



ICAO

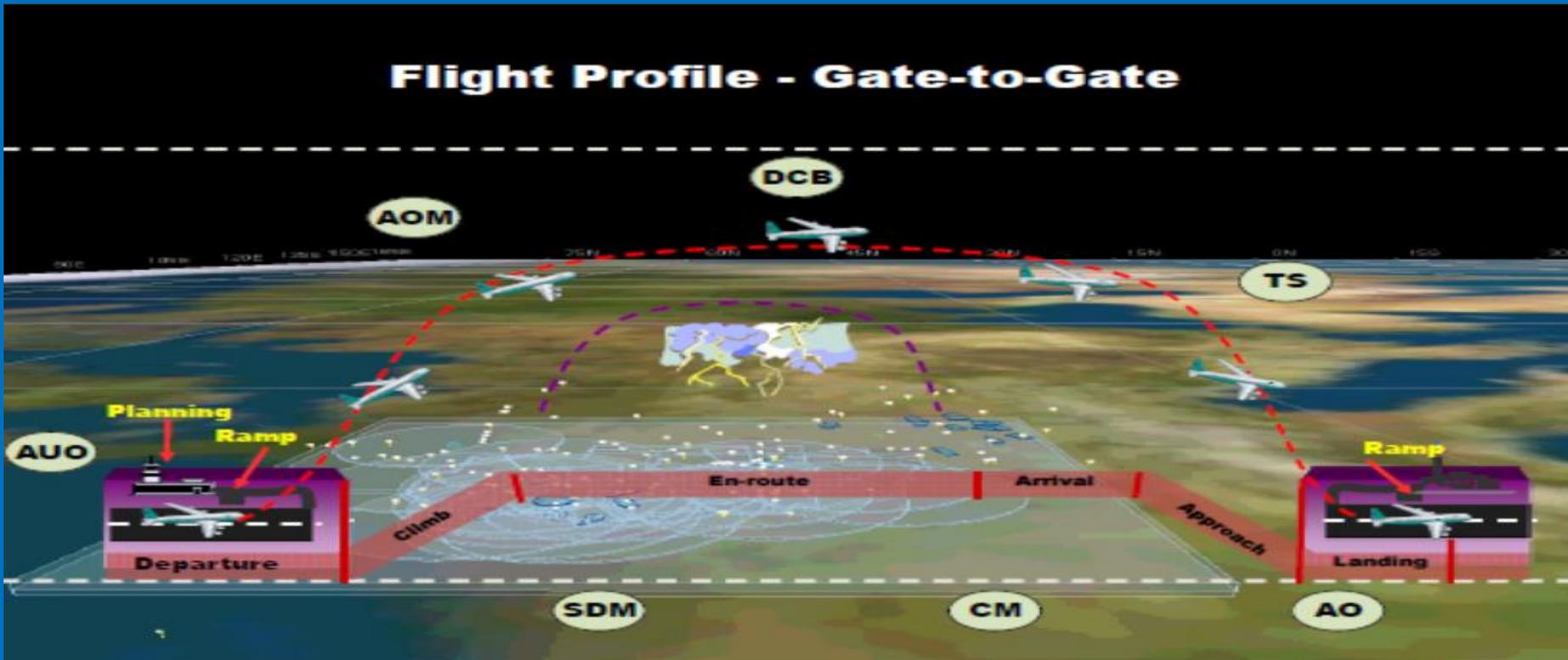
UNITING AVIATION

ICAO International Aviation and Environment Seminar

OPERATIONAL IMPROVEMENTS

Operations in the Context of Aviation

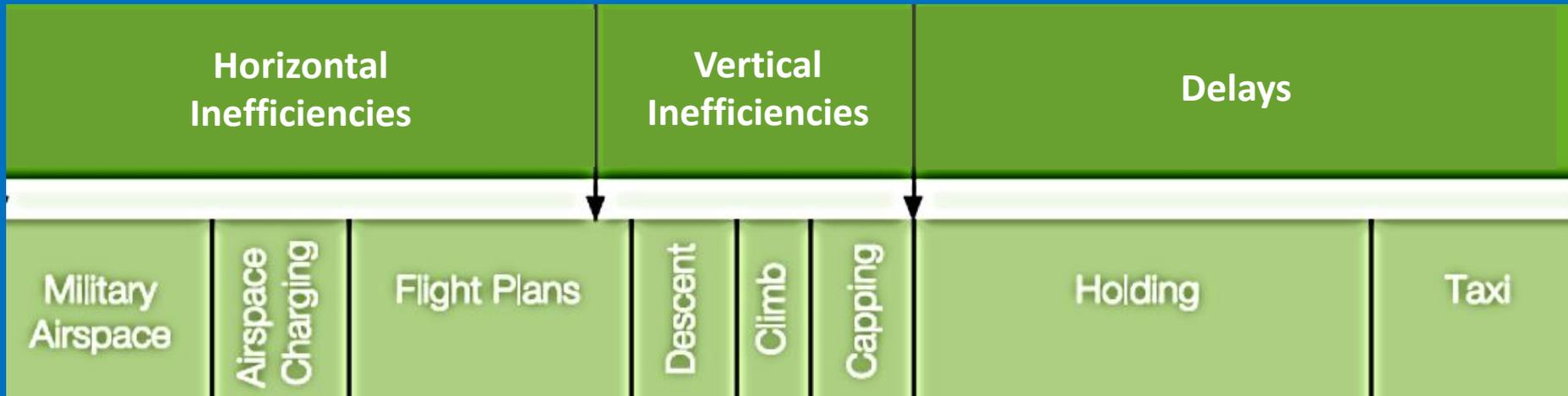
Flight Profile - Gate-to-Gate



<p>Planning & Pre-Flight</p>	<p>Taxi out</p>	<p>Departure</p>	<p>Enroute & Oceanic</p>	<p>Arrival</p>	<p>Taxi in</p>	<p>Post Landing</p>
----------------------------------	-----------------	------------------	------------------------------	----------------	----------------	---------------------



Applicable Operational Improvements



PNB

ATFM

CDM

FUA/CMC

CDO / CCO



Global Air Traffic Management Operational Concept*

Vision Statement

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.

*ICAO Doc 9854



Air Traffic Management

The operational concept addresses what is needed to :

- **increase user flexibility**
- **maximize operating efficiencies**

in order to :

- **increase system capacity**
- **improve safety levels.**



KEY ENABLERS

PBN - Performance Based Navigation

ATFM - Air Traffic Flow Management

CDM - Collaborative Decision Making

FUA – Flexible Use of Airspace



ICAO

UNITING AVIATION

PBN – An Introduction

Performance-Based Navigation (PBN) defines performance requirements for aircraft navigating on an ATS route or a terminal procedure in a designated airspace.



ICAO

UNITING AVIATION

PBN – An Introduction

ICAO's effort and objective is to redefine the regional differences of various Area Navigation (RNAV) and Required Navigation Performance (RNP) specifications into a globally harmonized set of PBN applications.



