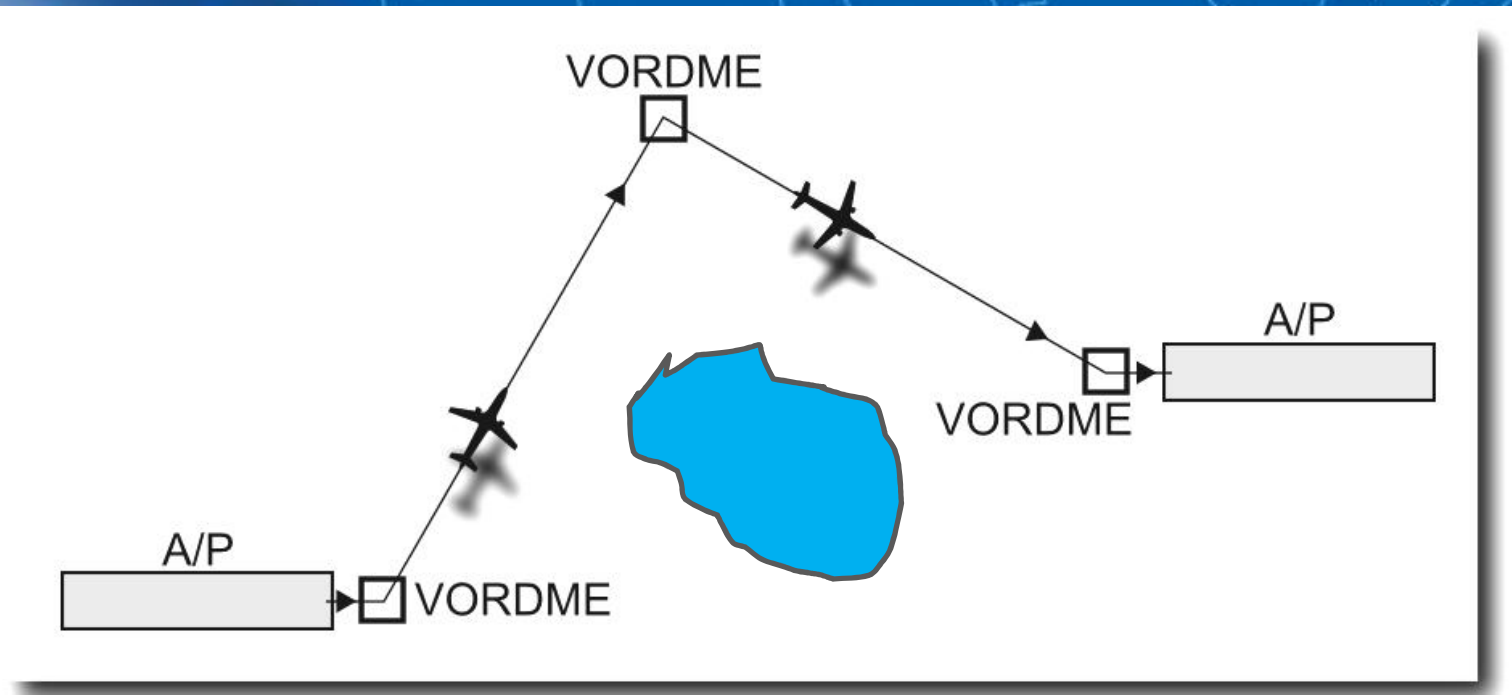
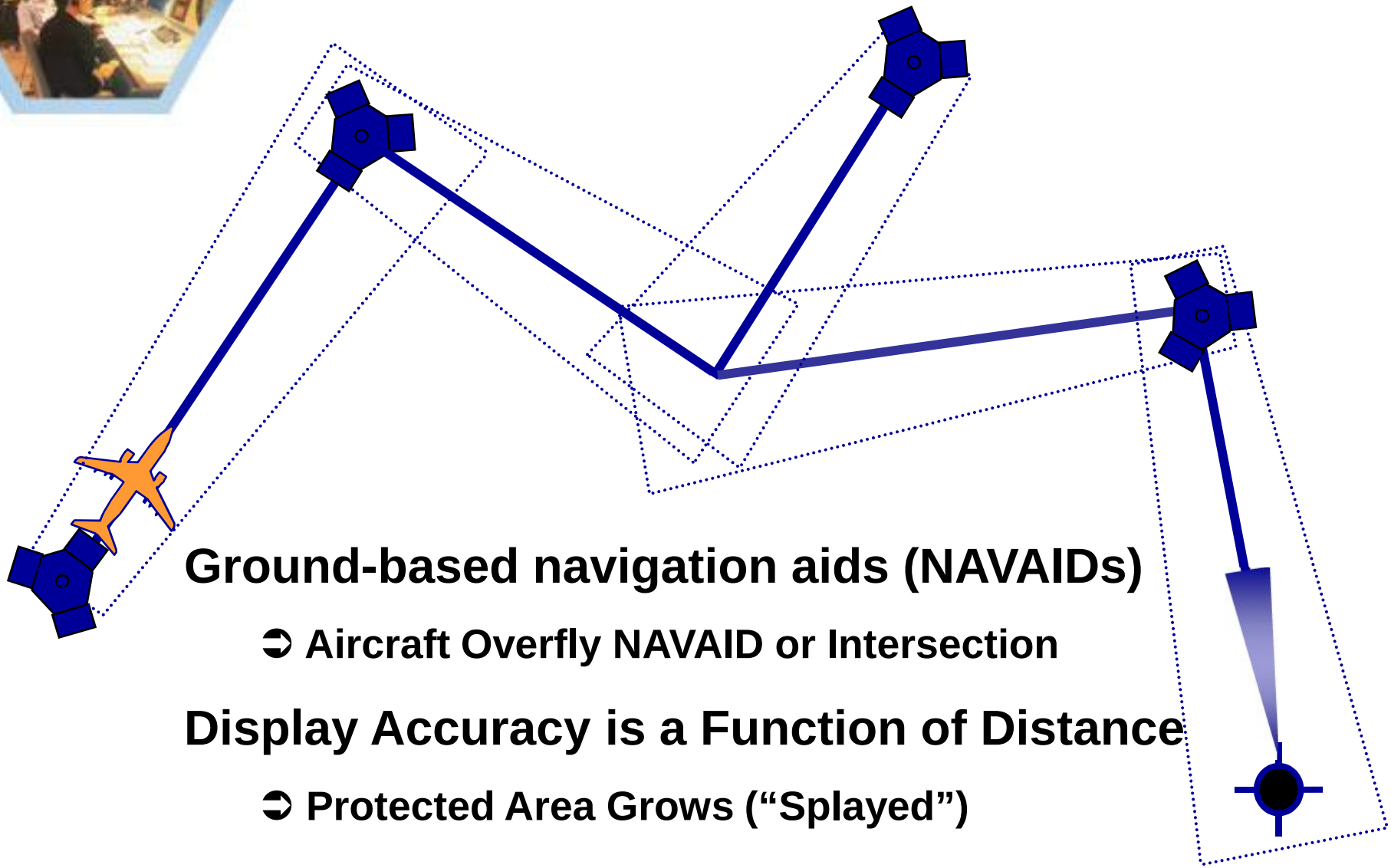
PBN
(RNAV & RNP)

What is the “Perfect Flight?”


VORDME
A/P
VORDME
A/P
VORDME

Conventional Navigation [1920s]



Ground-based navigation aids (NAVAIDs)

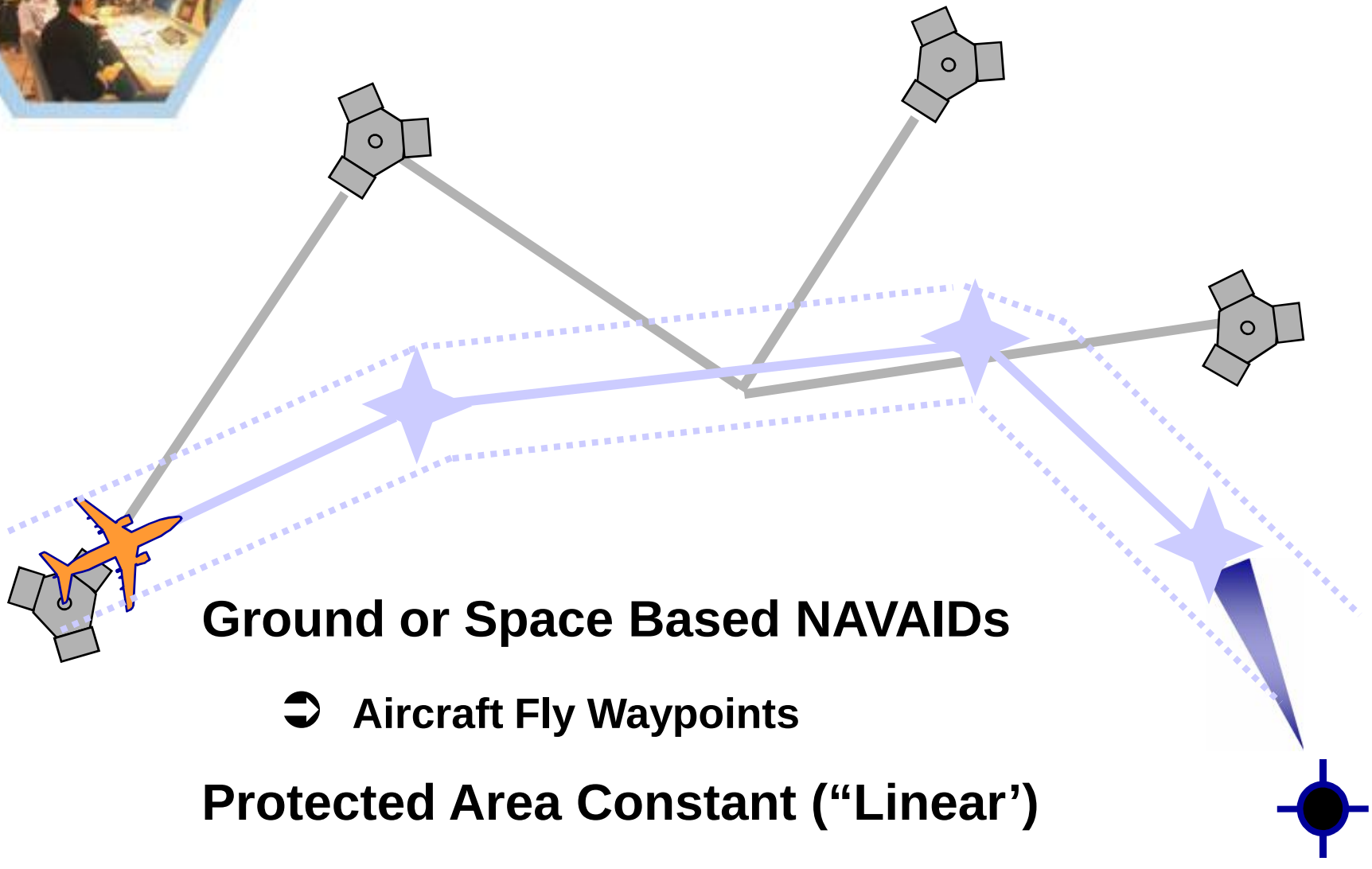
- ➲ **Aircraft Overfly NAVAID or Intersection**

