UK Performance-based Navigation (PBN) Implementation Status

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Directorate of Airspace Policy

26 January 2012
Presentation Overview

1. PBN within the UK’s Future Airspace Strategy
   - Policy for the Application of Performance-based Navigation in UK/Irish Airspace

2. UK implementation decision making process
   - Selecting the appropriate PBN application
   - PBN capability survey

3. Airspace developments

4. Summary

5. Spare Slides – PBN Capability
1 PBN within the UK’s Future Airspace Strategy (FAS)
International Obligations

• In applying PBN, the UK has to continue to meet its International Obligations
  – Remain consistent with the ICAO vision for the future ATM operational concept and transition to a performance based air navigation environment
  – Implement navigation applications in accordance with the ICAO Assembly Resolutions on PBN (A36-23 and A37-11)
  – Take account of available SESAR implementation package enablers
  – Align the UK with a future proposed SES legislation i.e., Implementing Rule for PBN circa 2018-2020
The Future Airspace Strategy (FAS)

• CAA in conjunction with major stakeholders published a high level Future Airspace Strategy (FAS) in June 2011
  – http://www.caa.co.uk/fas

• The FAS sets out the strategy for modernising the UK airspace system answering the question "How can we make the most efficient use of airspace, to meet users requirements, within future constraints?"
UK Airspace requirements for the future and the FAS Vision

**UK Airspace Requires Modernisation to:**

- Deal with current hotspots of congestion
- Enable and facilitate continuous improvement in safety
- Implement SES proposals
- Take advantage of technological developments to improve efficiency
- Be responsive to Government policy and decision-making
- Ensure access to sufficient airspace for non CAT users
- Provide flexibility within the system to enable future development and advancements

**FAS Vision**

Safe, efficient airspace, that has the capacity to meet reasonable demand, balances the needs of all users and mitigates the impact of aviation on the environment
PBN in a FAS Context

- PBN is an essential component in delivering the FAS objectives and modernisation of the UK airspace system.
- Transition from airspace, routes and instrument flight procedures including holds, predicated on conventional navigation systems e.g., VOR, DME, NDB to an airspace described in terms of Performance-based Navigation.
- Delivery on:
  - Increase in capacity and access to General Aviation
  - Improvement in safety
  - Reduction in the effects that flights have on the environment
  - Provision of ATM services to airspace users at a reduced cost
PBN Benefits

- Transition to a total RNAV environment
  - Flight efficiency, optimise airspace, reduced holding containment areas
- Avoids proliferation of standards (cost for certification)
- RNP harnesses aircraft capability
  - Predictable and repeatable path trajectories, moving to a systemised environment with designed interactions
  - Closer spaced routes
  - Curved path transitions
  - Greater tactical flexibility through parallel offsets
  - Higher integrity from RNP (avoid the need to cross-check against point source navigation aids e.g., VOR)
- Infrastructure
  - A move away from dependence on ground based navigation infrastructure towards dual GNSS with DME/DME reversion will permit rationalisation of VOR and NDB
Policy for the Application of PBN in UK/Irish Airspace

- The Future Airspace Strategy (FAS) sets out the roadmap for development of UK airspace
- UK and Ireland have jointly developed a FAB aligned PBN Policy as a key enabler to FAS
- Comprises 12 high-level policy statements
- The PBN Policy sets out a specific framework with guidance and support to ANSPs and operators to help facilitate implementation
- Approved at FAB Supervisory Committee Meeting in Dublin on 13 October 2011
Objectives of PBN Policy

- The PBN Policy takes due account of:
  - The current status of development of RNAV and RNP airspace, routes and procedures within the UK
  - The desire from operators to take greater advantage of onboard aircraft capability
  - The desire of ANSPs to have a clearer framework for PBN
  - The UK model for service provision, separate from State control
  - The future direction of the European ATM Master Plan and the introduction of a PBN Implementing Rule circa 2018-2020
  - Costs/business case involved in making any form of airspace change
Key Features of PBN Policy

- Extension of B-RNAV (RNAV 5) to all ATS routes (April 2011)
- Utilisation of P-RNAV (RNAV 1) capable aircraft on strategic ATS routes
- Statement on overlay of conventional procedures
- All new terminal airspace procedures shall be designed using PBN terminal airspace procedure criteria
- New terminal airspace designs should facilitate use of Continuous Climb and Continuous Descent Operations (CCO and CDO)
- A “Soft Mandate” for PBN in terminal airspace
- Facilitation of 3D approaches in accordance with the ICAO Assembly Resolution
- Progressive rationalisation of conventional navigation infrastructure
PBN Caveats

• PBN is only one element of technological and operational enhancements providing enablers for FAS

• Environmental policy, cost and business drivers will have an impact on how quickly PBN can be moved forward

• The PBN Policy does not contain all of the answers to implementation issues, these will have to be developed separately
UK Implementation Decision Making Process
Where do we want to be in 2020?

