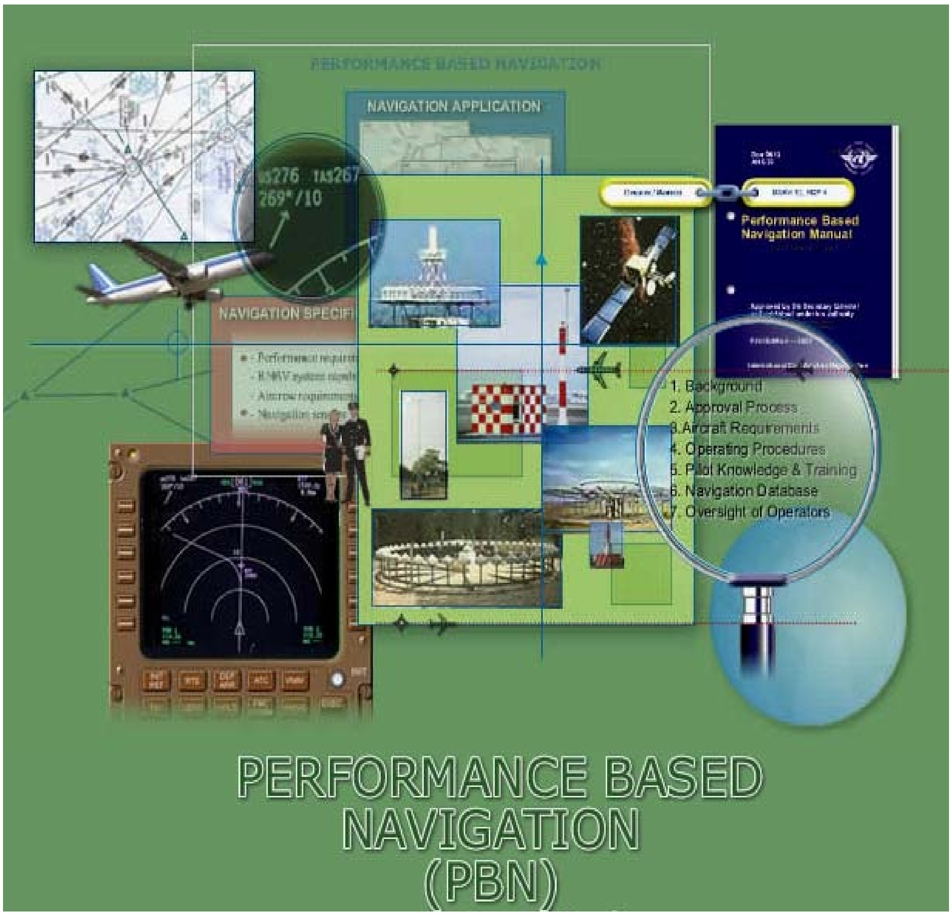
DEPARTMENT OF CIVIL AVIATION MALAYSIA



MALAYSIA PERFORMANCE-BASED NAVIGATION IMPLEMENTATION PLAN

Second Edition
2012

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MALAYSIA PERFORMANCE-BASED NAVIGATION IMPLEMENTATION PLAN

1. Executive Summary

1.1 This PBN Implementation Plan has been produced in line with APANPIRG Conclusion 19/25 adopted by APANPIRG/19. The PBN Plan addresses the strategic objectives for PBN implementation based on clearly established operational requirements, avoiding equipage of multiple on-board or ground based equipment, avoidance of multiple airworthiness and operational approvals and explains the contents relating to potential navigation applications. The Plan envisages the conduct of pre- and post-implementation safety assessments and continued availability of conventional air navigation procedures during transition. The Plan also discusses issues related to implementation which include traffic forecasts, aircraft fleet readiness, adequacy of ground-based CNS infrastructure etc. Implementation targets for various categories of airspace for the short term (2012 – 2015) and for the medium term (2016 – 2019) have been projected in tabular forms to facilitate easy reference. For the long term (2020 and beyond) it has been envisaged that GNSS will be the primary navigation infrastructure. It is also expected that precision approach capability using GNSS and its augmentation system will become available in the long term.

2. Explanation of Terms

2.1 The drafting and explanation of this document is based on the understanding of some particular terms and expressions that are described below:

2.1.1 **Malaysia PBN Implementation Plan.** A document offering appropriate guidance for air navigation service providers, airspace operators and users, regulating agencies, and international organizations, on the evolution of navigation capabilities as one of the key systems supporting air traffic management, and which describes the RNAV and RNP navigation applications that should be implemented in the short, medium and long term in Malaysian airspace.

2.1.2 **Performance Based Navigation** Performance based navigation specifies RNAV and RNP system performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in an airspace.

2.1.3 **Performance requirements.** Performance requirements are defined in terms of accuracy, integrity, continuity, availability and functionality needed for the proposed operation in the context of a particular airspace concept. Performance requirements are identified in navigation specifications which also identify which navigation sensors and equipment may be used to meet the performance requirement.

3. Acronyms

3.1 The acronyms used in this document along with their expansions are given in the following list

ABAS	Aircraft-Based Augmentation System
AIS	Aeronautical Information Services

APAC	Asia and Pacific Regions
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
APCH	Approach
APV	Approach Procedures with Vertical Guidance
ATC	Air Traffic Control
Baro VNAV	Barometric Vertical Navigation
CNS/ATM	Communication Navigation Surveillance/Air Traffic Management
CPDLC	Controller Pilot Data Link Communications
DME	Distance Measuring Equipment
EMA	En-route monitoring Agency
FASID	Facilities and Services Implementation Document
FIR	Flight Information Region
FMS	Flight Management System
GBAS	Ground-Based Augmentation System
GNSS	Global Navigation Satellite System
GRAS	Ground-based Regional Augmentation System
IATA	International Air Transport Association
IFALPA	International Federation of Air Line Pilots' Associations
KLIA	Kuala Lumpur International Airport
MAPA	Malaysia Airlines Pilots' Associations
INS	Inertial Navigation System
IRU	Inertial Reference Unit
PANS	Procedures for Air Navigation Services
PBN	Performance Based Navigation
PIRG	Planning and Implementation Regional Group
RASMAG	Regional Airspace Safety Monitoring Advisory Group
RCP	Required Communication Performance
RNAV	Area Navigation
RNP	Required Navigation Performance
SARP	Standards and Recommended Practices
SBAS	Satellite-Based Augmentation System
SID	Standard Instrument Departure
STAR	Standard Instrument Arrival
TMA	Terminal Control Area
VOR	VHF Omni-directional Radio-range
WGS	World Geodetic System

4. Introduction

Need for the PBN Implementation Plan

4.1 The Thirty-sixth Session of the ICAO Assembly held in Montreal in September 2007 adopted a Resolution to resolve that States to complete a PBN implementation plan by 2009.

4.2 Recognizing that the PBN concept is now established, Malaysia shall ensure that all RNAV and RNP operations and procedures are in accordance with the PBN concept as detailed in ICAO Doc 9613: PBN Manual for ensuring a globally harmonized and coordinated transition of PBN.

4.3 In view of the need for detailed navigation planning, Malaysia recognized the need to develop a PBN Implementation Plan to provide proper guidance to airspace operators and users on the RNAV and RNP navigation applications that should be implemented in the short and medium term in the Kuala Lumpur FIR and Kota Kinabalu FIR.

4.4 Furthermore, the development of Malaysia PBN Implementation Plan will be aligned with the Asia/Pacific PBN Implementation Plan in the implementation of air navigation infrastructure, such as ABAS and GBAS.

Benefits of Performance-Based Navigation

4.5 The main benefits derived from the implementation of PBN are:

a) Increased airspace safety through the implementation of continuous and stabilized descent procedures using vertical guidance;
b) Reduced aircraft flight time due to the implementation of optimal flight paths, with the resulting savings in fuel, noise reduction, and enhanced environmental protection;
c) Use of the RNAV and/or RNP capabilities that already exist in a significant percentage of the aircraft fleet flying in Malaysian airspace;
d) Improved airport and airspace arrival paths in all weather conditions, and the possibility of meeting critical obstacle clearance and environmental requirements through the application of optimized RNAV or RNP paths;
e) Implementation of more precise approach, departure, and arrival paths that will reduce dispersion and will foster smoother traffic flows;
f) Reduced delays in high-density airspaces and airports through the implementation of additional parallel routes and additional arrival and departure points in terminal areas;
g) Reduction of lateral and longitudinal separation between aircraft to accommodate more traffic;
h) Decrease ATC and pilot workload by utilizing RNAV/RNP procedures and airborne capability and reduce the needs for ATC-Pilot communications and radar vectoring;
i) Increase of predictability of the flight path.

