INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA/PACIFIC SEAMLESS ATM PLAN

Version 2.0, September 2016

This Plan was developed by the Asia/Pacific Seamless ATM Planning Group (APSAPG) and amended by APANPIRG

Approved by APANPIRG/27 and published by the
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SCOPE OF THE PLAN

Plan Structure

1.1 The Seamless Air Traffic Management (ATM) Plan (hereinafter referred to as the 'Plan') references different levels. At the upper level is a global perspective, which is guided mainly by references to the *Global Air Navigation Plan* (GANP, Doc 9750), the *Global ATM Operational Concept* (Doc 9854) and the *Global Aviation Safety Plan* (GASP). Beneath this level is regional planning primarily provided by this Plan and other guidance material, in order to define goals and means of meeting State planning objectives, such as:

- Asia/Pacific Regional Air Navigation Plan (RANP, Doc 9673) objectives;
- the Seamless ATM performance framework, with a focus on technological and human performance within Aviation System Block Upgrade (ASBU) Block 0 elements, non-ASBU elements (mainly emanating from the Concept of Operations – CONOPS, which is regional guidance material endorsed by APANPIRG/22), and civil/military cooperation elements;
- a deployment plan with specific operational improvements, transition arrangements, expected timelines and implementation examples; and
- an overview of financial outcomes and objectives, cross-industry business and performance/risk management planning.

1.2 The Plan incorporated the Asia/Pacific Air Traffic Flow Management (ATFM) Concept of Operations and the Asia/Pacific Air Navigation Concept of Operations (both hereinafter referred to as 'CONOPS'), and the Asia/Pacific PBN Plan, superseding these documents.

1.3 The RANP is expected to incorporate key components of this Plan and information on the mechanisms that enable these objectives to be met. High-level support may be necessary from regional bodies that can effectively support the Plan's implementation, such as the:

- Association of Southeast Asian Nations (ASEAN);
- Asia Pacific Economic Cooperation (APEC); and
- South Asian Association for Regional Cooperation (SAARC).

1.4 The Plan does not use 'continental', 'remote' and 'oceanic' areas to refer to an assumed geographical application area, as many Asia/Pacific States have islands or archipelagos that can support a higher density of Communications, Navigation, Surveillance (CNS) systems than in a purely 'oceanic' environment. In accordance with the CONOPS that air navigation services should be provided commensurate with the capability of the CNS equipment, it is important to categorise airspace in this manner, and simplify the numerous references to this capability throughout the Plan. Thus the Plan categorises airspace by reference to its CNS (Communications, Navigation and Surveillance) capability as:

a) Category R: remote en-route airspace with Air Traffic Services (ATS) HF or CPDLC communications and outside the coverage of ground-based surveillance coverage; or

b) Category S: serviced (or potentially serviced) en-route airspace – by direct (not dependent on a Communication Service Provider (CSP) ATS communications and surveillance; or

c) Category T: terminal operations serviced by direct ATS communications and surveillance.

1.5 The word ‘States’ in the Plan includes Special Administrative Regions and territories.

1.6 The Seamless ATM Plan is expected to be implemented in two phases. Neither phase, nor any element is binding on any State, but should be considered as a planning framework. The Seamless ATM Plan itself is therefore guidance material.

1.7 It was important to note that the Plan’s Phase commencement dates are planning targets, and should not be treated like a ‘hard’ date such as the implementation of Reduced Vertical Separation Minimum (RVSM). In this case, there was a potential major regional problem if all States did not implement at the same time by the specific agreed date, which was clearly not the case for the start of the Plan’s Phase I or II.

1.8 In that regard, although it would be ideal if all States achieved capability on day one of Phase I, this was probably not realistic. However States should consider the impact on stakeholders and improving capacity of the ATM system overall by not achieving target implementation dates. The draft Phase dates were chosen as being an achievable target for the majority of States. However the dates were not designed to accommodate the least capable State, otherwise the region as a whole would fall behind the necessary urgent ATM improvements required by the Director’s General of Civil Aviation and APANPIRG.

1.9 **Appendix E** provides a map of ASBU Elements to Plan references.

Plan Review

1.10 The Plan needs to be updated to take into account ASBU Block 1, 2 and 3 modules, when these modules and their associated technology become mature.

1.11 Periodic updates to the Plan are also required in respect of the economic information contained therein.

1.12 As an iterative process, the Plan requires regular updating to keep current with aviation system changes. It is intended that APANPIRG and its contributory bodies conduct a complete review every three years (or a shorter period determined by APANPIRG) of the Plan to align with the review cycle of the GANP. The Plan and its subsequent revisions should be endorsed by APANPIRG.

1.13 Review of the Navigation and Surveillance strategies needs to result in the update to the Seamless ATM Plan to ensure consistency.

Current review of the Plan 2016, extends the expected implementation date of phase II PARS and PASL items by one year to 07 November 2019, which aligns with the GANP Block 1 implementation. Moreover new ASBU Block 1 elements are added to Phase II: B1-ACDM, B1-SURF, B1-RSEQ, B1-CDO, B1-TBO (only DCL) and B1-NOPS. In addition, new regional items were identified and added: B1-SAR, Ballistic rocket launches/space re-entry management planning, Voice communications over IP between ATS units (VoIP), Common aeRonautical Virtual private network (CRV), Airport Master Plan.

1.14 The planned 2019 review of the Plan will introduce new ASBU Block 1 modules: B1-SWIM, B1-DATM, B1-TBO, B1-RPAS, B1-SNET, B1-FICE, B1- APTA, B1-AMET, B1-WAKE, B1-ASEP. The phase III and phase IV of PARS and PASL implementation framework will be created.

PLAN OBJECTIVES AND DEVELOPMENT

Plan Objective

2.1 The objective of the Plan is to facilitate Asia/Pacific Seamless ATM operations, by developing and deploying ATM solutions capable of ensuring safety and efficiency of air transport throughout the Asia/Pacific region. The Plan provides a framework for a transition to a Seamless ATM environment, in order to meet future performance requirements.

2.2 The Plan provides the opportunity for the Asia/Pacific region to adopt the benefits from research and development conducted by various States including the NextGen programme (United States of America), the European Single European Sky ATM Research (SESAR), and Japanese Collaborative Actions for Renovation of Air Traffic Systems (CARATS).

2.3 ICAO Doc 9854 contains a vision of an integrated, harmonized, and globally interoperable ATM System, with a planning horizon up to and beyond 2025. In this context, the Plan is expected to encourage more partnering relationships among States within sub-regions.

Hierarchy of Plans

2.4 The Plan was developed as part of a suite of Asia/Pacific air navigation plans, and thus, the Plan should not be considered in isolation. The Regional Air Traffic Flow Management (ATFM), Framework, Asia/Pacific ATM Contingency Plan and Asia/Pacific Search and Rescue (SAR) Plan all form part of the aforementioned suite of planning and guidance material connected to the Plan (**Figure 1**).

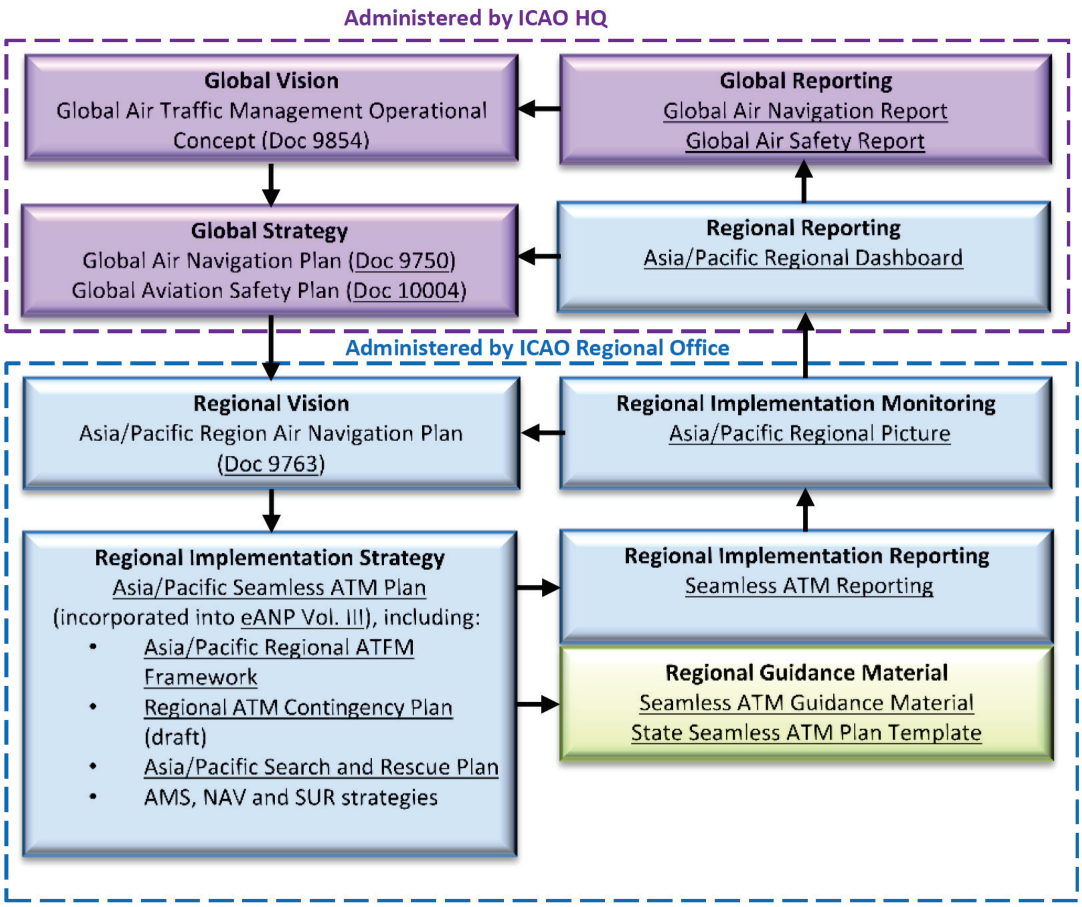


Figure 1: Structure of Global and Regional Planning and Reporting

2.5 This Plan addresses the full range of ATM stakeholders, including civil and military Air Navigation Services Providers (ANSPs), civil and military aerodrome operators as well as civil and military airspace users. The Plan has been developed in consultation with Asia/Pacific States, administrations and also with International Organizations (IO).

Note: civil airspace users include scheduled aviation, business aviation and general aviation.

2.6 States should consult with stakeholders and determine actions, in order to commit to achieving the objectives of Seamless ATM and the requisite performance objectives in the areas of safety, environment, capacity and cost-efficiency that flow from this Plan.

2.7 ASBU Block 0 modules contain technologies, systems and procedures which are expected to be available from 2013. However, the Plan also has references to ASBU Block 1, 2 and 3 modules, which are expected to be available from 2019, 2025 and 2031 respectively. Where such technology, systems, standards and procedures are available earlier than these dates and appropriate deliverables can be provided, the intention was to develop aggressive yet practical implementation schedules within this Plan in order to provide the earliest possible benefits.

2.8 The ICAO *Manual on Global Performance of the Air Navigation System* (ICAO Doc 9883) provides guidance on implementing a performance-oriented ATM System. The *Manual on ATM System Requirements* (ICAO Doc 9882) contains eleven Key Performance Area (KPA) system expectations, as well as a number of general performance-oriented requirements. In accordance with the expectations of these documents, the APSAPG developed the following performance objectives to facilitate Seamless ATM operations:

a) Preferred Aerodrome/Airspace and Route Specifications (PARS); and

b) Preferred ATM Service Levels (PASL).

2.9 The PARS/PASL introduced two Performance Objectives, which incorporate system expectations, such as general performance-oriented requirements. Each performance objective is composed of a list of expectations of different aspects of the aviation system.

2.10 In considering the planning necessary before the PARS/PASL Phase dates, it is important to ensure everyone in the planning process is aware that the necessary groundwork and capability building must take place as a priority, and that full operational capability by the Phase date commencement was a secondary consideration. It is recognised that it is possible a number of States would be working towards implementation during Phase I, in an effort to implement as soon as possible. Therefore it is considered that States in this position should not be identified as ‘deficient’ in regard to applicable elements.

2.11 Prior to implementation, each State should verify the applicability of PARS and PASL by analysis of safety, ATM capacity requirements to meet current and forecast traffic demand, efficiency, predictability, cost effectiveness and environment to meet the expectations of stakeholders. The PARS/PASL elements would be either:

a) not applicable; or

b) already implemented; or

c) not implemented.

2.12 The PARS and PASL are expected to be implemented in three phases, Phase I by 12 November 2015, Phase II by 07 November 2019, and Phase III by 01 December 2022. Recognising the economic and environmental costs associated with delay of system improvement using technologies available today, Phase I was considered to be the earliest date possible for ASBU elements and other non-ASBU elements, which mainly involved procedural changes and human training.

2.13 The PARS contain the expectations for airspace and ATS routes, including aircraft equipage to facilitate Seamless ATM operation, and is therefore a matter for the State regulator or the airspace authority, and is of primary interest to airspace planners, flight procedure designers and aircraft operators.

2.14 The PASL contain the expectations for Air Navigation Service Providers (ANSP), and is therefore a matter for the State regulator or the ATS authority. The PASL is of primary interest to ANSPs and aircraft operators. The PARS and PASL together form the foundation of Seamless ATM development, and as such should be enabled by national regulations, rules and policies wherever applicable to enable a harmonised effort by all stakeholders.

Seamless ATM Definition

2.15 The objective of Seamless ATM was agreed by the Asia/Pacific Seamless ATM Planning Group (APSAPG) as follows:

> *The objective of Seamless ATM is the safe and interoperable provision of harmonized and consistent air traffic management service provided to a flight, appropriate to the airspace category and free of transitions due to a change in the air navigation service provider or Flight Information Region.*

2.16 The APSAPG noted the following description as the CANSO definition of Seamless ATM:

> *Seamless ATM operations is defined as ATM operations in contiguous airspace that is technically and procedurally interoperable, universally safe, and in which all categories of airspace users transition between Flight Information Regions, or other vertical or horizontal boundaries, without requiring a considered action to facilitate that transition and without any noticeable change in:*
>
> *1) Type or quality of service received;*
>
> *2) Air navigation and communications performance standards; and*
>
> *3) Standard practices to be followed.*

2.17 The ICAO Twelfth Air Navigation Conference (AN-Conf/12, Montreal, 19-30 November 2012) endorsed 10 High Level Air Navigation Policy Principles in the GANP, and the Asia/Pacific Seamless ATM Principles are aligned with these high level principles.

EXECUTIVE SUMMARY

Seamless ATM

3.1 ICAO data indicates that the Asia/Pacific Region in 2011 was the busiest in the world in terms of Passenger Kilometres Performed (PKP): 1,496 billion compared to 1,434 for North America and 1,385 for Europe, with growth rates of 8.0 - 8.8%, 2.3 - 3.5% and 4.2 - 4.8% over the 2012-2014 period respectively. In 2015 Asia/Pacific accounted for the highest share of the world capacity offered, and grew by +5.9%. In 2012, the Asia/Pacific region had the largest regional market share of total domestic and international Revenue Passenger Kilometres (RPK) at 30%, compared to 27% for both Europe and North America. **Figure 2, Figure 3** and **Figure 4** indicating the projected air traffic growth which has necessitated the Seamless ATM approach.

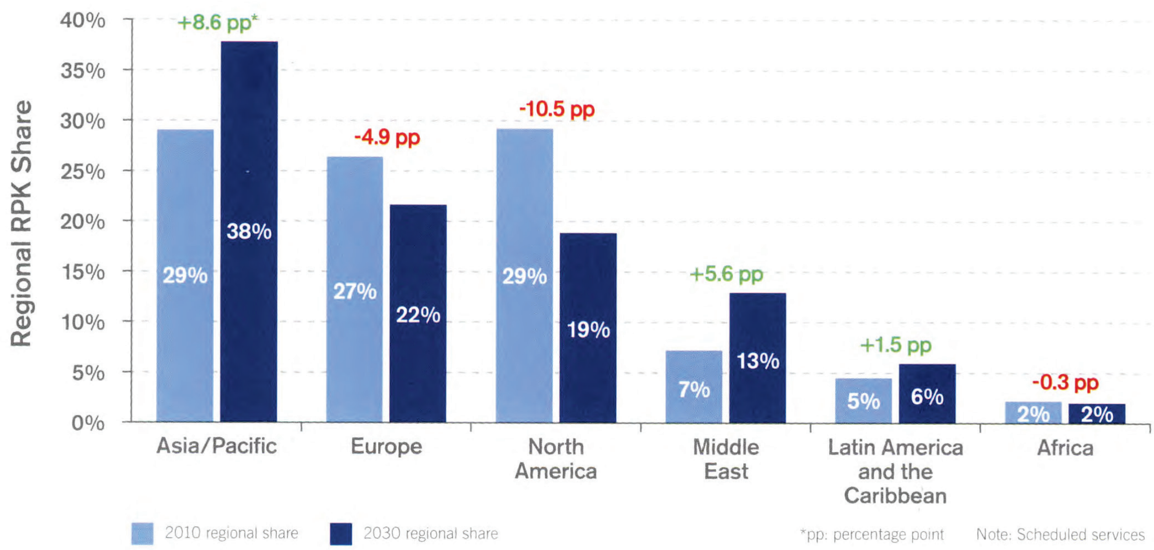


Figure 2: Regional Share of passenger traffic by airline of registration 2030 versus 2010

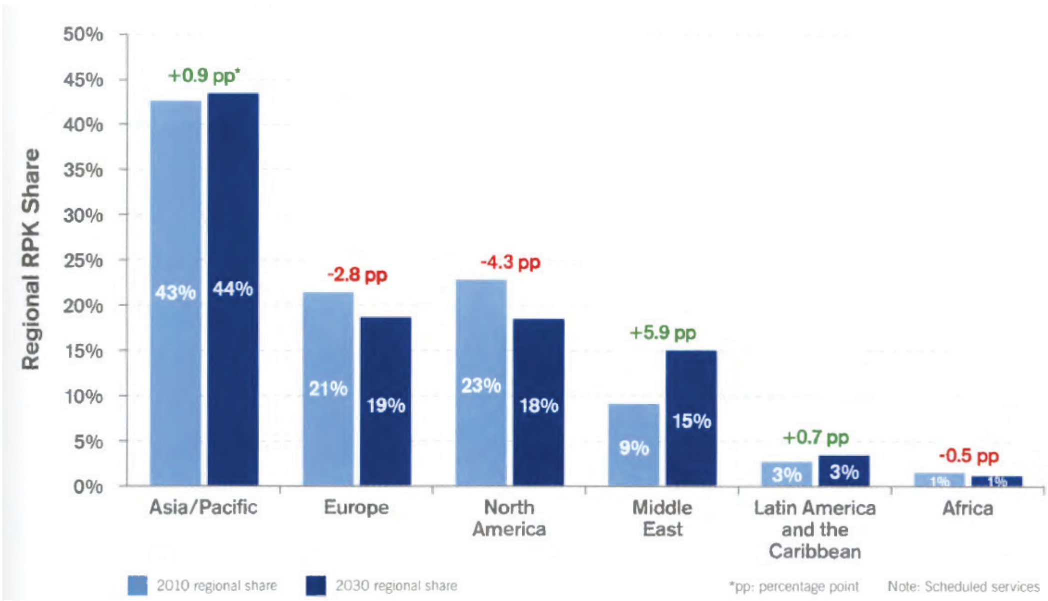


Figure 3: Regional Share of air cargo traffic by airline of registration 2030 versus 2010

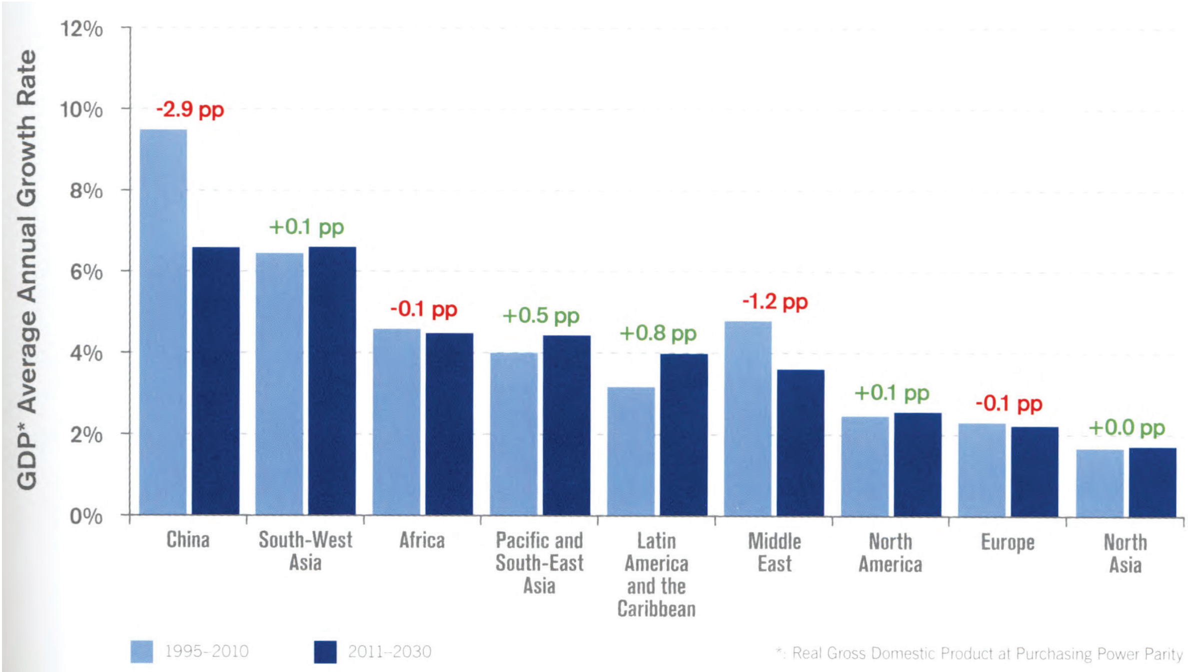


Figure 4: Regional economic growth: history and forecast

3.2 The 46th Directors General Civil Aviation (DGCA) Conference (Osaka, October 2009) was the genesis of Asia/Pacific Seamless ATM discussion, endorsing the Kansai Statement (**Appendix A**). The DGCA Conference requested the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) to take a lead role in development of Seamless ATM in the Asia/Pacific region.

