International Civil Aviation Organization

THE TENTH MEETING OF PERFORMANCE BASED NAVIGATION IMPLEMENTATION COORDINATION GROUP (PBNICG/10)

Bangkok, 19 - 21 April 2023

Agenda Item 6: PBN Training for ATC

PBN Training for ATC

(Presented by India)

SUMMARY

This paper describes the PBN training before implementation of RNP Approaches at the station is followed for ATCOs in India.

1. INTRODUCTION

1.1 Air traffic controllers, who provide control services at airports where RNP APCH operations down to LNAV or LNAV/VNAV minima, should have completed training as mentioned in Para 5.2.6.1. and 5.2.6.2. of Doc 9613.

2. DISCUSSION

The ATCOs of India are being trained and sensitized on PBN concepts and involved intricacies prior to implementations of PBN procedures at the Airports, considering ATC is the most critical link for safe and effective implementation of PBN. During this training program the undermentioned points are being discussed and emphasized including other associated concepts;

a) Navigation specifications
b) Various components of RNP-APCH
c) Effect of temperature
d) The importance of QNH setting for the PBN procedures
e) Phraseology/application of Separation

2.1 Brief Presentation showing the topics covered under ATCO training Program.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to: amend as appropriate

a) note the information contained in this paper; and
b) discuss any relevant matters as appropriate.

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AIRPORTS AUTHORITY OF INDIA

PBN TRAINING FOR ATCOs

Airports Authority of India

PBN training for ATCOs

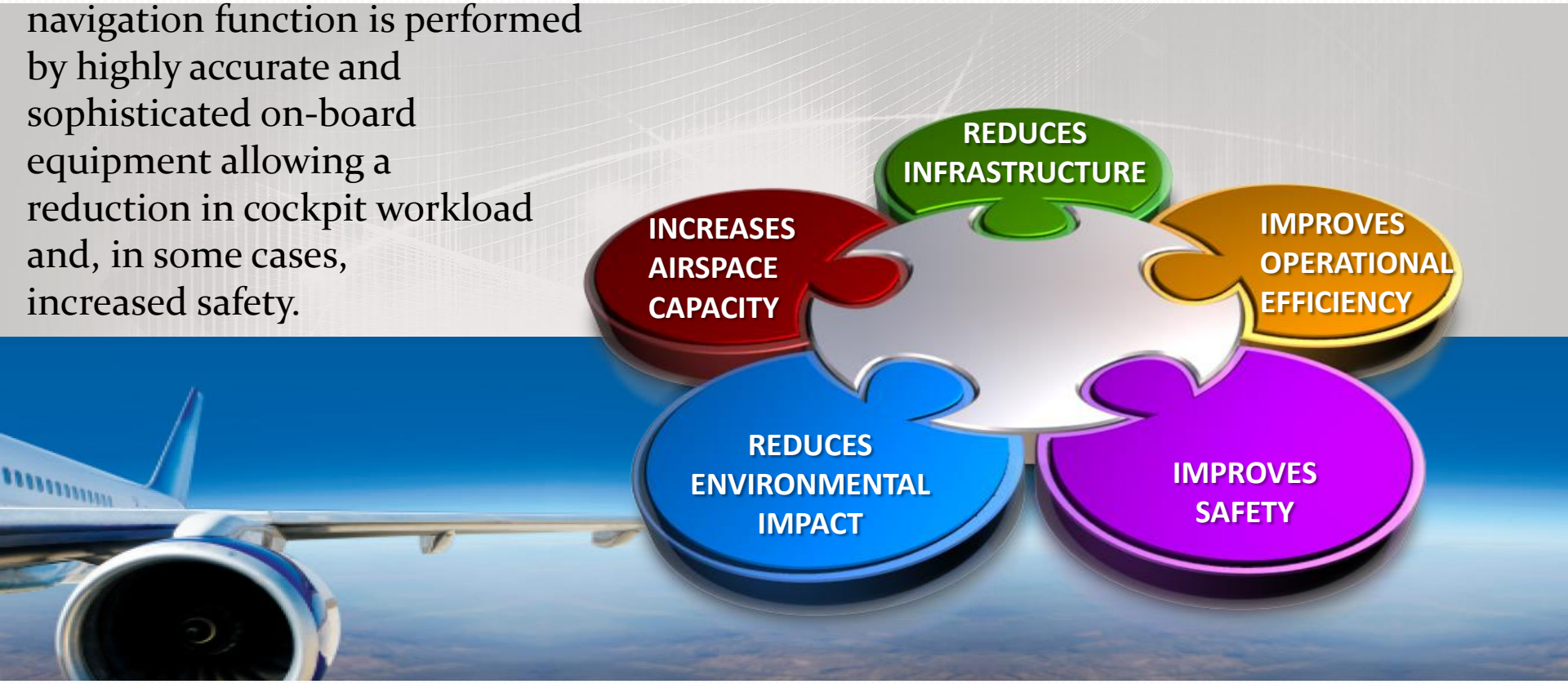
The ATCOs of India are being trained and sensitized on PBN concepts and involved intricacies prior to implementations of PBN procedures at the Airports, considering ATC is the most critical link for safe and effective implementation of PBN. During this training program the undermentioned points are being discussed and emphasized including other associated concepts;

- Navigation specifications
- Various components of RNP-APCH
- Effect of temperature
- The importance of QNH setting for the PBN procedures
- Phraseology/application of Separation

What is PBN?

