



PBN

Performance Based Navigation

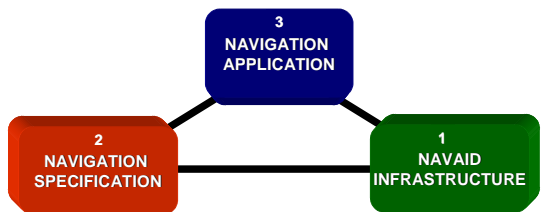
- PBN & Airspace Concepts -




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Introduction to PBN 1



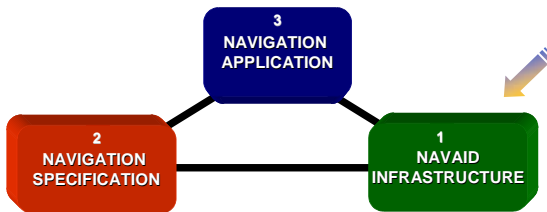
Components of PBN Concept




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Components of PBN Concept




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Components of PBN Concept - Navaid Infrastructure -

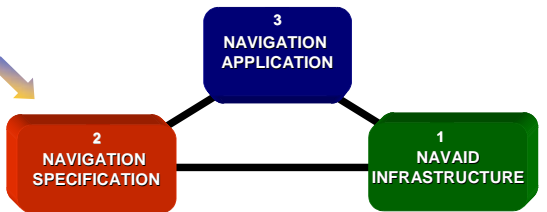
- > Ground-based Navigation Aids (Nav aids)
 - VOR; DME; (Not NDB)
- > Space-based Nav aids
 - GNSS
 - GPS; Glonass; future Galileo




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Components of PBN Concept - Navigation Specification -

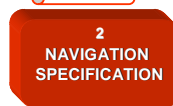
International Navigation Specifications published in Volume II of PBN Manual

2 Aim is to limit number of Nav. Specs in global use

- > 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?

Accuracy
Integrity
Continuity
Availability

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



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Components of PBN Concept - Navigation Specification -

International Navigation Specifications published in Volume II of PBN Manual

2 NAVIGATION SPECIFICATION

- PERFORMANCE
- Functionalities
- Navigation Sensors
- Air crew requirements

Previous RNP Concept

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

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Components of PBN Concept - Navigation Specification -

International NS in Volume II of PBN Manual

2 NAVIGATION SPECIFICATION

- RNAV System PERFORMANCE

Document used by State as basis for Certification & Operational Approval

On-Board performance Monitoring and Alerting

RNAV | RNP

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Components of PBN Concept - Navigation Specification -

RNAV | RNP

On-Board performance Monitoring and Alerting

- 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

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Components of PBN Concept - Navigation Specification -

ICAO NAVIGATION SPECIFICATIONS

- RNAV SPECIFICATIONS
 - Designation RNAV 10 (RNP10) For Oceanic and Remote Continental navigation applications
 - Designation RNAV 5 RNAV 2 RNAV 1 For En Route & Terminal navigation applications
- RNP SPECIFICATIONS
 - Designation RNP 4 For Oceanic & Remote Continental navigation applications
 - Designation Basic-RNP 2* Basic-RNP 1 Advanced-RNP 1 RNP APCH RNP AR APCH for various phases of flight
 - Designation RNP with additional requirements to be determined (e.g. 3D, 4D etc)

International NS in Volume II of PBN Manual | *Potential Nav Specs

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Components of PBN Concept - Designation -

NAVIGATION APPLICATION

NAVIGATION SPECIFICATION

- RNAV X, RNP X
- RNAV 10, B-RNP 1
- RNAV 5
- AP descriptor: RNP APCH, RNP AR APCH

NAVAID INFRASTRUCTURE

X = Navigation Accuracy in NM

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Components of PBN Concept

3 NAVIGATION APPLICATION

2 NAVIGATION SPECIFICATION

1 NAVIAID INFRASTRUCTURE

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Components of PBN Concept - Navigation Application -

3 NAVIGATION APPLICATION

The APPLICATION (use 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

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Components of PBN Concept

3 NAVIGATION APPLICATION

2 NAVIGATION SPECIFICATION

1 NAVIAID INFRASTRUCTURE

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Example: RNAV 1 Specification

RNAV 1 APPLICATION

ICAO RNAV 1 SPECIFICATION

- PERFORMANCE
- Functionalities
- Navigation Sensors
- Air crew requirements

NAVAID INFRASTRUCTURE

Navigation Sensors

(1) DME/DME/IRU	(1) DME
(2) DME/DME	(2) DME
(3) GNSS	(3) GPS

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E.G: RNAV 1 Specification (A)

STATE (A) RNAV 1 APPLICATION

STATE (A) RNAV 1 SPECIFICATION

NAVAID INFRASTRUCTURE

Navigation Sensors

(1) DME/DME/IRU	(1) DME
(3) GNSS	(3) GPS

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E.G: RNAV 1 Specification (B)