3.3 The ICAO Asia/Pacific (APAC) Seamless ATM Symposium and Ad Hoc Meeting (Bangkok, Thailand, 15 to 17 August 2011) developed:

a) proposed APSAPG objectives;

b) draft Seamless ATM principles;

c) civil/military cooperation Seamless ATM aspects;

d) the requirement for ASBUs to form a key part of Seamless ATM planning; and

e) the requirement for a capabilities matrix to provide a target and means of progressing to the Seamless ATM objectives.

3.4 APANPIRG/22 created the APSAPG in 2011 under Decision 22/56, with a primary goal to develop an Asia/Pacific Seamless ATM Plan.

3.5 The Global Air Navigation Industry Symposium (GANIS, Montréal, 20-23 September 2011) introduced the ASBU concept. This inferred an iterative improvement, from Block 0 (zero) to 3. Although the implementation of all ASBU elements is not mandatory, it is intended to achieve the highest level of conformance; thus supporting global interoperability and Seamless ATM.

3.6 Subject to several recommendations (**Appendix B**), the AN-Conf/12 endorsed the ASBU concept and the consequential changes to the GANP. The AN-Conf/12 stressed that ASBU Block 0 implementation and requirements needed to be coordinated at a regional level based on operational requirements, and that action plans to address identified impediments to ATM modernization should be developed. This Plan is part of the Asia/Pacific strategy to address the requirement for action plans, and to guide Asia/Pacific administrations in their ATM planning.

Air Navigation Service Provider Summary

3.7 The safety and efficiency of flights transcend national borders and airspace boundaries. Seamless ATM is therefore possible only if there is close regional collaboration among States, their ANSPs and all stakeholders. Cooperation is the key to success.

3.8 Given the size and diversity of the region, ATM harmonisation efforts will require the needs of the least developed ANSPs to be addressed especially in the areas of technical assistance such as funding, expertise and training. Differences in economic development may also mean that traffic demands are not uniform in the region, and therefore ATM solutions should be driven by performance requirements appropriate to the traffic demands.

Aerodrome Operator Summary

3.9 Aerodrome operations are a key component for Seamless ATM, especially in regard to infrastructure and operational efficiencies. The collaborative interaction of various stakeholders is important to ensure that aerodrome operations, facilities and equipment are suitable for all aircraft operators. Aerodrome operators require the airspace, ATM, aerodrome and aircraft operations to be cohesive and interoperable. This includes not only the aerodrome movement areas but the terminal and ancillary services, which may include border protection, fuel, baggage and passenger facilitation, which need to be aware of the interaction of their services with the aircraft operations.

3.10 Short, medium and long term aerodrome planning needs to take into account the seamless system so that capital investment is aligned to ATM operational efficiencies. Aerodrome development and airline changes are catalysts for changes driven by the aerodrome operator, but there is a need to ensure en-route and terminal ATS efficiencies are not impacted or lost, due to poor aerodrome infrastructure and operations. A saving in aircraft flight time can easily be eroded by lack of gates, poor taxiway-runway interface and inadequate terminal facilities. Stakeholder involvement and infrastructure changes needs to be coordinated to maximise the efficiencies from a systemic approach to aerodrome, airspace, air traffic management and aircraft operations.

ABBREVIATIONS AND ACRONYMS

AAR	Aerodrome Arrival Rate or Airport Acceptance Rate
ABI	Advanced Boundary Information (AIDC)
ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ACP	Acceptance (AIDC)
ADOC	Aircraft Direct Operating Cost
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
AIDC	ATS Inter-facility Data Communications
AIGD	ICAO ADS-B Implementation and Guidance Document
AIM	Aeronautical Information Management
AIRAC	Aeronautical Information Regulation and Control
AIRD	ATM Improvement Research and Development
AIRMET	Information concerning en-route weather phenomena which may affect the safety of low-level aircraft operations
AIS	Aeronautical Information Service
AIXM	Aeronautical Information Exchange Model
AMAN	Arrival Manager
AMS	Aeronautical Mobile Service
ANSP	Air Navigation Service Provider
AN-Conf	Air Navigation Conference
AOC	Assumption of Control (AIDC)
AOM	Airspace Organization and Management
APAC	Asia/Pacific
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
APCH	Approach
APEC	Asia Pacific Economic Cooperation
APSAPG	Asia/Pacific Seamless ATM Planning Group
APV	Approach with Vertical Guidance
APW	Area Proximity Warning
ASBU	Aviation System Block Upgrade
ASD	Aircraft Situation Display
ASEAN	Association of Southeast Asian Nations
ASMGCS	Advanced Surface Movements Guidance Control Systems
ATC	Air Traffic Control
ATCONF	Worldwide Air Transport Conference
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Service
ATS	Air Traffic Services
ATSA	Air Traffic Situational Awareness
ATM	Air Traffic Management
CANSO	Civil Air Navigation Services Organization
CARATS	Collaborative Actions for Renovation of Air Traffic Systems
CDM	Collaborative Decision-Making
CCO	Continuous Climb Operations
CDO	Continuous Descent Operations
CFIT	Controlled Flight into Terrain
CLAM	Cleared Level Adherence Monitoring
COM	Communication
CONOPS	Concept of Operations
CNS	Communications, Navigation, Surveillance
CPAR	Conflict Prediction and Resolution

CPDLC	Controller Pilot Data-link Communications
CPWG	Cross-Polar Working Group
CSP	Communication Service Provider
CTA	Control Area
CTR	Control Zone
DARP	Dynamic Airborne Re-route Planning
DGCA	Conference of Directors General of Civil Aviation
DMAN	Departure Manager
DME	Distance Measuring Equipment
EST	Coordinate Estimate
FAA	Federal Aviation Administration
FDPS	Flight Data Processing System
FIR	Flight Information Region
FIRB	Flight Information Region Boundary
FL	Flight Level
FLAS	Flight Level Allocation Scheme
FLOS	Flight Level Orientation Scheme
FRMS	Fatigue Risk Management System
FUA	Flexible Use Airspace
GANIS	Global Air Navigation Industry Symposium
GANP	Global Air Navigation Plan
GASP	Global Aviation Safety Plan
GBAS	Ground-based Augmentation System
GDP	Gross Domestic Product
GLS	GBAS Landing System
GNSS	Global Navigation Satellite System
GPI	Global Plan Initiative
HF	High Frequency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMC	Instrument Meteorological Conditions
INS	Inertial Navigation Systems
IO	International Organizations
IPACG	Informal Pacific ATC Coordinating Group
ISPACG	Informal South Pacific ATS Coordinating Group
ITP	In-Trail Procedure
IWXXM	ICAO meteorological information exchange model
KPA	Key Performance Area
LNAV	Lateral Navigation
LVO	Low Visibility Operations
MET	Meteorological
METAR	Aerodrome routine meteorological report *(in meteorological code)*
MLAT	Multilateration
MSAW	Minimum Safe Altitude Warning
MTF	Major Traffic Flow
MWO	Meteorological Watch Office
NAV	Navigation
NextGen	Next Generation Air Transportation System
OPMET	Operational Meteorological*(information)*
OLDI	On-Line Data Interchange
OTS	Organised Track System
PACOTS	Pacific Organized Track System
PARS	Preferred Aerodrome/Airspace and Route Specifications
PASL	Preferred ATM Service Levels

PBN	Performance-based Navigation
PIA	Performance Improvement Area
PKP	Passenger Kilometres Performed
PVT	Passenger Value of Time
RAIM	Receiver Autonomous Integrity Monitoring
RAM	Route Adherence Monitoring
RANP	Regional Air Navigation Plan
RPAS	Remotely Piloted Aircraft System
RPK	Revenue Passenger Kilometres
RNAV	Area Navigation
RNP	Required Navigation Performance
RVSM	Reduced Vertical Separation Minimum
SAARC	South Asian Association for Regional Cooperation
SATVOICE	Satellite Voice Communications
SAR	Search and Rescue
SBAS	Satellite-based Augmentation System
SCS	South China Sea
SESAR	Single European Sky ATM Research
SHEL	Software, Hardware, Environment and Liveware
SID	Standard Instrument Departure
SIGMET	Information concerning en-route weather phenomena in the atmosphere which may affect the safety of aircraft operations
SPECI	Aerodrome special meteorological report
STAR	Standard Terminal Arrival Route or Standard Instrument Arrival (Doc 4444)
STCA	Short Term Conflict Alert
STS	Special Handling Status
SUA	Special Use Airspace
SUR	Surveillance
SWIM	System-Wide Information Management
TAF	Aerodrome Forecast
TAWS	Terrain Awareness Warning Systems
TBO	Trajectory Based Operations
TCAC	Tropical Cyclone Advisory Centre
TCAS	Traffic Collision Avoidance System
TOC	Transfer of Control
UAS	Unmanned Aircraft Systems
UAT	Universal Access Transceiver
UPR	User Preferred Routes
VHF	Very High Frequency
VAAC	Volcanic Ash Advisory Centre
VMC	Visual Meteorological Conditions
VNAV	Vertical Navigation
VOLMET	Meteorological information for aircraft in flight
VOR	Very High Frequency Omni-directional Radio Range
VSAT	Very Small Aperture
WAFC	World Area Forecast Centre

BACKGROUND INFORMATION

Principles

5.1 There were considered to be three major areas of Seamless ATM Principles, involving People (human performance), Facilities (physical equipment), and Technology and Information. The 37 Principles agreed by APSAPG and endorsed by APANPIRG are included as **Appendix C**.

Aviation System Block Upgrade (ASBU)

5.2 At the Global level, ICAO started the ASBU initiative as a programme framework that developed a set of aviation system solutions or upgrades intended to exploit current aircraft equipage, establish a transition plan and enable global interoperability. ASBUs comprised a suite of modules organised into flexible and scalable building blocks, where each module represented a specific, well bounded improvement. The building blocks could be introduced and implemented in a State or a region depending on the need and level of readiness, while recognizing that all the modules were not required in all airspaces. ASBUs described a way to apply the concepts defined in the Doc 9854 with the goal of implementing regional performance improvements, and were used in the new edition of the GANP to guide implementation. AN-Conf/12 agreed that the ASBUs and the associated technology roadmaps were integral parts of the GANP and a valuable implementation tool kit.

5.3 ICAO estimated that US$120 billion would be spent on the transformation of air transportation systems in the next decade. While NextGen and SESAR accounted for a large share of this spending, parallel initiatives were underway in many areas including the Asia/Pacific region, North and Latin America, Russia, Japan and China. ATM modernization is a very complex but necessary task, given the benefit of these initiatives as traffic levels increased. It is clear that to safely and efficiently accommodate the increase in air traffic demand — as well as respond to the diverse needs of operators, the environment and other issues, it is necessary to renovate ATM systems, in order to provide the greatest operational and performance benefits.

5.4 ASBU are comprised of a suite of modules, each having the following qualities:

- a clearly-defined measurable operational improvement and success metric;
- necessary equipment and/or systems in the aircraft and on the ground along with an operational approval or certification plan;
- standards and procedures for both airborne and ground systems; and
- a positive business case over a clearly defined period of time.

5.5 ASBU are divided into four Performance Improvement Areas (PIA):

- PIA 1: Airport Operations;
- PIA 2: Globally Interoperable Systems and Data – *Through Globally Interoperable System Wide Information Management*;
- PIA3: Optimum Capacity and Flexible Flights – *Through Global Collaborative ATM*; and
- PIA 4: Efficient Flight Path – *Through Trajectory-based Operations.*

Asia/Pacific ASBU Implementation

5.6 ASBU Block 0 modules were incorporated into the Seamless ATM framework used to assess the uptake by Asia/Pacific States.

5.7 **Table 1** provides a summary of the Block 0 and 1 elements, and the expected priority for implementation within the Asia/Pacific region as discussed and agreed by APSAPG/2 (Tokyo, 6-10 August 2012). The allocation of priority was based on factors including its importance in promoting Seamless ATM (Priority 1 = critical upgrade, Priority 2 = recommended upgrade, Priority 3 = may not be universally implemented). A cost-benefit or economic analysis before implementation was identified as essential to determine whether to implement B0-SURF, B0-ASUR and B0-ACAS, but should not preclude an economic analysis of other elements as determined by the State.

5.8 The priorities were updated in accordance with input from the APANPIRG Chair's Meeting which recognised B0-APTA as a regional priority, and the Regional Aviation Safety Group, which agreed that B0-SNET B0-ACAS and B0-AMET were critical safety barriers for Control Flight into Terrain (CFIT), Runway Safety (RS) and Loss of Control (LOC).

PIA	Element	Economic Analysis	Priority
PIA 1	B0-APTA Optimization Of Approach Procedures Including Vertical Guidance	-	1
	B0-ACDM Improved Airport Operations Through Airport-Collaborative Decision-Making (A-CDM)	-	2
	B1-ACDM Enhanced Airport CDM	-	2
	B0-RSEQ Improve Traffic Flow Through Runway Sequencing (AMAN/DMAN)	-	2
	B1-RSEQ Improved Airport Operations: through Departure, Surface and Arrival Management.	-	2
	B1-SURF Enhanced Safety and Efficiency of Surface Operations – SURF, SURF-1A and Enhanced Vision System (EVS).	-	2
	B0-SURF Safety and Efficiency Of Surface Operations (A-SMGCS)	Yes	3
	B0-WAKE Increased Runway Throughput Through Optimized Wake Turbulence Separation	-	3
PIA 2	B0-FICE Increased Interoperability, Efficiency And Capacity Through Ground-Ground Integration (AIDC)	-	1
	B0-DATM Service Improvement Through Digital Aeronautical Information Management	-	1
PIA 3	B0-FRTO Improved Operations Through Enhanced En-Route Trajectories (CDM, FUA)	-	1
	B0-NOPS Improved Flow Performance Through Planning Based On A Network-Wide View	-	1
	B1-NOPS Enhanced Flow Performance through Network Operational Planning.	-	1
	B0-ASUR Initial Capability For Ground Surveillance	Yes	1
	B0-ACAS ACAS Improvements	Yes	1
	B0-SNET Increased Effectiveness Of Ground-based Safety Nets	-	1
	B0-AMET Meteorological Information Supporting Enhanced Operational Efficiency and Safety	-	1

	B0-SAR[1] Enhanced Search and Rescue Provisions	-	1
	B0- ASEP Air Traffic Situational Awareness (ATSA)	-	2
	B0-OPFL Improved Access To Optimum Flight Levels Through Climb/Descent Procedures Using Automatic Dependent Surveillance – Broadcast (ADS-B)	-	3
PIA 4	B0-TBO Improved Safety And Efficiency Through The Initial Application Of Data Link En-Route	-	1
	B1-TBO Improved Traffic synchronization and Initial Trajectory-Based Operation	-	1
	B0-CDO Improved Flexibility And Efficiency In Descent Profiles (Continuous Descent Operations - CDO)	-	2
	B1-CDO Improved Flexibility and Efficiency in Continuous Descent Profiles (CDOs) using VNAV	-	2
	B0-CCO Improved Flexibility And Efficiency Departure Profiles - Continuous Climb Operations (CCO)	-	2

Table 1: Asia/Pacific ASBU Block 0 Priority

Critical ASBU Upgrades

5.9 The following ASBU Block 0 elements were considered by APSAPG and endorsed by APANPIRG as critical upgrades for Seamless ATM, and thus should be accorded the highest priority in terms of the earliest implementation and the resources required to support this.

Note: This did not suggest that 'critical' elements had a higher priority than safety critical improvements.

5.10 **B0-FRTO** *Enhanced En-route Trajectories*: Flexible Use Airspace (FUA), User Preferred Routes (UPR), Dynamic Airborne Re-route Planning (DARP) and CDM. These will allow the use of airspace which would otherwise be segregated, along with flexible routing adjusted for specific traffic patterns for greater routing possibilities, reducing flight time and fuel burn.

5.11 **B0-FICE** Ground – Ground Integration and Interoperability: ATS Inter-facility Data Communications (AIDC). AIDC application exchanges information between ATS units in support of critical ATC functions, including notification of flights approaching a Flight Information Region (FIR) boundary, coordination of boundary-crossing conditions, and transfer of control. AIDC application improves the overall safety of the ATM system, as well as increasing airspace capacity, as it permits the controller to simultaneously carry out other tasks.

5.12 **B0-DATM** *Digital Aeronautical Information Management* (AIM). AIM is one of the foundation elements that supports other aspects of ASBU, and as such requires a high priority. A key strategy activity during Block 0 may include the development of the System-Wide Information Management (SWIM) concept of operations to support the next phase of AIM development and integration within the future SWIM framework.

5.13 **B0-NOPS** *Network Flow Management* ATFM: ATFM is used to balance demand and capacity to manage the flow of traffic in a manner that minimises delay and maximises the use of the available airspace. ATFM is one of the solutions to ensure a sustainable air traffic growth for the future. Inter-linked and networked ATFM nodes between ANSPs should be developed to serve various sub-regions (refer Doc 9971 *Manual on Collaborative Air Traffic Flow Management*).

[1] B0-SAR is not included in ICAO Global Air Navigation Plan ASBU Framework

5.14 **B1-NOPS** *Enhanced Flow Performance through Network Operational Planning*. Introduces enhanced ATFM processes to improve the overall flow. The main improvement is the increased collaboration among stakeholders in real-time regarding use preferences and system capabilities. This results in better use of airspace with positive effects on the overall cost of ATM.

