Established with PBN new route as a Civil Military Cooperation

- Y711 & Y722, the 8NM lateral separation -
Outline

1. PBN Road Map
2. Airspace Concept
3. Design Concept
4. Implementation
5. Safety Assessment
6. Cost-Benefit Analysis
1 PBN Road Map

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2013</th>
<th>2016</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>En route</td>
<td>RNAV 5</td>
<td>RNAV 2 partially</td>
<td>altitude separation between conventional routes and RNAV routes</td>
<td></td>
</tr>
<tr>
<td>Terminal</td>
<td>RNAV 1 SID/STARs in radar airports</td>
<td>RNP 1 SID/STARs in non-radar airports</td>
<td>mandate RNAV 1 or RNP 1 in major TMAs</td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td>RNP APCH APV</td>
<td>RNP AR APCH at selected airports</td>
<td>GNSS with GBAS at selected airports</td>
<td></td>
</tr>
<tr>
<td>Removal</td>
<td></td>
<td></td>
<td>Ground NAVAIDs removal validation</td>
<td>Ground NAVAIDs removal</td>
</tr>
</tbody>
</table>
2-1 Airspace Concept -1

Status of B576

Why? B576

• The most congested route
• Traffic Volume: 42%
• The largest ACAS Occurrence rate

Traffic Volume - Airways -

- B576: 42.0%
- G585: 8.9%
- G597-East: 9.8%
- G597-West: 11.0%
- A582: 22.0%
- others(Vicinity of Airports): 14.5%

Status of B576

- B576: 21.0%
- A582: 34.2%
- G597: 17.1%
- G585: 13.2%
- others(Vicinity of Airports): 14.5%
Airspace Concept - 2

- Reduction 10NM
- Expansion
- 8NM Separation
- Arrival
- Departure
- CJU
- SEL
“For both RNP and RNAV designations, the expression “X” (where stated) refers to the lateral navigation accuracy (TSE) in nautical miles, which is expected to be achieved at least 95 per cent of the flight time by the population of aircraft operating within the airspace, route or procedure.”

- ICAO Doc.9613 PBN Manual
For PBN Procedures

- $\frac{1}{2} W = XTT \times 1.5 + BV$
- $2\delta(95\%) = XTT$, $3\delta(99.7\%) = XTT \times 1.5$

½ W = 5NM for RNAV 2 and 5.77 NM for RNAV 5 is needed

<table>
<thead>
<tr>
<th>NAV</th>
<th>XTT (NM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNSS</td>
<td>2.51</td>
</tr>
<tr>
<td>DME/DME</td>
<td>3.30</td>
</tr>
</tbody>
</table>

Routes Spacing

RNAV 5

- 12NM
- 5.77NM

RNAV 2

- 8NM
- 5NM
- 5NM
- 2NM needed
**Upper Segment RNAV 2**

**Segments**
- MONSI~PANSI(Y711)
- SOT~SOSDO(Y722)

- **Separation Distance**: 8NM
- **Navigation Requirement**
  - RNAV 2
- **Required Equipment**
  - DME/DME/IRU, GNSS
Design Concept

Lower Segment RNAV 5

- **PANSI~BONSO(Y711)**
- **SOSDO~ATOTI(Y722)**

Segments

- **Separation Distance:** 12NM
- **Navigation Requirement**
  - RNAV 5
- **Required Equipment**
  - INS/IRU, GNSS
### Estimate of Collision Risk

**Collected Data**

- **Period of Traffic Sample data**
  - 1 July 2012 to 31 December 2012
- **Altitude:** Above 14,000 ft
- **Total Flight:** 80,280
- **Type of Aircraft**
  - A333, B737, B738, A321

### Collision Risk Estimate

<table>
<thead>
<tr>
<th>Route</th>
<th>Y711 (RNAV 2)</th>
<th>Y722 (RNAV 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate</td>
<td>4.33E-12</td>
<td>1.45E-12</td>
</tr>
</tbody>
</table>

- Estimate satisfies ICAO’ TLS 5.0 x 10^-9

### Trends of Collision Risk Estimate
### Traffic Sample Data of ATS routes

<table>
<thead>
<tr>
<th>Status</th>
<th>Pre-Implementation</th>
<th>Post-Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period of TSD</td>
<td>1 - 31 May 2012</td>
<td>1 - 31 July 2012</td>
</tr>
<tr>
<td>Altitude</td>
<td>Above FL 140</td>
<td>Above FL 140</td>
</tr>
<tr>
<td></td>
<td>(total 725 flights)</td>
<td>(total 864 flights)</td>
</tr>
<tr>
<td>Segment of ATS route</td>
<td>B576</td>
<td>Y711 &amp; Y722</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(RNAV 2 Segments)</td>
</tr>
</tbody>
</table>

**Simulation**

- **MATLAB**: for the database construction of the massive aircrafts trajectory file
- **BADA Model**: for the prediction of fuel consumption for different aircraft type and different altitude-velocity per time
## Outcome of Simulation

### Cost-Benefit Analysis

### Speed: 17 knots \( \uparrow \), Flight time: 1.2 min \( \downarrow \), Fuel consumption: 228.4 kg/flight \( \downarrow \)

<table>
<thead>
<tr>
<th>Status</th>
<th>Pre-Implementation</th>
<th>Post-Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment of ATS route</td>
<td>B576</td>
<td>Y711 &amp; Y722 (RNAV 2 Segments)</td>
</tr>
<tr>
<td>Flight distance</td>
<td>229NM</td>
<td>230NM</td>
</tr>
<tr>
<td>Flight speed</td>
<td>408 knots</td>
<td>425 knots</td>
</tr>
<tr>
<td>Flight time</td>
<td>33.8 min</td>
<td>32.6 min</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>4173.7 kg/flight</td>
<td>3945.3 kg/flight</td>
</tr>
</tbody>
</table>
Cost-Benefit Analysis

From 2013 through 2022

Type and estimated benefits

- Reduced airlines direct operating costs
  - $ 19.13 million
- Environmental benefits from reduced aircraft emission (CO2)
  - $ 0.37 million
- Passenger value of time
  - $ 8.16 million
- Total estimated cost-benefit
  - $ 27.66 million

The end of 2013

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Cost-Benefit Analysis

- Estimated benefits (2013~2022)