What is an Airspace Concept?
Module 4

European Airspace Concept Workshops for PBN Implementation
Overview

Learning Objectives:

- At the end of this presentation you should:
  - Understand what the purpose of an airspace concept is and how it should drive any successful implementation

- This presentation will discuss:
  - What is an Airspace Concept?
  - Why develop it?
  - Who develops it?
  - What do they need to develop it?
  - What does it look like?
  - After the Airspace Concept is developed, then what?
Components of PBN Concept

- Navigation Application
- Navigation Specification
- NAVAID Infrastructure
PBN Concept Review

Navigation
Application
Use of
RNP & RNP

Navigation
Specification

NAVAID Infrastructure

Ground-based or Space-based

RNAV RNAV XX
RNP RNP XX
RNP descriptor
PBN in Context:

Airspace Concept

COM NAV SUR ATM

Navigation Application
Navigation Specification
NAVAID Infrastructure
Navigation in Context

Airspace Concept

Communications

Navigation

Surveillance

Air Traffic Mgt

CNS/ATM
What is an Airspace Concept?

- A master plan or schema of the intended airspace design and its operation
  - Describes the intended operations within an airspace
  - Developed to satisfy explicit and implicit strategic objectives (e.g. improved safety, increased air traffic capacity, improved efficiency, mitigation of environmental impact)

- A fully developed Airspace Concept:
  - Describes in detail the planned airspace organization and its operations
  - Addresses all of the strategic objectives identified for the airspace project
  - Addresses all CNS/ATM enablers
  - Identifies operational and technical assumptions
Context of an Airspace Concept: Strategic Goals (Expected Benefits)

- Safety
- Capacity
- Efficiency
- Environment
- Access

Airspace Concept

COM  NAV  SUR  ATM

Navigation Specification
Navigation Application
NAVAID Infrastructure
RN A V  X  RNP  X
Translation of Strategic Objectives

**Increase Capacity**
- Addition of a new runway

**Reduce Environmental Impact**
- Avoid noise sensitive areas at night

**Increase Flight Efficiency**
- Use airspace users on-board capabilities

**Increase Safety on Approach**
- Improve vertical profile enabling stabilised approaches

**Increase Access**
- Provide alternative to conventional NPA

**Operational Requirements**

**Implementation Objectives**

- Design new RNP SIDs/STARs for new runway and adapt existing ATS route network to PBN
- Design of RNP SIDs/STARs with CCO and CDO
- Develop ATS route network based on Advanced RNP
- Introduce RNP APCH
- Develop RNP APCH procedures
Why develop an Airspace Concept?

- The development of an Airspace Concept provides a structured and systematic way of determining
  - **What** is to be achieved in an airspace, and
  - **How** it will be achieved

- Development process helps ensure
  - Goals (expected benefits) of planned airspace structure are clearly stated;
  - Objectives of the airspace change are met; and
  - the means chosen to achieve those benefits are appropriate to the goals as well as feasible within the resources available to the particular airspace system
Airspace Concept

- Assumptions: CNS/ATM/Traffic/RWY/MET
- Inter-centre letters of Agreement
- Traffic assignment [incl. regulation]
- Special techniques: CDO; CCO; Point Merge
- Flexible Use of Airspace
- Airspace Classification

Airspace Concept Workshop
Once the Airspace Concept is developed, what’s next?

- Lay out a detailed program plan for the specific implementation(s) in the Airspace Concept
- ICAO sample action plans (domain-specific and comprehensive)
  - Consider just as a starting point
  - Adapt as needed to the specific circumstances of a project
  - Steps not always conducted in strict sequence
  - Certain steps may be conducted on a recurring basis as the project progresses
  - Steps and the sequence in which they are performed in the project should be evaluated by the implementation team on the basis of experience and judgment
Who implements the Airspace Concept?

- **Team effort** by representatives of various organizations and technical specialties

- Particular composition of the team depends on the scale and nature of the project
  - A simple airspace concept (e.g. a SID, STAR and IAP) would have experts from
    - ANSP (including PANS OPS procedure designer)
    - civil aviation regulator
    - airport operator
    - operators’ representative
  - A more extensive Airspace Concept (e.g. new runway, plan for terminal and en route airspace) could also include
    - safety management system experts
    - simulation studies experts
    - additional operator representatives
    - environmental personnel

- **Team lead** - usually an airspace planner or knowledgeable ANSP air traffic manager. Not a hard and fast rule. The fundamental requirement is for the task are:

  Knowledge, proactive, dedicated, sound understanding of ATM and airspace organization, with support from all participating stakeholders
Airspace Design Team

Airspace Concept development requires the combined efforts of

– Air Navigation Service Providers;
– Regulators; and
– System Users

Airspace design team-
expanded on needs-basis

Airspace design team-core

Airspace Planners
Air traffic Controllers
(en route & approach)
Procedure Designer
ATM Operations Manager
(Regulator)
Airline Operators

Technical Pilots

Simulation Specialist

GAT users

Military users

Engineers

Sur

Comm/NAV

Environmental Manager

Airport Authority

ATM System Engineers
Implementation Team Initial Tasks

1. **Identify and Prioritise** strategic objectives
   - Safety?
   - Efficiency?
   - Capacity?