5.15 **B0-TBO** *En-route Data-link*: Automatic Dependent Surveillance-Contract (ADS-C), Controller Pilot Data-link Communications (CPDLC). Data-link application for ATC surveillance and communications supports flexible routing, reduced separation and improved safety. In areas where the provision of direct ATS surveillance is possible, ATC separation should be based on these surveillance systems (i.e. radar, multilateration and ADS-B), and that ADS-C and CPDLC with backup provided by High Frequency (HF) and/or Satellite Voice Communications (SATVOICE) were necessary elsewhere. Moreover, the Regional Surveillance Strategy states that ADS-C should be used where technical constraint or cost benefit analysis did not support the use of Automatic Dependent Surveillance-Broadcast (ADS-B), SSR or Multilateration (MLAT).

5.16 **B1-TBO** Improved Traffic synchronization and Initial Trajectory-Based Operation Improves the synchronization of traffic flows at en-route merging points and to optimize the approach sequence through the use of 4DTRAD capability and airport applications: DCL, D-TAXI. Trajectory Based Operations (TBO) are based on:

- **B1-RSEQ** (*extended arrival metering, integration of surface management with departure sequencing*);
- **B1-NOPS** (*integrated ATFM including airspace management, user driven prioritisation and collaborative ATFM solutions*);
- **B1-TBO** (*synchronisation of traffic flows at merge points through controlled time of arrival capability and airport applications such as D-TAXI*); and
- **B1-AMET** (*Enhanced Operational Decisions through Integrated Meteorological Information – Planning and Near-Term Service*).

5.17 **B0-ASUR** *Ground-Based ATS Surveillance*: ADS-B, MLAT. The Regional Surveillance Strategy stated that ADS-B should be used to support ATC separation service, while reducing dependence on Primary Radar for area surveillance and reliance on 4-digit SSR octal codes. ADS-B technology is an initial step in creating a more flexible air transportation system that will create seamless surveillance and shared situational awareness picture for both ground and air operations. Recommendation 1/7C adopted by the AN-Conf/12 urged States to share ADS-B data to enhance safety, increase efficiency, achieve seamless surveillance and work closely together to harmonize their ADS-B plans to optimize benefits. The provision of communication capability such as Very High Frequency (VHF) to support ATS surveillance is also necessary. Furthermore, APANPIRG/22 urged States to support provision of Very High Frequency (VHF) radio voice air/ground communication infrastructure for use by adjacent States to enable a reduction of ATS separation based on surveillance.

Recommended ASBU Upgrades

5.18 **B0-CDO** *Improved Flexibility and Efficiency in Descent Profiles* CDO and Standard Instrument Arrival (STAR). These arrival procedures allow aircraft to fly their optimum profile, taking into account airspace and traffic complexity by utilising Area Navigation (RNAV) and Required Navigation Performance (RNP) Standard Instrument Departures (SIDs) and STARs. This element has been accorded a high priority by ICAO HQ, due to the improvement in safety regarding Controlled Flight into Terrain (CFIT) and greater efficiency in terms of fuel usage and emissions.

Note: the terms 'Standard Terminal Arrivals' and 'Standard Instrument Arrival' from Doc 9750 and Doc 4444 respectively have the same meaning.

5.19 **B1-CDO** *Improved Flexibility and Efficiency in Continuous Descent Profiles (CDOs) using VNAV*. The arrival procedure with CDOs using VNAV allows the aircraft to fly close to its optimal profile enabling fuel savings and enhanced predictability. VNAV contributes to terminal airspace design and efficiency due to an aircraft's ability to maintain a vertical path during descent thus allows for development of vertical corridors for arriving and departing traffic thus increasing the efficiency of the airspace.

5.20 **B0-CCO** *Flexible and Efficient Departure Profiles* Continuous Climb Operations (CCO), SID. This element has been accorded a high priority by ICAO HQ, due to greater efficiency in terms of fuel usage and emissions.

5.21 **B0-RSEQ** Runway Sequencing: Arrival Manager (AMAN), Departure Manager (DMAN). AMAN/DMAN procedures are designed to provide automation support for synchronisation of arrival sequencing, departure sequencing and surface information. Training on automation support, operational standards and procedures were necessary.

5.22 **B0-APTA** Airport Accessibility: Performance-based Navigation (PBN) procedures with vertical guidance. The optimal use of appropriate PBN specification is a key enabler to progress Seamless ATM in the Asia/Pacific region. PBN lays the foundation for the airspace system for years to come as future navigation developments such as four-dimensional (4D) user prefer trajectories evolve. This element has been accorded a high priority by ICAO globally. Documents providing guidance on this subject were:

- *PBN Manual*, *GNSS Manual*, *Annex 10*, *PANS-OPS Volume 1 and 2*;
- *Manual on Testing of Radio Navigation Aids Volume 2* (Doc 8071);
- *Quality Assurance Manual for Flight Procedure Design Volume 5* (Doc 9906);
- and for avionics-
    - Basic IFR Avionics (TSO C129 with Receiver Autonomous Integrity Monitoring - RAIM);
    - Basic IFR Global Navigation Satellite System (GNSS) receivers with Baro-VNAV (Vertical Navigation), Satellite-based Augmentation System - SBAS avionics (TSO C145/146); and
    - GBAS receivers (TSO C161/162).

5.23 **B0-ACDM** *Airport CDM*: the decision making process at the airport is enhanced by sharing up-to-date relevant information and by taking into account the preferences, available resources and the requirements of the stakeholders at the airport. Material from the ICAO CDM Manual is being incorporated into a global manual on collaborative ATFM (Doc 9971).

5.24 **B1-ACDM** *Enhanced Airport CDM:* The decision making process at the airport is enhanced by sharing up-to-date relevant information and by taking into account the preferences, available resources and the requirements of the stakeholders at the airport. Material from the ICAO CDM Manual is being incorporated into a global manual on collaborative ATFM (Doc 9971). The collaborative Airport Operations Planning (AOP) and Airport Operations Centre (APOC) enhance the planning and management of the Airport operation and allow full integration with ATM.

5.25 **B0-ASEP** *Air Traffic Situational Awareness*: ADS-B OUT enabled for airborne surveillance. ATSA applications will enhance safety and efficiency by providing pilots with the means to achieve quicker visual acquisition of targets. These are cockpit based applications which do not require any support from ground, and hence can be used by any suitably equipped aircraft.

5.26 **B0-ACAS** *Airborne Collision Avoidance System Improvements*: ACAS (Airborne Collision Avoidance System). Traffic Collision Avoidance System (TCAS) version 7.0 or 7.1 is the expected standard. The requirement for forward fit from 01 January 2014 and retrofit by 01 January 2017 of aircraft ACAS installations with an upgraded collision avoidance logic known as TCAS V7.1 was adopted in 2010 by the ICAO Council. This element is designed to increase the effectiveness of surveillance and collision avoidance systems through mandatory use of pressure altitude reporting transponders, in accordance with the Regional Surveillance Strategy.

5.27 **B0-SNET** *Ground-Based Safety Nets*: Short Term Conflict Alert (STCA), Area Proximity Warning (APW), Minimum Safe Altitude Warning (MSAW).

5.28 **B0-AMET**: *Meteorological information supporting enhanced operational efficiency and safety* Global, regional and local meteorological information provided by world area forecast centres, volcanic ash advisory centres, tropical cyclone advisory centres, aerodrome meteorological offices and meteorological watch offices in support of flexible airspace management, improved situational awareness and collaborative decision making, and dynamically-optimized flight trajectory planning.

5.29 The future, net-centric oriented ATM system requires the smart use of uncertainty characteristics often associated with MET information, enabling decision-makers to make choices according to their own objectively determined thresholds for action. This needs a transition of MET information, specifically in table-driven data representation supporting ATM collaborative, knowledge-based, decision-making through free-flowing information exchange (ASBU B1-AMET).

5.30 The first evolutionary step in the improved provision of MET information included the provisions introduced in Amendment 76 to Annex 3 – *Meteorological Service for International Air Navigation* (applicable November 2013), which enabled the exchange of OPMET information (specifically METAR, SPECI, TAF and SIGMET) formatted in accordance with a globally interoperable information exchange model (i.e. IWXXM) using extensible markup language (XML)/geography markup language (GML), accompanied by the appropriate metadata, by States in a position to do so. These developments were designed to foster the future SWIM environment, which will include meteorological, aeronautical and flight information, amongst others.

5.31 Amendment 77 to Annex 3 (applicable 10 November 2016) ~~is~~ will elevate these particular provisions to the status of recommended practice and extend them to the provision of tropical cyclone and volcanic ash advisory information and AIRMET information. Amendment 78 to Annex 3 (intended applicability in November 2018) is expected to make these provisions an ICAO Standard . During Amendments 77 and 78 of Annex 3, and beyond, a significant portion of current MET information is envisaged to transition to IWXXM format in support of the SWIM environment. In addition, there will be an increased reliance on the automated relay of meteorological information to and from aircraft, including enhanced aircraft-based meteorological reporting capabilities (ASBU B3-AMET).

ASBU Elements Which May Not Be Universally Implemented

5.32 **B0-WAKE, B1-WAKE**: *Enhanced Wake Turbulence Separations*. As a function of local implementation plans, development of automation support (Decision Support Tools) is required to enable the display to ATC of the appropriate wake turbulence separation minima applicable between successive pairs of arriving and departing aircraft, to apply optimized wake turbulence standards. Such automation support is considered desirable for Block 0 (six wake turbulence category system), and necessary for Block 1 (pair-wise system).

5.33 **B0-SURF**: *Improved Runway Safety*: Advanced Surface Movements Guidance Control Systems (ASMGCS), where weather conditions and capacity warranted. Implementation of ASMGCS may not be a high priority in the Asia/Pacific except at high density aerodromes where the cost benefits of mandating this were positive.

5.34 **B1-SURF** *Enhanced Safety and Efficiency of Surface Operations* – SURF, SURF-1A and Enhanced Vision System (EVS). Provides enhancements to surface situational awareness, including both cockpit and ground elements, in the interest of runway and taxiway safety, and surface movement efficiency. Cockpit improvements including the use of surface moving maps with traffic information (SURF). The module implements additional capabilities by taking advantage of cooperative surveillance.

5.35 **B0-OPFL**: *Climb/Descent Procedures using ADS-B In-trail Procedure* (ITP). This element is applicable only for those ANSPs that provide services within Category R airspace, and may be rarely used in airspace where 30/30NM separation is applied using RNP4 or other more efficient standards, as ITP required a number of steps to apply correctly. Thus, ITP is optional, primarily for higher density Category R airspace with Organised Track Systems (OTS).

ASBU Elements Block 1 envisaged to be implemented from 2022

5.36 These elements are expected to be discussed during the 2019 review of the Seamless ATM Plan and implemented accordingly. States, international organizations and other stakeholders are expected to analyse these elements with regard to their own implementation strategy and actions, which may be earlier than 2022 as appropriate.

5.37 **B1-APTA** *Optimized Airport Accessibility*: Performance-based navigation (PBN) and Ground-based Augmentation System (GBAS) Landing System (GLS) Cat II/III approaches is a key enabler for the high density airports to increase the safety and the airport capacity by the increased runway throughput and more flexible use of terminal airspace.

5.38 **B1-SNET** *Ground Based Safety Nets on Approach*: introduction of Approach Path Monitor (APM).

5.39 **B1-FICE** *Ground-Ground Integration and Interoperability*: FF-ICE, Step 1 for ground-ground application facilitate the collaborative decision making (CDM), applicable between ATM service providers, airspace user operations and airport operations. Reduces controller workload and increases data integrity supporting improved capacity.

5.40 **B1-RPAS** *Remotely Piloted Aircraft*: Initial integration of RPA into non-segregated airspace applies to non-segregated airspace and at aerodromes. Implementation will cover detect and avoid system introduction and all necessary security systems supporting the RPAS operations.

5.41 **B1-AMET** *Enhanced Operational Decisions through Integrated Meteorological Information (Planning and Near-Term Service)* Full ATM-Meteorology integration is needed to ensure that meteorological information is included in the logic of an ATM decision process, including the impact of meteorological conditions on operations such as cross-polar and trans-polar routes with space weather forecasts..

Note: the Asia/Pacific may develop a specific regional Seamless ATM element to incorporate B1-RPAS and in addition, small Unmanned Aircraft Systems (UAS).

5.42 **B1-DATM** *Integration of Digital Information Management (AIM) Information*. Service improvement through ATM information reference model, integrating all ATM information, using common formats (ULM/XML and WXXM) for meteorological information, FIXM for flight and flow information and internet protocols enables the up-to-date access to the information by the variety of stakeholders.

5.43 **B1-SWIM** Performance Improvement through the Application of System-Wide Information Management (SWIM). The System Wide Information Management (SWIM) will complement human-to-human with machine-to-machine communication, and improve data distribution and accessibility in terms of quality of the data exchanged. SWIM is a key enabler to facilitate the Global ATM Operational Concept is a net-centric operation, where the air traffic management (ATM) network is considered as a series of nodes, including the aircraft, providing or using information. The scope extends to all information that is of potential interest to ATM including: trajectories, surveillance data, aeronautical information of all types, meteorological information etc.

5.44 **B1-ASEP** *Increased Capacity and Efficiency through Interval Management.* Interval management improves management of air traffic flows and aircraft spacing. Is based on ADS-B IN applications to achieve or maintain an interval or spacing from a designated aircraft. ATC is provided with a new set of (voice or data link) clearances directing, for example, that the flight crew establish and maintain a given time spacing from a reference aircraft. These new clearances will reduce the use of ATC vectoring and speed control.

5.45 In addition the following element may be considered in the category of "May not be universally implemented", in consideration during the review of 2019: **B1-RATS** *Remotely Operated Aerodrome Control.* Provides a safe and cost-effective air traffic services (ATS) from remote facility to one or more aerodromes. Can have also a significant importance in case of contingency situation occurrence.

Regional Elements

5.46 The Regional elements were incorporated into the Seamless ATM framework used to assess the uptake by Asia/Pacific States.

5.47 **Table 2** provides a summary of the Regional Seamless ATM elements, and the expected priority for implementation within the Asia/Pacific Region. The allocation of priority was based on factors including its importance in promoting Seamless ATM (Priority 1 = critical upgrade, Priority 2 = recommended upgrade, Priority 3 = may not be universally implemented).

PIA	Regional Seamless ATM Element	Priority
Aerodromes	Apron Management	3
	ATM-Aerodrome Coordination	3
	Aerodrome capacity	3
	Airport Master Plan*	3
Airspace Organization and Management	ATC Sector Capacity	2
	Performance-based Navigation (PBN) Visual Departure and Arrival Procedures	3
	Performance-based Navigation (PBN) Airspace	2
	Airspace classification	2
	Flight Level Orientation Scheme (FLOS)	2
	Flight Level Allocation Schemes (FLAS)	2
	Automated Transfer of Control	2
	ATS Surveillance data sharing	2
	ATC Horizontal separation	2
	Rocket launches/space re-entry management*	1
	Common aeRonautical Virtual private network*	1
	Voice communications over IP between ATS units*	2
Human Performance	ATM Managers' Performance	2
	ATC simulators performance	2
	Safety assessment of changes	2
	ATM Operators' performance	2

Civil military cooperation	Strategic Civil Military coordination	1
	Tactical Civil Military coordination	1
	Civil Military system integration	2
	Civil Military navaids joint provision	2
	Civil Military common training	2
	Civil Military common procedures	2

Table 2: Asia/Pacific Seamless Regional Elements Priority

Note: * New Seamless Elements planned to be incorporated in the 2016 Review

5.48 **Aerodrome Certification**. This element related to the implementation of management and design strategies to improve movement area utilization. ICAO Annex 14, Volume I required States to certify their aerodromes used for international operations in addition to aerodromes open for public use through an appropriate regulatory framework.

5.49 **Aerodrome Capacity Analysis**. This element related to the need to maximize runway capacity. In addition, there is a need to determine capacity and related constraints for runways, taxiways and gates, especially for Low Visibility Operations (LVO). Aircraft gate movement predictability affecting ATFM may be influenced by the efficiency of the embarkation and disembarkation of people and goods. In conducting aerodrome capacity analysis, it is important to include an assessment of the capacities of the airport passenger and cargo terminals and landside infrastructure to handle passengers, checked-in baggage, air freight and road traffic to ensure that the airfield, passenger/cargo terminals and landside capacities are balanced as much as possible.

5.50 Apron Management Services need to be integrated with ATC services using interoperable systems (including automated tools), shared data and harmonised procedures. Therefore clear procedures between a provider of aerodrome ATS services and the aerodrome operator are necessary in order to ensure that the planning, operation and review of aerodrome services are conducted collaboratively.

5.51 **The Airport Master Plan** development and regular updates are essential for the Seamless ATM alignment of the forecasted airport infrastructure development to introduce the applicable ASBU framework.

5.52 **Flight Information Regions** (FIRs). FIR boundaries should not limit the delivery of ATS surveillance-based separation services, and where possible the number of FIRs should be minimized, particularly along traffic flows.

Note: FIRs should not necessarily be based strictly on the boundaries of sovereign territories (Annex 11)

5.53 Recommendation 5/1 from the AN-Conf/12 (**Appendix B**) suggested that States fully assess the operational, safety, performance and cost implications of a harmonised transition altitude.

5.54 **Airspace Classification.** The harmonization of upper airspace and associated traffic handling through application of a common ICAO ATS Airspace Class in upper airspace is consistent with Seamless ATM principles.

5.55 **Reduced Vertical Separation Minimum** (RVSM). The optimization of the utilization of airspace and enhanced aircraft altimetry systems and the adoption by all States of the ICAO Flight Level Orientation Scheme (FLOS) based on feet as contained in Appendix 3a to Annex 2 is necessary for regional harmonisation. China is the only State that has adopted Appendix 3b to Annex 2, while some adjacent States continued to refer to the metre equivalent of feet (flight levels), as their domestic altimetry systems or regulations was commonly based on metres.

5.56 **Airspace Priority.** At the 6th Worldwide Air Transport Conference (ATCONF, Montréal, 18-22 March 2013) support was expressed for work to be undertaken on the schemes of economic incentives, 'best equipped or capable, best served' and 'most capable, best served' concepts. The CONOPS states that in each case where any aircraft that does not meet specified requirements, it should receive a lower priority, except where prescribed (such as for State aircraft).

5.57 Affording priority for flight levels or making specified levels unavailable for certain ATS routes under a Flight Level Allocation Scheme (FLAS) needs to be minimised, as this may penalise flights without consideration of actual capacity at the time and does not necessarily take advantage of the tactical capability of ATM systems. Thus FLAS should only be imposed to enhance safety and/or capacity, or where there were systemic operational limitations, such as the ability to deliver ATS surveillance-based separation services.

5.58 Establishing equipage mandates requiring operators to equip with a specific technology is an acceptable concept, provided the timeline for compliance is developed after due consultation and the [safety and economic] benefits in equipage were clearly identified and agreed (CONOPS).

5.59 **ATS routes**. The CONOPS had established the expectation that in upper controlled airspace and within terminal controlled airspace (CTA and CTR) associated with major international aerodromes, ATS routes should be PBN based, with an appropriate specification determined by the Airspace Authority based on the GANP and the Regional Navigation Strategy as endorsed by APANPIRG. However, the RANP amendment of all conventional regional ATS routes to PBN routes would be very time consuming, so changes to PBN are being made on an opportunity basis, or when a new route is established, consistent with this Plan. A harmonised en-route PBN implementation is a key to achieving seamless ATM in order to cater to capacity growth.

5.60 The Plan advocated moving to take early advantage of GNSS so Asia/Pacific States do not need to undertake expensive ground-based navigation aid updates to support PBN ATS routes. For any move to a GNSS-based system, consideration must be made of the appropriate backup requirements. The following redundancy should be considered by States in their Safety Assessment with regard to reliance on GNSS:

- use of linked GNSS/Inertial Navigation Systems (INS) that provide a degree of accuracy commensurate with the navigation accuracy requirements until an alternative form of navigation is available;
- retention of terminal VOR/DME at major aerodromes only;
- retention of some radar or MLAT capability supporting terminal operations to provide a degree of navigation assistance if GNSS is not available; and
- the use of multi-modal receivers that can use different GNSS constellations.