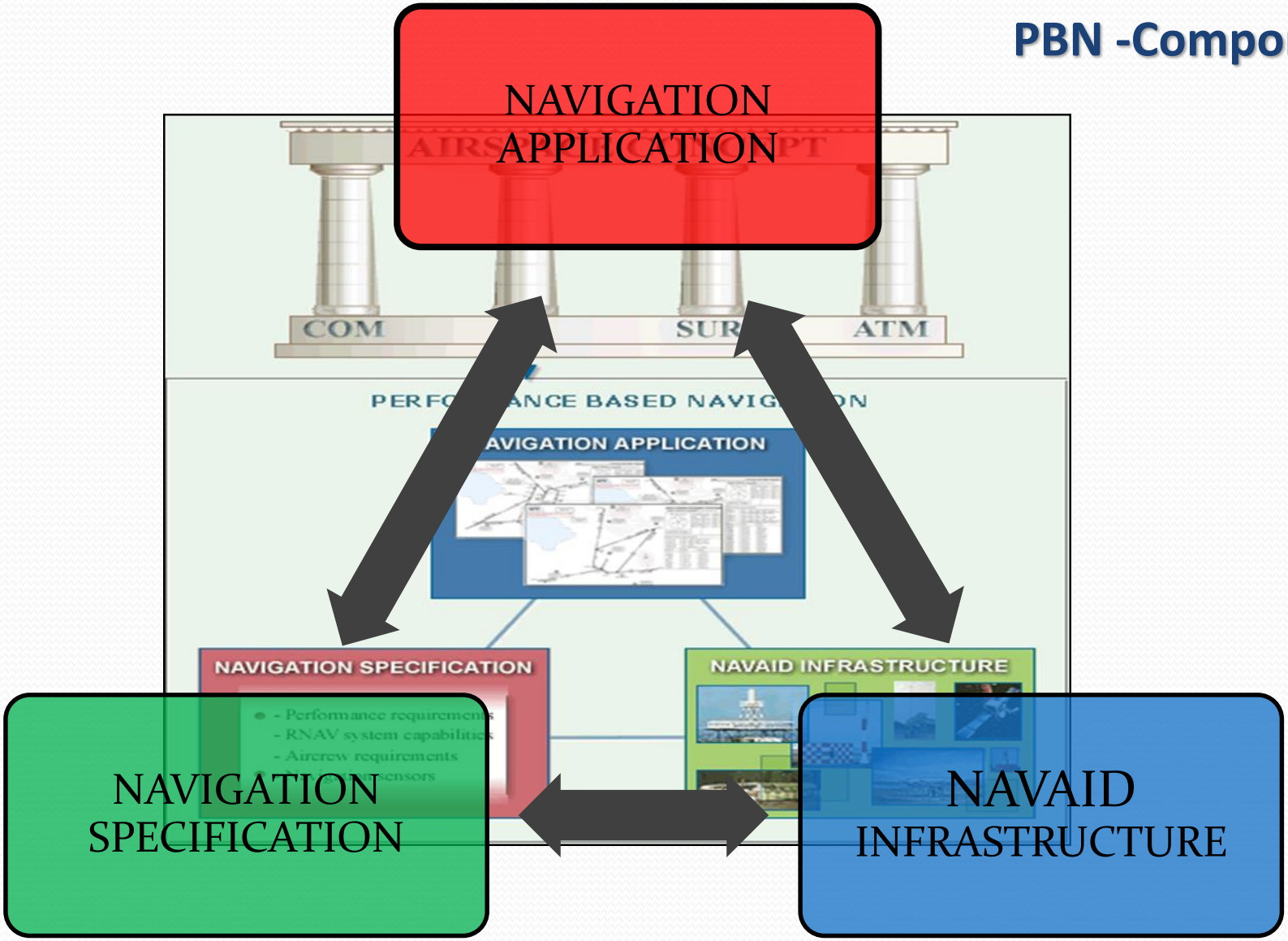
Benefits of PBN

navigation function is performed by highly accurate and sophisticated on-board equipment allowing a reduction in cockpit workload and, in some cases, increased safety.



What is PBN?

PBN -Component

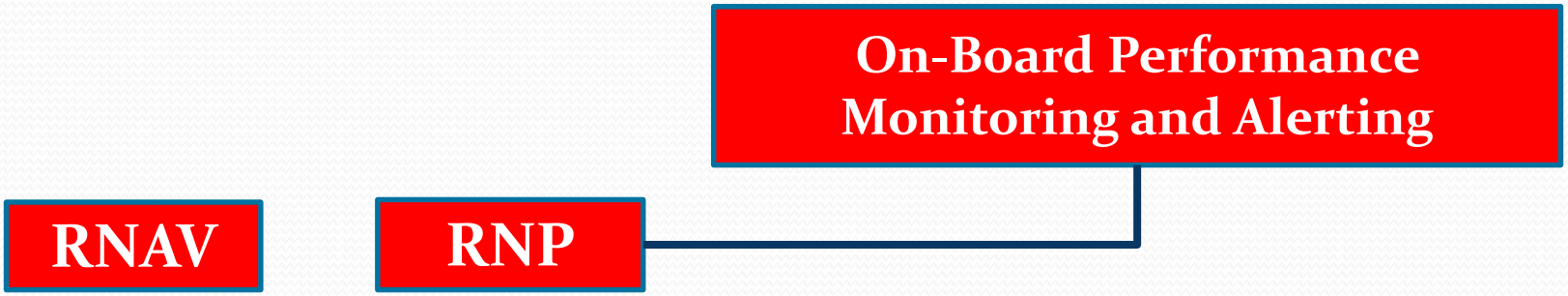


What is PBN?
Navigation Infrastructure

FMS

- GNSS
- INS / IRS
- DME DME
- VOR DME

What is PBN?
Navigation Specification



On-board performance monitoring and alerting capabilities provide: (OPMA)

- **Display and indication of both the required and the estimated navigation system performance**
- **Monitoring of the system performance and alerting the crew when RNP requirements are not met**

** OPMA may be provided in different forms depending on the system installation, architecture and configurations*

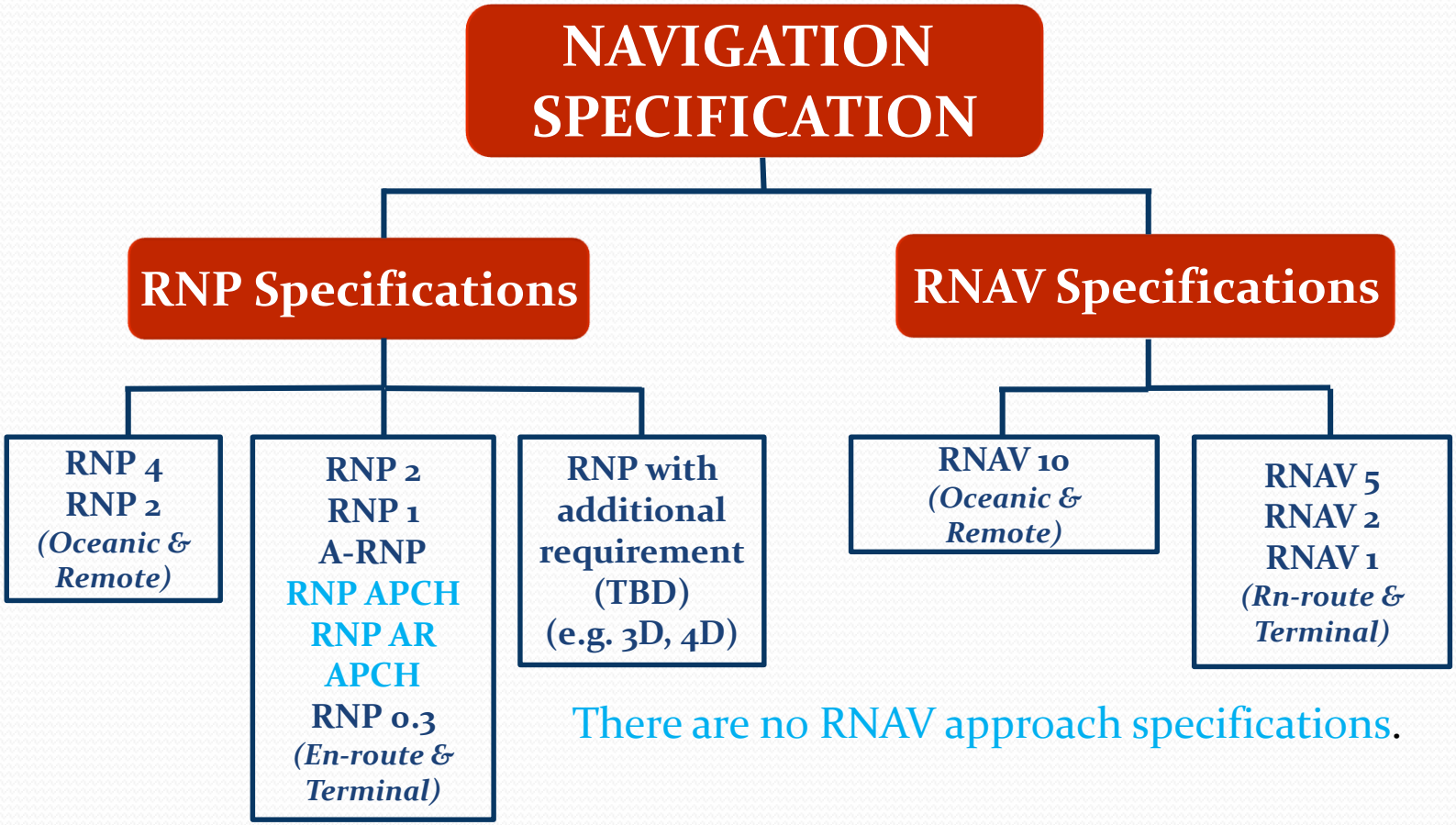
What is PBN?