ICAO

UNITING AVIATION

PBN – An Introduction

Through the application of RNAV and RNP specifications, PBN provides the means for flexible routes and terminal procedures that enable to improve capacity while increasing efficiency and safety



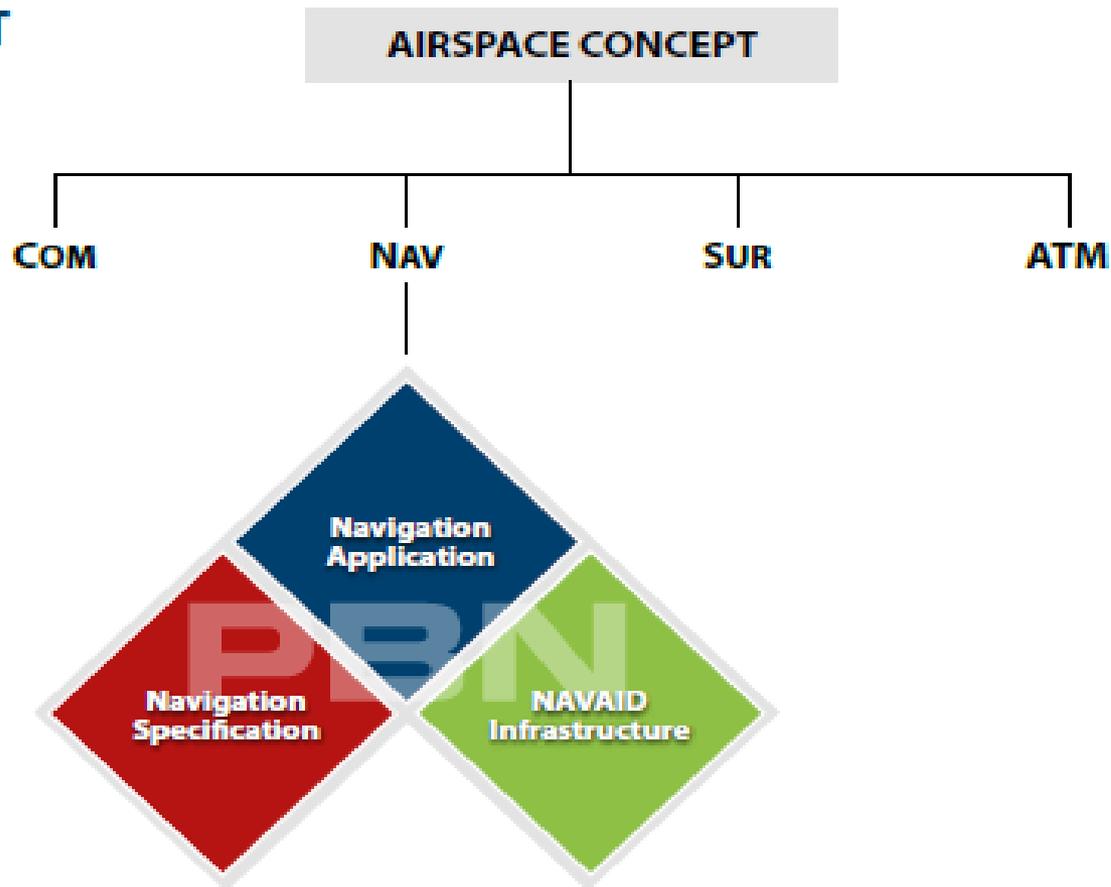
PBN – An Introduction

PBN is helping the global aviation community

- **Reduce aviation congestion**
- **Conserve fuel**
- **Protect the environment**
- **Reduce the impact of aircraft noise**
- **Maintain reliable, all weather operations**
- **Offers greater flexibility**
- **Gives better operating returns**
- **Increases safety**

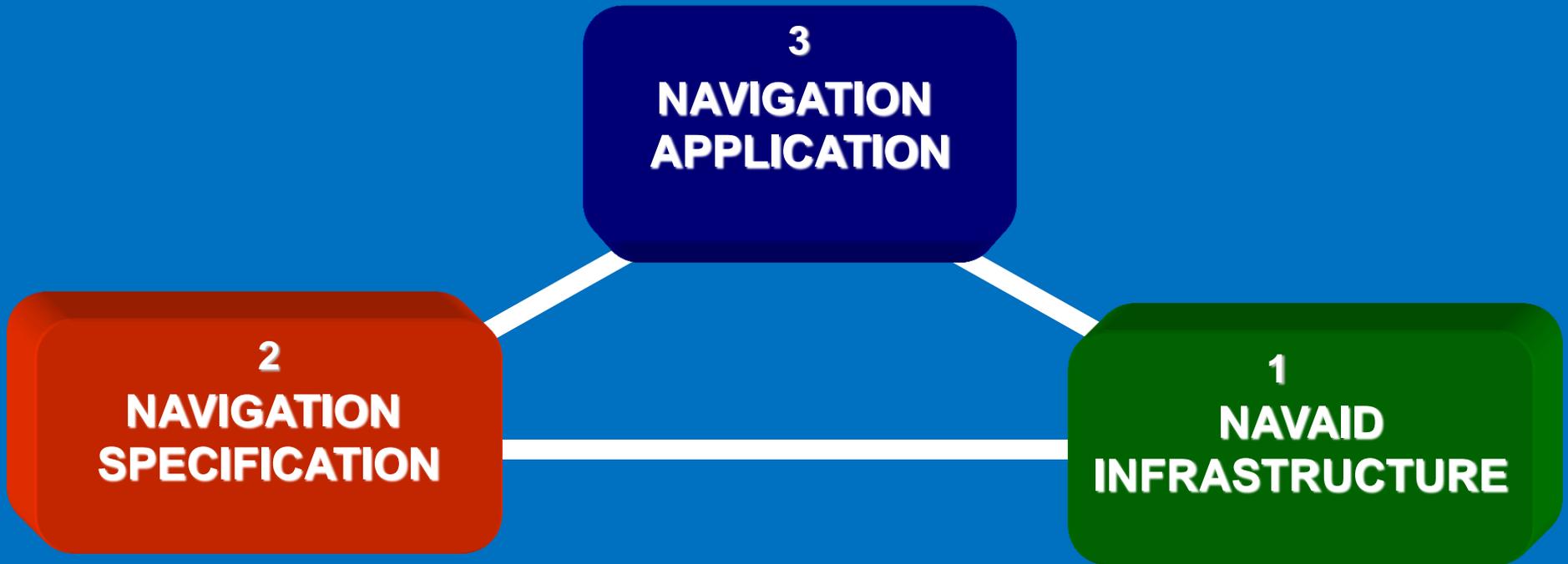
PBN as the 'N' Element of Airspace Concept

AIRSPACE CONCEPT





PBN as the 'N' Element of Airspace Concept





PBN as the 'N' Element of Airspace Concept

Components of PBN Concept - Navaid Infrastructure -

- **Ground-based Navigation Aids (Nav aids)**
 - **VOR; DME;** (Not NDB)

- **Space-based Nav aids**
 - **GNSS**
 - **GPS; Glonass; *future* Galileo**

**1
NAVAID
INFRASTRUCTURE**

PBN as the 'N' Element of Airspace Concept

Components of **P**BN Concept - Navigation Specification -

International Navigation Specifications published
in Volume II of PBN Manual

- What **PERFORMANCE** is required of the RNAV system?
- What Functionalities must RNAV system have to achieve *Performance*
- What Navigation Sensors must be integrated in RNAV system to achieve *Performance*
- What requirements are placed on the Air crew to achieve the required *Performance* from the RNAV system?

Accuracy
Integrity
Continuity
Availability

2
NAVIGATION
SPECIFICATION

Document used by State as basis for developing
Certification & Operational Approval

ICAO NAVIGATION SPECIFICATIONS

RNP Specifications

(includes a requirement for on-board performance monitoring and alerting)

Designation

RNP 4
RNP 2

Oceanic & Remote navigation applications

Designation

RNP 2
RNP 1
A-RNP
RNP APCH
RNP AR APCH
RNP 0.3

En-route & Terminal navigation applications

Designation

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

RNAV Specifications

(no requirement for on-board performance monitoring and alerting)

Designation

RNAV 10

Oceanic & Remote navigation applications

Designation

RNAV 5
RNAV 2
RNAV 1

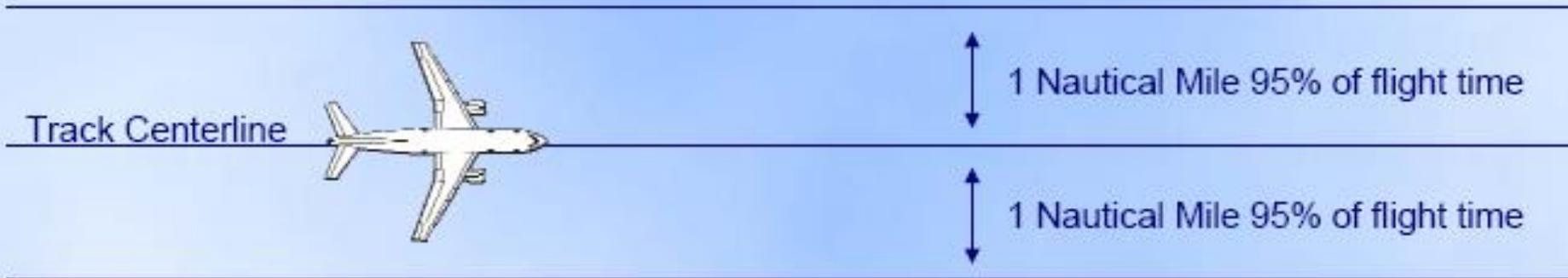
En-route & Terminal navigation applications



