PBN

RVSM / NAT HLA

Approach Guidance Mode

LVO

RNP AR approval

RNP(VPT) concept

Regional Seminar on MMEL/MEL and Special Operations

[Airbus Amber]

Organized by ICAO Regional Office for Western and Central Africa (WACAF)

Dakar - Senegal - from 30 June to 5 July 2025

PBN (Performance Based Navigation)

Julien BERNAGE, AIRBUS Approach and Navigation Flight Ops specialist

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#1 Aircraft Navigation
From Conventional to PBN

#2 PBN Concept

#3 Aircraft Documentation

#4 Aircraft Design


[Airbus Amber]
#1
Aircraft Navigation
From Conventional to PBN
1920
1930
1970‘s
1980‘s
1990‘s
2000‘s
Now

1920- First Step toward Instrumental flight

1923
Aeronautical lighthouse

First NAVAID at night!

1920 - 1930 The pioneers of instrumental flight

1929 First instrumental flight

- **1929**
  First Instrumental flight by Jimmy Doolittle
- **1930's**
  ILS, gonio, NDB, VOR...
- **1938**
  First ILS approach

First ILS

ILS: Instrument Landing System
NDB: Non Directional Beacon
VOR: VHF Omni Range

#1 Aircraft Navigation
From Conventional to PBN

1920
1930

1970‘s

1980‘s

1990‘s

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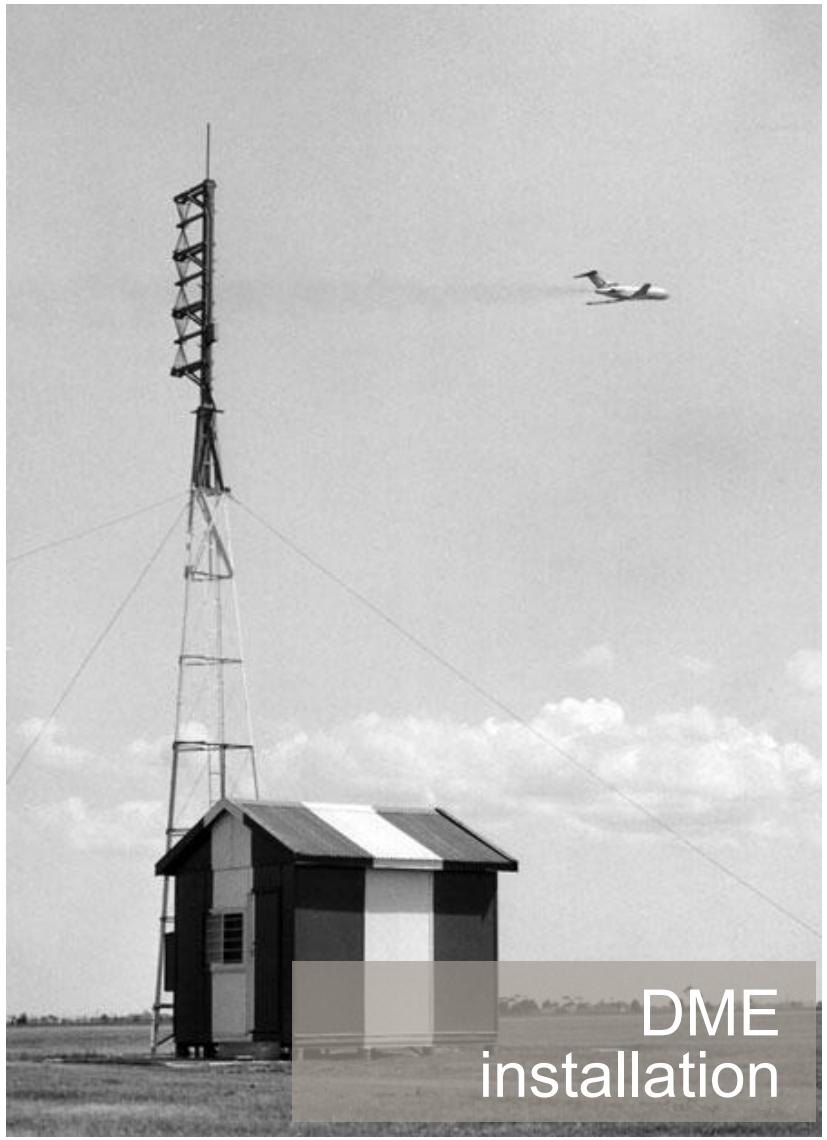
Up to 1970's- ILS and NAVAIDs era



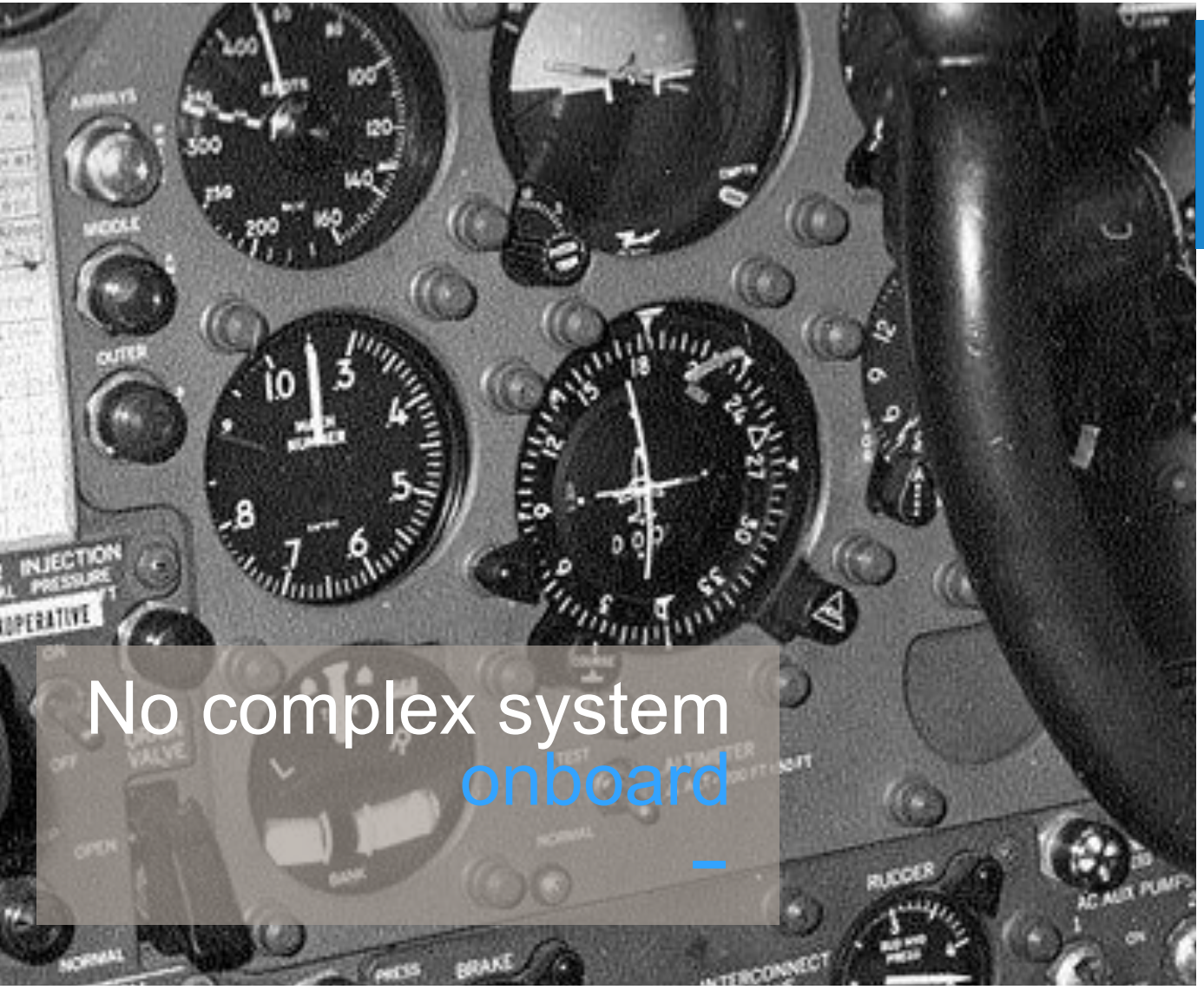
DME installation

Based on ground facilities

VOR installation

DME: Distance Measurement Equipment
VOR: VHF Omni Range

Up to 1970's- ILS and NAVAIDs era



No complex system onboard

Based on ground facilities

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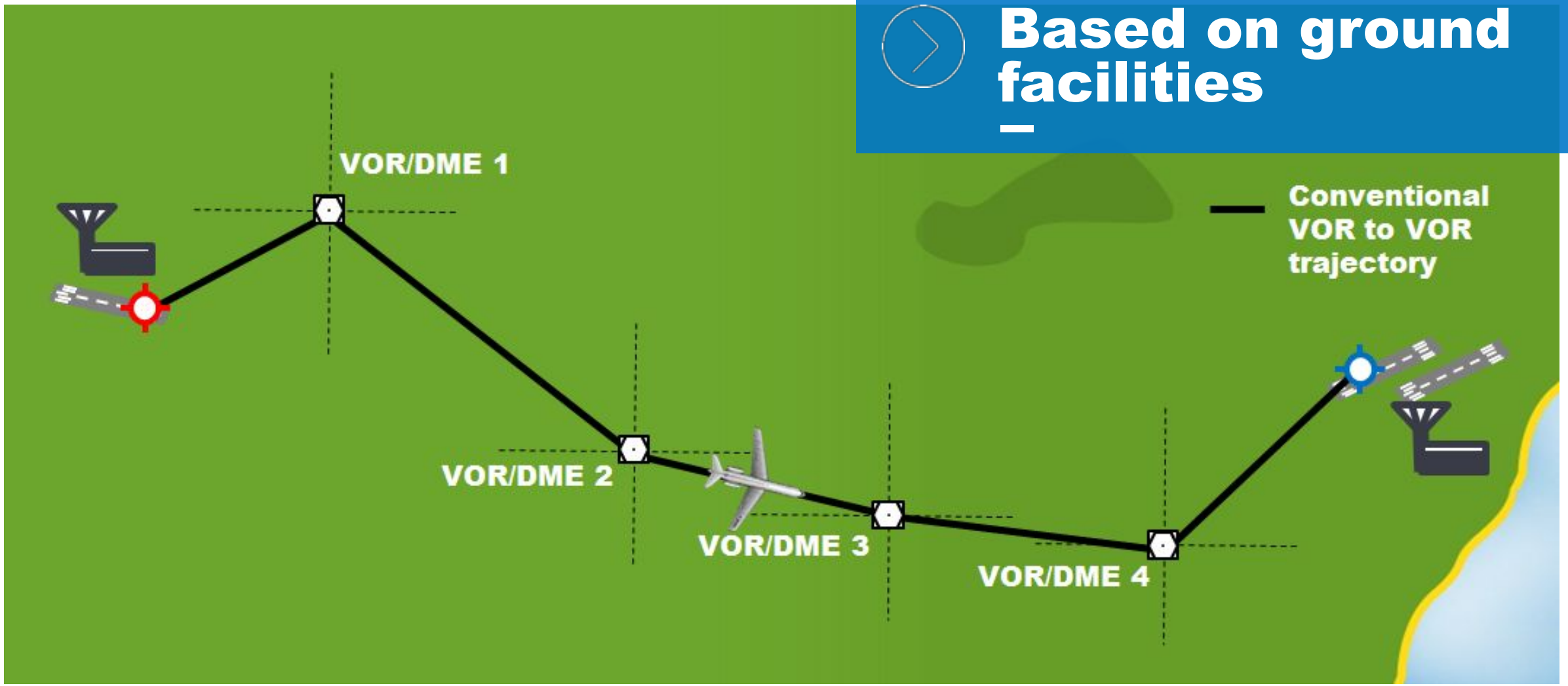
Up to 1970's- ILS and NAVAIDs era

Based on ground facilities



DME: Distance Measurement Equipment
VOR: VHF Omni Range

#1 Aircraft Navigation
From Conventional to PBN

1920
1930

1970‘s

1980‘s

1990‘s

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1980’s - The Flight Management System and Inertial Reference System

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FMS+IRS: revolution in the cockpit

- **A/C position and Navigation Display**
  Map with Flight Plan and A/C symbol
- **Distance to threshold**
  Altitude distance checks
- **RNAV (area navigation) concept**
  Waypoints in coordinate
- **Lateral guidance on FPLN**
  Approach coded in Nav DataBase, selection
- **RNAV approach with Vertical Guidance**
  in Barometric

RNAV: aRea NAVigation

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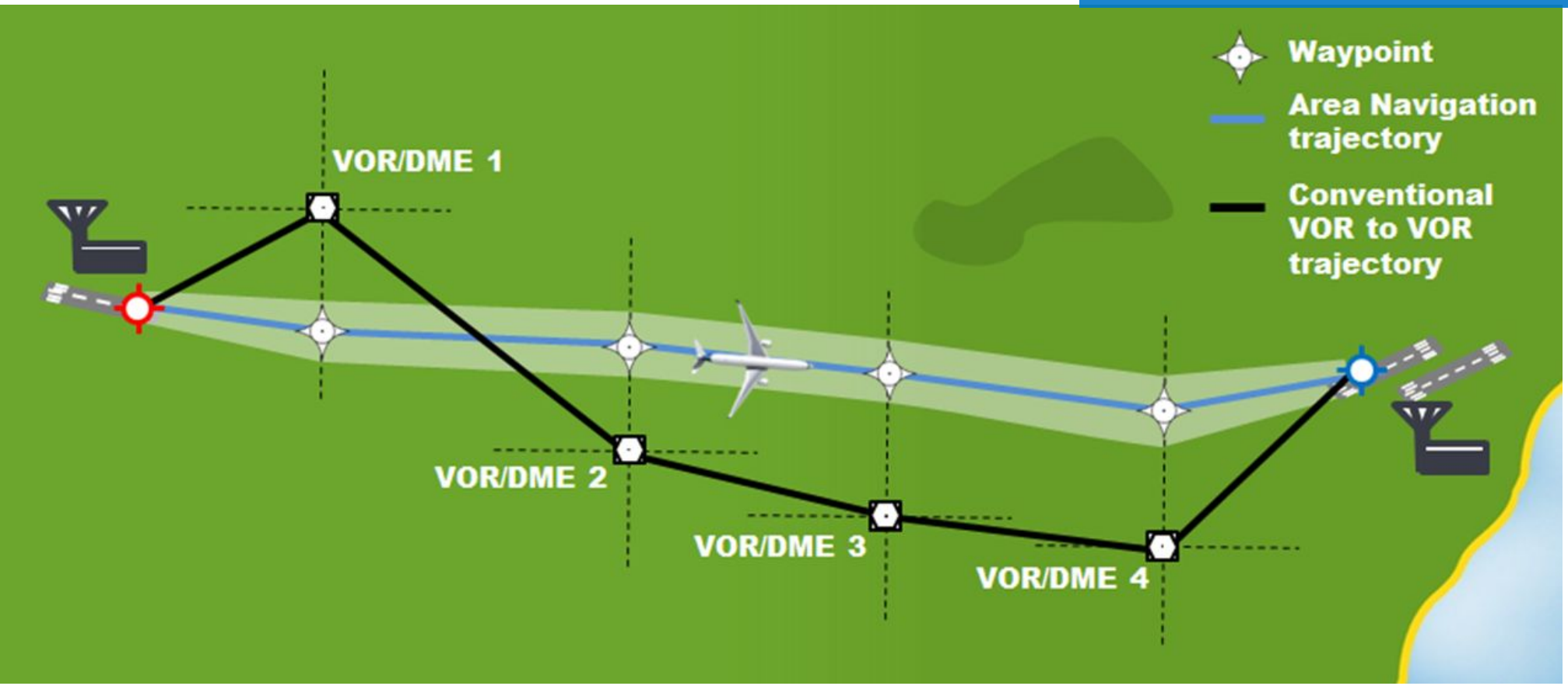
1980’s - The Flight Management System and Inertial Reference System

FMS+IRS: revolution in the cockpit



#1 Aircraft Navigation
From Conventional to PBN

1920
1930

1970‘s

1980‘s

1990‘s

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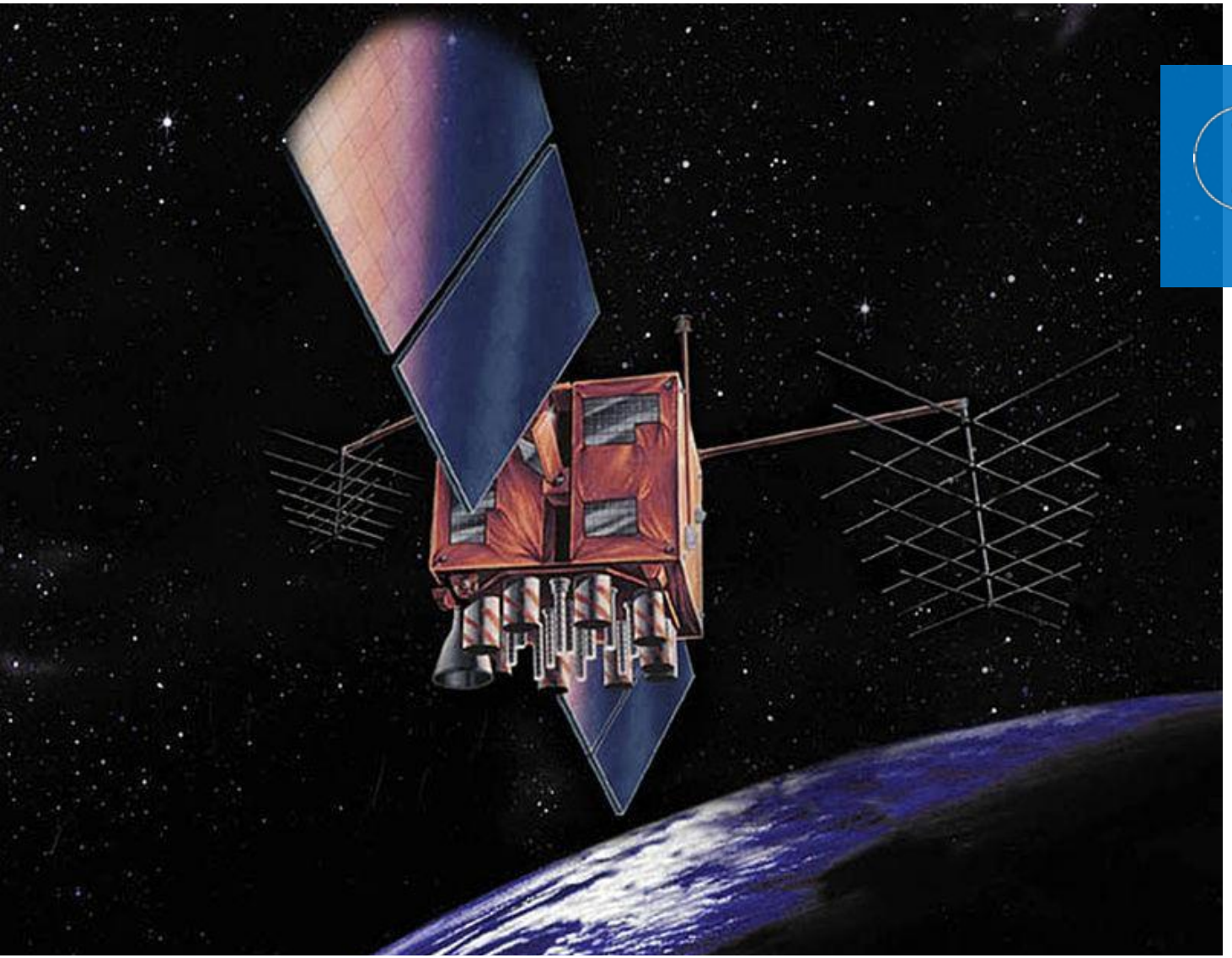
1990’s - The GNSS – Global Navigation Satellite System



Bring accuracy and integrity on position

- **PBN concept**
  the Navigation Performance

PBN: Performance Based Navigation
RNP AR: required Navigation Performance with Authorization required

#2 PBN Concept

Objectives Basics PBN Operations

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RNP objectives

Give access to remote areas

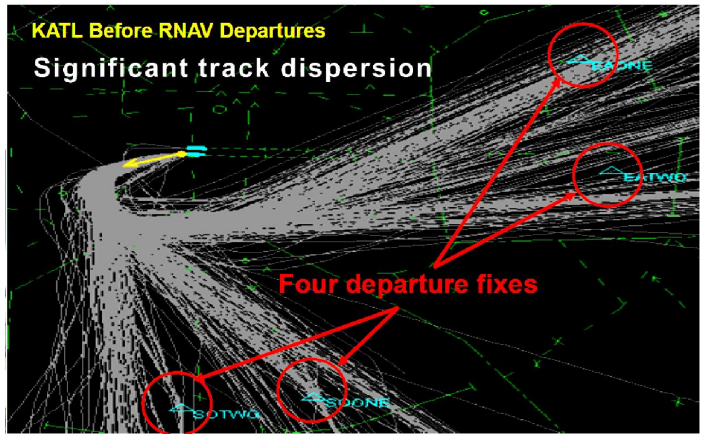
PBN in terminal Area to face congested airspace

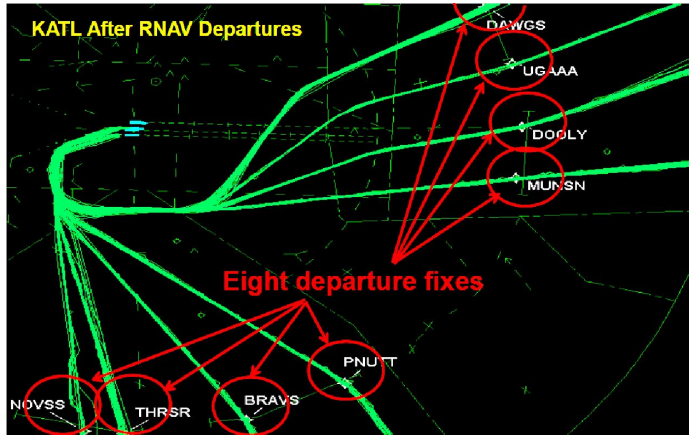
Advantages of PBN for ANSP

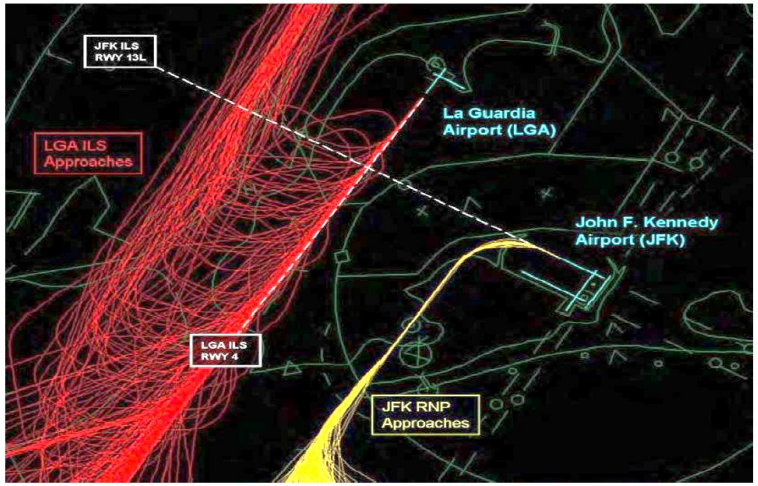
- **Independent routes**
  Not based from NAVAIDs location

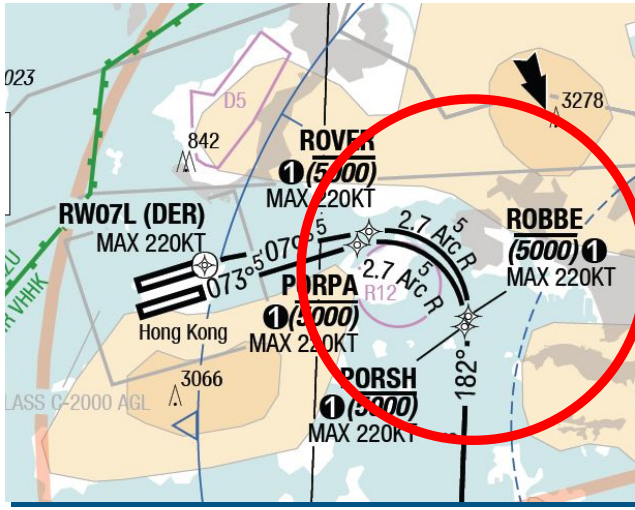
- **Fully coded route**
  NDB

- **Lateral & Vertical "containment"**
  - Reduction of the separations
  - Solution for traffic segregations between 2 airports
  - Noise sensitive area avoidance