Navigation Specification

- OPMA

What is PBN?

Navigation Specification



There are no RNAV approach specifications.

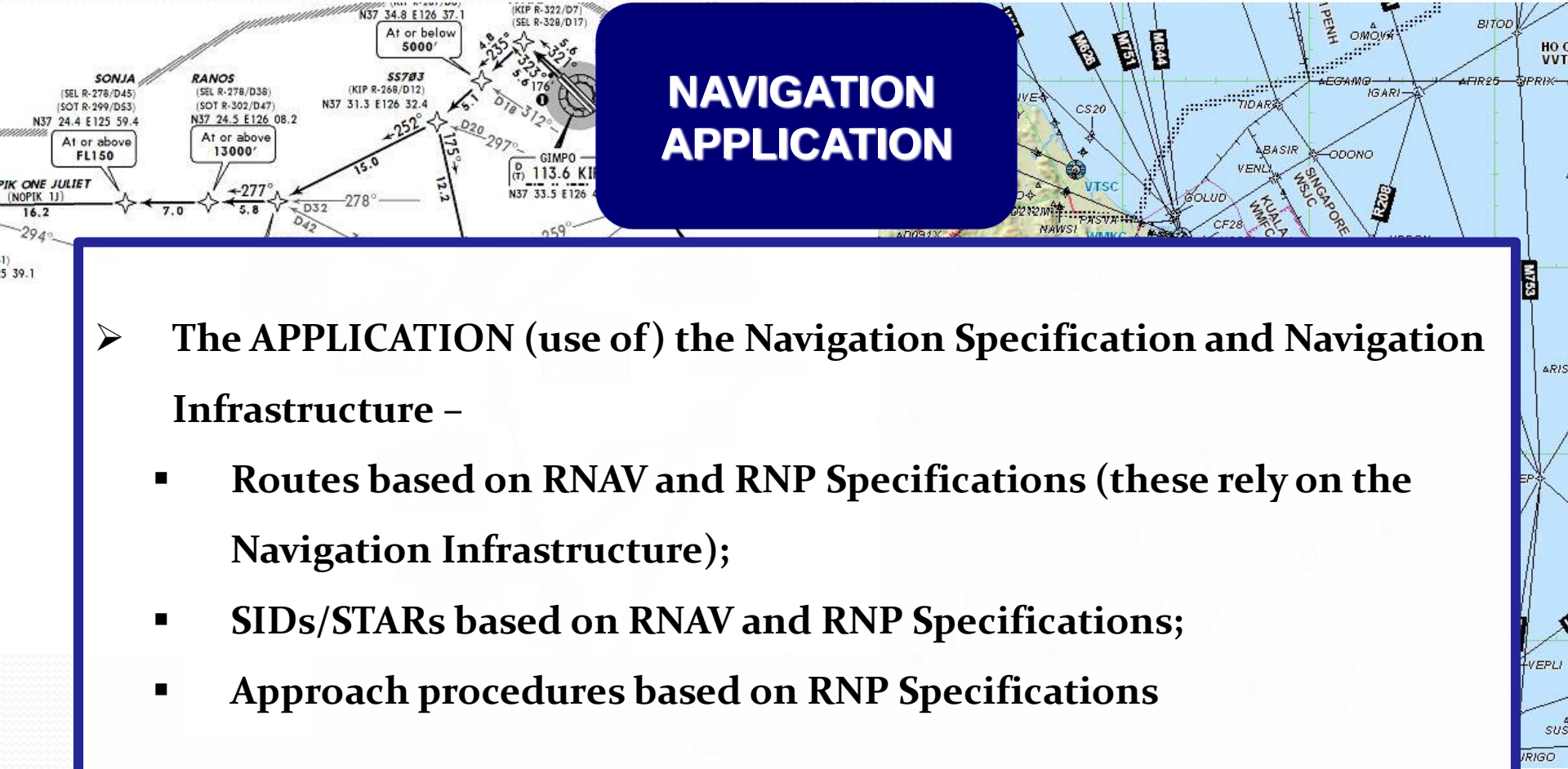
What is PBN?

Navigation Specification vs. Navigation Infrastructure

	GNSS	IRU	D/D	D/D/I	VOR/D
RNAV-10	X	X			
RNAV-5	X	X	X	X	X
RNAV -1 and RNAV -2	X		X	X	
RNP-4	X				
RNP-2	X				
RNP-1	X				
Advanced RNP	X				
RNP APCH	X				
RNP AR APCH	X				
RNP 0.3	X				

What is PBN?