5.61 **ATC Separation**. The CONOPS had stated that in areas where the provision of direct ATS surveillance is possible, ATC separation should be based on these surveillance systems (i.e.: radar, multilateration and ADS-B). The Regional Surveillance Strategy reinforced this by encouraging the provision of communication, navigation, and data management capabilities necessary to make optimal use of surveillance systems. Moreover, States were expected to enhance ATM automation tools and safety nets through the use of aircraft-derived data such as flight identification, trajectories and intentions.

5.62 ATS surveillance-based separation may be provided with only one ATS surveillance system. Multiple ATS surveillance systems such as radar, ADS-B or MLAT should not be required, unless a single system does not demonstrate reliable performance in terms of availability, or overlapping coverage is required near an ATS sector boundary, or a safety case required enhanced redundancy or for any other economic reason.

5.63 **Surveillance strategy.** The Asia/Pacific Seamless ATM Plan and the Asia/Pacific Surveillance Strategy should be aligned:
http://www.icao.int/APAC/Documents/edocs/APX.%20J%20%20Revised%20Surveillance%20Strategy.pdf

5.64 **Civil Data-Sharing**. The provision of ATS surveillance data between civil ANSPs (suitably filtered as appropriate in terms of national security) is important for harmonised Transfer of Control (TOC) procedures between ATC units, unless surveillance coverage extended well into the adjacent unit's airspace. ADS-B system data should not require filtering, as it is publically broadcast information, lending itself to improving safety through the sharing of ATS surveillance data across FIR boundaries, in accordance with the Regional Surveillance Strategy.

5.65 **Search and Rescue. B1-SAR**[2] *Enhanced Search and Rescue provisions.* This module develops critical Search and Rescue features like: State SAR Plan, international SAR agreements, SAR exercise (SAREX), Rescue Coordination Centres (RCCs), centralised SAR information source, SAR Quality Assurance (QA) programmes. The importance of enhancement of SAR service. States should develop SAR Plan, international SAR agreements and SAR exercises (SAREX).

5.66 **Common aeRonautical Virtual private network (CRV)** The objective of the CRV is to offer a safe, secure, robust and cost effective telecommunications transport service to the States. The scope of the CRV is to provide a cross-border cost-effective telecommunications network for States in the ICAO Asia/Pacific Region.

5.67 **Voice over Internet Protocol (VoIP):** The VoIP technology is planned to be implemented by 2022 to replace the current analogical technology. States may choose to upgrade their ATM voice communication systems in compliance with the EUROCAE ED-137 standards before migrating to VoIP, or implement Analog/digital VoIP converters meanwhile. In addition, ANSPs should perform the safety case as Voice communications are a critical service.

5.68 **Launch/Space re-entry activity management:** the efficient management of rocket/missile launch and space re-entry activity to minimize disruption to other airspace users. The coordination of all the stakeholders will be enhanced by: coordination agreements between the State civil aviation authority, the ANSP, and the launch/re-entry agency concerned; strategic coordination conducted between the State civil aviation authority prior the activity and tactical management of the launch/re-entry activity.

<u>Human Performance</u>

5.69 The Global ATM Operational Concept (Doc 9854) states:

> *Humans will play an essential and, where necessary, central role in the global ATM system. Humans are responsible for managing the system, monitoring its performance and intervening, when necessary, to ensure the desired system outcome. Due consideration to human factors must be given in all aspects of the system.*

5.70 The AN-Conf/12 emphasised the importance of human performance considerations by endorsing Recommendation 6/4 (**Appendix B**), which called for the integration of human performance as an essential element for the implementation of ASBU modules and in the planning and design phase of new systems and technologies, as part of a safety management approach.

[2] B0-SAR is not included in ICAO Global Air Navigation Plan ASBU Framework

5.71 The role of the human is especially important in delivering high quality and consistent services supporting Seamless ATM. Therefore it is crucial to ensure that, training and licensing requirements are developed using a competency-based framework, fatigue-related risk is managed appropriately, and safety data, including the reporting of hazards, is collected, analysed and acted upon within ATM systems that support Seamless ATM

5.72 One of the more important human performance aspects in order to deliver a consistent, harmonised and efficient service is ATC training, to change from a procedural mind set to one that used the tactical delivery of services based on ATS surveillance and automated safety net decision support tools (airborne and ground).

5.73 Moving from reliance on paper-based flight progress strips to an electronic equivalent connected to the ATS surveillance Flight Data Processing System (FDPS) or direct data inputs to the Aircraft Situation Display (ASD) support this paradigm shift. The use of paper flight progress strips in automated ATM environments reduces efficiency, increases transcription error/data mismatch, and artificially caps ATC capacity due to retention of manual tasks made redundant by the automation capability.

5.74 Controllers need to be trained on the application of tactical separation, including the use of positive control techniques, such as vectoring and speed control when conflict pairs approach minimum separation. In this regard, it is important that managers facilitate a modern operating environment in terms of air safety incidents and human factors, so personnel are confident using the full capability provided by the CNS facilities.

5.75 A critical human performance issue is the training of ANSP management and regulators in human performance issues. These decision-makers had an important influence on outcomes in terms of supporting the right environment for Seamless ATM activities, whether that is providing financial resources, or establishing high-level policies and procedures.

5.76 A key component of Seamless ATM is the ability of controllers to operate, and have confidence in, a new operating environment. The appropriate use of ATC simulators to enhance their learning experience is an essential part of the necessary training.

5.77 In planning to deliver Seamless ATM services, it is assumed that each State and aircraft operator will comply with the English language proficiency requirements in accordance with ICAO Standards and Recommended Practices. States should be considering the highest levels of English language proficiency for all operational controllers to ensure they can respond appropriately to irregular occurrences (e.g.: emergencies) by use of an internationally recognised system.

5.78 An optimal ‘aviation culture’ within regulators and service providers can only be implemented when top managers instil an understanding of a system-wide approach that creates an organic, learning and safe environment. When considering the key factors supporting an ‘aviation culture’, it is important to acknowledge that no ‘national culture’ is perfectly aligned with ‘aviation culture’, so there will always be a need for gap analysis and changes where development of an appropriate in culture is required. In focussing on management it is therefore important to train managers, and for managers to have a level of competency in the following areas (**Figure 5**):

a) the advantages of a responsible, informed and accountable management, which promotes a proactive organisational culture with safety as a first priority, using open communications and a team management approach; and

b) the implementation of an appropriate organizational culture which is effectively driven by management through embedded safety review and assessment teams, allowing the organization to respond organically to its operating environment;

c) the systematic application of human factors principles in –

- air safety investigation;
- system design (ergonomics, human-in-the-loop);
- effective training (including the use of simulators);
- fatigue management;
- automated safety nets; and
- contingency planning;

d) the implementation of effective safety reporting systems that –

- are non-punitive, supporting a 'Just Culture';
- promote open reporting to management; and
- focus on preventive (systemic), not corrective (individual) actions in response to safety concerns, incidents and accidents.

Figure 5: Optimal Aviation Culture Factors

Civil/Military Cooperation

5.79 One of the key enablers for improvement of ATM efficiencies supported by Doc 9854 (Global ATM Operational Concept) is the use of FUA. This is an airspace management concept based on the principle that airspace should not be designated as purely civil or military, but rather as a continuum in which all user requirements are accommodated to the greatest possible extent. FUA normally referred to the activation of Special Use Airspace (SUA), but could also include controlled airspace.

5.80 The establishment and operation of SUA required careful assessment, review and management, to ensure the most appropriate airspace designation is used, and the airspace is operated in a cooperative manner. This is ordinarily only possible through discussion between military and civil parties. Thus a key to the establishment of effective FUA is risk-based assessments, determining the risks or security issues involved through coordinated and cooperative methods if possible.

Note: Annex 2 Rules of the Air states that restricted areas were airspace of defined dimensions, above the land areas or territorial waters of a State, which means that restricted areas must not be designated over the high seas or in airspace of undetermined sovereignty

5.81 Restricted areas designed to segregate civil aircraft from airborne military operations or ordnance firing would be expected when the risk of an accident for non-segregated operations is higher than acceptable. However, lower risk military operations (such as using small calibre weapons at an established firing range) may only require the establishment of a danger area or even no SUA. Thus the type, dimensions, activation notice and duration of SUA activity should be appropriate and commensurate with the type of activity affecting the airspace.

5.82 APANPIRG/9 (August 1998) developed the following guidelines for civil/military cooperation in the following areas: military procedures, aeronautical facilities and ground services, civil and military ATS unit personnel, airspace, research and development, common terminology, abbreviations rules and procedures, military exercises, and non-sensitive military data.

- If at all possible, military training should be conducted in locations and/or at times that do not adversely affect civilian operations, particularly those associated with major aerodromes. This requires strategic planning by formal civil/military coordination bodies.
- Consideration of the interoperability and operations of military systems is an integral part of a Seamless ATM environment. With increasingly complex aircraft equipage civil requirements, non-compliant military or other State aircraft may become more difficult to manage using Special Handling Status (STS). The limitations or requirements of military aircraft cockpits, avionics and airframes may even preclude some civil systems, and yet military aircraft still need to transit airspace used predominantly by civil operations.
- Military participation at civil ATM meetings and within ATS Centres will often lead to a better understanding of civil needs, as well as military requirements, including the operation of Unmanned Aircraft Systems (UAS). UAS have been predominately used by the military in segregated airspace, but now many forms of State missions including customs, immigration and police operations are being planned, as well as a myriad of potential civil uses.
- Responses to Search and Rescue (SAR), Civil Defence (normally natural disaster emergencies), and national security events will inevitably require civil/military coordination so this needs to be taken into account during the planning for such operations. As these occurrences could involve a number of States, regional civil/military planning is crucial in order to reduce the response time for emergency services to aid those in need. The response to an international aviation SAR event may well involve a location over the high seas, so all States should have SAR agreements with neighbouring nations to ensure that SAR services were unimpeded to the maximum possible extent.

5.83 The Asia/Pacific Civil/Military Cooperation Seminar/Workshop (Bangkok, 28 February to 1 March 2012) recommended that the following civil/military cooperation/coordination principles and practices should be elevated to the highest political level in the Asia/Pacific regions:

- civil/military working arrangements should be enacted where discussion of both civil and military needs were able to be negotiated in a balanced manner;
- the importance of the interoperability of civil air transport infrastructure and national security was recognized;
- the interoperability of civil and military systems including data-sharing was

emphasized; and

- regular review of controlled airspace and special use airspace was encouraged to be undertaken by States to ensure its establishment, size, activation and operation was appropriate in terms of optimal civil/military operations.

5.84 The Asia/Pacific Civil/Military Cooperation Seminar/Workshop requested ICAO to update existing provisions related to civil/military cooperation/coordination and further develop guidance material related to airspace planning and management, including FUA.

5.85 Data sharing arrangements (including aircraft surveillance), are a key part of civil/military cooperation for tactical operational responses, and to increase trust between civil and military units. Data sharing between the civil and military could facilitate CDM, a vital component of ATFM. The Regional Surveillance Strategy espouses civil/military cooperation and system interoperability.

5.86 Aircraft operating ADS-B technology transmit their position, altitude and identity to all listeners, conveying information from co-operative aircraft that have chosen to equip and publicly broadcast ADS-B messages. Thus there should be no defence or national security issues with the use and sharing of such data.

Note: Some military transponders may support ADS-B using encrypted messages, but this data is not normally decoded or used at all by civil systems. In many cases, tactical military aircraft are not ADS-B equipped or could choose to disable transmissions. In future, increasing numbers of military aircraft would be ADS-B capable, with the ability to disable these transmissions. ADS-B data sharing should not influence the decision by defence agencies to equip or not equip with ADS-B. Moreover, it is possible for States to install ADS-B filters that prevent data from sensitive flights being shared. These filters can be based on a number of criteria and typically use geographical parameters to only provide ADS-B data to an external party if aircraft were near the boundary.

5.87 Ten civil/military elements were incorporated into the Seamless ATM framework after analysis of discussion of the APANPIRG/9 principles, and discussion from the Seamless ATM Symposium and Ad Hoc Meeting, APSAPG/1 and the Asia/Pacific Civil/Military Seminar/Workshop.

a) **Strategic Liaison**. This element emphasised the creation of a permanent body and procedures such as participation at appropriate civil ATM meetings, to ensure long and medium-term planning for optimal civil and military operations.

b) **Tactical Liaison**. The daily, safe and efficient tactical management of operations, including airspace scheduling through interaction and communications between civil and military units, which should include military representation within civil ATC Centres where necessary.

c) **Military SUA**. The minimisation of airspace exclusively assigned for civil or military use in accordance with FUA principles, assessed by the percentage of military SUA within an FIR.

d) **SUA Review**. The regular review of SUA, to ensure that the means and notice of activation provide adequate warning for other airspace users, and the airspace designations (SUA types) as well as the lateral and vertical limits are the minimum required to safely contain the activity therein. The review of airspace should be conducted by an airspace authority independent or a collaboration of civil and military airspace users.

e) **International SUA**. The minimisation of SUA that affected international civil ATS routes. Restricted and prohibited areas must not be designated in international airspace or airspace of undefined sovereignty.

f) **Integrated Civil/Military ATM Systems**. The integration of civil and military ATM systems where practicable, including joint procurement of systems where possible.

g) **Joint Civil/Military Aerodromes and Navigation Aids**: The operation of joint civil/military aerodromes if possible, and the provision of navigation aids that could be utilised by both civil and military aircraft where practical.

h) **Shared Civil/Military Data**: The provision of ATS surveillance data from civil surveillance systems to military units to improve monitoring (thereby reducing the need for individual defence identification authorisation), trust and confidence. The provision of surveillance data from military surveillance systems where this would enhance ATS surveillance coverage and redundancy; suitably filtered as appropriate.

i) **Common Civil/Military Training**. The familiarisation of civil and military ATM personnel in each other's systems and procedures where national security allows. Training and licensing of civil and military air traffic controllers to equivalent standards.

j) **Common Civil/Military Procedures**. The implementation of the same or equivalent standards, procedures and policies for the provision of ATS and the management of air traffic.

<u>Airspace Equipage Mandates</u>

5.88 From an operators' perspective, the following were important considerations:

- <u>Preparation Time:</u> Operators need time to prepare for any mandated equipage requirement – if new equipment is involved, several years may be required to allow fitment to take place during normal airframe maintenance cycles.

- <u>Cost Benefit:</u> Operational improvements, including the use of new technologies or implementing ASBUs, need to provide operational benefits that outweighed the total cost of implementation and operation. This included the airspace user side of the equation. States/ANSPs should carry out studies of the costs and benefits for all stakeholders.

- <u>Education and promulgation:</u> States/ANSPs should work with local airlines and International Organizations to ensure industry and other stakeholders are educated and informed regarding upcoming aircraft equipage mandates very early in the planning process. Ideally, the dialogue should begin with user consultation pertaining to the selection of appropriate solutions. Once a decision has been made, user education should include briefings, media notifications as well as required AIS promulgation.

- <u>Service Outcomes:</u> States/ANSPs must ensure the service delivery efficiencies enabled by an aircraft equipage mandate are actually delivered operationally coincident with the implementation date of the mandate. If service delivery is delayed, any related aircraft equipage mandate should also be delayed accordingly. States/ANSPs should consider offering operational advantages to early adopters of the desired equipage or capability to offset costs. This would enable operators to make at least partial use of the mandated capability in advance of the mandated date.

- Harmonization: it is essential that States/ANSPs harmonize requirements with neighbours as far as practicable, including implementation dates.

- Regulatory considerations: it is essential that regulators are involved very early in the planning process. Experience shows that regulatory approvals are often a problem with the introduction of aircraft equipage mandated environments.

- High Seas: Where airspace over the High Seas is affected, States must ensure appropriate ICAO processes are followed, including amendments to the required ICAO provisions.

CURRENT SITUATION

Aerodrome Analysis

6.1 In the 1990s and the first decade of the new millennium, aerodrome operators in Asia-Pacific invested billions of dollars to enhance capacity of existing aerodromes and to build new ones to meet increasing air traffic demand. Notable examples are the opening of Bangalore, Hong Kong, Incheon, Kuala Lumpur International, Shanghai Pudong and Suvarnabhumi airports and the expansion of New Delhi and Beijing Capital airports. The automation and the adoption of self-service technology for passenger handling such as check-in and automated border control has enabled many airports to build up capacity without expanding passenger terminal footprint.

6.2 However new capacities are often taken up quickly by tremendous traffic growth experienced by the Asia-Pacific region in the same period. From year 2000 to 2011, world passenger traffic increased by 56% while the Asia-Pacific region saw an increase of 139%. Runways are typically the capacity bottleneck of aerodromes but aircraft parking stands, baggage sorting and transfer facilities, aprons and passenger security screening points operating close to or over capacity are becoming choke points as well, especially at hub airports. A-CDM promises to alleviate congestion but the close collaboration between airport management and other stakeholders such as its shareholder, ATM and airlines is essential to a coordinated development of the capacity of the regional air transport network in the long-term.

Airspace and FIR Analysis

6.3 As a result of the 2013 Major Traffic Flow (MTF) study, there were several features of the lack of seamless ATM facilities and practices evident in the Asia Pacific region.

a) Size of FIR – fragmented FIRs resulting in flights transiting multiple FIRs with multiple TOC points.

b) Traffic density – the capacity of ANSP infrastructure and airspace had not kept up with traffic growth.

c) Airspace and Route design and capacity –

- route structure based on historical requirements and not on current aircraft navigational capability;
- ground-based navigation aid routes, around which SUAs have grown;
- crossing tracks with and without ATS surveillance, whereby States mainly rely on the use of FLAS for procedural flight level separation;
- requirement for vertical transitions because of the two different FLOS (metric and imperial) in the region;
- routes with flight level, direction, and time restrictions making flight planning more complex;
- routes with restrictions that are un-coordinated with neighbouring FIRs; and
- restrictive route structures agreed to in a historical context which is inadequate for today's traffic requirements.

d) ATS surveillance and communications capability -

- Non- existent or unreliable surveillance or communications capability in critical locations;
- Capability not fully utilised to provide appropriate level of service; and
- Hand-off procedures not aligned to ATM facilities and capabilities.

e) Compatibility between FIRs –

- Infrastructure development based only on national requirements, resulting in duplicated and yet uncoordinated facilities; and
- Unnecessarily conservative separation requirements at TOC points (it was not clear if this is due to lack of confidence in adjacent FIRs capability to adhere to agreed procedures, or for other operational reasons).

f) ATC standards –

- Apparent reluctance in applying ICAO standard separation minima (it was not clear if this is due a lack of confidence in ATM competence or capability); and
- Although GNSS separation is available in Doc 4444, few ANSPs in the Asia/Pacific Region used this as an alternative means of providing longitudinal separation.

g) Focus groups

- Lack of effective focus groups to address airspace capacity and FIR issues, although there had been a recent increase in informal and bi-lateral ATM coordination;
- Lack of a requirement for regular review mechanisms of operational issues within an FIR, including feedback from aircraft operators.

h) Uncoordinated and limited use of AIDC.

6.4 Generally flights operating on MTFs between large FIRs (particularly where there were multiple FIRs being provided services by one State) in Category R airspace were already reasonably seamless, such as in the Pacific. However, apart from being largely oceanic in nature, these MTFs had the advantage of being usually in an east/west alignment between continents and not impacted by busy crossing routes.

6.5 In addition, lower traffic density MTF enabled flexible tracks such as UPR applications. It was notable that these MTFs tended to have dedicated focus groups like Informal South Pacific ATS Coordinating Group (ISPACG) and Informal Pacific ATC Coordinating Group (IPACG) conducting regular reviews of operational efficiency.