Display Accuracy is a Function of Distance

- ➲ **Protected Area Grows (“Splayed”)**

= Limited Design Flexibility

Area Navigation (RNAV) [1970s]



Ground or Space Based NAVAIDs

- **Aircraft Fly Waypoints**

Protected Area Constant (“Linear’)

= Increased Design Flexibility

Required Navigation Performance (RNP) [1990s]

Adds to RNAV

- **On Board Monitoring & Alerting**
- **May Incorporate Radius to Fix Turns**

= Optimized Use of Airspace

NEXT GEN Components: RNAV/RNP

Moving to Performance-Based Navigation

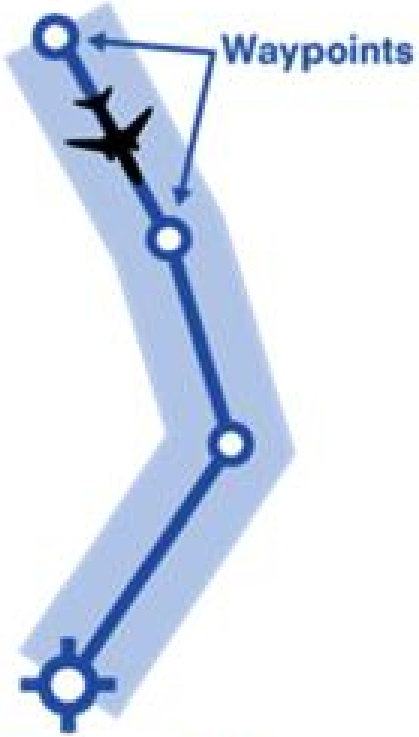
Conventional Routes

Today's airways connect ground-based navigation aids

Limited Design Flexibility

RNAV

Area Navigation (RNAV) routes follow defined "waypoints"



Increased Airspace Efficiency

RNP

Required Navigation Performance (RNP) routes within specified "containment area"

Optimize Use of Airspace

Source: Federal Aviation Administration

Evolution of Air Navigation

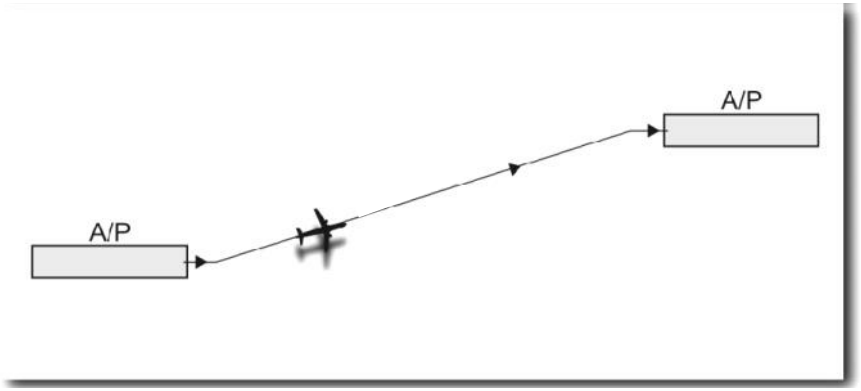
Conventional Navigation	**1920s**
Area Navigation (RNAV)	**1970s**
Required Navigation Performance (RNP)	**1990s**
Performance Based Navigation (PBN)	**2007**

Existing Air Navigation System

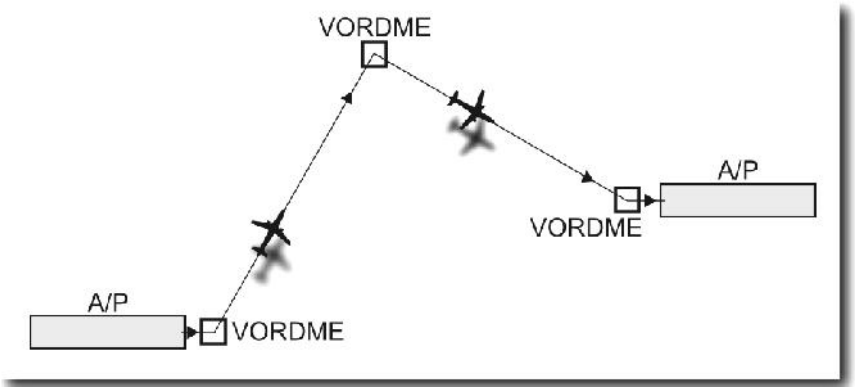
PBN

RNAV

RNP

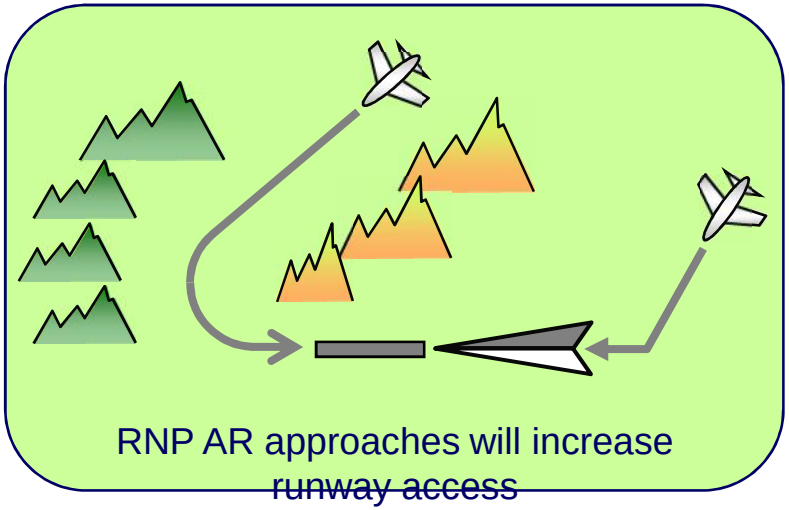


Conventional Navigation



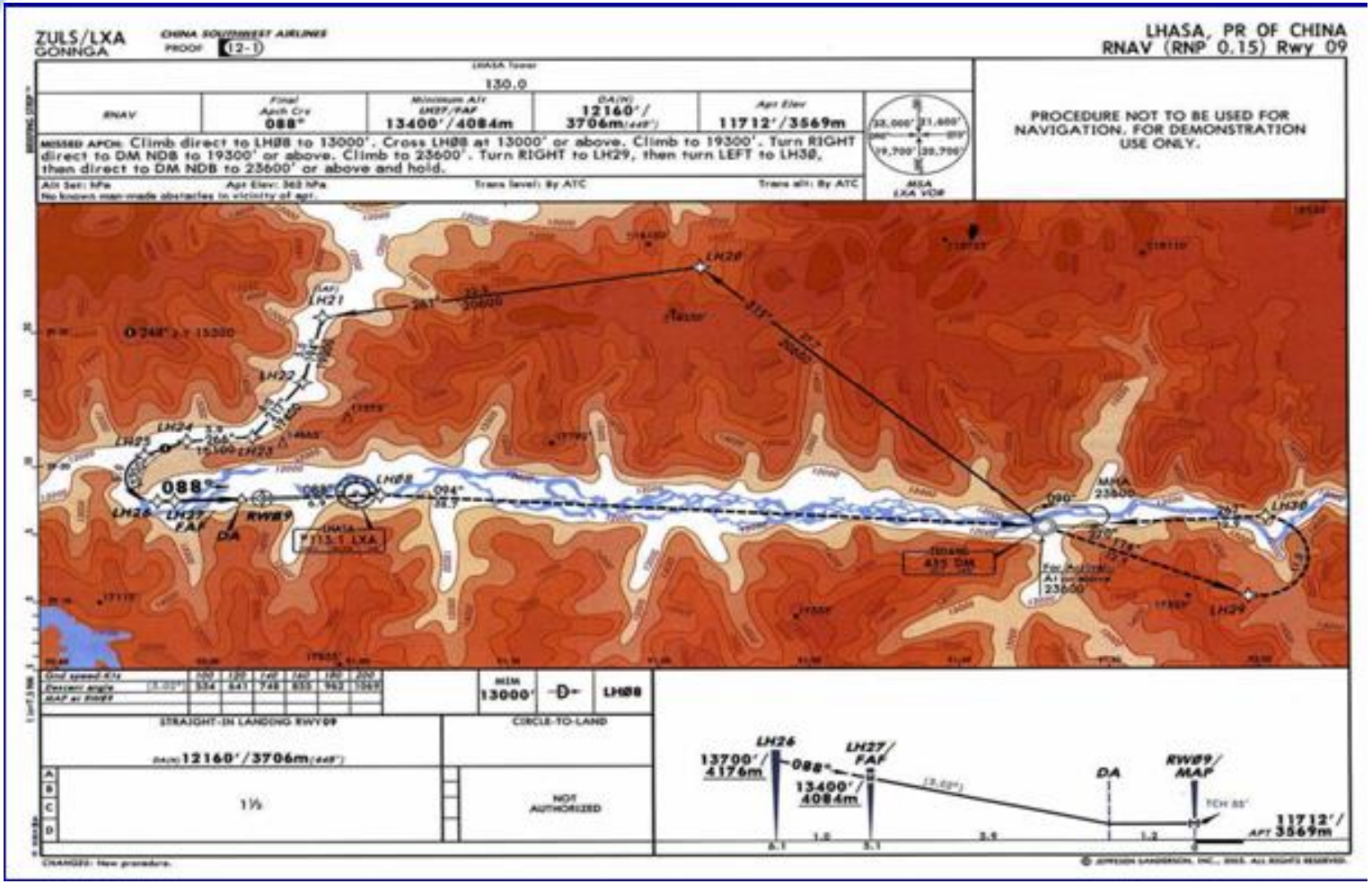
Airspace Concept

Access - Improve airport and airspace access in all weather conditions and the ability to meet limiting obstacle constraints caused by challenging terrains or restricted area



Increase runway access, Increase safety, Reduce noise

Airspace Concept



What is the “Perfect Flight?”