Application of Nav Specs

RNAV and RNP (Notional)

RNAV 1



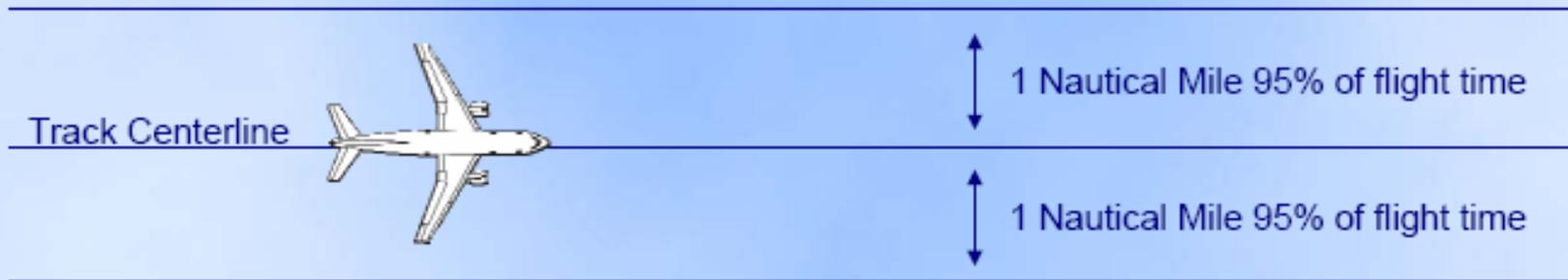


Application of Nav Specs

RNAV and RNP (Notional)

RNP 1

Alert to Pilot

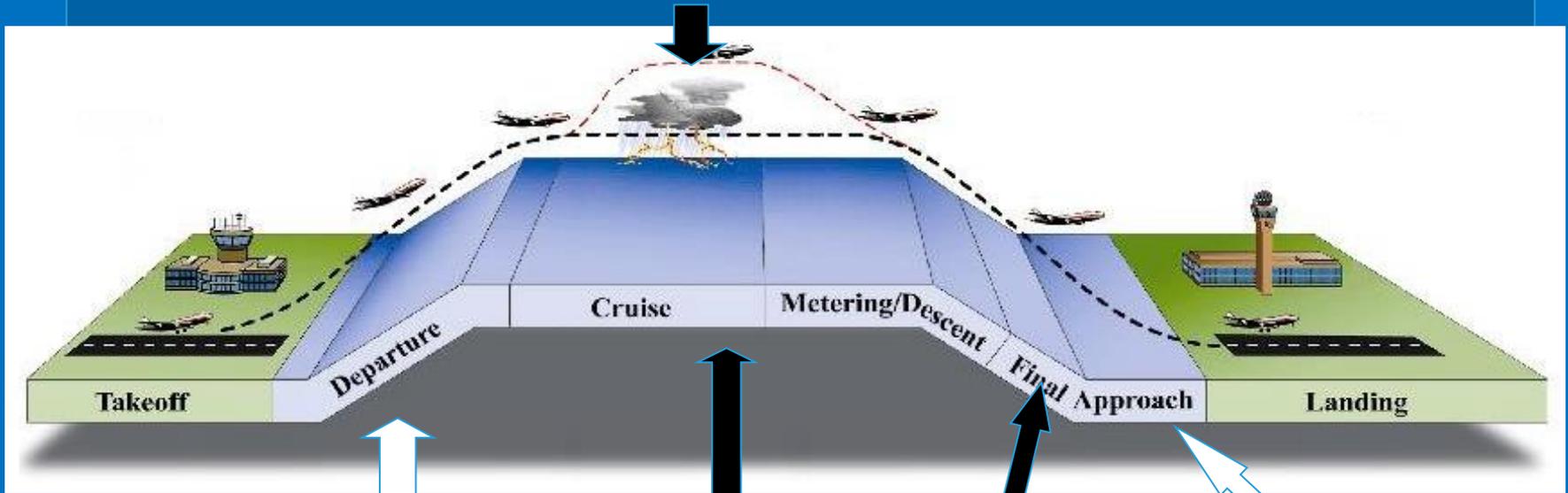


The Key Difference:

