What is an Airspace Concept?
Module 5

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 in the big picture

- AIRSPACE CONCEPT
- CQM
- NAV
- SUR
- ATM
- DCPC Voice
- Interoperability SET
- Navigation Application
- Navigation Specification
- NAVAID Infrastructure
- Standardisation SET
- Selected
  - Navigation Sensor must match infrastructure

In ECAC = RADAR >> ADS-B; WAM

Procedures & Tools
Airspace Requirements

Lateral navigation
a. Closer route spacing, particularly in the en-route;
b. Maintaining same spacing between routes on straight and turning segments without a need to increase route spacing on the turn*;
c. Reduction of the size of the holding area to permit holds to be placed closer together or in more optimum locations;
d. Aircraft ability to comply with tactical parallel offset instructions as an alternative to radar vectoring;
e. Means of enabling curved approaches, particularly through terrain rich areas but also to support environmental mitigation.*

* Note: Repeatable and predictable turn performance is the basic operational requirement.

Longitudinal navigation
f. Some means to enable the metering of traffic from en-route into terminal airspace;

Vertical navigation
g. Effective management of vertical windows to segregate arrivals and departures (example in diagram);
h. Effective use of CDIs and CCIs (again for environmental mitigation);

The above requirements serve various benefits viz. capacity, flight and ATM system efficiency (particularly requirements b, c, e, f and h), airport access (requirement e), enhanced system and sequencing predictability (requirements b and f) etc.

European High Level Concept

At a very generic level, Europe’s current airspace concept, which extends well beyond PBN, can be said to have the following characteristics:

- A parallel network of ATS routes, based on RNAV 5, across the continent
- A move to Free Route airspace (FRA) where density of traffic allows it
- Extensive use of the ‘Flexible Use of Airspace’ concept
- A system of feeder or link routes, mainly based on RNAV 5 which connect to RNAV 1 or Conventional SIDs and STARs starting at the nominal TMA boundary.
- An organised track system (OTS) in the North Atlantic based currently on MNPS (this is likely to change to RNP4)
- The use of Reduced Vertical Separation Minima (RVSM) between FL290 and FL410.
- Airspace Classification Class C above FL195
- Slow evolution from State managed upper airspace to Functional Airspace Blocks (FABs).

Europe’s Airspace Concept for high density airspace is evolving to include RNP1 with RF for SIDs and STARs and RNP APCH for the approach. In en-route, to enable reduced route spacing A-RNP with consistent turn performance delivered by FRT will be required.
Connectivity and Airways Records

Free Routes Airspace (FRA)

FL 310

PCP AF#3

DCTs

Fixed ATS Routes

SID/STARs

RNP 1 with RF

Approach

RNP APCH

PCP AF#1

Some Current Operations

<table>
<thead>
<tr>
<th>Sweden</th>
<th>Iceland</th>
<th>EUROPE GEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRA</td>
<td>Conv SIDs/STARs</td>
<td>FRA / Fixed routes</td>
</tr>
<tr>
<td>Conv SIDs/STARs</td>
<td>Conv SIDs/STARs</td>
<td>SIDs/STARs / RNAV1</td>
</tr>
<tr>
<td>RNP A/R</td>
<td>ILS / NPA / RNP APCH</td>
<td>P-RNAV / AR</td>
</tr>
<tr>
<td>ILS / RNP (AR) APCH</td>
<td>RVSM</td>
<td>ILS / NPA / RNP (AR) APCH</td>
</tr>
<tr>
<td>RVSM</td>
<td>Class A &gt;FL195</td>
<td>GBAS</td>
</tr>
<tr>
<td>Class C</td>
<td>FUA</td>
<td>RVSM</td>
</tr>
<tr>
<td>FUA</td>
<td>D’Link / Voice</td>
<td>Class C &gt; FL195</td>
</tr>
<tr>
<td>Voice</td>
<td>RADAR → ADS-B</td>
<td>FUA</td>
</tr>
<tr>
<td>RADAR</td>
<td>Voice</td>
<td>RADAR / ADS-B / MLAT</td>
</tr>
</tbody>
</table>
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
Translation of Strategic Objectives

**Increase Capacity**
- Addition of a new runway
- Design new RNP SIDs/STARS for new runway and adapt existing ATS route network to PBN

**Reduce Environmental Impact**
- Avoid noise sensitive areas at night
- Design of RNP SIDs/STARS with CCO and CDD

**Increase Flight Efficiency**
- Use airspace users on-board capabilities
- Develop ATS route network based on Advanced RNP

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

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

- A 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

To Do What?
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

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*!
OPS CONCEPTS

2 Prevailing 'Philosophies' to Route Design

- The pressure cooker
  - Common to large European airports
  - Permits systematic feeding of runways and maximizing efficiency of runway throughput
  - Lots of holding

- Extensive Radar Vectoring
  - More popular at less concentrated hubs
  - Sometimes vectoring worse than holding…
Arrival Sequencing and Metering

- Present strategy relies on aircraft stacks, or vectoring to maximise landing rates and cope with overload of TMA
- Sequencing and metering is the responsibility of a controller and does not usually take place before the TMA
- Aim to minimise delay in TMA while optimising the available airport resources to the full

AMAN history – No common system

Specific to airport and based on local rules

- **ZURICH**
  - COMPASS
  - Coordination tool
  - Advisories (not used)
  - Volume control
  - No concept
  - No CDA

- **HELSEINKI**
  - MAESTRO
  - Coordination & pre-sequencing tool
  - No advisories
  - Volume control
  - TMA concept
  - CDA

- **FRANKFURT**
  - 4D PLANNER
  - Coordination & pre-sequencing tool
  - No advisories
  - Volume control
  - Adapts to controller
  - No CDA

- **COPENHAGEN**
  - MAESTRO
  - Coordination & pre-sequencing tool
Perceived benefits

- Environmental
- Capacity (sustainability)
- Efficiency
- Operators (costs)
- Predictability (CDM)
- Safety (to be assessed)
- Possible workload reduction (ATC & Cockpit)

Concept of an AMAN

- At 1 - the aircraft becomes eligible for AMAN
- At 2 - the controller will be provided with active advisories
- At 3 - Common Path Protection may be provided
- At 4 - Common Path Protection will be provided
How it works

- Aircraft maintain ATS routes
- AMAN calculates arrival sequence
  - 10-15 min ‘Look Ahead’
  - Locally devised rules
  - Rough sequencing at range
  - Provides:
    - Metering and Flow to RWY
    - Closer to RWY, more predictable and stabilised
    - Local rules dictate when sequence becomes fixed

Extended AMAN

- Planned look ahead:
  - 20-25 mins
- Will require:
  - Earlier information
  - Significantly more prediction accuracy
- Could impact/influence other en route operations in the upstream sectors
- Common rules on priorities?
Distributed Processing

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

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

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

Delay Sharing

- Change over Point (COP)
- Estimated Time Over (ETO)

- COP 1
  - ETO 1414
  - ETO 1418

- COP 2
  - ETO 1425
  - ETO 1433

- ETO 1438
- ETO 1448

- Required Time of Arrival (RTA)
- Controlled Time of Arrival (CTA)
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
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
Skills and Proficiency

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

- Controller
  - RV mainly
  - Afraid losing skill
  - Is there a resemblance ;-)
Flight Profile (Baseline)

Flight Profile (RNAV1)
Flight Profile (RNAV1 + AMAN-P)

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.
Scenario “Talk-Through” (4/5)

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.

Scenario “Talk-Through” (5/5)

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