Deriving Airspace Concept

Safety? Capacity? Efficiency? Environment? Access?

AIRSPACE CONCEPT

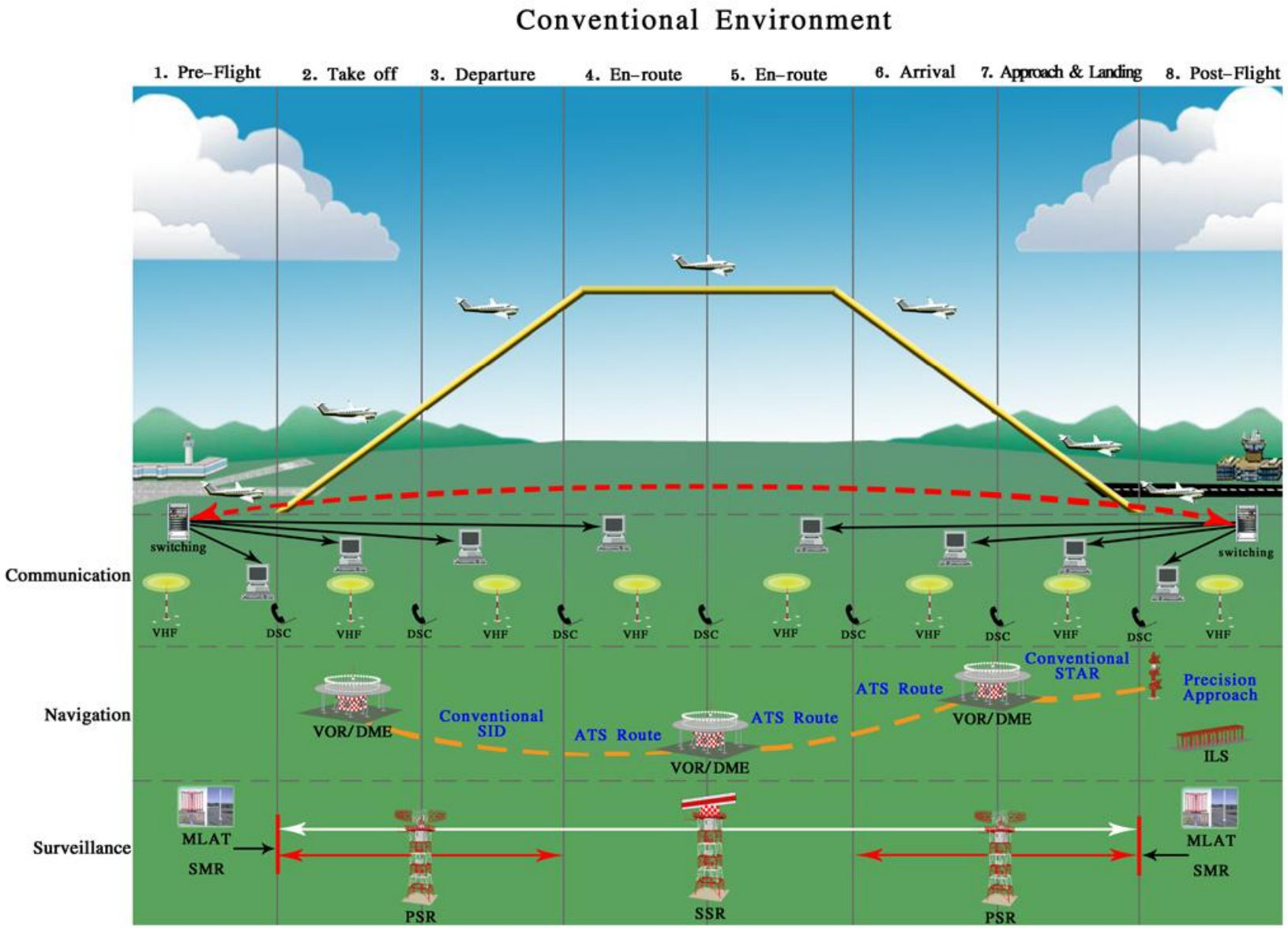
COM NAV SUR ATM

Element of Airspace Concept

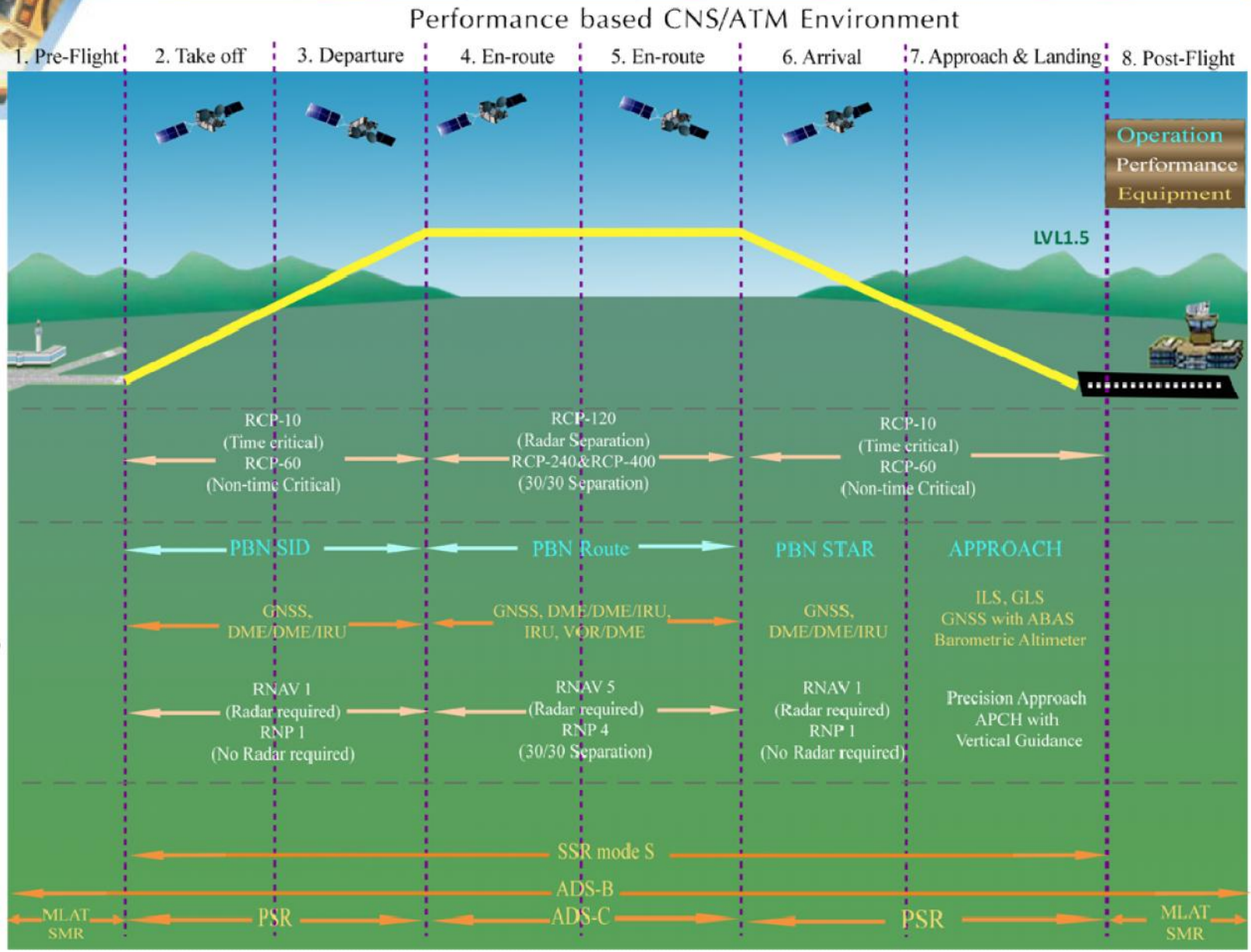
Airspace Concept

- COM
  - PBC
- NAV
  - PBN
- SUR
  - PBS
- ATM

Phases of Flight



Phases of Flight



C = Performance-Based Communication (PBC)

N = Performance-Based Navigation (PBN)

S = Performance-Based Surveillance (PBS)

ATM = Air Traffic Management

Performance Based Navigation (PBN) Implementation

Introduction to PBN

Area Navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.

Note: Performance requirements are expressed in navigation specifications in terms of accuracy, integrity, continuity and functionality needed for the proposed operation in the context of particular airspace concept. Availability of GNSS SIS or some other NAVAID infrastructure in considered within the airspace concept in order to enable the navigation application.

ICAO PBN Strategies

ICAO Assembly Resolution

- State Letter on Issuance of ICAO PBN Manual (Doc 9613)
- States and planning and implementation regional groups (PIRGs) to complete a PBN implementation plan by 2009 to achieve
  - Implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones; and
  - Implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches.
    - 30% by 2010; 70% by 2014, and 100% by 2016

Progress on Thailand Implementation

Thailand WG on PBN&GNSS

Since May 2007, Thailand National Working Group on PBN & GNSS Implementation consists of representatives from:

- DCA Thailand
- Airlines
- Thai Pilots' Association
- Airports of Thailand
- Aeronautical Radio of Thailand

Area 1: Policy & Implementation Planning

- **Conduct feasibility,** e.g. why should we implement PBN and GNSS? How much would it cost?

- **Define roadmap,** e.g. where and when should we implement?

- **Address regulatory issues,** e.g. what regulations/legislations are needed?