On-Board Performance Monitoring and Alerting

Application of Nav Specs

**OCEANIC / Enroute Remote (nonSUR)
RNAV 10, RNP 4, RNP 2, Advanced RNP 2**



**RNAV 1/2 &
RNP 1 SIDs
ARNP 1 SIDs**

**RNAV 5/2/1
RNP 2
Advanced RNP 2 or 1
Enroute Continental**

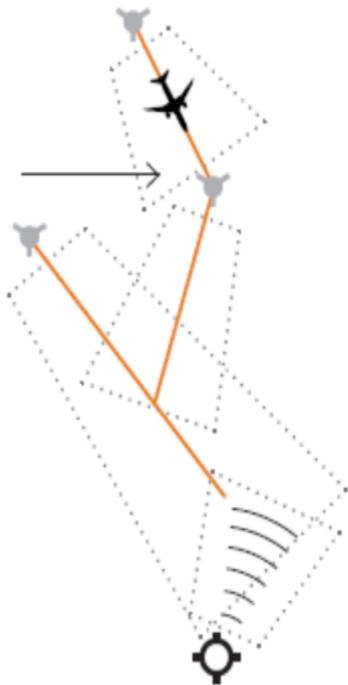
**RNAV 1/2 & RNP
1 STARs ARNP 1
STARs**

**RNP Approach
RNP-AR Approach**

Conventional vs PBN Routes

Conventional Routes

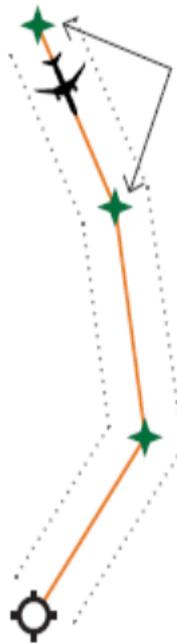
Current
Ground
Nav aids



Limited Design
Flexibility

RNAV

Waypoints



Increased Airspace
Efficiency

RNP

Narrow
Obstacle
Clearance

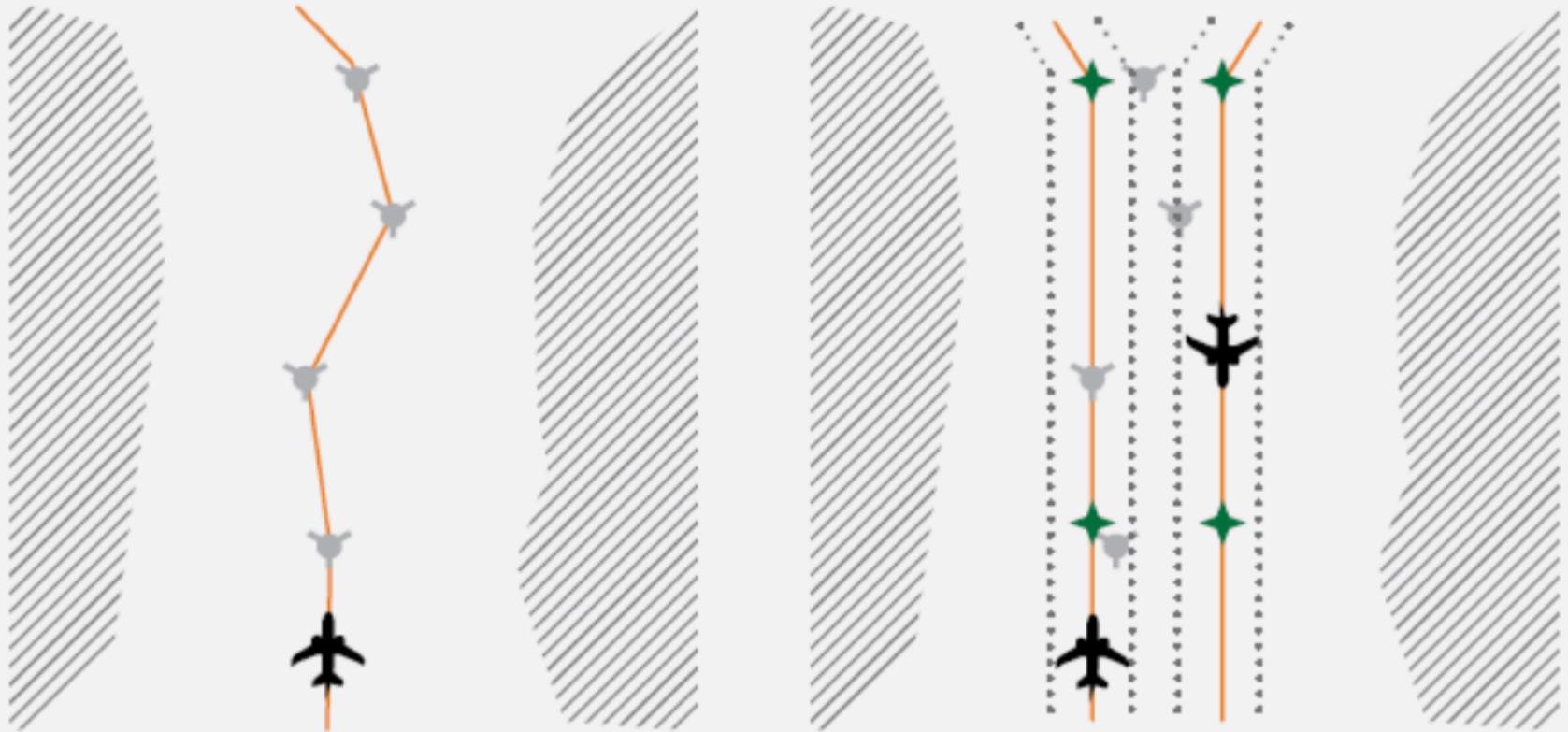
Seamless
Vertical
Path

Constant
Radius
Turns



Optimal Use of
Airspace

Conventional vs PBN Routes - Capacity



Before

After



PBN - Operational Improvements Achievable

- **Direct routing particularly for short segments**
- **Multiple routes to provide flexibility – long sectors**
- **Predictable availability of optimum flight levels**
- **Navigation through/by special use airspace**
- **Flexible Use of Airspace (FUA)**
- **Avoidance of noise sensitive areas**
- **Terminal area precision: capacity, flexibility**
- **Cruise climb in certain airspaces**
- **Enabling Continuous Climb Operations (CCO)**
- **Enabling Continuous Descent Operations (CDO)**

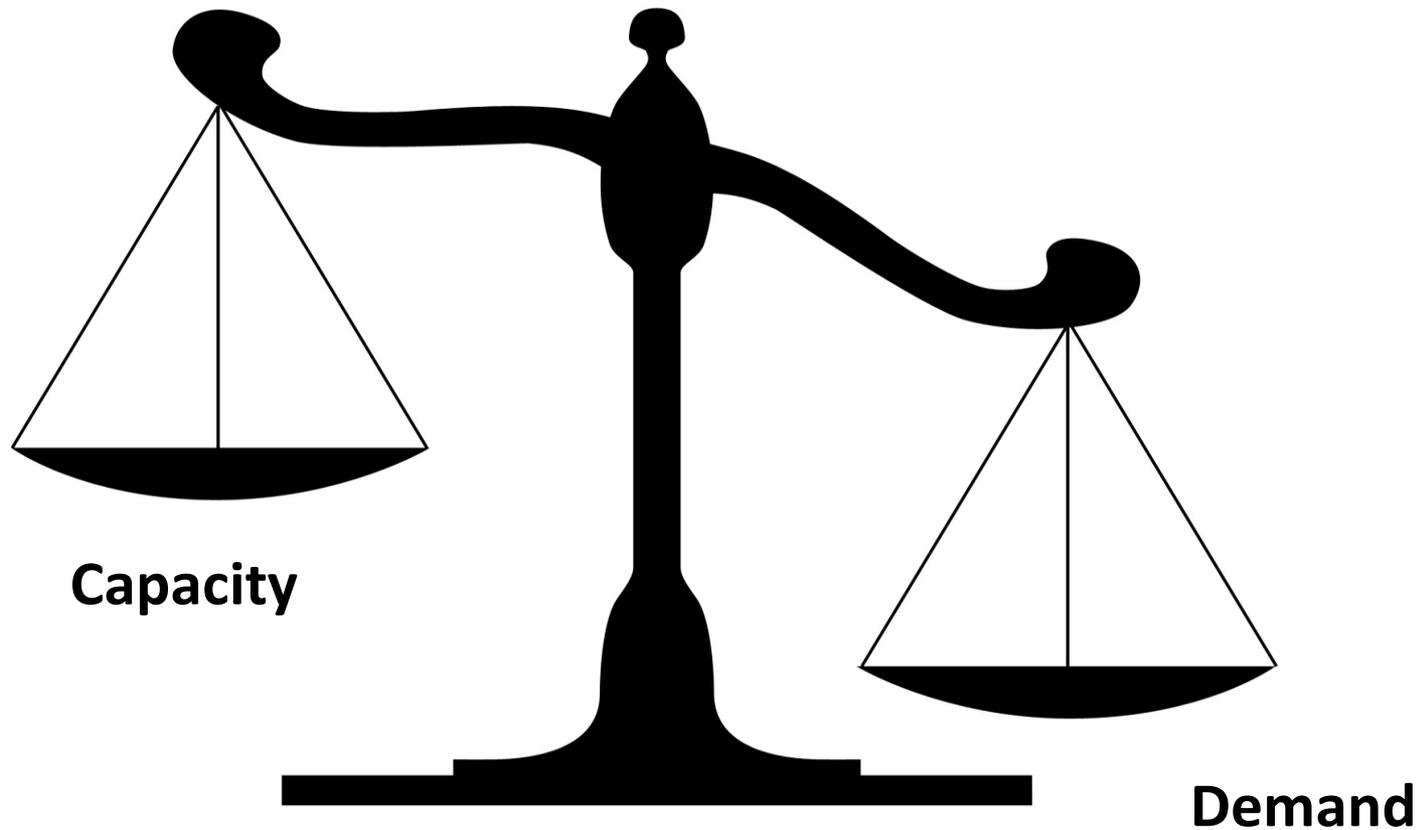


ATFM - AIR TRAFFIC FLOW MANAGEMENT

ATFM:

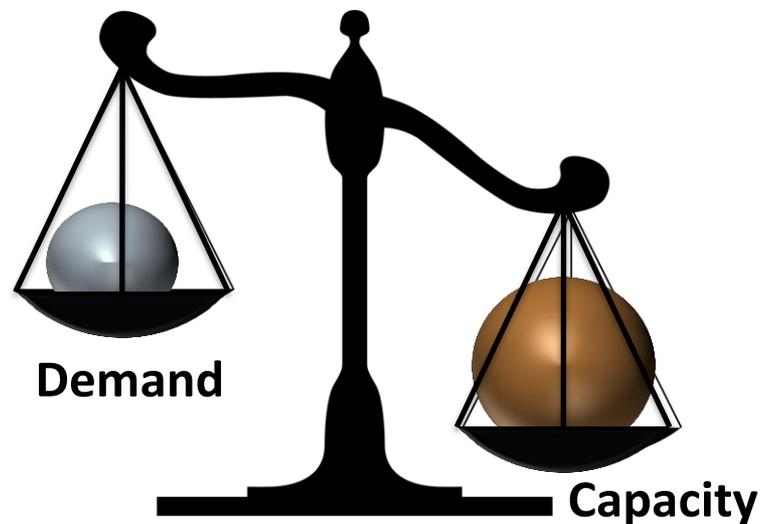
- is an enabler ATM efficiency and effectiveness.
- is a Technique to improve operations by using most current information to anticipate traffic demand, and strategically controlling traffic flows to balance between Capacity and Demand