4.6 Specific benefits on the implementation of PBN procedures in Malaysia are:

a) To serve as a back-up procedures to all instrument runway in Malaysia as most airports are equipped with single navigation infrastructure.
b) Increase approach possibility to most airports during monsoon season.
c) Enhance safety by providing aligned final approach tracks at airports with offset navigational aids sitting, e.g. Kuching, Kinabalu and Ipoh.
d) RNP AR APCH may be a solution to provide sufficient procedures to obstacle and terrain challenged airport e.g. Johor Bahru, Alor Star, Kerteh and Subang.

Goals & Objectives of PBN Implementation

4.7 The Malaysia PBN Implementation Plan has the following strategic objectives:

a) To ensure that the implementation of the navigation item of the CNS/ATM system is based on clearly established operational requirements.
b) To avoid undue equipage of multiple on board equipment and/or ground-based systems.
c) To avoid the need for multiple airworthiness and operational approvals for intra- and inter-regional operations.

4.8 Furthermore, the PBN Implementation Plan will provide a high-level strategy for the evolution of the navigation applications to be implemented in the Kuala Lumpur FIR and Kota Kinabalu FIR in the short term (2013-2015), medium term (2016-2019) and long term (2020 and beyond). This strategy is based on the concepts of Area Navigation (RNAV) and Required Navigation Performance (RNP) in accordance with ICAO Doc 9613 and will be applied to aircraft operations involving instrument approaches, standard departure (SID) routes, standard arrival (STAR) routes, and ATS routes in continental and oceanic areas.

4.9 The Malaysia PBN Implementation Plan is developed by the National Working Group consisting of various unit in DCA Malaysia, Malaysia Airlines, Air Asia, Firefly, Transmile Air and Malaysia Airlines Pilots' Associations (MAPA). It is intended to assist the main stakeholders of the aviation community plan a gradual transition to the RNAV and RNP concepts.

4.10 This Plan is intended to assist the main stakeholders of the aviation community plan the future transition and their investment strategies. For example, airlines and operators can use this Plan to derive future equipage and additional navigation capability investments; DCA Malaysia can plan a gradual transition for the evolving ground infrastructure.

Planning Principles

4.11 Planning for the implementation of PBN in Malaysia is based on the following principles:

a) Pre- and post-implementation safety assessments will be conducted to ensure the application and maintenance of the established target levels of safety.
b) Continued application of conventional air navigation procedures during the transition period, to guarantee the operations by users that are not RNAV- and/or RNP-equipped.

c) The Malaysia PBN implementation plan will address the short term (2012-2015) and medium term (2016-2019) and take into account long term regional and global planning issues.

5. PBN Operational Requirements & Implementation Strategy

5.1 Introduction of PBN will be consistent with the Regional and Global Air Navigation Plan. Moreover, PBN implementation will be in full compliance with ICAO SARPs and PANS and support relevant ICAO Global Plan Initiatives.

5.2 The introduction of PBN will be supported by an appropriate navigation infrastructure consisting of an appropriate combination of Global Navigation Satellite System (GNSS), self-contained navigation system (inertial navigation system) and conventional ground-based navigation aids.

5.3 The *Strategy for the Provision of Precision Approach, Landing & Departure Guidance Systems and the Strategy for Implementation of GNSS Navigation Capability* as being reviewed and updated by the Eleventh meeting of CNS/MET Sub Group of APANPIRG in July 2007. The updated strategies were reviewed and adopted by APANPIRG as *Strategies for the Provision of Navigation Services* in its Eighteenth meeting held in September, 2007 under Conclusion 18/30.

Route Operations

5.4 Considering the traffic characteristics and CNS/ATM capability, en-route operations are classified as Oceanic and Domestic en-route.

5.5 In principle, classification of en-route operation will adopt, but not be limited to, a single RNAV or RNP navigation specification. This implementation strategy will be applied in coordination with airspace users, and the RNAV and RNP navigation applications will be coordinated between neighbouring states to ensure harmonization.

5.6 In areas where operational benefits can be achieved and appropriate CNS/ATM capability exists, a more accurate navigation specification than that specified in this plan, will be introduced on the basis of coordination with stakeholders and affected neighboring States.

TMA Operations

5.7 TMA operations have their own characteristics, taking into account the applicable separation minima between aircraft and between aircraft and obstacles. TMA operations also involve the diversity of aircraft, including low-performance aircraft flying in the lower airspace and conducting arrival and departure procedures on the same path or close to the paths of high-performance aircraft.

5.8 In this sense, a plan for the implementation of PBN in TMAs, will be based on the Asia/Pacific Regional PBN Implementation Plan, seek the harmonization of the application of PBN and avoid the need for multiple operational approvals for intra- and inter-regional operations. Applicable aircraft separation criteria will also be considered.

Instrument Approaches

5.9 PBN approaches that provide Vertical Guidance will be introduced to enhance safety. Conventional approach procedures and conventional navigation aids will be maintained to support non-equipped aircraft during the transitional period.

5.10 IFR Approaches based on PBN will be designed to accommodate mixed-equipage (PBN and non-PBN) environment. ATC workload will be taken into account while developing approach procedures. One possible way to accomplish this is to co-locate the Initial Approach Waypoint for both PBN and conventional approaches.

6. Current Status & Forecast

6.1 APAC traffic forecast

6.1.1 The GEN part of FASID (Doc9673 Vol. II) provides the information and data of the following traffic forecasts:

- **Forecasts of air traffic demand for air navigation systems planning**
- **Passenger forecasts**
- **Aircraft movement forecast**
- **Major city-pairs forecasts**

6.1.2 The forecast data as well as the figures contained in the FASID document are the results of the regular meetings of Asia/Pacific Area Traffic Forecasting Group (APA TFG).

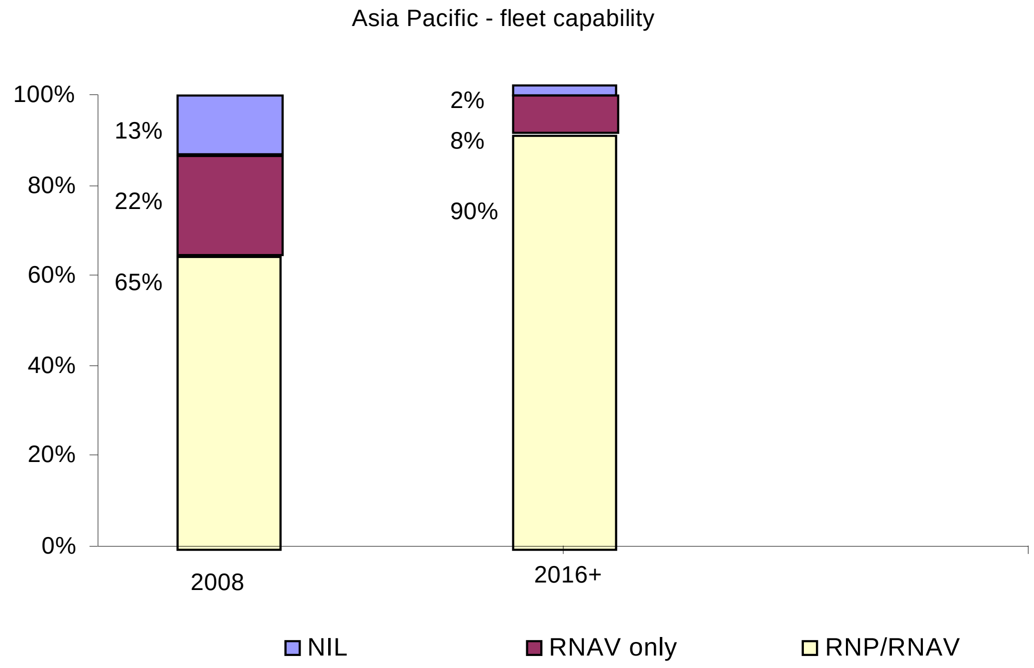
6.1.3 The forecast conducted by IATA on 27 February 2008 for Asia and Pacific traffic in respect of passenger, cargo, aircraft movements and new aircraft deliveries in all the Regions is also provided in the Appendix A to this plan as reference.

6.2 Aircraft fleet readiness status

6.2.1 All major commercial aircraft manufacturers since the 1980's have included RNAV capabilities. The commercial aircraft currently produced incorporate an RNP capability.