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#2 PBN Concept

Objectives Basics PBN Operations

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PBN Concept: Positioning

Performance Based Navigation

Performance of the navigation system

Characterize the position error

PBN Concept: Positioning

TSE: Total System Error

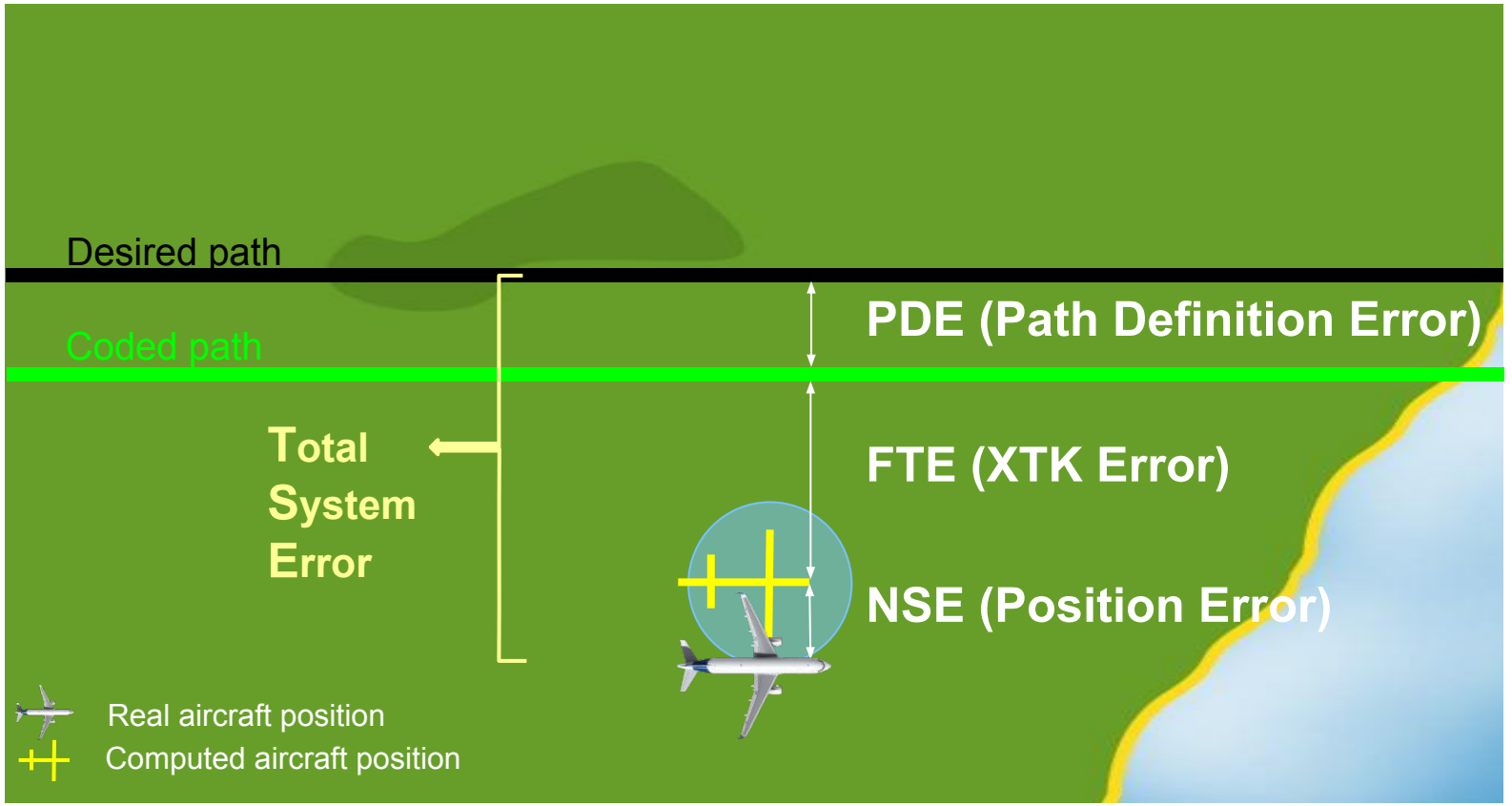
PDE: Path Definition Error
From NDB coding

+

FTE: Flight technical Error
From Cross Track

+

NSE: Navigation System Error
From position computation



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PBN Concept: Design of a RNP or RNAV procedure

- **On-board position error estimated**

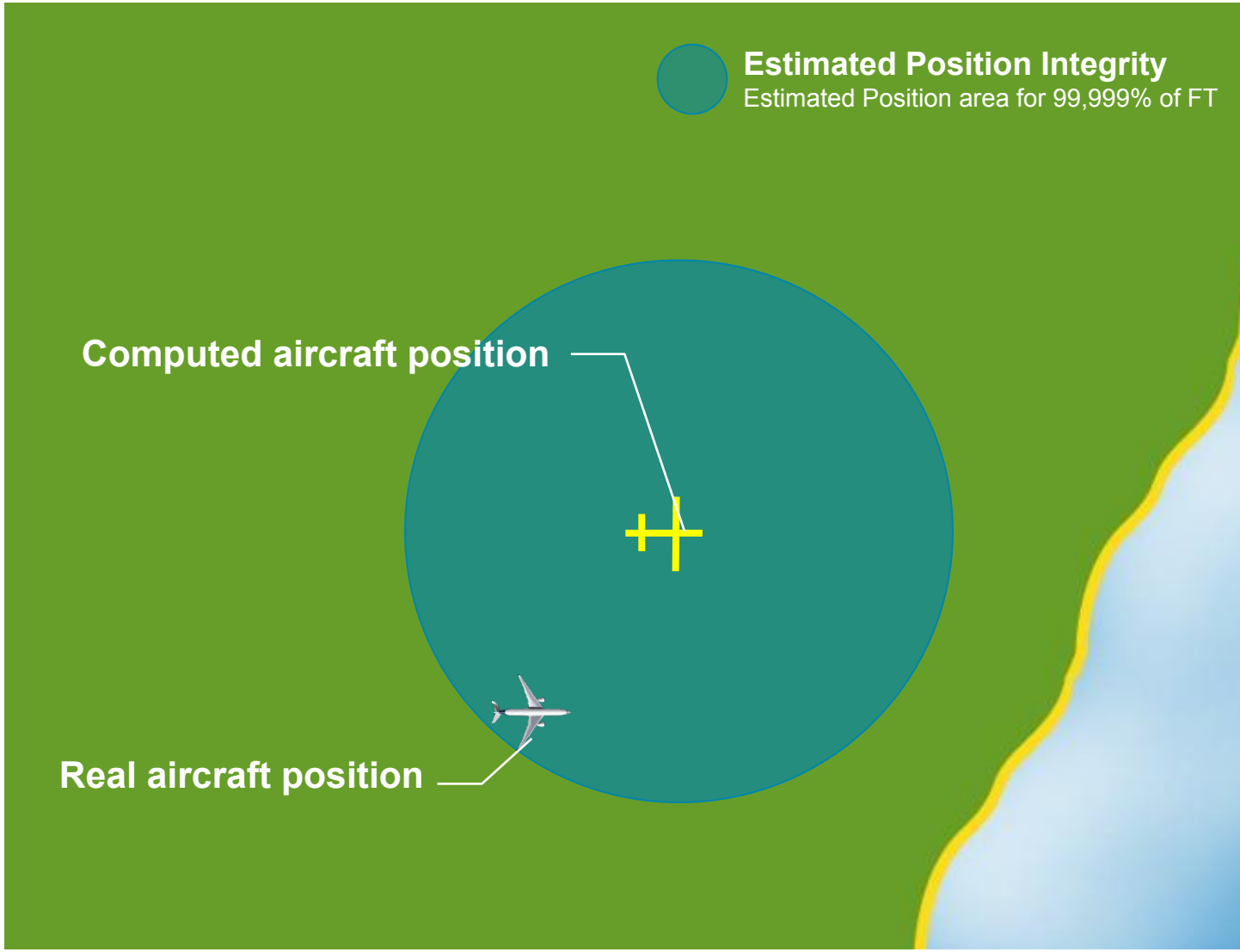
  Accuracy

PBN Concept: Design of a RNP or RNAV procedure

- **On-board position error estimated**

Accuracy

Integrity



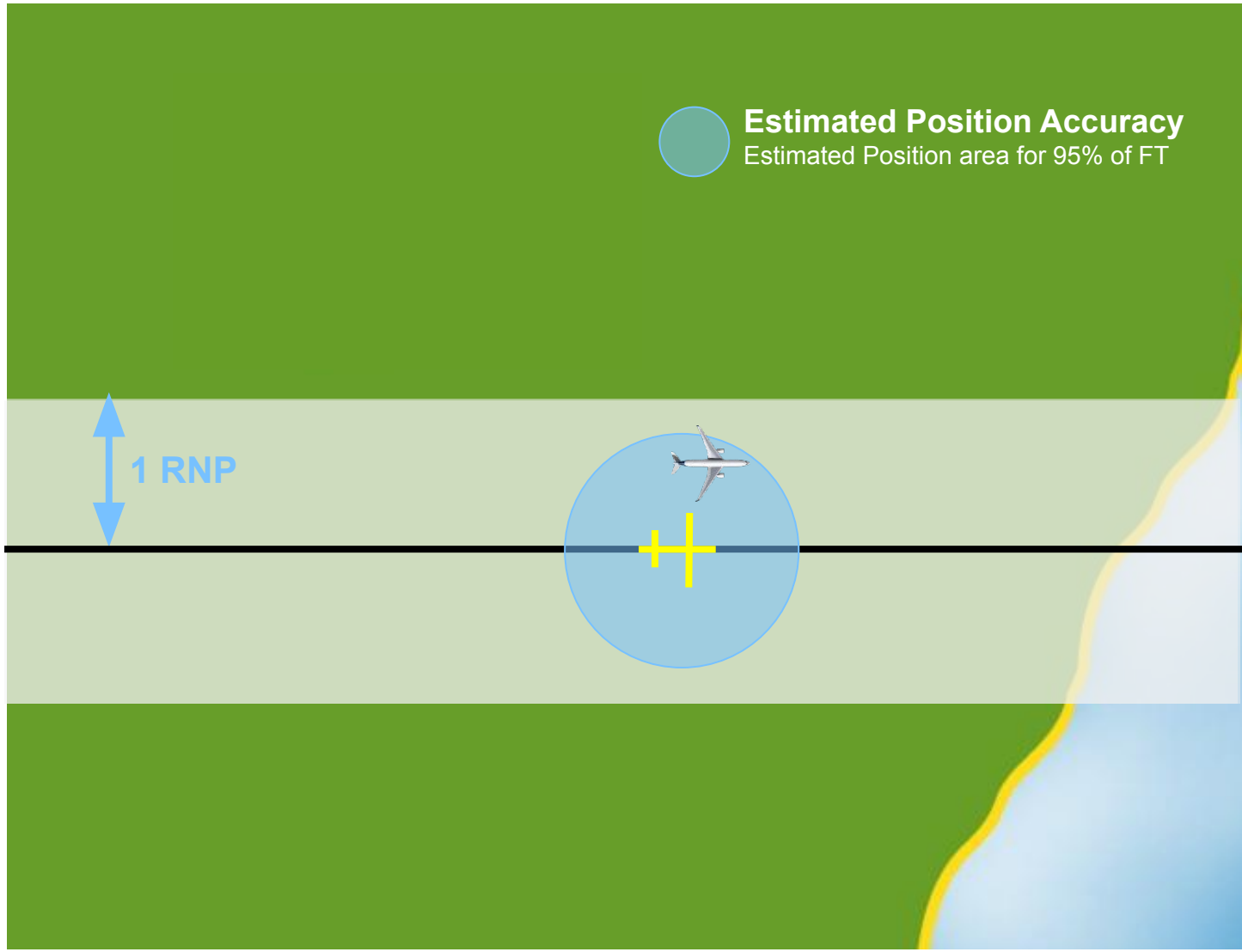
PBN Concept: Performance Criteria

- **Accuracy criteria**

TSE 95 % < 1 RNP

Under normal condition

A/C position inside 2 RNP corridor
95% of flight time



PBN Concept: Performance Criteria

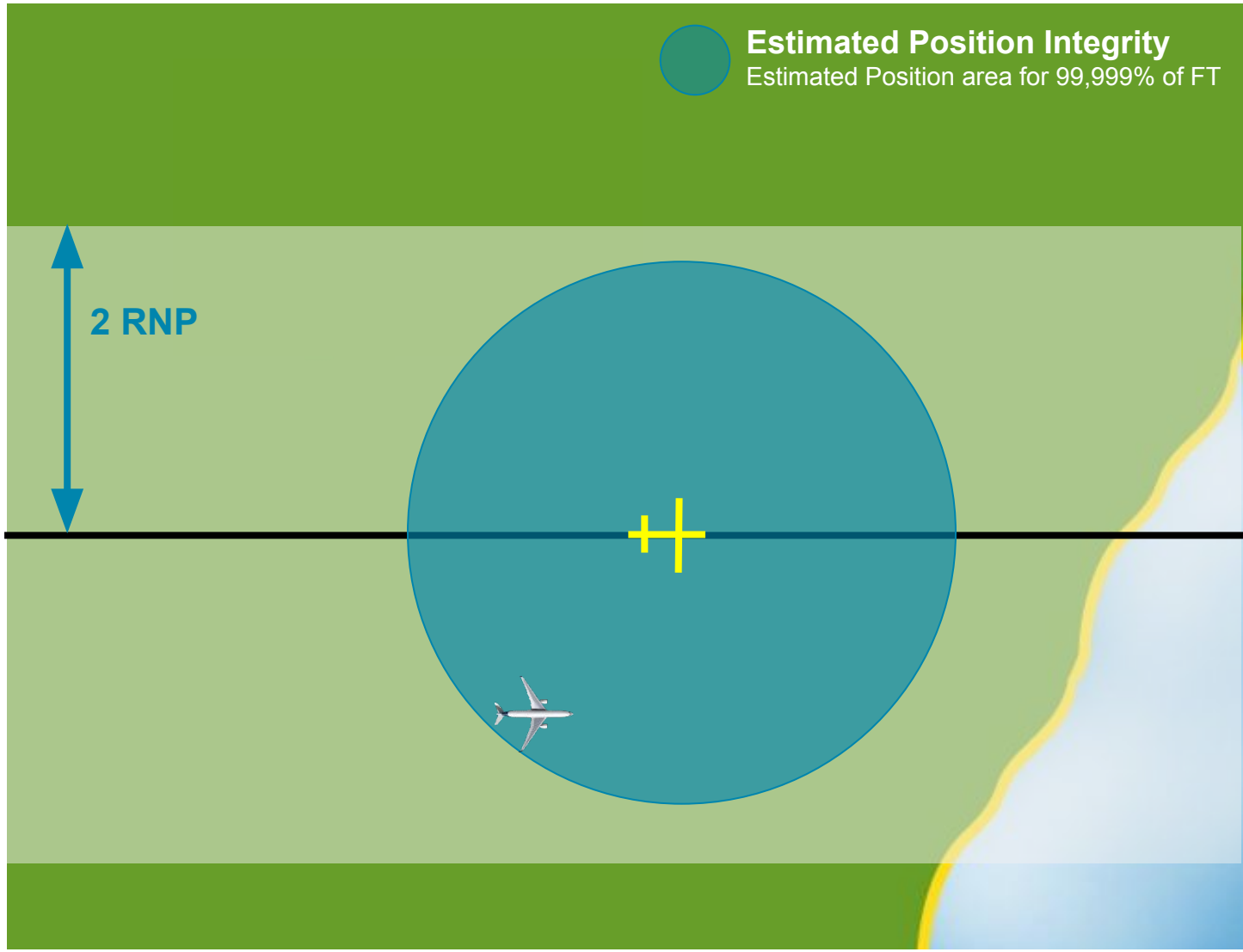
- **Integrity criteria**

TSE 99.999% < 2 RNP

A/C position inside 4 RNP corridor 99.999% of flight time

Demonstration considering probable failure

- Guidance failures impact on FTE
- Navigation failures impact on NSE



PBN Concept

- **Procedure Design**

Corridor 2 RNP each side of the A/C

Buffers

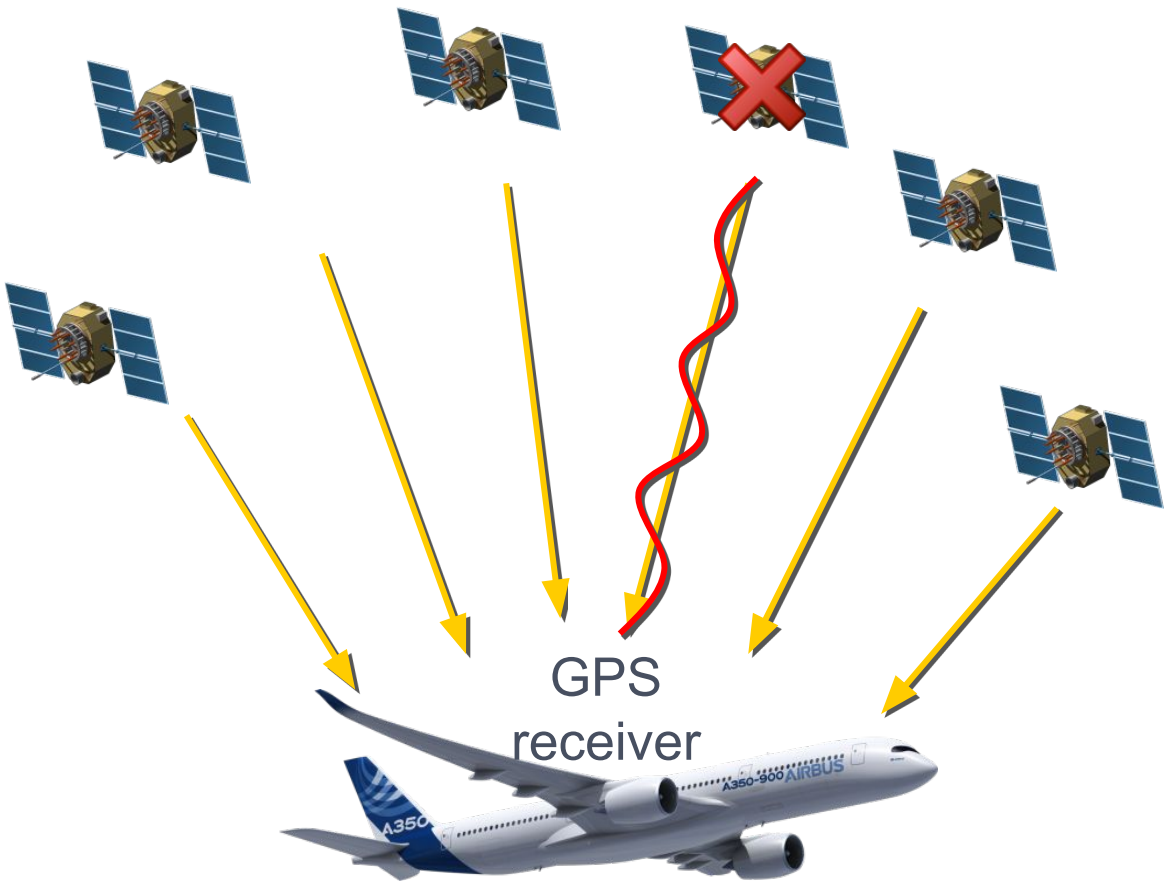
Obstacle or other airspace outside

NOT a corridor where the aircraft can fly !
But limit that a/c computed position must not exceed.

The GNSS – Global Navigation Satellite System

- GNSS Position
- Accuracy parameter
- Integrity parameter

Integrity Augmentation: RAIM algorithm



4 satellites ⇨ NAV position

Min 5 satellites ⇨ FD

Min 6 satellites ⇨ FDE

RAIM ⇨ Integrity & Warning

Integrity parameter ⛓ **Number of Satellites**

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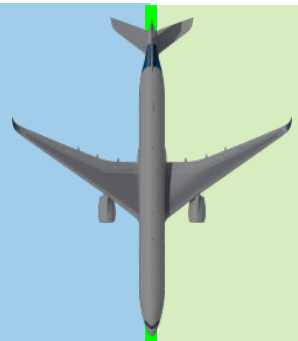
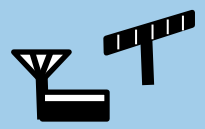


External Monitoring
ATC (mode S, ADS-B, ….)



RNAV

On-Board Monitoring
TSE

NSE
Accuracy
Integrity

NAV ACCURACY
GPS PRIMARY

FTE
XTK

OBPMA

RNP

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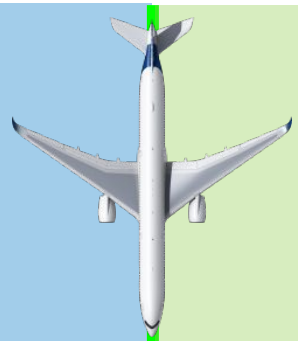

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External Monitoring
ATC (mode S, ADS-B, ….)

On-Board Monitoring
TSE

NSE
Accuracy
Integrity

NAV ACCURACY
GPS PRIMARY

FTE
XTK

OBPMA

On-Board Monitoring
OBPMA

RNAV

RNP

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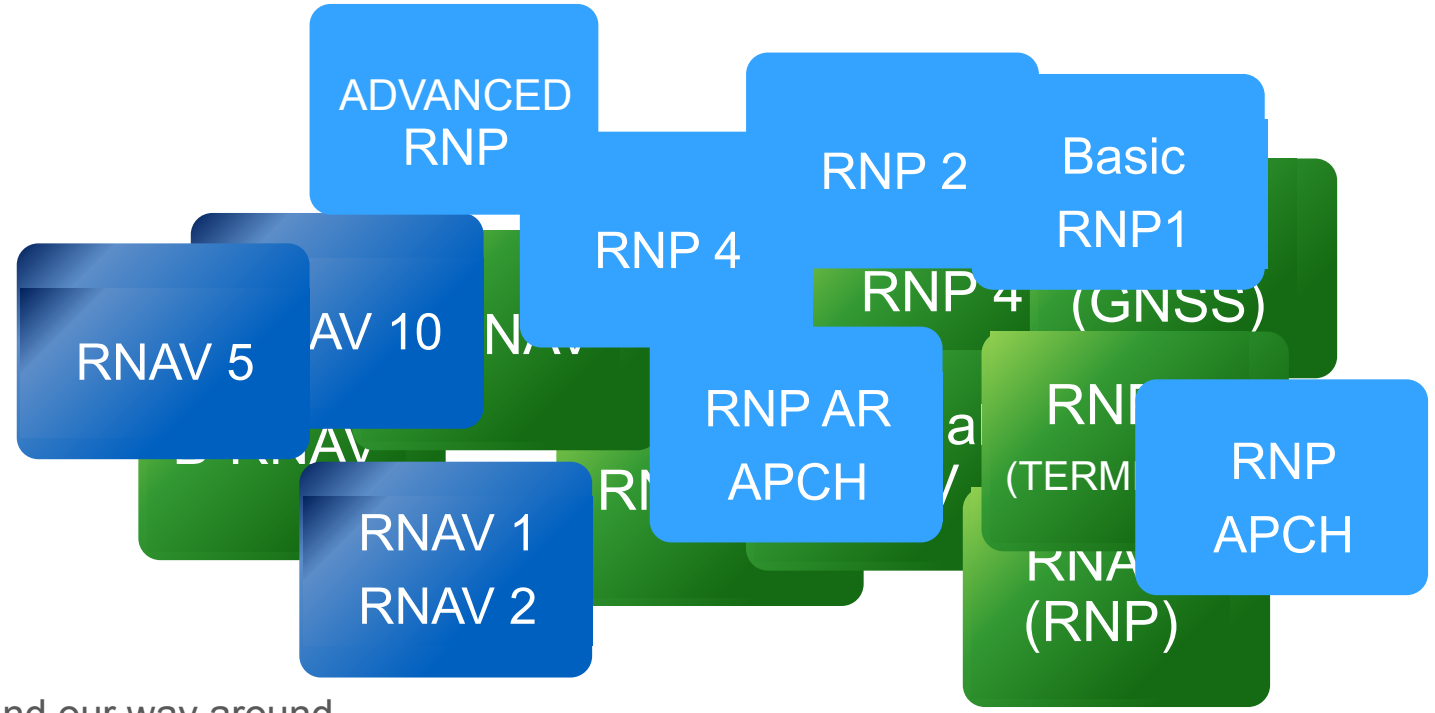
Lot of different operations and names



- Difficult to find our way around

ICAO PBN MANUAL (Doc 9613) PANS-OPS (Doc 8168)

Navigation Specification	Navigation Accuracy (NM) per flight phase						
	En-route		Terminal	Approach			Departure
	Oceanic Remote	Continental		Initial Interm.	Final	Missed	
RNAV 10 (RNP 10)	10						
RNAV 5		5	5				
RNAV 2		2	2				2
RNAV 1		1	1	1		1	1
RNP 4	4						
RNP 2	2	2					
RNP 1			1	1		1	1
RNP APCH				1	0.3 or angular	1	
RNP AR APCH				1-0.1	0.3-0.1	1-0.1	

PBN Standard

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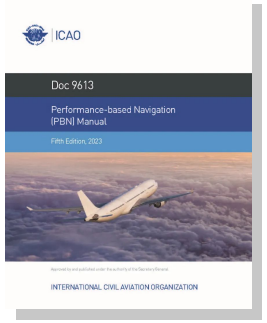
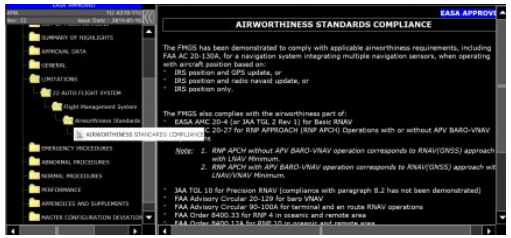
PBN Manual and Airbus documentation



NOT a regulatory guidance
Standard and recommended practices

A/C compliant to FAA or EASA regulations



Operational documentation (AFM/FCOM)
Statement of compliance with EASA or FAA regulation

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FAA and EASA regulations for PBN operations

operation	EASA regulation	FAA Regulation
RNAV 10	-	FAA Order 8400.12 / AC 90-105A / AC 20-138(D)
RNAV 5	AMC 20- 4 / CS-ACNS	AC 90-96
RNAV 2	-	AC 90-100(A)
RNAV 1	TGL 10	AC 90-100(A)
RNP 4	CS-ACNS	FAA Order 8300.33 / AC 90-105A / AC 20-138(D)
RNP 2	CS-ACNS	AC 90-105A / AC 20-138(D)
RNP 1	CS-ACNS	AC 90-105(A) / AC 20-138(D)
RNP APCH	AMC 20-27 / CS-ACNS	AC 90-105(A) / AC 20-138(D)
RNP APCH LPV	AMC 20-28 / CS-ACNS	AC 90-107
RNP AR	AMC 20-26 / CS-ACNS	AC 90-101(B) / AC 20-138(D)
A-RNP	CS-ACNS	AC 90-105A / AC 20-138(D)

