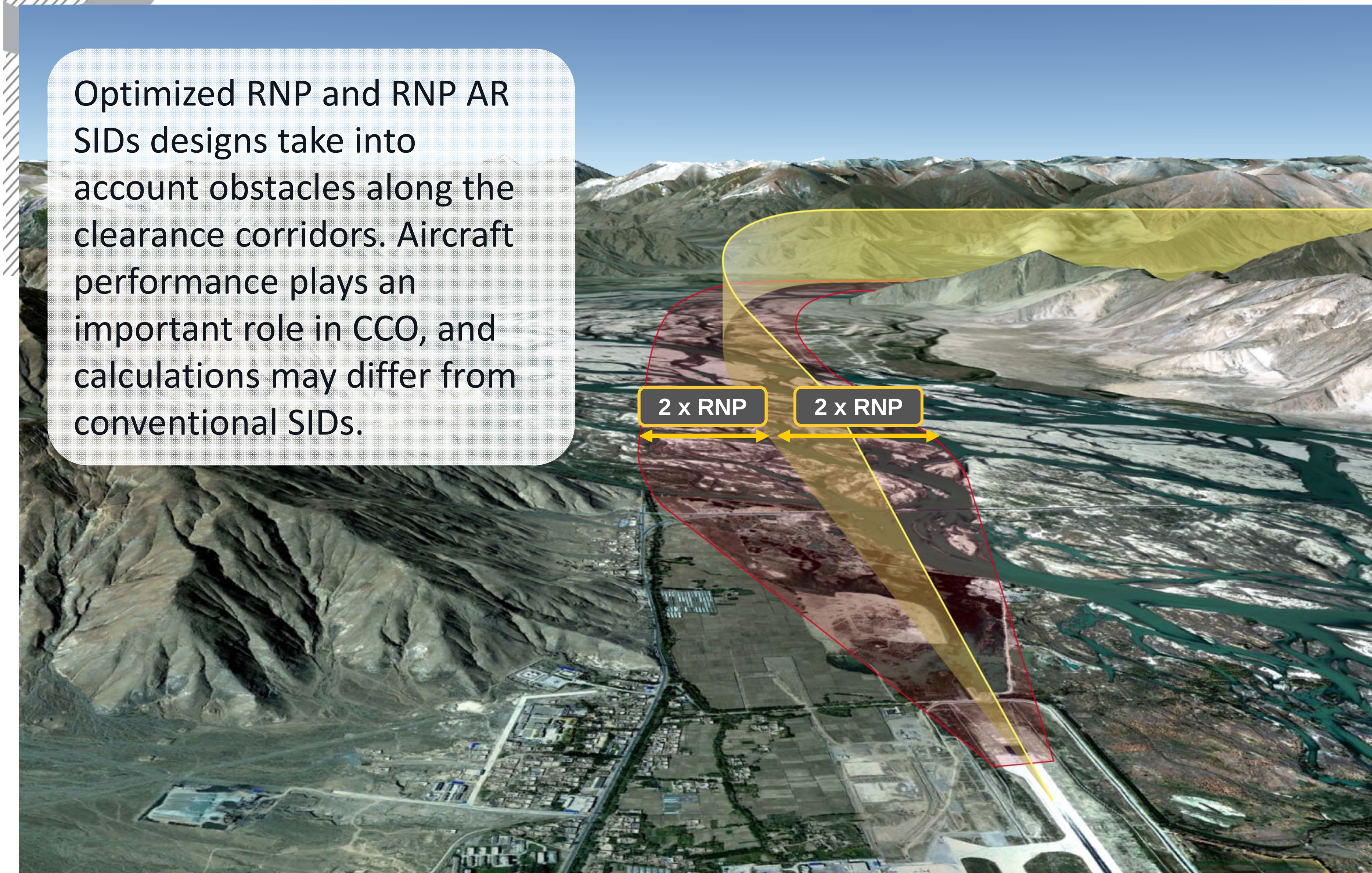
Example Before PBN



Example After PBN



CCO Continued…



Optimized RNP and RNP AR SIDs designs take into account obstacles along the clearance corridors. Aircraft performance plays an important role in CCO, and calculations may differ from conventional SIDs.

AGENDA

- CCO and CDO Documentation
- Continuous Climb Operations
- **Continuous Descent Operations**
- CCO and CDO Design Thoughts

AIRBUS PRO SKY

Definition CDO

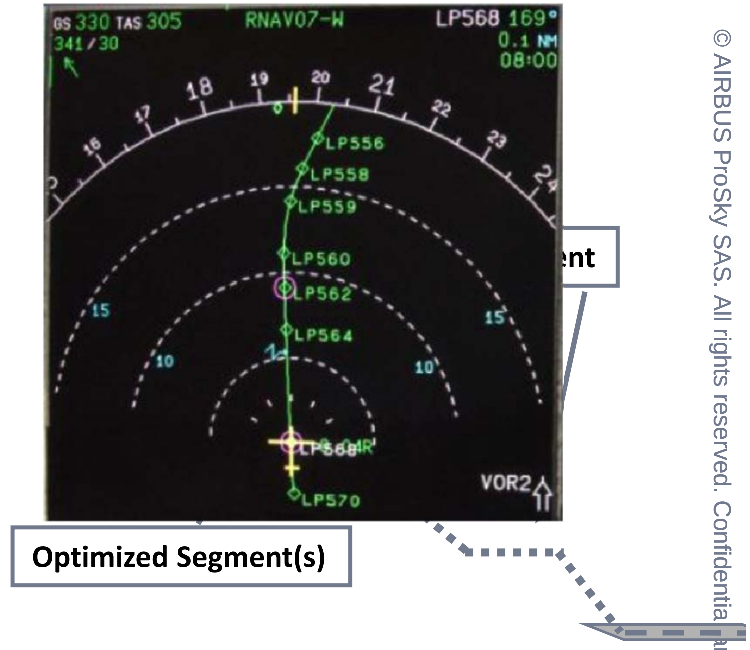
Continuous Descent Operations (CDO)

Is a flight operation enabled by:

- ✓ Airspace design,
- ✓ Procedure design, and
- ✓ ATC facilitation.

