Operational improvements and Environment Performance Based Navigation (PBN)
Air Traffic Management (ATM)

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Regional Officer Air Traffic Management / Search And Rescue
International Civil Aviation Organization
North American Central American and Caribbean Regional Office
ICAO – ENV Activities

- Improve Airport and air navigation infrastructure (operational improvements)
  - PBN
  - ATFM

- Improve aircraft technology;
  - (A380) 3Lts x 100PAX/km = 75g CO2 x PAX/km
  - Renew aircraft fleet, 5500 a 2020

- Improve fuel:
  - BIO - Green emissions

- Reduce CO2 emissions:
  - 2020, 21%
  - 2050, 50%

- Reduce noise level
  - Airports & surrounding areas
Evolution of Air Navigation

- Visual Navigation
- Estimated Navigation
- Astronomic Navigation
- Radio Navigation (ground based - conventional)
- Global Navigation Satellite System (GNSS)
Air Transport Growth (ICAO)

Passengers carried in 2012:
3.0 billion
+4.7% growth rate vs. 2011

Forecasted passengers carried in 2030:
6.4 billion
+4.4% average annual growth rate

Aircraft departures in 2012:
31 million
+0.7% vs. 2011

Forecasted aircraft departures in 2030:
59 million
+3.6% average annual growth rate

*Preliminary figures

Traffic Statistics for Revenue Schedule Services
World economic growth vs. air traffic growth (passenger and cargo)

Source: IHS Global Insight, ICAO
ATM Vision

To achieve an interoperable global air traffic management system for all users during all phases of flight, that

- meets agreed levels of safety;
- provides for optimum economic operations;
- is environmentally sustainable; and
- meets national security requirements.
• Access and Equity
• Capacity
• Cost-effectiveness
• Efficiency
• Environment
• Flexibility
• Global interoperability
• Participation by the ATM community
• Predictability
• Safety
• Security
Integration

Information rich environment

People
- Management
- Airspace User
- Conflict Management

Systems
- Communications
- Navigation
- Surveillance
- Aerodrome
- ATM
- Aircraft operations
- Maintenance Engineering
- ATM Service provider
- Demand capacity balancing
- Airspace user operations
- Airspace organization and Management
- ATM service delivery management
- Traffic synchronisation
• ICAO global vision for air traffic management (ATM)

• ATM Community to find the best way to maximize the efficiency for all the stakeholders

• Maximize the benefits of modern navigation methods
• Volume I
  – Part A - The PBN Concept
  – Part B – Implementation Guidance

• Volume II – Implementing RNAV and RNP

- ICAO Doc 8168, PANS-OPS Vol II
- Doc 9906, Vol I, FPD QA System
  - Vol 2, FDP Training
  - Vol 3, FPD Software validation
  - Vol 5, Validation of FPD
  - Vol 6, Flight validation, Pilot Training and evaluation
- Doc 9905, RNP AR Procedure Design Manual
- Doc 9992, PBN in Airspace Design
- Doc 9933, CCO Manual
- Doc 9931, CDO Manual
PBN Airspace Concept

- Communication
  - Navigation
  - Surveillance
- CNS

- Air Traffic Management
  - Regulations
  - Procedures
  - Training
  - Service Provider
  - Human Factors
PBN Implementation Programme

Regional implementation

Regional

National

Upper Airspace

Lower airspace & terminal areas

PBN approach procedures

Aerodrome

2005 Short term Medium term Long term

States
58% of States have PBN Implementation Plan
PBN approaches
Regional PBN Implementation

% of PBN Runways per Country for NACC

Source: ICAO SPACE
PBN RWYs vs CONVENTIONAL RWYs

% of Runways for NACC

2010 Resolution | 2014 Resolution | 2016 Resolution

PBN: 84.1 % | Conventional: 15.9 %

% of Instrument Runways
What’s next?
Airspace Redesign / ATC Sectorization

Upper ACC Sectors

ACC S1
ACC S2
ACC S3
ACC Lower

GEOGRAPHIC

FUNCTIONAL
Continuous Descent Operations (CDO)

**EXAMPLE**

Top Limit
(100 NM x 350 ft/NM) + 200 ft (runway elevation) = 35,200 ft MSL

Bottom Limit
((90 nm - 5 nm) x 220 ft/nm) + 3000 ft = 21,700 ft MSL

If altitudes are needed here:
Note: to illustrate the example the point chosen is 100 nm from Runway end and 90 nm from IAF. Actual approach distances may differ.