Area 2: Establishments of Standards and Requirements

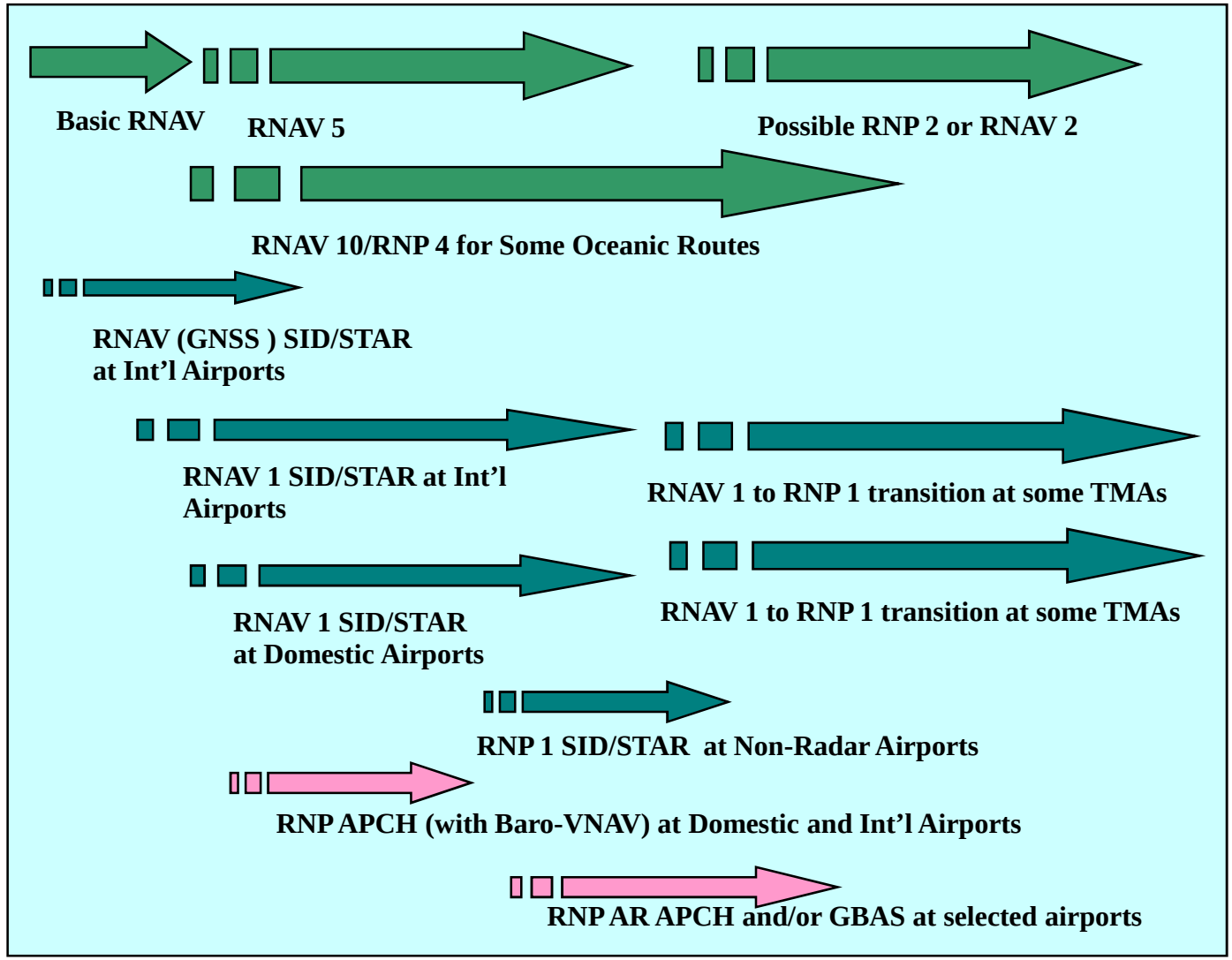
- **Identify/Establish standards,** e.g. how should we implement? What actions are needed to be done? Who are responsible for doing what?

Area 3: Communication with Stakeholders

- **Notify stakeholders,** e.g. let other people know what we have planned and accomplished.

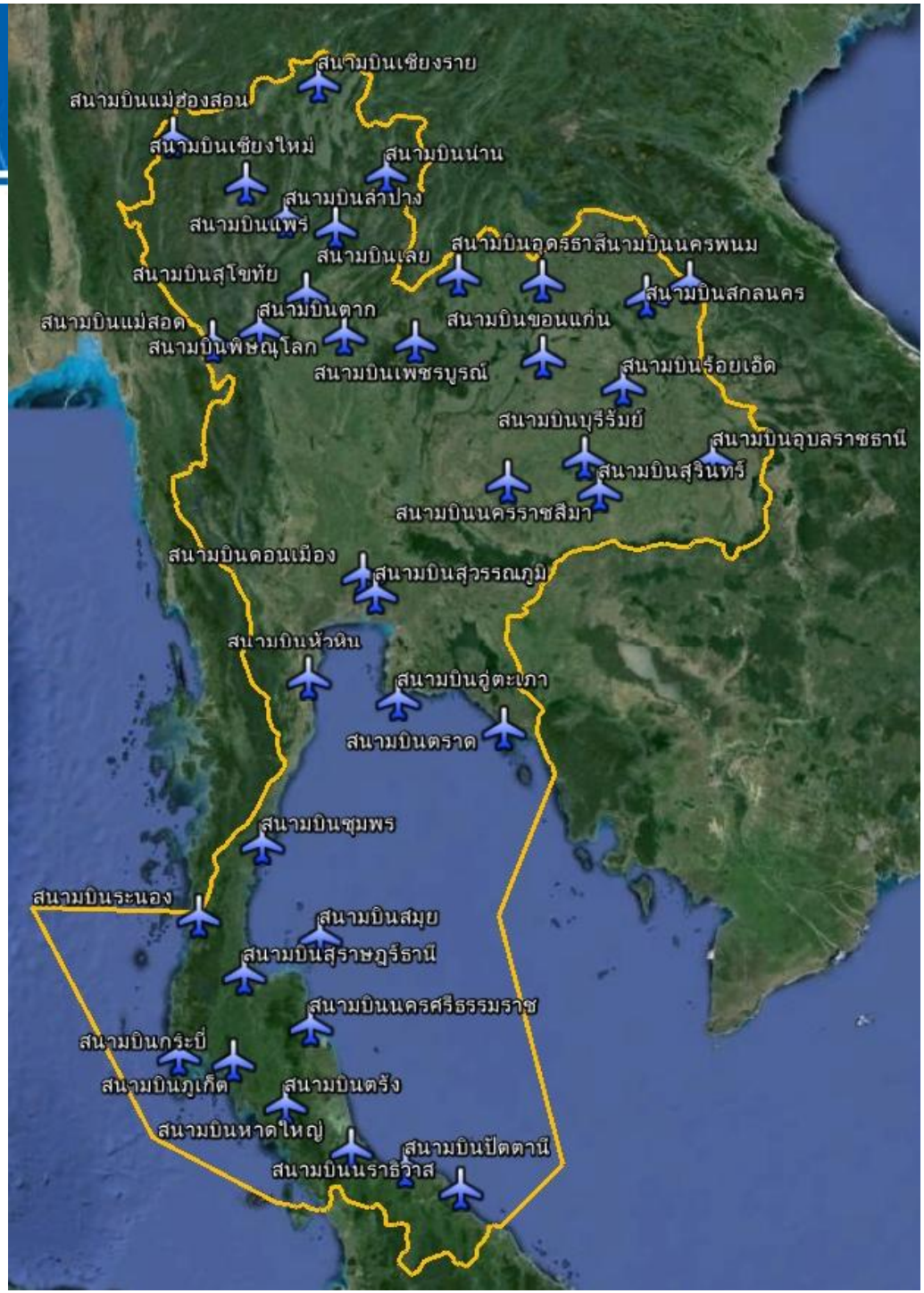
- **Gather feedback,** e.g. what do other stakeholders think? How can we improve what we have done?

Thailand PBN Roadmap



PBN TMA Implementation

- 37 สนามบิน


สนามบินเชียงราย
สนามบินแม่ฮ่องสอน
สนามบินเชียงใหม่
สนามบินน่าน
สนามบินลำปาง
สนามบินแพร่
สนามบินเลย
สนามบินอุดรธานี
สนามบินนครพนม
สนามบินสุโขทัย
สนามบินสกลนคร
สนามบินตาก
สนามบินแม่สอด
สนามบินขอนแก่น
สนามบินพิษณุโลก
สนามบินเพชรบูรณ์
สนามบินร้อยเอ็ด
สนามบินบุรีรัมย์
สนามบินอุบลราชธานี
สนามบินสุรินทร์
สนามบินนครราชสีมา
สนามบินดอนเมือง
สนามบินสุวรรณภูมิ
สนามบินหัวหิน
สนามบินอู่ตะเภา
สนามบินตราด
สนามบินชุมพร
สนามบินระนอง
สนามบินสมุย
สนามบินสุราษฎร์ธานี
สนามบินนครศรีธรรมราช
สนามบินกระบี่
สนามบินภูเก็ต
สนามบินตรัง
สนามบินหาดใหญ่
สนามบินปัตตานี
สนามบินนราธิวาส

Progress on PBN Approach Implementation for Phuket International Airport

Phuket International Airport

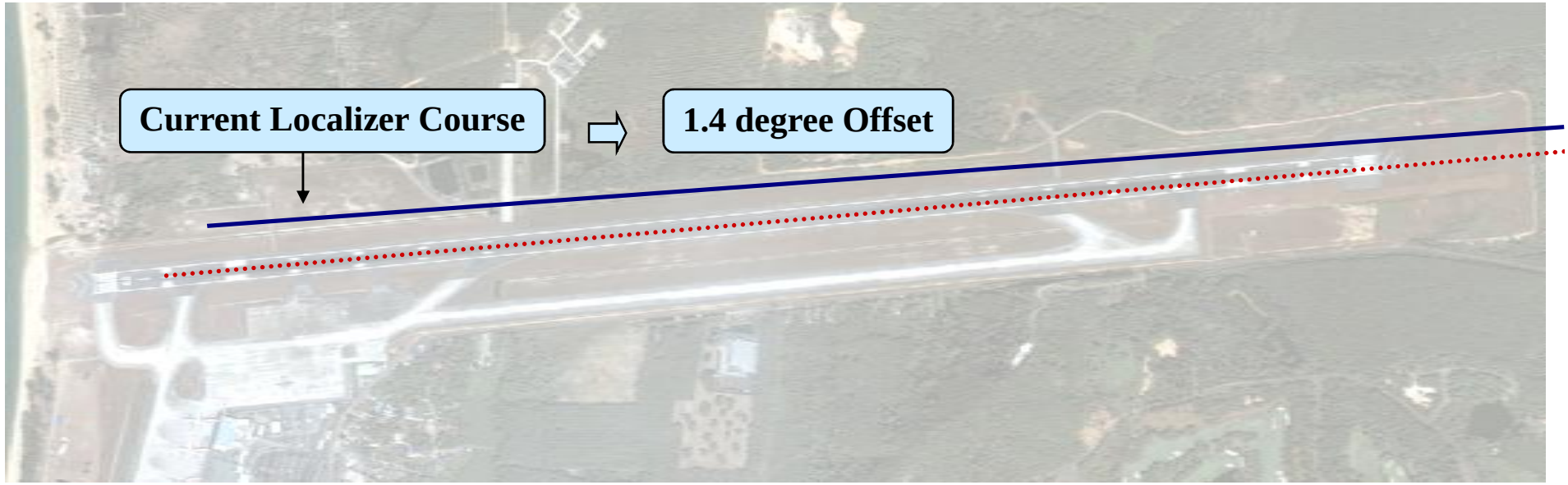
Navigation Infrastructure at Phuket

Existing Conventional Navigation Aids
• 1 Doppler VHF Omni-directional radio Range (DVOR) for RWY 27 & RWY 09 • 1 Instrument Landing System (ILS) for RWY 27