Definition CDO

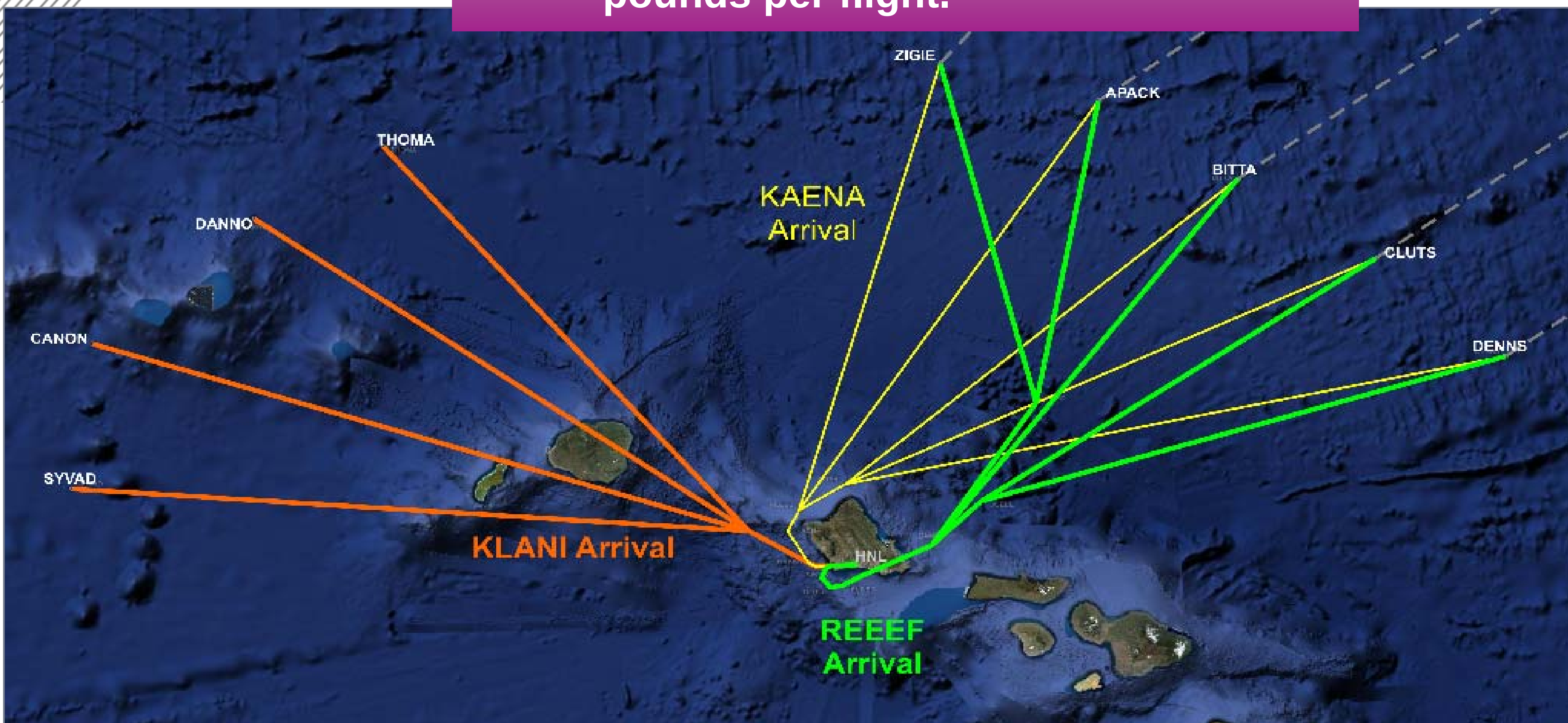
- Where an arriving aircraft descends continuously to the greatest possible extent;



- Employing minimum engine thrust, ideally in a low drag configuration

HNL CDO Example

- **KAENA, KLANI, REEEF CDO**
  - ✓ **Fully integrated/linked to approach.**
  - ✓ **Descend via from cruise flight levels.**
  - ✓ **Initial Fuel Savings 300-1200+ pounds per flight.**