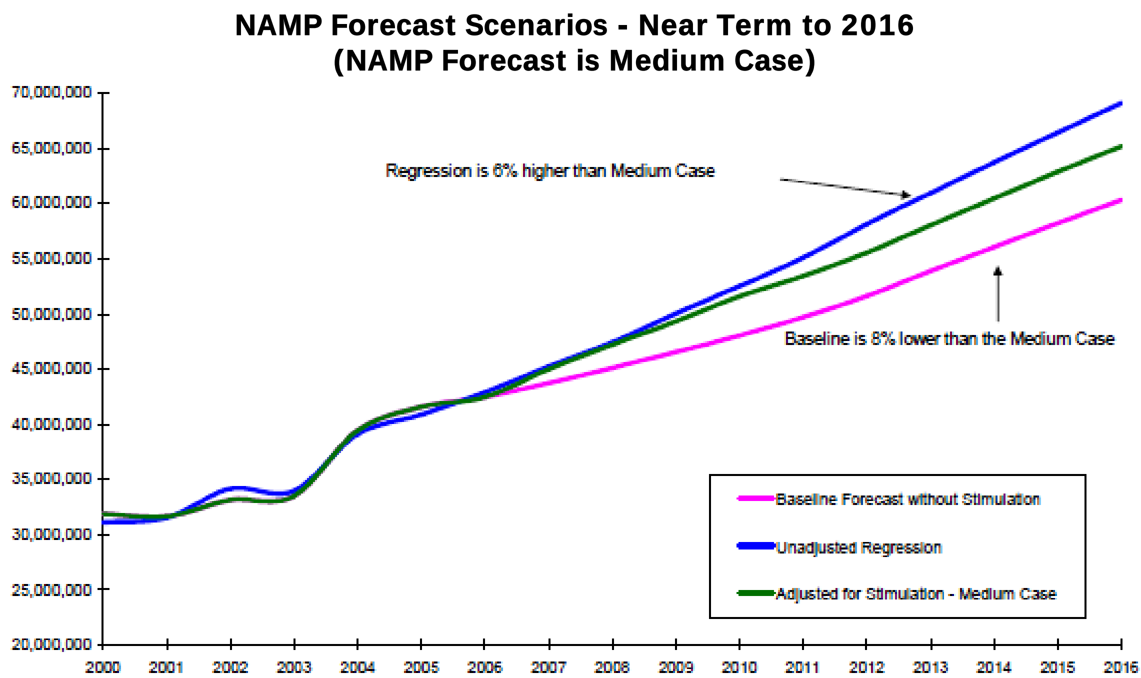
6.2.2 The diagram below displays a high level analysis based on fleet numbers from Ascend Online Fleets database March 2008 and RNAV/RNP classification by IATA.

6.2.5 National airlines i.e. Malaysia Airlines, Air Asia and Transmile fleet readiness status are attached in Appendix B, Appendix C and Appendix D respectively.

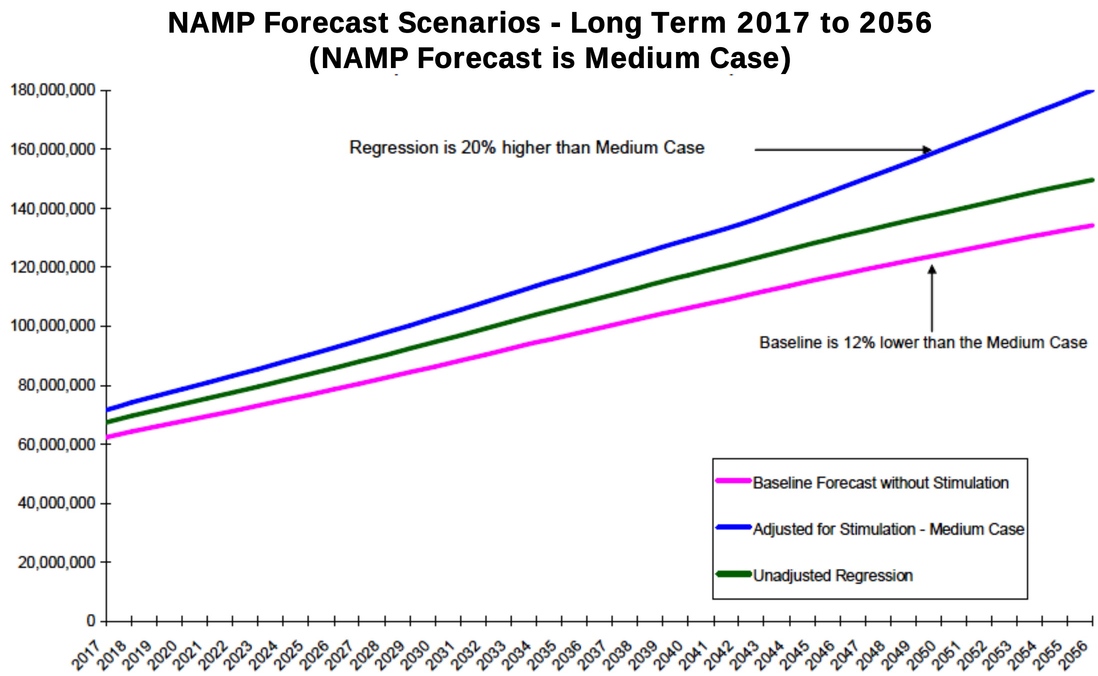


6.3 Domestic Traffic Forecast

6.3.1 Air passengers within Malaysia expect to see a growth triple in the next 50 years. It is believed that the fastest growth will occur in the next 20 years. A mere 42 million passengers in 2006 will exponentially leap to about 150 million in 2056. A study made by Malaysia Airport Holding Bhd. (MAHB) in the National Airport Master Plan (NAMP) predicts KLIA will grow to almost 70 million passengers by 2016, followed by Kota Kinabalu with 21 million passengers, then Kuching with 17 million passengers and Penang with 16 million passengers.



KLIA Forecast near Term Results to 2016



KLIA Forecast Long Term Results, 2017 to 2056

6.3.2. Six largest airports in Malaysia accounted for 87% of passenger traffic in 2006 and air cargo is even more intense. Abbreviated forecast medium case air passenger results for all NAMP in-scope the airports are displayed in Table below:-

Code	Airport	2006 Passengers	2011 Passengers	2016 Passengers	2031 Passengers	2056 Passengers
KUL	KLIA	24,129,748	31,380,328	37,362,886	51,450,094	69,538,768
PEN	Penang	3,103,772	3,901,954	5,016,097	8,551,416	15,691,911
LGK	Langkawi	934,024	1,410,918	1,854,295	3,329,919	6,549,587
KBR	Kota Bharu	678,306	846,345	998,461	1,333,736	1,690,268
TGG	Kuala Terengganu	398,252	465,422	548,989	733,119	929,341
AOR	Alor Star	292,549	323,495	382,037	512,110	653,895
KUA	Kuantan	273,005	289,246	341,290	456,615	583,149
SZB	Subang	83,502	104,748	126,640	212,545	334,601
IPH	Ipoh	64,711	72,929	86,126	115,415	147,132
MKZ	Malacca	18,509	32,189	37,981	50,815	64,897
BKI	Kota Kinabalu	4,015,221	5,154,641	6,643,376	11,402,413	21,283,890
TWU	Tawau	660,331	852,950	1,004,068	1,332,678	1,671,941
SDK	Sandakan	633,194	692,212	815,688	1,086,196	1,371,468
LBU	Labuan	575,684	598,914	706,456	943,998	1,201,380
LDU	Lahad Datu	108,697	76,855	90,683	121,326	154,947
KCH	Kuching	3,196,352	4,060,091	5,253,642	9,102,768	17,221,902
MYY	Miri	1,559,379	1,734,944	2,264,616	4,007,370	7,781,631
SBW	Sibu	898,923	899,431	1,060,375	1,414,101	1,790,182
BTU	Bintulu	449,673	417,537	491,760	653,885	823,967
LMN	Limbang	89,814	53,647	63,297	84,676	108,120
MZV	Mulu	48,825	38,403	45,313	60,622	77,418
		42,212,471	53,407,201	65,194,076	96,955,818	149,670,393

Actual 2006 and Forecast Passengers to 2056

6.3.3 Country-wide forecast approach underpinnings of the general airport forecast model comprise three key demand variables: (1) an organic forecast of local traffic based on Malaysian general economic indicators; (2) an adjustment to the local traffic forecast for passenger stimulation resulting from greater service levels and lower fares that will be driven in large part by the increase in LCC capacity and expected traffic shares at each airport, and;

(3) a forecast of transfer traffic at KLIA considering for hub and alliance development and competition from Bangkok and Singapore hubs.