STATE (B) RNAV 1 APPLICATION

STATE (B) RNAV 1 SPECIFICATION

NAVAID INFRASTRUCTURE

Navigation Sensors

(1) DME/DME/IRU	(1) DME
(2) DME/DME	(2) DME

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Context of PBN

Airspace (Operational) Concept

COM NAV SUR ATM

NAVIGATION APPLICATION

NAVIGATION SPECIFICATION

PBN

NAVAID INFRASTRUCTURE

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Context of PBN

ICAO GLOBAL ATM CONCEPT

The diagram illustrates the ICAO Global ATM Concept. At the top is 'Airspace Concept', which branches into four main components: COM, NAV, SUR, and ATM. The NAV component is further detailed in a sub-diagram, showing 'NAVIGATION APPLICATION' at the top, 'PBN' in the middle, and 'NAVAID INFRASTRUCTURE' at the bottom. 'NAVIGATION SPECIFICATION' is also shown as a related element.

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What is an Airspace Concept?

- General **Vision** or **Master Plan** for an airspace
- Geared towards **Strategic Objectives**
- Covers all air traffic system **“Enablers”**

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What is an Airspace Concept?

The diagram shows a 'Chapeau TMA' (Terminal Manoeuvring Area) with various flight paths and a 'Noisy Area' where 'AIRSPACE NOT AVAILABLE'. It illustrates how terrain and noise constraints affect airspace availability and flight paths.

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Strategic Objectives

Answer the question: What Do We want to Achieve?

Safety? Capacity? Efficiency? Environment? Access?

Airspace Concept

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Examples: Strategic Objectives

Safety	Capacity	Efficiency	Environment	Access
Reduce Controlled Flight Into Terrain via lateral & vertical course guidance to runway	Increase number of air traffic routes to reduce congestion; accommodate projected growth	Reduce delays that result from excessive "levelling off" flight profiles	Reduce noise over sensitive areas	Improve airport and airspace access in all weather conditions

Airspace Concept

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Airspace Concept: Enablers

Communications

Navigation

Surveillance

Air Traffic Management

CNS/ATM

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Airspace Concept: Enablers

Communications

Navigation → **PBN** ← **Surveillance**

CNS/ATM

Surveillance

Air Traffic Management

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Airspace Concept Development

Airspace Concept development requires the combined efforts of

- Air Navigation Service Providers (“Air Traffic”);
- Regulators; and
- System Users

“STAKEHOLDERS”

To Do What?

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Airspace Concept: Stakeholder Roles

Air Traffic Service Providers, Regulators and System Users:

1. **Identify** strategic objectives
 - Safety?
 - Efficiency?
 - Capacity?
 - Environment?
 - Access?
2. **Prioritise** strategic objectives
 - Safety?
 - Capacity?
 - Access?
 - Efficiency?
 - Environment?
3. **Address** enablers

CNS/ATM

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Addressing Enablers

Communications
VHF? HF? Two Way?

Navigation
NAVAIDs?
– Primary/Reversionary?
Aircraft and Operator Capabilities?

Surveillance
Radar? Non-Radar?

Air Traffic Management
ATC Procedures? Workload? Automation?

Capacity

Increase number of ATS routes to reduce congestion; accommodate projected growth

Efficiency

Reduce delays that result from excessive “levelling off” flight profiles

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Objectives → Implementation

Safety	Capacity	Efficiency	Environment	Access
Reduce Controlled Flight Into Terrain via lateral & vertical course guidance to runway	Increase number of air traffic routes to reduce congestion; accommodate projected growth	Reduce delays that result from excessive “levelling off” flight profiles	Reduce noise over sensitive area	Improve airport and airspace access in all weather conditions
RNP approach to replace circling approach	Parallel RNAV-2 ATS routes between cities	RNAV-1 SID that allows continuous climb to enroute	RNP (AR) APCH w/ guided Curved Missed Approach Segment	RNP approach allowing lower minima

