

# What is PBN?

## Module 2

European Airspace Concept Workshops  
for PBN Implementation

# Overview

## Learning Objectives:

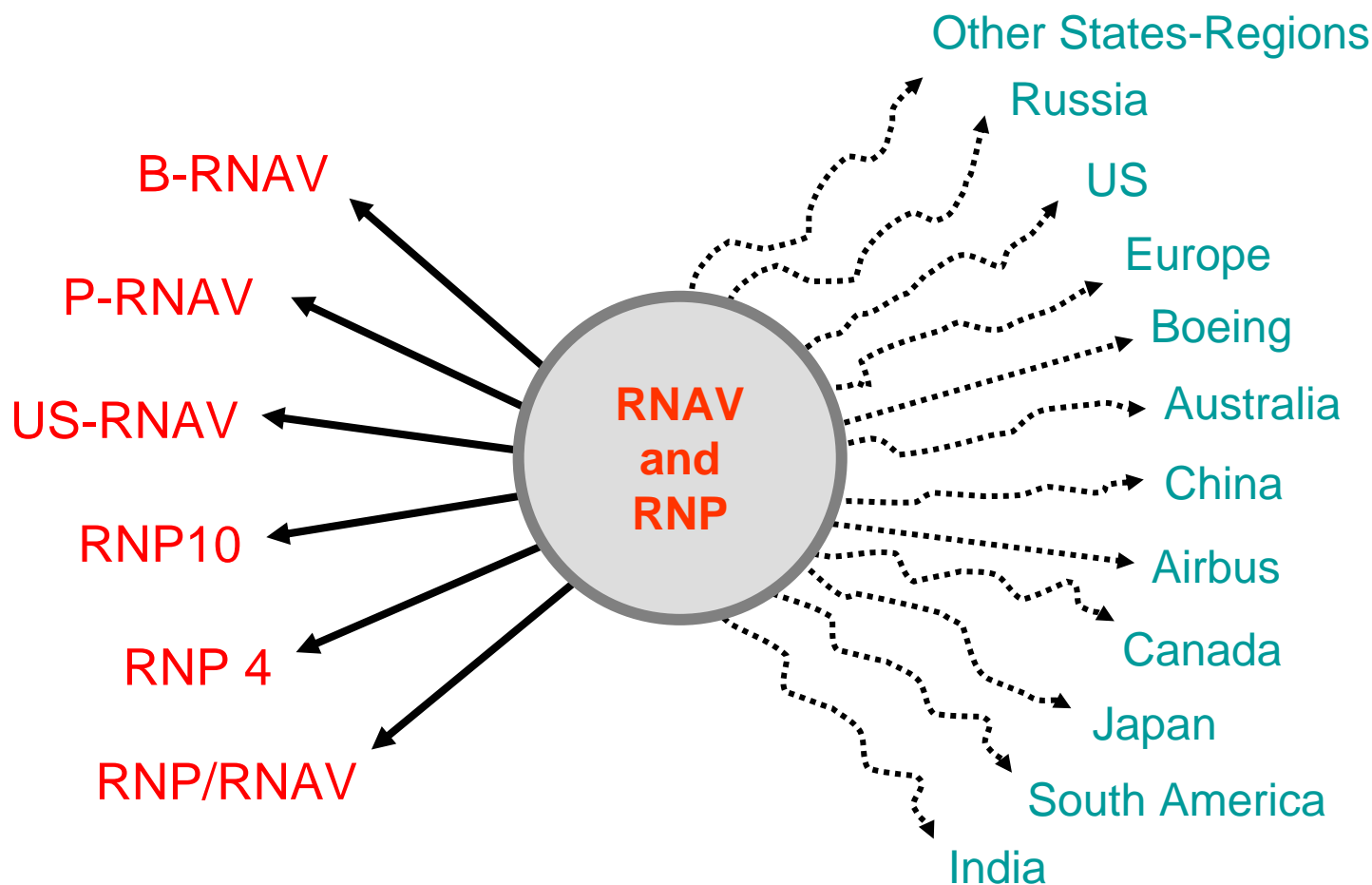
- At the end of this presentation you should:
  - Understand what is RNAV and RNP and how correct use can improve operational efficiency and Airspace Capacity
- This presentation will discuss
  - Navigation in Context
  - Evolution to Performance Based Navigation
  - Performance Based Navigation
    - What is it?
    - What is RNAV?
    - What is RNP?
    - What is the Key Difference?

# Navigation before PBN

- There was the RNP concept, which
  - Did not specify the need for an RNAV system
  - Sometimes sounded as if it was all about lateral accuracy
  - Had each ICAO region inventing its own interpretation
- The result
  - Cost to operators, who had to qualify several times to operate in 'RNP' airspace where the RNP 'value' was the same.
  - Confusion in the stakeholder community – uncertainty as to what RNP meant.

# Action was Required

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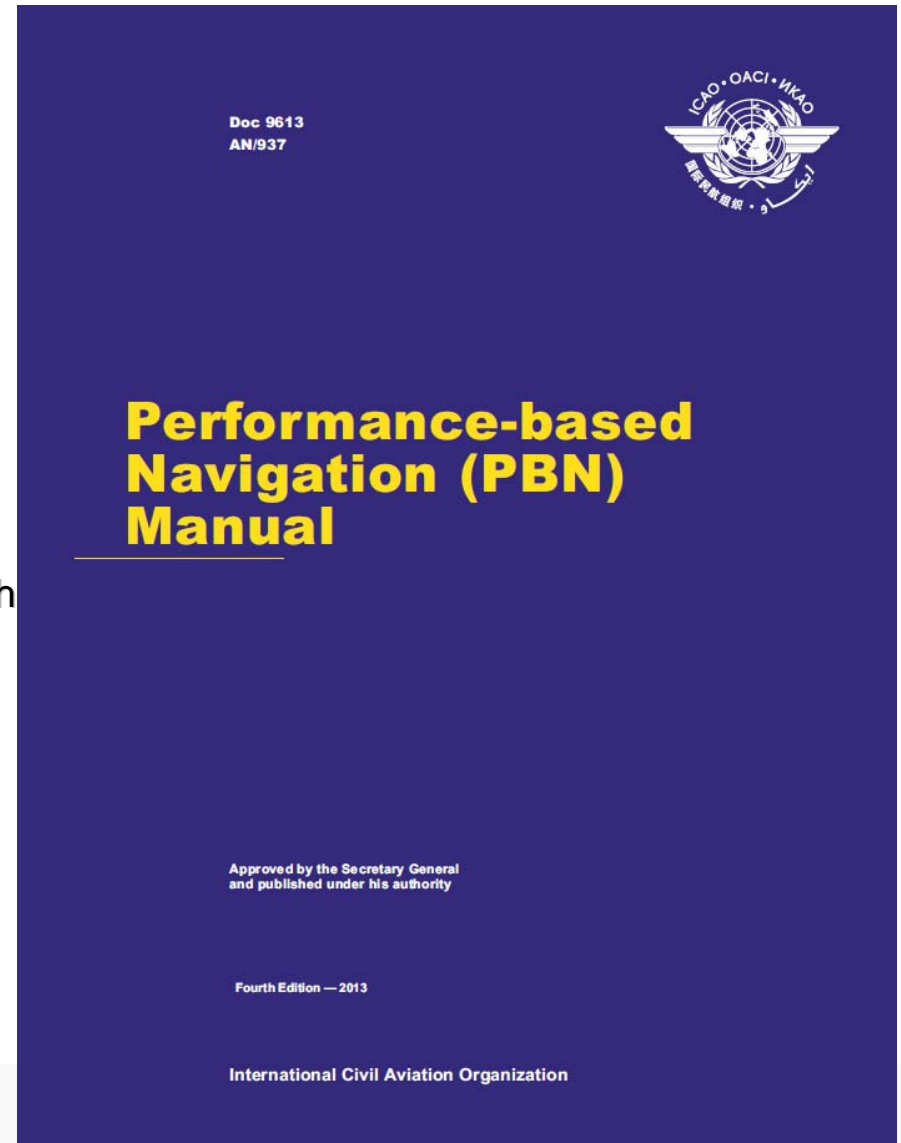
# RNPSORSG Main Goals

- Achieve and document a common understanding of RNP and RNAV and associated concepts and functionalities
  - Define RNAV and RNP
  - How do they relate to each other?
  - What is the essential distinction?
- Harmonize use of RNP and RNAV on global basis, for benefit of operators and service providers
  - Identify operational and airworthiness requirements for RNP and RNAV