ATFM – Demand and Capacity Balancing



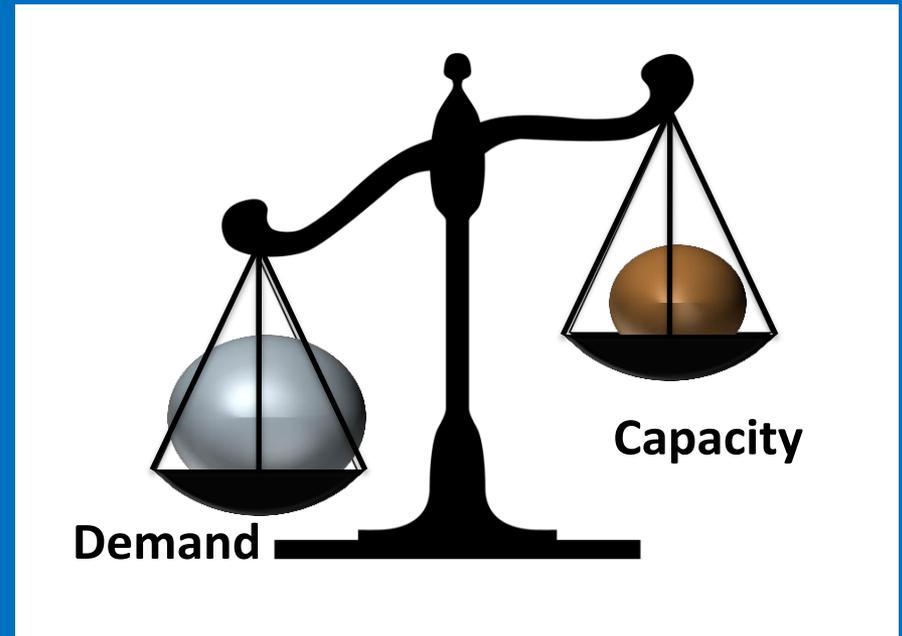
ATFM – Demand Vs Capacity

Demand = 80,
Capacity = 100
Dem/Cap = 80 %



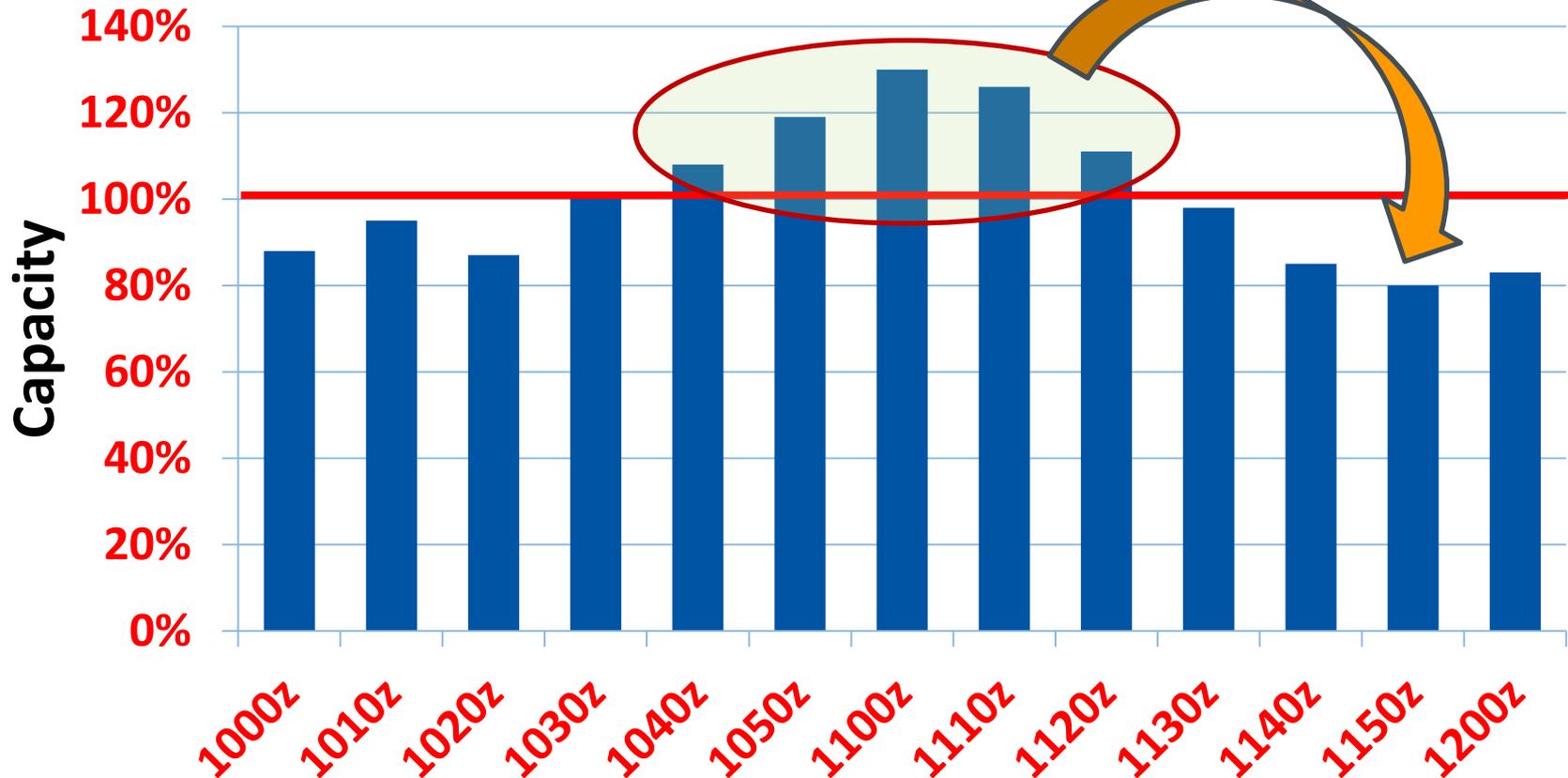
ATFM – Demand Vs Capacity

Demand = 100,
Capacity = 80
Dem/Cap = 125%



ATFM – How do you manage it?