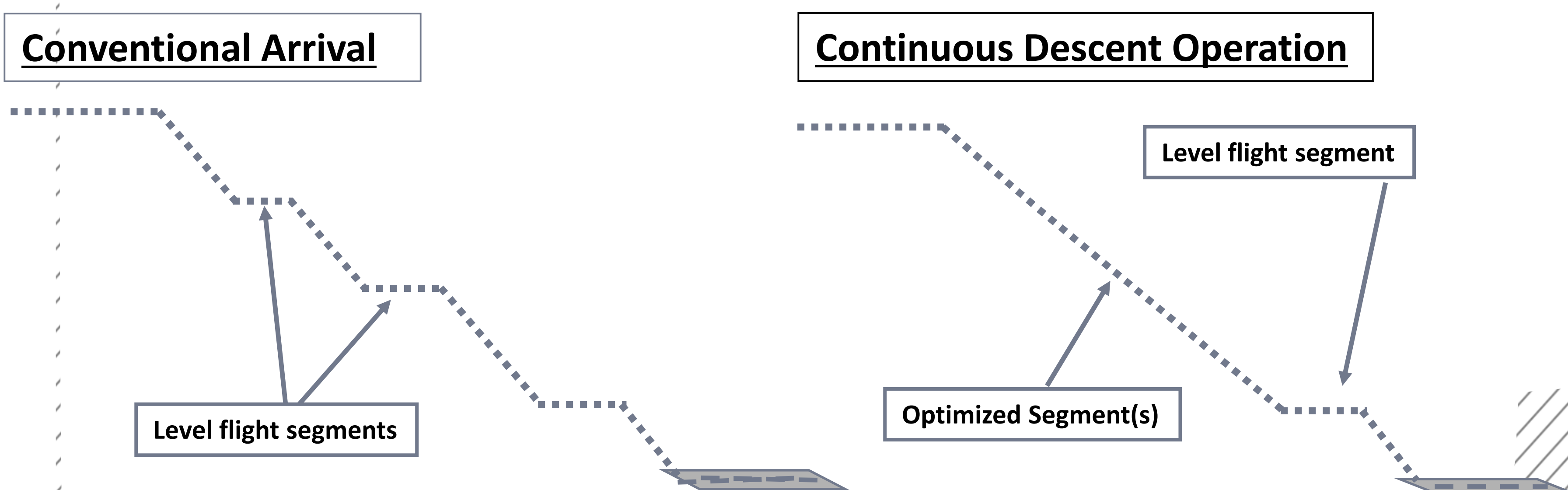


AIRBUS PRO SKY

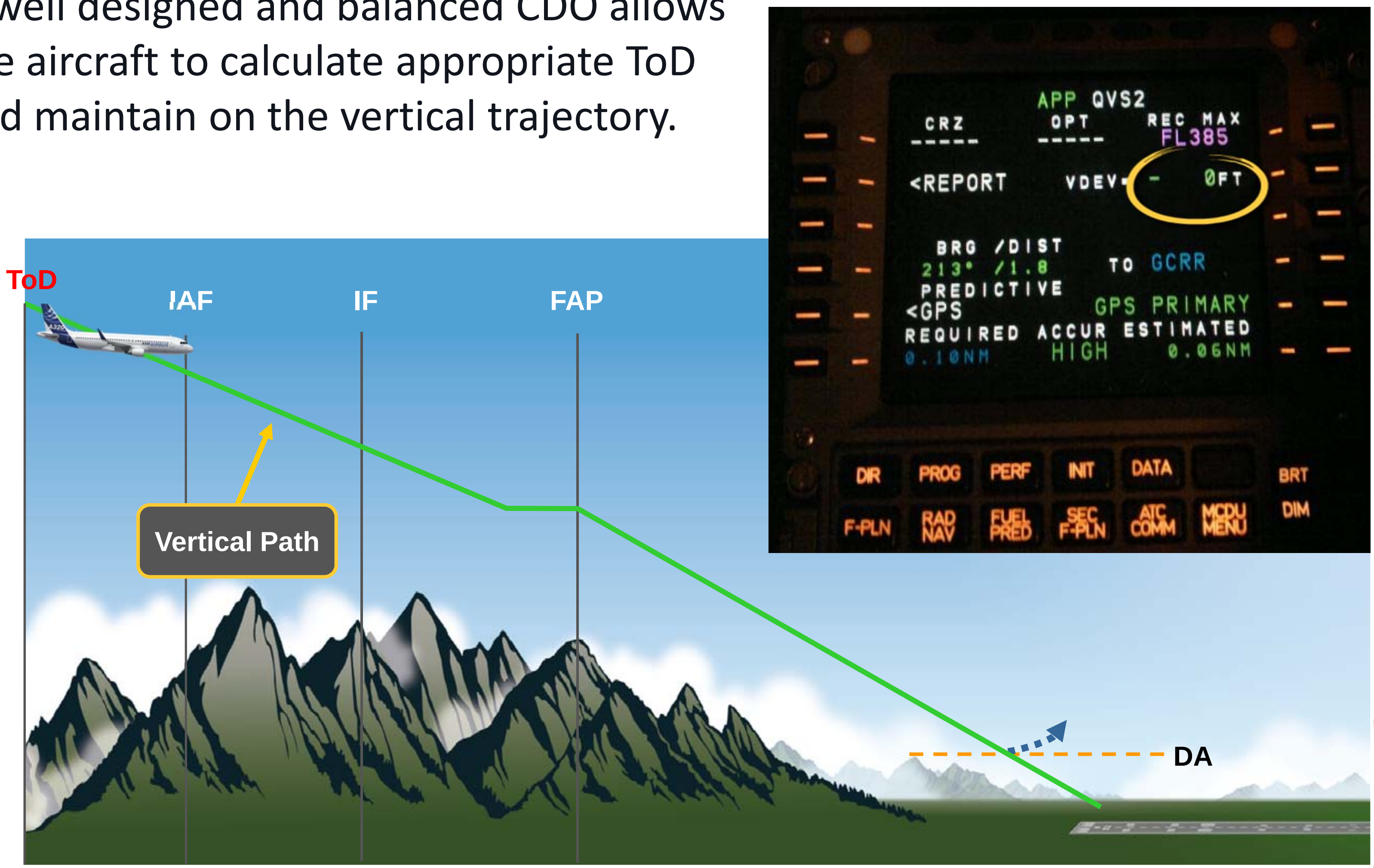
Continuous Descent Operations (CDO) Vs. Conventional Arrival

✓Leverages RNAV STAR implementations