6.3.4 The greatest driver to Malaysian air travel stimulation in the future will be greater LCC capacity and increasing shares of local traffic. LCCs are expected to grow to a steady state of about 40 percent of total local traffic in and around Asia. Greater LCC capacity will, then, work to increase service levels and lower fares – each of which will stimulate new passengers to the market.

6.3.5 Optimistic passenger under the optimistic forecast scenario, MAHB airports' traffic volumes will increase from a total 42 million passengers in 2006 to about 172 million in 2056. Forecast optimistic scenario annual results for select years are shown in Tables as below:

Optimistic Scenario - Forecast total Passenger Results

Code	Airport	2006 Passengers	2011 Passengers	2016 Passengers	2031 Passengers	2056 Passengers
KUL	KLIA	24,129,748	32,996,171	42,969,524	59,537,716	83,186,088
PEN	Penang	3,103,772	4,003,233	5,458,177	10,046,927	19,585,777
BKI	Kota Kinabalu	4,015,221	5,338,746	7,451,606	13,236,481	26,516,938
	All Others	10,963,730	12,970,277	16,171,716	25,551,895	43,155,825
		42,212,471	**55,308,428**	**72,051,023**	**108,373,019**	**172,444,628**

Optimistic Scenario - Forecast LCC Passenger Results

Code	Airport	2006 LCC Passengers	2011 LCC Passengers	2016 LCC Passengers	2031 LCC Passengers	2056 LCC Passengers
KUL	KLIA	5,646,314	15,129,287	21,824,480	30,863,411	45,705,627
PEN	Penang	510,766	1,532,157	2,431,187	5,651,971	13,112,864
BKI	Kota Kinabalu	794,851	2,492,070	3,866,039	7,511,133	16,736,990
	All Others	2,891,588	6,479,137	8,170,272	13,338,661	23,377,525
		9,843,519	**25,632,651**	**36,291,978**	**57,365,175**	**98,933,007**

A snapshot of forecast aircraft movements over the planning horizon is shown in Table below.

Forecast Aircraft Movements

Code	Airport	2006 AC Movements	2011 AC Movements	2016 AC Movements	2031 AC Movements	2056 AC Movements
KUL	KLIA	183,579	223,119	258,089	347,779	461,363
PEN	Penang	30,967	40,855	51,234	87,169	157,949
LGK	Langkawi	8,147	12,891	16,832	29,662	56,658
KBR	Kota Bharu	10,025	13,914	16,155	20,619	24,464
TGG	Kuala Terengganu	3,880	5,123	5,978	7,738	9,343
AOR	Alor Star	2,873	2,957	3,489	4,665	5,927
KUA	Kuantan	2,768	4,182	4,945	6,652	8,541
SZB	Subang	9,031	5,792	6,725	10,547	15,257
IPH	Ipoh	953	602	696	876	999
MKZ	Malacca	593	779	897	1,194	1,525
BKI	Kota Kinabalu	50,221	57,391	71,823	112,795	202,120
TWU	Tawau	8,024	8,201	9,412	12,352	15,452
SDK	Sandakan	9,740	8,863	10,180	12,554	15,562
LBU	Labuan	9,198	12,740	14,563	17,741	20,341
LDU	Lahad Datu	3,161	2,505	2,883	3,579	4,137
KCH	Kuching	36,991	41,312	53,217	90,953	168,135
MYY	Miri	39,334	40,902	51,831	86,481	164,678
SBW	Sibu	15,079	13,517	15,487	19,145	23,802
BTU	Bintulu	11,188	7,434	8,519	10,433	11,741
LMN	Limbang	4,216	2,559	2,946	3,656	4,225
MZV	Mulu	2,235	1,783	2,052	2,547	2,872
		442,204	**507,422**	**607,953**	**889,137**	**1,375,090**

6.4 CNS Infrastructure

6.4.1 Navigation infrastructure

6.4.1.1 Global Navigation Satellite System (GNSS)

6.4.1.1.1 Global Navigation Satellite System (GNSS) is a satellite-based navigation system utilizing satellite signals, such as Global Positioning System (GPS), for providing accurate and reliable position, navigation, and time services to airspace users. ICAO noted the increased flight safety, route flexibility and operational efficiencies that could be realized from the move to space-based navigation.

6.4.1.1.2 GNSS supports both RNAV and RNP operations. Through the use of GNSS augmentations, GNSS navigation provides sufficient accuracy, integrity, availability and continuity to support en-route, terminal area, and approach operations.

6.4.1.1.3 GNSS augmentations include Aircraft-Based Augmentation System (ABAS), Satellite-Based Augmentation System (SBAS), Ground-Based Augmentation System (GBAS), and Ground-based Regional Augmentation System (GRAS).

6.4.1.1.4 A Ground Based Augmentation System (GBAS) is planned to be installed at Kuala Lumpur International Airport (KLIA) in the medium term implementation plan to accommodate SIDs, STARs and RNP Approaches for the 3 runways.

6.4.1.2 Other PBN navigation infrastructure

7.1.2.1 Other navigation infrastructure includes INS, VOR/DME, DME/DME, and DME/DME/IRU. These navigation infrastructures will satisfy the requirements of RNAV navigation specifications, but not those of RNP.

6.4.1.2.2 INS may be used to support PBN en-route operations with RNAV-10 and RNAV-5 navigation specifications.

6.4.1.2.3 VOR/DME will be used to support PBN en-route and STAR operations based on the RNAV-5 navigation specification.

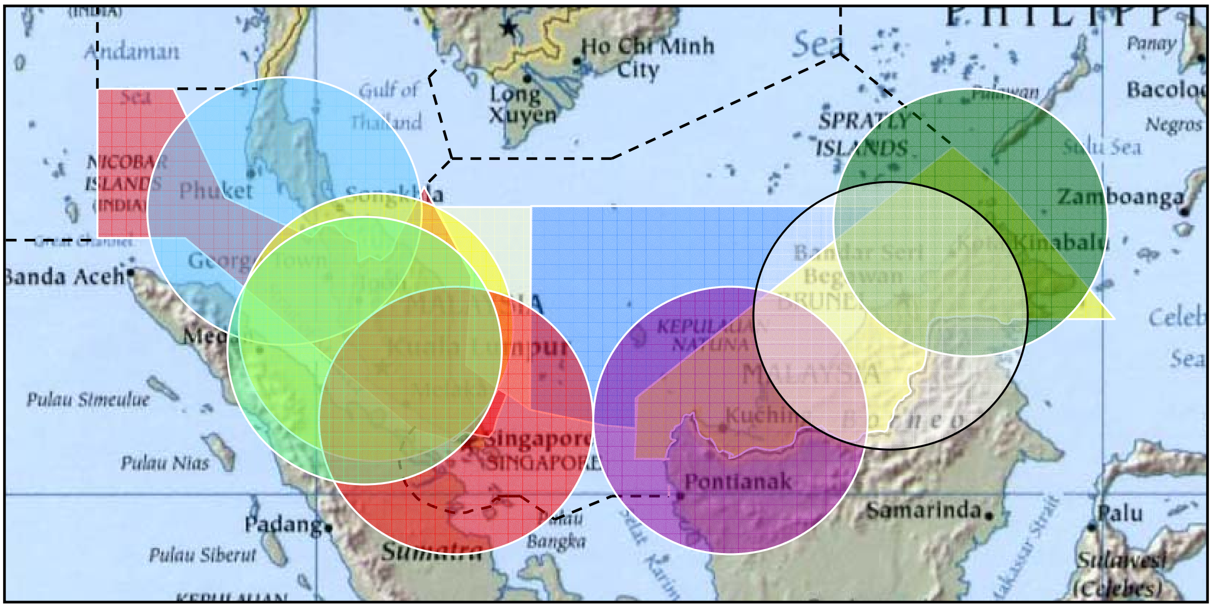
6.4.1.2.4 Uses of DME/DME and DME/DME/IRU will support PBN en-route and terminal area operations based on RNAV-5, RNAV-2 or RNAV-1 navigation specifications.

6.4.1.2.5 The list of VOR/DME currently available in Kuala Lumpur FIR and Kinabalu FIR is attached on Appendix Y.

6.4.2 Surveillance infrastructure

6.4.2.1 For RNAV operations, sufficient surveillance coverage will be provided to assure the safety of the operations. For RNP operations, surveillance coverage is not required.