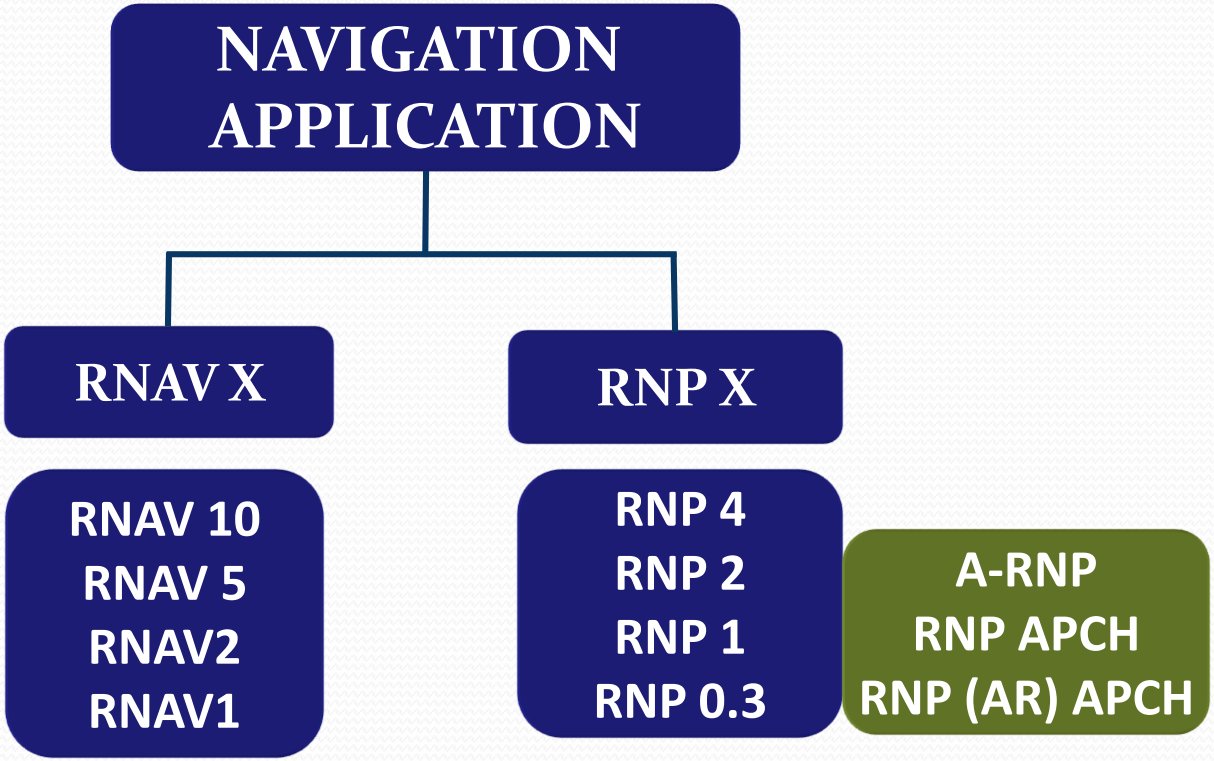
Navigation Application



- **The APPLICATION (use of) the Navigation Specification and Navigation Infrastructure –**
  - **Routes based on RNAV and RNP Specifications (these rely on the Navigation Infrastructure);**
  - **SIDs/STARs based on RNAV and RNP Specifications;**
  - **Approach procedures based on RNP Specifications**

What is PBN?

Navigation Application



X = Navigation Accuracy in NM 95% of flight time

Components of RNP Approaches

Waypoints

Two types of waypoint is used to define a flight path

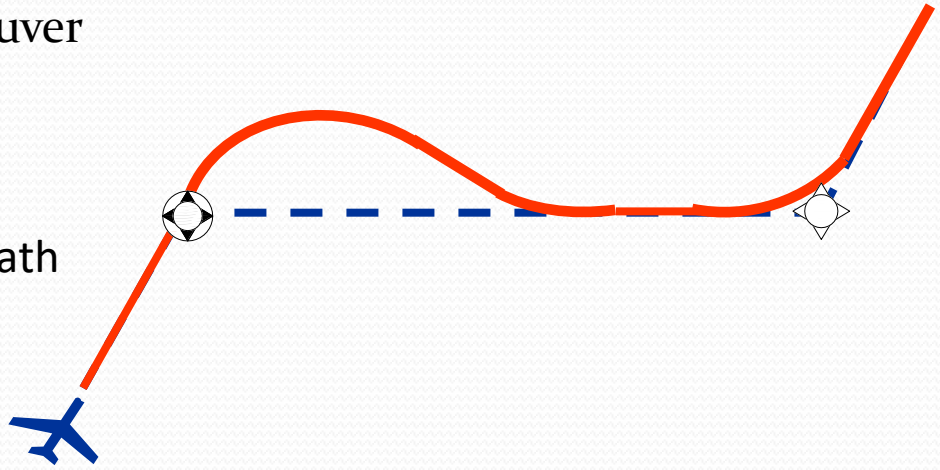
- Fly-over waypoint :
- Fly-by waypoint :

Minimum Stabilization Distance (MSD)

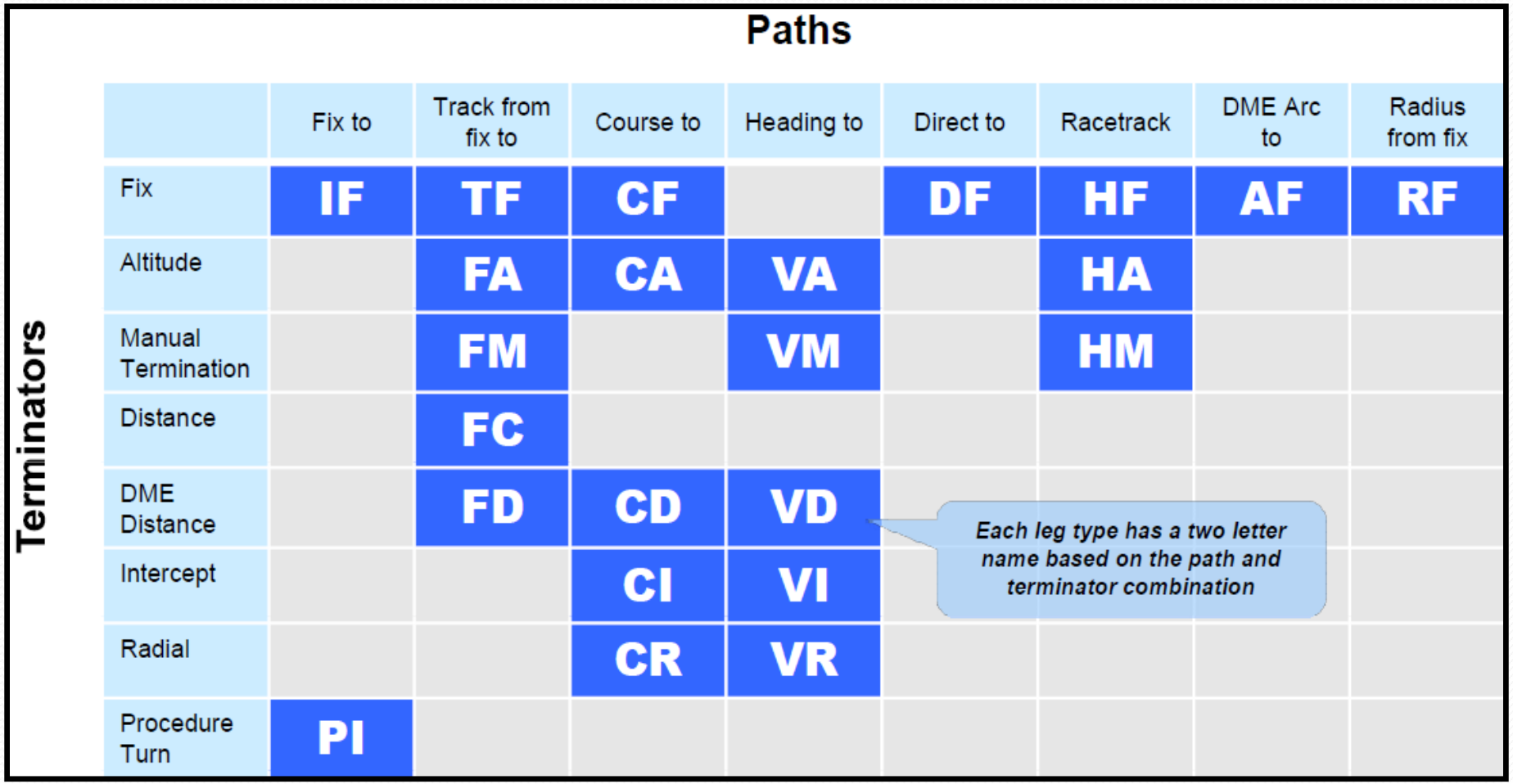
The minimum distance to complete a turn maneuver and after which a new maneuver can be initiated.