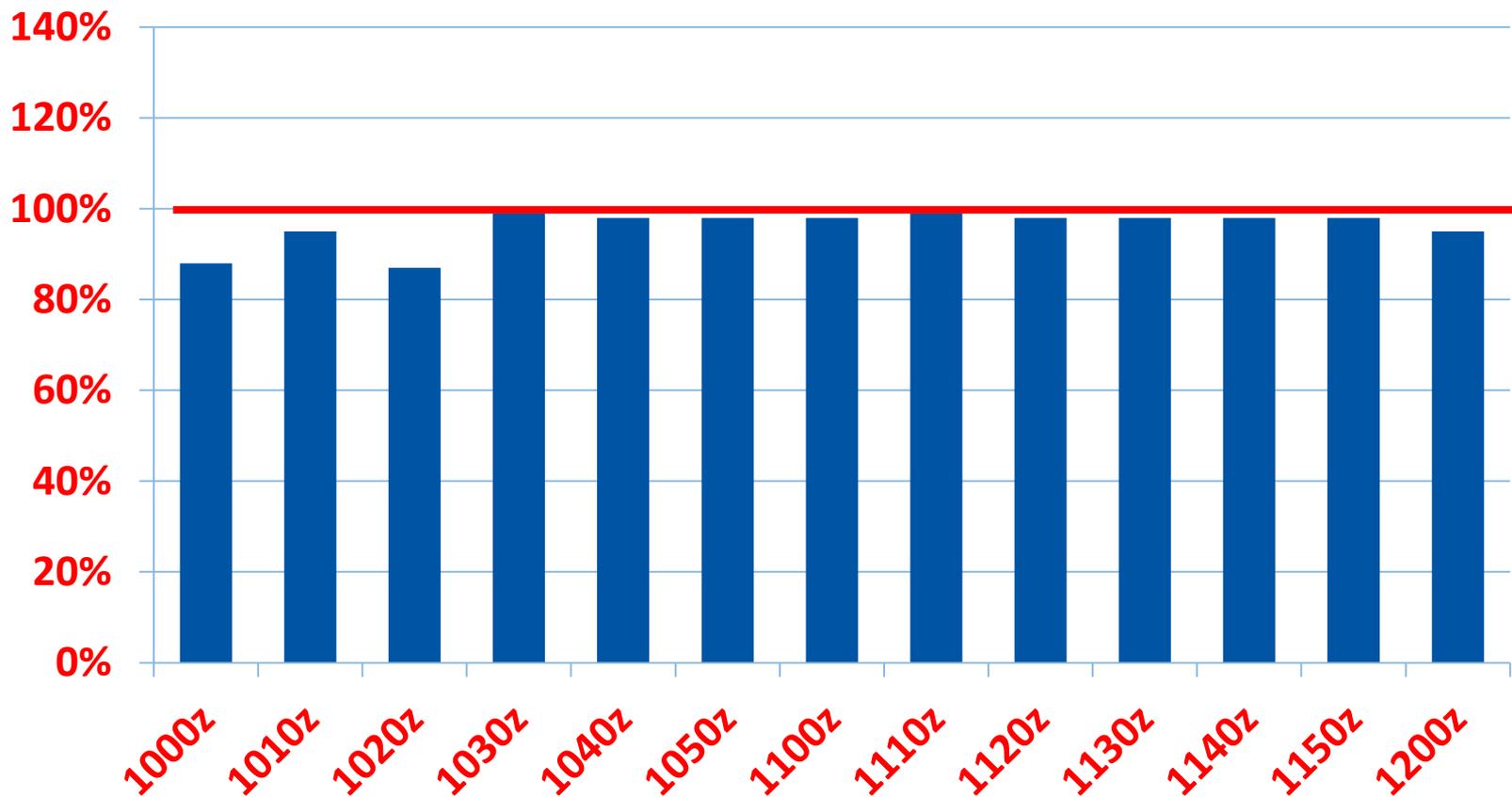
Demand



ATFM – How do you manage it?

Demand

Capacity



ATFM – How do you Achieve it?

- **Achieving robust coordination among aviation stakeholders (CDM)**
 - All the stakeholders work together to improve the overall performance of the ATM system
 - Such coordination can be within an FIR, between FIRs and ultimately, between regions

ATFM – How do you Achieve it?

- **Strategic, pre-tactical and tactical traffic flow management through slot allocations and calculated takeoff times (CTOT)**
- **Pre-tactical and tactical departure management for merging into an en route stream or to a common departure fix**
- **Pre-tactical and tactical aircraft sequencing, scheduling and runway allocations to meet airport arrival operating constraints**
- **Pre-tactical and tactical airport surface management for optimizing operations**



ICAO APAC Regional Sub-Office

- ICAO Council agreed to establish a Regional Sub-Office (RSO) of the Asia Pacific (APAC) Office on 14 November 2011.



The RSO was inaugurated in Beijing, China on 27 June 2013



Strategic Framework for the Regional Sub-Office (RSO)

A. Improve Safety and Efficiency of Flight Operations through Innovative Procedures.

B. Enhance Airspace Capacity and Efficiency to Accommodate Asian Aviation Growth

C. Optimize ATM Operations via Collaborative Management of Traffic Flow



In coordination with ANB and APAC Regional Office

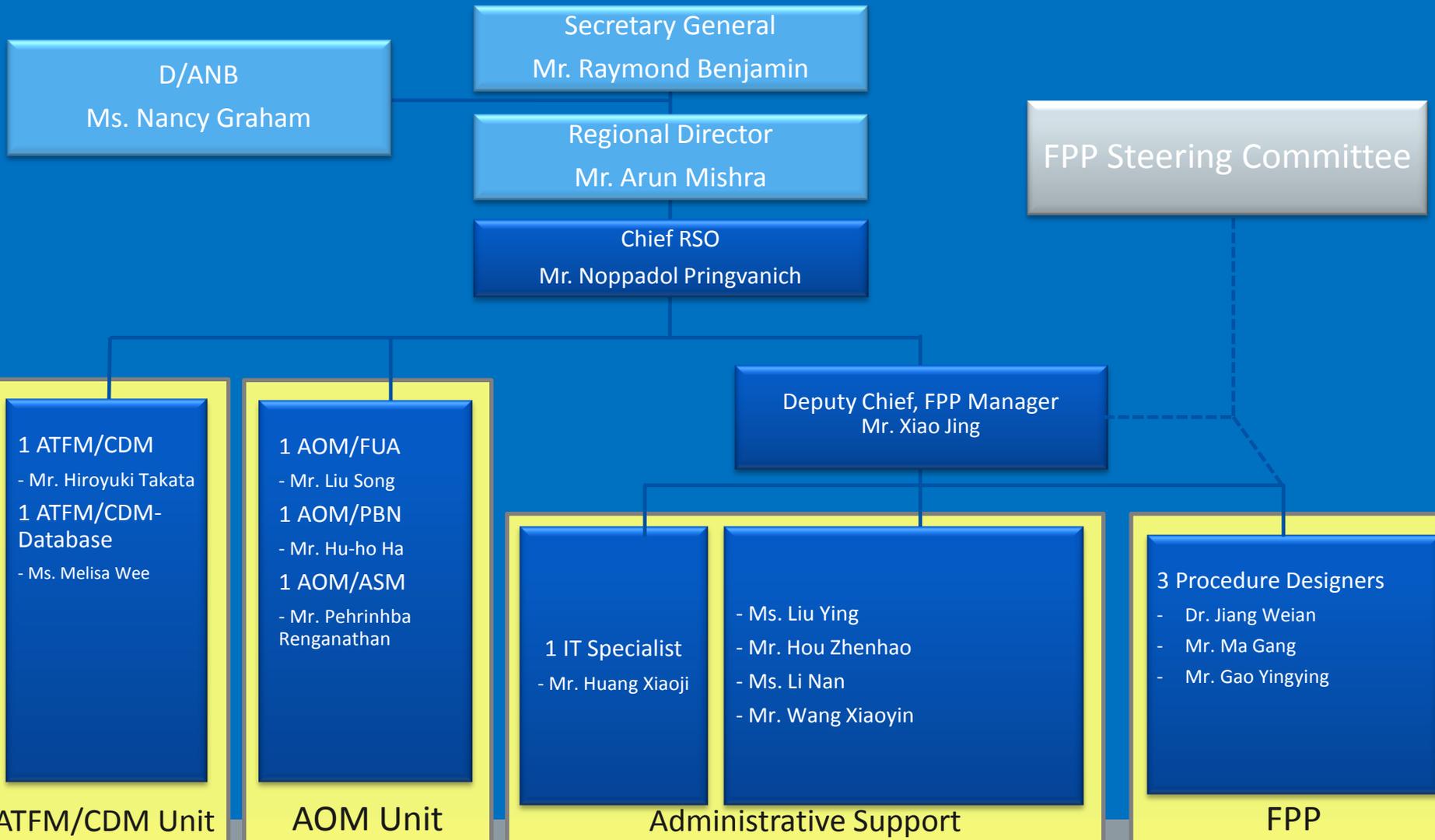
D. Ensure Continuous Improvement of Organizational Performances by Proper Managements of Quality, Work Plans, Resources and Developments of Team-members' Capacity