6.6 Where long and short haul routes crossed multiple smaller FIRs, particularly with busy regional flows, there was a greater likelihood of reduced efficiency caused by a combination of inconsistent application of ATM procedures and standards, non-harmonized infrastructure development, route structure, TOC and other legacy issues. However, there were also examples of partly seamless ATM between some busy city pairs (such as Singapore/Kuala Lumpur and the Kuala Lumpur/Bangkok) in the region, resulting from bilateral efforts between ANSPs.

6.7 The Pearl River Delta airspace containing very dense air traffic served by Hong Kong, Macau, Shenzhen, and Guangzhou aerodromes, and associated heliports had Airspace Organization and Management (AOM) and civil/military coordination issues that stemmed largely from the division of responsibility between FIRs. Segregated SIDs and STARs, application of FUA and holistic 'Metroplex' planning principles as well as more integrated ATS systems are needed to achieve greater optimisation of the limited airspace available.

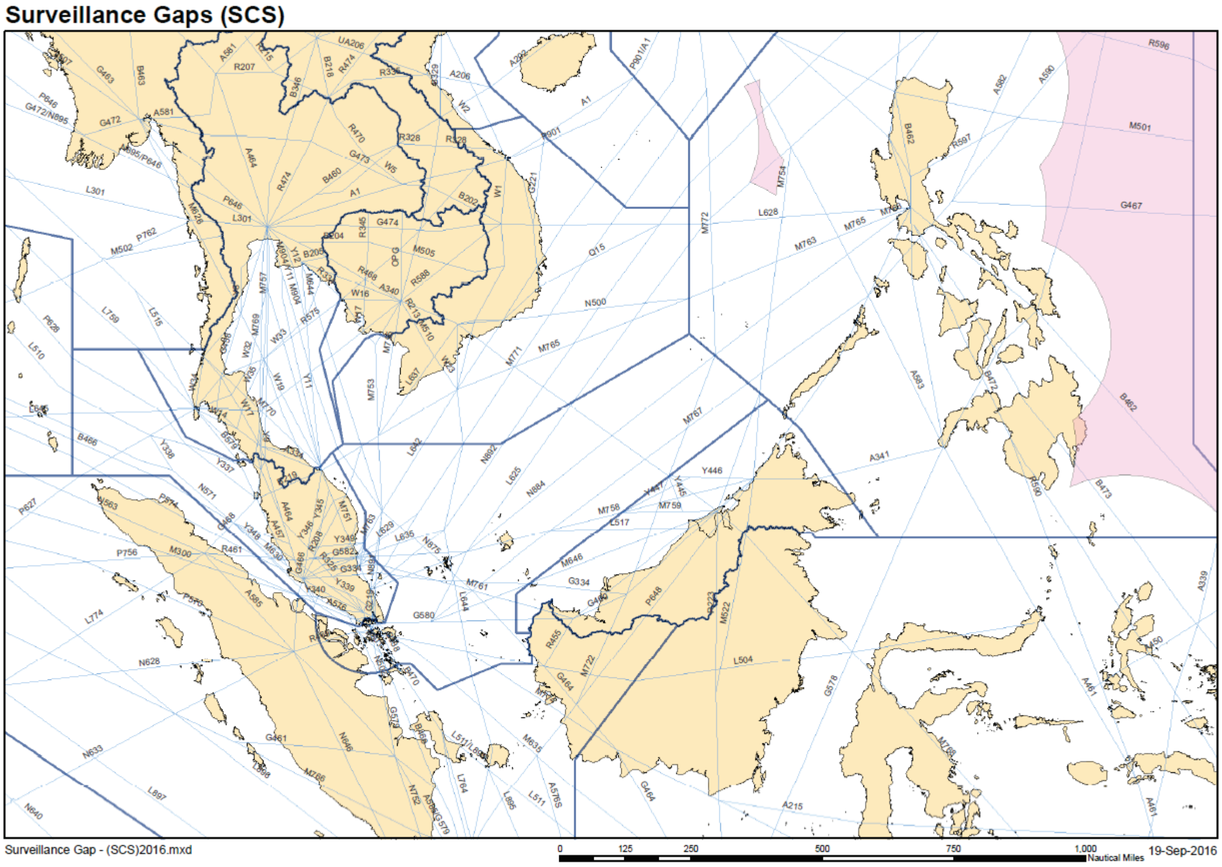


Figure 6: South China Sea ATS surveillance gaps (as at 19 September 2016)

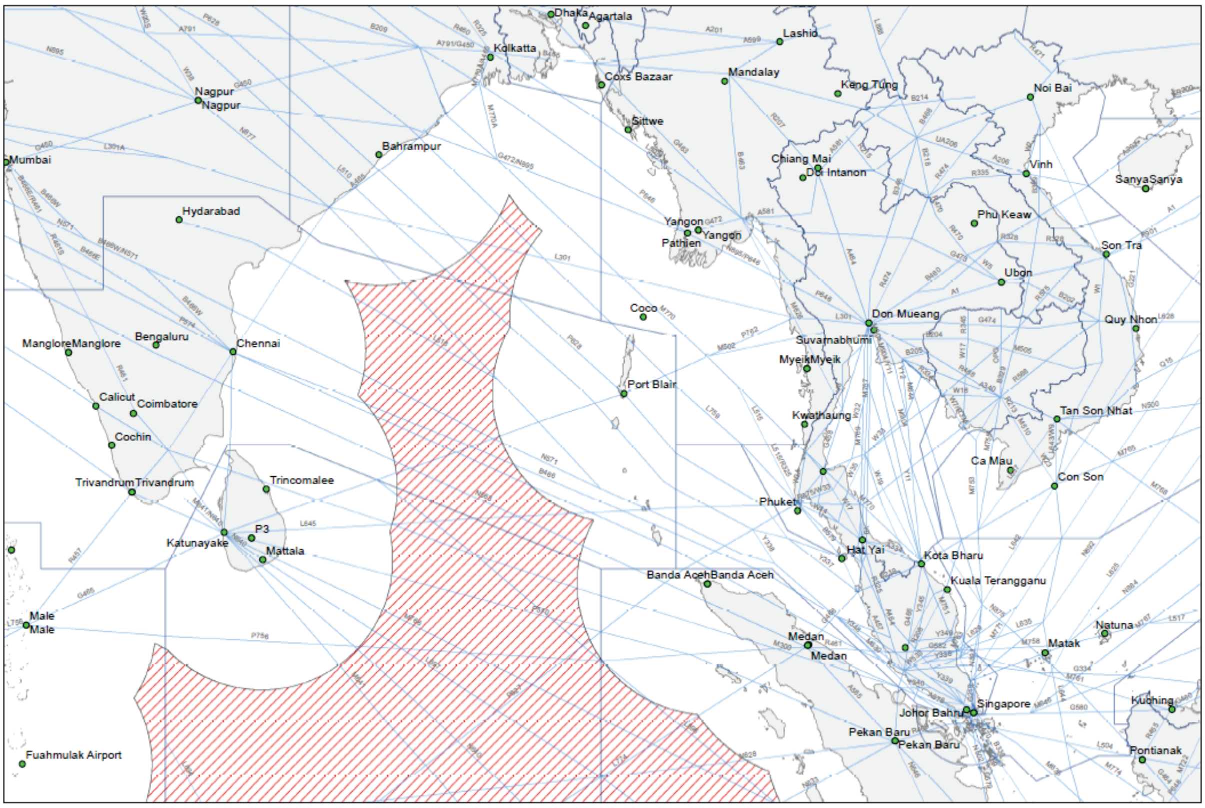


Figure 7: Bay of Bengal ATS surveillance gaps (as at December 2015)

6.8 The main areas of the Asia/Pacific region lacking ATS surveillance and communication coverage which need to be rectified due to traffic density, weather deviations and contingency responses are as follows:

a) highest priority: South China Sea airspace between Viet Nam, Brunei Darussalam and the Philippines (**Figure 6**);

b) high priority: Bay of Bengal airspace between the Indian subcontinent and the Andaman Islands (**Figure 7**);

c) medium priority:

- airspace between Indonesia and Australia (between Java and West Australia);
- airspace between the Philippines and Indonesia (**Figure 6**); and

d) lower priority: Coral Sea between Papua New Guinea and Australia.

<u>Europe – Asia/Pacific Trans-Regional Issues</u>

6.9 A number of ATS routes from the Russian Federation converged within Mongolian airspace because of the limited number of entry/exit points on the Mongolian/Chinese airspace boundary. Military restrictions had affected ATS route development to China/Mongolia/DPRK and Japanese airspace. An enhancement of civil/military cooperation and ATM coordination is necessary to address these trans-regional issues.

6.10 There is a long-standing problem with the incompatibility of the some elements of the European On-Line Data Interchange (OLDI) system with the more global AIDC messages from the Russian Federation to China and Mongolia. It is possible that a solution may be determined by the Inter-Regional APAC/NAT AIDC Task Force.

6.11 Russia utilised a 30 km (16NM) separation within its upper airspace, while Mongolia initially used 80NM when ATS surveillance was implemented in mid-2012, with an intention to reduce this to a surveillance-based separation after appropriate training.

6.12 Given the need to minimise safety issues such as Large Height Deviations and to improve confidence in order to minimise trans-regional separations, ATS surveillance data-sharing between the Russian Federation and China/Mongolia is necessary in accordance with PASL Phase I, even if only based on ADS-B.

North/South America – Asia/Pacific Trans-Regional Issues

6.13 There were no major trans-regional issues between Asia and North America via the Anchorage Oceanic, Fukuoka and Oakland Oceanic FIR due to the continuing work at the IPACG involving Japan and the United States. The Cross-Polar Working Group (CPWG) also discussed operations extending into the area between Asia and North America. The Fukuoka and Oakland Oceanic FIRs had high-density Category R airspace but is served by an OTS (PACOTS; Pacific Organized Track System). ADS-C, CPDLC and AIDC were fully deployed in the Anchorage Oceanic, Fukuoka and Oakland Oceanic FIRs, and common procedures, including 30NM separation standards based on RNP4, DARP, UPR were applied.

6.14 The Oakland Oceanic FIR and South Pacific utilised technologies consistent with Block 0 and with Conflict Prediction and Resolution (CPAR), AIDC, CPDLC and ADS-C, were able to provide a Seamless ATM service already between Asia/Pacific and North America. This included the provision of UPRs and DARP where operationally possible. These developments had been managed through the ISPACG, and were a model for other oceanic regions in the Asia/Pacific.

6.15 The airspace between the Pacific and South America had very low density traffic. South American States had not yet developed the same Seamless ATM services capability in the trans-regional airspace to support ATM and essential SAR services. However, Chile is an active member of ISPACG, and Ecuador is enhancing services in the airspace adjacent to the Tahiti FIR.

Middle East/Africa – Asia Trans-Regional Issues

6.16 The transition of traffic from the Muscat FIR to the Mumbai FIR is identified as a contributing factor to the congestion in the Bahrain FIR and causal factor for the delayed departures from airports, particularly in the United Arab Emirates. India had recently reduced horizontal separation on some routes to 50/50NM. In addition, a FLAS is also used by India and applied to low density traffic from/to African Regions, against the higher density Middle East (MTF AR-10) routes.

6.17 Oman require 10 minute longitudinal separation between eastbound aircraft from the United Arab Emirates regardless of the level the aircraft were climbing to, with plans to reduce this to seven minutes, consistent with the 50NM standard applied within the Mumbai FIR. However this is still very restrictive, given the ATS surveillance coverage within the Muscat FIR and the fact that the aircraft were climbing to a number of different flight levels.

6.18 Complicating trans-regional operations is the configuration of the Sana'a FIR (OYCS), which projected a triangle of airspace between the Muscat FIR (OOMM) and Mumbai FIR (**Figure 8**). This required aircraft that were operating between the Muscat and Mumbai FIRs to transit a short segment of the Sana'a FIR, which used procedural ATC standards.

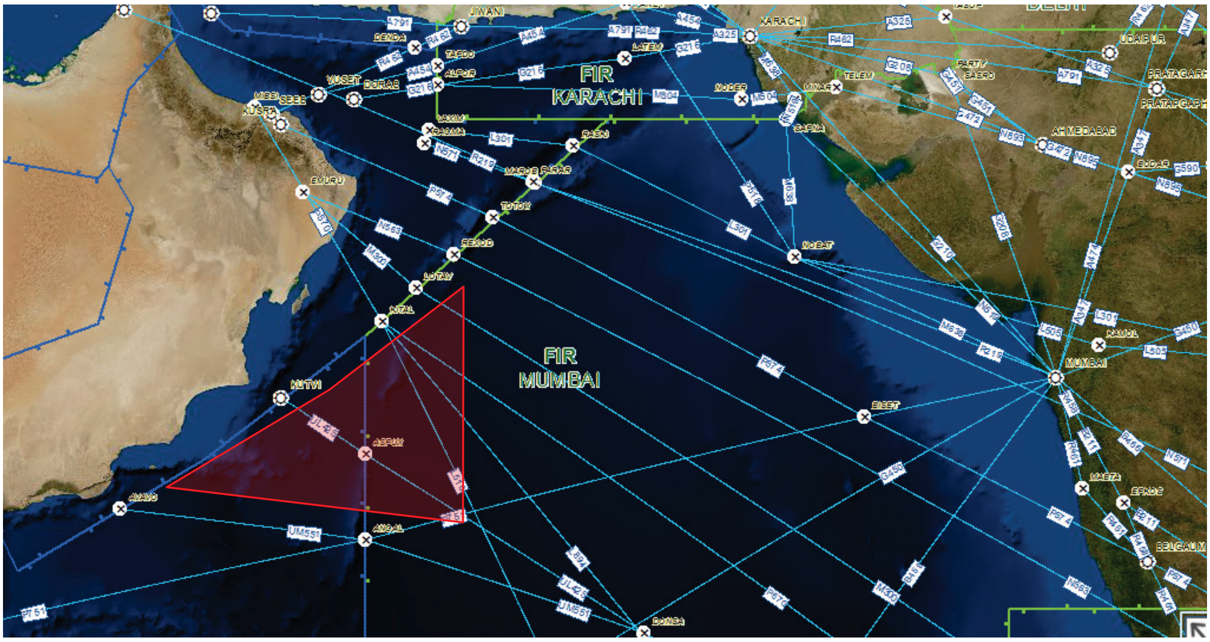


Figure 8: Middle East – Asia Trans-Regional Routes

6.19 The area shown in red in **Figure 8** had since been delegated to Muscat so ATS surveillance and VHF communications (Category S airspace services) could be provided from Oman. In addition, this reduced radiotelephone and TOCs, improving ATC workload.

6.20 The problem of OLDI conversions to AIDC between India and the Sultanate of Oman had prevented implementation of AIDC trans-regionally in this area thus far.

APSAPG Discussions on Economic Aspects

6.21 Action Item 48/2 from the DGCA/48 requested the APSAPG to study the ASBU elements and provide advice on the benefits, business case and implications to States and Administrations and explore formulating a regional position prior to the AN-Conf/12. APSAPG/1 discussed the economic aspects of ASBU and determined that the APSAPG itself would not provide detailed economic and business case data because each implementation situation would vary according to the operating environment; thus this is a matter for each State to analyse. However, the APSAPG agreed it is possible to provide high-level guidance such as guidance to States for the development of cost benefit analysis of implementation activity.

ADS-B South China Sea Cost-Benefit Study Summary

6.22 In 2009 CANSO and IATA agreed to conduct a cost-benefit study for the initial phase of the ADS-B project (**Figure 9**) over the South China Sea involving two trunk routes L642 and M771 (See Fig 6). . The study concluded that there was a strong business case for the project taking into account the economic savings in fuel burnt, carbon emissions, Aircraft Direct Operating Costs (ADOC) and Passenger Value of Time (PVT). The project involved the sharing of the ADS-B data and VHF communications among Indonesia, Vietnam and Singapore to cover gaps in radar surveillance and VHF communications over the two trunk routes L642 and M771. . The initial phase of ADS-B implementation over South China Sea had since been completed. Aircraft longitudinal separation was reduced from 80-50 NM to 40NM when the ADS-B mandated became effective in December 2013 followed by further reduction to 30NM in July 2014.

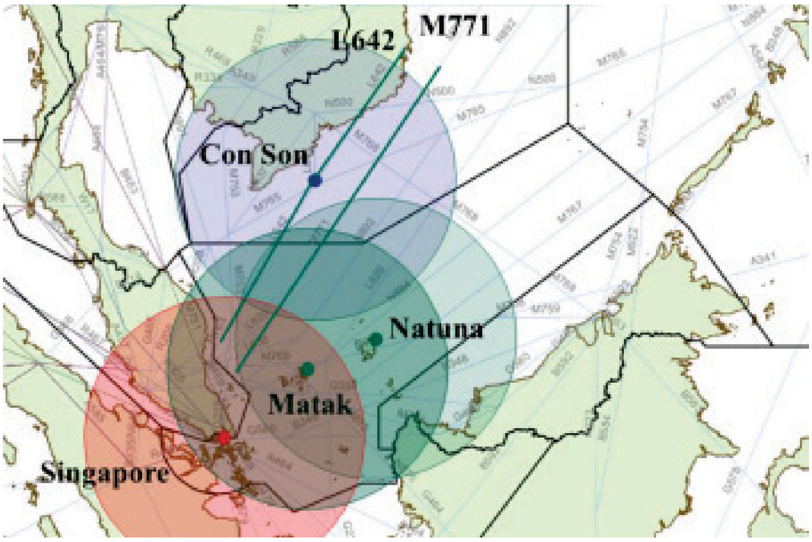


Figure 9: Initial Phase of ADS-B collaboration project over the South China Sea

Airborne Efficiency Savings

6.23 The implementation of the ADS-B exclusive airspace has led to enhancement in the allocation of cruising levels for flights that operate on the two trunk routes. Statistical samples of flight level allocation after implementation of ADS-B showed that approximately 5% of the flights achieved a more optimum level of between 1,000 to 5,000 feet above their assigned cruising levels prior to ADS-B implementation.

6.24 With the use of the ICAO Fuel Savings Estimation Tool (IFSET), the projected fuel savings achieved by these flights over the period of 1 year in 2014 amounts to 1.5 million kilograms of fuel. At an average fuel price of S$2.72 per US gallon, this amounts to about $2 million worth of fuel savings for the airlines.

6.25 In addition to fuel saved from the optimum cruising level allocation, the previous study by Singapore also took into account benefits from reduction of airborne delay from cruising at the optimum flight level. This equates to savings in passenger value of time (PVT) and aircraft direct operating cost (ADOC). The total PVT and ADOC savings is about $1 million. Overall the benefit yield amounts to about $3 million (**Table 3**).

Airborne Efficiency – Savings 2014	**12 months**
Fuel Burn Savings (kg)	1,567,920 kg
Fuel Burn Savings (2014 US$)	$1,966,694
Flight time savings (hours)	138
Airborne ADOC w/o fuel savings (2014 US$)	$411,499
PVT savings (2014 US$)	$576,513
CO2 Emissions Savings (kg)	4,938,948 kg
CO2 Savings (2014 US$)	$44,451
Total Economic Savings (2014 US$)	**$2,999,156**

Table 3: ADS-B Airborne Efficiency

Ground Delay Savings

6.26 The previous study by Singapore also took into account potential reduction in ground delays arising from the elimination of queuing time for optimum levels. However, in reality the estimation of ground delay savings is complicated by many other factors contributing to ground delays at the airport. If we exclude these other factors the estimated economic benefits from ground delay savings is about to $1 million from savings in PVT, ADOC and fuel burn (**Table 4**).