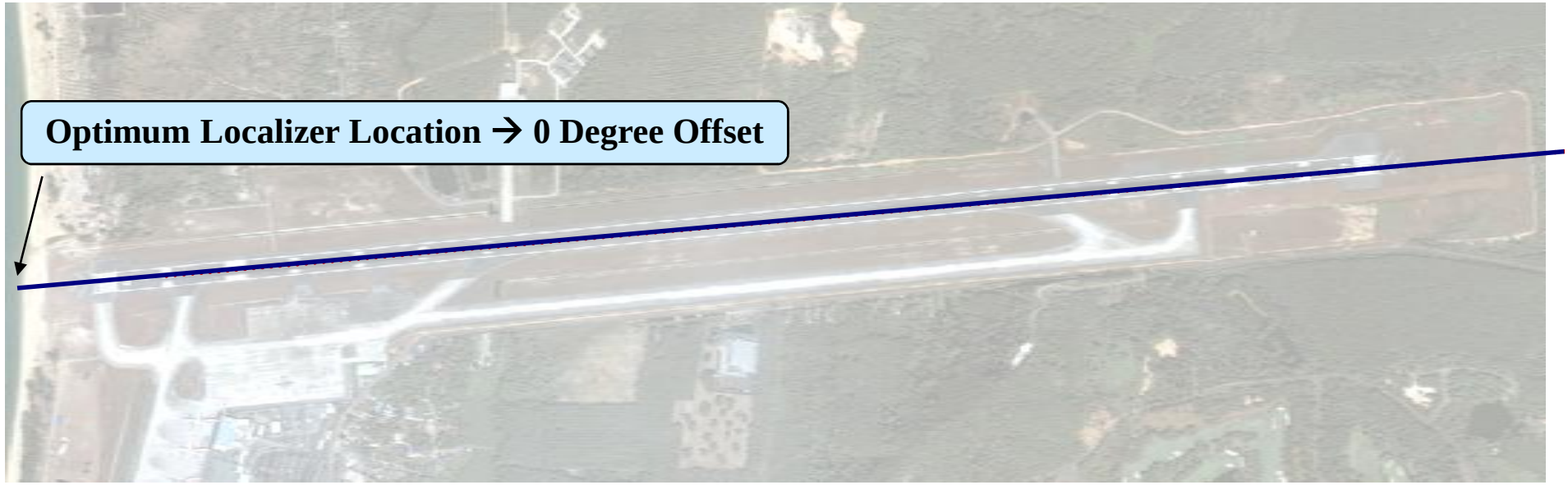
DVOR @ Phuket

ILS @ Phuket

ILS @ Phuket



ILS @ Phuket

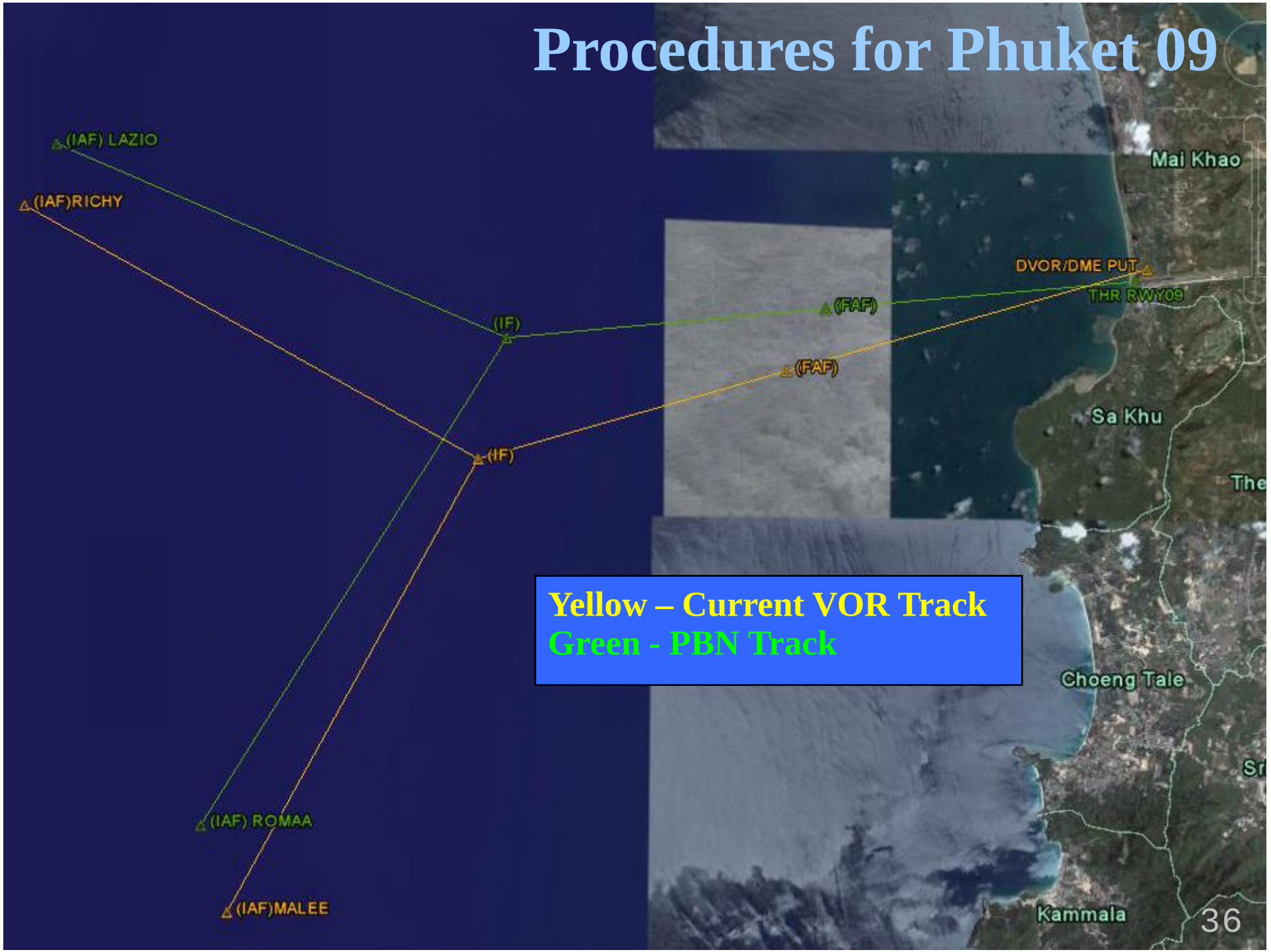


Not advisable due to environment impacts and lack of construction site

Summary: Limitations of Conventional Navigation

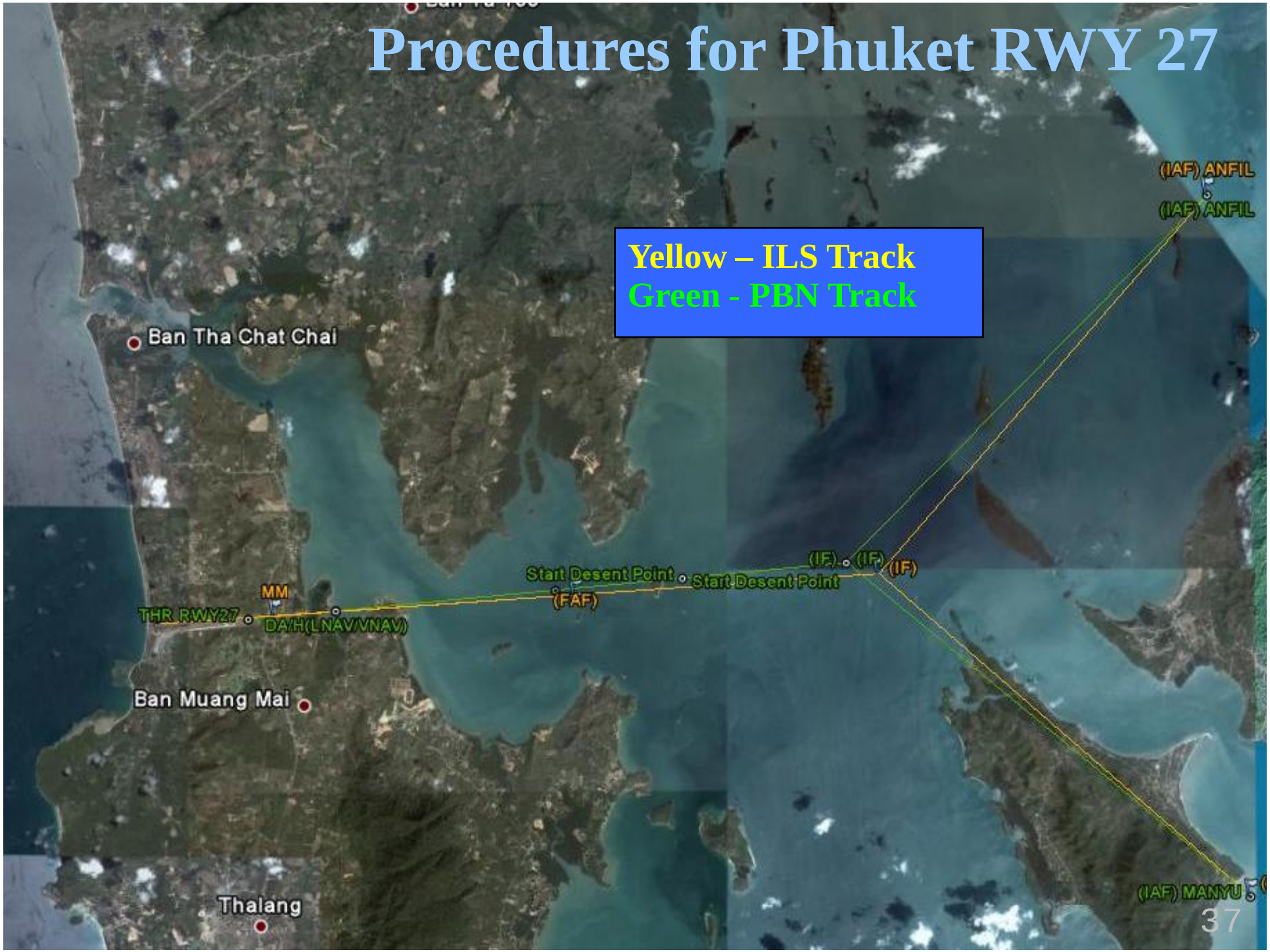
	Conventional
Runway 27	1.4-degree ILS offset
Runway 09	10-degree VOR offset
	No vertical guidance
	High OCA at 850 feet