✓Reduce the amount of time spent in level flight on published arrival procedures (i.e., STARs)

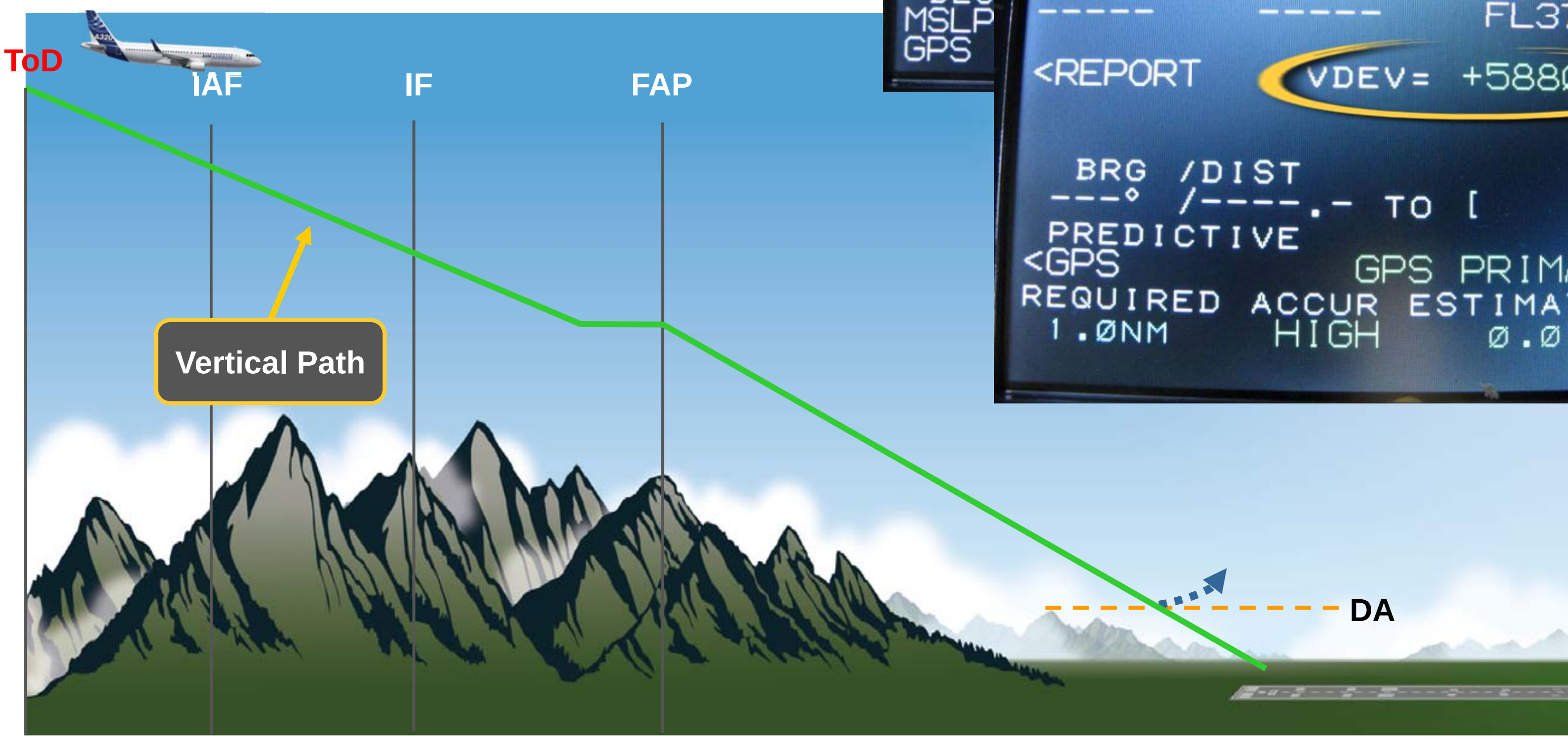


A well designed and balanced CDO allows the aircraft to calculate appropriate ToD and maintain on the vertical trajectory.