Consistent with ICAO culture and practices

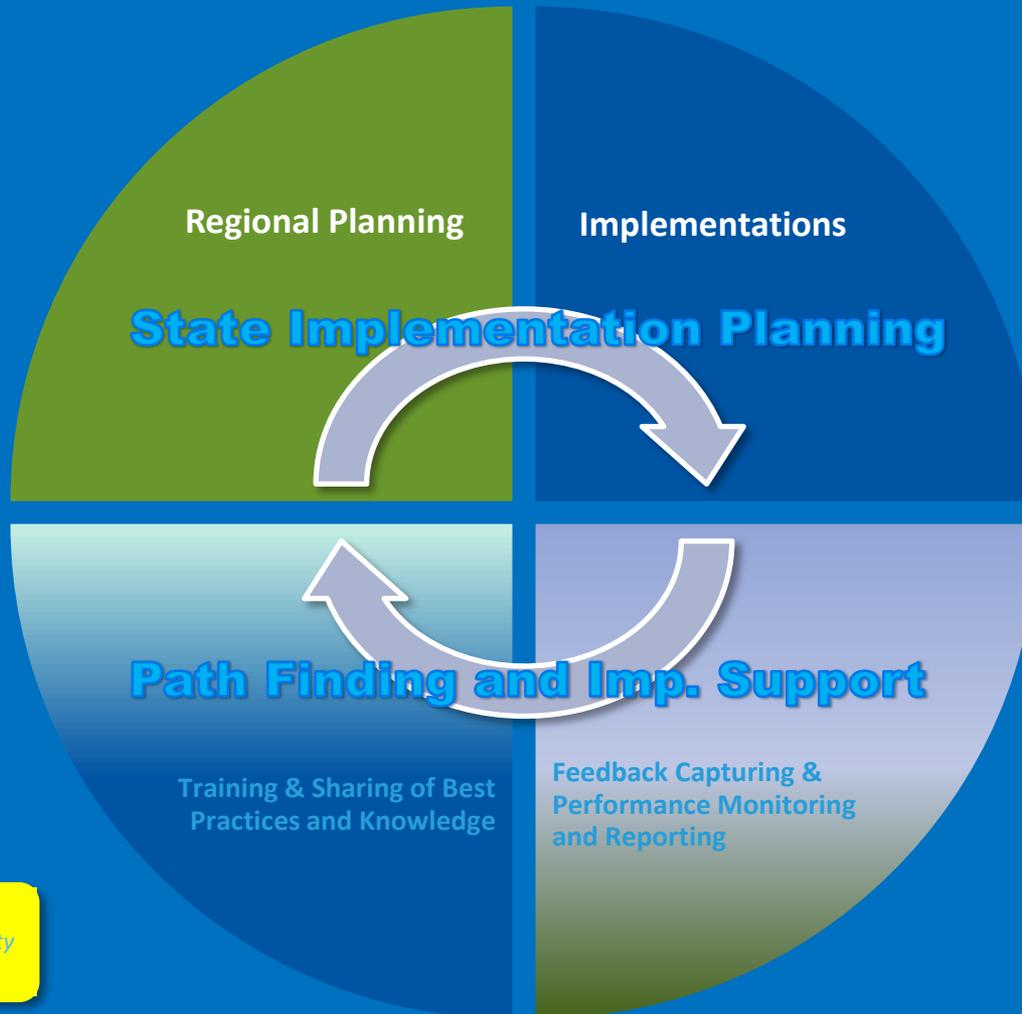


Current Work Structure and Team Members of the RSO





Coordination Structure between APAC RO and RSO



RO as Main Player
RSO as Supporting Player

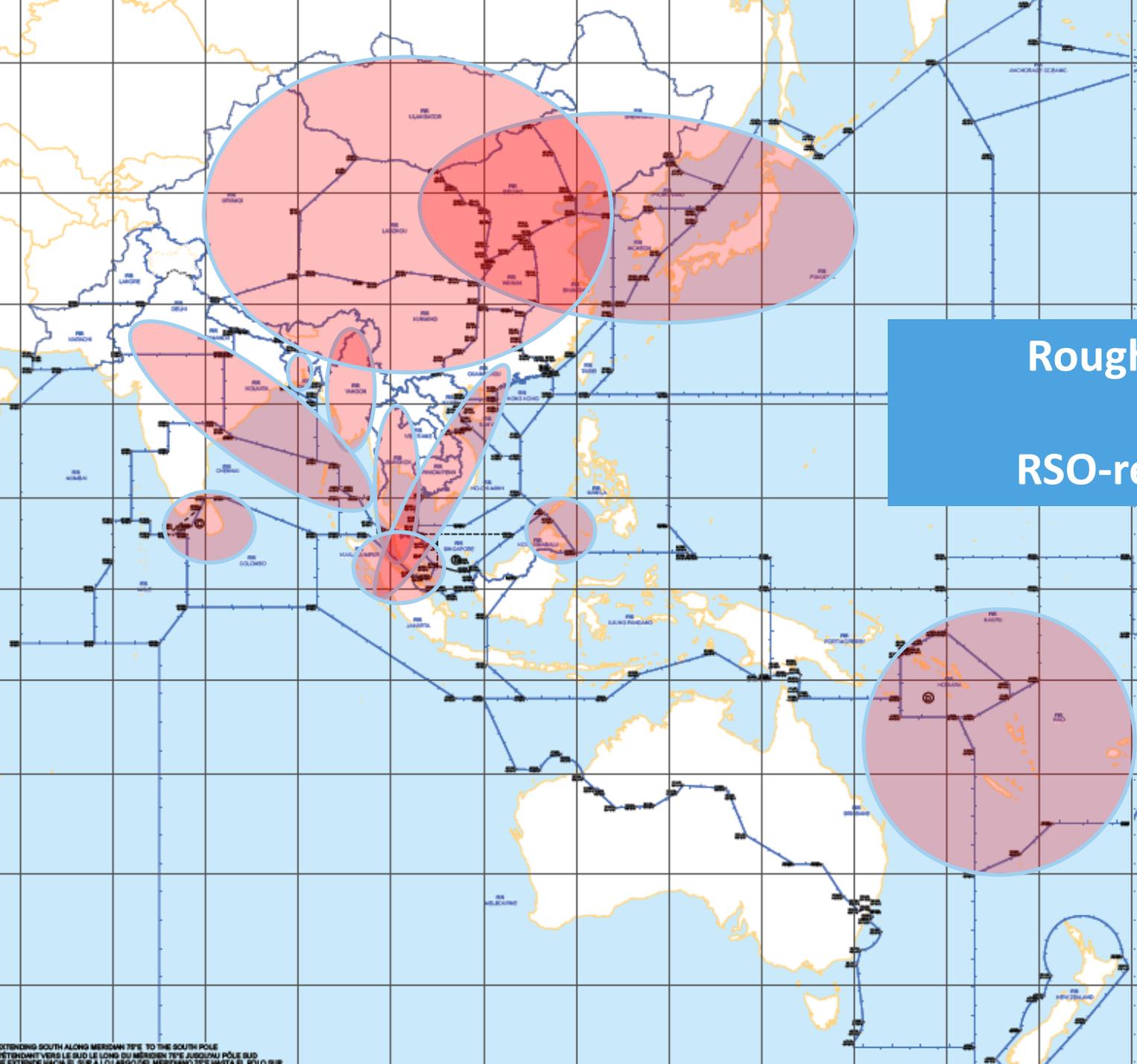
RO as Supporting Player
RSO as Main Player

Note: Performance Monitoring and Reporting will be under the responsibility of the RO.