Path Terminators

Transform procedures into coded flight path



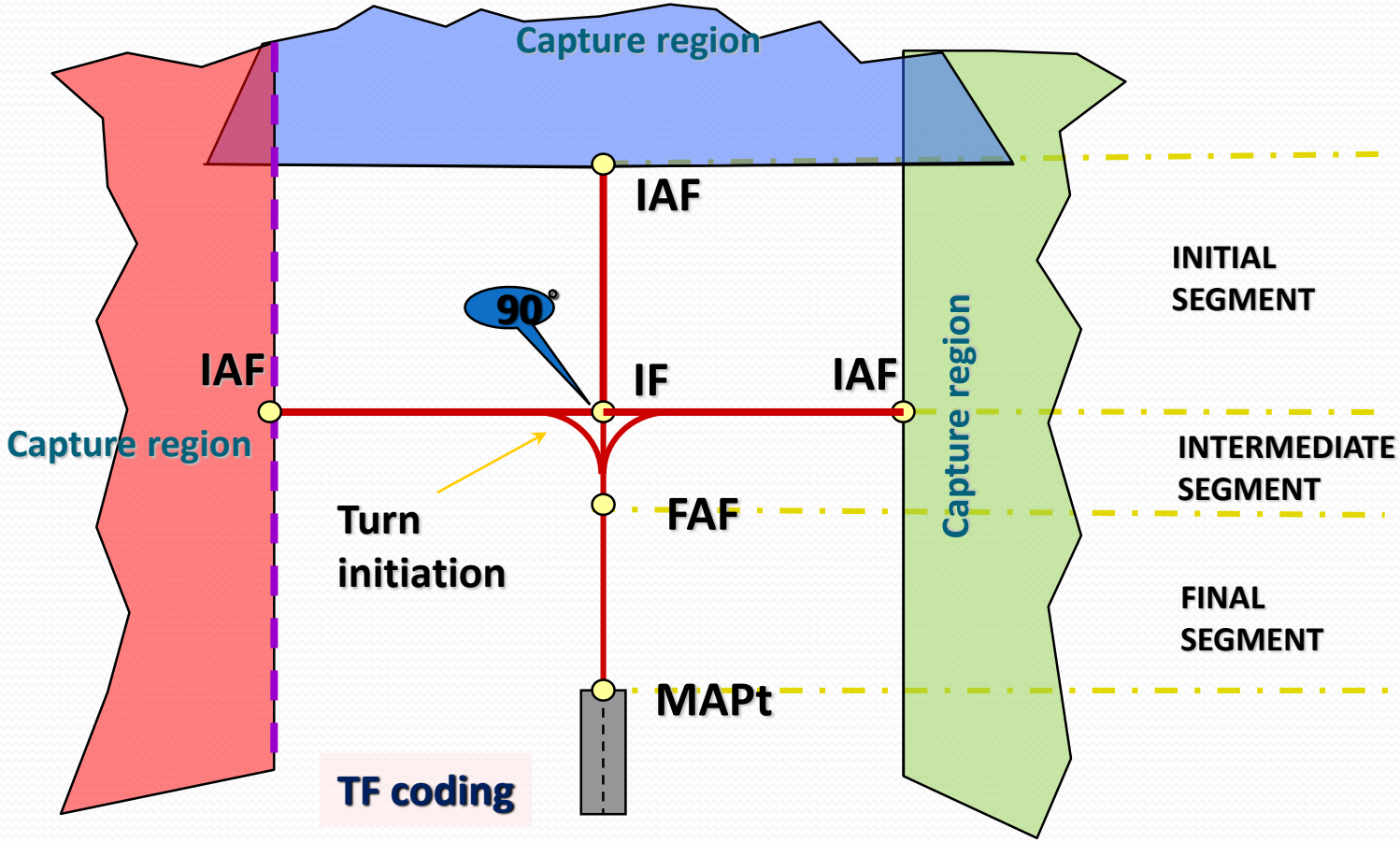
Components of RNP Approaches
Path Terminators