6.4.2.2 Currently, Radar services are available covering over the land area and Automatic Dependant Surveillance (ADS) is available over Bay of Bengal in Kuala Lumpur FIR. (Surveillance infrastructure in Appendix H)



Radar coverage over land area in KL and KK FIRs

6.4.3 Communication infrastructure

6.4.3.1 Implementation of RNAV/RNP routes includes communication requirements.

6.4.3.2 Currently, VHF Air-Ground radio communication is covering over land route. HF services are available over Oceanic area beyond VHF coverage. CPDLC is available over Bay of Bengal. (Refer Appendix H)

7. Implementation Plan for Performance Based Navigation

7.1 ATM Operational Requirements

7.1.1 The Global ATM Operational Concept (Doc 9854) makes it necessary to adopt an airspace concept able to provide an operational scenario that includes Route networks, Minimum separation standards, assessment of obstacle clearance, and a CNS infrastructure that satisfies specific strategic objectives, including safety, access, capacity, efficiency, and environment.

7.1.2 In this regard, the following programs will be developed:

a) traffic and cost benefit analysis
b) necessary updates on automation
c) operational simulations in different scenarios
d) ATC personnel training
e) Flight plan processing

f) Flight procedure design training to include PBN concepts and ARINC-424 coding standard

g) Enhanced electronic data and processes to ensure appropriate level of AIS data accuracy, integrity and timeliness

h) WGS-84 implementation in accordance with ICAO Annex 15

i) uniform classification of adjacent and regional airspaces, where practicable

j) RNAV/RNP applications for SIDs and STARs

k) Coordinated RNAV/RNP routes implementation

l) RNP approach with vertical guidance

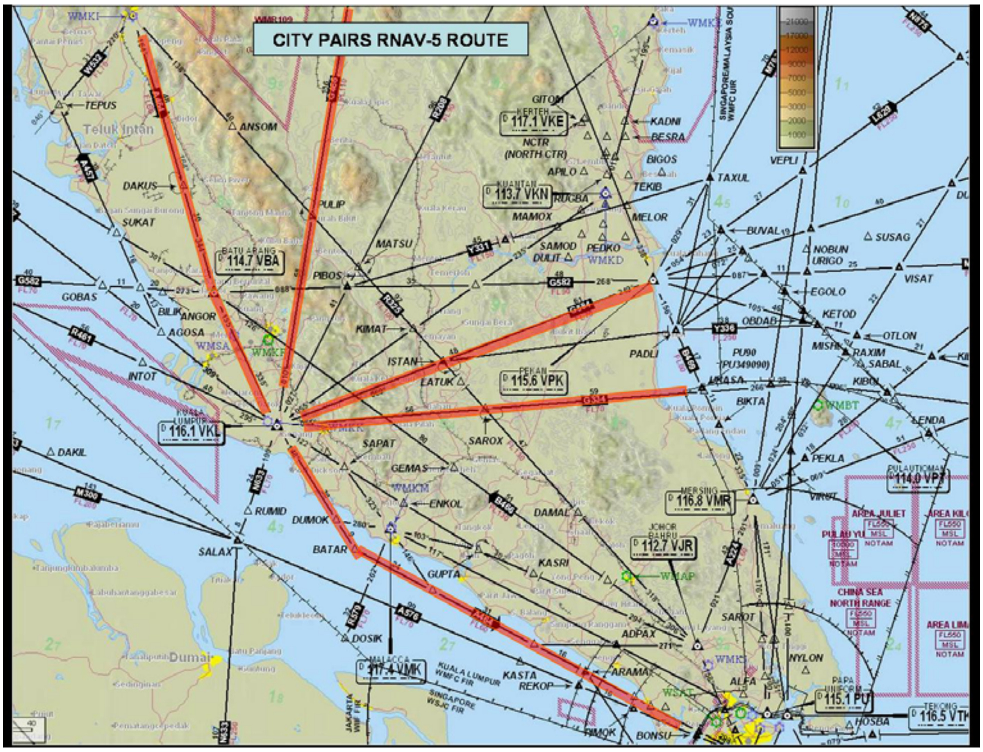
7.2 Short Term Implementation Plan

7.2.1 Route Operations

7.2.1.1 During the planning phase of the implementation of PBN routes, inputs from all aviation stakeholders will be gathered to obtain operational needs and requirements. These needs and requirements will be used to derive airspace concepts and to select appropriate PBN navigation specification.

7.2.1.2 The application of RNAV-10 navigation specifications has been implemented for Oceanic routes and RNP-4 will be considered in the near future. Prior to implementation of RNP-4, air traffic demands, ATC workload, and fleet readiness statistics will be considered and all stakeholders will be consulted.

7.2.1.3 For other routes on key traffic flows and city pairs, the application of RNAV-5 navigation specifications is expected. The international routes identified are from KLIA to Singapore, Bangkok, Jakarta and Ho Chi Minh City. The domestic route will be from KLIA to Kuching and Kota Kinabalu.



7.2.2 TMA Operations

7.2.2.1 In several TMAs i.e. Kuala Lumpur TMA, Johor TMA, Kuching TMA and Kota Kinabalu TMA, the application of RNP-1 and RNAV-1 in a radar environment will be implemented with the support through the use of GNSS. In this short term phase, mixed operations (equipped and non-equipped) will be permitted.

7.2.3 Instrument Approaches

7.2.3.1 The application of RNP APCH with Baro-VNAV procedures will be implemented at major airports, primarily international airports. Conventional approach procedures and conventional navigation aids will be maintained for non-equipped aircraft. ILS currently available at all instrument airports is expected to be satisfactorily operational for the next 10 years (Refer Appendix F). RNP AR APCH procedures will be introduced in selected airports where operational benefits can be obtained.

Summary table & Implementation targets

Short Term (2012-2015)		
Airspace	**Preferred Nav. Specifications**	**Acceptable Nav. Specifications**
Route – Oceanic	RNP-4	RNAV-10
Route – Domestic en-route (City pair)	RNAV-5	
TMA – Arrival	RNP-1 or RNAV-1 in radar environment and with adequate navigation infrastructure.	
TMA – Departure	RNP-1 or RNAV-1 in radar environment and with adequate navigation infrastructure.	
Approach	RNP APCH LNAV/VNAV RNP AR APCH if beneficial RNP 0.3 for helicopters	

Implementation Targets

- RNP APCH (with Baro VNAV) in 30% of instrument runways by 2014 and 70% by 2016 and prioroty will be given to airports with operational benefits
- RNAV-1 SID/STAR for 30% of international airports by 2014 and 70% by 2016
- Re-defining existing RNAV/RNP routes into PBN navigation specification by 2016
- Implementation of additional RNAV/RNP routes

7.3 Medium Term Implementation Plan

7.3.1 Route Operations

7.3.1.1 The implementations of all existing RNAV/RNP routes are consistent with PBN navigation specifications and separation standards. Implementations of additional RNAV/RNP routes will be considered.

7.3.1.2 With the utilization of ADS and CPDLC, the application of RNP routes in the Oceanic airspace is expected. This will permit the use of smaller lateral and longitudinal separation, such as 30 NM based on the RNP 4 navigation specification. The fleet readiness status will be considered during the planning.

7.3.1.4 In this phase, the establishment of a backup system in case of GNSS failure or the development of contingency procedures is necessary.

7.3.2 TMA Operations

7.3.2.1 It is expected that the application of RNP-1 will be expanded in selected TMAs especially KL TMA, KK TMA and Kuching TMA. The application of RNP-1 will depend on GNSS availability and aircraft navigation capability. In TMAs of high air traffic complexity and movement, the use of RNP-1 equipments will be mandatory. In TMAs of less air traffic complexity, mixed operations will be permitted (equipped or non-equipped).

7.3.3 Instrument Approaches

7.3.3.1 In this phase, the application of RNP APCH with Baro-VNAV in major international airports is expected. These applications may also serve as a back-up to precision approaches and provide vertical guided approaches for the runways without precision approach capability.