#2 PBN Concept

Objectives Basics PBN Operations

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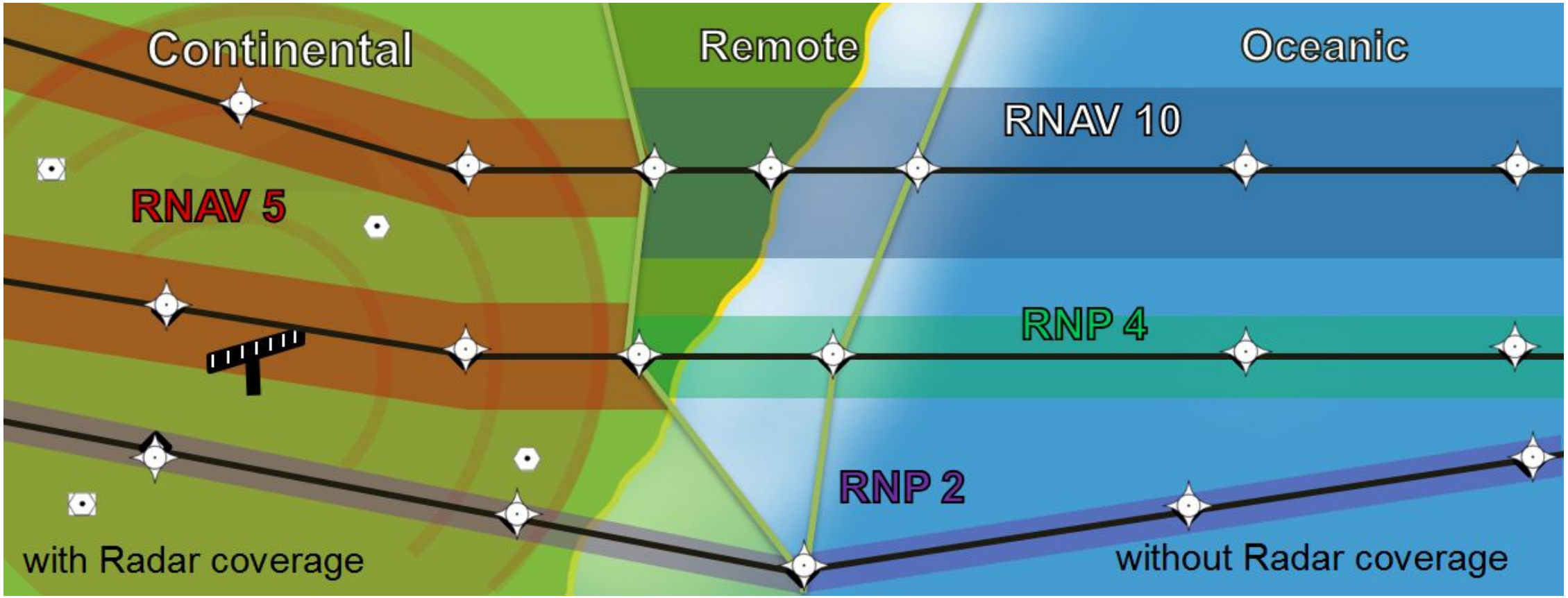
En Route Operations



Continental vs Remote/Oceanic area

Continental

- Radio Navaids coverage
- ATC monitoring (ADS-B Radar)

⇓

- Possibility to revert in Conventional radio, spacing under ATC responsibility
- No redundancy required
  ⇒ 1 RNAV system only

Remote and Oceanic

- No Radio Navaids coverage
- No ATC monitoring
  A/C autonomous

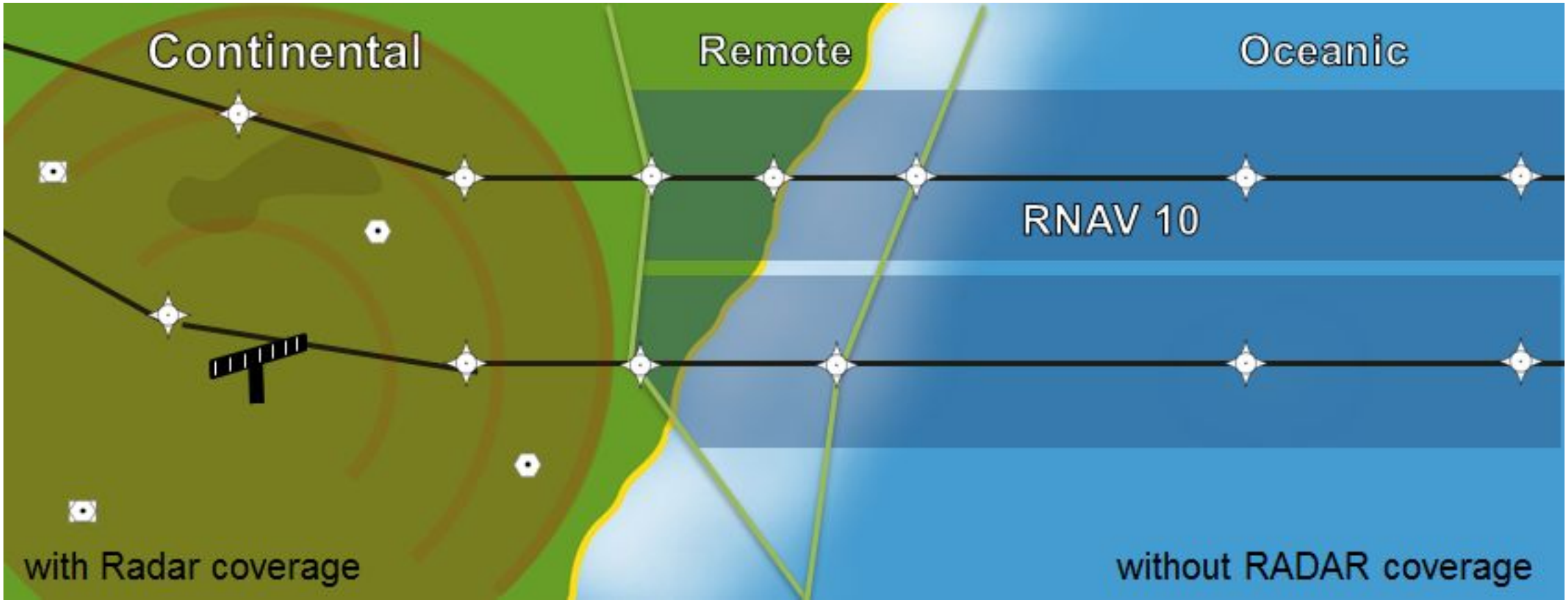
⇓

- No Possibility to revert in Conventional radio
- Redundancy required
  ⇒ 2 LRNS

En Route Operations

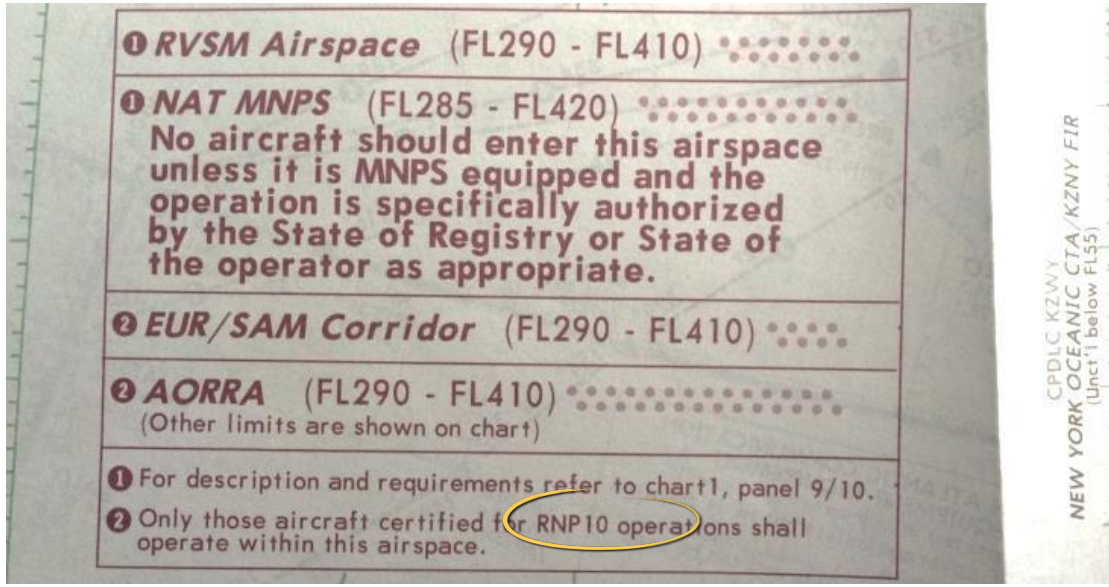
	ICAO Name	Other name	Airspace	Compliance
RNAV	RNAV 10	RNP 10	Remote	All
	RNAV 5	Basic RNAV	Continental	All
	RNAV 2	En Route RNAV	Continental	All
RNP	RNP 4		Remote	With GPS
	RNP 2	Continental RNP 2	Continental	With GPS
		Remote RNP 2	Remote	With GPS

En Route Operations: RNAV 10



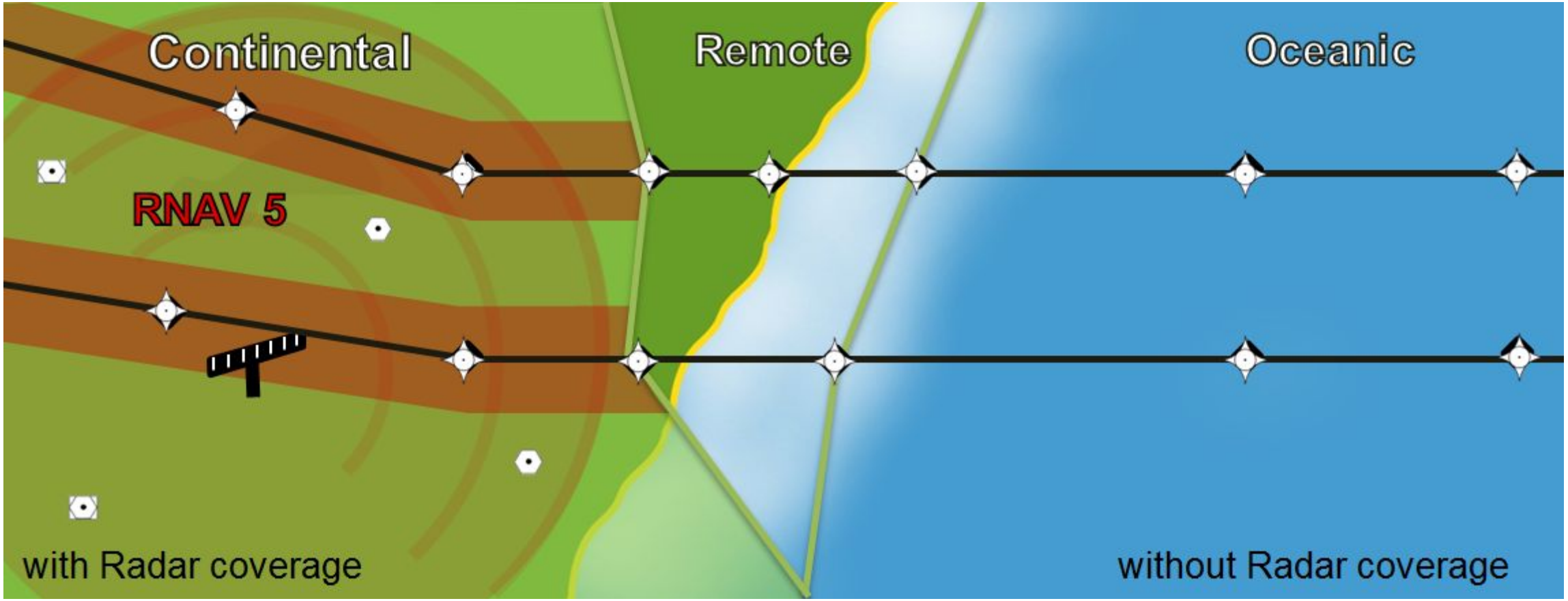
RNAV 10

- Operation called **RNP 10** (language abuse)
- **Enroute** and **Remote Area**
- **10 NM** RNP value
- **50NM / 50NM** separation minima



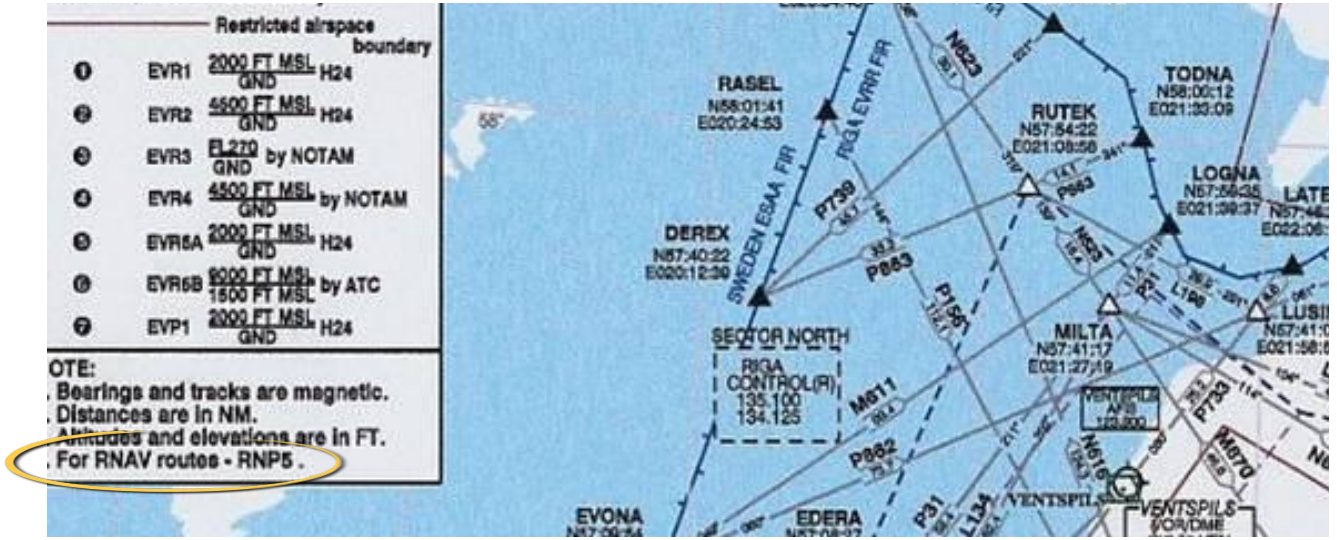
Regulation	Aircraft compliance
FAA order 8400.12 AC 90-105A app G	All Airbus A/C (except A300 family)
No regulation	

En Route Operations: RNAV 5



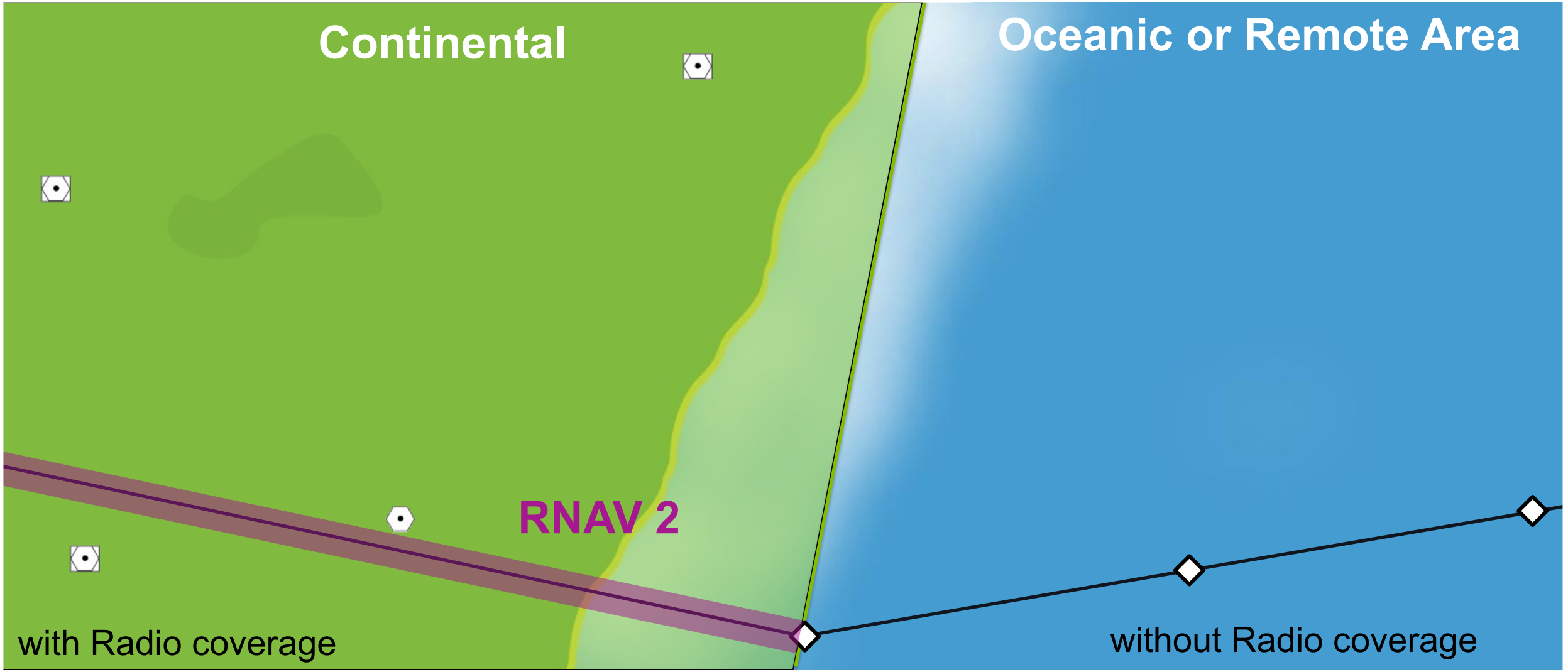
RNAV 5

- Operation called **B-RNAV**, **Basic RNAV** or **RNP 5**
- **Enroute** and **Continental** only in Europe
- **5 NM** RNP value



Regulation	Aircraft compliance
AC 90-96	All Airbus A/C
AMC 20-4 (old TGL2)	

En Route Operations

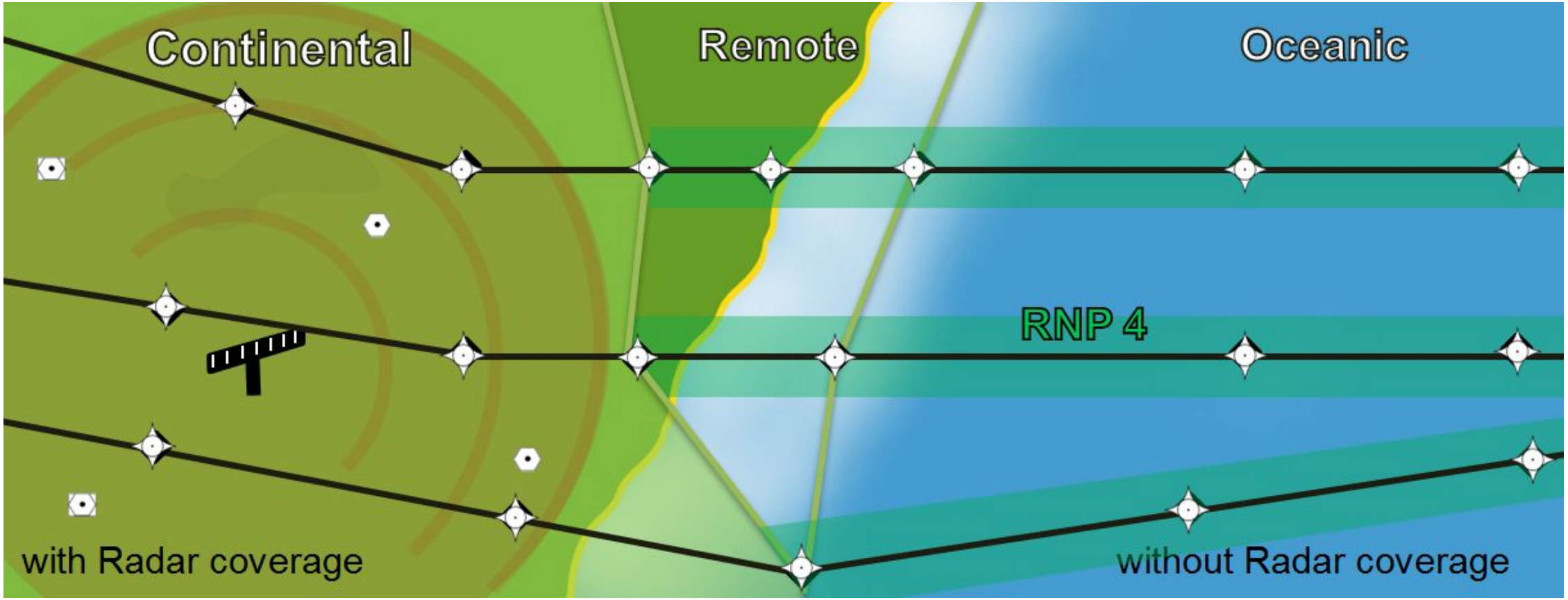


RNAV 2

- Operation called **Enroute RNAV**
- **Enroute** and **continental Airspace** only in US
- **2NM** RNP value

Regulation	Aircraft compliance
AC 90-100 No regulation	All Airbus A/C

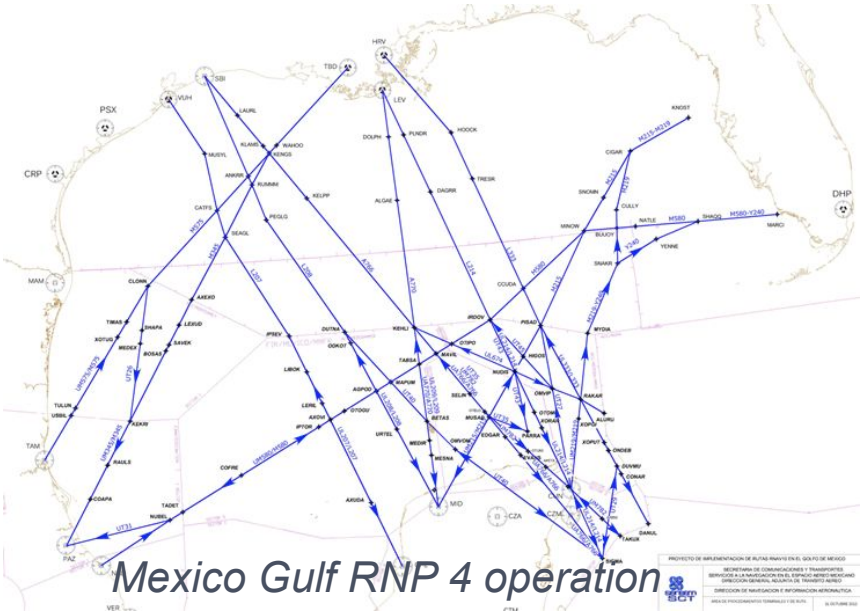
En Route Operations: RNP 4



RNP 4

- Operation called **RNP 4 Enroute**
- **Enroute and Remote Area**
- **4 NM** RNP value
- Supporting today **30NM/30NM** separation (also ADS C requested)

GPS mandatory



Mexico Gulf RNP 4 operation

Regulation	Aircraft compliance
FAA order 8400.33 AC 90-105A app F	All Airbus A/C with GPS (except A300 family)
CS-ACNS	

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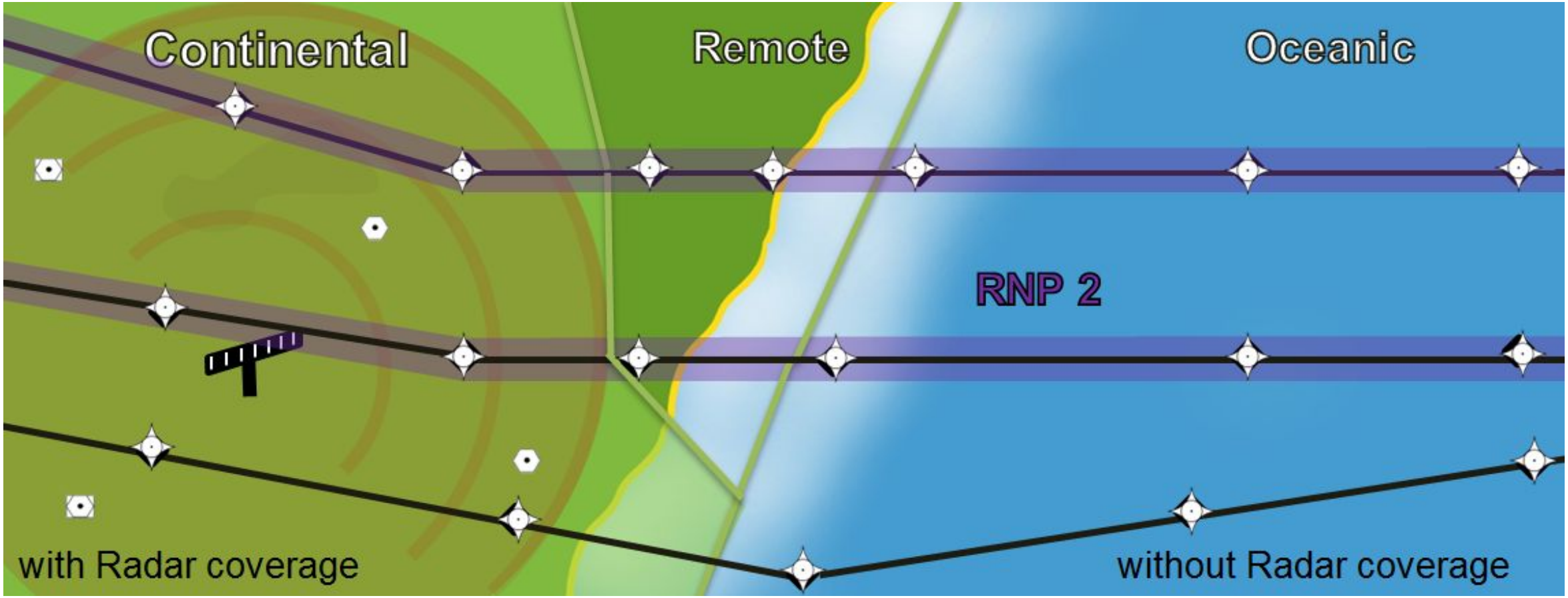
En Route Operations: RNP 2