Components of RNP Approaches

T - Bar Procedure Construction

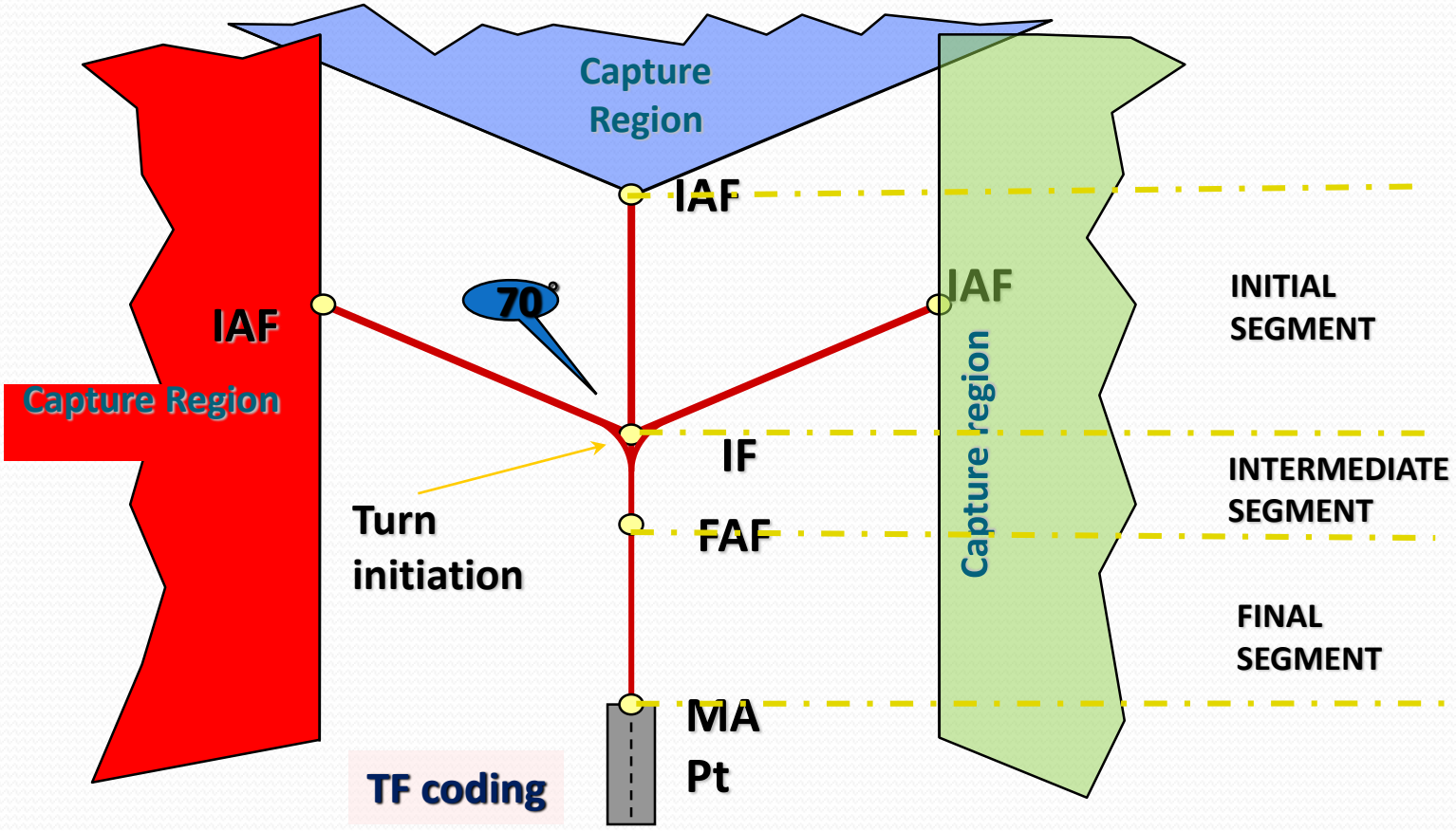
T Bar Concept



Components of RNP Approaches

Y -Bar Procedure Construction

Y Bar Concept



Components of RNP Approaches

RNP Approach

- RNP APCH = Sensor used GNSS (ABAS or SBAS)
- DMEDME and VORDME are not acceptable for RNP APCH
- It is an RNP application ⇒ OPMA function
- RNP = 1 Nm for initial, intermediate and missed approach
- RNP = 0.3 Nm for final
- No vertical guidance : 2D RNP APCH
  - LNAV
- Vertical guidance : 3 D RNP APCH
  - LNAV VNAV baro vertical guidance
  - LPV SBAS vertical guidance

LPV (Localizer Performance with Vertical guidance) is similar to LNAV/VNAV except it is much more precise (40m lateral limit), enables descent to 200-250 feet above the runway

Components of RNP Approaches

Baro-VNAV

- APV (Approach Procedures with Vertical Guidance) – supports Type A operation
- GNSS (lateral guidance) + Barometric altimeter (vertical guidance)
- Cannot be used with remote altimeter setting
- DA/H, not MDA/H
- No FAF and MAPt (instead FAP)
- The LNAV-only FAF and MAPt are used to define the areas but are not part of the VNAV procedure.
- 3° Vertical Path Angle defined from FAP to THR above 50ft
- Considers cold temperature correction during designing procedures
- Publishes a minimum promulgated temperature
- Identified as “LNAV/VNAV” in the minimum box

Temperature limits

- For aircraft using Baro-VNAV without temperature compensation to conduct the approach, low temperature limits are reflected in the procedure design and identified along with any high temperature limits on the charted procedure. Cold temperatures reduce the actual GPA, while high temperatures increase the actual GPA. Aircraft using Baro-VNAV with temperature compensation or aircraft using an alternate means for vertical guidance (e.g. SBAS) may disregard the temperature restrictions.

Components of RNP Approaches

Baro-VNAV

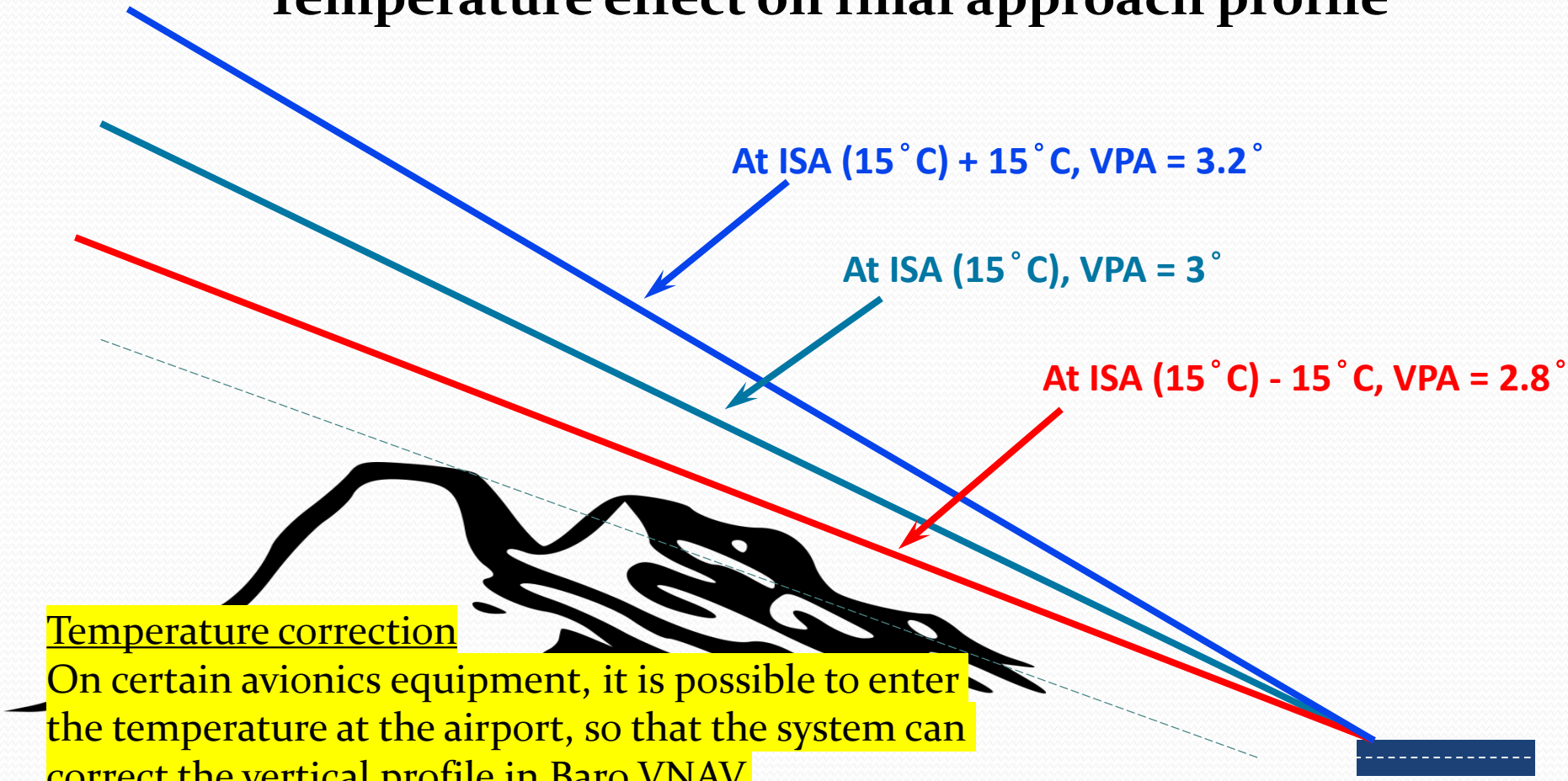
Temperature effect on final approach profile