Procedures for Phuket 09

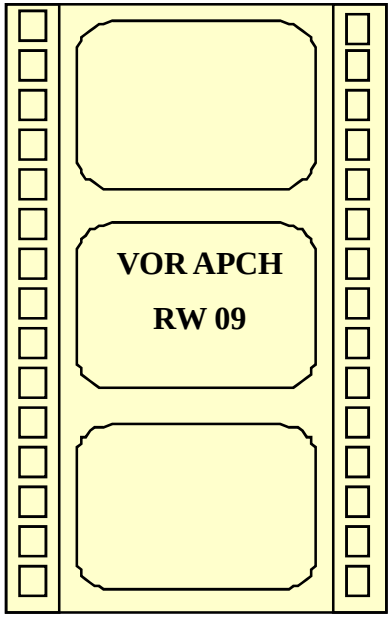


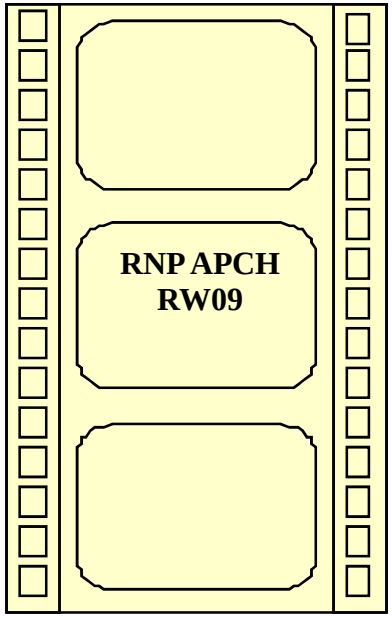
Yellow – Current VOR Track
Green - PBN Track

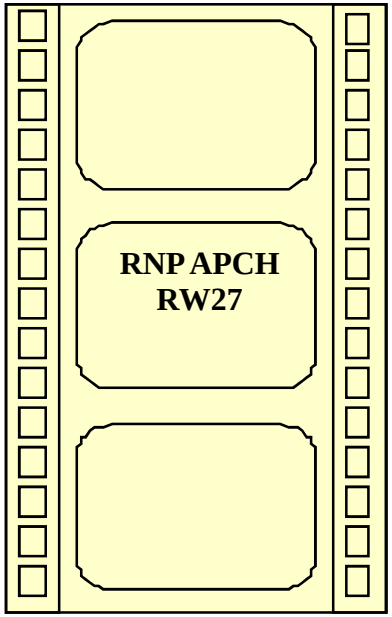
Procedures for Phuket RWY 27



Flight Validation – On Flight







Summary: Safety Improvements with PBN

	Conventional	PBN
Runway 27	1.4-degree ILS offset	Straight-in approach
Runway 09	10-degree VOR offset	Straight-in approach
	No vertical guidance	Vertical guidance
	OCA at 850 feet	OCA at 750 feet

Current Progress

Phone: 66 02 286 0922
Fax: 66 02 287 4060
AFTN: VTBAYOYX
E-mail: aisthai@aviation.go.th

DEPARTMENT OF CIVIL AVIATION
Aeronautical Information Service
Tung Mahamek, Bangkok 10120
Thailand