# Enter Performance Based Navigation



- *PBN Concept* replaced RNP Concept
- Publication of Doc 9613, PBN Manual
- Resolution of ICAO's 36<sup>th</sup> Assembly then reiterated at 37<sup>th</sup> Assembly
- ICAO global PBN seminars
- Manual updated in 2013



# PBN SG



- In November 2008, RNPSORSG replaced by Performance Based Navigation Study Group (PBN SG)
- Aims:
  - Consolidate information learnt during ICAO Seminars
  - Develop Operational Requirements for RNAV and RNP

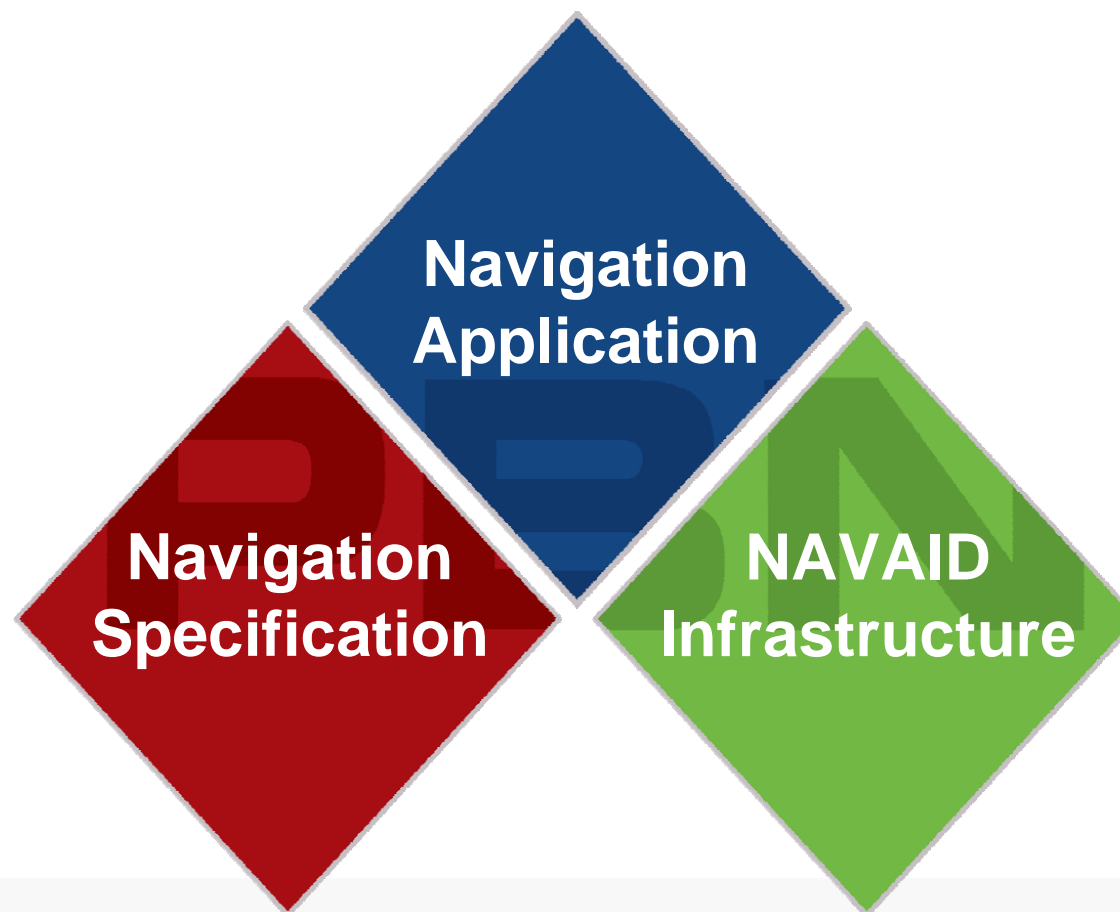


# Transition to Performance Based Navigation

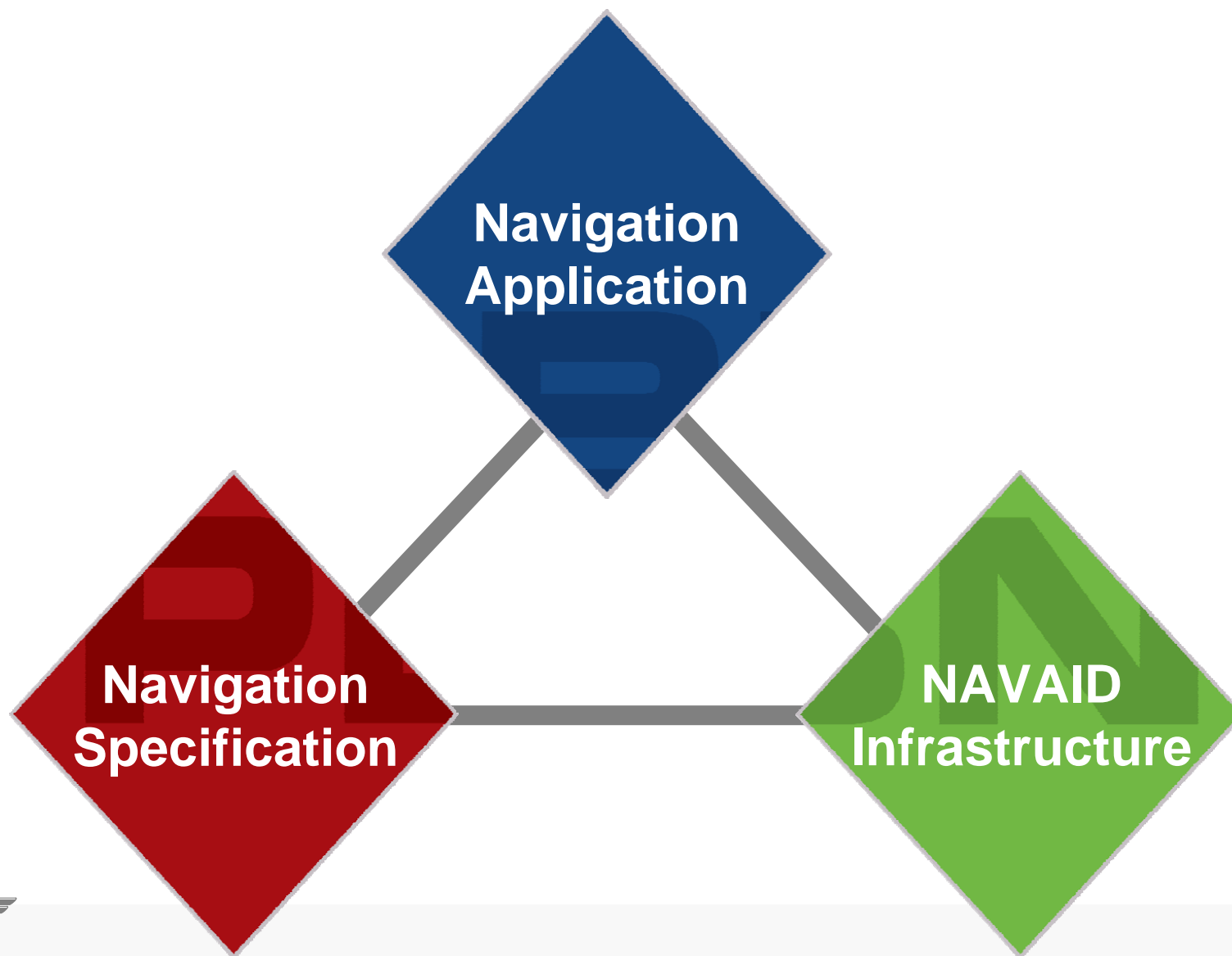
- Navigation based on specified system performance requirements for aircraft operating on a ATS route, instrument approach procedure, or in a designated airspace