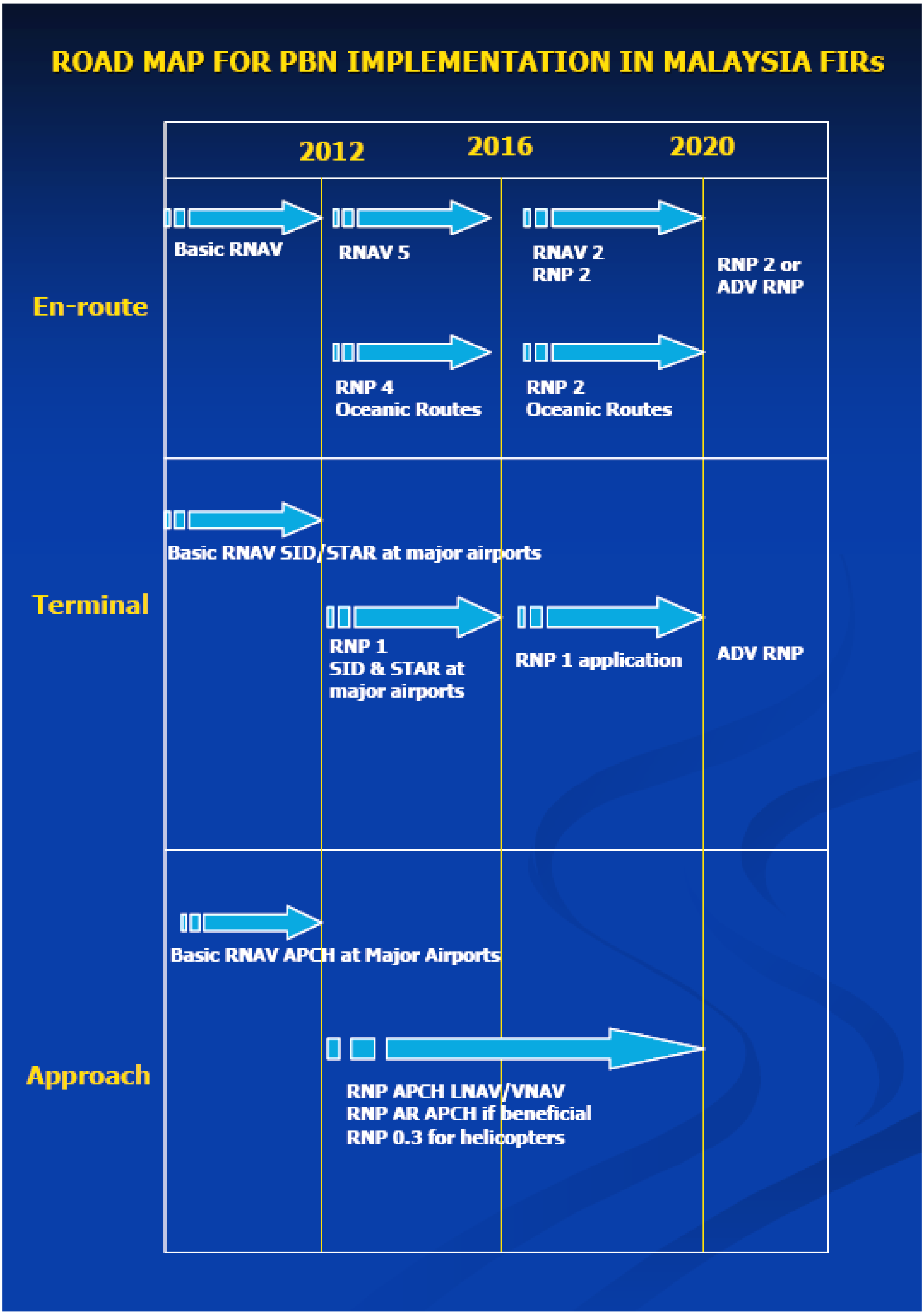
7.3.3.2 The extended application of RNP AR Approaches will be considered for airports where there are operational benefits.

Summary table & Implementation targets

Medium Term (2016-2019)		
Airspace	**Preferred Nav. Specification**	**Acceptable Nav. Specification**
Route – Oceanic	RNP-4	RNP-4, RNAV-10
Route – Domestic en-route	RNP 2	RNAV-2, RNAV-5
TMA – Arrival	RNP-1 application	
TMA – Departure	RNP-1 application	
Approach	RNP APCH (with Baro-VNAV) RNP AR APCH where there are operational benefits	

Implementation Targets

- RNP APCH with Baro-VNAV in 80% of instrument runways by 2018
- RNAV-1 or RNP-1 SID/STAR for 80% of international airports by 2018
- RNAV-1 or RNP-1 SID/STAR for 80% of busy domestic airports where there are operational benefits
- Implementation of additional RNAV/RNP routes


ROAD MAP FOR PBN IMPLEMENTATION IN MALAYSIA FIRs
2012
2016
2020
En-route
Basic RNAV
RNAV 5
RNAV 2
RNP 2
RNP 2 or
ADV RNP
RNP 4
Oceanic Routes
RNP 2
Oceanic Routes
Terminal
Basic RNAV SID/STAR at major airports
RNP 1
SID & STAR at
major airports
RNP 1 application
ADV RNP
Approach
Basic RNAV APCH at Major Airports
RNP APCH LNAV/VNAV
RNP AR APCH if beneficial
RNP 0.3 for helicopters

7.4 Long Term Implementation Strategies (2020 and beyond)

7.4.1 In this phase, GNSS is expected to be a primary navigation infrastructure for PBN implementation. Malaysia will work co-operatively on a regional basis to implement GNSS in order to facilitate seamless and inter-operable systems and undertake coordinated research and development programs on GNSS implementation and operation.

7.4.2 Moreover, during this phase, Malaysia will consider segregating traffic according to navigation capability and granting preferred routes to aircraft with better navigation performance.

7.4.3 With the expectation that precision approach capability using GNSS and its augmentation systems will become available, Malaysia will explore the use of such capability where there are operational and financial benefits.

8. Transitional Strategies

8.1 During transition to PBN, sufficient ground infrastructure for conventional navigation systems will remain available to serve non-equipped flights. Before existing ground infrastructure is considered for removal, users will be given reasonable transition time to allow them to equip appropriately to attain equivalent PBN-based navigation performance. Malaysia will approach removal of existing ground infrastructure with caution to ensure that safety is not compromised. Performance of safety assessment and consultation with users through regional air navigation planning process will be necessary.

8.2 Malaysia will coordinate to ensure that harmonized separation standards and procedures are developed and introduced concurrently in all flight information regions along major traffic flows to allow for a seamless transition towards PBN.

8.3 Malaysia will cooperate on a multinational basis to implement PBN in order to facilitate seamless and inter-operable systems and undertake coordinated research and development programs on PBN implementation and operation.

8.4 Malaysia will consider segregating traffic according to navigation capability and granting preferred routes to aircraft with better navigation performance, taking due consideration of the needs of State/Military aircraft.

8.5 Malaysia will encourage operators and other airspace users to equip with PBN-capable avionics. This can be achieved through early introductions of RNP approaches, preferably those with vertical guidance.

9. Safety Assessment & Monitoring Requirements

9.1 Need for a safety assessment

9.1.1 To ensure that the introduction of PBN applications within Malaysia FIR is undertaken in a safe manner, in accordance with relevant ICAO provisions, implementation shall only take place following conduct of a safety assessment that has demonstrated that an acceptable level of safety will be met. This assessment may also need to demonstrate that levels of risk associated with specific PBN implementations are acceptable. Additionally, ongoing periodic safety reviews will be undertaken where required in order to establish that operations continue to meet acceptable levels of safety.

9.2 Undertaking a safety assessment

9.2.1 DCA Malaysia will ensure that a safety assessment and, where required, ongoing monitoring of the PBN implementations are conducted. DCA Malaysia may seek assistance from other relevant body in the government agencies i.e. institutional department to undertake such activities.

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Appendix A

IATA Traffic Forecast

By 2010 Asia will be the largest single market for aviation - IATA 27th Feb 2008. Globally predicted passenger traffic will rise by 4.9 per cent per year between 2007 and 2026, almost trebling in two decades as jet planes got bigger and more people flew on them. Meanwhile airfreight will rise by 5.8 per cent annually in the same period. The greatest demand will come from the Asia-Pacific region, where airlines will take delivery of 31 per cent of new planes in the next 20 years, compared with 24% for Europe and 27% for North America.

Passenger

Asia Pacific airlines saw a marginal drop in demand growth from 6.2 per cent in December 2007 to 5.7 per cent in January 2008. Currently, airlines in the region benefited from increased competitiveness due to the strong Euro and the booming economies of both India and China.

Cargo

Steady year-on-year airfreight growth of 4.5 per cent was recorded in January 2008. In the larger freight markets there is continued strength. Asia Pacific airlines saw demand increase 6.5 per cent, up from 6 per cent in December 2007, boosted by the booming economies in China and India.

For the period 2002-2020 aircraft movements are expected to increase at an annual growth rate of 5.4 per cent, to reach almost 294 thousand aircraft movements by the year 2020. Average annual growth rates of 6.5, 5.7 and 5.2 per cent are forecast for the periods 2005 - 2010, 2010-2015 and 2015 - 2020, respectively.