- Actual flight altitude is lower in cold days than in warm days since air mass is compressed
- The minimum obstacle clearance actually achieved could be lower than the prescribed minimum obstacle clearance
- In order to prevent this, pilots shall correct for low temperatures
- Pilots are responsible for any necessary cold temperature corrections to all published minimum altitudes/heights
- Minimum temperature for which Baro-VNAV is authorized is published

Components of RNP Approaches

Baro-VNAV

Temperature effect on final approach profile



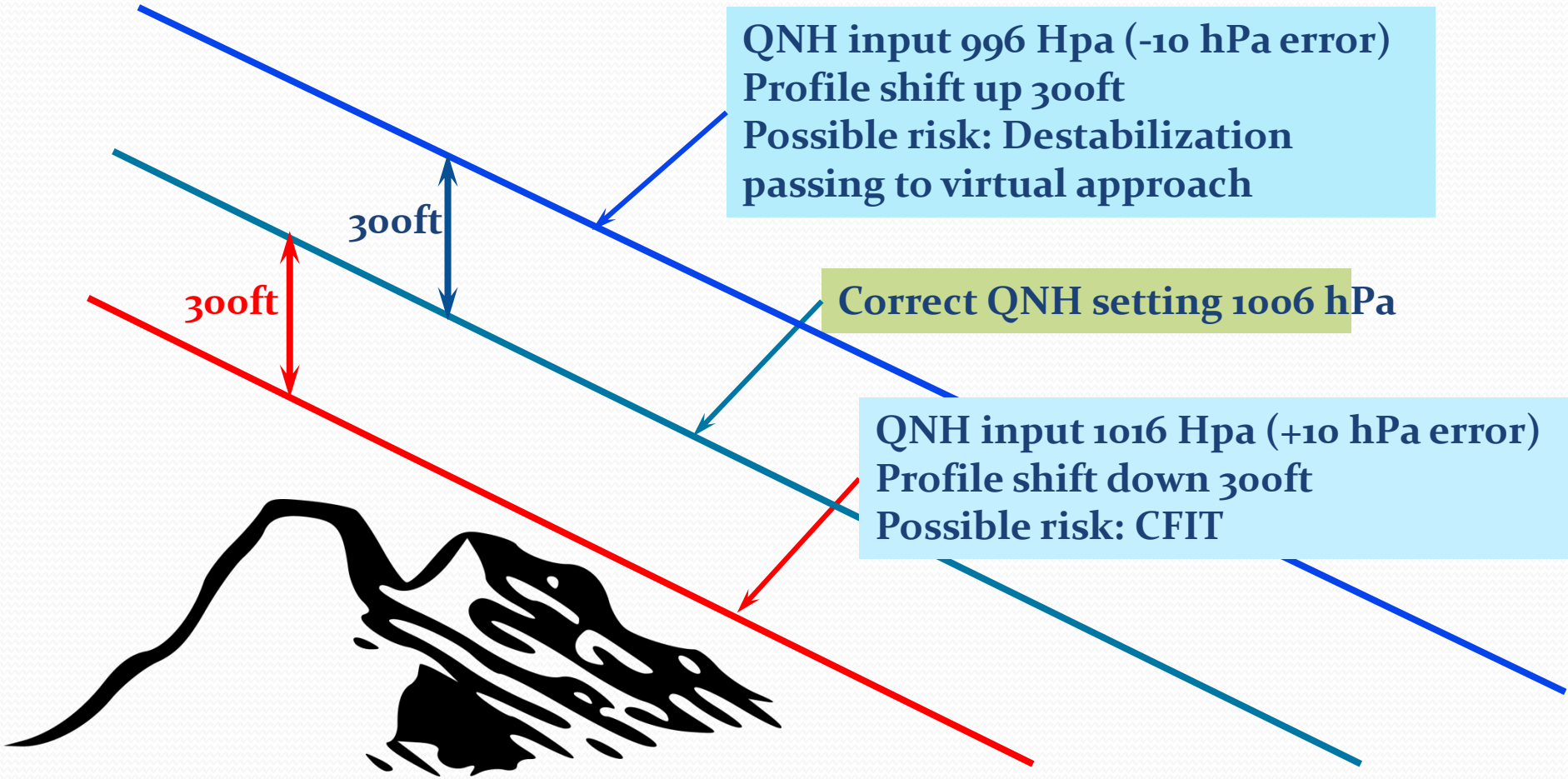
Temperature correction

On certain avionics equipment, it is possible to enter the temperature at the airport, so that the system can correct the vertical profile in Baro VNAV.