- Mid-way to realising objectives from the Future Airspace Strategy (FAS)
- Compatibility with SESAR objectives
- Delivery on:
  - Increase in capacity
  - Improvement in safety
  - Reduction in the effects that flights have on the environment
  - Provision of ATM services to airspace users at a reduced cost
- Putting down the foundations for future 3D and 4D User Preferred Trajectories
- From a navigation and infrastructure perspective that means embracing the concept of PBN and moving the UK controlled airspace environment towards RNP
The Implementation Decision Making Process

• Options for an airspace change:
  – Servicing those equipped and capable
  – Wait for natural equipage rate
  – Airspace Notification “at least we know where we are”

• Driven by the ANSP

• Consulted upon with:
  – airspace users and airports
  – consideration for the environmental impact

• Airspace Change Proposal accepted by the regulator

• Industry implementation plan needed
Selecting the Appropriate PBN Application

Airspace Concept of Operation

- Nav Infrastructure
- ATC Procedures + Training
- ATM Tools
- Airspace Structure and Design
- Target Capacity, Safety, Flight Efficiency, Environment
- Flight Ops Approvals
- Aircraft Certification
- PBN Navigation Specification

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Navigation Capability

Performance Based Navigation (PBN)

En-route

- RNAV 5
- RNAV 1
- A-RNP + FRT
- A-RNP + FRT + TOAC

Terminal Operations

- RNAV 1
- RNP 1
- A-RNP + RF
- RNP-AR Authorisation Required

Approach Operations

- RNP APCH Non-Precision 2D
- A-RNP + RF
- RNP APCH Approach with Vertical Guidance 3D
- A-RNP + RF
- RNP-AR Authorisation Required
PBN Capability Survey

- CAA/NATS recognise that aircraft fleet mix is key to any change
- Alignment of operator fleet investment plans with ATM and airspace development
- To understand the operator fleet capability and identify operator upgrade plans
- In support of the London Airspace Management Programme (LAMP) and Northern Terminal Control Area (NTCA) Development Plans for 2014, 2016 and 2018, currently under development
- Utilise the information to create an airspace change programme, maximising this capability whilst respecting the operator fleet equipage differences and the economic ability to equip
- Ensure timely notification of technical requirements
- Ensure that the selected design standards can yield meaningful benefits i.e., cost benefits can be shown
PBN Capability Survey

- Using previous CNS Avionics surveys to inform this assessment
  - EUROCONTROL 2007
  - IATA 2008
  - EUROCONTROL/IATA 2010

- Has been difficult to obtain a complete picture of operations within UK airspace
  - Combination of operator survey fatigue, data errors
  - Using other techniques to plug the gaps e.g., age of fleet, production equipment capability

- Informing the airspace development process through the FAS Industry Implementation Group (FASIIG)
Background & Assumptions

- Capability by Airport Group derived from aircraft capability data and flight plan traffic for a sample taken in UK airspace during Summer 2010
- % are therefore based on numbers of movements by a given aircraft capability operating into or out of an airport
- Airport Group capability combines all airports in the region based on the ATS airport groupings
  - Individual airport capability is available
- In the absence of aircraft fleet data, assumptions were made based on age of aircraft and manufacturer’s specifications
- Business jets are more bespoke therefore no assumptions are made about these types
- MoD aircraft are still being assessed
RNAV 1 Capability by Airfield

RNAV 1 Capability in the London Terminal Area

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Count of Flights against Summer’10 Flight plan data
RNP 1 Capability by Airfield

RNP 1 Capability in the London Terminal Area

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26 January 2012

ICAO-EUR PBN TF/6
Radius To Fix (RF) Capability by Airfield

Radius To Fix Capability in the London Terminal Area

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Count of Flights against Summer’10 Flight plan data
2014+ PBN Objectives

- The following capabilities should be considered for use in future airspace development projects:
  - RNAV 1 (P-RNAV) should form the baseline design standard
  - Holding capability will be designed, based on manually flown holding defined using an RNAV fix. Aircraft systems providing an automated RNAV or RNP holding capability can be utilised
  - Initial utilisation of vertical constraints e.g., Use of AT or ABOVE vertical path constraints to establish high/optimised departure performance.
  - RNAV 1 Route Spacing:
    - En-route, minimum spacing of 7 NM (subject to validation) for straight parallel routes for same and opposite direction traffic, based on a 5 NM minimum radar separation, ATM monitored but without reliance on radar vectors to provide separation assurance
    - Terminal, 5 NM for straight parallel routes for same and opposite direction traffic, based on a 3 NM minimum radar separation, ATM monitored but without reliance on radar vectors to provide separation assurance
2016+ PBN Objectives

- The following capabilities should be considered for use in airspace development projects:
  - Advanced-RNP Required Capabilities
  - Predicated on mandatory carriage of GNSS supporting Onboard Performance Monitoring and Alerting (track assurance), with DME/DME/IRU providing reversionary capability supporting RNAV 1 performance and monitored by radar
    - Apply RNP 1 where required in the en-route airspace.
    - Tactical Parallel Offset (en-route only)
    - Radius to Fix (RF) - Turn assurance through RF Leg capability in terminal airspace
    - RNAV Racetrack Holding - Automatic holding, where holding is required, to contain primary areas
  - Altitude and speed constraints coded in the aircraft navigation data base
2016+ PBN Objectives - Optional