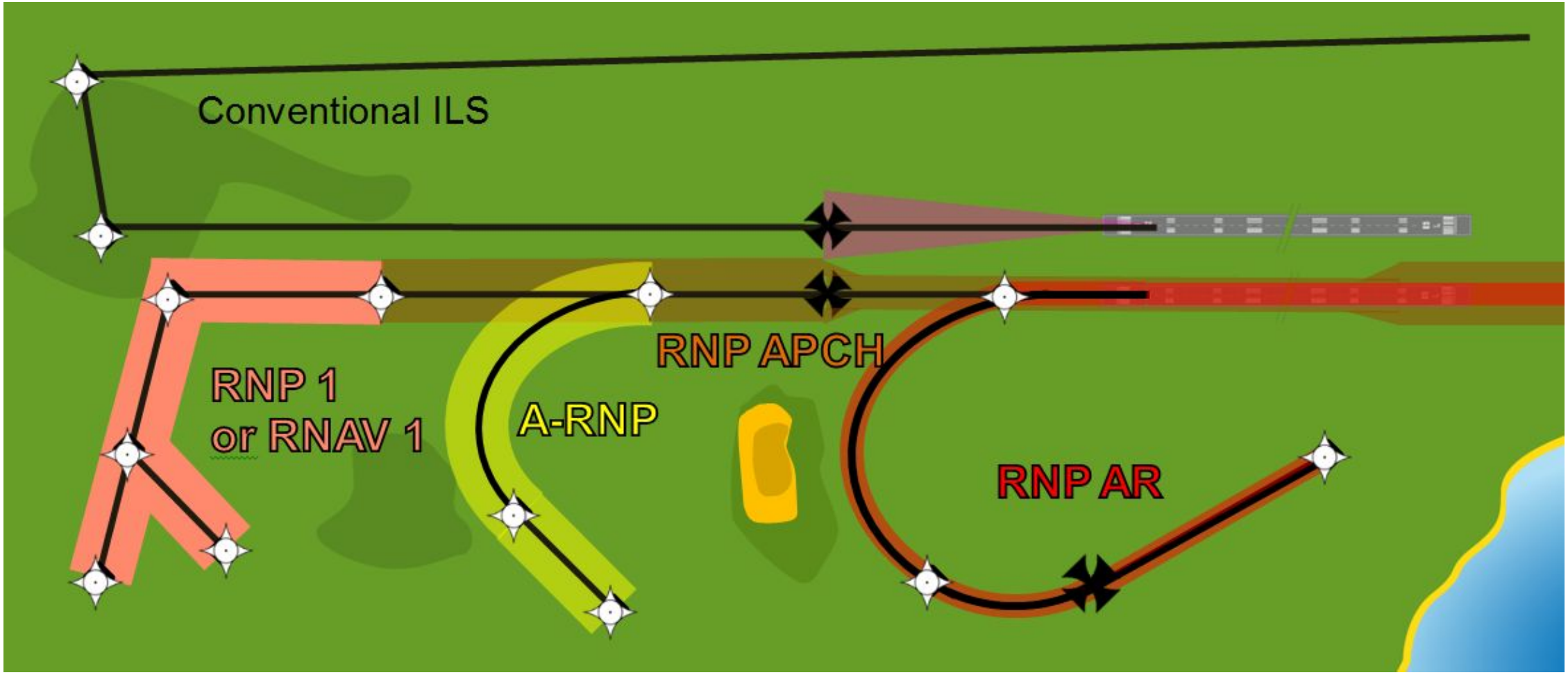
RNP 2

- **Enroute Operation** for **Continental** or **Remote Area**
- **2 NM** RNP value

GPS mandatory

Regulation	Aircraft compliance
AC 90-105A app E CS-ACNS	All Airbus A/C with FMS2 and GPS

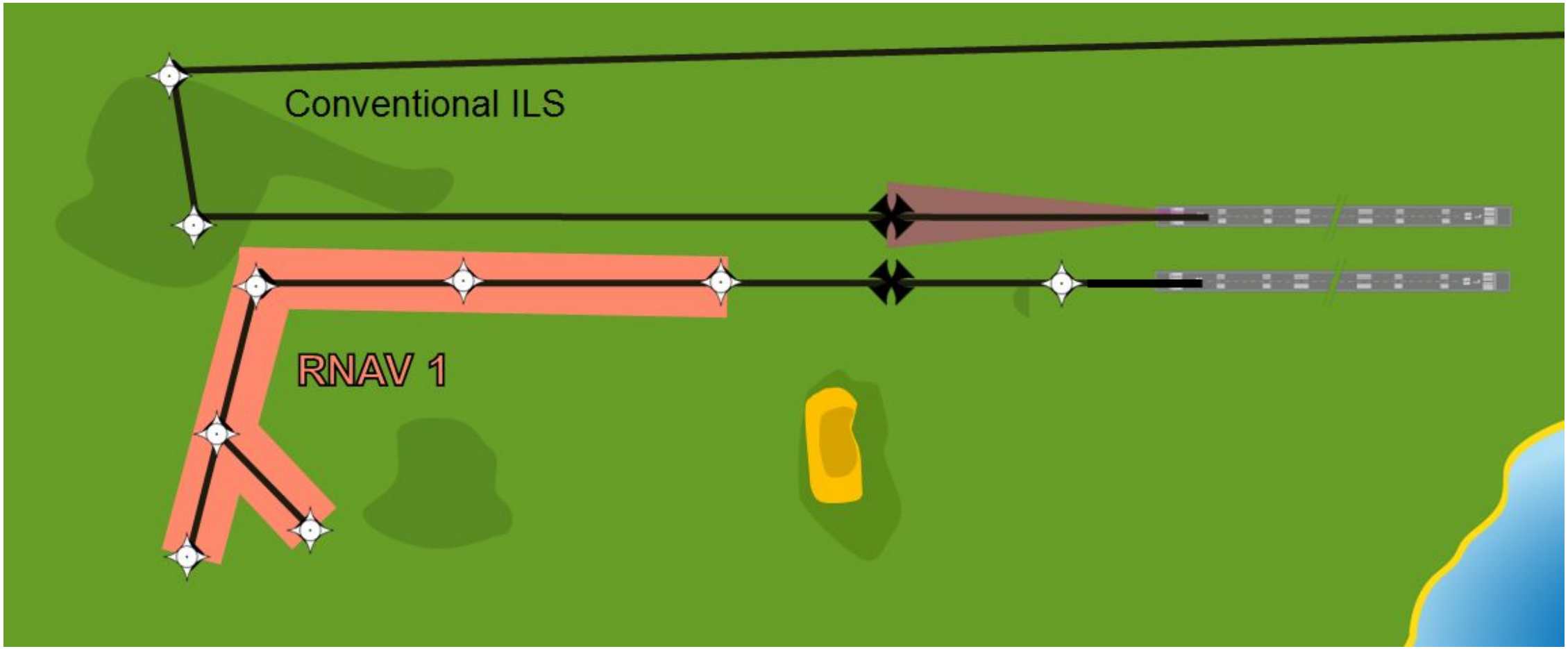
RNP in terminal area



Terminal Area Operations

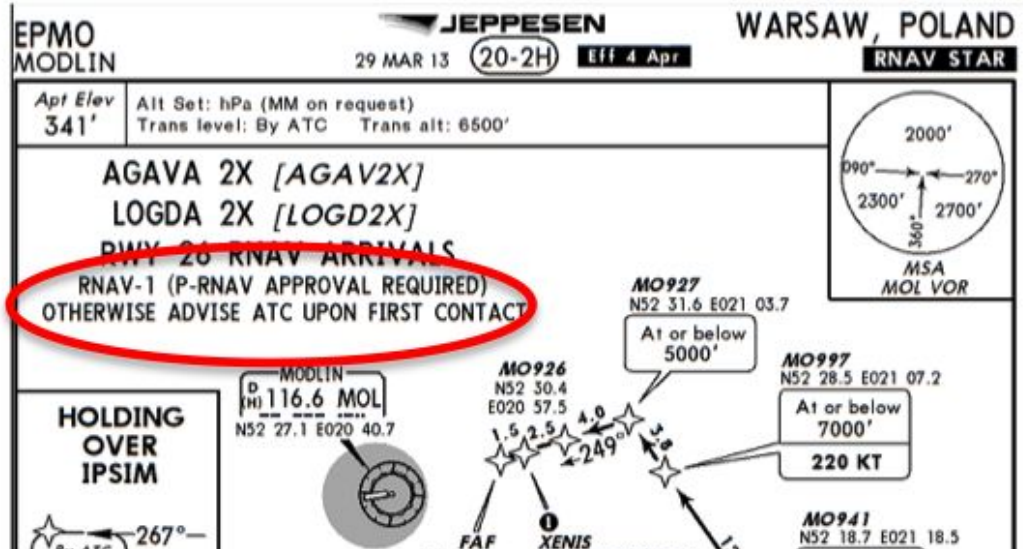
	ICAO Name	Other name		Compliance
SID / STAR	RNAV 1	Terminal RNAV P-RNAV		All
	RNP 1	Basic RNAV		With GPS
Approaches	RNP APCH	RNAV(GNSS) RNP	LNAV	With GPS
			LNAV/VNAV	With GPS
			LPV	With Dedicated MOD
	RNP AR	RNAV(RNP) RNP (AR)		With Dedicated MOD

RNAV 1



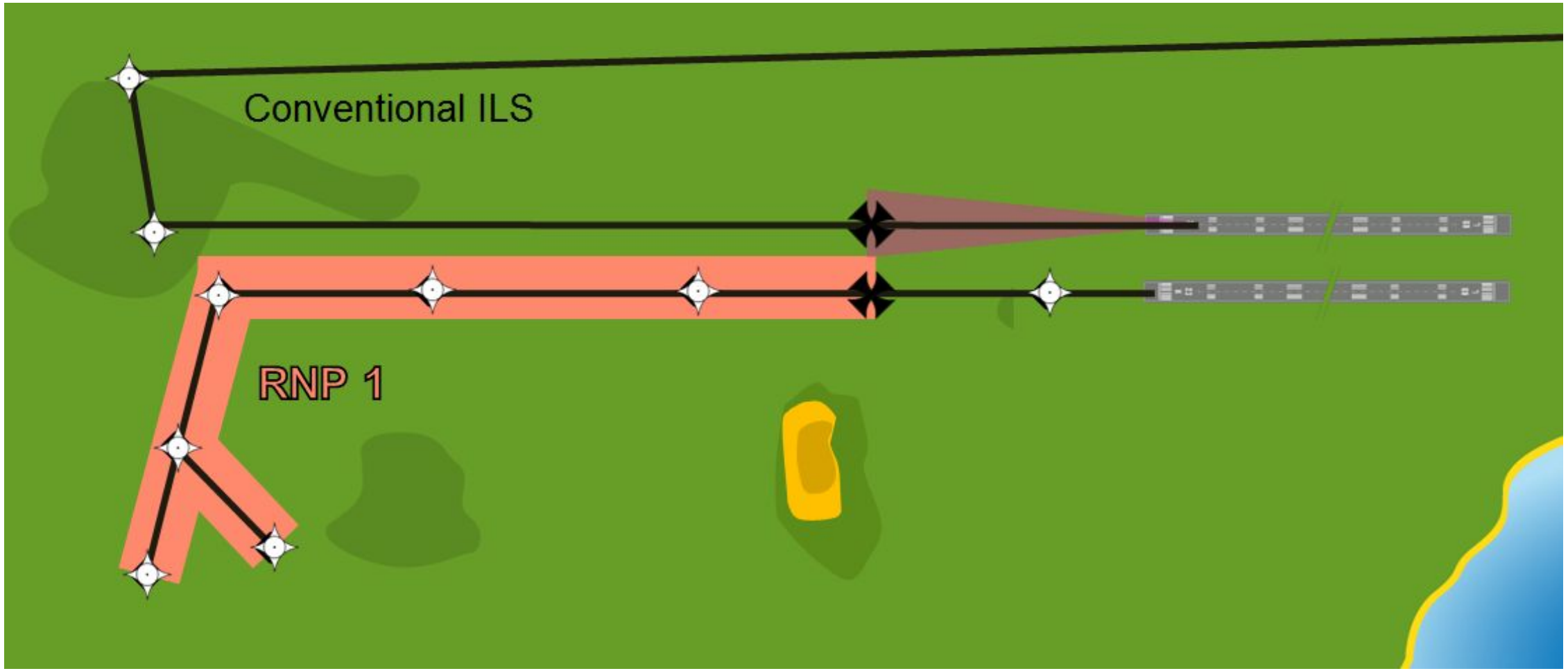
RNAV 1

- Operation called **Terminal RNAV** (USA) or **Precision RNAV** (Europe)
- **Terminal Airspace**: SIDs or STARs
- **1NM** RNP value



Regulation	Aircraft compliance
AC 90-100 TGL 10	All Airbus A/C

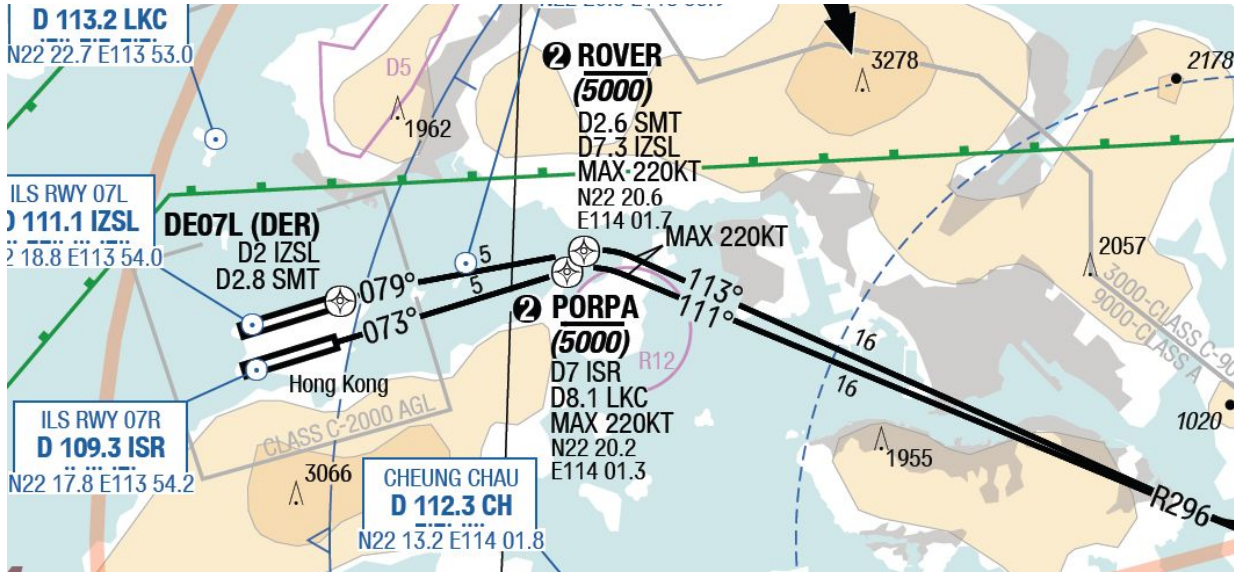
RNP 1



RNP 1

- Operation called **BRNP 1** or **Basic RNP1**
- **Terminal Airspace:** SIDs or STARs
- **1NM** RNP value

GPS mandatory

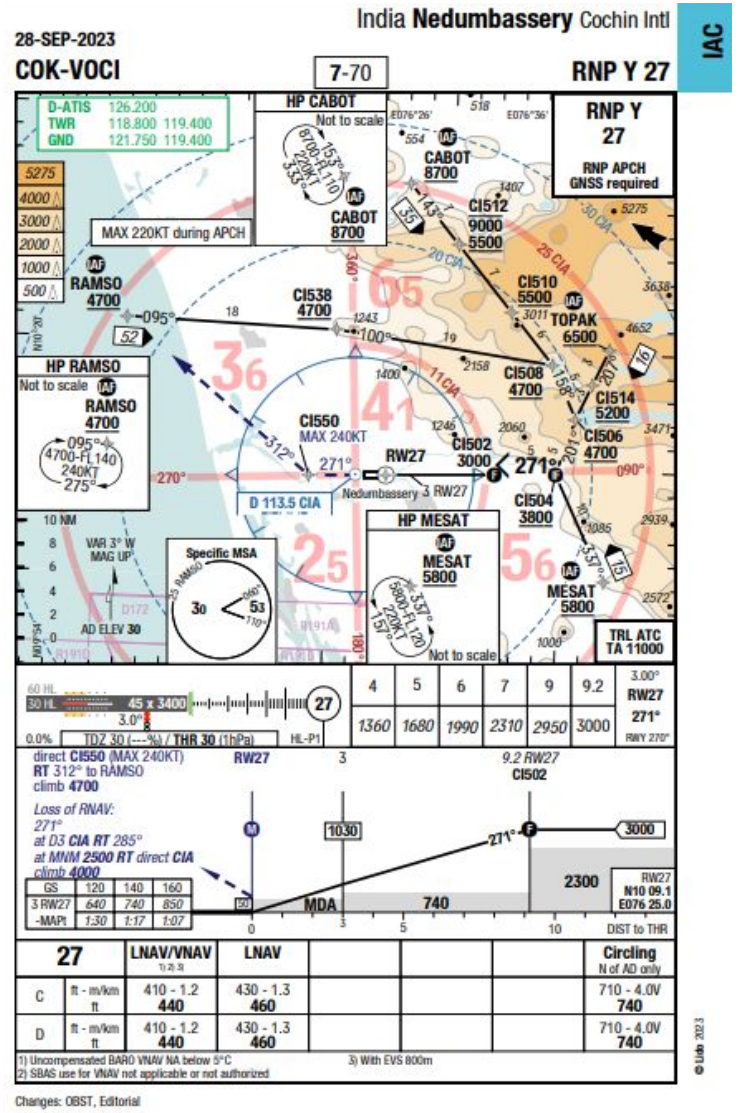


Regulation	Aircraft compliance
AC 90-105 AC 90-105A app C CS-ACNS	FMS2 + GPS FMS1+GPS: Mean of Compliance

RNP APCH concept

- **Overlay of existing procedure**
- **RNP value 0.3NM in final**
- **Decongestion of Terminal Airspace**

[Airbus Amber]



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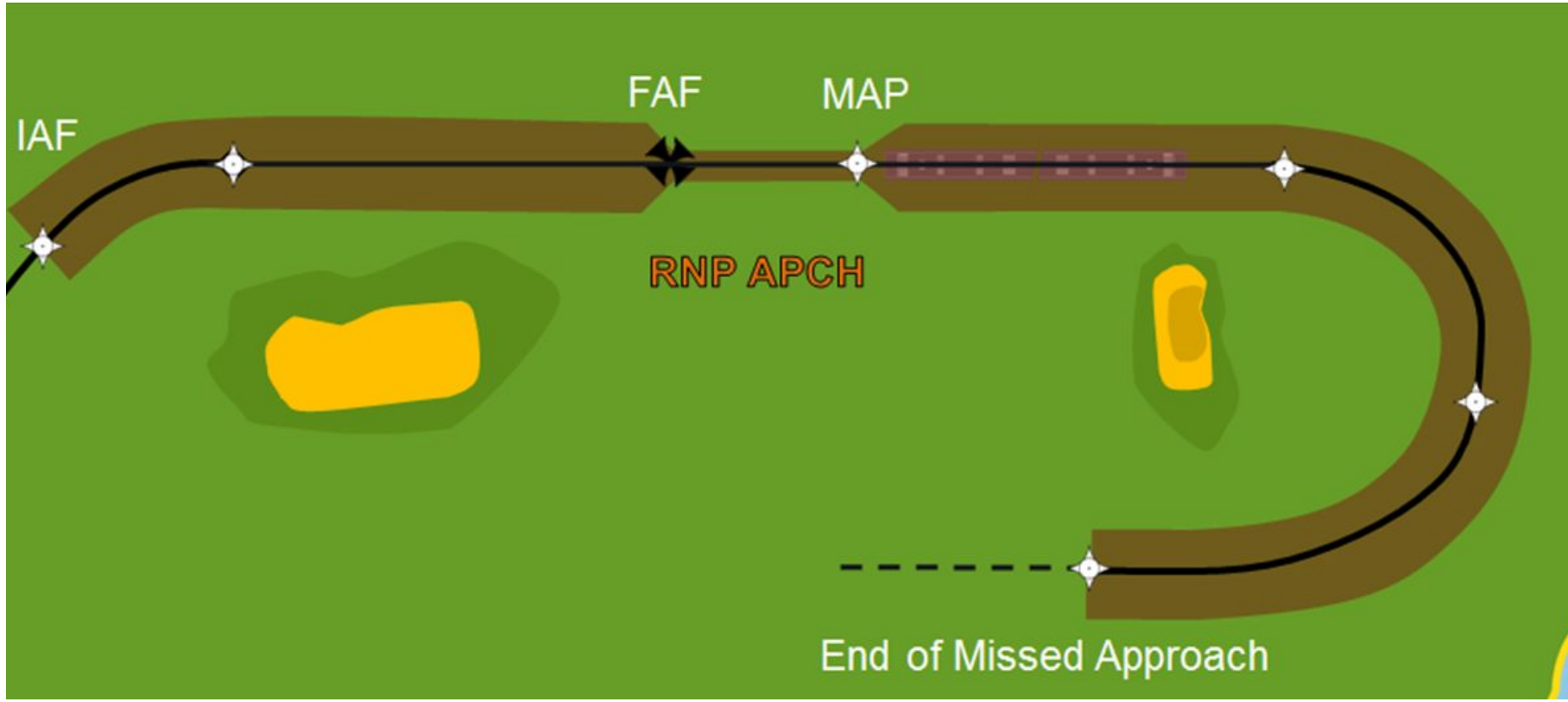
RNP APCH

Concept:

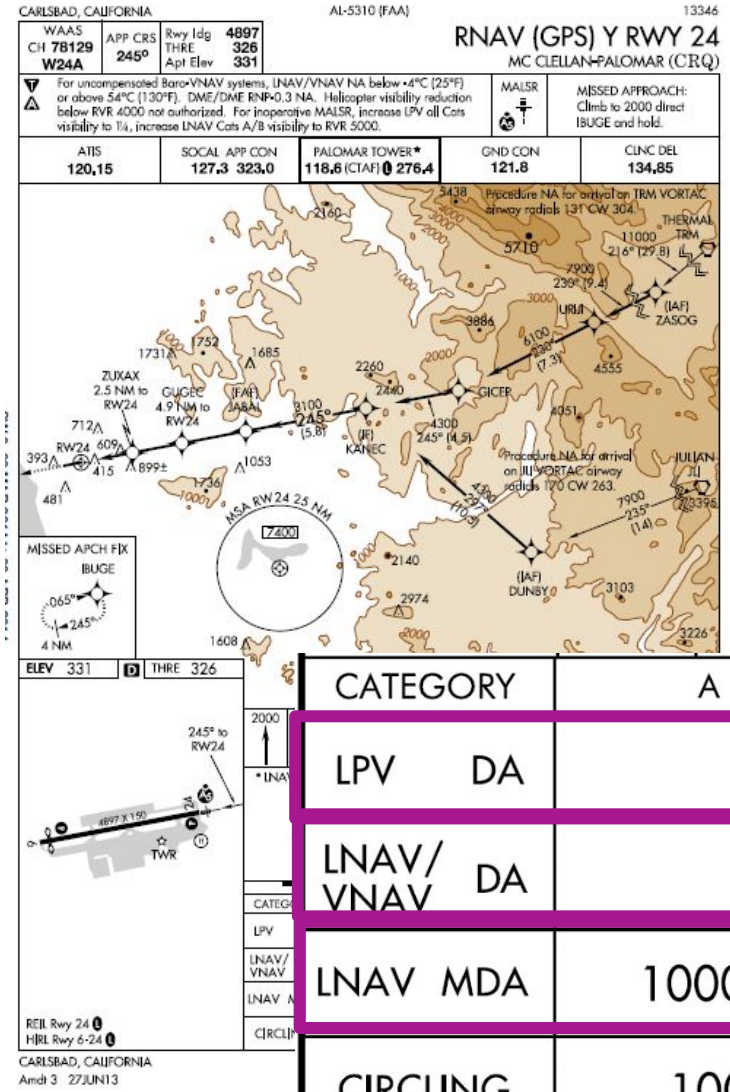
- Straight approach after FAF
- RNP 0.3 NM in Final Leg
- RNP 1 NM in Initial, Intermediate and Missed Approach



RNP APCH concept

Concept:

- Straight approach after FAF
- RNP 0.3 NM in Final Leg
- RNP 1 NM in Initial, Intermediate and Missed Approach
- Several minima



CATEGORY	A	B	C	D
LPV DA	737/45 411 (500-⅞)			NA
LNAV/ VNAV DA	927-1½ 601 (600-1½)			NA
LNAV MDA	1000/40 674 (700-¾)		1000-1½ 674 (700-1½)	NA
CIRCLING	1000-1 669 (700-1)		1080-2¼ 749 (800-2¼)	NA