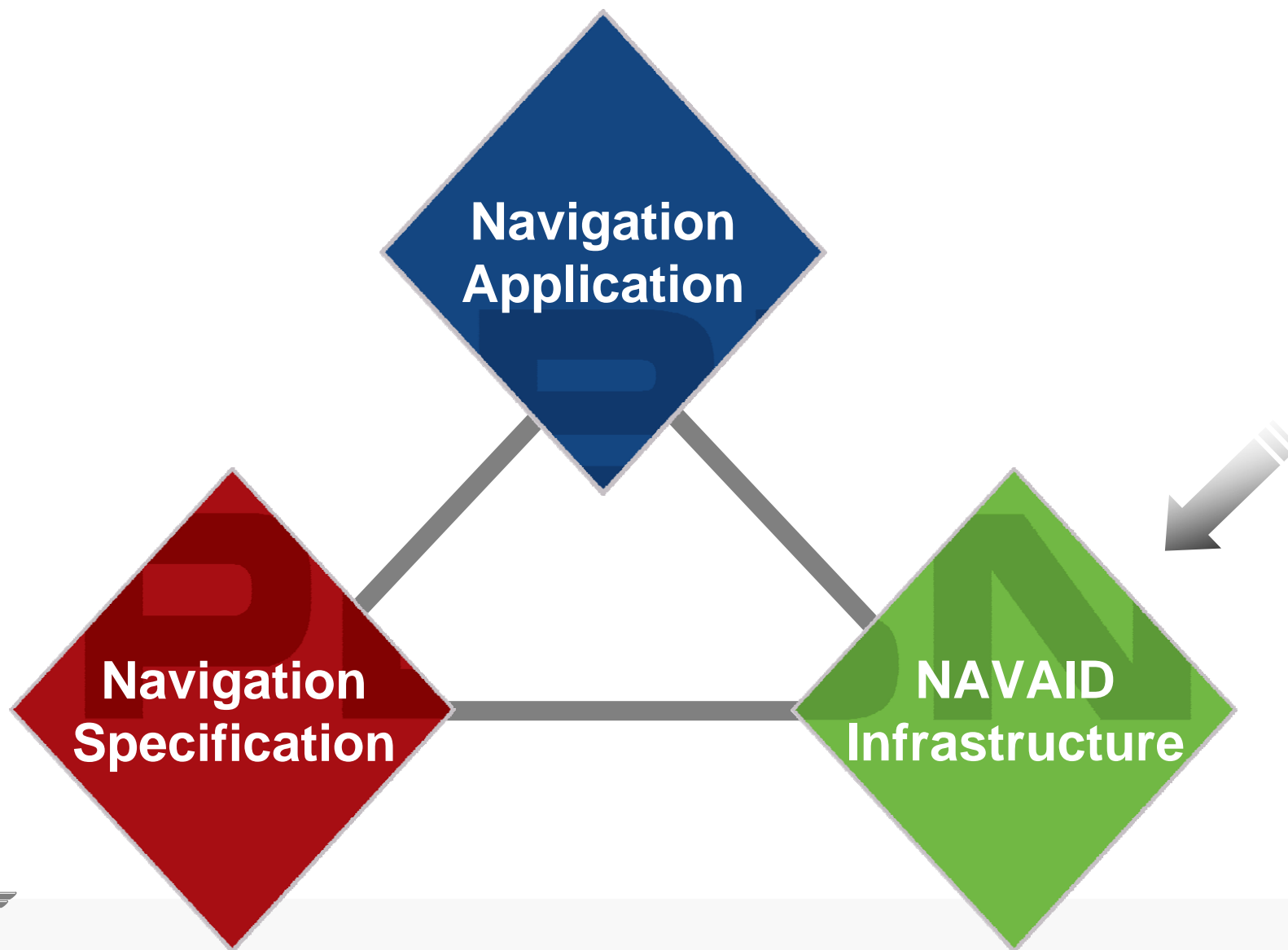
# What is PERFORMANCE-BASED NAVIGATION?



# Components of PBN Concept



# Components of PBN Concept



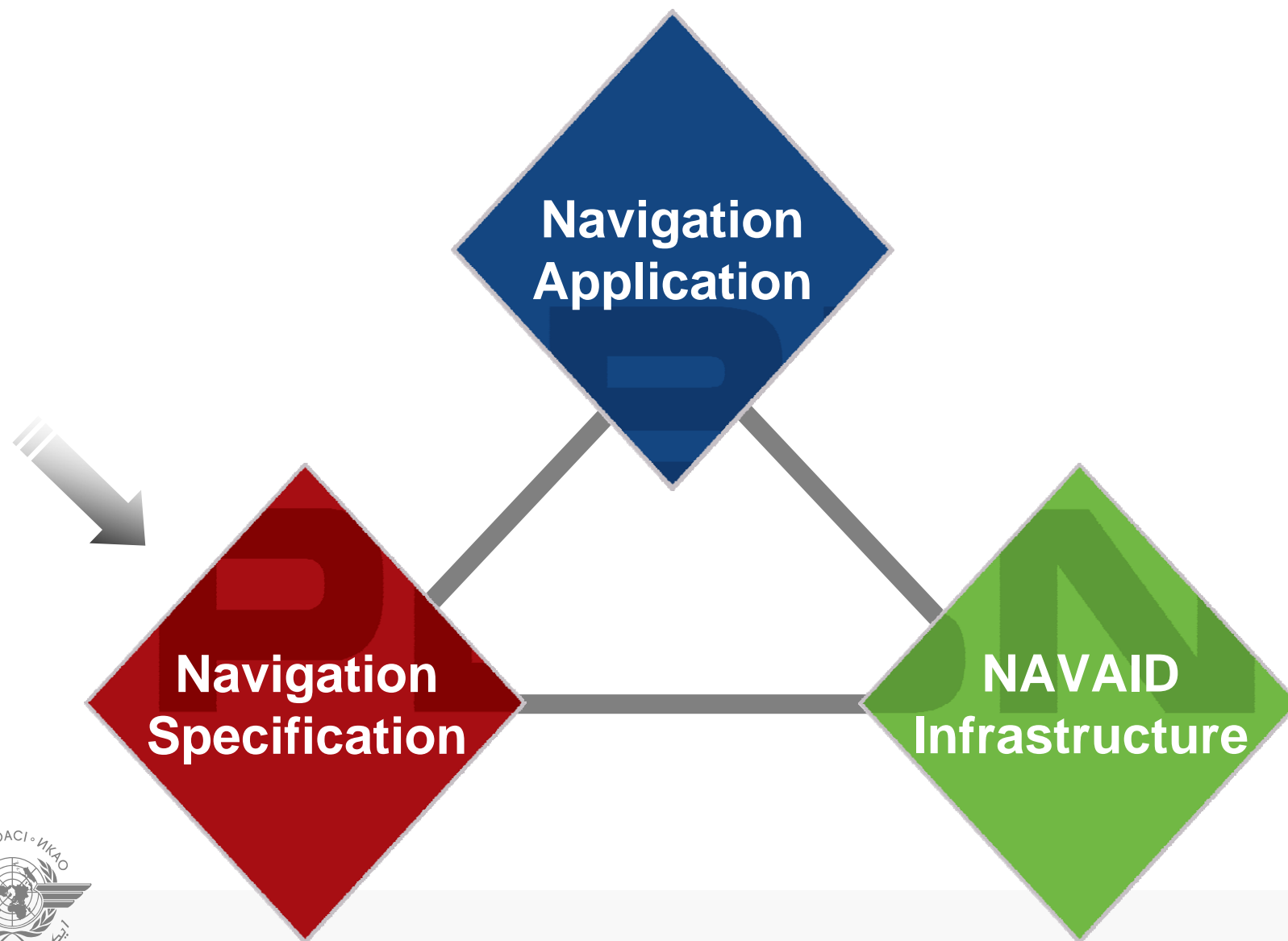
# Components of PBN Concept

- **Ground-based Navigation Aids (Nav aids)**
  - **VOR; DME; (Not NDB)**
- **Space-based Nav aids**
  - **GNSS**
    - **GPS; Glonass; *future* Galileo**



**NAVAID  
Infrastructure**

# Components of PBN Concept



# Components of **P**BN Concept

Accuracy  
Integrity  
Continuity

ICAO aim is to  
limit  
number  
of Nav. Specs  
in global use

**Navigation  
Specification**

International Navigation Specifications published  
in Volume II of PBN Manual

- What **PERFORMANCE** is required of the RNAV system?
- What Functionalities must RNAV system have to achieve *Performance*
- What Navigation Sensors must be integrated in RNAV system to achieve *Performance*
- What requirements are placed on the Air crew to achieve the required *Performance* from the RNAV system?