2. **Develop the target airspace design**

3. **Address** enablers

4. **Identify** technical/operational assumptions
Airspace Concept

**Airspace Design**
- Routes; Volumes; Sectors.

**Conventional Navigation**
- Airspace Design based on assumptions that all aircraft equipped with NDB/VOR and/or DME and airspace designed on those assumptions.

**RNAV (pre-PBN)**
- Airspace Design based on assumptions that 'RNAV equipped' aircraft can use RNAV routes. Exceptionally, Nav Spec required e.g. RNP 4.

**PBN**
- Airspace Design must, in all cases match...

- Aircraft fleet approval, which must match...
- An ICAO PBN Navigation Specification
- ...and available NAVAID Infrastructure
What does the team need to implement an Airspace concept (1)?

- **TIME** – to explore the needs of the various stakeholders, reach agreement on goals, identify current ground and airborne equipment limitations, conduct traffic flow analyses, etc

- **MONEY** – Costs may include (but are not limited to)
  - education and training (regulators, operators, ATC, procedure designers, etc),
  - establishment and sustainment of robust airworthiness, operations approvals, data quality techniques,
  - changes to ATC automation, flight validation, possibly new NAVAIDS (DMEs), etc

- **TOOLS** - design and modeling tools to support the design, validation and assessment of the present (“reference scenario”) and planned Airspace Concept
What does the team need to implement an Airspace Concept (2)?

- CONOPS
  - Overarching plan covers:
    - CNS/ATM
    - Supports strategic objectives of airspace concept
    - Ensures buy in from all parties
    - Enables systemization of TMA
  - Strategy on how to handle traffic
What does it look like?

- An Airspace Concept can be in any document format
- Maintain configuration control!
What is the most critical point in implementing an Airspace Concept?

- The most critical part of developing an airspace concept is *setting the appropriate objectives and scope of the project*.

- Enables the project team to remain focused and the budget to be managed within the set time.

  - Most projects which fail to meet the intended goal do so because of poorly defined scope and objectives.
    - Beware of *project creep*!
Components of PBN Concept

Navigation Specification

RNP SPECIFICATIONS

- Designation: RNP 4
  For Oceanic & Remote Continental navigation applications

- Designation: RNP 2
  RNP 1
  A-RNP
  RNP 0.3
  RNP APCH
  RNP AR APCH
  for various phases of flight

- Designation: RNP
  * with additional requirements to be determined
  (e.g. 3D, 4D etc)

RNAV SPECIFICATIONS

- Designation: RNAV 10
  For Oceanic and Remote Continental navigation applications

- Designation: RNAV 5
  RNAV 2
  RNAV 1
  For En Route & Terminal navigation applications

International NS in Volume II of PBN Manual
What's new with PBN

**Conventional Navigation**
Airspace Design based on assumptions that all aircraft equipped with NDB/VOR and/or DME and airspace designed on those assumptions.

**RNAV (pre-PBN)**
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**PBN**
Airspace Design must, in all cases match....

(a) Aircraft fleet approval, which must match...

(b) An ICAO PBN Navigation Specification

(c) ...and available NAVAID Infrastructure
Address 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 “leveling off” flight profiles
Objectives to Implementation

Safety
- Reduce Controlled Flight Into Terrain via lateral & vertical course guidance to runway

Capacity
- Increase number of air traffic routes to reduce congestion; accommodate projected growth

Efficiency
- Reduce delays that result from excessive “leveling off” flight profiles

Environment
- Reduce noise over sensitive area

Access
- Improve airport and airspace access in all weather conditions

- RNP APCH (APV Baro/SBAS) to replace conventional NDB NPA
- Parallel A-RNP with FRT ATS routes between cities
- RNAV-1 SID that allows continuous climb to en-route
- RNP APCH with RF or RNP (AR) APCH providing guided curved approach or missed approach segments
- RNP APCH (APV Baro/SBAS) allowing lower minima
Agree Assumptions

**Traffic**
In/Out/Transit
IFR/VFR/Military

**Runway in Use**
Primary
Secondary

**Aircraft Nav Equipage**

**Aircraft Performance**
Speeds / Climb / Descent

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

- **Efficiency**
  Reduce delays that result from excessive “leveling off” flight profiles

Increase number of ATS routes to reduce congestion; accommodate projected growth; reduce delays that result from excessive “leveling off” flight profiles.
Design the Airspace

Identify known traffic flows

Determine placement for SIDS/STARS

Include special techniques, e.g., CDO, CCD & Point Merge

Find good crossing points

Build airspace volume & sectorise

Capacity

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

Efficiency

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

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

Efficiency

Reduce delays that result from excessive “leveling off” flight profiles
Thank you
OPS CONCEPTS
OBJECTIVE

- This module will provide an overview of a concept of operations (CONOPS)
- Provide examples of different CONOPS
- Provide generic understanding of the purpose and need to develop a CONOPS in support of a PBN Airspace concept
Current Airspace – Complexity
What is a CONOPS?