CDO Vertical Trajectory

… otherwise, an aircraft may have a challenging time descending and decelerating at the appropriate schedules.



- CCO and CDO Documentation
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Think broad

A CDO or CCO trajectory is designed

BUT

- ✓ If it can not be coded

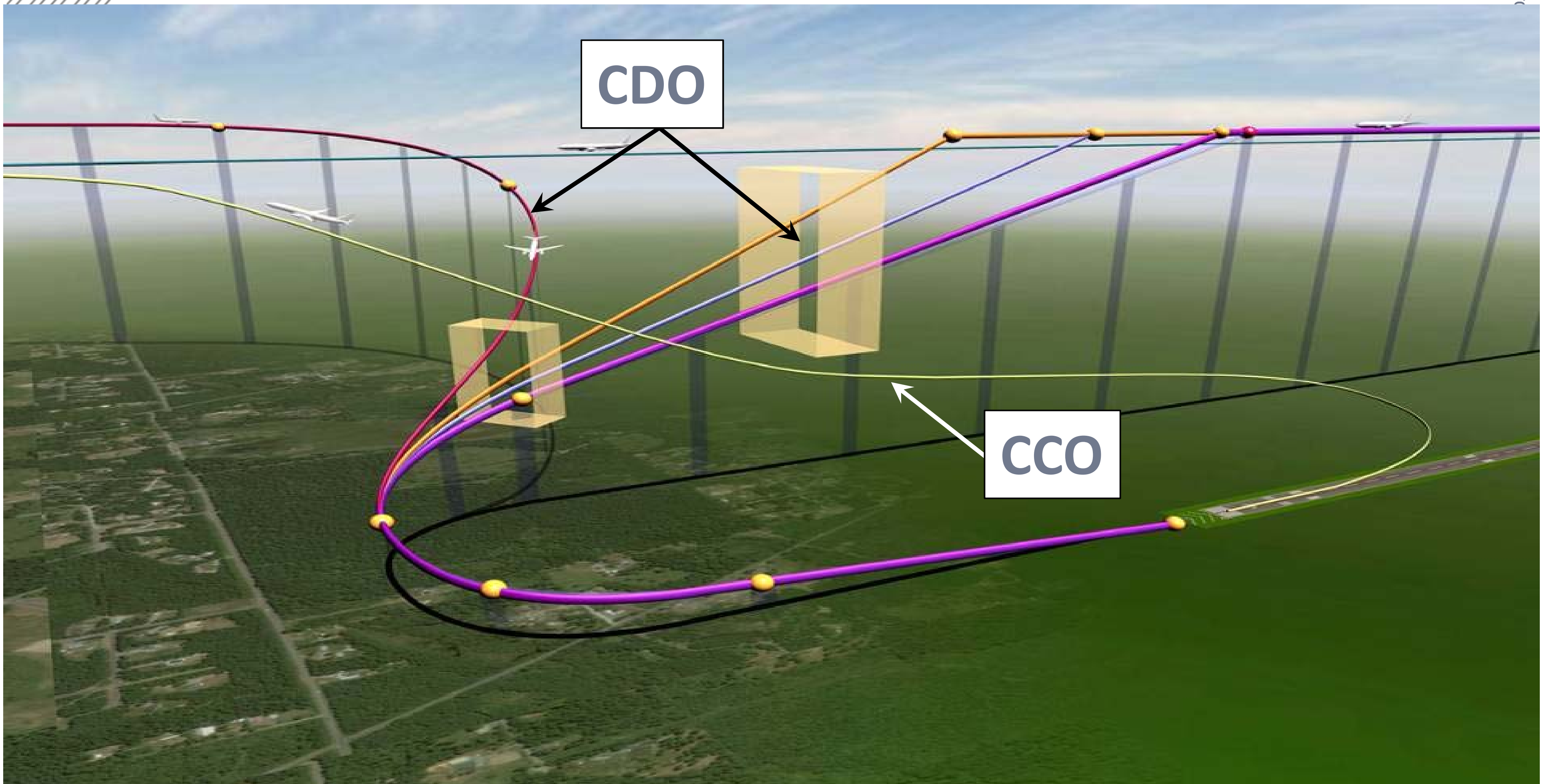
or

- ✓ The aircraft can not fly it,

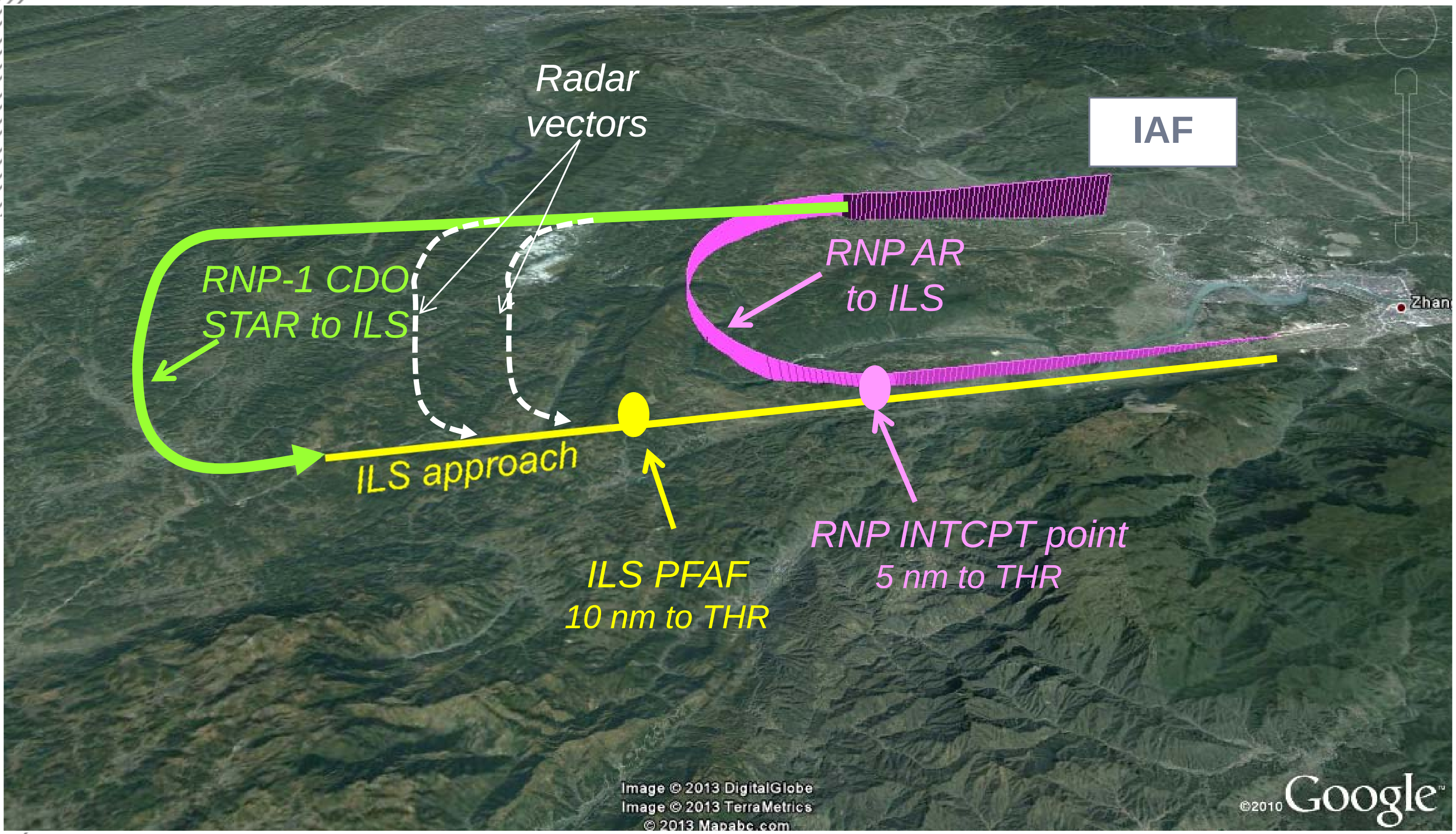
chances are it may never be used…

Closed Path Design

Altitude windows safely separate aircraft and allow predictable flight performance