Document used by State as basis for developing  
Certification & Operational Approval

# Components of PBN Concept

International Navigation Specifications published  
in Volume II of PBN Manual

➤ PERFORMANCE

➤ Functionalities

➤ Navigation Sensors

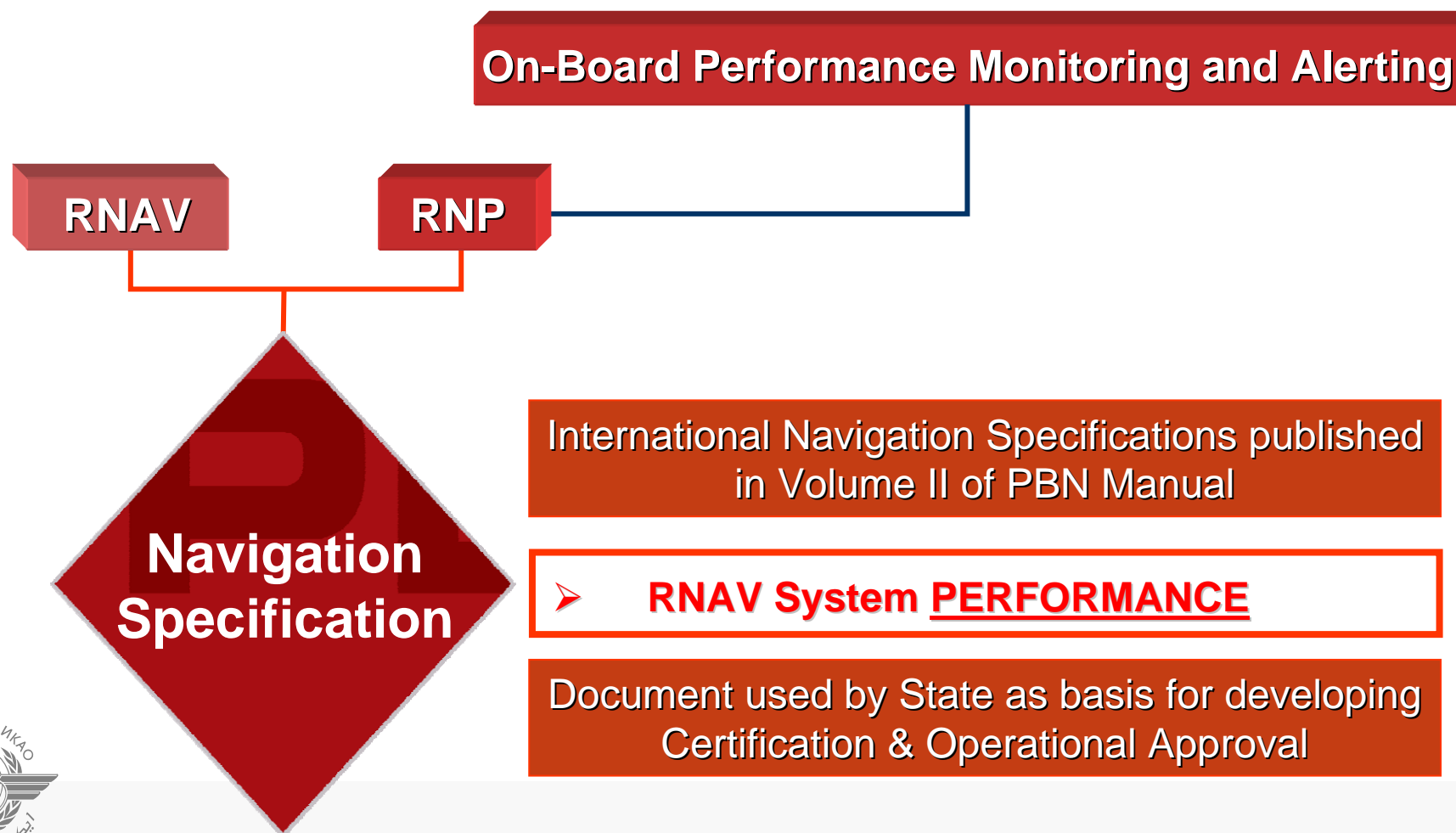
➤ Air crew requirements

Previous  
RNP  
Concept

Navigation  
Specification

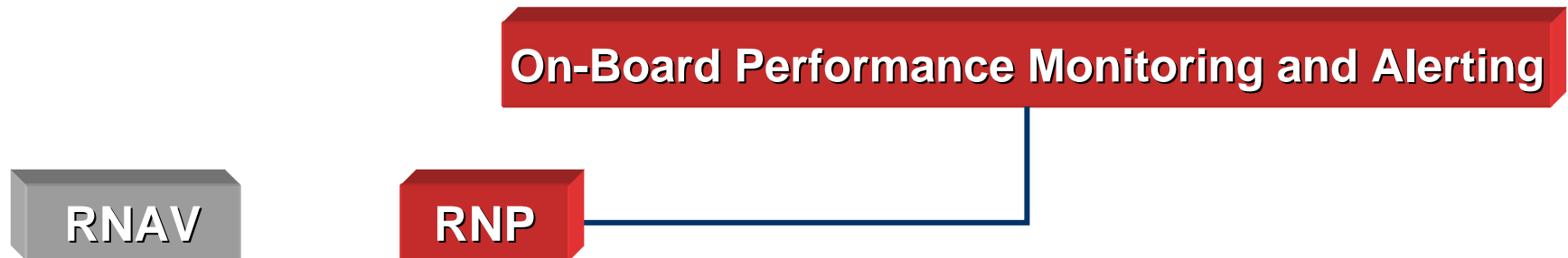
Document used by State as basis for developing  
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# Components of PBN Concept





# Components of PBN Concept



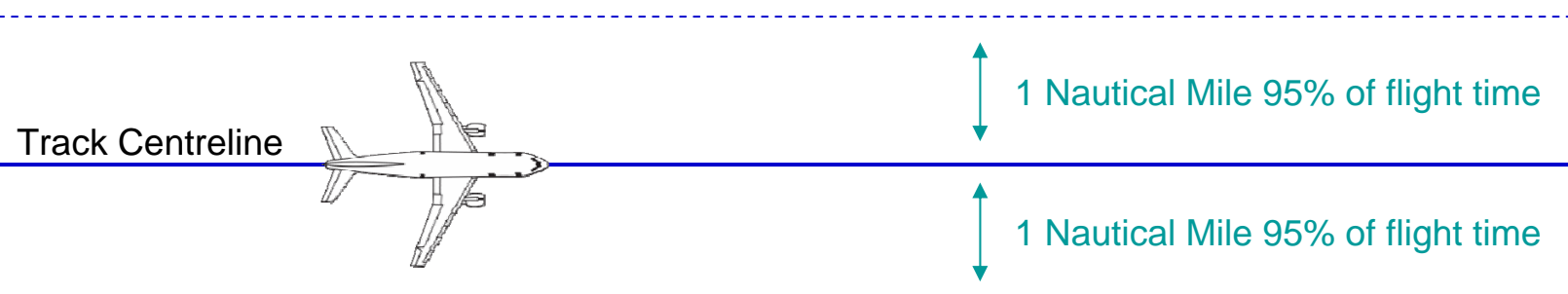
- On-board performance monitoring and alerting does not only refer to 'containment' in the MASPS; Annex 11 or PANS-OPS.
- On-board performance monitoring and alerting allows the air crew to detect that the RNP system is not achieving the navigation performance required of the RNP system