- Overarching plan covers:
  - CNS/ATM
  - Supports strategic objectives airspace concept
  - Ensures buy in from all parties
  - Enables systemisation of TMA

- Strategy on how to handle traffic
Why a CONOPS?

Without CONOPS:

- Risk to have only a nice airspace design
- No Predictability
- No Uniform handling of traffic
- no planning
- No benefits from PBN
- No awareness of developments of trends
- Less means to analyse trends
  - Traffic spreads
  - New conflict areas
  - Capacity issues
Controllers vs Engineers

- Controllers
  - Conservative
  - Reluctant to change
  - RV ‘rules’

- Engineers
  - Not conservative
  - Embrace change
  - Always in detailed level
Poor Examples

- TMA redesign with AMAN – (US)
- New sectorisation (en route) – (EU)
- Combining tasks – (EU)
Good Examples

- London TMA re-design
- Atlanta RNAV departures
- What about your experiences in this?
Skills and Proficiency

- Pilot
  - System managers
  - Special skills trained on flight sim

- Controller
  - RV mainly
  - Afraid losing skill
  - Is there a resemblance ;-)
TMA 2010+

- Advanced arrival manager
- Monitoring tool
- Speed and level advice to controllers
- Allows CDAs in peak hours
- Requires support from ACC
Sequencing and Metering

- Present strategy relies on aircraft stacks to maximise landing rates

- Sequencing and metering is the responsibility of the controller and does not usually take account of AO preferences or priorities

- Future operational concept aims to minimise delay while optimising the available airport resources to the full
**Concept**

- **At 1:**
  - Aircraft becomes eligible for AMAN
- **At 2:**
  - Controller will be provided with active advisories
Concept (2)

- At 3:
  - Common Path Protection may be provided

- At 4:
  - Common Path Protection will be provided
Re-sequencing Criteria

- Re-sequencing adjustment
  - Aircraft cannot meet the scheduled landing time
  - Changed demand for arrival and departure slots
Distributed Processing

Unit A
- Receive delay data (ASC)
- Provide controller advisories

Unit B
- Receive delay data (ASC)
- Provide controller advisories
- Provide data upstream

Unit C
- (Full AMAN)
- Determine Optimised Sequence
- Determine need for delay
- Provide data upstream
- Provide controller advisories

Eligible for AMAN
Eligible for active advisories
COP-1
COP-2
Delay Sharing

+2 mins

COP1
ETO 1414
ETO 1416

+3 mins

COP2
ETO 1426
ETO 1431

+5 mins

ETO 1438
ETO 1448

Airspace Concept Workshop
Monitoring functionality (MONA-P)

- Compares the actual progress of the flight against its proposed trajectory
- If discrepancies occur, the system will generate active controller advisories
AMAN-P

- **AMAN-P HMI**

- **Landing list**
AMAN-P

- **AMAN-P HMI**

- Controllers advisory in label zero line
Flight Profile (Baseline)
Flight Profile (RNAV1)
Flight Profile (RNAV1 + AMAN-P)
Point Merge System (PMS)

Integrated sequence

Envelope of possible paths

Sequencing legs (each leg arcs the same distance from the merge point)

Point Merge System - example with two inbound flows
Scenario “Talk-Through” (1/5)

Scenario “talk-through” for Grey, Green, Gold and Blue aircraft
Scenario “Talk-Through” (2/5)

Initial situation with a busy flow of traffic to the merge point
Scenario “talk-through” (3/5)

Grey heavy jet cleared direct to the merge point. Controller determines when to issue the “Direct to merge point” instruction to the Gold aircraft to ensure that the required WTC spacing behind the preceding aircraft will be achieved.
Controller issues the “Turn left direct to merge point” instruction to the Gold aircraft using the range ring arcs to assess the appropriate WTC spacing from the Grey aircraft.
The same technique is repeated for the Green aircraft and subsequently for the Blue aircraft once the Green aircraft passes the next ‘Range Ring’.
Configurations Tested (1/2)

- Straight sequencing legs
- Segmented sequencing legs
- 3 flows, with 2 sequencing legs of same direction
- Dissociated sequencing legs
Configurations Tested (2/2)
Example with 36 arrivals per hour on each runway
Point Merge - Norway
THANK YOU