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Airspace Concept Use

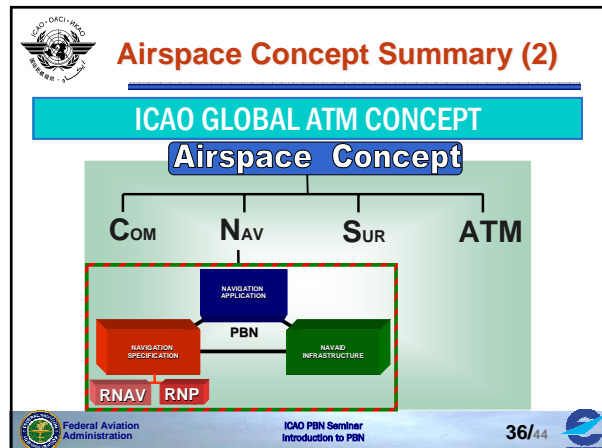
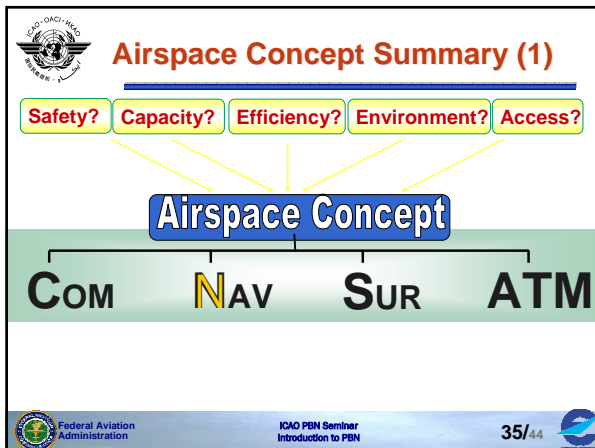
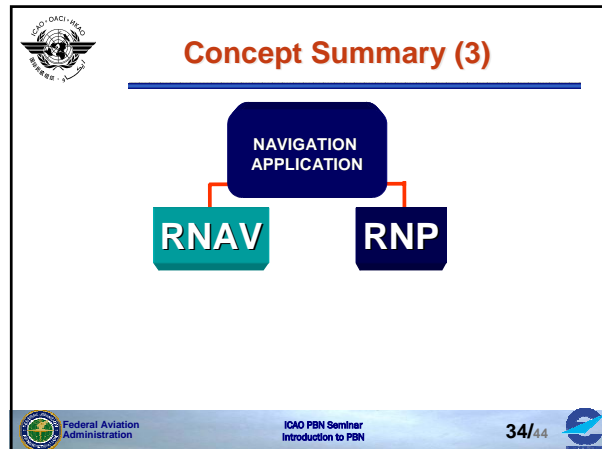
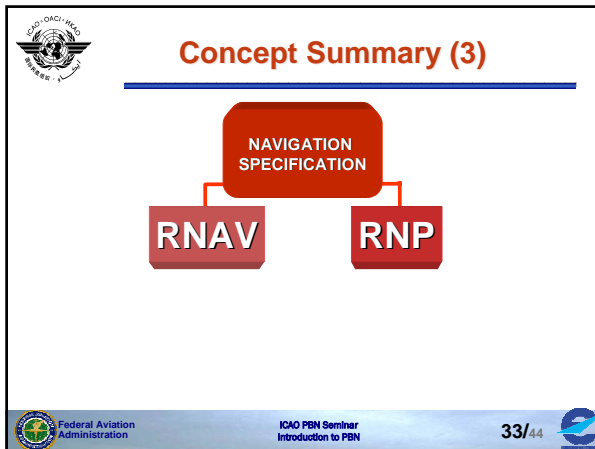
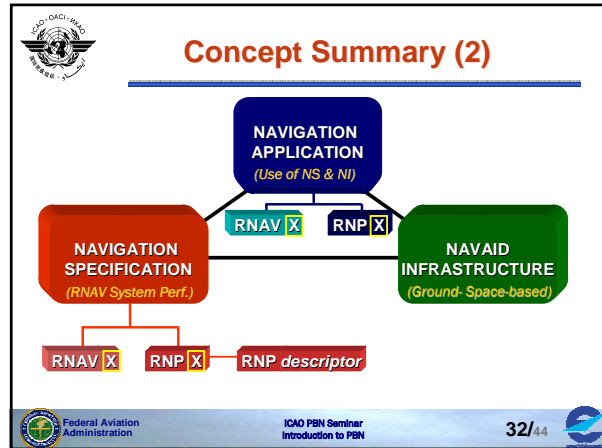
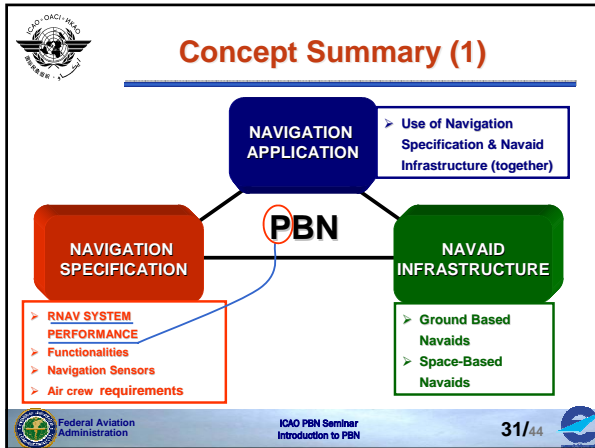
Airspace Concept development requires the combined efforts of

- Air Navigation Service Providers (“Air Traffic”);
- Regulators; and
- System Users
- PANS-OPS specialist

“STAKEHOLDERS”

To identify and prioritise Strategic Objectives, considering the entire CNS/ATM environment

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Case Study - Day 1

Case Study - Day 2

Case Study - Day 3

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Case Study

Fictitious Airport (Does not exist!)

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Case Study

Fictitious Airspace (Does not exist!)

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Case Study

Fictitious Problems (Do not exist!)

- Accommodate increased traffic
- Minimise noise impact
- Develop and Instrument Approach Procedure

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Case Study

- Next
 - Processes 1, 2, 3
 - Will make Reference to our Case Study
- At end of each day, will present Case Study

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Audience Response System Questions

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