Introduction to PBN and RNP

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Summary

- What is PBN?
- Some History
- The ICAO PBN Manual
- The Benefits of PBN
- Some Examples
- PBN Approaches
- PBN and the Environment
- Available Guidance Material
CONVENTIONAL ROUTES: In search of a safe & perfect ‘path’

- **Conventional Navigation**
  - Route stuck to Nav aids
  - Not flexible

- **Area navigation (RNAV):** permits aircraft operation on any desired flight path within coverage of available positioning sources:
  - **Great flexibility in route placement both lateral & vertical.**
What is Performance Based Navigation?

The lateral accuracy is only one of several performance and functional requirements included in any PBN specification.
What came before PBN?

A variety of navigation applications, High Certification Costs
… action required!
The Result was PBN

- PBN Concept replaced RNP Concept
- Resolution of ICAO’s 36th Assembly
- Reiterated at 37th Assembly
- Manual updated in 2013
The components of PBN

- Navigation Application
- NAVAID Infrastructure
- Navigation Specification
PBN improves **Safety** – which tops any list.

On a route*, PBN provides ‘**Confidence**’ in navigation performance both laterally and vertically.

**Confidence** is provided by PBN’s ten RNAV and RNP specifications. These spell out crew and aircraft navigation performance needed to operate on a route.

*Any ATS route, SID, STAR, Final Approach Procedure flown Using an RNAV system, is a PBN ‘route’.*
The Navigation Specifications

**RNAV**
- **Designation**
  - RNP 10*
  - RNAV 5
  - RNAV 2
  - RNAV 1

  *Actually RNAV 10
- For **En Route & Terminal navigation applications**

**RNP**
- **Designation**
  - RNP 4
  - RNP 2
  - RNP 1
  - Advanced RNP

  - RNP AR APCH
  - RNP 0.3

  - for various phases of flight
- **Designation**
  - RNP with additional requirements to be determined (e.g. 3D, 4D etc)

On-Board Performance Monitoring and Alerting
Navigation Specification

- PERFORMANCE
  - Functionalities
  - Navigation Sensors
  - Air crew requirements

Document used as the basis for developing Certification & Operational Approval
Why PBN is good for you..

- Interoperability costs less
- Improved Flight Efficiency, Environmental impact, safety, capacity ...
  - Enables CDO and CCO
- While RNAV is good … RNP is better, harnessing aircraft capability and space technology
  - RNP Approaches with Vertical Guidance (APV) > Baro or SBAS
  - Curved path transition
  - Greater track assurance - alert if the aircraft is not meeting its requirements
  - Alleviation on airspace interaction constraints
  - Reduces ATC radar monitoring requirements
  - Greater tactical flexibility through parallel offsets
  - Higher integrity from RNP
  - Lays the foundation for more advanced concepts e.g., trajectory management (3D/4D)

- Infrastructure
  - Extensive use of GNSS
  - DME/DME for reversion where required
Radius to Fix (RF) Functionality

Fly-by Turns

Aircraft anticipates the turn. Not repeatable

Radius to Fix (RF)

Designer stipulates the radius and defines the arc centre
Before RF - Schiphol R/W 24

Schiphol first 2 weeks of January 2008, all aircraft types (390 flights)
RF Benefits - Schiphol R/W 24

Schiphol first 2 weeks of January 2008, KLM B737 type (136 flights)
Riga RNP AR – Reduced Track Miles
Gothenburg, Fewer miles = Less noise,

- Baseline scenario RNAV 1 STAR followed by ILS approach to RWY21.

- RNP AR to RWY21.

- Benefits with RNP AR:
  - 11 NM shorter than the baseline scenario.
  - Relieving a noise sensitive area of over flying aircraft
RNP Approaches

Lateral Guidance only

- **LNAV**
  - Expected to be flown as CDFA

- **LP**
  - SBAS supported
  - Lateral only

- **LNAV/VNAV**

- **LPV**

With Vertical guidance

- **APV**
  - APV-Baro
  - APV-SBAS (SBAS supported Localiser Performance with vertical guidance)
General Evolution of Approaches

**Lateral**
- NPA (Non Precision Approaches)
  - Conventional
  - RNP APCH

**Vertical**
- APV (Approaches with Vertical Guidance)
  - APV Baro
  - APV SBAS
- PA (Precision Approaches)
  - Conventional
  - GBAS Approach

**Sensors**
- VOR/DME/NDB Localizer
- GPS
- GPS + Baro
- GPS + SBAS
- ILS/MLS
- GPS + GBAS
The Case for RNP APCH

- **Safety**
  - Vertically guided approach allows stabilized approaches with standard crew ops procedures
    - Reduces runway excursions caused by unstabilised approach
  - Improved situation awareness reduces CFIT risk
  - Reduced pilot workload compared to conventional step-down approach and CDFA
  - Better obstacle design criteria (low temperature protection in LNAV/VNAV procedure design)

- **Low Cost**: No dependence on ground based Nav aids

- **Reduced minima = Improved Access**
  - DH as low as 200ft based on SBAS LPV
  - Potential for straight-in instead of offset approach (due to reduced obstacle clearance surfaces from RNP and/or lack of navaid siting problems)
EUROCONTROL activities on RNP approaches

- RNAV Approach implementation Support Group
- Input to Standards
- Guidance Material
- Training Courses
- Targeted Implementation Projects
- Deployment Monitoring
Some PBN <> Environmental Issues

- **Track placement flexibility** provided by PBN allows more options for route placement > noise can be spread – or concentrated.
  - Concentration > noise under ‘single’ flight path
  - Dispersion > noise annoys more communities.
  - Precise on-board navigation functions make it possible to by-pass noise sensitive areas.

- **PBN’s better vertical path management** enables improved (lateral) track placement as well as CDOs and CCOs.

- **Thanks to RNP APCH**, reduced diversions

  *PBN can be used to reduce Environmental Impact.*
PBN’s challenge

- Airport neighbours and local communities view PBN:
  - As a dirty word
- Environmental objection can block PBN implementation.
New Gatwick flight path trials are 'destroying' Sussex village life
Face the facts

- Aviation is not an impact free industry

- Balance is needed – between
  - Environmental Impact and
  - Social, Economic, Institutional Benefits

SUSTAINABLE DEVELOPMENT
Implementation Steps
PBN is a Team Game

- Requires a multi-disciplinary approach
- This is why an industry implementation plan is needed with “Buy-In” from all stakeholders
- This is why ANSP implementation plan is needed with stakeholder buy-in…

OEMs

Industry

Data Houses

Engineers

Regulators

Airspace Designers

Procedure Designers

Pilots

Controllers

ALL Airspace Users
RNP toolkit

Generic and common material to support RNP implementation

To be developed in cooperation with the Deployment Manager and other stakeholders

To be applied by particular stakeholders
Thank you for your attention.
PBN SIDs/STARs: franca.pavlicevic@eurocontrol.int
PBN on-board functions: david.de-smedt@eurocontrol.int
PBN Training: charlie.eliot@eurocontrol.int
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