Ground Delay –Savings 2014	
Fuel Burn Savings (kg)	275,700 kg
Fuel Burn Savings (2014 US$)	$345,820
Time savings (hours)	128
Ground ADOC w/o fuel savings (2014 US$)	$95,236
PVT savings (2014 US$)	$534,737
CO_2 Emissions Savings (kg)	868,455 kg
CO_2 Savings (2014 US$)	$7,816
Total Economic Savings (2014 US$))	**$981,992**

Table 4: Ground Delay Savings

<u>Costs</u>

6.27 The cost incurred in 2014 is based on the depreciation and recurrent cost of equipment used to support the ADS-B operations but excludes sunk costs of existing facilities prior to the project. These include the ADS-B stations in Singapore and Con Son, VHF radios in Con Son, Matak and Natuna, as well as the various telecommunications links. As with the original Cost Benefit Analysis, the costs exclude the ATC system cost and the ADS-B stations in Matak and Natuna which were already installed prior to the project and therefore considered as sunk cost. Avionics and aircraft equipage were also not included as the aircraft operate beyond the airspace concerned. The total cost incurred in 2014 amounts to about $3.5m (**Table 5**).

Cost Items – Savings 2014	
Facilities	Cost incurred in 2014
ADS-B stations in Singapore and Vietnam	$310,000
VHF radios in Indonesia and Vietnam	$1,030,000
Communication links to bring the ADS-B signals from Con Son and Jakarta to Singapore	$1,000,000
Communication links to bring the VHF signals from Con Son, Matak and Natuna to Singapore	$1,110,000
Total Cost	**$3,450,000**

Table 5: Cost Savings

6.28 Overall, the economic savings in 2014 exceeded the total cost by about $0.5m. In the 2009 cost benefit study, it was assumed that aircraft separation in the airspace concerned would be reduced to 5NM with the commencement of ADS-B operations. Based on this current study, it can be seen that even with 30NM separation, the annual benefits in 2014 alone already outweigh the cost. According to ACI, air traffic has been growing strongly in the region with Singapore and Hong Kong chalking up average growth rates of 9.1% and 7.4% per annum over the period 2009-2013. For the region as a whole, the average growth rate during the same period is 6.4%. Clearly, as air traffic continues to grow coupled with further reduction in aircraft separation one can expect the overall economic benefits to increase further.

<u>Other Benefits</u>

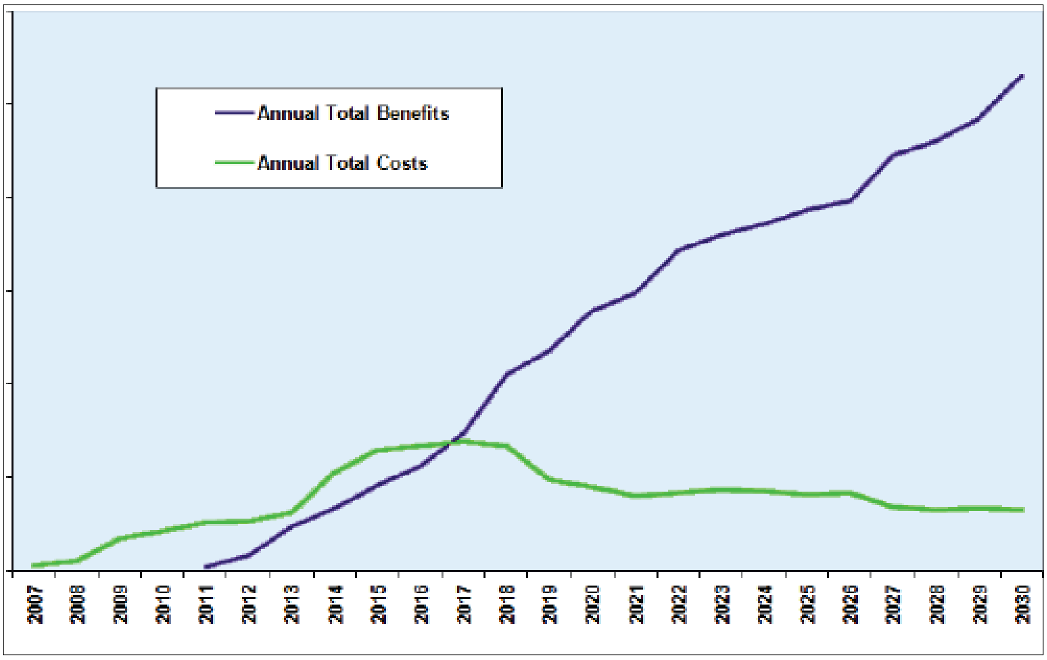
6.29 It should also be noted that there are other benefits apart from economic savings and these include improved safety with enhanced tracking of aircraft and safer and more efficient weather deviations; enhanced aircraft surveillance with increased situational awareness for ATC and the facilitation of search and rescue as well as enhanced flight data collection for better analysis and planning

<u>Other Areas for ADS-B Collaboration</u>

6.30 The successful implementation of the initial phase of the South China Sea should provide a strong impetus for similar collaborative arrangements in the Bay of Bengal and the rest of the South China Sea and indeed for the region as a whole. Potential projects highlighted in the past include ADS-B data sharing between Myanmar and India over the Bay of Bengal and among Singapore, Brunei Darussalam and the Philippines in the eastern part of the South China Sea.

6.31 In May 2015 the ANSPs of India and Myanmar signed an ADS-B data sharing agreement at the sidelines of the CANSO Asia Pacific Conference in Fukuoka, Japan thus establishing the collaborative framework for ADS-B data sharing involving ADS-B stations in India (Port Blair and Agartala) and ADS-B stations in Myanmar (Coco Island and Sittwe). The objective is to provide end to end surveillance for several busy airways over the Bay of Bengal similar to that accomplished over the South China Sea

6.32 ADS-B collaboration over the eastern part of the South China Sea has also been making good progress recently. Singapore is working closely with the Philippines and Brunei Darussalam to share ADS-B data and VHF communications to plug surveillance gaps on the trunk routes M767 and N884. When completed, these airways will have end to end surveillance coverage similar to that achieved in the initial phase of the South China Sea.



<u>United States NextGen Economic Benefits</u>

6.33 The Federal Aviation Administration had conducted a business case study for the Next Generation Air Transportation System (NextGen). NextGen is a wide-ranging transformation of the air transportation system, including ATM technologies and procedures; airport infrastructure improvements; and environmental, safety and security-related enhancements. It is consistent with the GANP and the ASBU initiative.

The cost and benefit calculations underlying the business case for NextGen were developed based on the FAA's 2011 Mid-Term Concept of Operations and the 2012 NextGen Implementation Plan. Modelling of NextGen benefits and costs was based on various inputs. For basic inputs, the USA used traffic data from 2010, along with traffic and fleet forecasts released in early 2011. Recommended economic values, such as those for passenger value of time, etc., were used from early 2011. Based on these inputs, the FAA's analysis showed that NextGen mid-term improvements (until 2020) would generate more than two-and-a-half times in benefits as costs (**Figure 10**).

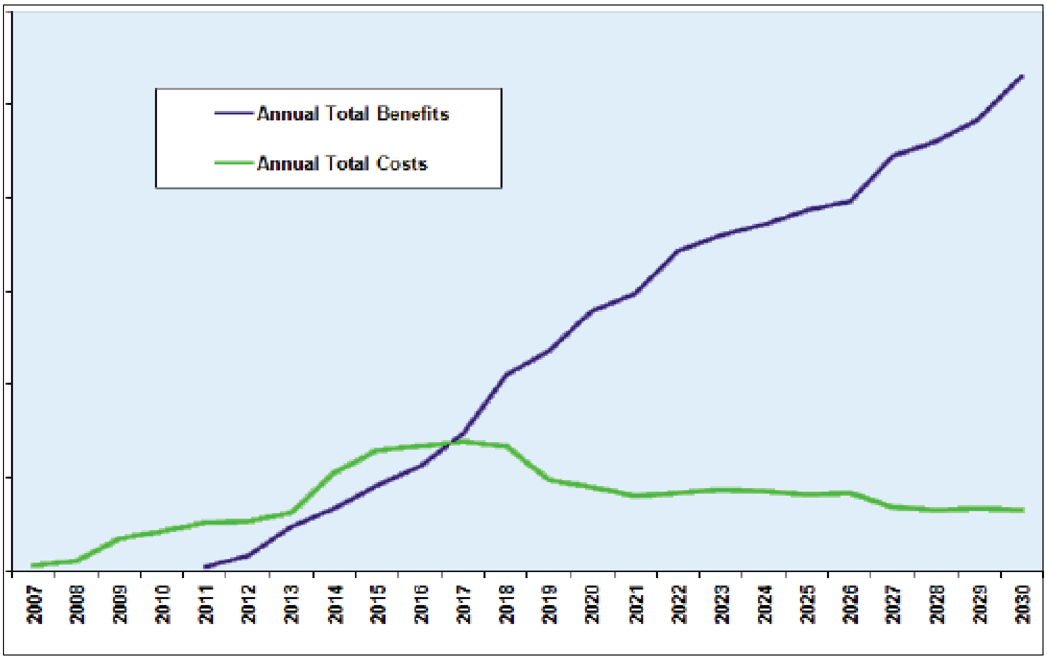


Figure 10: Annual Costs and Benefits

6.34 The NextGen business case focused on the direct benefits to aircraft operators, passengers, and taxpayers from the rollout of NextGen improvements. Benefits identified in the business case were:

- ADOC;
- PVT;
- Reduced FAA operating costs;
- Additional flights enabled by greater capacity;
- Reduced flight cancellations;
- Increased safety; and
- Environmental benefits from reduced aircraft emissions (CO_2 only).

6.35 Types of benefits that were **not** included in the business case were:

- New jobs and economic growth associated with major technology initiatives;
- environmental benefits of bio-fuels or improved engine/aircraft technologies; and
- Environmental benefits from reduced aircraft emissions (NO_X or SO_2).

6.36 The resulting benefit estimates are shown in **Figure 11**:

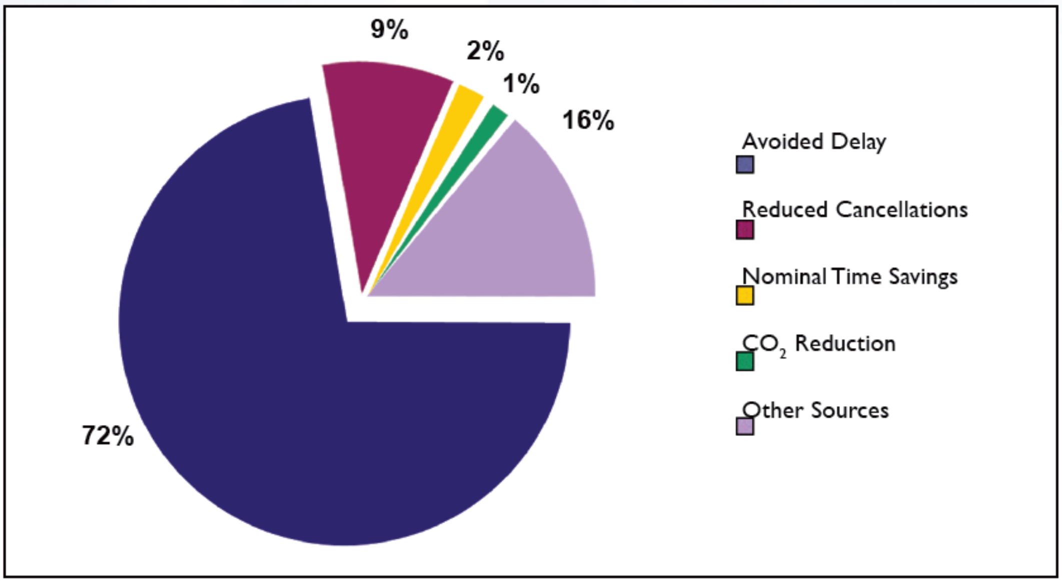


Figure 11: Types of NextGen Benefits until 2030

<u>IATA Seamless ATM Cost-Benefit Analysis</u>

6.37 As general rule, prior to any significant system change, a cost/benefit analysis (CBA) would be conducted to demonstrate the value, negative or positive, of the projected change.

6.38 A CBA of the transition to an Asia Pacific Seamless ATM environment will be developed when the Seamless ATM Plan has been accepted by APANPIRG on behalf of all Asia Pacific States. Although each State retains responsibility for their sovereign airspace, acceptance of the Seamless ATM Plan by APANPIRG, on behalf of all States, creates an obligation on each State to follow the agreed upgrade path. This agreed upgrade path will provide the basis for a Regional CBA.

6.39 Whilst the outcome of the CBA will be determined in future it was felt necessary to demonstrate, at a high level, the benefits of the proposed Seamless ATM Plan.

6.40 IATA conducted an initial economic analysis which was tabled at APSAPG/3 (Chennai, India, 21-25 January 2013).

6.41 Today, demand exceeds capacity at many locations and along some MTF. Many Asia Pacific airports have implemented slot management schemes for part of the day when demand exceeds supply. The consequence of this demand-supply gap is that many MTF are subjected to lengthy delays (e.g. Bay of Bengal) due to capacity limitations.

6.42 Any system delay causes the costs to increase exponentially. When the demand approaches the capacity limits, aircraft must wait to use the system, or various parts of it, until they can be accommodated. These delays impose costs both in terms of aircraft operating expenses and the value of wasted passengers' time.

6.43 In addition to the economic and cost benefits, the existing operational environment also causes longer flight trajectory, inefficient airport capacity usage, flight inefficiencies, higher CO2 emission impacting environment and lower predictability of flight operations.

6.44 IATA's initial economic analysis indicated that if the States in Asia Pacific do not implement the critical ICAO Aviation System Block Upgrade (ASBU) elements of the Seamless ATM Draft Plan, aviation's contribution to the Regional GDP will fall from today's **2.2%** to **0.81%** by 2030.

6.45 Although a "worst case" scenario this would represent a Regional potential economic benefit **loss** of **US$16.63 billion per annum** (based on 2012 data), which will reach an accumulated loss of **US$ 502 billion by 2030**. Upgrading the existing operational environment of ATM is essential in order to enhance the region's economic growth.

6.46 It can be argued that lack of investment in aviation infrastructure will result in this investment being diverted to sectors. However investment in aviation infrastructure, given the reliance in Asia Pacific on aviation, will yield a greater benefit than any other transport modality investment.

PERFORMANCE IMPROVEMENT PLAN

Preferred Aerodrome/Airspace and Route Specifications (PARS)

Note: prior to implementation, the applicability of PARS should be verified by analysis of safety, current and forecast traffic demand, efficiency, predictability, cost effectiveness and environment to meet expectations of stakeholders.

PARS Phase I (expected implementation by 12 November 2015)

Aerodrome Operations

7.1 All high density international aerodromes (100,000 scheduled movements per annum or more) should:

a) provide an appropriate apron management service in order to regulate entry of aircraft into and coordinate exit of aircraft from the apron;

b) have appropriate ATM coordination (including meetings and agreements) related to:

- airport development and maintenance planning;
- coordination with local authorities regarding environmental, noise abatement, and obstacles;
- ATM/PBN procedures for the aerodrome;

c) conduct regular airport capacity analysis, which included a detailed assessment of passenger, airport gate, apron, taxiway and runway capacity; and

d) provide electronic surface movement guidance and control.

Note 1: the 100,000 movement benchmark must not be viewed as lessening more stringent existing requirements and criteria established by the State, or superseding ICAO Annex 14 Volume I requirements, especially with regard to aerodrome certification.

Note 2: the provision of A-SMGCS should be subject to economic analysis.

7.2 All high density aerodromes should operate an A-CDM system serving the MTF and busiest city pairs, with priority implementation for the busiest Asia/Pacific aerodromes[3].

[3] Based on 2015 ICAO data, the 51 busiest Asia/Pacific aerodromes were:

- Australia (Sydney, Melbourne, Brisbane);
- China (Beijing, Shanghai Pudong and Hong Jiao, Guangzhou, Hong Kong, Xi'an, Shenzhen, Chengdu, Kunming, Hangzhou, Chongqing, Xiamen, Wuhan, Zhengzhou, Changsha, Nanjing, Qingdao, Urumqi, Dalian, Guiyang, Tianjin, Haikou, Sanya);
- India (New Delhi, Mumbai, Chennai, Bangalore);
- Indonesia (Jakarta, Surabaya, Bali, Makassar);
- Japan (Haneda, Narita, Fukuoka, Osaka, Sapporo, Naha);
- Malaysia (Kuala Lumpur);
- New Zealand (Auckland)
- Philippines (Manila);
- Republic of Korea (Incheon, Jeju, Seoul);
- Singapore (Changi);
- Thailand (Suvarnabhumi, Don Mueang);
- United States (Honolulu); and
- Viet Nam (Ho Chi Minh, Hanoi).

Terminal Operations (Category T airspace)

7.3 CCO and CDO operations should be considered for implementation at all high density international aerodromes after analysis, based on a performance-based approach.

Note: this does not preclude a State considering implementation of CCO/CDO at other aerodromes as appropriate.

7.4 All international high density aerodromes should have **RNAV 1** (ATS surveillance environment) or **RNP 1** (ATS surveillance and non-ATS surveillance environments) SID/STAR.

7.5 Where practicable, all high density aerodromes with instrument runways serving aeroplanes should have:

a) GBAS precision approaches; or ILS/MLS approaches (with APV approach as a backup); or

b) Approaches with Vertical Guidance (APV), either RNP APCH with Barometric Vertical Navigation (Baro–VNAV) or augmented GNSS (e.g. SBAS); or

c) if an APV is not practical, straight-in RNP APCH with Lateral Navigation (LNAV).

En-route Operations

7.6 Unless supported by alternative means of ATS surveillance (such as radar, where there are no plans for ADS-B), all Category S upper controlled airspace and Category T airspace supporting high density aerodromes should be designated as non-exclusive or exclusive as appropriate ADS-B airspace requiring operation of ADS-B using 1090ES with DO-260/260A and 260B capability, with priority implementation for the following high density FIRs (**Figure 12**) supporting the busiest Asia/Pacific traffic flows (APANPIRG Conclusion 22/8 and 23/5 refer):

a) South Asia: Delhi, Mumbai;

b) Southeast Asia: Bangkok, Hanoi, Ho Chi Minh, Jakarta, Kuala Lumpur, Kota Kinabalu, Manila, Sanya, Singapore, Vientiane; and

c) East Asia: Beijing, Fukuoka, Guangzhou, Hong Kong, Kunming, Incheon, Shanghai, Shenyang, Taibei, Wuhan.

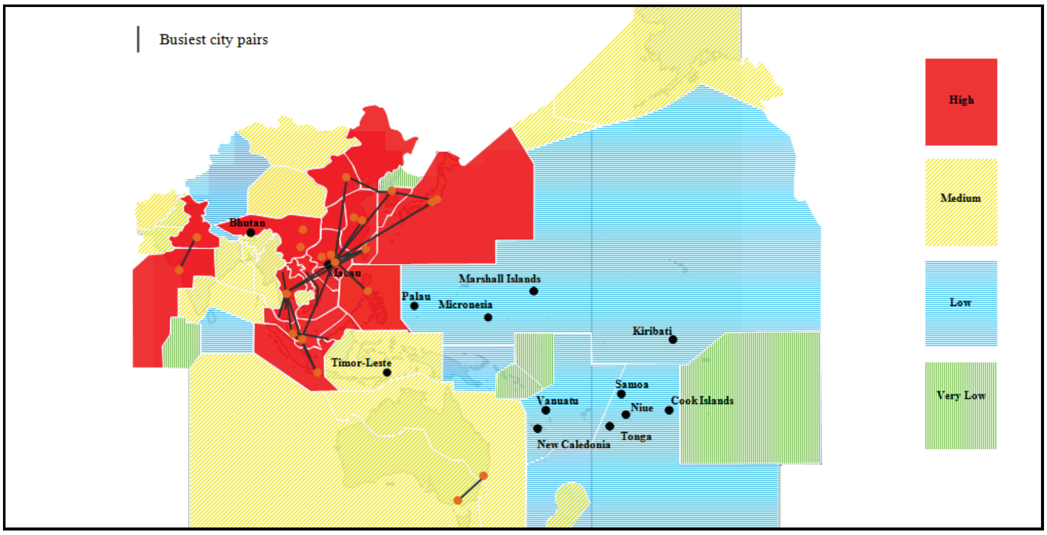


Figure 12: High Density FIRs

Note 1: in areas where ADS-B based separation service was provided, the carriage of ADS-B OUT using 1090ES with DO260/60A or 260B is recommended.