TRANSPACIFIC PASSENGER FORECAST			
Average Annual Percentage Growth Rates			
Low	Medium	High	
2005-2010	5.3	6.5	7.8
2010-2015	4.5	5.7	7.0
2015-2020	4.0	5.2	6.5
2002-2020	4.1	5.4	6.7

The Intra-Asia/Pacific passenger aircraft movements are expected to increase at an average annual growth rate of 4.6 per cent to the year 2020. The growth rates for the intermediate periods of 2005-2010, 2010- 2015 and 2015-2020 are 5.0, 4.3 and 4.2 per cent, respectively.

INTRA ASIA /PACIFIC AIRCRAFT MOVEMENT FORECAST			
Average Annual Percentage Growth Rates			
Low	Medium	High	
2005-2010	3.6	5.0	5.5
2010-2015	3.1	4.3	5.2
2015-2020	3.1	4.2	5.2
2002-2020	3.3	4.6	5.6

New Aircraft Deliveries by Region

Record new aircraft orders were placed by the airline industry in 2005 – 2007. The large numbers of new orders represent strong confidence in the future prospects of the global airline industry. In its latest forecast of aviation growth, European aircraft maker Airbus said the world's fleet of large passenger jets (of more than 100 seats) would double in the next 20 years to nearly 33,000. The greatest demand will come from the Asia-Pacific region, where airlines will take delivery of 31 per cent of new planes in the next 20 years, compared with 24 per cent for Europe and 27 per cent for North America.

New Aircraft Deliveries by Region	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012+**
	Existing						
Africa	**665**	**26**	**15**	**20**	**16**	**13**	**28**
Asia Pacific	**3,578**	**329**	**428**	**407**	**344**	**267**	**440**
Europe	**5,301**	**292**	**348**	**364**	**251**	**153**	**297**
Latin America/Caribbean	**1,031**	**93**	**91**	**45**	**66**	**43**	**65**
Middle East	**626**	**41**	**57**	**44**	**36**	**27**	**164**
North America	**6,987**	**240**	**293**	**309**	**222**	**163**	**412**
Total	**18,188**	**1,026**	**1,237**	**1,208**	**944**	**679**	**1,551**
Increase in Global aircraft fleet (%)	**4.2**	**4.9**	**4.6**	**4.9**	**3.4**	**2.4**	**2.4**

Appendix B

Malaysia Airlines – Aircraft Readiness 2012

Malaysia Airlines Fleet Size and PBN Capability										
	A380	B744	B744F	B777	A330 Old	A330 New	A332F	A332	B738	B734
RNP10	2	6	2	17	5	10	4	3	27	
RNAV5	2	6	2	17	5	10	4	3	27	23
RNAV1&2	2	6	2	17	5	10	4	3	27	23
RNP1	2	6	2	17	5	10	4	3	27	
RNAV IAP	2	6	2	17	5	10	4	3	27	
By End of 2013										
Fleet size	6	0	2	14	0	15	4	0	45	0
New Ops Specs Applications										
RNP4	6		2	14		15	4		45	
RNP APCH LNAV	6		2	14		15	4		45	
RNP APCH LNAV/VNAV	6		2	14		15	4		45	

Appendix C

AIR ASIA – Aircraft Readiness 2012

Malaysia AirAsia and AirAsia X's PBN Ops Spec 2012			
	A320-214 & 216	A330-300	A340-300
RNP10	59	9	2
RNAV5	59	9	2
RNAV1&2	59		
RNP1	59		2

Appendix D

Transmile Air Services Sdn. Bhd.

Attachment for
TAIR/TRG/ADMIN
Dated 28 Apr 2009

PBN IMPLEMENTATION
STATISTIC ON FLEET READINESS

No	Acft Type	Qty	RNAV/RNP Equipage	RNAV 10	RNAV 5	RNAV 2	RNAV 1	RNP 4	RNP 1	RNP 0.3
1	MD-11	4	Honeywell GNSSU P/N HG2021MO1	Yes	Yes	No	No	No	No	No
2	B727-200	9	GPS Trimble Free Flight 2100	Yes	Yes	No	No	No	No	No
3	B737-200	3	GPS Trimble Free Flight 2100	Yes	Yes	No	No	No	No	No

Note:

a. All Transmile MD-11 aircrafts are RNP-10 and BRNAV (RNAV 5) approved ONLY. Based on Boeing Service Letter MD11-SL-02-101 dated 4 June 03, Transmile MD-11 aircrafts are also PRNAV (RNP 1) compliance but Transmile never apply for MD-11 PRNAV approval from DCAM.

b. For B727 and B737, all aircrafts are RNAV approved using GPS Trimble Free Flight 2100. 06 X B727 (Ex-UPS aircrafts) are in process to get the RNP-10 approval. These aircrafts will be installed with Free Flight 2101 I/O Approach Plus GPS system (which coupled to HSI) for RNP-10 compliance. Please note that 2101 I/O Approach Plus GPS system is also comply for BRNAV (RNAV 5).

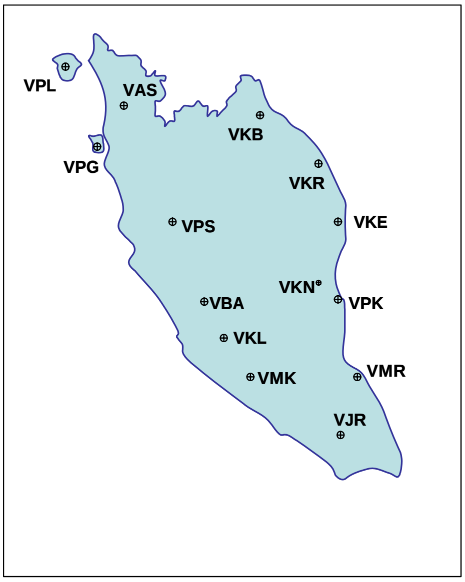
Appendix E

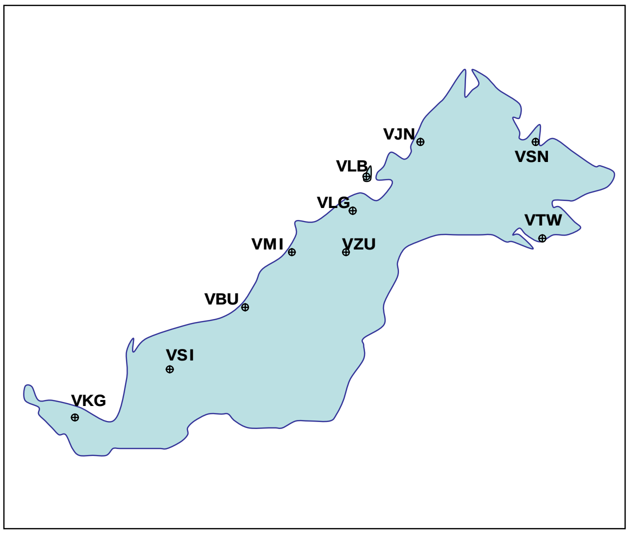
Other Air Operator Fleet Readiness 2012

NEPTUNE AIR (Cargo)			
	B727 - 277	B737 - 300	
RNP10	1	1	
RNAV5			
RNAV1&2			
RNP1			

Appendix F

VOR/DME IN KUALA LUMPUR & KOTA KINABALU FIR (2010)



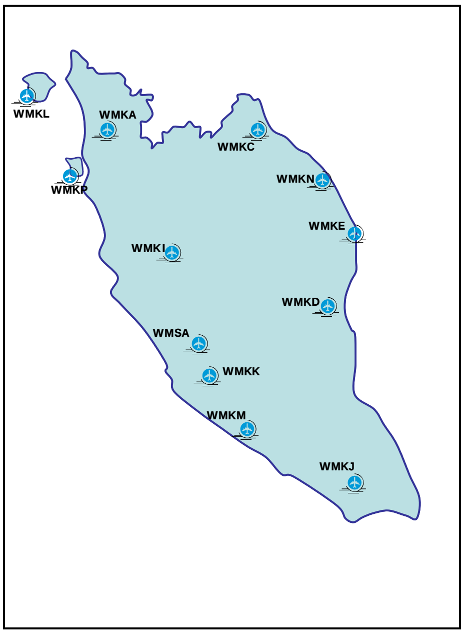


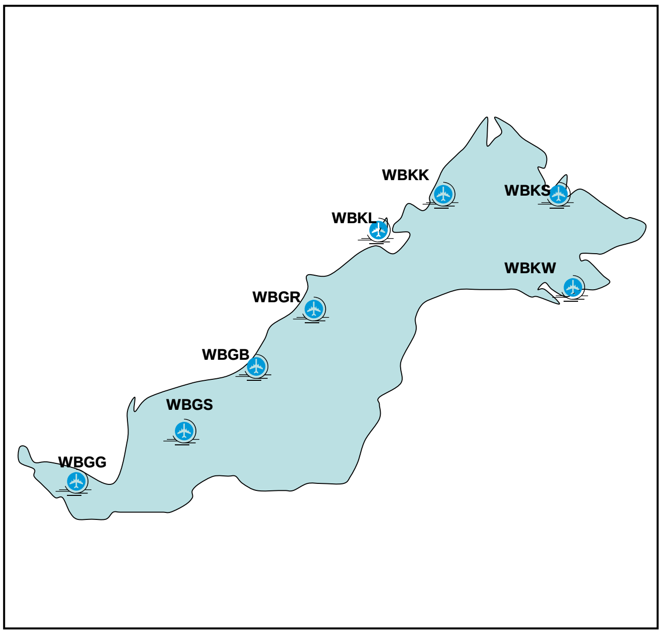
VHF OMNI DIRECTIONAL RADIO RANGE (VOR) & DME