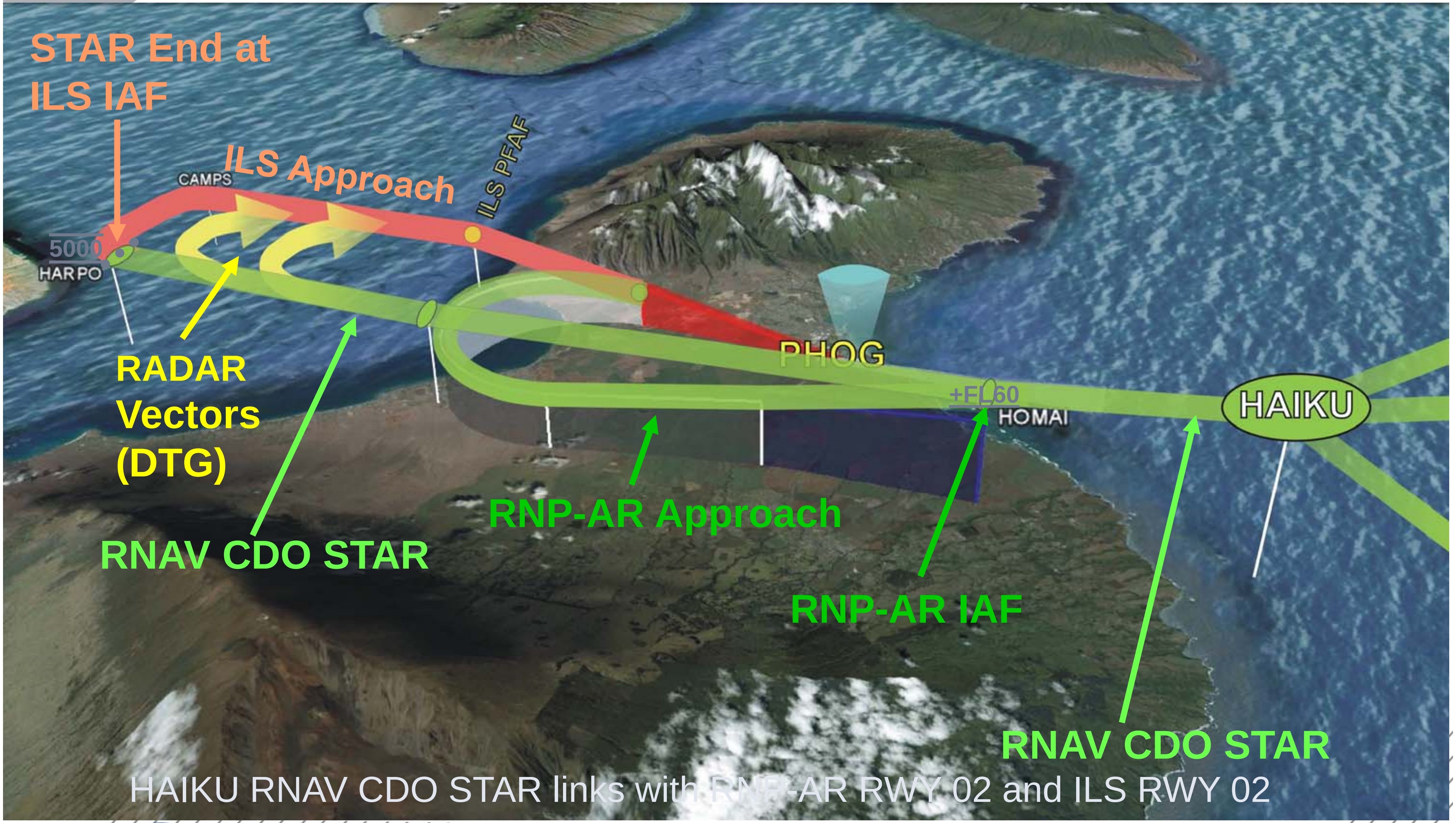


Good Design Integrates PBN, CDO, & Conventional Capabilities



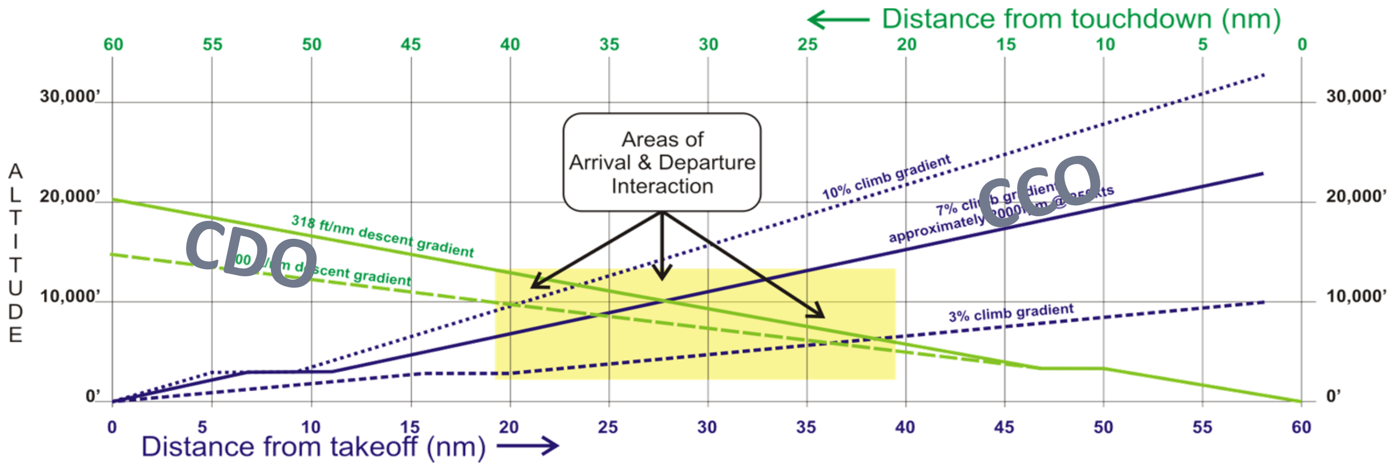
CDO Integration

Integrating RNAV, RNP, & Conventional Capabilities



ATC operating procedures to accommodate PBN.

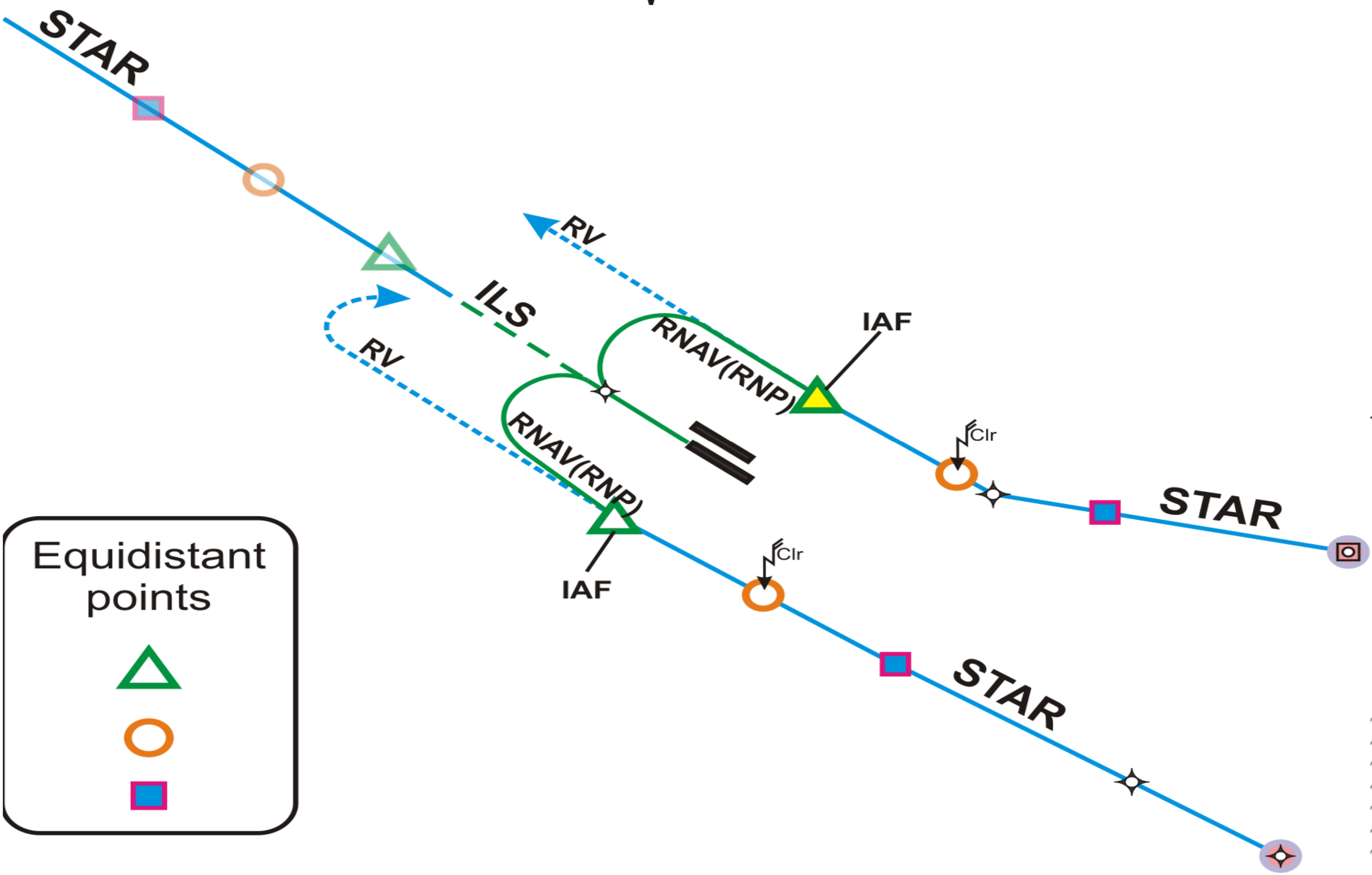
- Design using updated techniques to minimize interaction
  - CDO
  - CCO