Cruise Flight Level

53,000

280kt

DOUGR

DAVID

ATAGA

IGONO

33,200

21,500

14,764

11,811

220 feet/nm

10,000

3,510

8,858

5200

16,000

6890

19,100

31,200

5,300

37

CON

89

Possible

Top of Descent Point

5000'

3700'

2200'

1000'

500'

200'

Runway

200' MSL
(example)

50

10 nm

14.8

3000' MSL
(example)

6890

3937

90 nm

85.2

5 nm deceleration segment

10000'

8500'

6800'

3700'

2200'

1000'

500'

200'

FAF

IAF

CEN

MIKEY

50 feet/nm from AER

60 feet/nm from Runway end

3 degrees approach path

Note: to illustrate the example the point chosen is 100 nm from Runway end and 90 nm from IAF. Actual approach distances may differ.

Cruise Flight Level
PBN Implementation Benefits

**ENHANCE SAFETY**
- Fully Managed Approaches
- Better descent profile
- Stable configuration
- Route Predictability

**SAVE OPERATIONAL COSTS**
- Less...
- ...Diversions
- ...cancellations
- ...fuel burn

**BE GREENER**
- Reduce CO2 emissions
- Avoid Noise Sensitive Areas
MMTC - MMTJ

NAV Route: 1215 NM
RNAV Route: 1202 NM
SAVINGS: 13 NM
## PBN performance metrics

<table>
<thead>
<tr>
<th>ROUTE</th>
<th>NAV</th>
<th>DISTANCE</th>
<th>TIME</th>
<th>FUEL</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>GROUND</td>
<td>AIR</td>
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<tr>
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<td>CONV</td>
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<td>PBN - RNAV</td>
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### Monthly Savings

<table>
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<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Abr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
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<tr>
<td>Kg</td>
<td>47,857</td>
<td>45,437</td>
<td>52,987</td>
<td>51,230</td>
<td>55,831</td>
<td>54,030</td>
<td>143,127</td>
<td>143,127</td>
<td>117,360</td>
<td>121,272</td>
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<td>Min</td>
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<td>1,325</td>
<td>1,281</td>
<td>1,396</td>
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</table>

1 gl = 1 Kg CO2
1 lt. = 3.157 kg. -CO2
1 Ton = 3.157 Tons CO2

Fuel: 1,000 Tons. CO2: 3,140 Tons.

Ref: Interjet / Volaris
Performance Metrics

- PBN achievements
- WATRS (25) = 40% + Capacity
- Polar Routes (5) = TBD
- Estimated Savings +USD$ 8 Millions
Fuel Savings with PBN

Gulf of Mexico for a 31-day period in 2011 on the new route structure estimated a $1.5M operator fuel cost savings.
Utilización de procedimiento PBN en MHTG, del 10 de marzo de 2010, al 28 de febrero de 2014

<table>
<thead>
<tr>
<th>TOTALES</th>
<th>EP RWY 02</th>
<th>NP RWY 20</th>
<th>02 SOUTH</th>
<th>02 NORTH</th>
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<tr>
<td>0</td>
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<table>
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<th>RNAV RNP RWY 02 NORTH</th>
<th>RNAV RNP RWY 02 SOUTH</th>
<th>RNAV RNP RWY 20</th>
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</table>
### Utilización de procedimiento PBN en MHTG, del 10 de marzo de 2010, al 28 de febrero de 2014

<table>
<thead>
<tr>
<th>AAL</th>
<th>UAL</th>
<th>COPA</th>
<th>DELTA</th>
<th>OTROS</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>229</td>
<td>482</td>
<td>272</td>
<td>1269</td>
<td>45</td>
<td>2297</td>
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</tbody>
</table>

**Pie Chart:**

- AAL: 55%
- UAL: 21%
- COPA: 12%
- DELTA: 10%
- OTROS: 2%

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**Diagrama:**

- AAL
- UAL
- COPA
- DELTA
- OTROS
That, considering the importance of obtaining effective information on the consumption of fuel, IATA

a) coordinate with Canada, Dominican Republic, Mexico and United States regarding effective information of fuel savings resulted from the use implementation of RNAV routes as well as PBN approach procedures at peak hour in 10% of airports with largest number of operations in States, as applicable; and

b) provide the ICAO NACC Regional Office not later than 31 December 2014, the effective information on fuel savings and reduction of CO2 gas emissions obtained from the implementation of PBN routes and approach procedures in the NAM and CAR Regions.
• Develop PBN training programmes for all staff concerned (Civil Aviation Authority (CAA), ATS, airlines, etc.)

• Develop and implement PBN operational approval processes and recognize other State’s PBN operational approval as described in the ICAO Doc 9613, PBN Manual

• Review ATS Letters of Agreement among adjacent ATC units With the implementation of continuous descent operations (CDO)

• ensure the high quality of the aeronautical information and data associated to the publication of PBN aeronautical charts.

• review their navigation infrastructure (DME/DME, VOR, etc.) coverage for PBN implementation in the terminal areas.

• revise restricted areas based on the Flexible Use of Airspace (FUA)