# RNAV and RNP

**RNAV 1**

**RNP 1**

**2\*RNP  
Alert to Pilot**

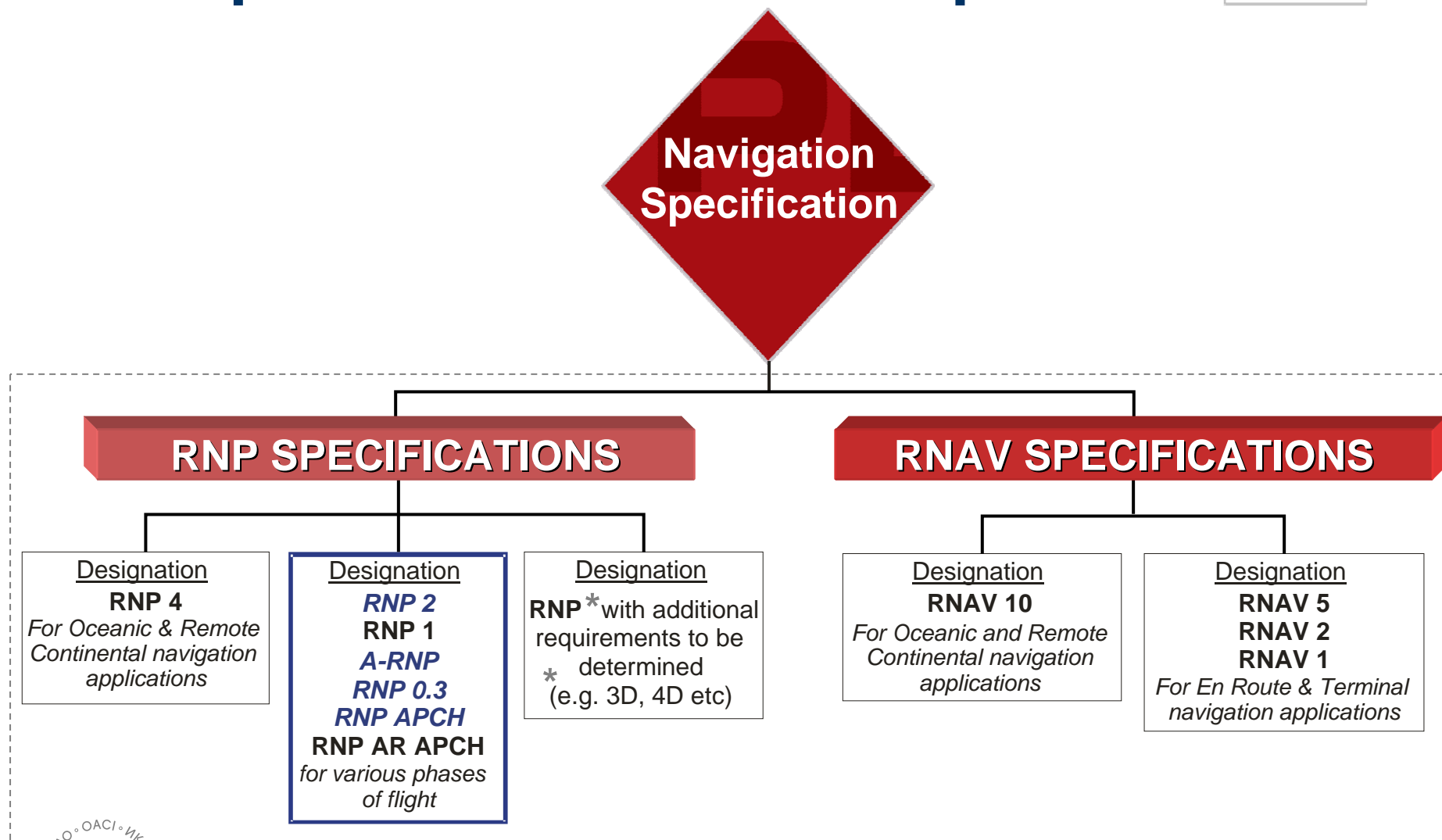


RNP isn't "fundamentally different" from RNAV:  
RNP is ***MORE*** Than RNAV

**The Key Difference:**

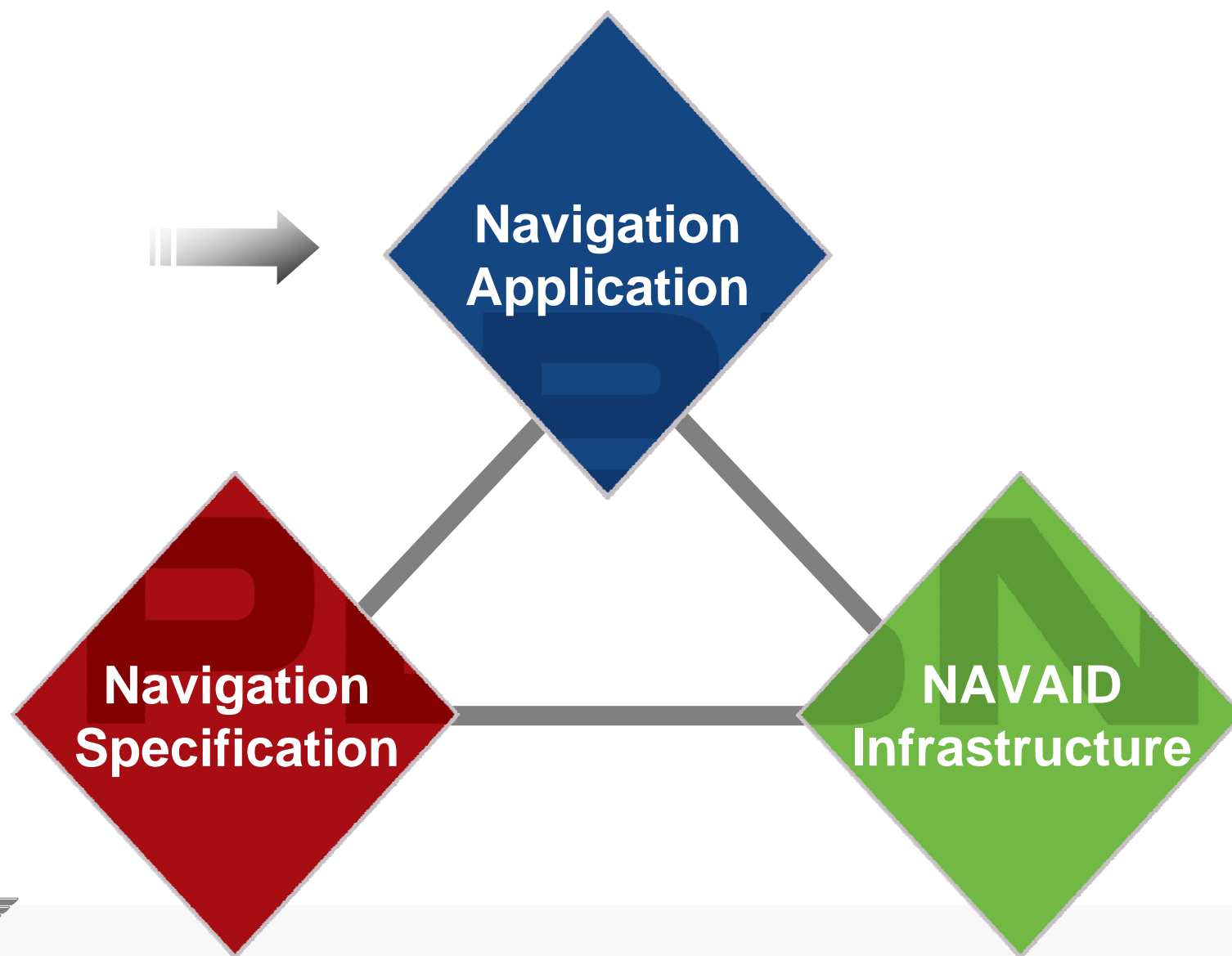
**On-Board Performance Monitoring and Alerting**

# Components of PBN Concept





# Components of PBN Concept



# Navigation Application

- The APPLICATION of the Navigation Specification and Navaid Infrastructure -
- For example: Routes based on RNAV and RNP Specifications (these rely on the Navaid Infrastructure);
  - For example: SIDs/STARs based on RNAV and RNP Specifications;
  - For example: Approach procedures based on RNP Specifications