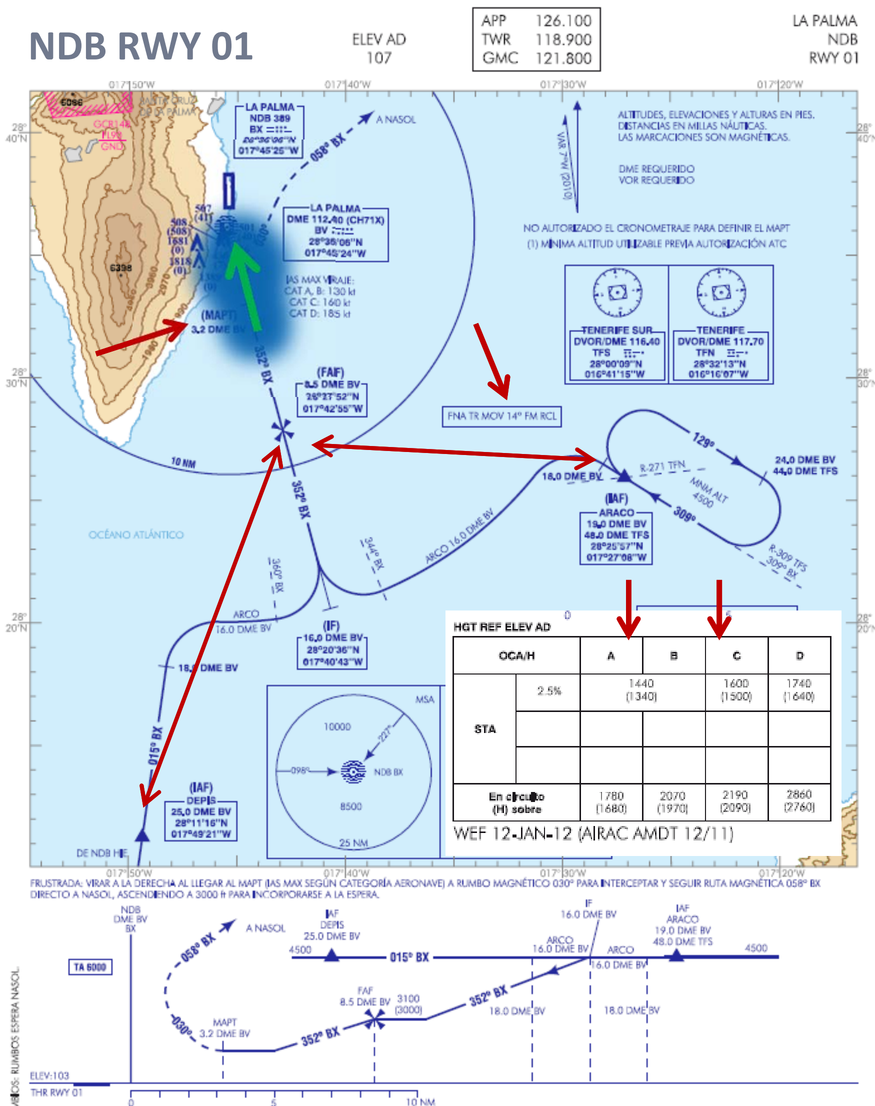
- Education is critical
  - Concept of operations
  - ATC benefits
  - Clear responsibilities defined
  - Structured Decision Points give ATC ability to judge control actions early.

PBN CCO/CDO Sequencing Methods

V

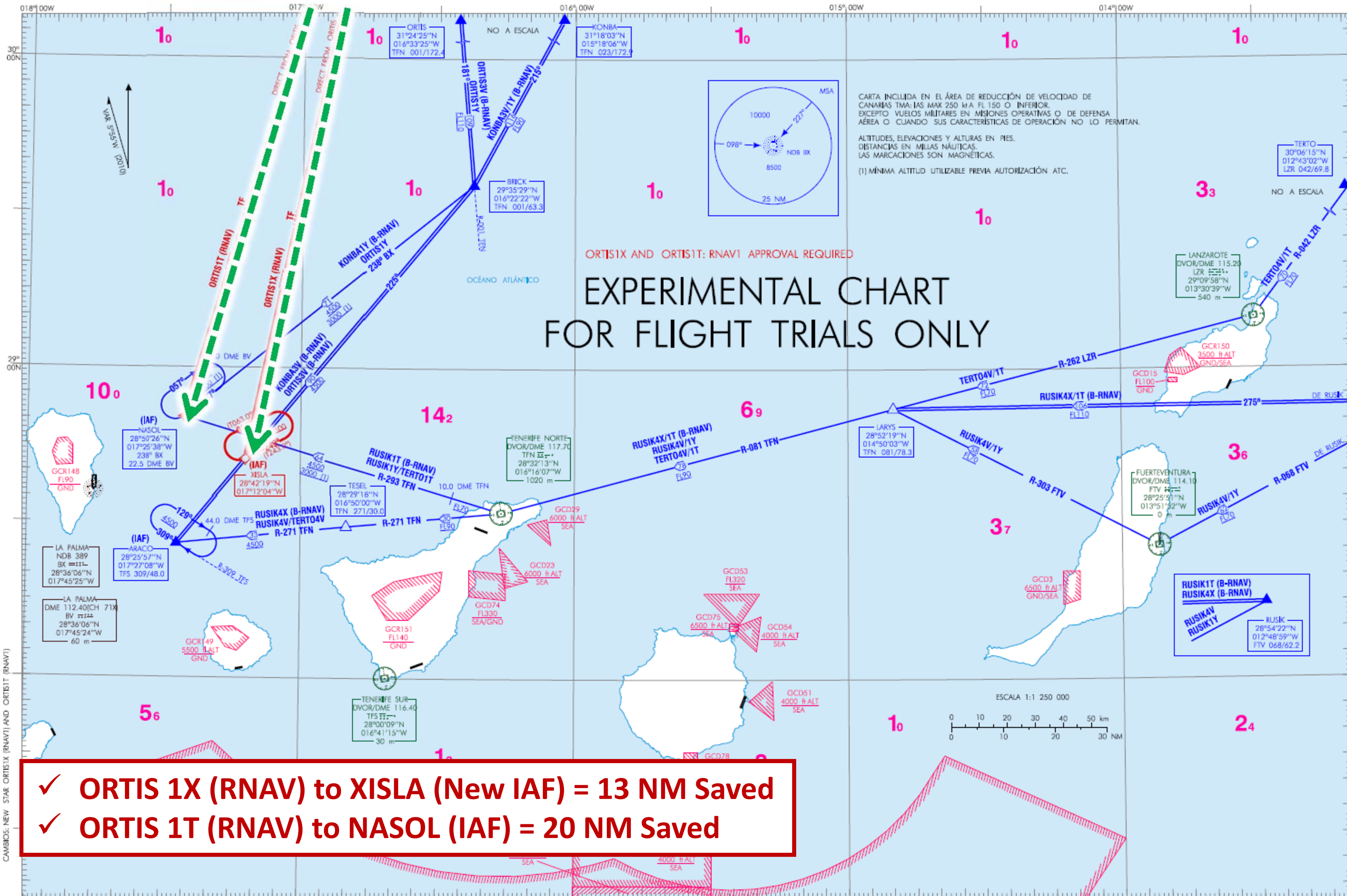


- CCO and CDO Documentation
- Continuous Climb Operations
- Continuous Descent Operations
- CCO and CDO Design Thoughts
  - Example



- ✓ **HIGH MINIMA**
- ✓ **Final Approach NOT ALIGNED with Runway Centerline**
- ✓ **NO VERTICAL GUIDANCE**
- ✓ **NOT OPTIMIZED**

