Long term cooperation with China

- RNP AR at Lhasa, Linzhi, Shigatse, Bangda, Ali, Liping and Yan’an airports
- **High elevation and terrain challenging airports**
- RNP network between the different airports
  - From departure to arrival
  - RNP APCH in Sanya
  - RNP to ILS at Xian and Zhangjiajie
Challenging airport operations

Complex projects in China

RNP AR at Kathmandu airport

KATHMANDU: “circumnavigating the high terrain” resulting in smooth descent with vertical guidance

- RNP-1 STARs and RNP AR approach and missed approach
- Fully Managed Approach and Missed Approach
- Smooth 2.8° descent slope / Stabilized approaches
- Lower minima: 340ft DH vs. 635 ft MDH
Tutoring initiatives worldwide

- Support to Airport Authority of India
- RNP-1 STARs and RNP APCH approach to RWY 27
- Seventh Busiest airport in India
- 40nm shorter flight path compared to conventional VOR

- Complex projects in China
- RNP AR at Kathmandu airport

Cochin : First RNP APCH in India

Nationwide implementation plan in the Philippines
PBN network and transfer of knowledge at 12 airports in the Philippines

- Tutoring: CAAP procedure designers benefit from Quovadis/ENAC advice and validation at 6 airports
- Training: ATC, data survey, procedure design, flight Inspectors, safety assessment
- Efficient: CAAP will be fully autonomous at the end of the project
- Quovadis design at 6 airports to speed up the implementation

Complex projects in China
RNP AR at Kathmandu airport
Cochin: First RNP APCH in India

Nationwide implementation plan in the Philippines
Removal of visual and circle-to-land procedures

- **Drawbacks of Circling:**
  - Challenging flying procedure in marginal visual conditions
  - “Disliked” by most pilots
  - Identified as a major cause of several fatal accidents
  - Needs specific training

- **Removal of circling and visual procedures without need for additional ground infrastructure**

- **Reduction of tailwind landings on short runways to avoid the circling**

- **Might require flexibility in terms of trajectories (curved path) depending on surrounding terrain**
## ASBU Block Upgrades

CCO and CDO implementation listed as near term (now thru 2018) steps in the ICAO Aviation System Block Upgrades and Global Air Navigation Capacity & Efficiency Plan

<table>
<thead>
<tr>
<th>Module</th>
<th>Performance Improvement Area</th>
<th>Module Title</th>
<th>Module Description</th>
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<tbody>
<tr>
<td>B0-05</td>
<td>Efficient Flight Path</td>
<td>Improved Flexibility and Efficiency in Descent Profiles (CDO)</td>
<td>To use performance-based airspace and arrival procedures allowing aircraft to fly their optimum profile using continuous descent operations (CDOs). This will optimize throughput, allow fuel efficient descent profiles and increase capacity in terminal areas.</td>
</tr>
<tr>
<td>B0-20</td>
<td>Efficient Flight Path</td>
<td>Improved Flexibility and Efficiency in Departure Profiles - Continuous Climb Operations (CCO)</td>
<td>To implement continuous climb operations in conjunction with performance-based navigation (PBN) to provide opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb profiles and increase capacity at congested terminal areas.</td>
</tr>
</tbody>
</table>
Continuous Descent Operations (CDO) vs Conventional Arrival

- Leverages RNAV STAR implementations
- Reduce the amount of time spent in level flight on published arrival procedures (i.e., STARs)
Closed Path Design

Altitude windows safely separate aircraft and allow predictable flight performance
ATC Integration

ATC operating procedures to accommodate PBN.

- Design using updated techniques to minimize interaction
  - CDO
  - CCO

- Education is critical
  - Concept of operations
  - ATC benefits
  - Clear responsibilities defined
  - Structured Decision Points give ATC ability to judge control actions early.
OMAA: RWY 13R/L
Structured decision points

PBN CCO/CDO Sequencing Methods

Equidistant points

- △
- ○
- □

V
Integration of traffic from various arrival routes
Display of RNP tracks on the ATC radar screen
CDO Integration Techniques

Good Design Integrates PBN, CDO, & Conventional Capabilities
Example of RNP AR to ILS track – Lateral profile
• The RNP AR track should connect from below; to ensure G/S capture from below
• Importance to study the effect of Delta ISA on the barometric profile of the RNP AR track, to ensure correct transition to the ILS
Separations for parallel runways

State of the Art in the U.S.

- ILS / RNP dependent approaches with current FAA criteria

**Approach gate:** point before which ATC expects aircraft to be established on final approach course

3NM horizontal or 1000ft vertical sep until both A/C reach approach gate

Then, horizontal separation

- 1.5 NM for $2500ft < d < 4300ft$
- 2.0 NM for $d > 4300ft$

Then, horizontal separation 1.5/2 NM for $2500ft < d < 4300ft$
2.0 NM for $d > 4300ft$

Logitudinal sep.
Expected benefits for ATC

- Simplify ATC work and reduce the workload per aircraft
- Increase the traffic flow (reduce average time for approach)
- Reduce separations and optimize airspace use

Expected benefits for aircraft

- Average reduction in flight time and distance flown for approach (less fuel burn)
- Less Delays
- Possibility to implement CDOs
Approach Integration Using Structured Decision Points
Approach Integration Using Structured Decision Points
Conclusion

• PBN is a great tool
  • to reshape the airspace
  • Enhance the flow
  • Increase capacity

• PBN allows to prepare the future growth of the African traffic

• All the modern aircraft are PBN capable

• Let’s fly the Airbus the most efficient and safest way