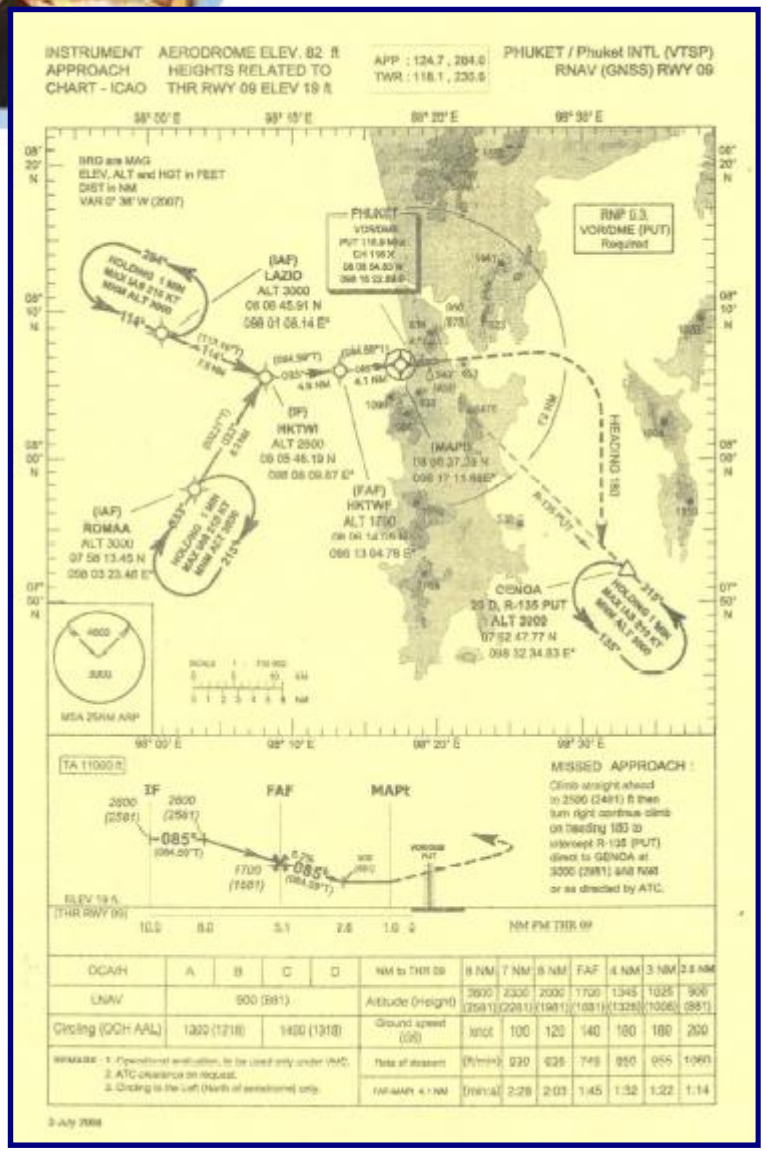
AIRAC
AIP SUPPLEMENT

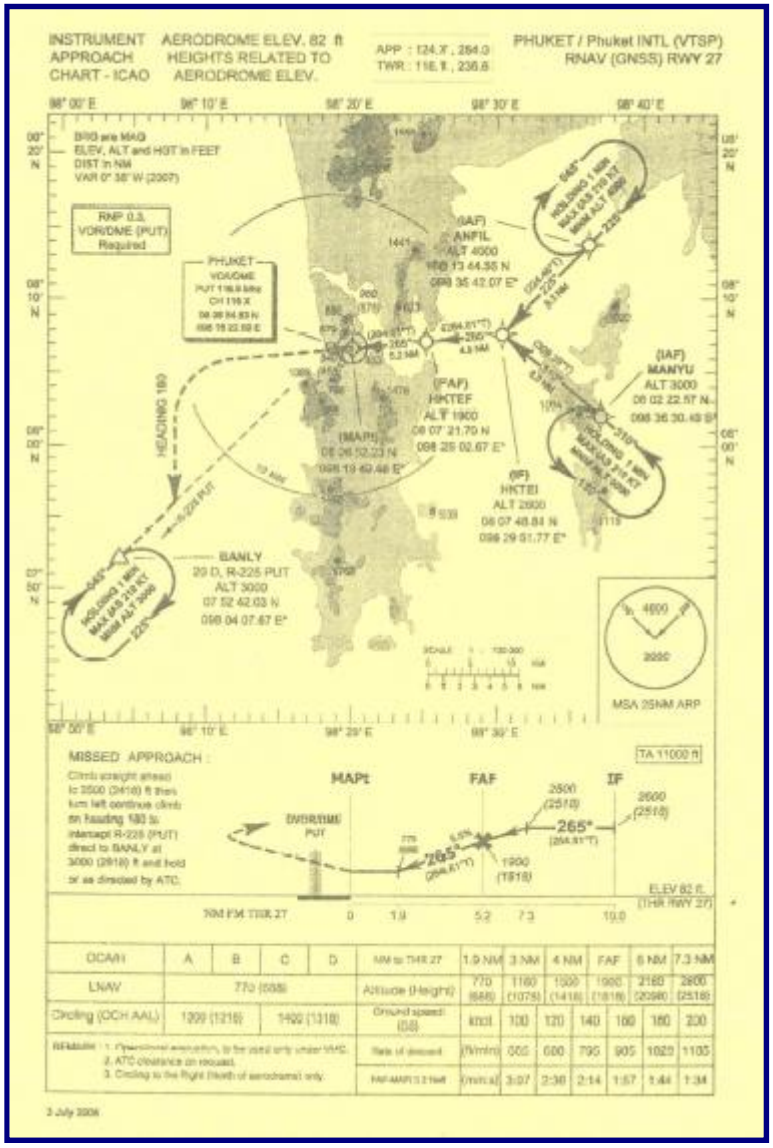
A 11/08
22 May 2008

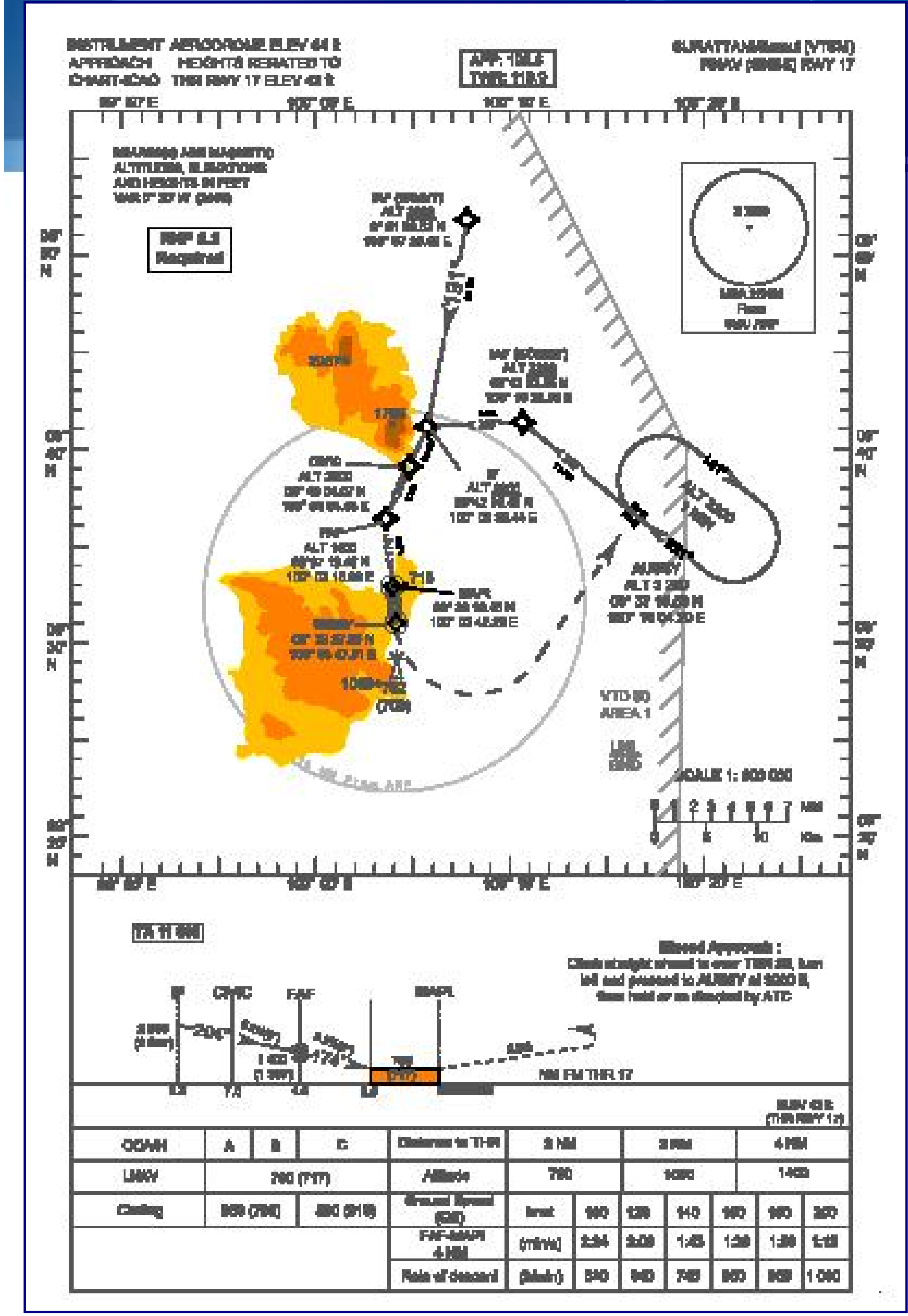
Establishment of Operational Evaluation for RNAV(GNSS) Approach Charts at Phuket International Airport

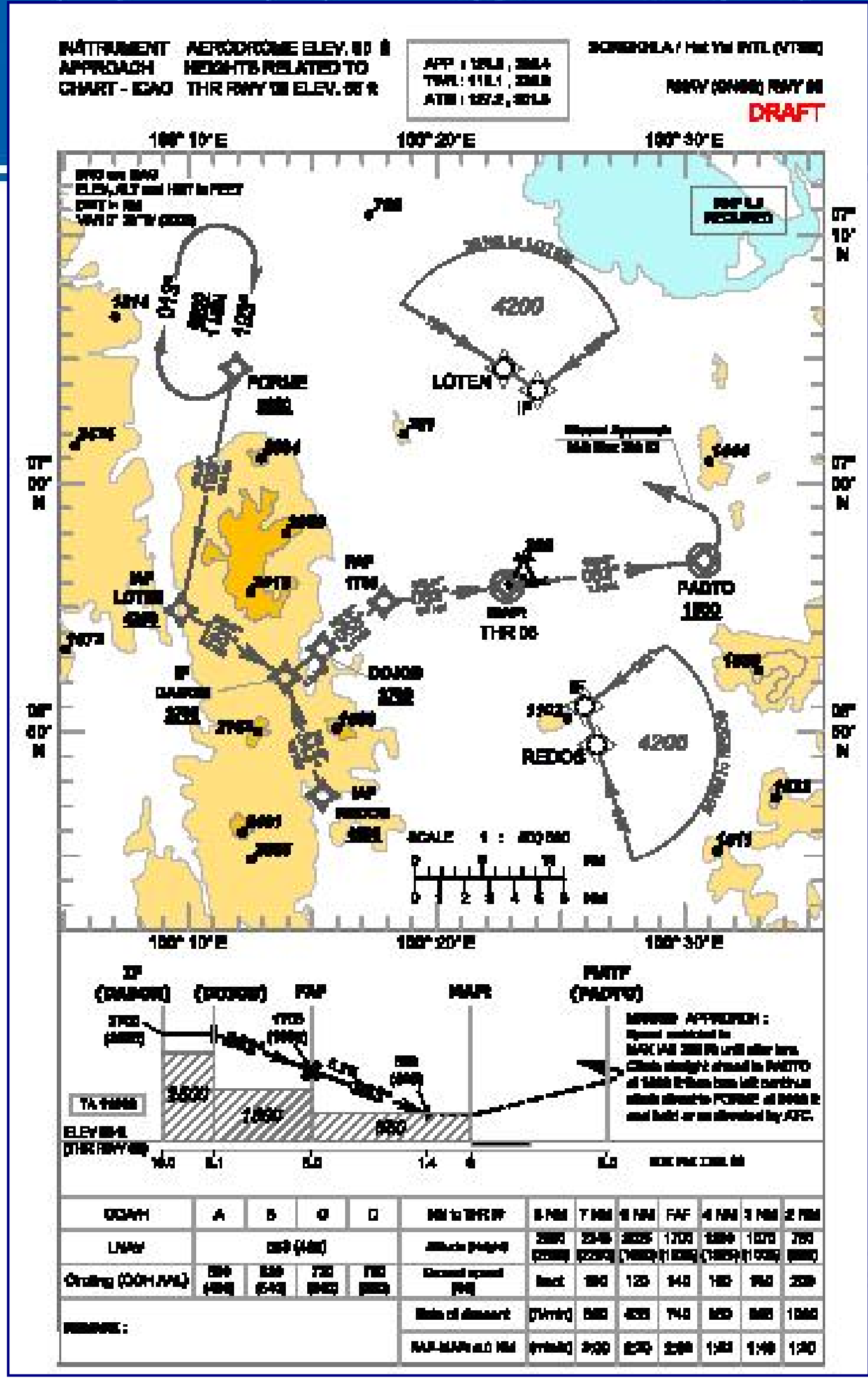
Effecting on 3 July 2008 – 3 October 2008, an operational evaluation for RNAV(GNSS) Approach Charts at Phuket International Airport, namely RNAV(GNSS) Approach RWY27 and RNAV(GNSS) Approach RWY09. The charts for the operational evaluation are attached herewith. During this operational evaluation, the RNAV(GNSS) Approach Charts shall be used only under VMC.

Current Progress






RNP 0.3
Required
Missed Approach :
OCA/H
LNAV
Circling


INSTRUMENT
APPROACH
CHART - ICAO
DRAFT
4200
LOTEN
IF
FORME
PADTO
THR 08
DOJOB
REDOS
FAF
MAPt
OCA/H
LNAV
REMARK :

Safety and Efficiency Improvements with PBN

Phuket (VTSP)	Conventional	PBN
Runway 27	1.4-degree ILS offset	Straight-in approach
Runway 09	6-degree VOR offset	Straight-in approach
	OCA at 850 feet	OCA at 750 feet

Samui (VTSM)	Conventional	PBN
Runway 17	Straight-in yet through unstable weather area	Straight-in approach, yet able to side-step to avoid the unstable weather area

Hat Yai (VTSS)	Conventional	PBN
Runway 08	Unavailable due to mountainous terrain	Straight-in approach

Chiang Mai (VTCC)	Conventional	PBN
Runway 18	VOR circling approach with high circling OCA/H	Runway aligned approach

Thailand PBN Implementation (1)

Implementation Activities Starts	Terminal Areas	Target Nav. Specifications		Expected Operation Date
2008	VTSP (Phuket)	Approach	RNP APCH (w/ Baro-VNAV)	RNP APCH since Feb 2009
2008	VTSS (Hat Yai)	Approach	RNP APCH (w/ Baro-VNAV)	RNP APCH since Dec 2009
2008	VTSM (Samui)	Approach	RNP APCH (w/ Baro-VNAV)	RNP APCH since May 2010
2008	VTBS (Suvarnabhumi)	Approach	RNP APCH (w/ Baro-VNAV)	2012
		Precision Approach	GLS CAT 1	2014
		SID	RNAV 1 (D/D/I or GNSS)	2012
		STAR	RNAV 1 (D/D/I or GNSS)	2012
2008	VTBD (Don Mueang)	Approach	RNP APCH (w/ Baro-VNAV)	2012
		SID	RNAV 1 (D/D/I or GNSS)	2012
		STAR	RNAV 1 (D/D/I or GNSS)	2012
2009	VTCC (Chiang Mai)	Approach	RNP APCH (w/ Baro-VNAV)	2011
2009	VTSG (Krabi)	Approach	RNP APCH (w/ Baro-VNAV)	2011
2010	VTUD (Udornthani)	Approach	RNP APCH (w/ Baro-VNAV)	2012
2010	VTCL (Lum Pang)	Approach	RNP APCH (w/ Baro-VNAV)	2012
		SID	RNAV 1 (D/D/I or GNSS)	2012
2010	VTUK (Khon Kaen)	Approach	RNP APCH (w/ Baro-VNAV)	2012
2010	VTCT (Chiang Rai)	Approach	RNP APCH (w/ Baro-VNAV)	2012

✓

✓ w/o Baro-VNAV

✓ w/o Baro-VNAV

2015

✓ w/o Baro-VNAV

✓ w/o Baro-VNAV

✓ w/o Baro-VNAV

✓ w/o Baro-VNAV

✓ w/o Baro-VNAV

✓ w/o Baro-VNAV

Thailand PBN Implementation (2)