Note 2: States should refer to the ADS-B implementation in the ICAO ADS-B Implementation and Guidance Document (AIGD).

7.7 All Category R and S upper controlled airspace, and Category T airspace supporting high density aerodromes should require the carriage of an operable mode S transponder within airspace where Mode S radar services are provided.

7.8 All Category R and S upper controlled airspace, and Category T airspace supporting high density aerodromes should be designated as non-exclusive or exclusive PBN airspace as appropriate. This is to allow operational priority for PBN approved aircraft, harmonised specifications and to take into account off-track events such as weather deviations, with priority implementation for high density FIRs.

Note: Non-exclusive means that non-PBN aircraft may enter the airspace, but may be accorded a lower priority than PBN aircraft, except for State aircraft.

7.9 All ATS routes should be designated with a navigation performance specification to define the CNS/ATM operational environment. The ATS route navigation performance specification selected should be harmonised and utilise the least stringent requirement needed to support the intended operation. When obstacle clearance or ATC separation requirements demand, a more stringent navigation specification may be selected. As far as practicable, all new ATS Routes designed after June 2013 (adoption of the seamless ATM plan v1.0) should be PBN Routes in accordance with the following specifications :

- Category R airspace – **RNP 4**, **RNP 10** (RNAV 10) (other acceptable navigation specifications – RNP 2 oceanic); and
- Category S airspace –**RNAV 2** or **RNP 2** (other acceptable navigation specifications – RNAV 5).

Note 1: RNP 2 is expected to be utilised before Phase 2, when the RNP 2 instrument procedure design, ATC separation standards and operational approval are in place.

Note 2: within Category R airspace, transition to RNP 4 or RNP 2 oceanic specifications is recommended at the earliest opportunity. RNP 2 oceanic requires dual independent installations, plus CPDLC and ADS-C.

7.10 The ICAO Table of Cruising Levels based on feet as contained in Appendix 3a to Annex 2 should be used.

Civil/Military Cooperation

7.11 Civil/Military Airspace expectations are as follows:

a) SUA should only be established after due consideration of its effect on civil air traffic by the appropriate Airspace Authority to ensure it will be:
   - used for the purpose that it is established;
   - used regularly;
   - as small as possible, including any internal buffers, required to contain the activity therein;
   - if applicable, operated in accordance with FUA principles; and
   - activated only when it is being utilised; and

b) SUA should be regularly reviewed to ensure the activities that affect the airspace, and size and timing of such activity are accurately reflected by the SUA type, dimensions, activation notice and duration of activation.

PARS Phase II (expected implementation by 07 November 2019)

Aerodrome Operations

7.12 Where practicable, all high density aerodromes should provide the following infrastructure and facilities to optimise runway capacity:

a) additional runway(s) with adequate separation between runway centrelines for parallel independent operations;

b) parallel taxiways, rapid exit taxiways at optimal locations to minimize runway occupancy times and entry/exit taxiways;

c) rapid exit taxiway indicator lights (distance to go information to the nearest rapid exit taxiway on the runway);

d) twin parallel taxiways to separate arrivals and departures;

e) perimeter taxiways to avoid runway crossings;

f) taxiway centreline lighting systems;

g) adequate manoeuvring area signage (to expedite aircraft movement);

h) holding bays;

i) additional apron space in contact stands for quick turnarounds;

j) short length or tailored runways to segregate low speed aircraft;

k) taxi bots or towing systems, preferably controlled by pilots, to ensure efficiency and the optimal fuel loading for departure; and

l) advanced visual docking guidance systems.

7.13 All high density aerodromes should have a declared airport terminal and runway capacity based on a capacity and efficiency analysis, to ensure the maximum possible efficiency of aircraft and passenger movement. Sample runway capacity figures are provided from several States in **Appendix D**. In addition, all high density aerodromes should develop and regularly update the Airport Master Plan to align the airport infrastructure future planning with the Seamless ATM needs.

7.14 All high density international aerodromes should implement collaborative Airport Operations Planning (AOP) and where practicable an Airport Operations Centre (APOC).

7.15 All high density international aerodromes should integrate arrival/departure management (AMAN/DMAN) with the surface management systems: A-SMGCS with SMAN or ASDE-X.

7.16 All high density international (ICAO codes 3 and 4) aerodromes and aircraft operators operating from these aerodromes should implement EVS and runway safety alerting logic (SURF-1A) in accordance with EUROCAE document EUROCAE/RTCA documents ED-159/DO-312/ ED-165.

Terminal Operations (Category T airspace)

7.17 **RNP 0.3** arrival/departure, approach and/or en-route transiting procedures should be considered at high density aerodromes with rotary wing operations.

7.18 All international aerodromes should have **RNAV 1** (ATS surveillance environment) or **RNP 1** (ATS surveillance and non-ATS surveillance environments) SID/STAR.

7.19 Where practicable, all aerodromes with instrument runways serving aeroplanes should have:

a) GBAS precision approaches; or ILS/MLS approaches (with APV approach as a backup); or

b) APV, either RNP APCH with Barometric Vertical Navigation (Baro–VNAV) or augmented GNSS (e.g. SBAS); or

c) when an APV is not practical, straight-in RNP APCH with LNAV.

7.20 When establishing the implementation of PBN approach procedures in accordance with Assembly Resolution A37-11, States should first conduct an analysis of the instrument runway eligibility for APV approaches. This analysis should include the feasibility of the APV at a particular location, the presence of regular commercial operations and the current or projected user fleet capability for APV. The introduction of landing capability using GNSS and its augmentations such as GBAS Landing System (GLS) is recommended where these systems were economically beneficial. Locations where APV approach were either not feasible or where regular operators could not realise the benefit of APV should implement RNP APCH with LNAV minima instead of APV, to provide the safety benefits of straight-in approach procedures. Where a short length or tailored runway designed to segregate low speed aircraft is established, the runway should be served by PBN procedures including SID and STAR that provided segregation from the procedures serving other aerodrome runways as far as practicable.

7.21 PBN procedures that overlay visual arrival and departure procedures should be established where this provided an operational advantage.

7.22 Airspace and instrument flight procedures associated with high density international aerodromes should not be constrained by international borders and political barriers as far as practicable. Airspace and procedures should be established only after appropriate consideration of:

a) environmental efficiencies;

b) noise abatement and local authority regulations;

c) adjacent aerodromes;

d) conflicting instrument flight procedures; and

e) affected ATC units or ATM procedures.

<u>En-route Airspace</u>

7.23 All <u>Category R and S</u> upper controlled airspace, and <u>Category T</u> airspace should, unless approved by the State, require the carriage of an operable mode S transponder within airspace where Mode S radar services are provided.

7.24 All en-route controlled airspace should be designated as being exclusive PBN airspace with mandatory carriage of GNSS utilising RNP navigation specifications, except for State aircraft. Such implementation mandates should be harmonised with adjacent airspace. PBN ATS routes should be established in accordance with the following specification:

- <u>Category R and S</u> airspace – **RNP 2**.

Note: the Asia/Pacific recognises an equivalency for RNP 2 as being an aircraft approved for RNAV 2, RNP 1 and with GNSS. Prior to the ICAO standard flight plan being updated to recognise RNP 2, States should ensure that aircraft operators with RNP 2 approval file designator 'Z' in field 10 and 'NAV/RNP 2' in field 18.

7.25 All Category S upper controlled airspace and Category T airspace should be designated as non-exclusive or exclusive as appropriate ADS-B airspace requiring operation of ADS-B using 1090ES with DO-260/260A or 260B capability.

7.26 In areas where ADS-B based separation service is provided, the mandatory carriage of ADS-B OUT using 1090ES with DO260/60A or 260B should be prescribed .

7.27 All high density international aerodromes should implement approaches with the Continuous Descent Operations (CDOs) using VNAV as far as practicable.

Note: Refer to RTCA DO-236CB, Minimum Aviation System Performance Standards: Required Navigation.

7.28 All high density FIRs should implement data-link Departure Clearance (DCL) compliant with EUROCAE WG78/RTCA SC 214 standards.

Common network services

7.29 All ANSPs serving high density FIR should connect to CRV (Common aeRonautical Virtual private network). ANSPs serving as Inter-regional Backbone Boundary Intermediate Systems should connect to the IP network infrastructure of other regions.

Preferred ATM Service Levels (PASL)

Note: prior to the implementation, the applicability of PASL should be verified by analysis of safety, current and forecast traffic demand, efficiency, predictability, cost effectiveness and environment to meet expectations of stakeholders.

PASL Phase I (expected implementation by 12 November 2015)

Aerodrome Operations

7.30 All high density aerodromes should have AMAN/DMAN facilities.

Terminal Operations

7.31 All high density aerodromes should have meteorological information provided by aerodrome meteorological offices (e.g., aerodrome meteorological forecasts and reports, aerodrome warnings and wind shear warnings) and automated equipment (e.g., wind shear alerts) as necessary supporting enhanced efficiency and safety of efficient terminal operations.

En-route Operations

7.32 High density FIRs (refer **Figure 12**) supporting the busiest Asia/Pacific traffic flows and high density aerodromes should implement ATFM incorporating CDM to enhance capacity, using bi-lateral and multi-lateral agreements.

7.33 Harmonization of upper airspace classification should be as follows:

a) Category R controlled airspace– **Class A**; and

b) Category S controlled airspace– **Class A**, or if there are high level general aviation or military VFR operations: **Class B** or **C**.

7.34 Where practicable, all ATC Sectors within the same ATC unit with ATS surveillance capability should have automated hand-off procedures that allow the TOC of aircraft without the necessity for voice communications, unless an aircraft requires special handling.

ATM Systems

7.35 The delivery of CNS/ATM services should be based primarily on the CNS/ATM capability. All ATC units should authorise the use of the horizontal separation minima stated in ICAO Doc 4444 (PANS ATM), or as close to the separation minima as practicable, taking into account such factors as:

a) the automation of the ATM system;

b) the capability of the ATC communications system;

c) the performance of the ATS surveillance system, including data-sharing or overlapping coverage at TOC points; and

d) ensuring the competency of air traffic controllers to apply the full tactical capability of ATS surveillance systems.

7.36 The efficacy, continuity and availability of ATM services should be supported by adherence with regional planning and guidance material regarding ATM automation and ATM contingency systems.

7.37 Paper flight progress strips should not be used in automated ATM environments due to efficiency and transcription error/data mismatch issues.

7.38 ADS-B (using 1090ES) or MLAT or radar surveillance systems should be used to provide coverage of all Category S-capable airspace as far as practicable. Data from ATS surveillance systems should be integrated into operational ATC aircraft situation displays (standalone displays of ATS surveillance data should not be used operationally).

7.39 Mode S surveillance and the use of Mode S Downlinked Aircraft Parameters (DAPS) should be enabled in all upper level Category S airspace and all Category T airspace servicing high density city pairs. ATM automation system specifications should include the processing and presentation in ATC human-machine interfaces and decision support and alerting tools, the communications, navigation and approach aid indicators received in items 10 and 18 of FPL and ATS messages, where applicable, and the following Mode S or ADS-B downlinked aircraft parameters as a minimum:

- Aircraft Identification;
- Aircraft magnetic heading;
- Aircraft indicated airspeed or Mach Number; and
- Pilot selected altitude.

Note1: DAPS may not be present in downlinked reports from some aircraft ADS-B applications.

Note 2: Downlinking of correct Aircraft Identification (Flight ID) enables automated coupling of ATS surveillance system information with the flight plan, and unambiguous ATC identification of aircraft. States should undertake comprehensive education programs to ensure pilots set the correct Flight ID. Guidance on the correct use of the aircraft identification function is provided in the ADS-B Implementation and Operations Guidance Document, available on the ICAO Asia/Pacific Regional Office website.

7.40 All Category S upper controlled airspace, and Category T airspace supporting high density city pairs and wholly served by Mode S SSR and/or ADS-B surveillance should implement the use of a standard non-discrete Mode A code for Mode S transponder equipped aircraft to reduce the reliance on assignment of discrete Mode A SSR codes and hence reduce the incidences of code bin exhaustion and duplication of code assignment.

7.41 Within Category R airspace, ADS-C surveillance and CPDLC should be enabled to support PBN-based separations, as well as UPR and DARP.

7.42 Subject to appropriate filtering, ATS surveillance data, particularly from ADS-B, should be shared with neighbouring ATC units within high density FIRs (refer **Figure 12**). Direct speech circuits and appropriate handoff procedures should be implemented between controllers providing ATS surveillance in adjacent airspace.

7.43 ATM systems should enable AIDC (version 3 or later) between ATC units where transfers of control are conducted unless alternate means of automated communication of ATM system track and flight plan data are employed. As far as practicable, the following AIDC messages types should be implemented:

- Advanced Boundary Information (ABI);
- Coordinate Estimate (EST);
- Acceptance (ACP);
- TOC; and
- Assumption of Control (AOC).

Note: the 18th Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/18) determined that the following interface areas required AIDC priority implementation in order to reduce Large Height Deviations:

a) Indonesia: between Jakarta and Chennai/Ujung Pandang/Brisbane/Melbourne FIRs;

b) India: between Chennai and Kuala Lumpur FIRs;

c) Philippines: between Manila and Fukuoka/Taibei/Hong Kong/Ho Chi Minh/Singapore/Kota Kinabalu/ Ujung Pandang FIRs; and

d) China: between –

i. Urumqi and Lahore FIRs; and

ii. Beijing and Ulaan Baatar FIRs.

Note: States should note the necessity to utilise Logical Acknowledgement Message processing (LAM) when implementing AIDC (refer to guidance in Chapter XX in PAN ICD).

7.44 Priority for FLAS level allocations should be given to higher density ATS routes over lower density ATS routes. FLAS should comply with Annex 2, Appendix 3a unless part of an OTS. FLAS other than OTS should only be utilised for safety and efficiency reasons within:

a) Category R airspace with the agreement of all ANSPs that provide services:

- within the airspace concerned; and
- within adjacent airspace which is affected by the FLAS; or

b) Category S airspace with the agreement of all ANSPs that provide services:

- where crossing track conflictions occur within 50NM of the FIRB; and
- ATS surveillance coverage does not overlap the FIRB concerned, or ATS surveillance data is not exchanged between the ATC units concerned.

7.45 ATM systems, including communication and ATS surveillance systems and the performance of those systems, should support the capabilities of PBN navigation specifications and ATC separation standards applicable within the airspace concerned.

Note: guidance on the performance of ATS communication and surveillance systems is available in the Global Operational Data-link Document.

7.46 ATM systems should be supported by digitally-based AIM systems through implementation of Phase 1 and 2 of the AIS-AIM Roadmap in adherence with ICAO and regional AIM planning and guidance material.

7.47 Each component of an ATM systems should be supplied with the meteorological information necessary for the performance of its respective functions, including *inter-alia,* meteorological reports, forecasts, warnings alerts, advisory and briefing information

Priority

7.48 Where a minimum aircraft equipage is specified, any aircraft that does not meet specified equipage requirements should receive a lower priority, except as prescribed (such as for State aircraft). States should require State aircraft to comply with equipage requirements as far as practicable.

Human Performance

7.49 The following should be established to support human performance in the delivery of a Seamless ATM service. The systems should consider all the elements of the SHEL Model (Software, Hardware, Environment and Liveware – humans), in accordance with the ICAO Human Factors Digest No. 1 and related reference material:

a) human performance training for all managers of operational air navigation services (such as aerodrome operators, ATC organisations and aeronautical telecommunications), such training to include the importance of:

- a proactive organisational culture where managers and operational staff are informed and safety is a first priority, using open communications and an effective team management approach;
- assessment and management of risks by safety review and assessment teams comprising multidisciplinary operational staff and managers which review safety performance and assess significant proposals for change to ATM systems, particularly those related to human capabilities and limitations;
- human factors in –
  - air safety investigation;
  - system design (ergonomics, human-in-the-loop);
  - effective training (including the improved application of simulators);
  - fatigue management;
  - automated safety nets; and
  - contingency planning;
- effective safety reporting systems that –
  - are non-punitive, supporting a 'Just Culture';
  - promote open reporting to management; and
  - focus on preventive (systemic), not corrective (individual) actions in response to safety concerns, incidents and accidents.

b) human performance-based training and procedures for operational staff providing ATS, including:

- the application of tactical, surveillance-based ATC separation;
- control techniques near minimum ATC separation; and
- responses to ATM contingency operations, irregular/abnormal operations and safety net alerts.

c) human performance-based training and procedures for staff providing operational air navigation services (such as aerodrome staff operating 'airside', air traffic controllers and aeronautical telecommunications technicians) regarding the importance of:

- an effective safety reporting culture; and
- 'Just Culture'.

Note: regarding ATM contingency operations, refer to the Regional ATM Contingency Plan.

Civil/Military Cooperation

7.50 Civil/Military ATM expectations are as follows:

a) a national civil/military body should be formed to coordinate strategic civil-military activities(military training should be conducted in locations and/or at times that do not adversely affect civilian operations, particularly those associated with major aerodromes);

b) formal civil-military liaison should take place for tactical responses by encouraging military participation at civil ATM meetings and within ATC Centres;

c) integration of civil and military ATM systems using joint procurement, and sharing of ATS surveillance data (especially from ADS-B systems) should be provided as far as practicable;

d) joint provision of civil/military navigation aids should be encouraged;

e) common training should be conducted between civil and military ATM units in areas of common interest; and

f) civil and military ATM units should utilize common procedures as far as practicable.

PASL Phase II (expected implementation by 07 November 2019)

Aerodrome Operations

7.51 ATM system design (including ATS surveillance, ATS communication systems, ATC separation minimum, aircraft speed control and ATC training) should be planned and implemented to support optimal aerodrome capacity expectations for the runway(s) concerned.

Terminal Operations

7.52 All terminal ATC Sectors should have a nominal aircraft capacity figure based on a scientific capacity study and safety assessment, to ensure safe and efficient aircraft operations.

*Note: A study of the terminal ATC Sector airspace capacity every 15 minutes is provided in **Appendix D**.*

7.53 All AMAN systems should take into account airport gates for runway selection and other aircraft departures from adjacent gates that may affect arriving aircraft.

En-route Operations

7.54 Where practicable, all ATC Sectors with adjacent ATC Centres using ATS surveillance capability should have automated hand-off procedures that allow the TOC of aircraft without the necessity for voice communications, unless an aircraft requires special handling.

7.55 All FIRs supporting Major Traffic Flows (detailed in the Asia/Pacific eANP) should implement ATFM incorporating CDM to enhance capacity, using bi-lateral and multi-lateral agreements.

Note: refer to the Asia/Pacific ATFM Framework on Collaborative ATFM for more details on Network Operations expectations.

7.56 All high density FIRs (detailed in the Asia/Pacific eANP) should enhance the ATFM and CDM in accordance with the ATFM Framework in order to enhance and monitor the airspace capacity.

Note: refer to the Asia/Pacific ATFM Framework for Collaborative ATFM paragraphs 7.6, 7.7, 7.8, 7.11, 7.18, 7.19, 7.21, 7.23, 7.26, 7.27, 7.28, 7.30, 7.31, 8.9.

Note: full flexible use of airspace (FUA) not yet incorporated into the Asia/Pacific ATFM Framework for Collaborative ATFM.

7.57 Subject to appropriate filtering, ATS surveillance data, particularly from ADS-B, should be shared with all neighbouring ATC units.