Components of RNP Approaches
Procedure Construction

Baro-VNAV

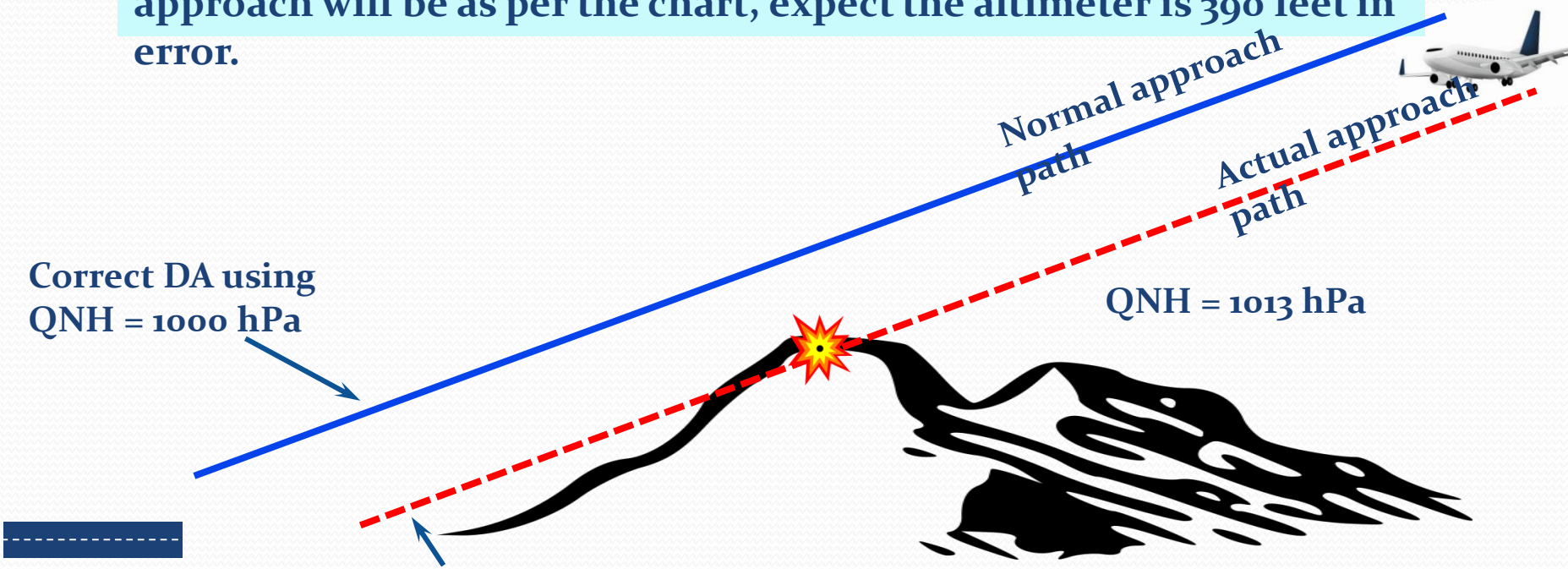
Altimeter Setting Error



Components of RNP Approaches
Procedure Construction

Baro-VNAV
Altimeter Setting Error

The aircaft flies a descent path which is 390 feet (13x30ft) below the required path. The barometric information display to the crew is incorrect. All distance and barometric altitude checks during the approach will be as per the chart, expect the altimeter is 390 feet in error.



Equipage-Flight Plan

- ATC need to identify aircraft capability from the flight plan
- Aircraft capabilities are shown at
  - Item 10 Equipment and capabilities
    a) presence of relevant serviceable equipment on board the aircraft, e.g. GNSS, Inertial Navigation, DME, VOR
    b) equipment and capabilities commensurate with flight crew qualifications, e.g. GLS, LPV
    c) where applicable, authorization from the appropriate authority, e.g. PBN
  - Item 18 Other information
    - RNAV/ and/or PBN/
    - NAV/
    - RMK/

Phraseologies

Confirmation of PBN Approval

- To ascertain PBN approval status of an aircraft,
- Confirm (Navigation Specification) Approved
- To establish aircraft position:

report established on final approach track/ report 2 miles from final approach fix/report passing final approach fix

- Phraseology for RNP APCH (e.g. RWY 14)

ATC: (C/S) cleared RNP Approach Runway 14, or Expect RNP Approach Runway 14.

- In case of loss of RNP capability:

P: (C/S) unable RNP due equipment

- In case of degradation of navigation performance:

P: (C/S) unable RNP due (reason, e.g. loss of RAIM, or RAIM alert)

Contingency Procedures

GNSS failure/interference

- If ATC is aware of problems with the GNSS system, the information shall be provided for pilot
  - Notify related authority of the received information to find out the source of interference for appropriate action.

GNSS NOTAM

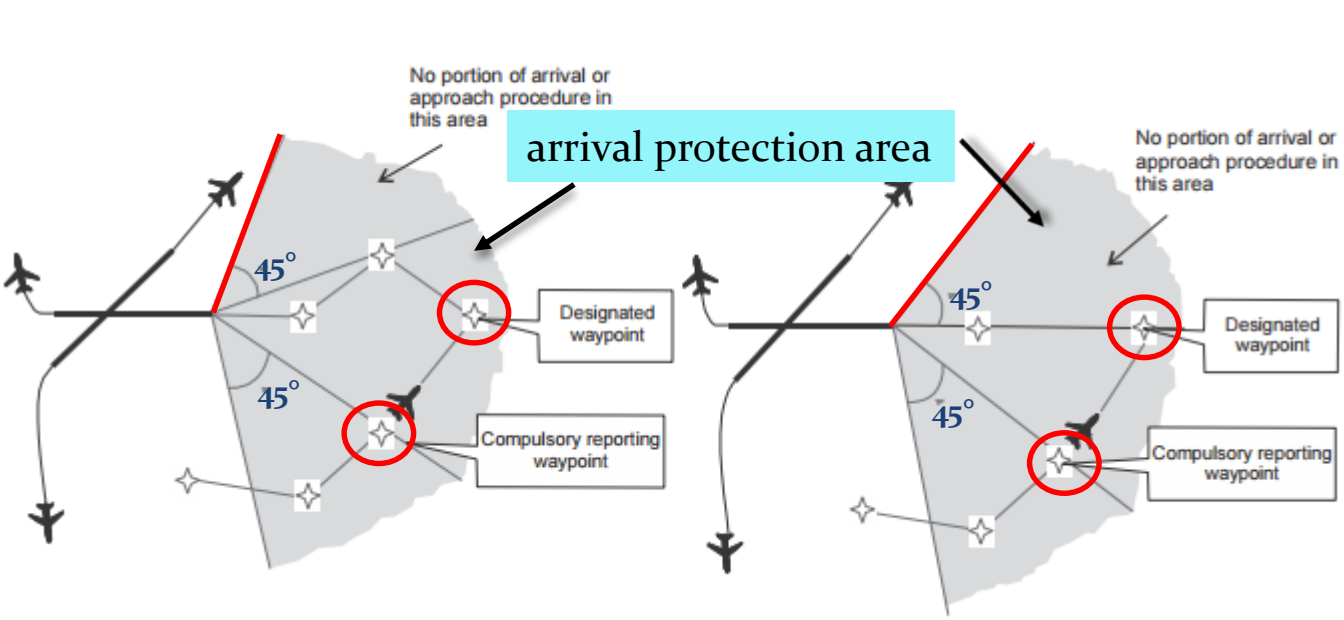
- Availability of GNSS is published by NOTAM (RAIM prediction Notam is issued on daily basis by all NOF centers)

Communication Failure

- **Action as per published RCF procedures**

Separation of departing aircraft from arriving aircraft

- If an arriving aircraft is following RNAV/RNP IFP, a departure path should be clear of the arrival protection area by:
  - Vertical separation until passing the predetermined compulsory reporting waypoint on IFP
  - Taking off before the arriving aircraft crosses a designated waypoint on IFP
  - the departing aircraft remains clear of the arrival protection area until another form of separation is established.



RNP Approach Charts

Minima Box

Type of approach	Type of guidance	MDA or DA	Minima line
NPA	lateral	MDA	LNAV
APV baroVNAV	Lateral Vertical	DA	LNAV/VNAV

Benefits in terms of ATC

- Fewer radio transmissions consequently less chance of readback/readback errors
- Better flight path predictability
- Airspace Containment
- Stabilised approaches hence fewer go-arounds.

AIRPORTS AUTHORITY OF INDIA

THANKYOU !