# Link between airspace design & PBN

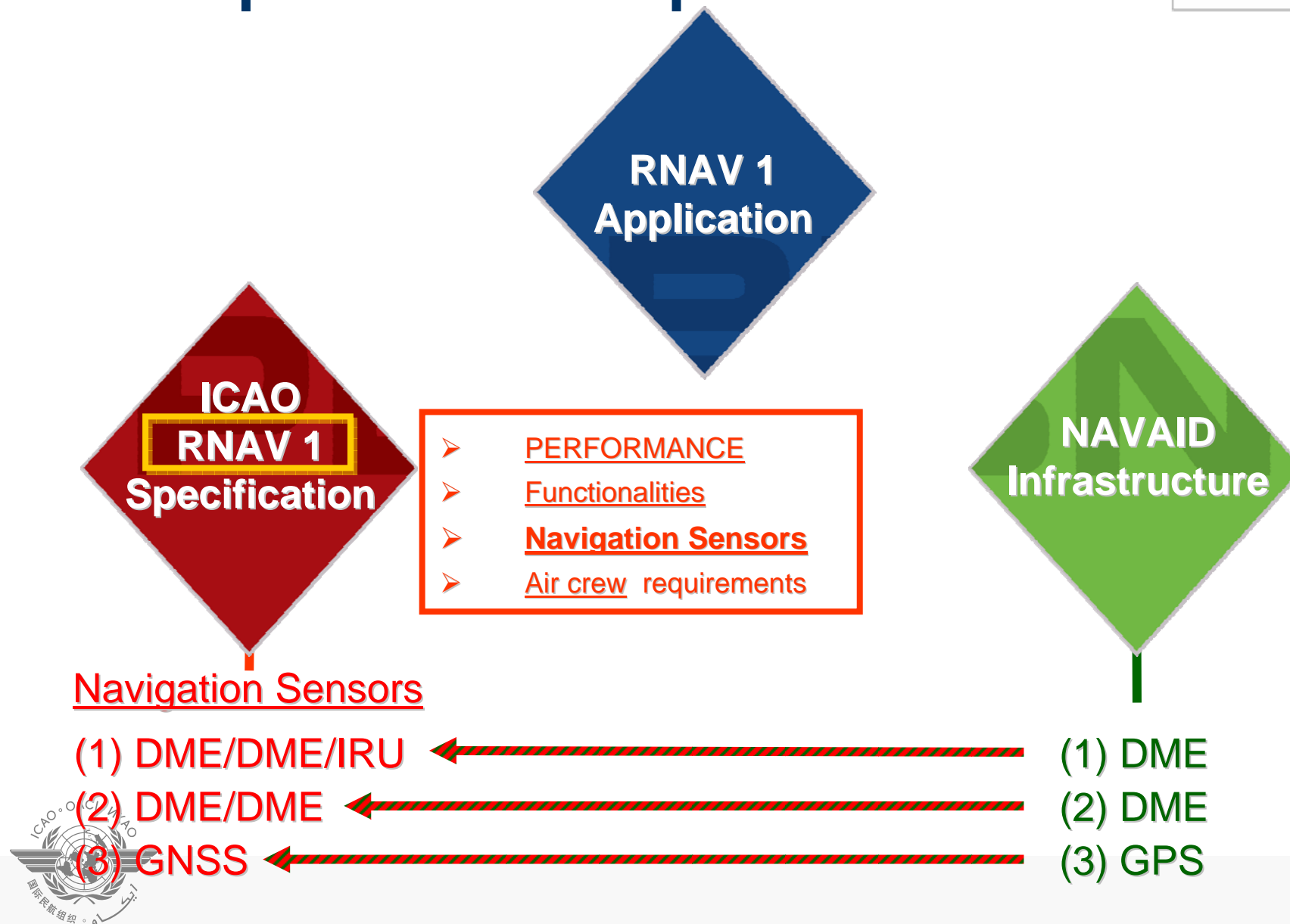
- **Separation minima** in procedural environment;
- **Configuration/proximity of ATS Routes** (including SIDs, STARs and IFP) for an airspace organisation.
- **Above** determined in part, but not exclusively by:
  - **area navigation system performance** stipulated in the **Navigation Specification** (required for operation in an airspace).