RSO - Responsibilities

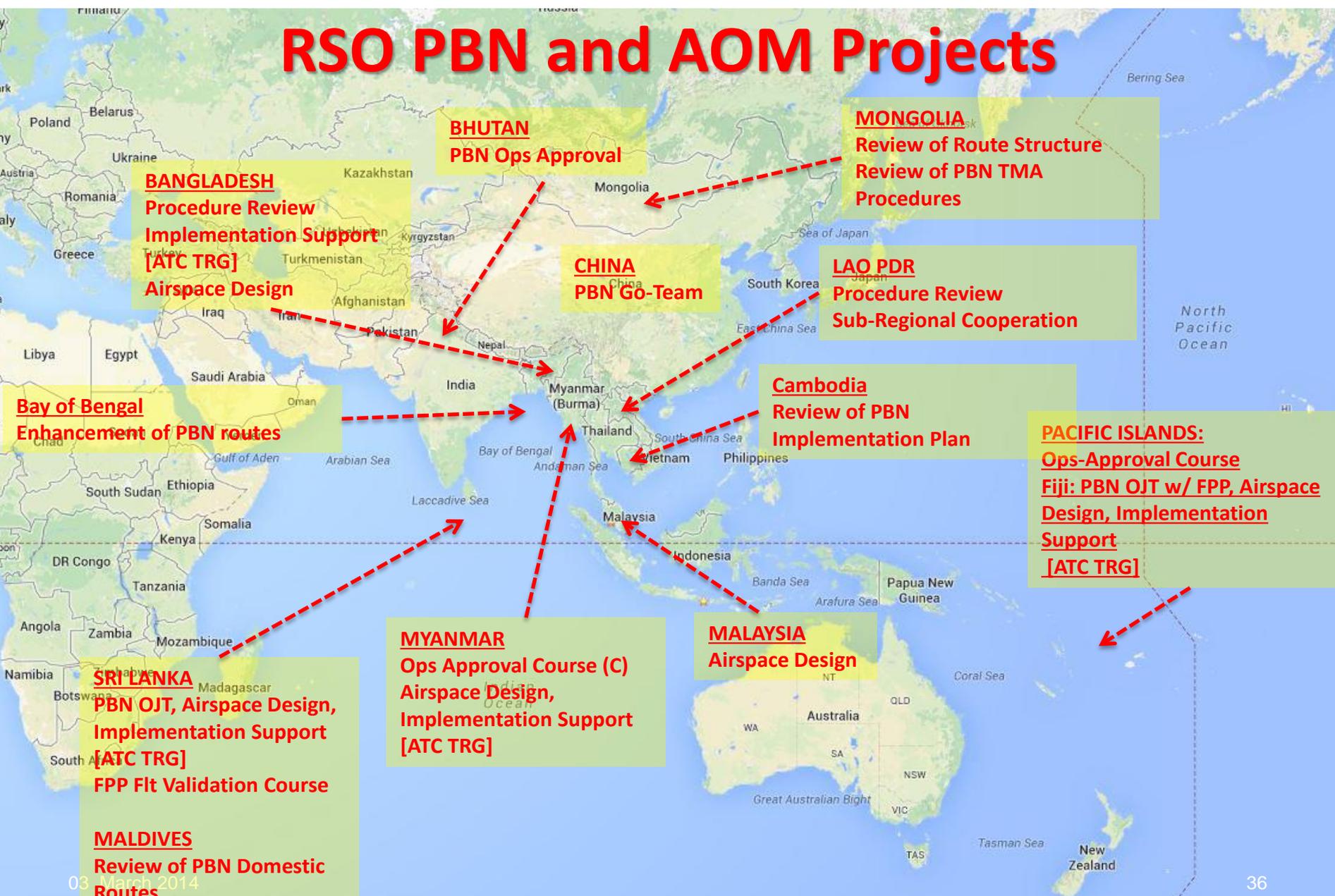
- To improve airspace organization and maximize ATM performance and capability in APAC
- Entrusted by ICAO Council to support States for **implementation** of efficient management of airspace and air traffic flow in the APAC Region through Airspace Organization and Management (AOM), Collaborative Decision Making (CDM), Air Traffic Flow Management (ATFM), Flexible Use of Airspace (FUA) and Performance-Based Navigation (PBN) aimed at meeting traffic growth.

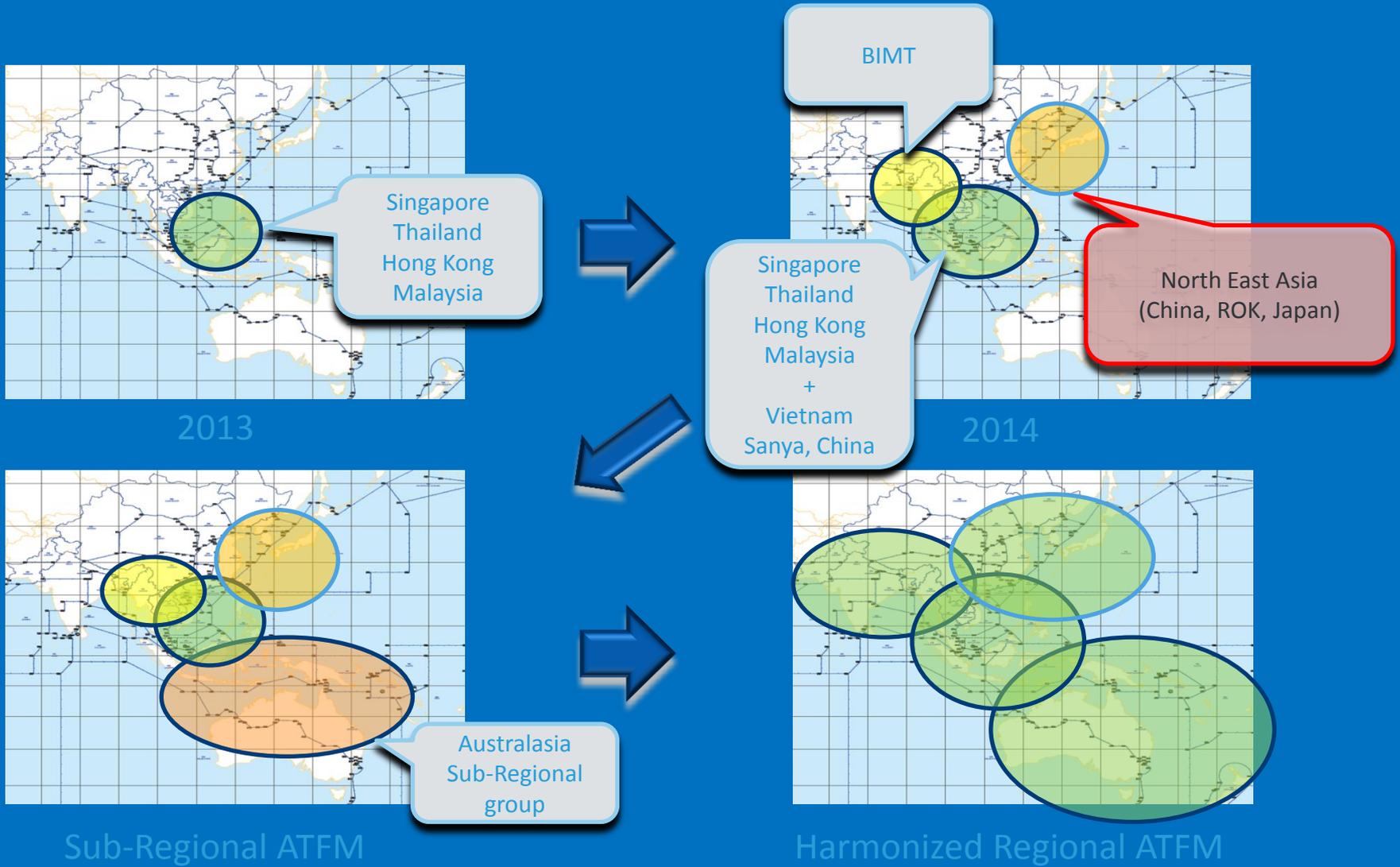


Rough Geographical Coverage of RSO-related Projects

EXTENDING SOUTH ALONG MERIDIAN 79°E TO THE SOUTH POLE
ÉTENDANT VERS LE SUD LE LONG DU MÉRIDIEN 79°E JUSQU'AU PÔLE SUD
SE EXTIENDE HACIA S. SUR A LO LARGUO DEL MERIDIANO 79°E HASTA S. OCUPIENDE

RSO PBN and AOM Projects







ICAO

UNITING AVIATION



ICAO

North American
Central American
and Caribbean
(NACC) Office
Mexico City

South American
(SAM) Office
Lima

ICAO
Headquarters
Montréal

Western and
Central African
(WACAF) Office
Dakar

European and
North Atlantic
(EUR/NAT) Office
Paris

Middle East
(MID) Office
Cairo

Eastern and
Southern African
(ESAF) Office
Nairobi

Asia and Pacific
(APAC) Sub-office
Beijing

Asia and Pacific
(APAC) Office
Bangkok



THANK YOU