More details in Approach and Landing presentation

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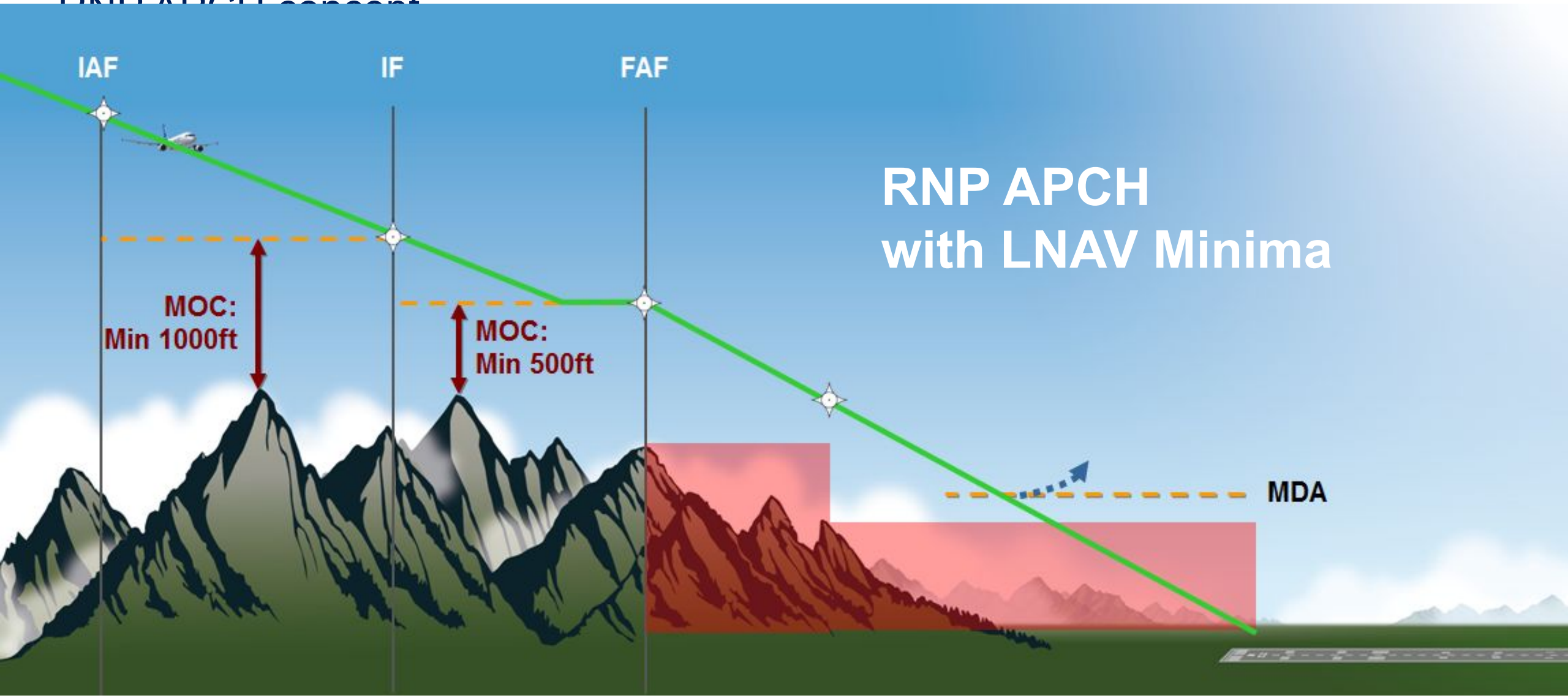
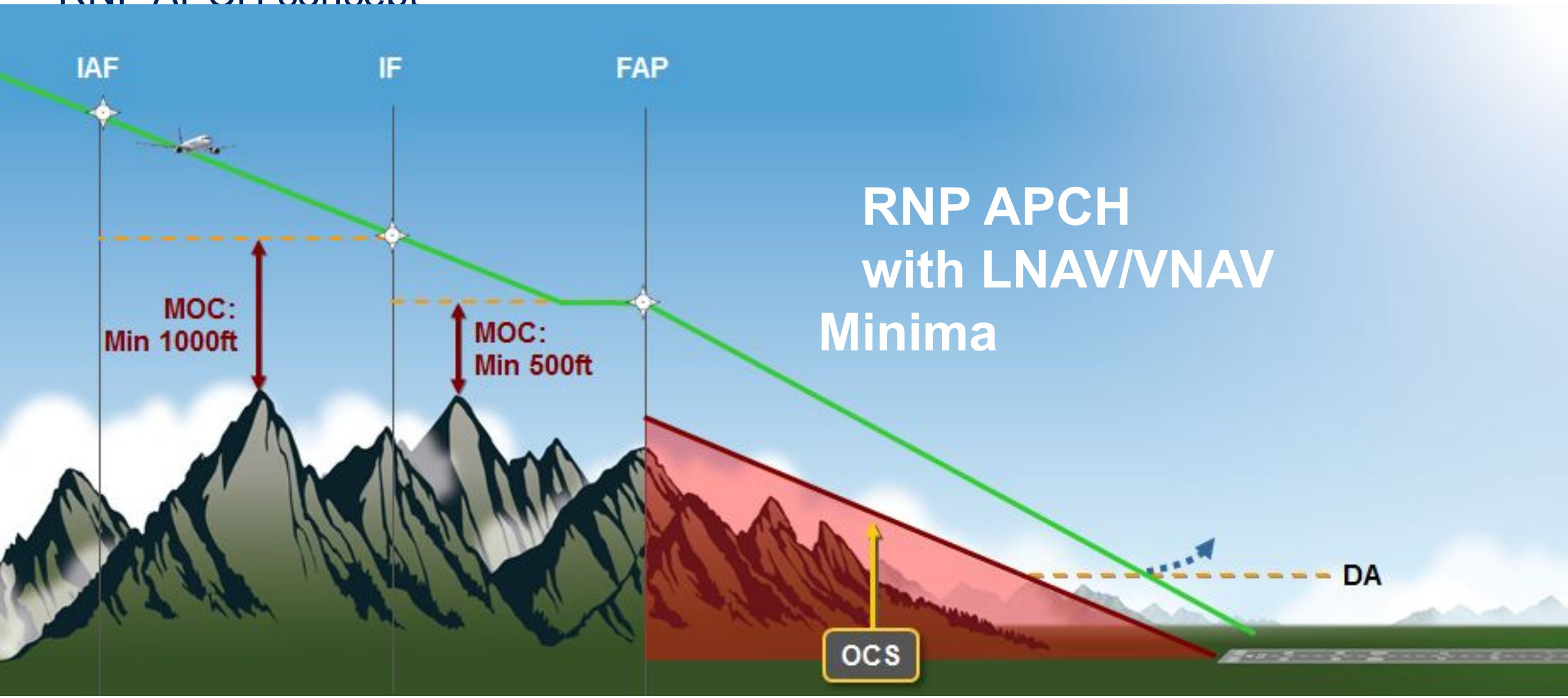
RNP APCH concept

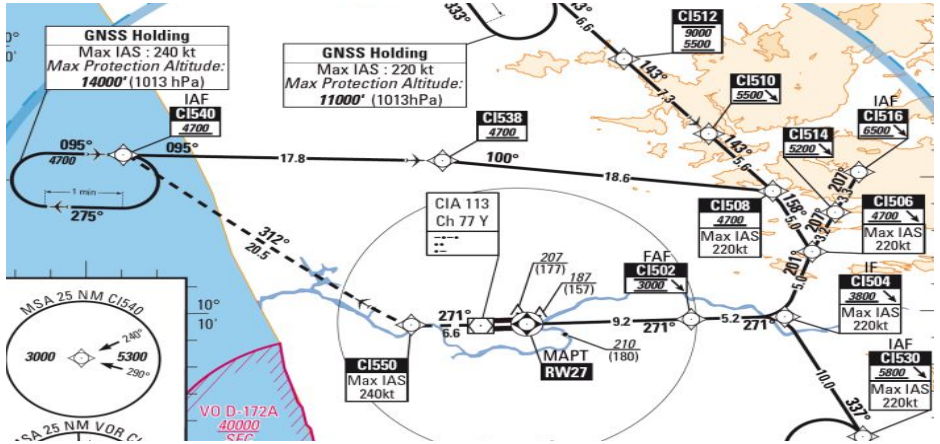


RNP APCH concept



RNP APCH with LNAV and LNAV/VNAV

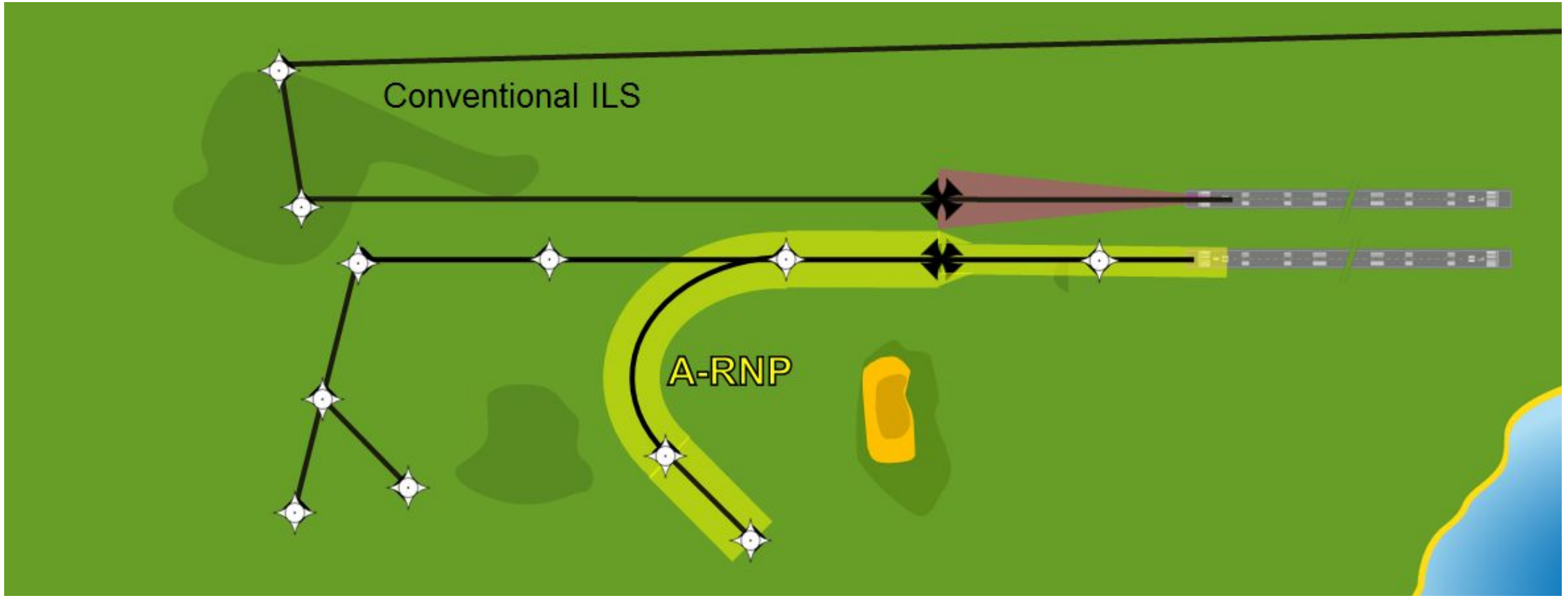
- **Operation called RNP or RNAV(GNSS) or RNAV(GPS)**



Regulation	Aircraft compliance
AC 90-105 AC 90-105A app A and B AMC 20-27 CS-ACNS	**LNAV/VNAV:** All A/C with GPS (except A300)

AIRBUS

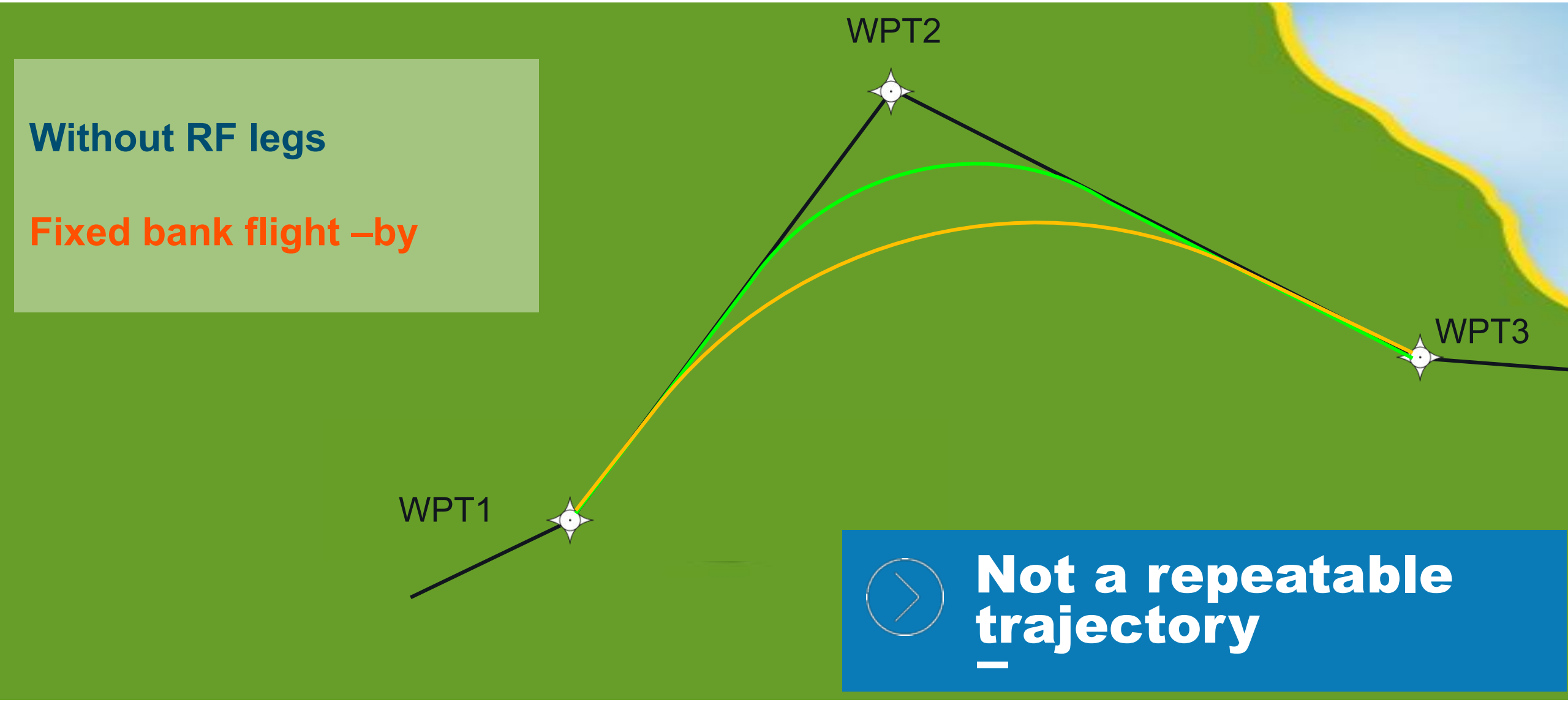
Advanced RNP and RF leg



RF legs

Without RF legs

Fixed bank flight –by

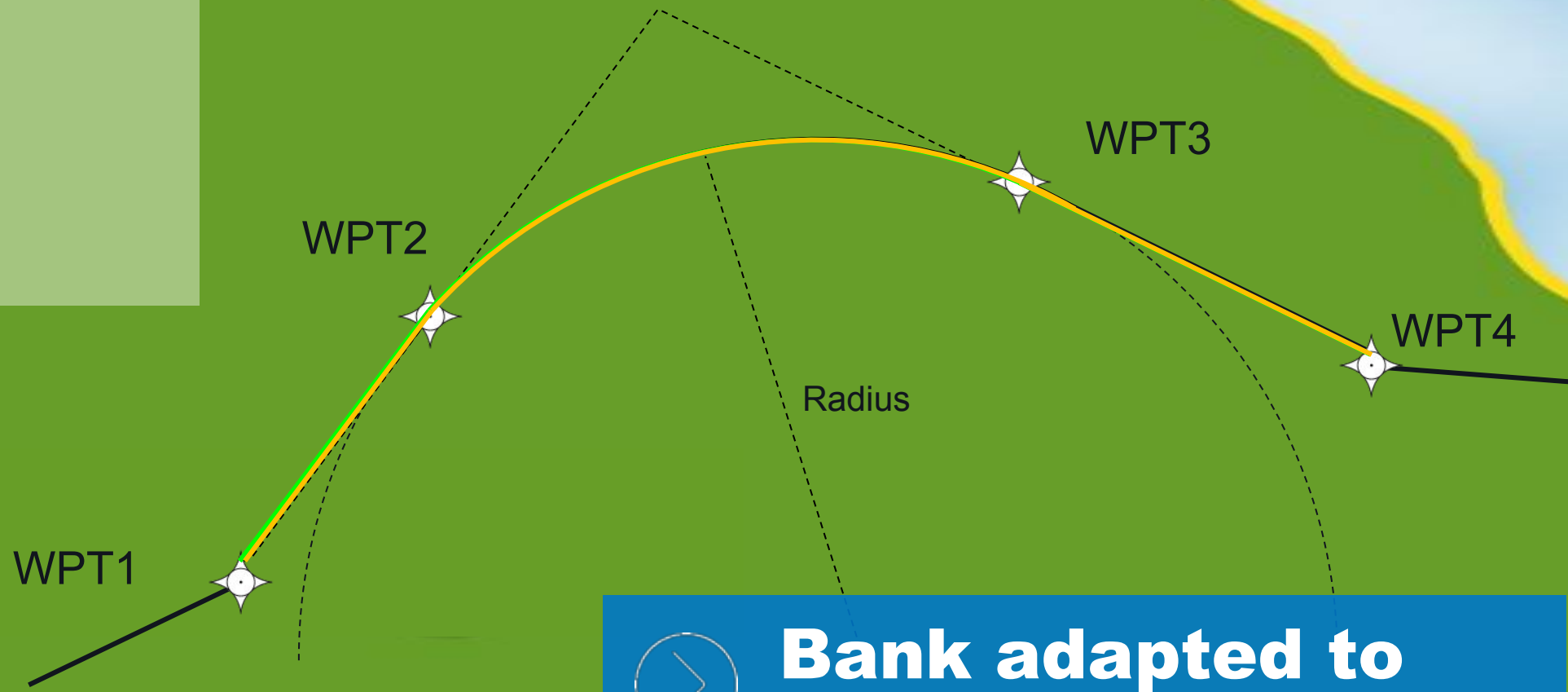


Not a repeatable trajectory

ADVANCED RNP: RF legs

With RF legs

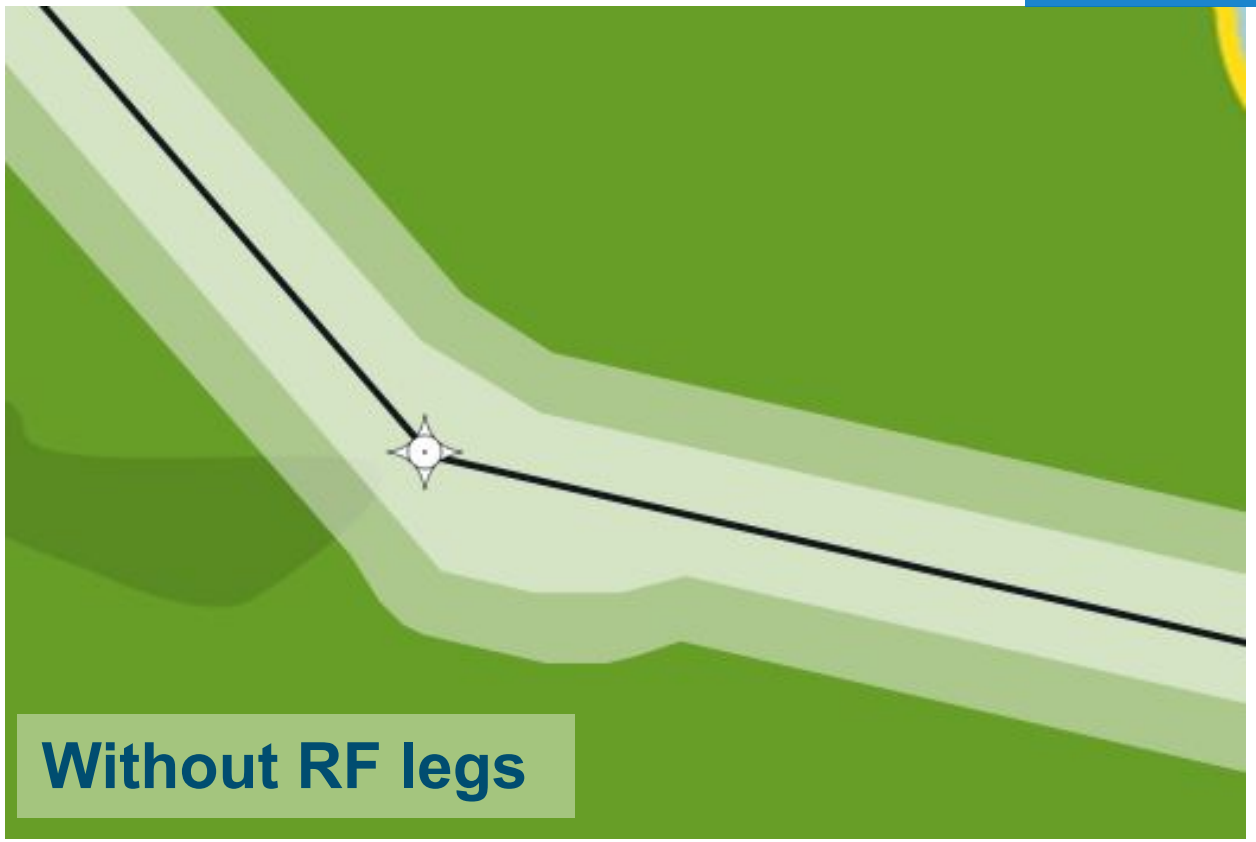
Fixed trajectory

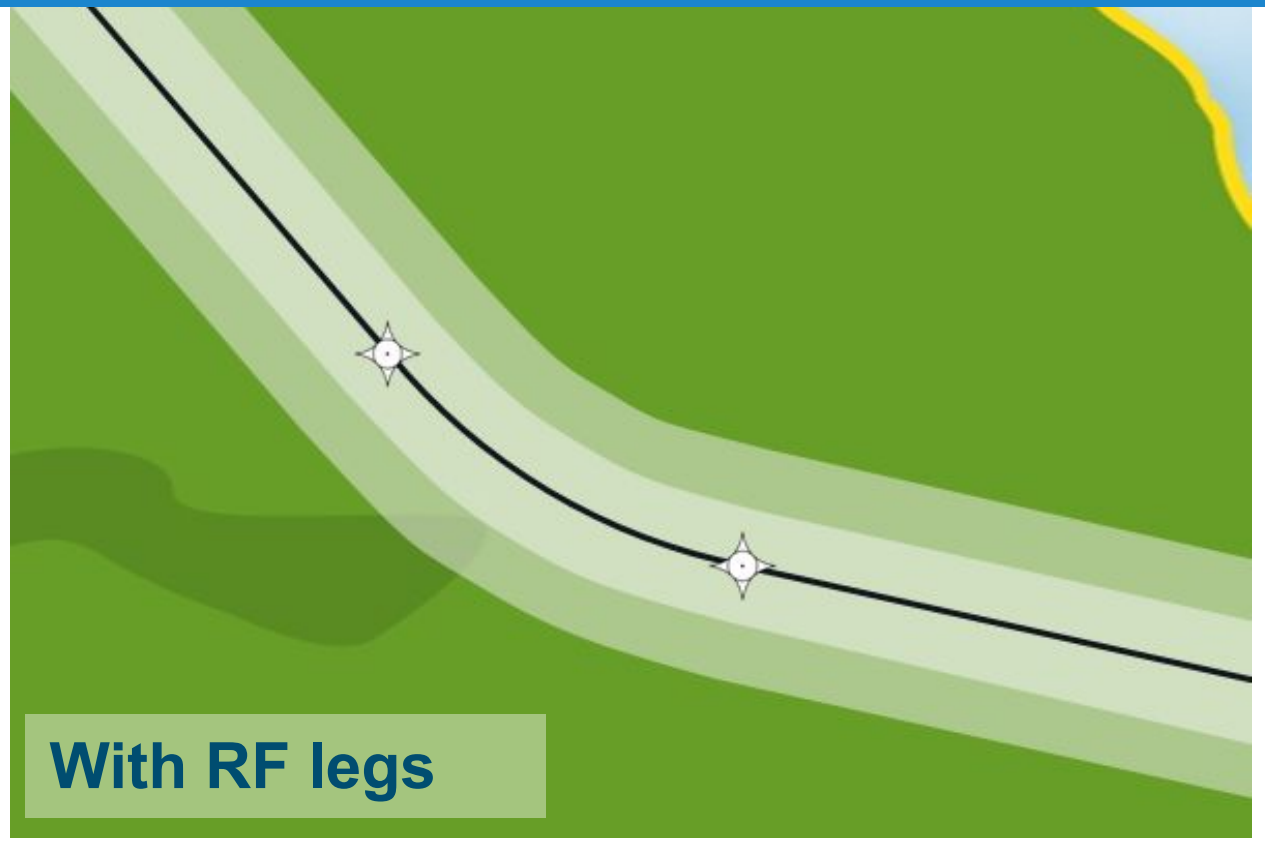


Bank adapted to the trajectory

ADVANCED RNP: RF legs

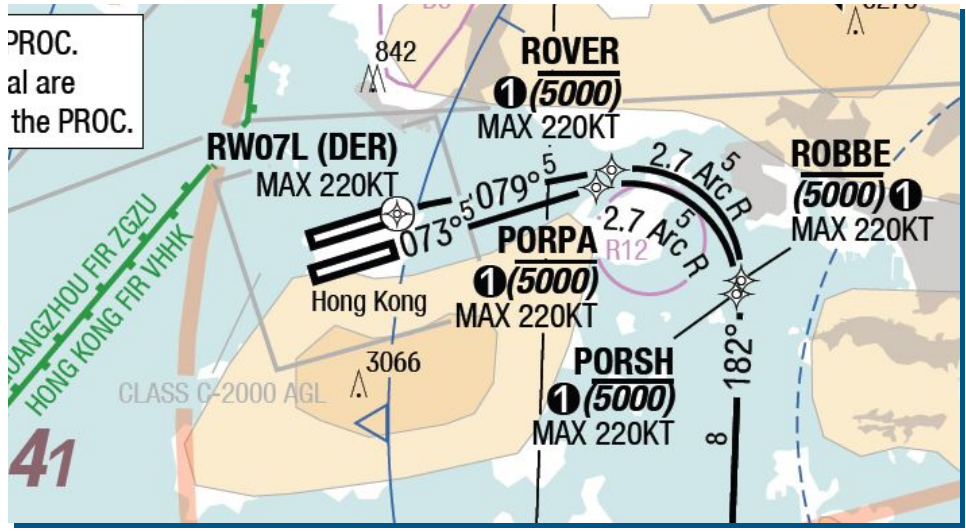
Smaller protection zone
Gain of Airspace





RF leg capability

- **Decongestion of Terminal Airspace**
- **Use of RF legs**
- **SIDs, STARS:** RNP 1 with RF leg
- **Approach:** RNP APCH with RF (outside Final segment



Regulation	Aircraft Compliance
AC 90-105 app5 RF capability AC 90-105A app I CS-ACNS	FMS2 + GPS 75% of Airbus fleet

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Advanced RNP according to ICAO PBN Manual

New operation

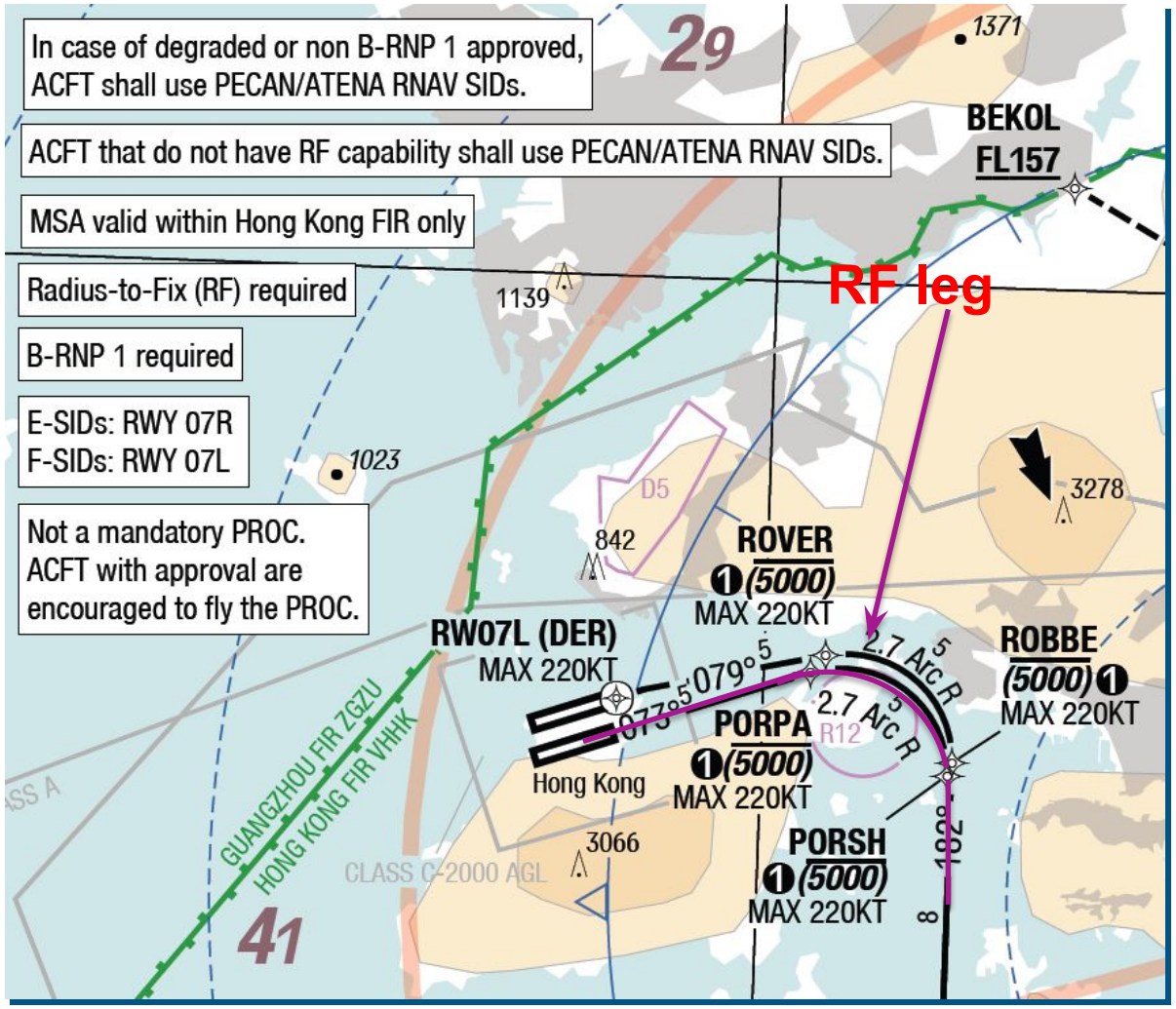
- **Concern operation**

  RNAV 5, 2, 1

  RNP 2, 1, APCH

- **Functional requirement**

— RF legs	required
— Fixed Radius Transition	optional
— RNP scalability	optional
— Higher continuity	optional
— Baro VNAV	optional
— Time Of Arrival Control	optional (not yet defined)