Accuracy  
Integrity  
Continuity

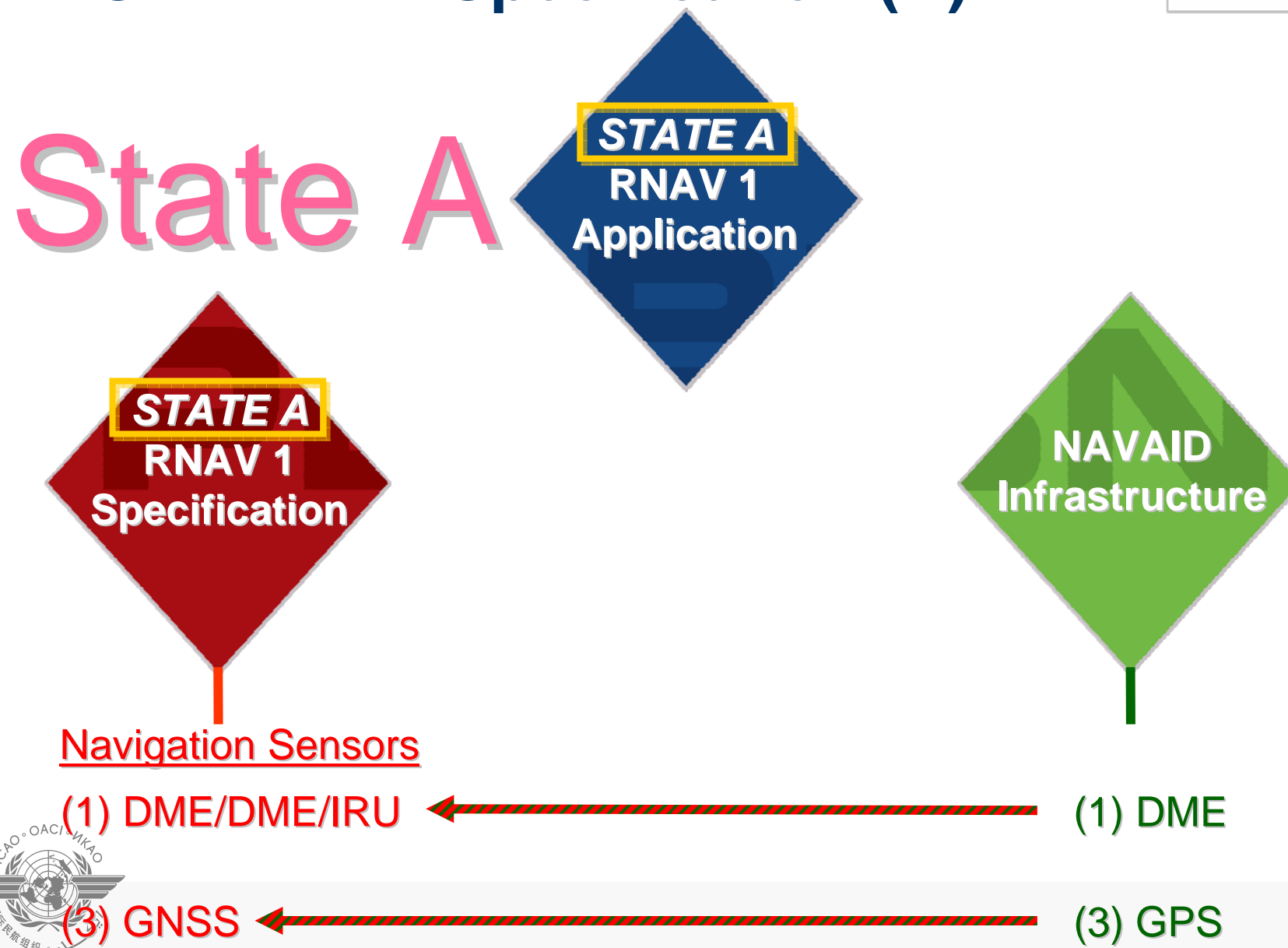




# Example: RNAV 1 Specification



# E.G: RNAV 1 Specification (A)



# E.G: RNAV 1 Specification (B)

State B

**STATE B**  
RNAV 1  
Application

**STATE B**  
RNAV 1  
Specification

NAVAID  
Infrastructure

Navigation Sensors

(1) DME/DME/IRU

(2) DME/DME

(1) DME

(2) DME

## E.G: RNAV 1 Specification (C)

State C

**STATE C**  
RNAV 1  
Application

**STATE C**  
RNAV 1  
Specification

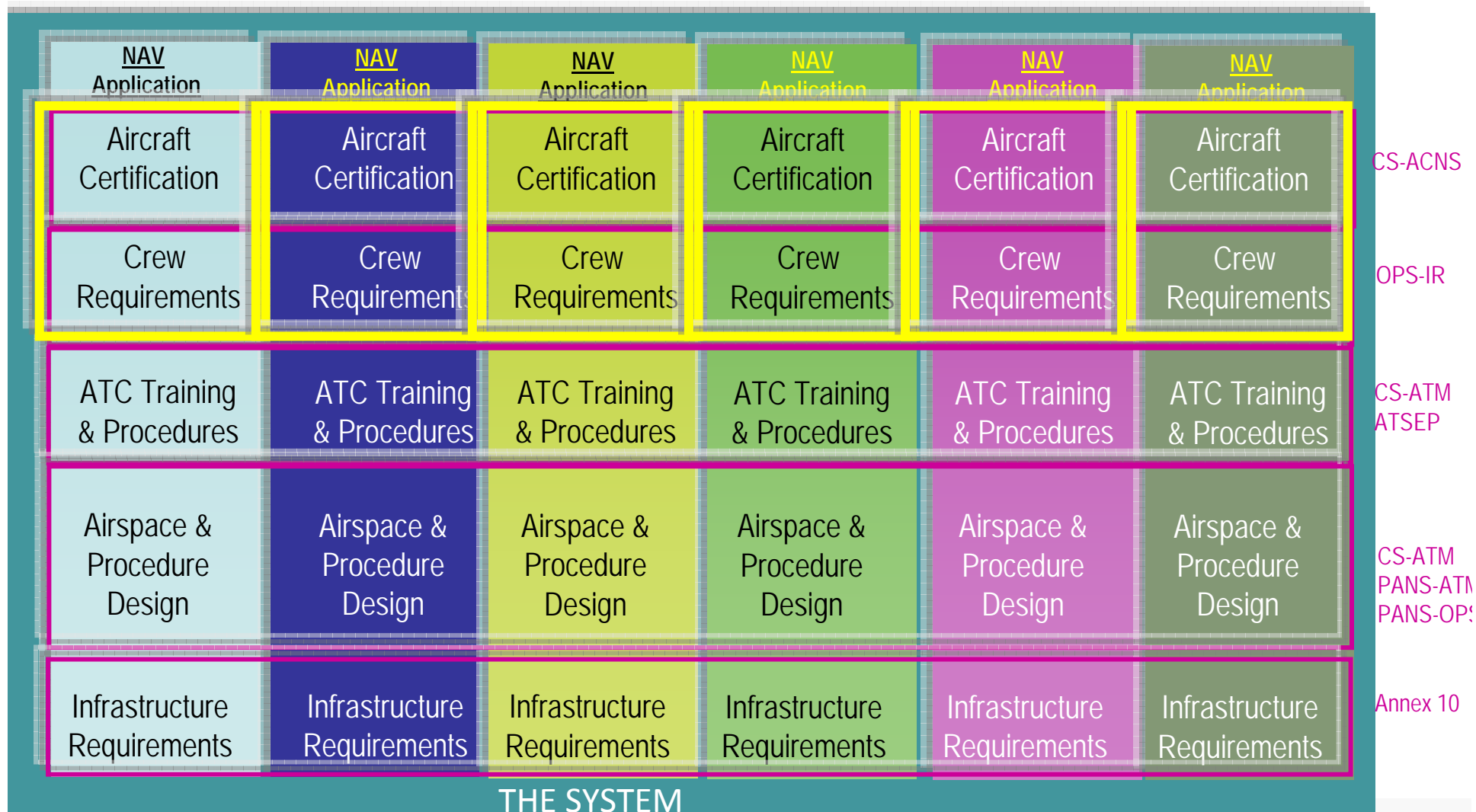
NAVAID  
Infrastructure

Navigation Sensors



# Implementing PBN - the Package in the PBN Manual Vol II

## Part B – Implementing RNAV; Part C – Implementing RNP



## PBN in Context:

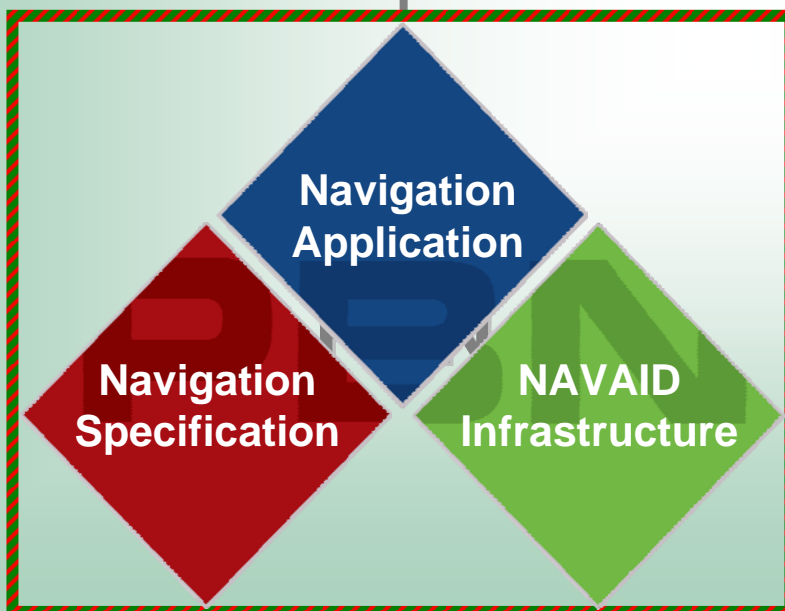
# Airspace Concept

**CoM**

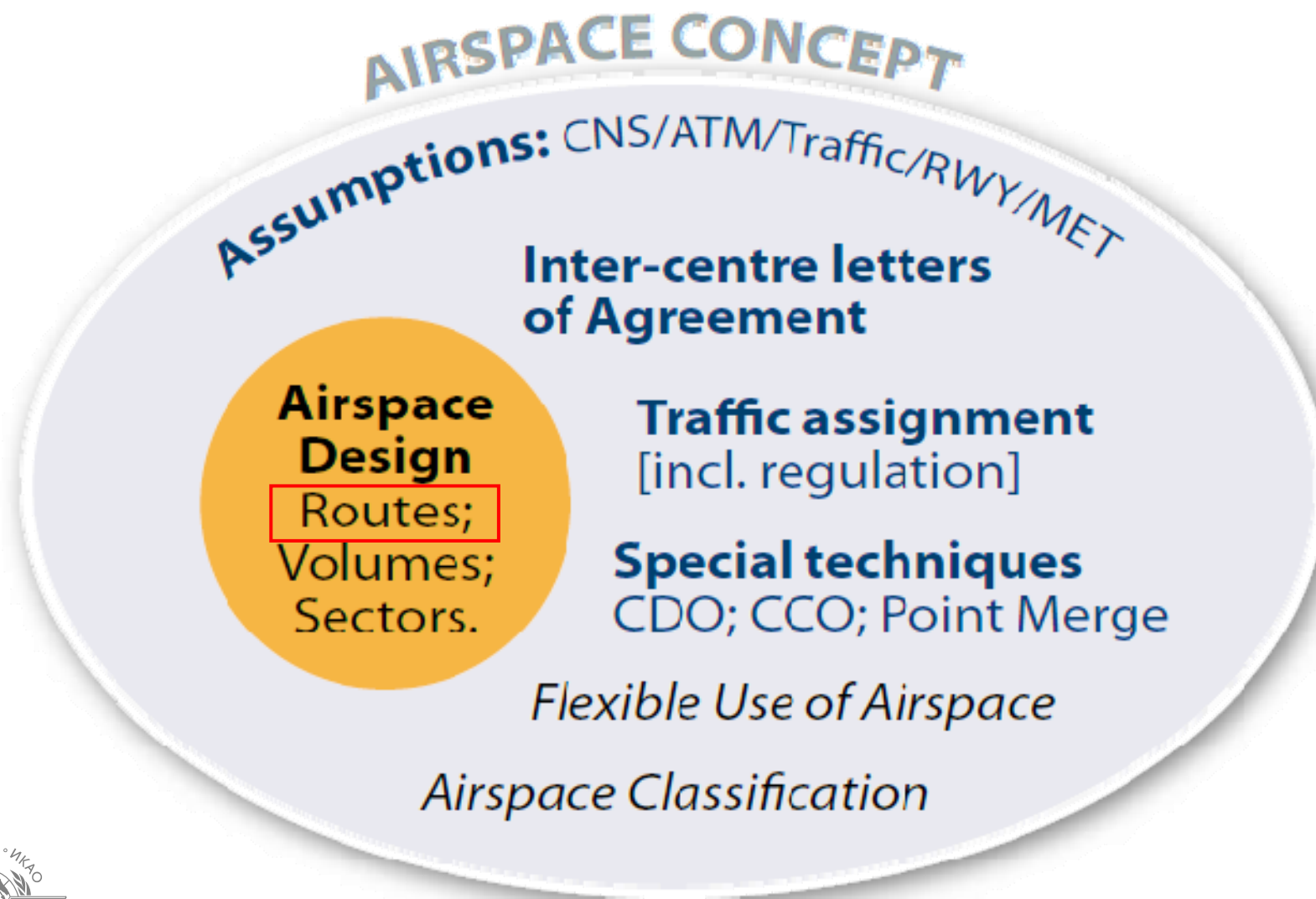
**NAV**

**SUR**

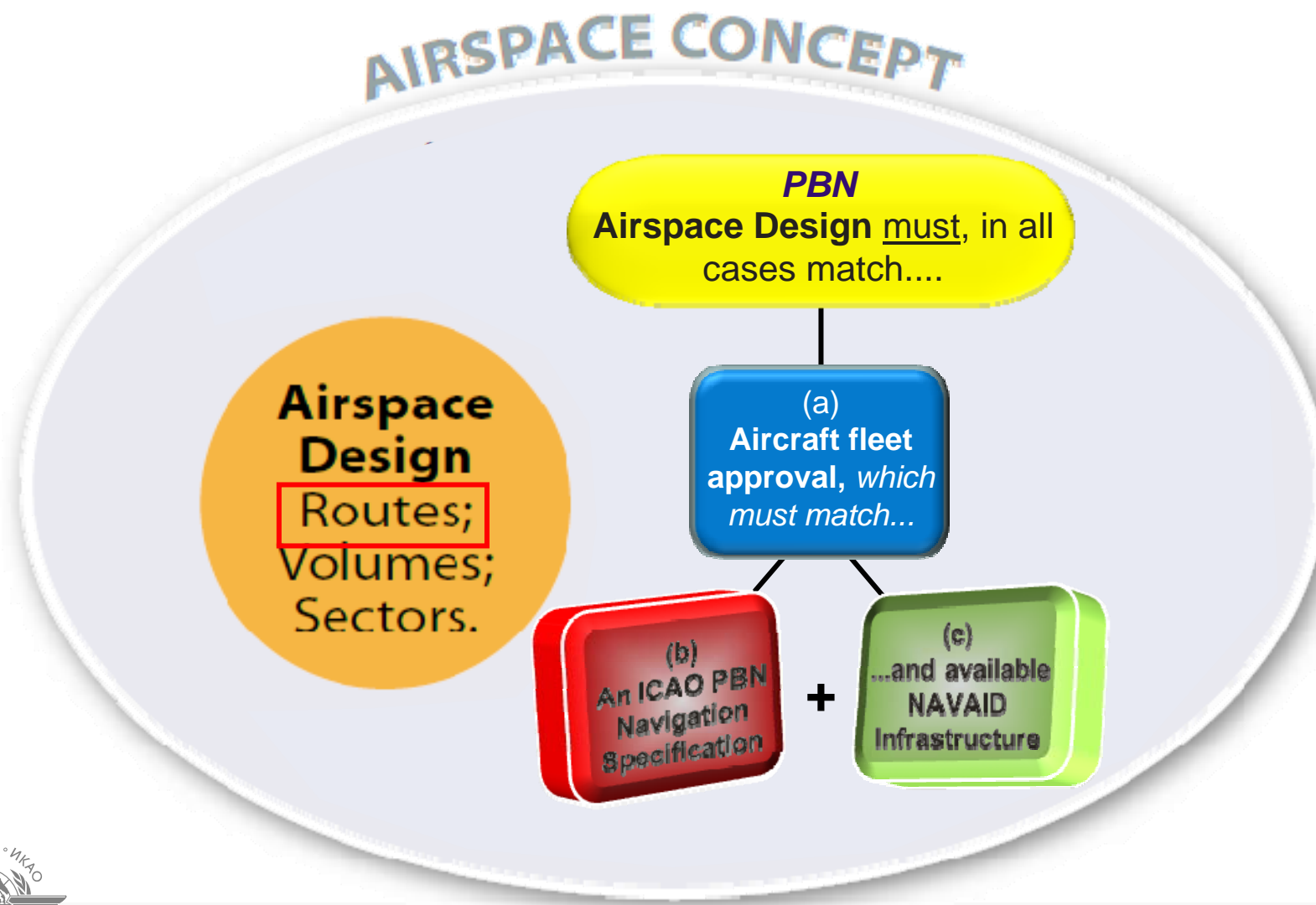
**ATM**



# Airspace Concept



# Airspace Concept





# Stakeholder uses of PBN

- Airspace Planners and procedure designers use PBN for spacing ATS routes, procedural aircraft separation minima and procedure design (obstacle clearance).
- Airworthiness and regulatory authorities ensure that aircraft and aircrew satisfy the operating requirements of the intended RNP or RNAV Application.
- Aircrew and ATC must know pilot/aircraft PBN qualification

# Current Limits of PBN



*The notion of PBN 'airspace' is yet to be developed.*

- To apply an RNAV/RNP specification in an airspace, it is necessary to prescribe the performance to an ATS Route.
- In context, an ATS routes is one designated in Accordance with ICAO Annex 11, Appendix 1 or Appendix 3.
- Thus for ATM purposes
  - DCT tracks are excluded
  - So are company routes
- Navigation performance cannot be ascribed to a route which is not an ATS Route

# ATS Routes and PBN

- Navigation performance cannot be ascribed to a route which is not a designated ATS Route.
- Designated ATS route are packed into the navigation database and navigation performance requirements ascribed to the route.
- Thus GOOD and high INTEGRITY data are essential to PBN.
- This is regulated in Europe through the ADQ mandate.