GCLA Flight Trials - STARs



✓ **ORTIS 1X (RNAV) to XISLA (New IAF) = 13 NM Saved**

✓ **ORTIS 1T (RNAV) to NASOL (IAF) = 20 NM Saved**

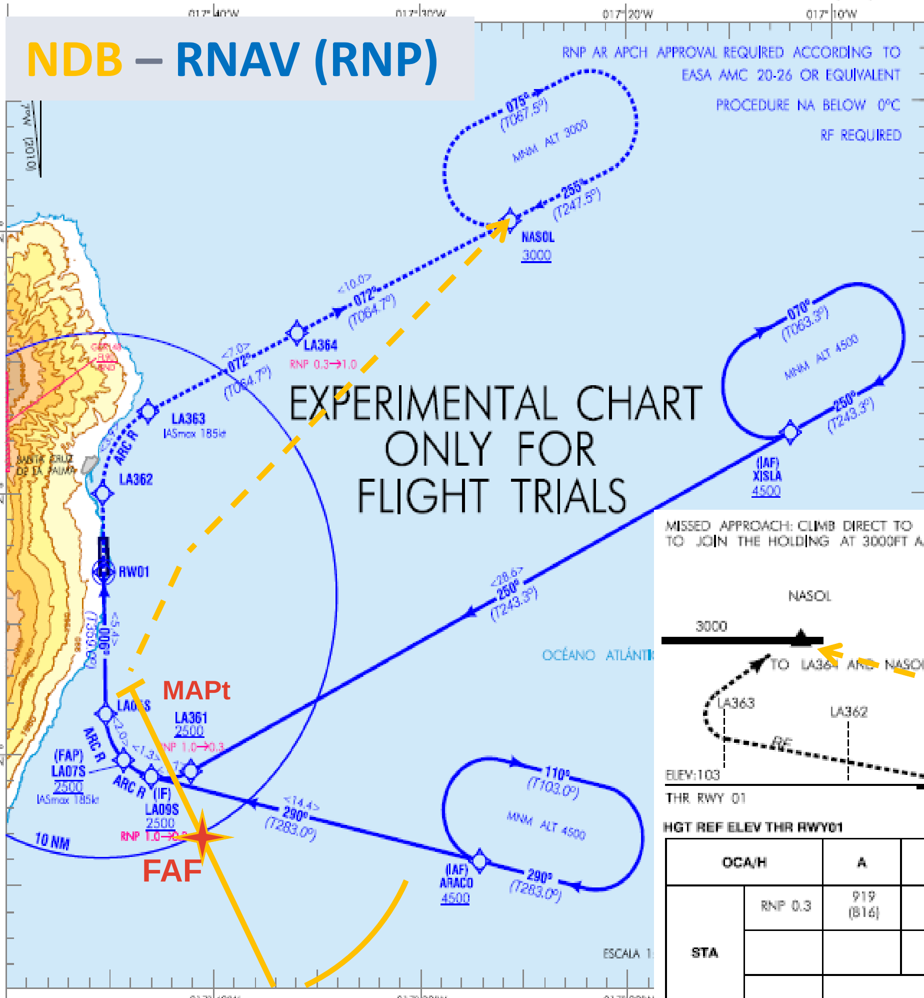
GCLA RNAV (RNP) RWY 01

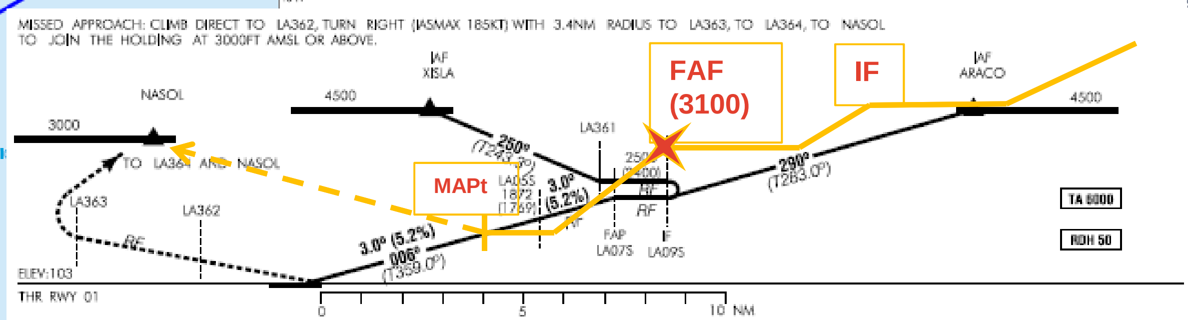
SESAR - LOT1, AIRE CANARIAS PROJECT PROPOSAL
INSTRUMENT APPROACH CHART - ICAO

ELEV AD 107

APP	126.100
TWR	118.900
GMC	121.800

LA PALMA
IATM-13-DTC-001-2.0 V2
RNAV (RNP) RWY01





HGT REF ELEV THR RWY01

OCA/H		A	B	C	D
STA	RNP 0.1	509 (406)	521 (418)	529 (426)	540 (437)
	RNP 0.3	919 (816)	931 (828)	939 (836)	950 (847)
En circuito (H) sobre 107		1780 (1680)	2070 (1970)	2190 (2090)	2860 (2760)

CAT C Minima cut by 700ft

HGT REF ELEV THR RWY01

OCA/H		A	B	C	D
STA	RNP 0.3	919 (816)	931 (828)	939 (836)	950 (847)
En circuito (H) sobre 107		1780 (1680)	2070 (1970)	2190 (2090)	2860 (2760)

GS	kt	80	100	120	140	160	180
FAF-THR: 7.4NM	min:s	5.32	4.25	3.41	3.10	2.46	2.27
FAF-MAPT:	min:s						
ROD: 5,2%	ft/min	425	531	637	743	849	956

AUTHORIZATION REQUIRED

ALT/HGT RWY01 FNA							
8 DME	7 DME	6 DME	5 DME	4 DME	3 DME	2 DME	1 DME
	2390 (2290)	2070 (1970)	1750 (1650)	1430 (1330)	1110 (1010)	790 (690)	

AENA -Departamento de Espacio Aéreo, Medio Ambiente y SS.AA.

PROPOSAL (14/06/13)

CCO/CDO benefits:

- ✓ Lower pilot/controller workload
- ✓ Shorter time in sector
- ✓ Improved safety
- ✓ Improved flight predictability and containment
- ✓ Reduced radio transmission
- ✓ Reduced chance of readback / hearback errors
- ✓ Reduced fuel consumption
- ✓ Increased throughput
- ✓ Reduced departure delays
- ✓ More departure lanes and exit points to the en route airspace

Successful CCO/CDO implementation requires joining a number of disciplines including:

- ✓ Previous CCO/CDO design experience
- ✓ Previous CCO/CDO ATC implementation experience
- ✓ ATM CCO/CDO implementation experience
- ✓ PBN Airspace design knowledge
- ✓ Pilot, Aircraft, and Airframe performance knowledge