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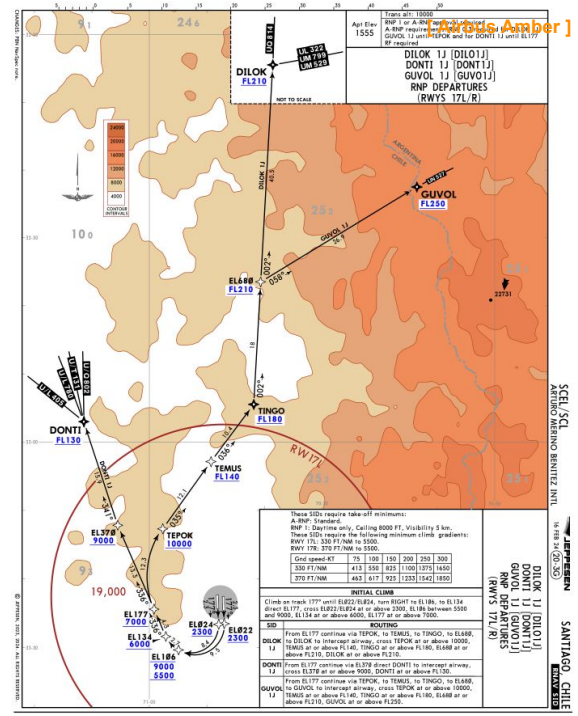
Advanced RNP and **RNP scalability option**

- **Allows RNP value down to 0.3NM** in initial and intermediate
- Concept is changing on ICAO PBN manual ed 5th
- Not harmonised between EASA and FAA
- Airbus is waiting for harmonized requirements (and operational usage)



Regulation	Aircraft Compliance
AC 90-105A app H	
CS-ACNS	under study

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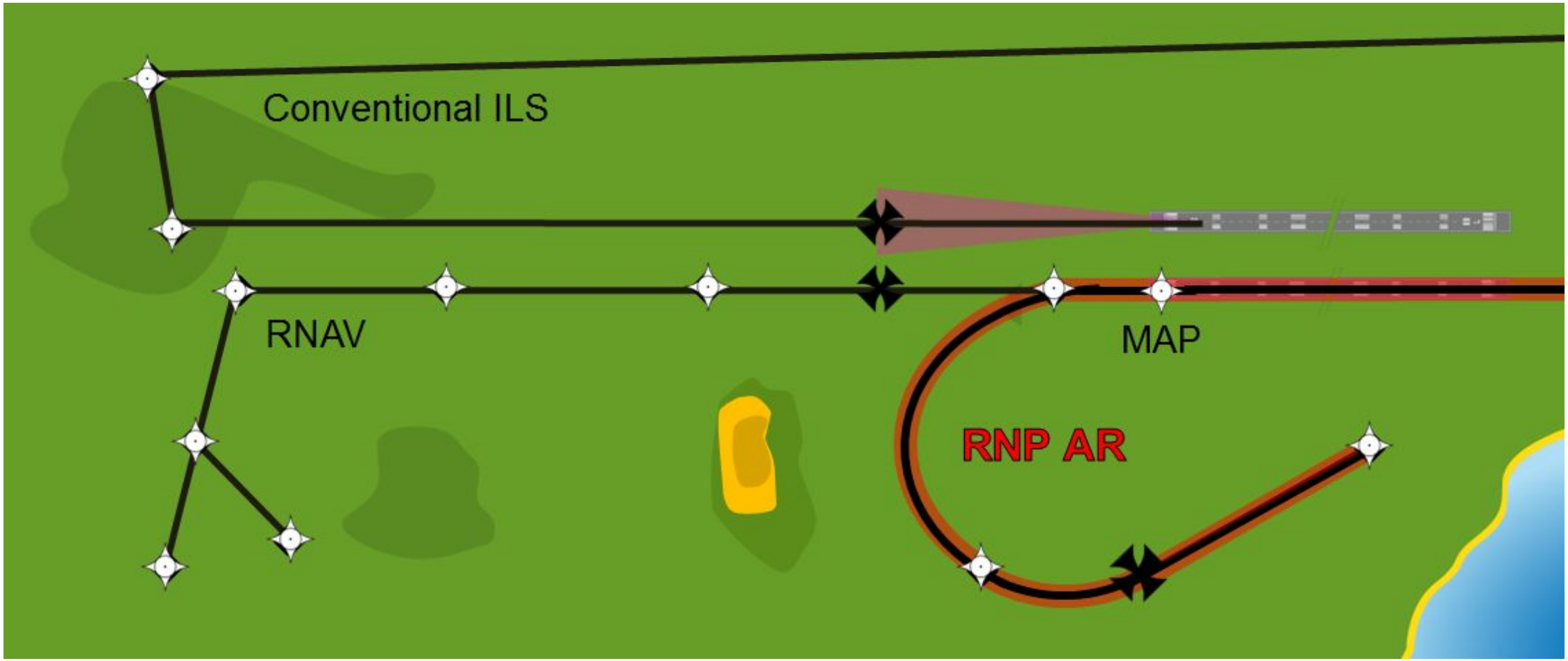
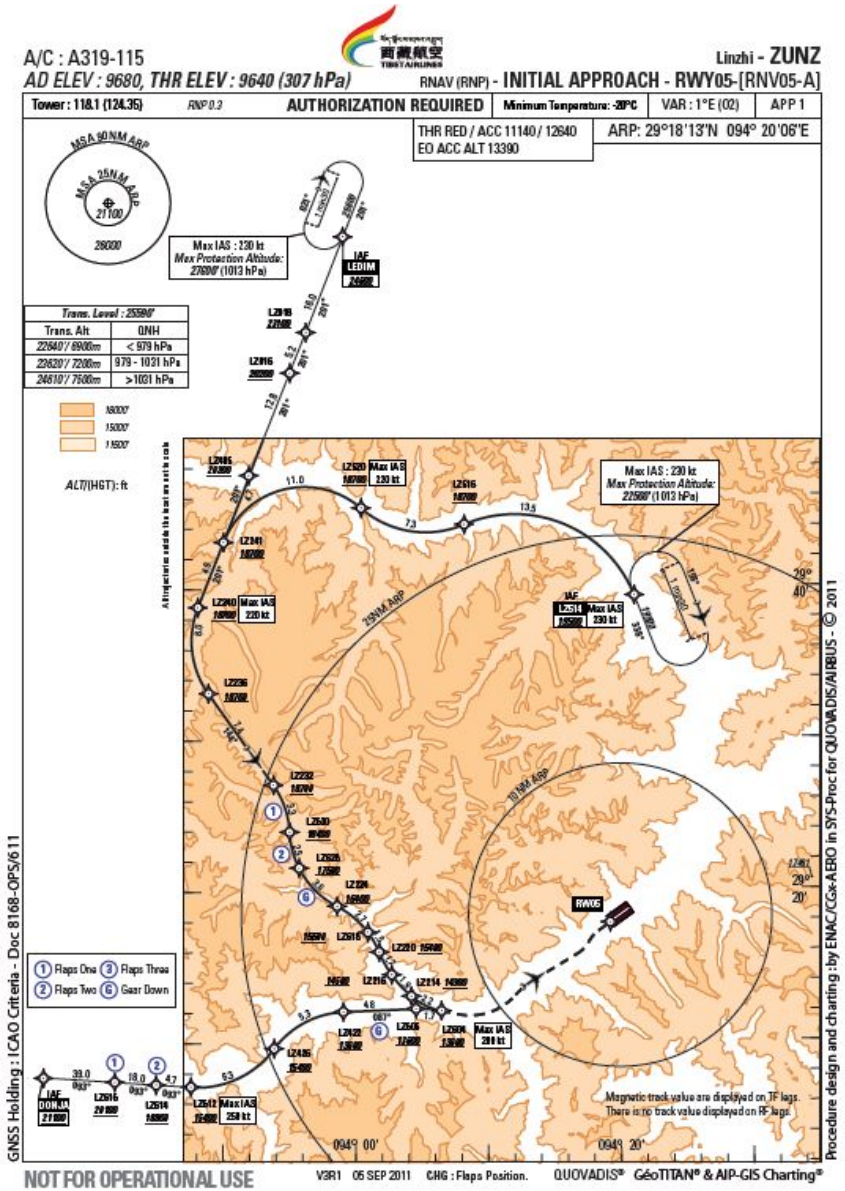
RNP AR: Authorisation Required



RNP AR in terrain-challenging environment

- **RF turn after FAP**
- **No Buffers**
- **Low RNP value**
  - **Design flexibility for terrain avoidance**
- **Better accessibility**
- **LNAV and VNAV guidance** including on turn

[Airbus Amber]



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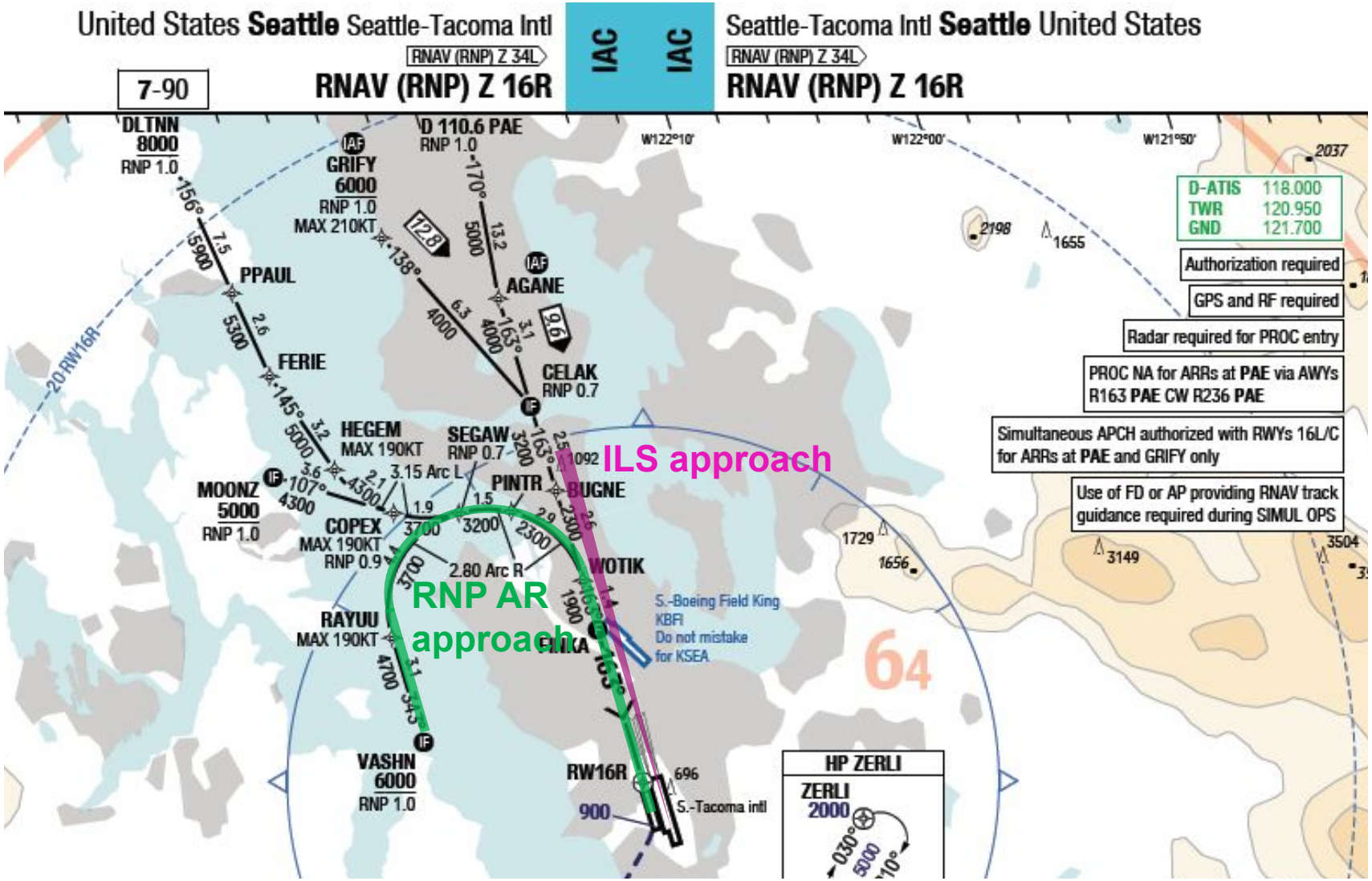
RNP AR in traffic-challenging environment

- **Late turn**
- **Closely Space Parallel Operation**



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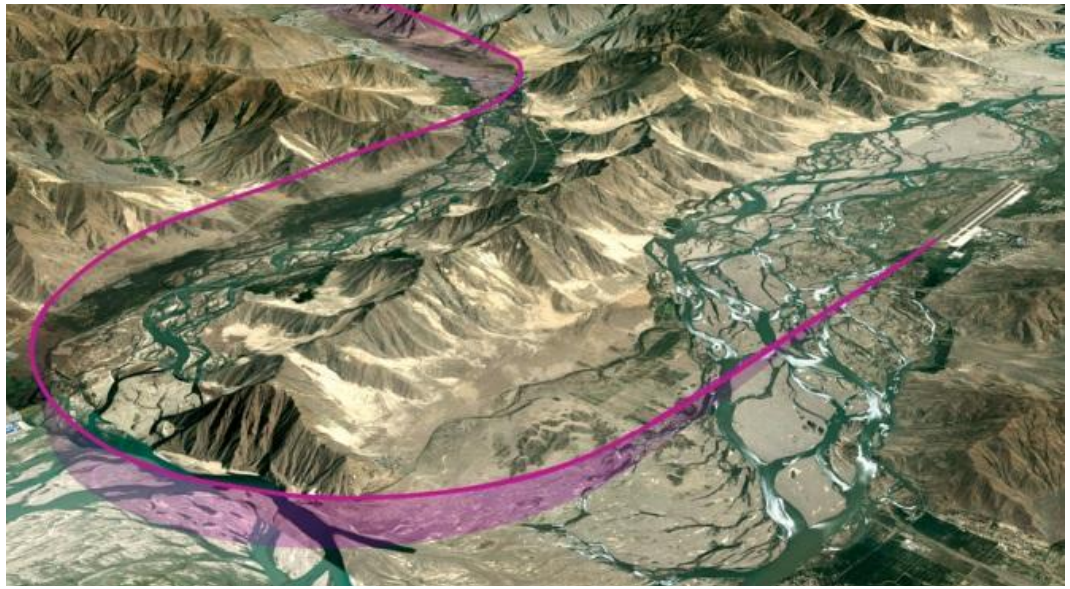
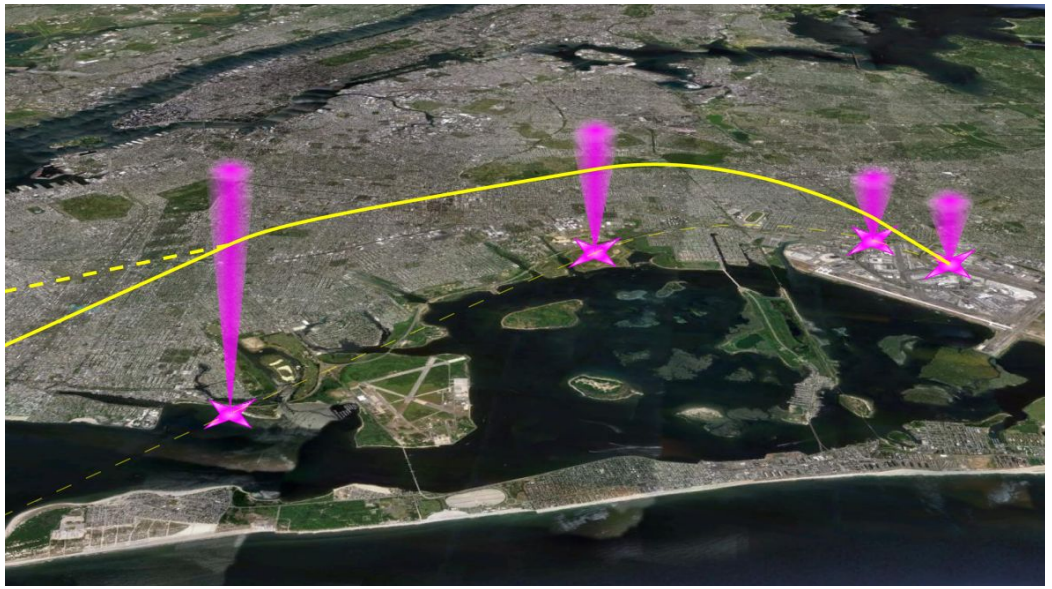
RNP AR: Authorisation Required





Regulation	Aircraft compliance
AC 90-101A	Specific aircraft modification
AMC 20-26	Specific equipment (minimum configuration)

Required system standard for RNP AR operations (e.g. A320/A330)

In addition to the RNP AR MOD

- **Minimum FMS standard:** R1A + additional options (NAV in GA, No deconnection below MDA, Baro/Radio...)
- **TAWS with direct GNSS input**

Specific to RNP AR below 0.3NM

- **Minimum ADIRS Standard**
- **EIS with Lateral deviation**
- **T3CAS or EGPWS (PEAK, ELEVIEW)**

[Airbus Amber]

#3 Aircraft Documentation

AIRBUS

PBN Manual and Airbus documentation

EASA & FAA Regulations

Compliance statement	SOPs	Minimum Equipment To start procedure
AFM / Lim Airworthiness Standard Compliance	**FCOM SOPs** - Normal SOPs - Management of degraded navigation	**MMEL** **FCOM SOPs** - Equipment required to start procedure

Aircraft Documentation

AFM **FCOM** **FCTM** **MMEL**

AIRBUS

Compliance with PBN regulation indicated in AFM

Compliance with EASA and/or FAA regulations for PBN

In AFM/LIMITATIONS / 22-AFS / FMS / Airworthiness Standard Compliance

If capability installed (MOD) ⇒ AFM of the MSN indicates the capability

If not capable ⇒ no statement of compliance in the AFM of the MSN

AFM is the proof for A/C capability regarding PBN

Airbus documentation: Compliance to PBN regulations in AFM

In AFM/LIMITATIONS / 22-AFS / FMS / Airworthiness Standard Compliance

AIRWORTHINESS STANDARD COMPLIANCE

The FMGES has been demonstrated to comply with applicable airworthiness requirements, including FAA AC 20-130A, for a navigation system integrating multiple navigation sensors, when operating with aircraft position based on:

- IRS position and GPS update, or
- IRS position and radio navaid update, or
- IRS position only.

The FMGES also complies with the airworthiness part of:

- EASA AMC 20-4 (JAA TGL 2 REV 1) for Basic RNAV
- EASA AMC 20-27 for RNP APPROACH (RNP APCH) operations with or without APV BARO-VNAV operations
- FAA Advisory Circular 90-105A for RNP2 operations in domestic, oceanic and remote continental area
- FAA AC 90-105 for:
  - RNP1 operations in Terminal area with or without RF leg
  - RNP APCH operations with or without APV BARO-VNAV Operations in final approach segment
  - RNP APCH operations with or without RF leg capability in the initial, the intermediate and the missed approach segments.

Note : 1. RNP APCH without APV BARO-VNAV operation corresponds to RNAV(GNSS) approach with LNAV Minimum.
2. RNP APCH with APV BARO-VNAV operation corresponds to RNAV(GNSS) approach with LNAV/VNAV Minimum.

- JAA TGL 10 for Precision RNAV (compliance with paragraph 8.2 has not been demonstrated)
- FAA Advisory Circular 90-100A for terminal and en route RNAV operations
- FAA Advisory Circular 20–129 for baro VNAV
- FAA Order 8400.33 for RNP 4 in oceanic and remote area.
- FAA Order 8400.12A for RNP 10 in oceanic and remote area.

  RNP 10 oceanic/remote area operations are approved:
  - with GPS PRIMARY
  - without GPS PRIMARY (GPS deselected or inoperative), provided time limitations in IRS only navigation, acceptable to the operational authorities, are established.

Note : Compliance with the applicable airworthiness requirements does not constitute an operational approval.
Such authorization must be obtained by the operator from the appropriate authorities.

--- END ---

Airbus documentation: Compliance to PBN regulations in AFM

Specificities for RNP AR

- Compliance in LIMITATIONS / 22-AFS / FMS / NAVIGATION PERFORMANCE
- Reference of the ACD: Airworthiness Compliance Document

NAVIGATION PERFORMANCE

With GPS PRIMARY:

The FMGES is certified in accordance with the performance requirements of MASPS ED-75/DO-236 for RNP operations.
The RNP accuracy with GPS PRIMARY has been demonstrated to be :

	With AP ON: - In NAV mode (all phases), or - In F-LOC (approach phase)	With AP OFF and FD ON: - In NAV mode (all phases), or - In F-LOC (approach phase)	With AP OFF and FD OFF
En Route	1 NM	1 NM	1.1 NM
In Terminal Area	0.5 NM	0.51 NM	0.51 NM
In Approach	0.3 NM	0.3 NM	- With F-LOC deviation: 0.3 NM , or - Without F-LOC deviation: not authorized

For RNP AR (SAAAR or equivalent):

The aircraft is compliant with the airworthiness part of the EASA AMC 20-26 and FAA AC 90-101A Appendix 2 and FAA AC 20-138C Appendix 2.

Note : Compliance with the applicable airworthiness requirements does not constitute an operational approval. Such authorization must be obtained by the operator from the appropriate authorities.

The aircraft is capable of conducting RNP AR operations when operated in accordance with the recommendations provided in the Airbus Airworthiness Compliance Document (ACD) reference LR34D14013950 at the latest issue.
Detailed RNP AR levels approved through the Airworthiness Approval of the aircraft are provided in the ACD.
Guidance for Operational Approval is provided in the ACD.
RNP AR performance has been demonstrated with AP ON (*See the note below*), based on the operational assumptions of the ACD for the following modes:

- Departure in NAV mode,
- Initial approach in NAV or APP NAV modes,
- Final approach in FINAL APP mode,
- Missed approach in NAV mode.

Note : Navigation performance and recommendations regarding RNP AR operations with AP OFF / FD ON are available in the ACD.

Without GPS PRIMARY:

The FMGES is certified in accordance with the accuracy requirements and assumptions of MASPS ED-75/DO-236 for RNP operations provided the appropriate RNP value is checked or entered on the MCDU and HIGH accuracy is displayed.
Without GPS PRIMARY (GPS deselected or inoperative) the navigation accuracy is a function of ground radio navaid infrastructure or elapsed time since last radio update.

END

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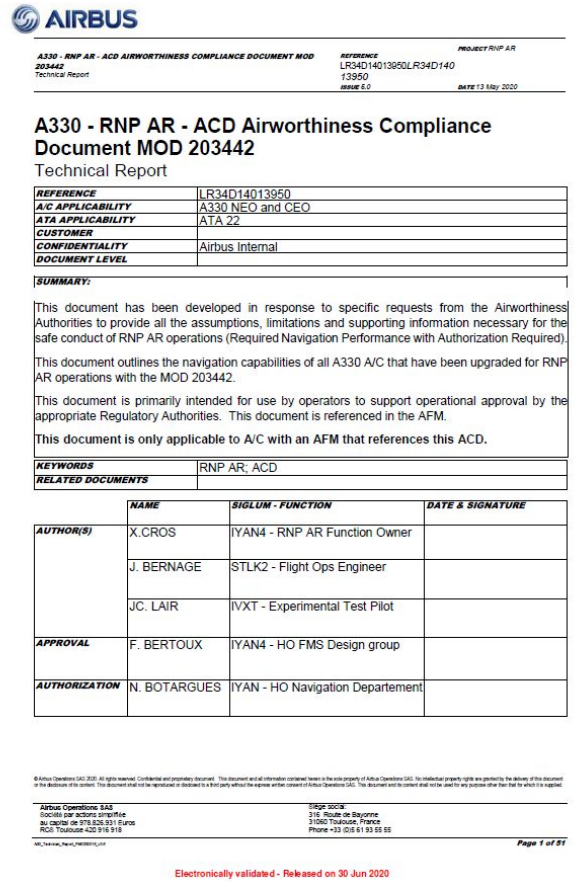
RNP AR: Airworthiness Compliance Document

- **Only applicable to A/C with the ACD referenced in AFM (specific by MOD)**
- **Part of the certification dossier and approved by EASA**
-
- **ACD structure**
  - **RNP AR demonstration hypothesis (minimum configuration, definitions)**
  - **Demonstrated excursion values for:**
    - Normal operations
    - Engine Out
    - Probable failures (sizing failures indicated)
    - Remote failures (sizing failures indicated)
  - **Operational recommendations, operational mitigations**
  - **Annexes :**
    - Flight Crew Training Program
    - System description
    - Operational approval dossier



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A330 - RNP AR - ACD AIRWORTHINESS COMPLIANCE DOCUMENT MOD 203442
Technical Report

REFERENCE LR34D14013950LR34D140
13950
ISSUE 6.0
PROJECT RNP AR
DATE 13 May 2020

A330 - RNP AR - ACD Airworthiness Compliance Document MOD 203442

Technical Report

REFERENCE	LR34D14013950
A/C APPLICABILITY	A330 NEO and CEO
ATA APPLICABILITY	ATA 22
CUSTOMER	
CONFIDENTIALITY	Airbus Internal
DOCUMENT LEVEL	

SUMMARY:

This document has been developed in response to specific requests from the Airworthiness Authorities to provide all the assumptions, limitations and supporting information necessary for the safe conduct of RNP AR operations (Required Navigation Performance with Authorization Required).