# What's new with PBN



- PBN requires the use of an **on-board RNAV system**;
- PBN creates **requirements for airworthiness certification and operational approval** to use RNAV systems in airspace implementations;
- The RNAV system's **performance** *and* the general operation must **conform** to the requirements stipulated in the relevant **ICAO navigation specification**.

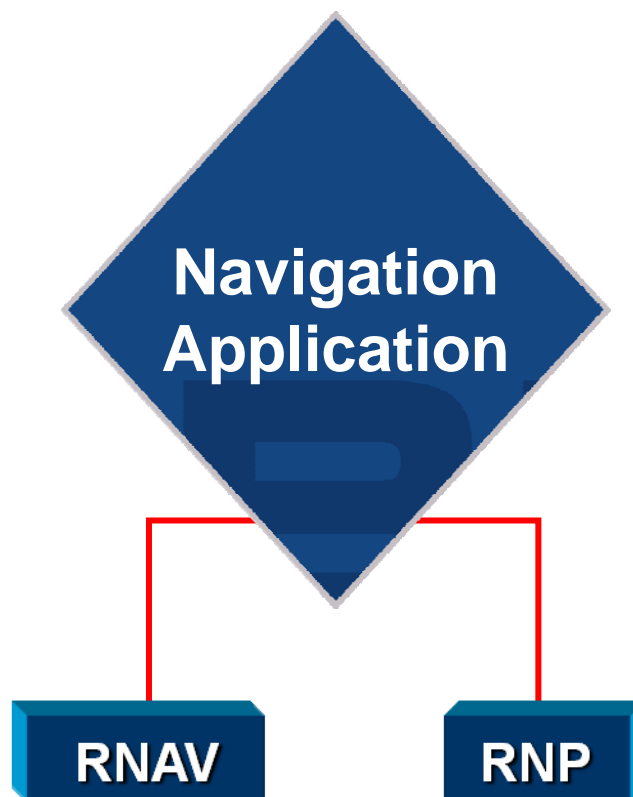
# Benefits of PBN

- Transition to a total RNAV/RNP environment
  - Flight efficiency, optimise airspace etc
- PBN systematises RNAV and RNP
  - Avoid proliferation of standards (costs for certification)
- RNP allows increased reliance on area navigation
  - Closer routes
  - Avoid need to cross check against point source NAVAIDs (e.g. VOR)
- Infrastructure
  - Once Dual GNSS (supported in certain dense airspace by DME)
  - VOR and NDB can be decommissioned

# Concept Summary



# Concept Summary







# Aircraft - Equipment Certification and Operator Approval

## A

### EQUIPMENT LEVEL APPROVAL



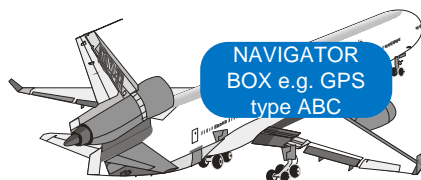
NAVIGATOR  
BOX e.g. GPS  
type ABC

#### Comments/Notes

- GPS could be a sensor in multi-sensor system or a self-contained and stand-alone navigator;
- FAA/EASA (E) TSO against a MOPS e.g. DO229, incl. functions, performance qualification. Attributes incl. accuracy, functionality (e.g. Nav database), integrity, alerting, path steering;

## B\*

### AIRCRAFT LEVEL APPROVAL



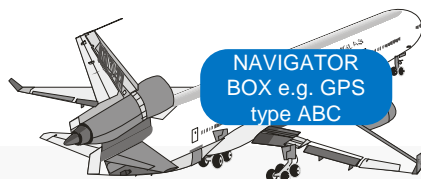
NAVIGATOR  
BOX e.g. GPS  
type ABC

*based on MASPs or PBN Nav Spec*

- Installation approval on aircraft against an EASA AMC or FAA AC which includes an operational context e.g. RNAV 5;
- Takes into account a/c level integration e.g. displays, controls, interface with other systems e.g. auto-pilot; flight director; safety requirements and HF.

## C

### OPERATOR LEVEL APPROVAL



NAVIGATOR  
BOX e.g. GPS  
type ABC



- For the aircraft installation to be used by pilot, operational approval needed against, for example, EU-OPS 1.
- Operational Approval is concerned with training, flight crew procedures, quality, database management, etc.