2011	VTSF (Nakhon si Thammarat)	Approach	RNP APCH (w/ Baro-VNAV)	2012	✓
2011	VTSB (Surat thani)	Approach	RNP APCH (w/ Baro-VNAV)	2012	✓ w/o Baro-VNAV
2011	VTBO (Trat)	Approach	RNP APCH (w/ Baro-VNAV)	2012	✓ w/o Baro-VNAV
2011	VTSC (Narathiwat)	Approach	RNP APCH (w/ Baro-VNAV)	2012	✓ w/o Baro-VNAV
2012	VTPO (Sukhothai)	Approach	RNP APCH (w/ Baro-VNAV)	2013.	2015
		SID	RNAV 1 (D/D/I or GNSS)	2013	
2012	VTPP (Phitsanulok)	Approach	RNP APCH (w/ Baro-VNAV)	2013	2016
2012	VTSR (Ranong)	Approach	RNP APCH (w/ Baro-VNAV)	2013	2015
2013	VTUU (Ubon Ratchathani)	Approach	RNP APCH (w/ Baro-VNAV)	2013	✓
2013	VTCH (Mae Hong Son)	Approach	RNP APCH (w/ Baro-VNAV)	2014	2016

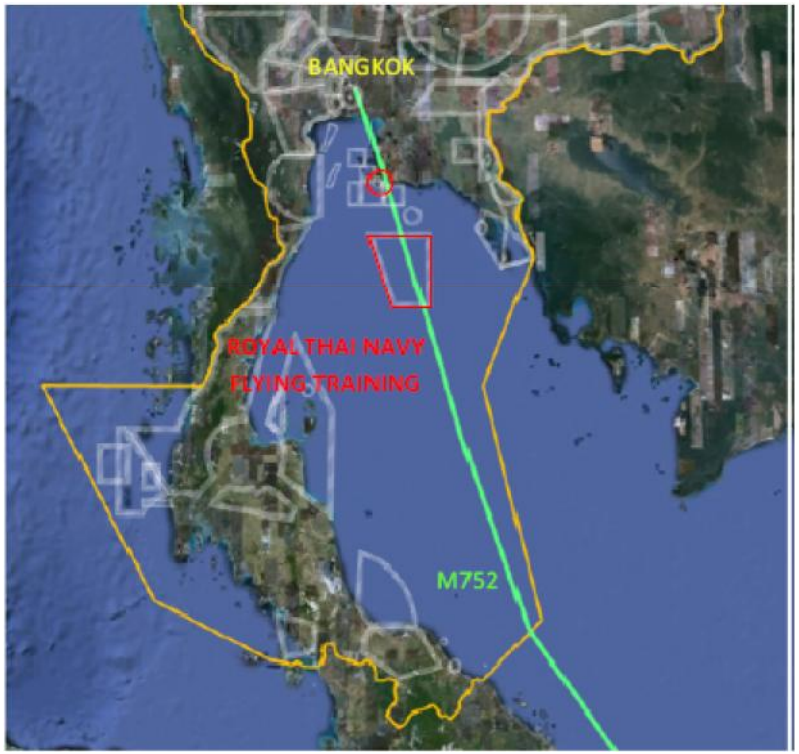
Thailand PBN Implementation (3)

2013	VTCP (Phrae)	Approach	RNAV (GNSS) RWY01 (w/ BARO-VNAV)	2014	✓ w/o Baro-VNAV
2013	VTUW (Nakhon Panom)	Approach	RNAV (GNSS) RWY15 RNAV (GNSS) RWY33 (w/ BARO-VNAV)	2014	✓ w/o Baro-VNAV
2013	VTUI (Sakon Nakhon)	Approach	RNAV (GNSS) RWY05 RNAV (GNSS) RWY23 (w/ BARO-VNAV)	2014	✓ w/o Baro-VNAV
2013	VTPH (Huahin)	Approach	RNAV (GNSS) RWY16 (LNAV)	2014	✓ w/o Baro-VNAV

50% (18 Airports) by the end of 2014

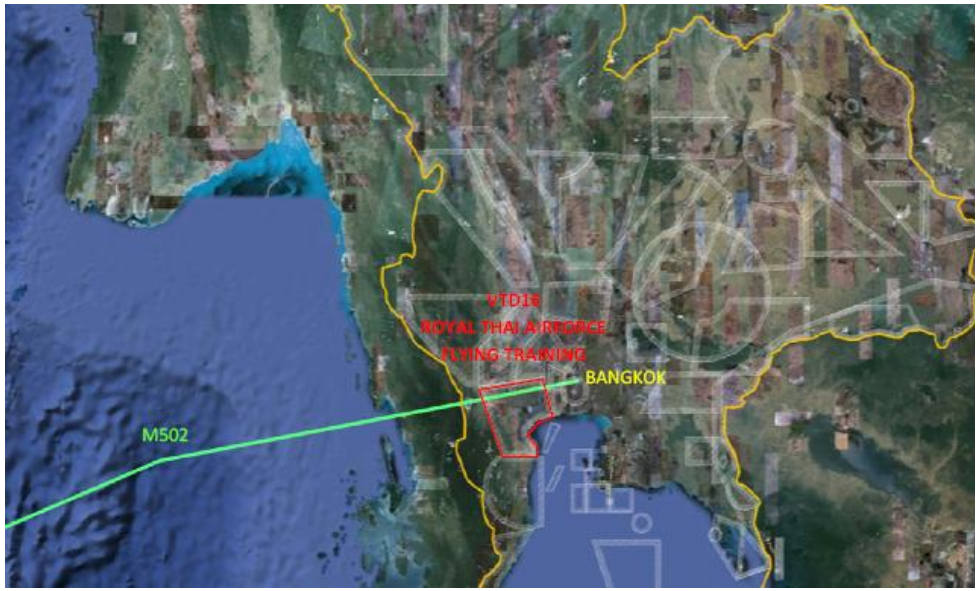
PBN En-route Implementation

PBN En-route



M752 connecting Suvarnabhumi with Australia

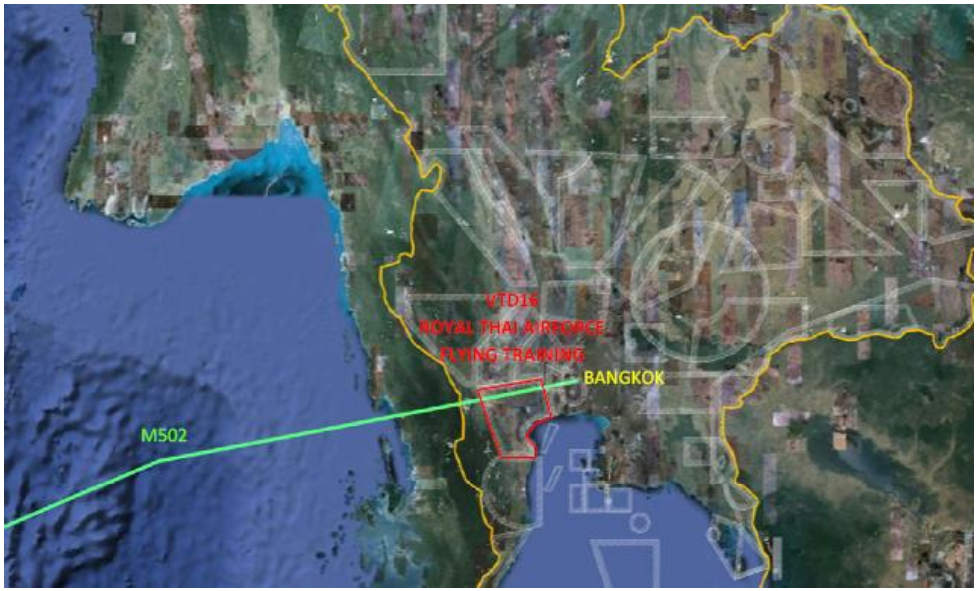
Expect RNAV-5 Navigation Specification



M502 connecting Suvarnabhumi with South Asia

Expect RNAV-5 Navigation Specification

PBN En-route

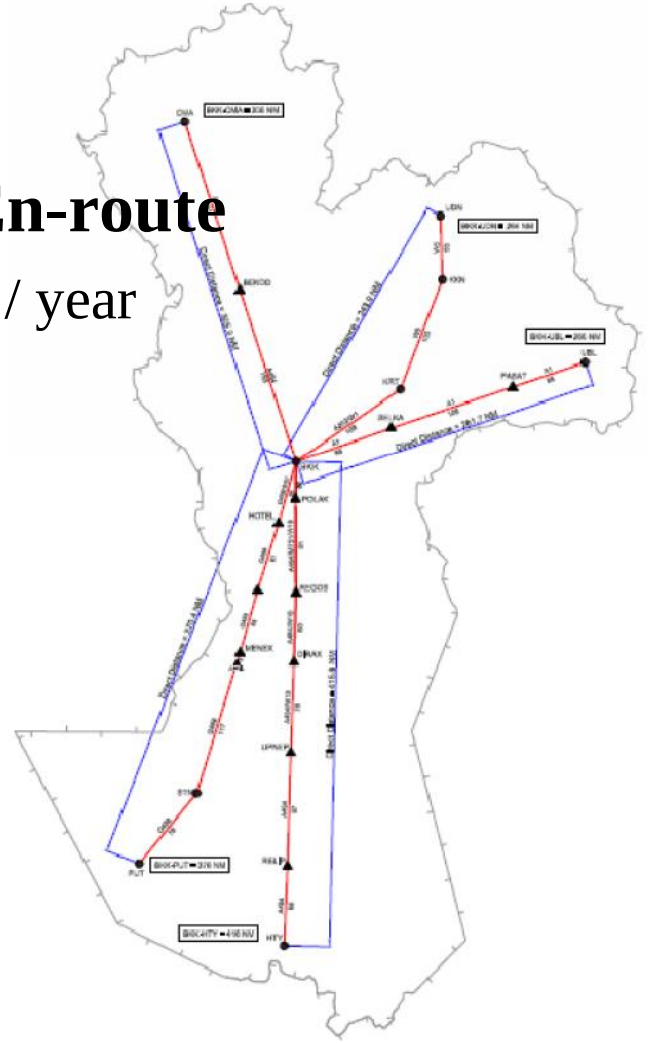


Route	Number of Flight (Month)	Reduce Fuel Burn (Month)	Reduce Carbon Emission (Month)
Suvarnabhumi – Male	24 Flights	~1,488 Kg	~5,208 Kg

Fuel Saving from M502: Data from Bangkok Airways

PBN En-route

- On-Going Initiatives : **PBN Domestic En-route**
  - ***Domestic Enroute* : 2.2 mil kg** of fuel save / year estimated
    - Bangkok – Phuket
    - Bangkok – Samui – Hat Yai
    - Bangkok – Chiang Mai
    - Bangkok – Udon Thani
    - Bangkok – Ubon Ratchathani
    - Implementation On-going



PBN En-route: International

- On-going Initiatives : **PBN International Routes via ICAO**
  - ***Bay of Bengal –*** *ICAO BOB Reduced Separation Minima*
  - ***South China Sea –*** *ICAO South China Sea Route Review Task Force*