This document outlines the navigation capabilities of all A330 A/C that have been upgraded for RNP AR operations with the MOD 203442.

This document is primarily intended for use by operators to support operational approval by the appropriate Regulatory Authorities. This document is referenced in the AFM.

This document is only applicable to A/C with an AFM that references this ACD.

KEYWORDS	RNP AR; ACD
RELATED DOCUMENTS	

	NAME	SIGLUM - FUNCTION	DATE & SIGNATURE
AUTHOR(S)	X.CROS	IYAN4 - RNP AR Function Owner	
	J. BERNAGE	STLK2 - Flight Ops Engineer	
	JC. LAIR	IVXT - Experimental Test Pilot	
APPROVAL	F. BERTOUX	IYAN4 - HO FMS Design group	
AUTHORIZATION	N. BOTARGUES	IYAN - HO Navigation Departement	

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Electronically validated - Released on 30 Jun 2020

Available in Airbus World for operator. can be provided to NAA by Airbus on request

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Aircraft Documentation

AFM | **FCOM** | **FCTM** | **MMEL**

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Airbus documentation: FCOM contents

Specific FCOM chapter in PRO / SPO / 51-PBN

- General
  - Compliance
  - Definition
- Equipment Required
- Procedure
  - Flight preparation
  - Before entering Airspace
  - Inside Airspace
  - Management of degraded navigation
  - Leaving Airspace

RNP 1 / TERMINAL RNP 1 - BASIC RNP 1

GENERAL

RNP 1 operations correspond to RNP 1 Terminal operations.

In RNP 1 airspace, GPS enables to ensure the RNP value of 1 nm.

REQUIRED RNP 1 EQUIPMENT

The minimum navigation equipment required to enter RNP1 airspace is:

- One FMGEC
- One MCDU
- One GPS
- Two IRS
- One FD in NAV mode
- Two NDs (the temporary display of ND information via the PFD/ND switch is permitted on one side).

PROCEDURE

FLIGHT PREPARATION

RAIM/AIME availability should be confirmed for RNP 1 operations.
Refer to GPS PRIMARY Availability (If Installed)

BEFORE ENTERING RNP 1 AIRSPACE

The FMS navigation database provides the terminal procedure (RNAV SID, RNAV STAR, RNAV TRANSITION, etc.) of the flight plan. The flight crew must check the terminal procedure from the published charts with the FMS navigation database on the F-PLN page (waypoint sequences, tracks, distances, and altitude or speed constraints)

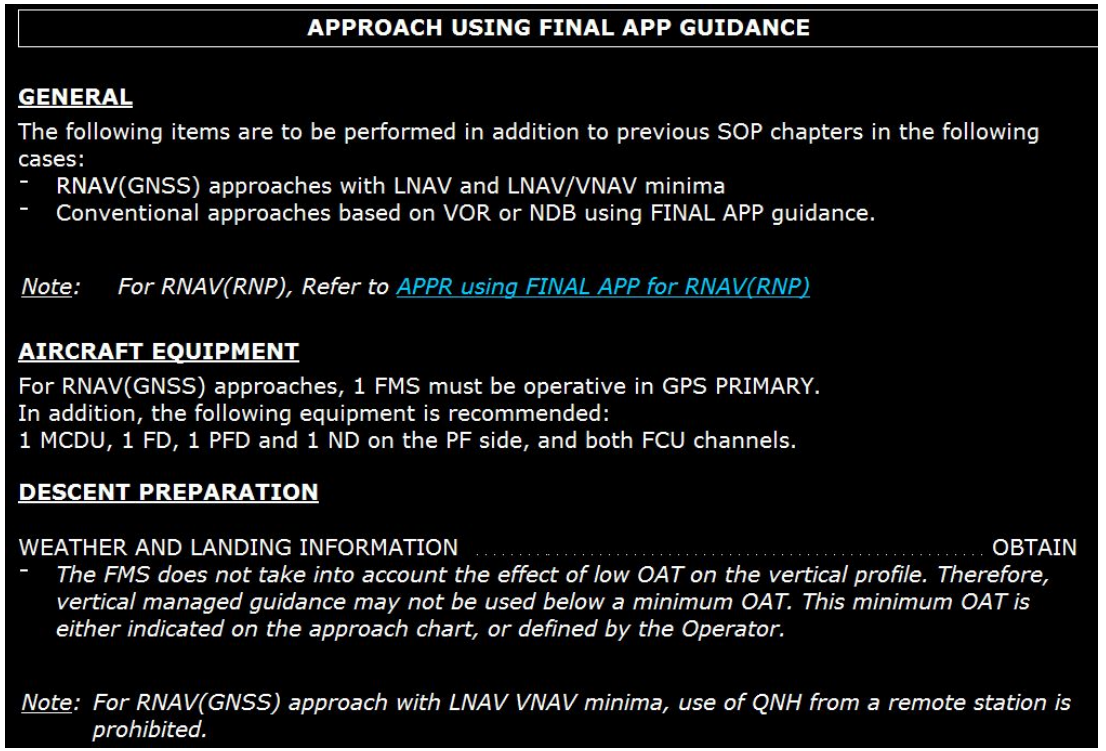
Airbus documentation: FCOM contents for RNP APCH / RNP AR

- **For RNP APCH**

Approach RNP operations in **PRO /NOR /SOP /approach /guidance management /using FINAL APP guidance**

- **For RNP AR** (when MOD embedded)

Specific chapter in **PRO/NOR/SOP approach /guidance management /using FINAL APP guidance for RNAV(RNP) for Approach procedure**



APPROACH USING FINAL APP GUIDANCE

GENERAL

The following items are to be performed in addition to previous SOP chapters in the following cases:

- RNAV(GNSS) approaches with LNAV and LNAV/VNAV minima
- Conventional approaches based on VOR or NDB using FINAL APP guidance.

Note: For RNAV(RNP), Refer to APPR using FINAL APP for RNAV(RNP)

AIRCRAFT EQUIPMENT

For RNAV(GNSS) approaches, 1 FMS must be operative in GPS PRIMARY.
In addition, the following equipment is recommended:
1 MCDU, 1 FD, 1 PFD and 1 ND on the PF side, and both FCU channels.

DESCENT PREPARATION

WEATHER AND LANDING INFORMATION ..... OBTAIN

- *The FMS does not take into account the effect of low OAT on the vertical profile. Therefore, vertical managed guidance may not be used below a minimum OAT. This minimum OAT is either indicated on the approach chart, or defined by the Operator.*

Note: For RNAV(GNSS) approach with LNAV VNAV minima, use of QNH from a remote station is prohibited.

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Focus on equipment management concept, example of RNP 1 on A320

[Airbus Amber]

Before the PBN procedure

Equipment required list

EQUIRED RNP 1 EQUIPMENT

The minimum navigation equipment required to enter RNP 1 airspace is:

- One FMGC
- One MCDU
- One GPS
- Two IRS
- One FD in NAV mode
- Two NDs (the temporary display of ND information via the PFD/ND sw is permitted on PM side).

During the PBN procedure

Rely on messages and A/C behaviour

MANAGEMENT OF DEGRADED NAVIGATION

- **If one of the following messages is displayed, the flight crew should resume navigation with the FMGC that provides the correct position:**

GPS PRIMARY LOST. on one ND/MCDU
NAV ACCUR DOWNGRAD on one ND/MCDU.

- **If one of the following MCDU or ECAM messages is displayed, the flight crew should check the position data via the MCDU PROG page in order to identify which FMGC position is correct:**

GPS PRIMARY LOST. on both NDs/MCDUs
FMS1/FMS2 POS DIFF
CHECK IRS 1(2)(3)/FM POSITION.
CHECK A/C POSITION .
NAV FM/GPS POS DISAGREE .

The flight crew should resume navigation with the FMGC that provides the correct position.

- **If NAV ACCUR DOWNGRAD is displayed on both sides:**

The flight crew should inform the ATC that the RNP 1 capability is lost.

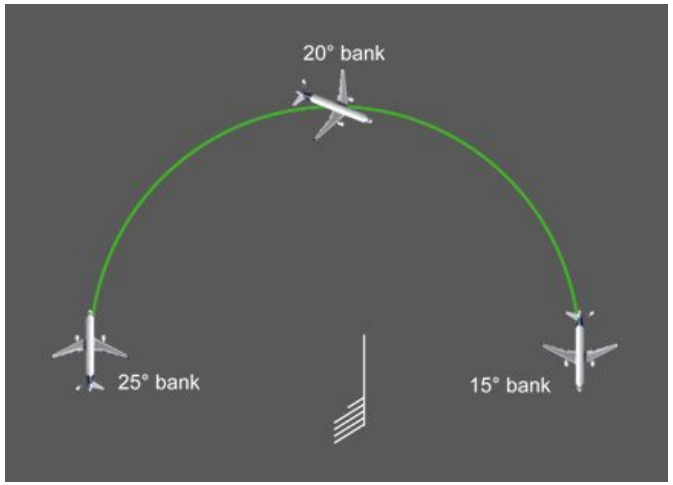
AIRBUS


[Airbus Amber]
Aircraft
Documentation
AFM
FCOM
FCTM
MMEL

Airbus documentation: FCTM contents on RF leg

- **Introduction on guidelines to fly an RF leg in the FCTM**

- **Contains:**
  1. RF leg Characteristics
  2. Use of AP/FD
  3. Speeds management along RF legs
  4. Go-around during RF leg
  5. Use of DIR TO function consideration
  6. Engine-Out considerations



AIRBUS

Aircraft Documentation

AFM **FCOM** **FCTM** **MMEL**

Airbus documentation: MMEL contents for PBN

PBN Operations taken into account in the MMEL

22-10-01A 22-10-01B	Autopilot (AP)

FLIGHT PREPARATION/LIMITATIONS

▲ **When one AP is inoperative:**

For aircraft with the RNP AR capability, RNP AR operations strictly below 0.3 NM are not permitted.

Maximum landing capability is CAT 3 SINGLE.

▲ **When both APs are inoperative:**

For aircraft with the RNP AR capability, RNP AR operations are not permitted.

RVSM operations are not permitted.

Maximum landing capability is CAT 1.

// END

#4 AIRCRAFT DESIGN

Position

Flight Guidance

Cockpit HMI

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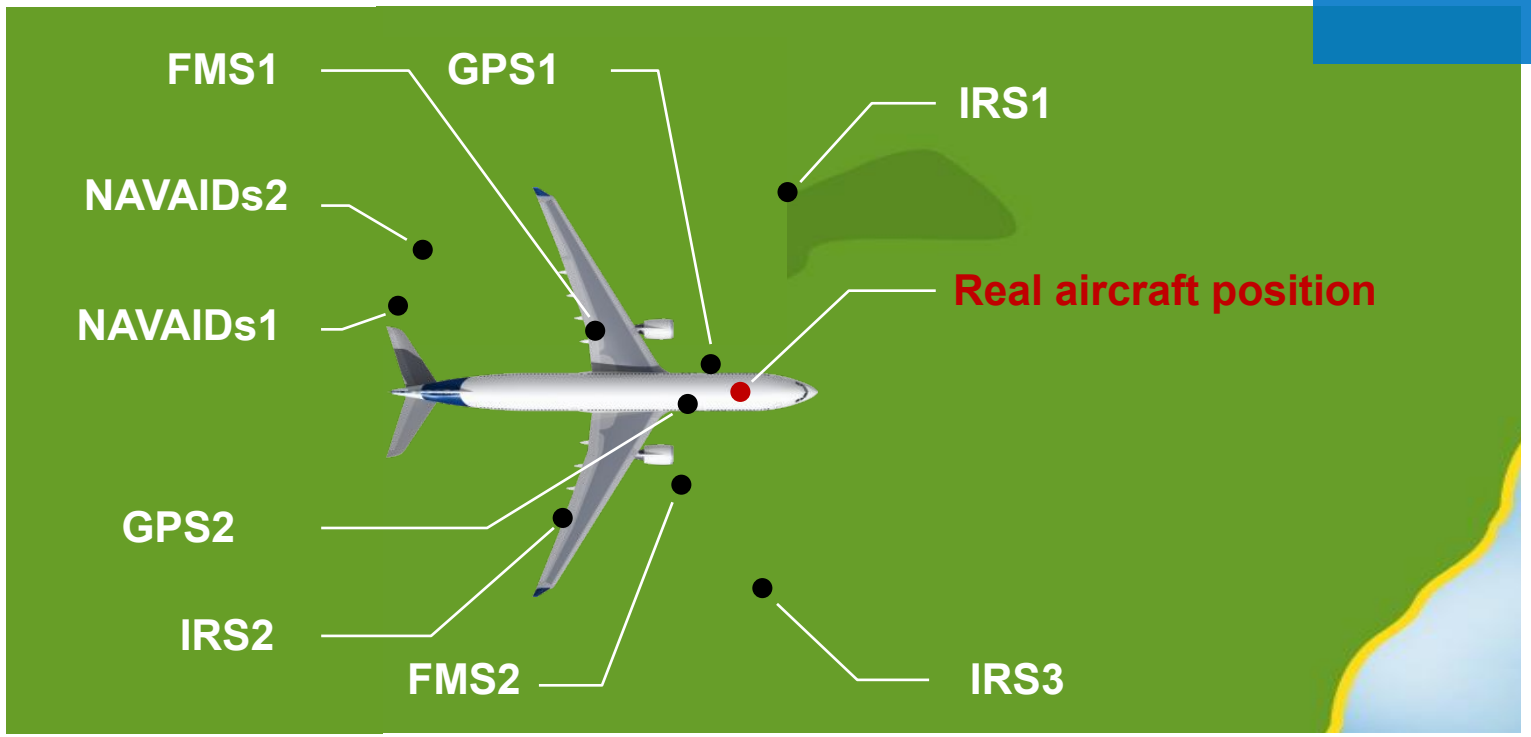
AIRCRAFT POSITION



Based on different position sources

- **Inertial position**
  ADIRS
- **GNSS position**
  MMR/GPS SU
- **Radio position**
  VOR, DME, LOC

A/C position on A350
FMS position on others

AIRCRAFT POSITION

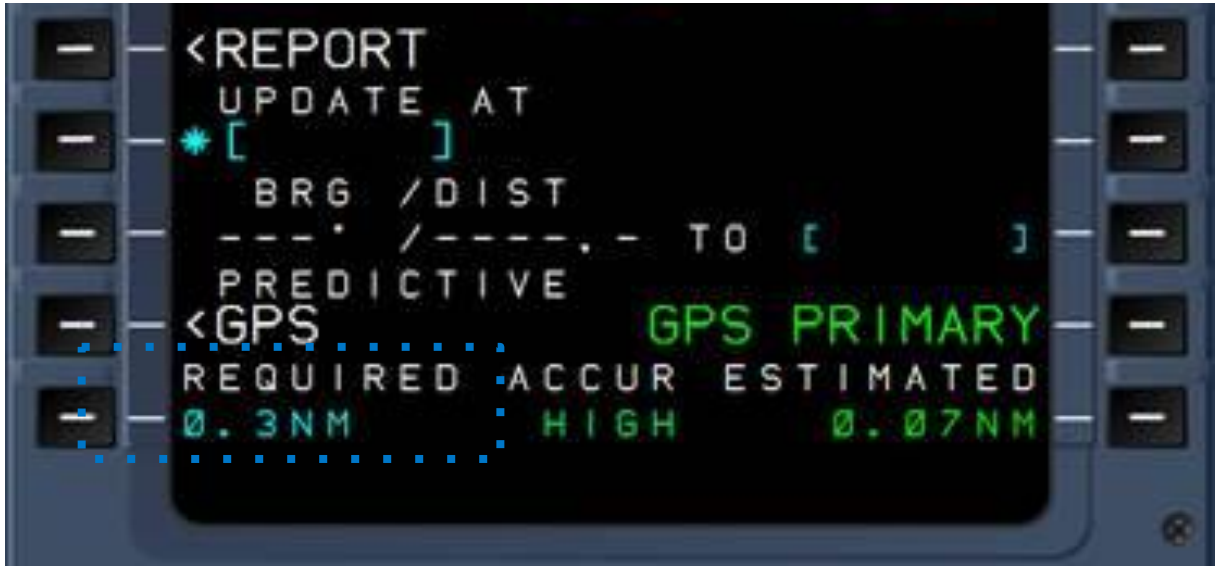
Position sources

- **Inertial position**
  ADIRS
- **GNSS position**
  MMR
- **Radio position**
  NAVAIDs

Navigation modes

- **GNSS/Inertial**
  IRS/GPS
- **NAVAIDS/inertial**
  IRS/DME/DME **IRS/VOR/DME**
- **Inertial Only**
  3IRS

AIRCRAFT POSITION : ACCURACY & INTEGRITY LIMITS

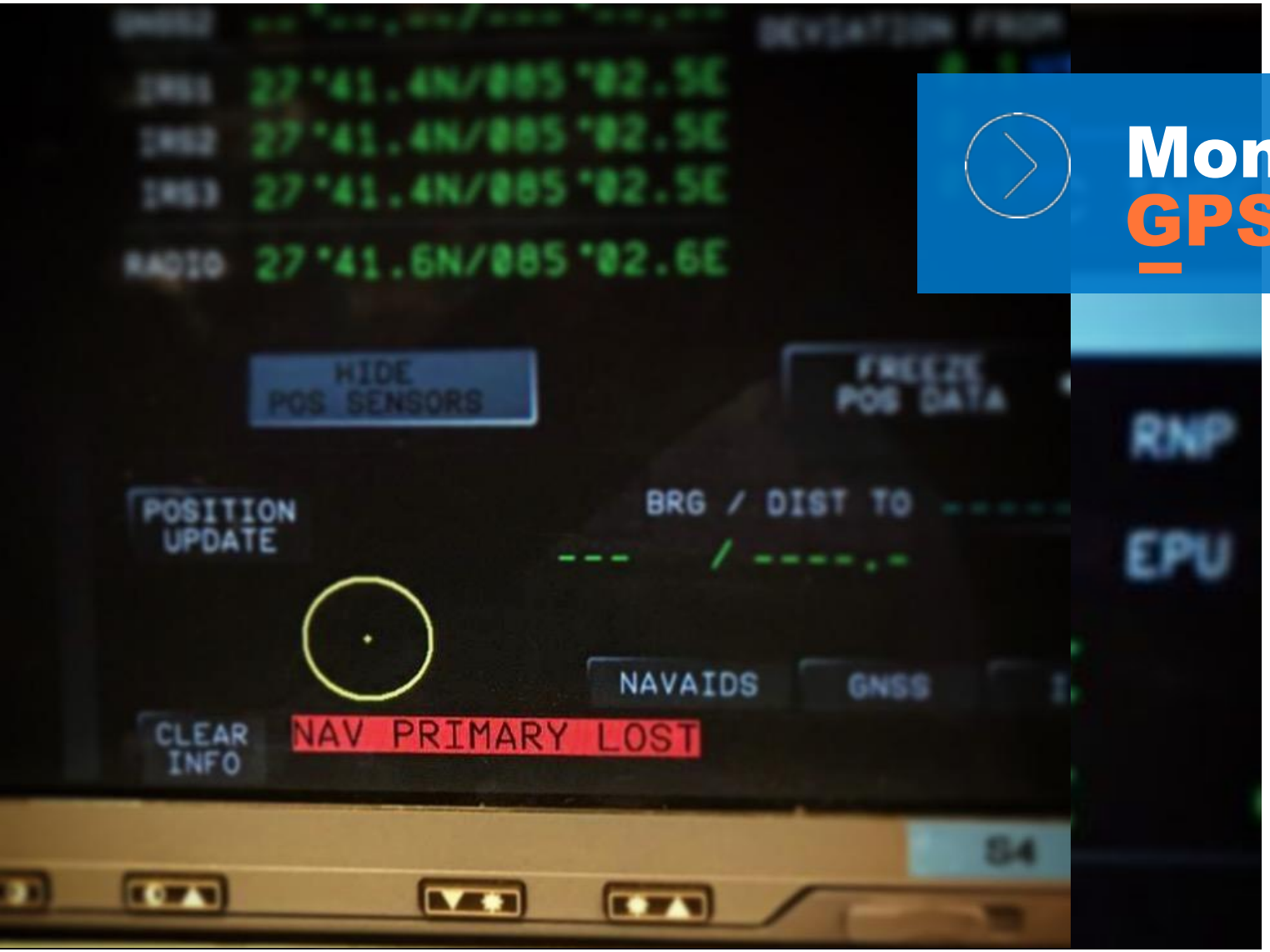


RNP value

- From NDB
- Default value
- Manually entered

  (Not recommended)

MONITORING / **INTEGRITY**



Monitoring and Alerting: GPS/NAV PRIMARY LOST

- **Based on GNSS/Inertial mode**
  Integrity monitoring related to threshold

GPS/NAV PRIMARY LOST
message triggered regardless of the selected RNP value

MONITORING / **INTEGRITY**

Monitoring and Alerting: GPS/NAV PRIMARY LOST

HIL_{GPIRS} > MAX (UIL, 2xRNP)

UIL = 2NM in Enroute, 1NM in Terminal, 0.3NM in approach

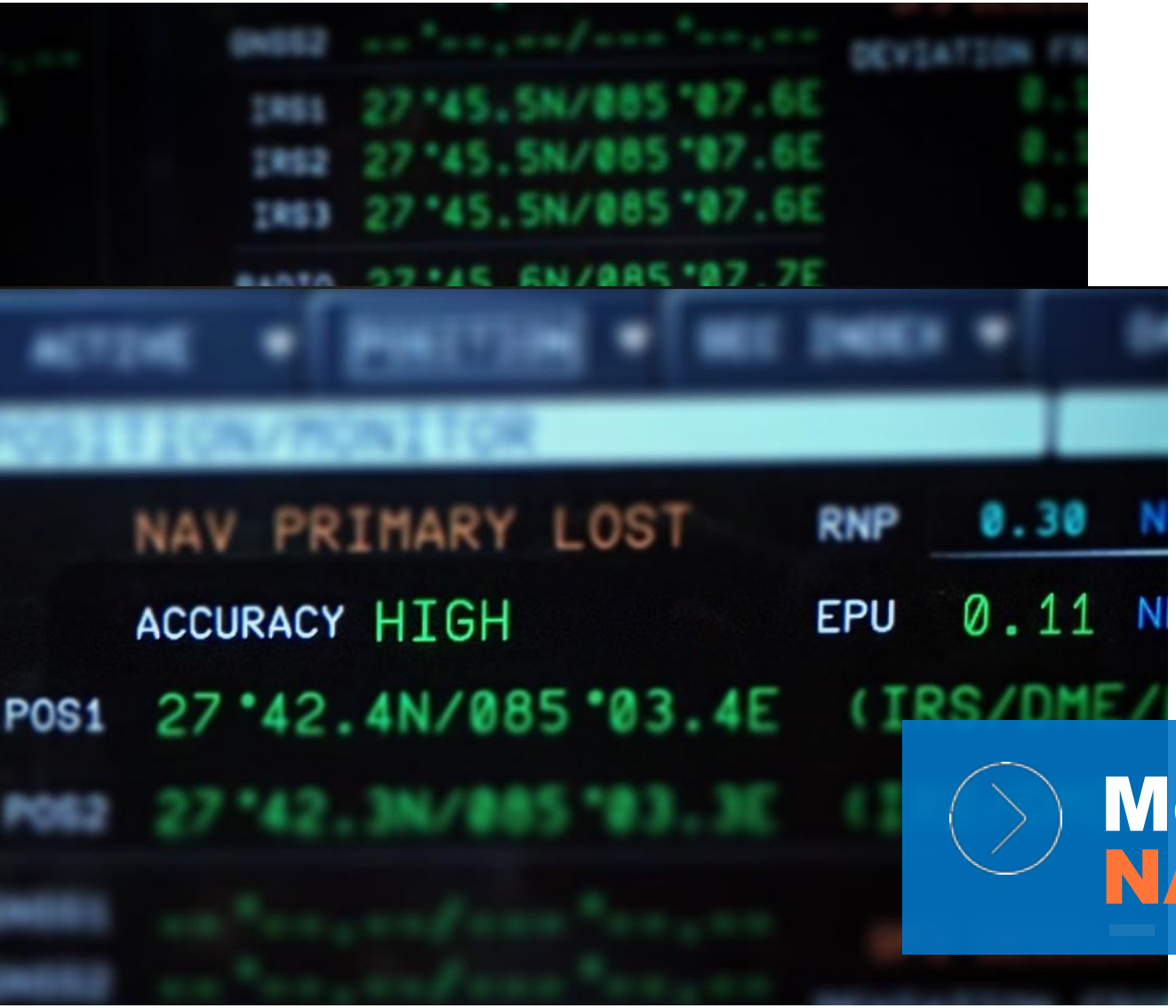
→ **GPS PRIMARY LOST**

Example: RNP ARCH procedure, RNP=0.3NM

GPS PRIMARY LOST triggered when HIL_{GPIRS}>MAX(0.3, 2x0.3)= 0.3 ⇒ corresponding to RNP= 0.15 criteria

Note: More complex algorithm on A350 and A380 Batch 7 with a budget for PDE and FTE in HIL monitoring

MONITORING / **ACCURACY**



- **If GNSS/Inertial mode lost**
  Reversion to NAVAIDS/Inertial or Inertial only