- Optional Capabilities (where supported by fleet survey):
  - Utilise range of RNP navigation accuracies from 1 NM to 0.3 NM in terminal airspace to alleviate airspace interaction constraints from earlier RNAV 1 designs and reduce ATC radar monitoring requirements
  - VNAV - Develop vertical path definitions in-line with airline operator’s capabilities where available:
    - Vertically constrained fix construction
    - Vertical path definition
2018+ PBN Objectives

• Consistent with the planned European PBN-IR and the required carriage of Advanced-RNP and additional to 2016 objectives:
  – Fixed Radius Transition (en-route, FL195+ only on RNP 1 routes)

• Advanced-RNP optional capabilities (where supported by fleet survey) and additional to those features outlined in 2016 objectives:
  – Time of Arrival Control (TOAC) – Controlled Time of Arrival (CTA) and then Required Time of Arrival (RTA) into terminal airspace of 30 seconds
  – Final approach intercepts - RNP to RNP APCH or RNP to xLS (ILS, MLS or GLS) to mimic vectors.
Conditions of Implementation

- Applicable to all terminal airspace as required and where it can be justified
- Cognisant of airport Approach developments RNP APCH (LNAV, LNAV/VNAV and/or LPV) to ensure alignment
- Will be forward compatible with A-RNP features and future plans i.e., PBN-IR and cognisant of the wider European migration path
- Development of TMA airspace is likely to be in phases therefore utilisation of PBN capabilities may be airport specific to accommodate this phasing
Areas of Risk

- Airspace Change Process and lack of Government policy framework
- Timescales (too short)
- Timely availability of PANS-OPS Instrument Flight Procedure design criteria from ICAO
- Timely availability of aircraft certification and operational approval criteria from EASA
- Operator compliance and risk of mixed capabilities
  - Non-compliant aircraft will be accommodated for a limited period but may be disadvantaged
- GNSS vulnerabilities
- Navigation data base capacity constraints
- Understanding the requirement for ATM ground based trajectory monitoring based on aircraft derived data
- PBN-IR delayed
3 Airspace Developments
Major Airspace Developments

- Design of major airspace changes under consideration by NATS for London and Manchester
  - London Airspace Management Programme – LAMP
  - Northern Terminal Control Area – NTCA

- Based on fleet survey data, CAA seeking to provide an effective PBN implementation plan

- Looking to issue an AIC in order to provide sufficient notice to both operators and airports
  - Agreement of Draft AIC by end of January
  - Publication in March/April 2012
## RNP APCH Status at the end of 2011

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RNP APCH Status into 2012/2013

- Thanks to EC ACCEPTA Project funding, proposals for:
  - 39 LNAV procedures at 20 airports
  - 18 LNAV/VNAV procedures at 8 airports
  - 32 LPV procedures at 15 airports
- Not all ACCEPTA funded, but programme has created interest
- Challenge to find sufficient IFP resources
- Will likely place demands on ability of CAA to provide the necessary regulatory oversight
- Development of CAA policy for:
  - Instrument Approach Procedures To Aerodromes Without an Instrument Runway and/or Approach Control
  - Consultation Summer 2012, publication end of 2012
Other UK Developments

- Conducting feasibility assessment for potential RF trials at Stansted RWY 04 DVR and RWY 22 CLN Departures
- SID and NPR Working Group
- Navaid rationalisation
Summary
Summary

- PBN Policy in place
- PBN implementation programme has a high dependence upon the aircraft and operator capability - hence the need for data survey
- Proposed implementation goals for 2014, 2016 and 2018
- In-line with PBN-IR thinking
- Seeking endorsement from industry to allow the design of LAMP and NTCA to proceed ahead of a formal implementation programme
  - Proposed CAA AIC to inform industry
- Seeing significant uptake of RNP APCH – mainly at regional aerodromes
Questions?

Point of contact:

geoff.burtenshaw@caa.co.uk
5

Spare Slides
PBN Capability
## PBN Capability by Airport Group

<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage RNAV 1 Capable</th>
<th>Percentage B-RNP 1 Capable</th>
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0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Count of Flights against Summer’10 Flight plan data
Radius To Fix (RF) Capability by Airfield

Radius To Fix Capability in the Northern Terminal Area

<table>
<thead>
<tr>
<th>Airfield</th>
<th>YES</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Total</td>
<td>36843</td>
<td>18390</td>
</tr>
<tr>
<td>EGNR</td>
<td>1</td>
<td>827</td>
</tr>
<tr>
<td>EGGP</td>
<td>7802</td>
<td>2888</td>
</tr>
<tr>
<td>EGCC</td>
<td>29040</td>
<td>14669</td>
</tr>
<tr>
<td>EGCB</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

Count of Flights against Summer’10 Flight plan data