AIRPORT	IDENT	YEAR INSTALLED	AGE (Yr)	REMARKS
ALOR SETAR	VAS	2009	1	
BATU ARANG	VBA	1990	20	New replacement in 2011
BUTTERWORTH	VBT			
IPOH TERMINAL	VIH			
JOHOR BARU	VJR	1994	16	New replacement in 2011
KERTEH	VKE	2000	10	
KOTA BHARU	VKB	1996	14	
K. TERENGGANU	VKR	2009	1	
KUANTAN	VKN	2010	0	DVOR/TAC
PEKAN	VPK	2007	3	
MERSING	VMR	1996	14	
MELAKA	VMK	1996	14	
PENANG	VPG	1995	15	New replacement in 2011
P.LANGKAWI	VPL	1997	13	
PUSING (IPOH)	VPS	1994	16	
KLIA	VKL	2008	2	
TULAI (TIOMAN)	VPT	1996	14	
K.KINABALU	VJN	2009	1	
SANDAKAN	VSN	1998	12	
TAWAU	VTW	1998	12	
KUCHING	VKG	2009	1	
MIRI	VMI	1995	15	
SIBU	VSI	2005	5	
LABUAN	VLB	1994	16	
BINTULU	VBU	2003	7	
LIMBANG	VLG	2004	6	
MULU	VZU	2003	7	

Appendix G

AERODROME WITH INSTRUMENT LANDING SYSTEM (2010)

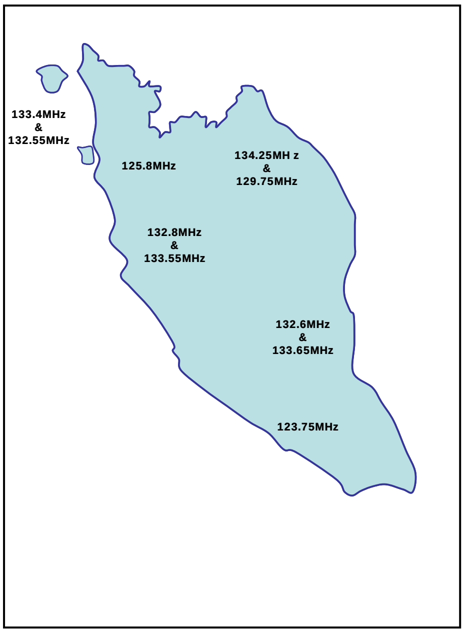




INSTRUMENT LANDING SYSTEM (ILS)

NO.	AIRPORT	RWY	YEAR INSTALLED	AGE (Yr)
1	JOHOR BAHRU	16	1996	14
2	KLIA SEPANG	32L	1997	13
3	KLIA SEPANG	32R	1997	13
4	KLIA SEPANG	14L	1997	13
5	KLIA SEPANG	14R	1997	13
6	LANGKAWI	03	1995	15
7	PENANG	04	1996	14
8	KUCHING	25	2000	10
9	KOTA KINABALU	02	2010	1
10	ALOR STAR	04	2006	4
11	KOTA BHARU	10	2005	5
12	KUANTAN	36	1992	18
13	IPOH	04	1992	18
14	KERTEH	34	2002	8
15	MELAKA	03	2010	1
16	K. TERENGGANU	04	2008	2
17	SUBANG	15	2005	5
18	BINTULU	17	2003	7
19	MIRI	02	1994	16
20	SIBU	13	2005	5
21	LABUAN	14	2008	2
22	SANDAKAN	08	1994	16
23	TAWAU	24	2001	9
24	SUBANG	33	1996	14

Appendix H
VHF RADIO COMMUNICATION (ENROUTE) – 2010



KUALA LUMPUR FIR

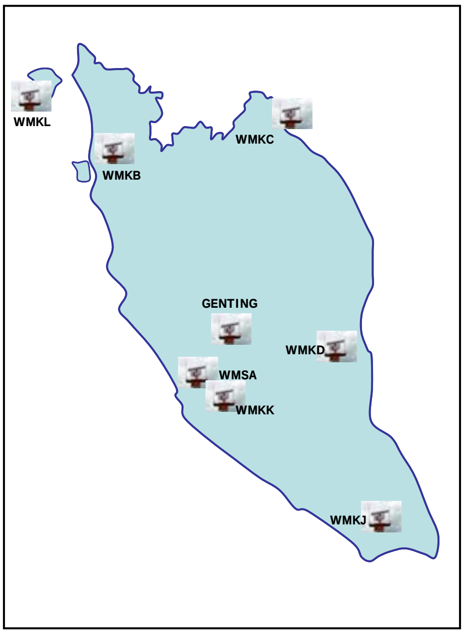
SECTOR	FREQUENCY	
	PRIMARY	SECONDARY
1	132.80	133.55
2	123.75	123.75
3	132.60	133.65
4	133.40	132.55
5	134.25	129.75
		134.25
		(Standby)

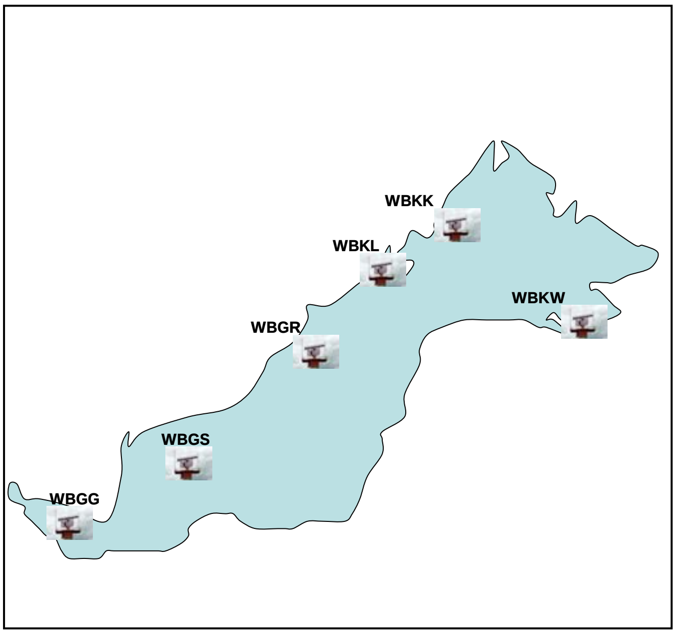
KINABALU FIR

SECTOR	FREQUENCY	
	PRIMARY	SECONDARY
1	126.1	128.3
2	134.5	125.35

Appendix I

SURVEILLANCE INFRASTRUCTURE – RADAR STATION (2010)





NO.	RADAR HEAD	YEAR INSTALLED	SSR/PSR	AGE (Yr)
1	SUBANG	1994	SSR/PSR	16
2	GENTING HIGHLAND	1995	SSR	15
3	KLIA	1996	SSR/PSR	14
4	TRAD (KLIA)	1996	SSR/PSR	14
5	BUTTERWORTH		SSR/PSR	
6	LANGKAWI	1995	SSR/PSR	15
7	KUANTAN		SSR/PSR	
8	JOHOR BAHRU	2007	SSR/PSR	3
9	KOTA BHARU	2007	SSR/PSR	3
10	KUCHING	1996	SSR/PSR	14
11	SIBU	2010	SSR/PSR	1
12	MIRI	2003	SSR/PSR	7
13	LABUAN		SSR/PSR	
14	KOTA KINABALU	1995	SSR/PSR	15
15	TAWAU	2010	SSR/PSR	0

AUTOMATIC DEPENDENT SURVEILLANCE (ADS)

NO.	AREA	YEAR INSTALLED
1	INDIAN OCEAN	2009
2	TERENGGANU	2010