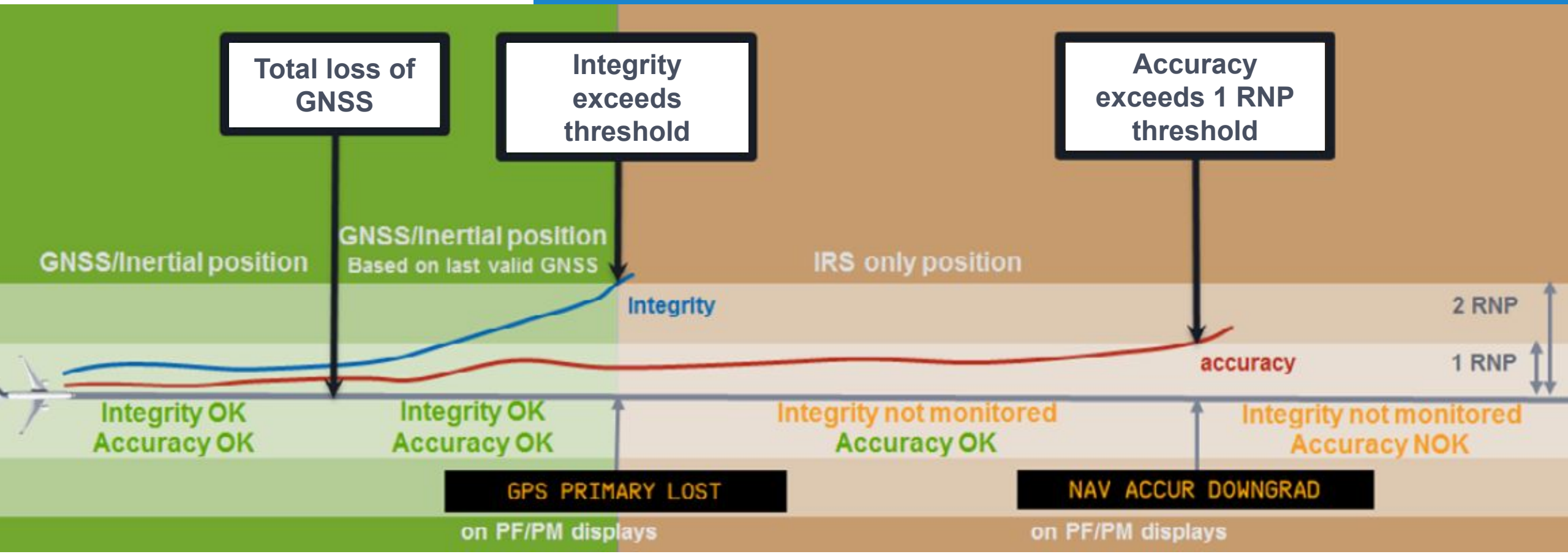
  No more integrity monitoring

  Accuracy monitoring related to RNP Value

Monitoring and Alerting:
NAV ACCUR DOWNGRADED

MONITORING example on A320 aircraft

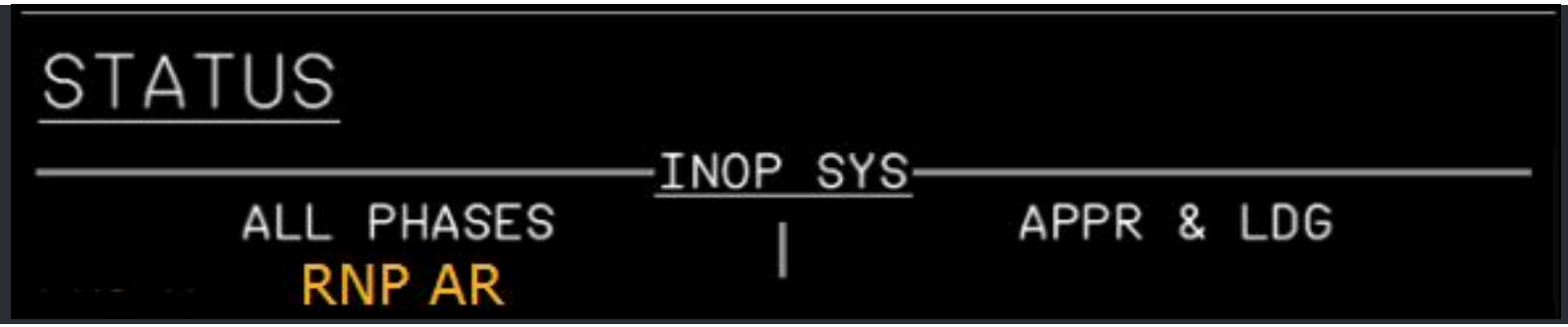
Example of GNSS loss in low RNP operations without NAVAIDS



A350 RNP AR CAPABILITY MANAGEMENT

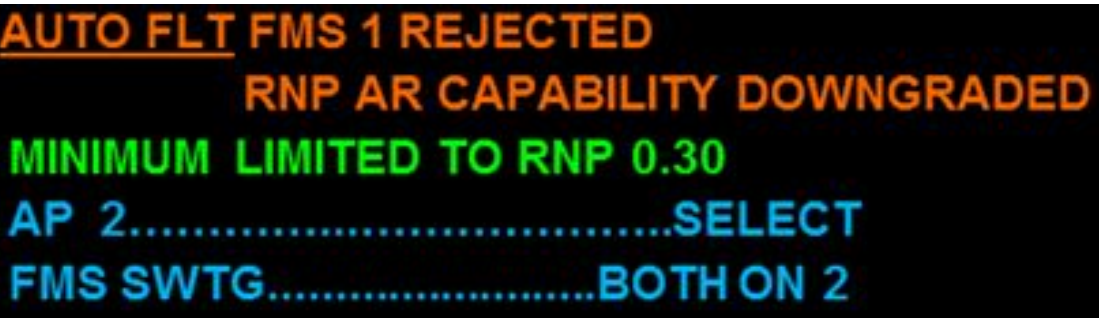
Dedicated RNP AR monitoring function for A350

- **Management of the RNP AR capability by PRIMs**
  Monitoring Performance & minimum configuration for RNP AR



A350 RNP AR CAPABILITY MANAGEMENT

RNP AR CAPABILITY DOWNGRADED



ECAM message

- **Triggered when**

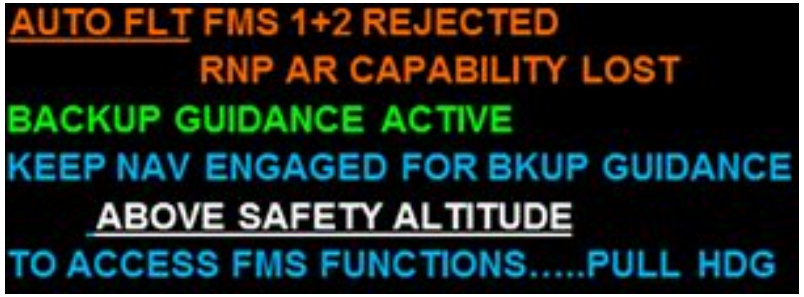
  System failure leading to a loss of capability (but not 0.3NM capability)

  - **redundancy loss**

- **revert to 0.3NM minima or Go Around**

A350 RNP AR CAPABILITY MANAGEMENT

ND message



ECAM message

- **Triggered when**

Integrity/Accuracy NOT in accordance with RNP level

System failure leading to a loss of RNP AR capability

- **Go Around**
- **Additional help like Backup Guidance...**

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DISPATCH and RAIM Prediction

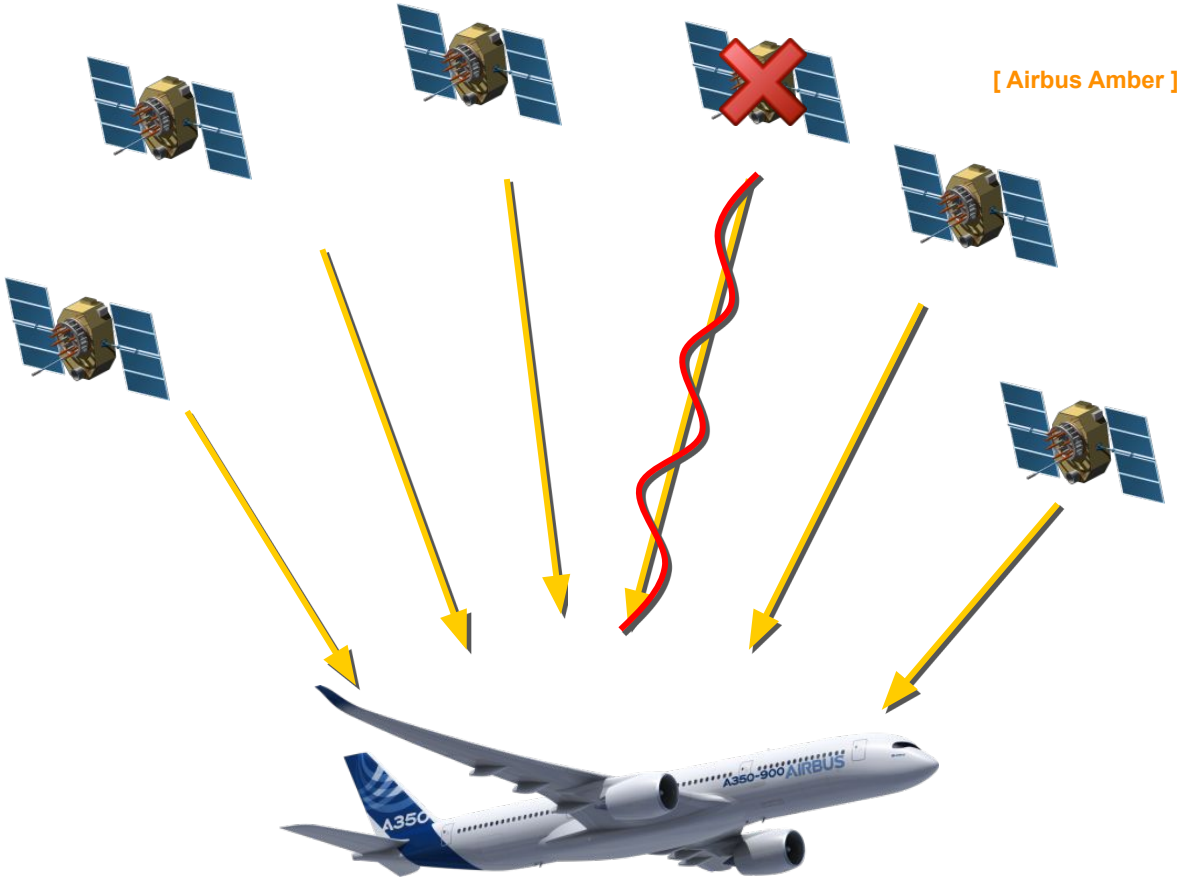
- **RNP operation requires GPS**
  - **Check the GNSS availability at dispatch**

- **“RAIM prediction”**

- **Check the number of satellites in sight**

But

- **GPS hybridation on Airbus A/C**
- **Check the availability of GPS PRIMARY**



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CHECK GNSS Availability at dispatch

with 24 satellites worldwide,
GPS PRIMARY function available all the time

GNSS AVAILABILITY

SHOW TREE Path : FCOM / PRO / NOR / SOP / Flight Preparation / GPS PRIMARY Availability (If Installed) /

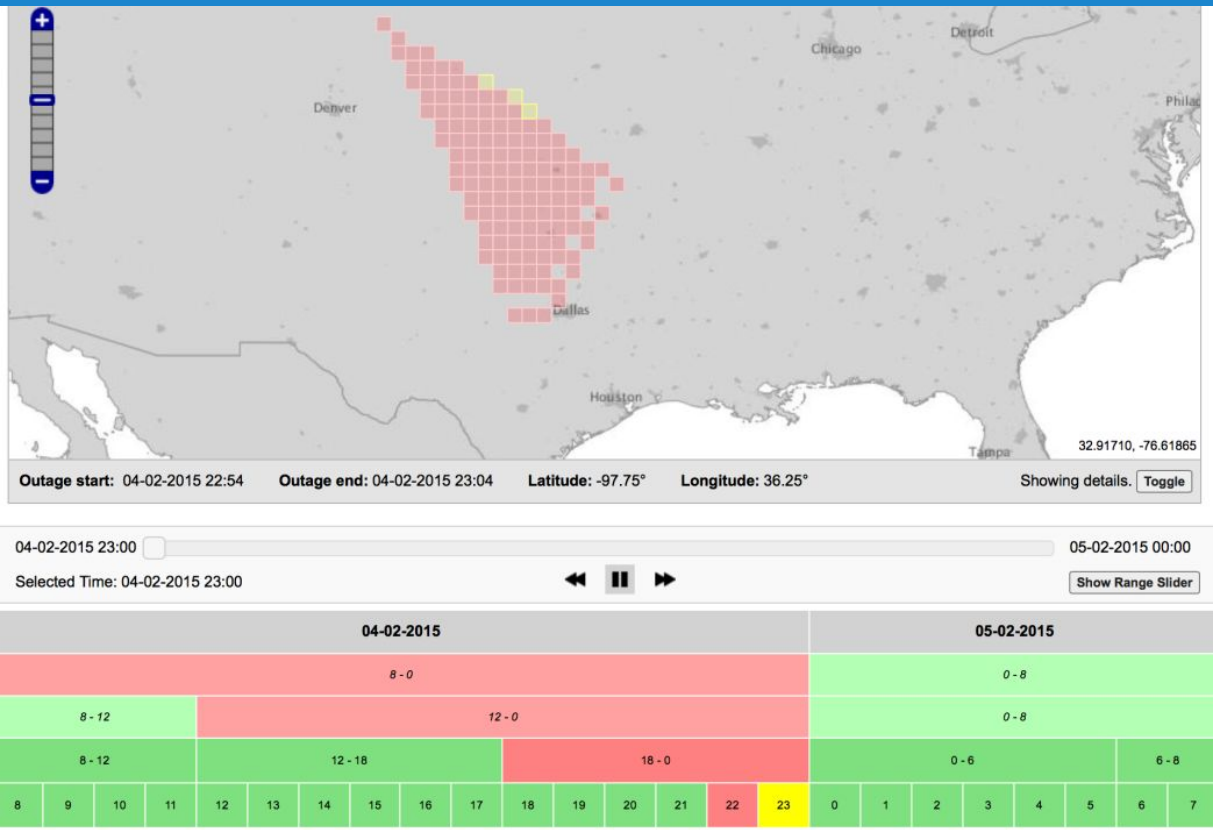
GPS PRIMARY AVAILABILITY (IF INSTALLED)

For RNP operations requiring RAIM check:
RAIM availability may be checked using the PREDICTIVE GPS MCDU page.

For RNP operations requiring RAIM/AIME check:
RAIM and AIME are available worldwide, if 24 GPS satellites or more are operative.
If the number of GPS satellites is 23 or less, the flight crew should check RAIM/AIME availability using the approved version of the Honeywell/Litton ground-based prediction software.
RAIM availability may be checked using the PREDICTIVE GPS MCDU page.

CHECK GNSS Availability at dispatch

Ground Based Prediction Program



Otherwise, **use Ground Based Prediction Program** when

- GNSS availability demonstration not declared in the AFM (old A/C)
- less than 24 satellites available
- Potential terrain masking of GNSS signal (RNP AR in montaineous area)

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[Airbus Amber]

AIRCRAFT DESIGN

Position

Flight Guidance

Cockpit HMI

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Flight Guidance modes

With Managed Modes

- **NAV mode**

- **Approach modes**
  - FPA|NAV
  - FINAL APP
  - APP-DES|NAV (A350)
  - FLS
  - SLS

#5 AIRCRAFT DESIGN

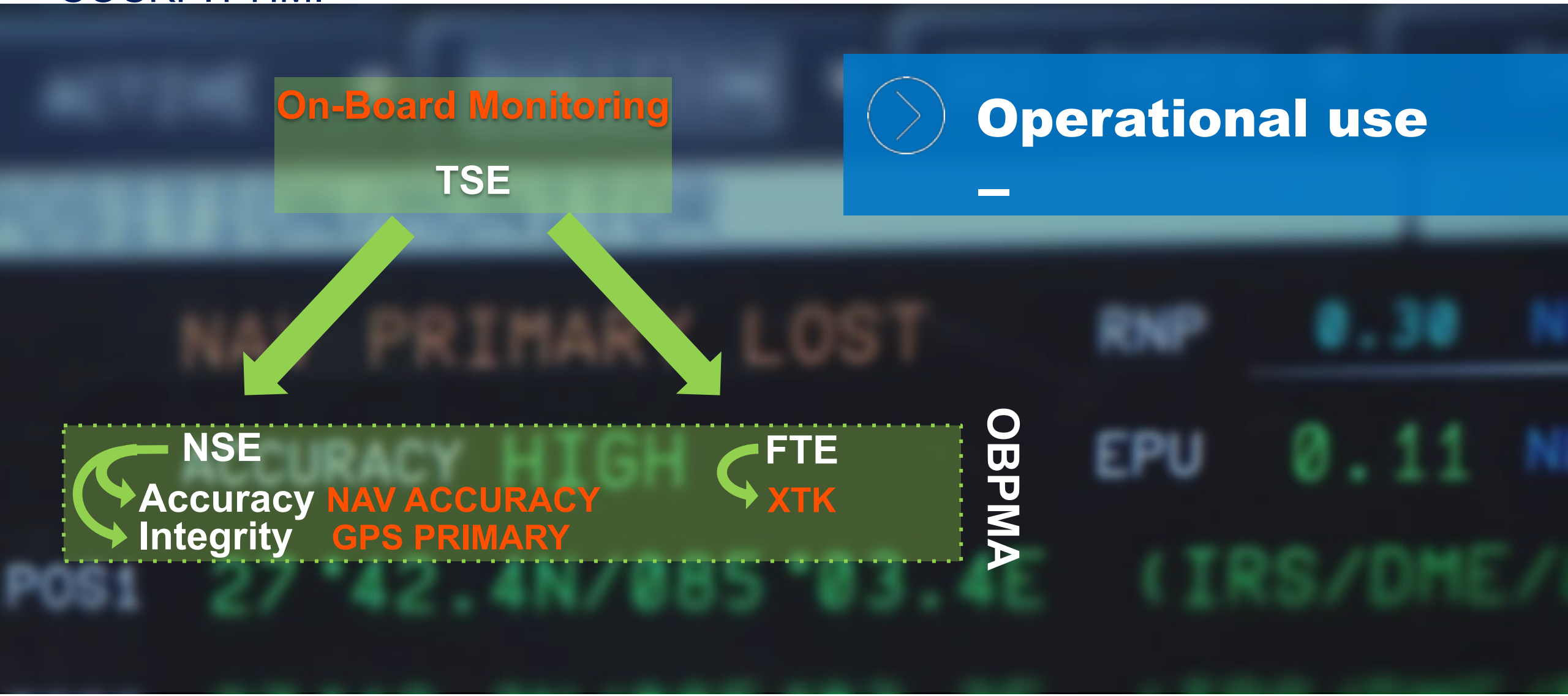
Position

Flight Guidance

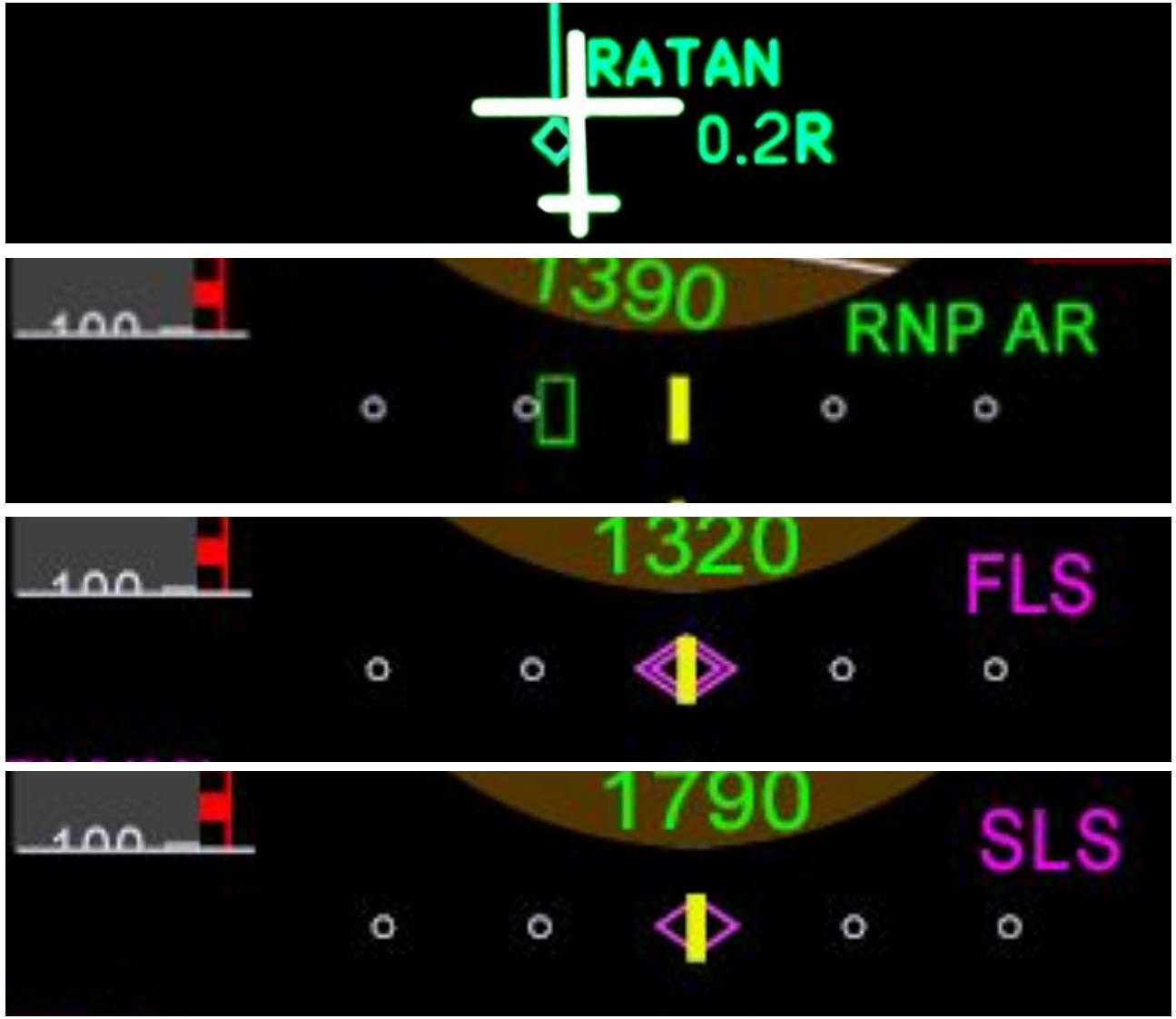
Cockpit HMI

AIRBUS

COCKPIT HMI


On-Board Monitoring
TSE
Operational use
NSE
Accuracy
Integrity
NAV ACCURACY
GPS PRIMARY
FTE
XTK
OBPMA

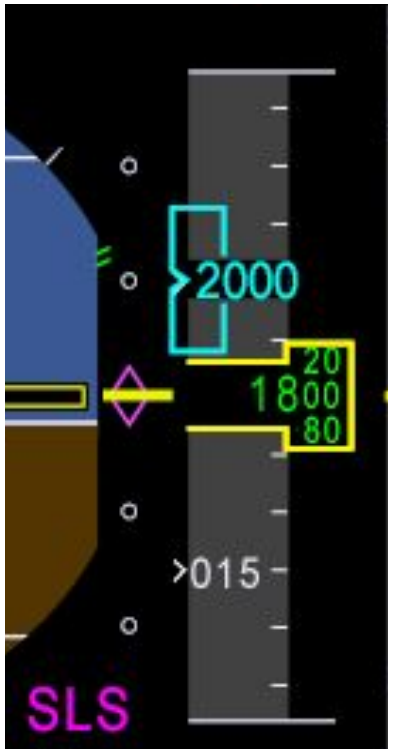
COCKPIT HMI – Lateral excursion monitoring

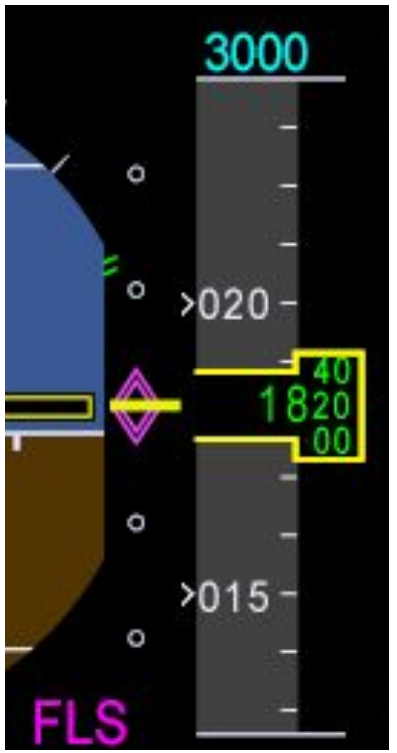


- **XTK on ND**
- **L/DEV on PFD**
- **xLS deviations**

COCKPIT HMI – Vertical excursion monitoring

V/DEV on PFD





xLS deviations

Material

Getting to Grips

AIRBUS World

Context | ICAO | Customization | Aircraft type: A300 | A300-600 | A3... | Tail Number - MSN | ATA: 34

- Home
- Search
- App catalogue
- Content library
- Downloads
- Publication tool
- HELP / Contacts

Content library

- Airworthiness and Certification
- Corporate Jets
- Events
- Flight Operations
  - Manuals
  - Operational Expertise
    - Digest of available enhancements
    - FOBN - Flight Operations Briefing Notes
    - Flight Deck and Systems Briefing For Pil...
    - Getting to Grips
  - Operational Material
  - Specific Flight Operations Topics
  - Miscellaneous
- Information on applications
- Leasing
- Maintenance and Engineering
- Material Solutions
- Publications
- Supplier Support
- Training

Use context

Revision Date: From to

Results :

and fuel saving	
Getting to Grips with Aircraft Noise	01 Dec 2003
Getting to Grips with Aircraft Performance	01 Jan 2002
Getting to Grips with Aircraft Performance Monitoring	01 Jan 2003
Getting to Grips with Cabin Safety	01 Apr 2015
Getting to Grips with Cat II & III Operations	01 Oct 2001
Getting to Grips with Cold Weather Operations	01 Dec 2015
Getting to Grips with Cost Index	01 May 1998
Getting to Grips with ETOPS volume 1: certification and approval	01 Dec 2014
Getting to Grips with ETOPS volume 2: the flight operations view	01 Dec 2014
Getting to Grips with FANS	01 May 2014
Getting to Grips with Fuel Economy	01 Oct 2004
Getting to Grips with MMEL and MEL	01 Jul 2005
Getting to Grips with Performance-Based Navigation (PBN) - High Resolution (50Mo)	09 Nov 2016
Getting to Grips with Performance-Based Navigation (PBN) - Light Edition (8Mo)	08 Nov 2016
	01 May 2009
Getting to Grips with Weight and Balance	01 Feb 2004

New issue planned in 2025

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Thank you

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