7.58 ATM systems should enable AIDC, or an alternative process that achieves at least the same level of performance as AIDC, between en-route ATC units and terminal ATC units where transfers of control are conducted.

7.59 To ensure the safety and efficiency of aircraft operations, a nominal aircraft capacity figure based on a scientific capacity study and safety assessment should be available for all en-route ATC sectors.

*Note: a study of the en-route ATC Sector airspace capacity every 15 minutes is provided in **Appendix D**.*

7.60 All States with Agencies that conduct ballistic launch or space re-entry activities should ensure:

a) the development of written coordination agreements between the State civil aviation authority and the launch/re-entry agency concerned;

b) that strategic coordination is conducted between the State civil aviation authority and any States affected by the launch/re-entry activity at least 14 days prior to the proposed activity, providing notice of at least:

   i) three days for the defined launch window; and

   ii) 24 hours for the actual planned launch timing;

c) that consideration of affected airspace users and ANSPs is made after consultation, so that the size of the airspace affected is minimized and the launch window is optimized for the least possible disruption to other users ; and

d) that communication is established with affected ANSPs to provide accurate and timely information on the launch/re-entry activity to manage tactical responses (for example, emergencies and activity completion).

ATM Systems

7.61 ATM systems should be supported by complete implementation of AIM Phase 3 (using at a minimum, version AIXM 5.1).

7.62 ATM systems providing services within Category R airspace should enable appropriate ATC capabilities including CPAR, which is a key enabler for UPR and DARP operations.

7.63 Electronic flight progress strips should be utilised wherever automation systems allow the capability.

7.64 Direct speech circuits or digital voice communications, meeting pre-established safety and performance requirements, and appropriate handoff procedures should be implemented between controllers providing ATS surveillance in adjacent airspace.

7.65 An agreement between the MET authority and the appropriate ATS authority should be established to cover the exchange of meteorological information obtained from aircraft.

7.66 All States should ensure appropriate SAR capability by complying with the provisions of the Asia/Pacific SAR Plan.

7.67 All States should upgrade their ATM voice communication systems or implement analog/digital VoIP converters in compliance with the EUROCAE ED-137 standards (interoperability standards for VOIP ATM components).

Safety Nets

7.68 ATS surveillance systems should enable STCA, APW and MSAW. Route Adherence Monitoring (RAM) should be utilised when monitoring PBN route separations. Cleared Level Adherence Monitoring (CLAM) should be utilised to monitor RVSM airspace.

Human Performance

7.69 Prevention of fatigue systems should be established to support human performance in the delivery of a Seamless ATM service. The systems should be consistent with guidance within ICAO Doc 9966 *FRMS – Fatigue Risk Management System*.

PASL Phase III (expected implementation by 03 November 2022)

7.70 Digital Clearance Delivery should be implemented for flights departing high density airports or operating on routes between the busiest Asia/Pacific city pairs.

En-Route Operations

7.71 Where practicable, free routes can be introduced in Category S controlled upper airspace, where the flight plan is not defined as segments of a published route network or track system, to facilitate user-preferred profiles.

ASBU Block 1 After 2019

7.72 In view that provisions for ASBU Block 1 modules would be available after 2019, the following ASBU Block 1 modules should be considered for implementation in PASL Phase III to enhance ATM services throughout the region:

a. **B1-NOPS** – Better use of the airspace and ATM network, with positive effects on the overall cost-efficiency of ATM. Optimization of DCB measures by using assessment of workload/complexity as a complement to capacity. Airspace users would have greater visibility and say on the likelihood to respect their schedule and can make better choices based on their priorities. The module is expected to further reduce the number of situations where capacity or acceptable workload would be exceeded.

b. **B1-FICE** – The use of a new mechanism for FPL filing and information sharing will facilitate flight data sharing among the actors. FF-ICE, Step 1 for ground-ground application will facilitate collaborative decision-making (CDM), the implementation or the systems interconnection for information sharing, trajectory or slot negotiation before departure providing better use of capacity and better flight efficiency. Reduced air traffic controller (ATC) workload and increased data integrity supporting reduced separations translates to cross-sector / cross-border capacity flow increases. Better knowledge of aircraft capabilities allows trajectories closer to airspace user preferred trajectories and better planning.

c. **B1-AMET** –Improvements in the content, format, quantity, quality, timeliness and availability of meteorological information (observations and forecasts) will lead to enhanced situational awareness of meteorological conditions, and in particular the location, extent, duration and severity of hazardous meteorological conditions, as well as space weather, and their impacts on airspace.

d. **B1-SWIM** – Implementation of system-wide information management (SWIM) services (applications and infrastructure) to create an aviation intranet based on standard data models, and internet-based protocols to maximize interoperability. Using better information allows operators and service providers to plan and execute better trajectories. There can be further reduction of costs when all information are managed consistently across the network, limiting bespoke developments. This module also allows that the right, up-to-date and accurate data is timely available to the right user with the required performance and quality. It represents the achievement of a significant paradigm shift in ATM and is the enabler, together with the appropriate telecommunication infrastructure, of the most advanced features of the Global concept, in particular seamless trajectory based operations.

e. **B1-DATM** – Aim is to provide greater and timelier access to up-to-date information by a wider set of users. Benefits include reduced processing time for new information, increased ability of the system to create new applications through the availability of standardized data, reduced probability of data errors or inconsistencies, reduced possibility to introduce additional errors through manual inputs etc.

RESEARCH AND FUTURE DEVELOPMENT POSSIBILITIES

Research and Development

8.1 To develop the tools and systems required to meet foreseeable long-term requirements, there is a need for States to undertake and co-operate on ATM Improvement. This includes major efforts to define concepts, to extend knowledge and invent new solutions to future ATM challenges so these new concepts are selected and applied in an appropriate timely manner. Such efforts could be forged through collaborative partnerships between, States, ANSPs, International Organizations, institutes of higher learning and specialised technical agencies. This concept is consistent with Seamless ATM Principle 36 (*Inter-regional cooperation ('clustering') for the research, development and implementation of ATM projects*).

8.2 The need for concepts beyond current technology and systems had been reinforced at APANPIRG/23. With the end goal of a globally interoperable ATM system in mind, the region will have to consider planning for a long term supporting concept and infrastructure. States should not overlook the need to include the development of future ATM concepts that will ensure the safety and fluidity of air transportation over the next few decades. The following are possible areas that should be considered for future development, in order to continue pursuance of seamless ATM beyond ASBU Block 0 implementations and global interoperability:

a. Space-Based ATS Surveillance - The AN-Conf/12 endorsed Recommendation 1/9 regarding space-based ADS-B systems being included in the GANP (**Appendix B**);

b. Sub-Regional ATFM - Inter-linked (data-sharing) ATFM units (which may be virtual offices) should be developed to serve various sub-regions. This concept is consistent with Seamless ATM Principle 8 (*Sub-regional ATFM based on system-wide CDM serving the busiest terminal airspace and MTF*). The Global ATM Operational Concept paragraph 2.4.3 states: *Demand and capacity balancing will be integrated within the ATM system*;

c. Collaborative Air Navigation Services - This concept is consistent with the following Seamless ATM Principles: 9 (*Cross-border/FIR cooperation for use of aeronautical facilities and airspace, collaborative data sharing, airspace safety assessment and ATM Contingency planning*) and 15 (*Collaboration by ANSPs for evaluation and planning of ATM facilities*). The AN-Conf/12 endorsed Recommendation 5/1, regarding collaboration in airspace organization and routing, which emphasised, *inter alia*, the need to take advantage of improved models for inter-regional coordination and collaboration to achieve seamless air traffic management and more optimum routes through airspace (**Appendix B**);

d. Airspace Optimisation - the CONOPS states: *Where possible the number of FIRs should be minimized particularly along traffic flows. FIRs should not necessarily be based strictly on the boundaries of sovereign territories*. This concept is consistent with and the following Seamless ATM Principles: 12 (*The optimisation of airspace structure through amalgamation and use of technology*) and 16 (*Optimization of ATM facilities through amalgamation and the use of technology, including automation, satellite-based systems and remote facilities*). The Global ATM Operational Concept paragraph 2.2.2 states: *While acknowledging sovereignty, airspace will be organized globally. Homogeneous ATM areas and/or routing areas will be kept to a minimum, and consideration will be given to consolidating adjacent areas*;

e. Consistent Operating Practices and Procedures - this is aligned with Seamless ATM Principle 3 (*Harmonised regional or sub-regional rules and guidelines*) and 4 (*Shared ATM operational standards, procedures, guidance materials through common manuals and templates*); and

f. Transition Altitude/Layer Harmonisation – this is consistent with AN-Conf/-12 Recommendation 5/1 b).

MILESTONES, TIMELINES, PRIORITIES AND ACTIONS

Milestones

9.1 Section 7 (Performance Improvement Plan) provides milestones and timelines for a number of elements in the PARS and PASL Phase I and II, being effective 12 November 2015 and 07 November 2019 respectively.

9.2 It should be noted that States should commence planning for the various elements, such as PBN specifications detailed in the PARS to cover overall ATM operations, taking into account the whole phase of flight. This should be planned from the approval of this Plan, to ensure a smooth transition by the onset of Phase I, and should include consideration of issues such as:

- aircraft equipage and certification;
- safety/operational analysis and assessment;
- cost-effectiveness;
- budgetary issues;
- development of operational procedures; and
- training.

9.3 States should commence planning for PBN specifications detailed in the PARS and other initiatives which have been globally documented, to facilitate a smooth transition by the onset of Phase I. The Regional PBN Plan is expected to transition to a general guideline for implementation during this period, with the prescriptive PBN specifications being incorporated into this Plan.

9.4 Section 8 (Research and Future Development Possibilities) provides, subject to future agreement by concerned parties, possible Seamless ATM improvements beyond 2019 until 2031.

Priorities

9.5 It is a matter for each State to determine priorities in accordance with its own economic, environmental, safety and administrative drivers. The ASBU Block 0 priorities determined by APSAPG/2 in Section 5 (Background Information) were used to determine the ASBU elements that should be contained within which PARS and PASL Phase.

Actions

9.6 This Plan necessitated a number of implementation actions. The Implementation Guidance was developed by the ICAO Regional Office. It is expected that each Asia/Pacific State and administration will put high priority to develop Seamless ATM Implementation Planning based on applicable parts of the Implementation Guidance Material, and implementation progress be reported to APANPIRG.

9.7 The ICAO Seamless ATM Reporting System supports the implementation of the global and regional items by monitoring progress of States and administrations. The regional picture is updated periodically and available to access on the ICAO APAC website.

9.8 APANPIRG and its contributory bodies such as the ATM Sub-group and the CNS Sub-group are responsible for the oversight of air navigation issues within the Asia/Pacific, so these bodies needed to be made aware of State implementation progress of Seamless ATM initiatives. APANPIRG and its contributory bodies need to manage the implementation of Seamless ATM through the ASBU framework and this Plan.

9.9 Section 6 (Current Situation) provides detailed analysis and major concerns in the region. Some of the non-ICAO sub-regional collaborative frameworks or actions have successfully achieved ATM operational improvements in the past. These forums will continue to be important in Seamless ATM implementation in the future.

9.10 The ICAO Asia and Pacific Regional Office is responsible for taking actions that assisted the implementation of Seamless ATM within its accredited States. In addition, the Asia and Pacific Regional Office coordinated with adjacent ICAO regional offices on an ad hoc basis or at relevant trans-regional meetings.

Appendix A: KANSAI Statement

The Directors General of Civil Aviation (DGCA) of the Asia and Pacific Regions met for the 46th DGCA Conference in Japan, 12-16 October, 2009. Recalling that the 45th Conference had endorsed the Theme Topic for the 46th DGCA Conference as "Seamless Sky: Bringing Together the Asia/Pacific Regions," Directors General of the Region held a productive discussion focusing on three aspects of the "Seamless Sky," namely Air Traffic Management (ATM), Air Cargo Security, and Aviation Safety, and agreed to issue this Kansai Statement.

KANSAI STATEMENT

1. We recognized that as civil aviation develops and globalization progresses, harmonization in civil aviation systems is becoming critically important in the Asia and Pacific Region, which has been characterized by the diversities of the member States. What people expect from harmonization in civil aviation is that aircraft operators will become capable of seamlessly flying between regions, that the whole of the network will be secured at the agreed level, and that transparent and interoperable standards will be set among States and regions. In this regard, "Seamless Sky" is particularly important in the areas of air traffic management, aviation security and aviation safety.

2. Regarding Air Traffic Management (ATM), we recognized that the ICAO has been leading the development and implementation of the Global Air Traffic Management system with the implementation target of 2025. The Global Air Traffic Management system will be based on the components described in the Global ATM Operational Concept. We also recognized that the United States and Europe have been developing their future air traffic modernization programmes. Taking such global trends of future ATM system into consideration, we recognized the necessity of planning the future ATM system for the Asia and Pacific Region by the active collaboration and participation of the whole of the Region. In this regard, we agreed that APANPIRG be the starting platform to discuss and plan the future ATM system of the Asia and Pacific Region including targets and a time schedule.

3. Regarding aviation security, we recognized the significance of enhancing air cargo security. Such efforts will enable member States to protect the flow of air cargo, raise security standards and facilitate international trade in the Asia and Pacific Region. To achieve these desired outcomes effectively, member States are encouraged to collaborate with one another and with ICAO towards developing internationally harmonized measures and processes in air cargo security. We agreed that the further sharing of information and best practices should be promoted, and to consider including provisions on air cargo security into Annex 17, taking into account the need to protect the entire cargo supply chain.

4. Regarding the aviation safety, we acknowledged the ICAO's leadership in the improvement of aviation safety. We recognized the importance of the member States' role in ensuring that their air operators establish and maintain the highest standards in safety through the proper implementation of Safety Management System as envisaged under the State Safety Programme. In addition, we recognized the importance of the safety monitoring activities regarding foreign aircraft by the member States in the Region. We agreed to further enhance the cooperation in these efforts and activities in the Region in a harmonized manner.

5. We are determined to realize the Seamless Sky in the Asia and Pacific Region from this conference onwards. We agreed to make efforts to move forward toward the harmonized aviation in the Asia Pacific Region in cooperation with all the member States and the ICAO Asia Pacific Regional Office.

Appendix B: Relevant 12th Air Navigation Conference Recommendations

1 Recommendation 1/7 – Automatic dependent surveillance — broadcast

That States:

a) recognize the effective use of automatic dependent surveillance — broadcast (ADS-B) and associated communication technologies in bridging surveillance gaps and its role in supporting future trajectory-based air traffic management operating concepts, noting that the full potential of ADS-B has yet to be fully realized;

b) recognize that cooperation between States is key towards improving flight efficiency and enhancing safety involving the use of automatic dependent surveillance — broadcast technology.

That ICAO:

c) urge States to share automatic dependent surveillance — broadcast (ADS-B) data to enhance safety, increase efficiency and achieve seamless surveillance and to work closely together to harmonize their ADS-B plans to optimize benefits.

2 Recommendation 1/9 – Space-based automatic dependent surveillance — broadcast

That ICAO:

a) support, subject to validation, the inclusion in the GANP, development and adoption of space-based automatic dependent surveillance — broadcast surveillance as a surveillance enabler;

b) develop Standards and Recommended Practices and guidance material to support space-based automatic dependent surveillance — broadcast as appropriate; and

c) facilitate needed interactions among stakeholders, if necessary, to support this technology.

3 Recommendation 2/1 – ICAO aviation system block upgrades relating to airport capacity

That States:

a) according to their operational needs, implement the aviation system block upgrade modules relating to airport capacity included in Block 0;

b) endorse the aviation system block upgrade modules relating to airport capacity included in Block 1 and recommended that ICAO use them as the basis of its standards work programme on the subject;

c) agree in principle to the aviation system block upgrade modules relating to airport capacity included in Blocks 2 and 3 as the strategic direction for this subject.

4 **Recommendation 3/1 – ICAO aviation system block upgrades relating to Interoperability and data – through globally interoperable system-wide information management**

That States:

a) endorse the aviation system block upgrade module relating to interoperability and data – through globally interoperable system-wide information management included in Block 1, and recommend that ICAO use it as the basis of its work programme on the subject;

b) agree in principle with the aviation system block upgrade module relating to interoperability and data – through globally interoperable system-wide information management included in Block 2, as the strategic direction for this subject; and

That ICAO:

c) include, following further development and editorial review, the aviation system block upgrade modules relating to interoperability and data – through globally interoperable system-wide information management for inclusion in the draft Fourth Edition of the *Global Air Navigation Plan* (Doc 9750, GANP).

5 **Recommendation 4/2 – ICAO ASBU relating to ground surveillance using ADS-B/MLAT, air traffic situational awareness, interval management and airborne separation**

That States:

a) according to their operational needs, to implement the aviation system block upgrade modules relating to ground surveillance, improved air traffic situational awareness and improved access to optimum flight levels included in Block 0;

b) endorse the aviation system block upgrade modules relating to interval management included in Block 1 and recommend that ICAO use them as the basis of its work programme on the subject;

c) endorse the aviation system block upgrade modules relating to airborne separation included in Blocks 2 and 3 as the strategic direction for this subject;

That ICAO:

d) include, following further development and editorial review, the aviation system block upgrade modules relating to airborne separation in the draft Fourth Edition of the *Global Air Navigation Plan*;

e) adopt "airborne separation" concepts involving controllers assigning tasks to flight crews, with controllers able to apply different, risk-based separation minima for properly equipped ADS-B IN aircraft;

f) in the development of provisions, acknowledge the relationship between airborne separation and airborne collision avoidance system;

g) modify aviation system block upgrade (ASBU) Module B2-85 to reflect e) and f), modify ASBU Module B2-101 to reflect f); and

h) review the concept and terminology supporting B2-25 "airborne separation" and amend the module accordingly.

6 Recommendation 5/1 - Improved operations through enhanced airspace organization and routing

Considering that performance-based navigation (PBN) is one of ICAO's highest air navigation priorities and the potential benefits achievable through creation of additional capacity with PBN:

That States:

a) implement performance-based navigation in the en-route environment;

b) fully assess the operational, safety, performance and cost implications of a harmonization of transition altitude and, if the benefits are proven to be appropriate, undertake further action on a national and (sub) regional basis;

c) take advantage of improved models for inter-regional coordination and collaboration to achieve seamless air traffic management and more optimum routes through the airspace;

d) through the planning and implementation regional groups improve their methods of coordination to increase implementation of en-route performance-based navigation in order to achieve more optimum routes through the airspace;

That ICAO:

e) encourage the planning and implementation regional groups to support the early deployment of performance-based navigation.

7 Recommendation 6/1 – Regional performance framework – planning methodologies and tools

That States and PIRGs:

a) develop and maintain regional air navigation plans consistent with the Global Air Navigation Plan;

b) finalize the alignment of regional air navigation plans with the Fourth Edition of the *Global Air Navigation Plan* by May 2014;

c) focus on implementing aviation system block upgrade Block 0 Modules on the basis of operational requirements, recognizing that these modules are ready for deployment;

d) use the electronic regional air navigation plans as the primary tool to assist in the implementation of the agreed regional planning framework for air navigation services and facilities;

e) consider how the continuous monitoring approach to safety oversight maps to the evaluation of Member States' safety oversight capabilities concerning aviation system block upgrades;

f) involve regulatory and industry personnel during all stages of planning and implementation of aviation system block upgrade modules;

g) develop action plans to address the identified impediments to air traffic management modernization as part of aviation system block upgrade planning and implementation activities.

8 Recommendation 6/4 – Human performance

That ICAO:

a) integrate human performance as an essential element for the implementation of ASBU modules for considerations in the planning and design phase of new systems and technologies, as well as at the implementation phase, as part of a safety management approach. This includes a strategy for change management and the clarification of the roles, responsibilities and accountabilities of the aviation professionals involved;

b) develop guidance principles, guidance material and provisions, including SARPs as necessary, on ATM personnel training and licensing including instructors and assessors, and on the use of synthetic training devices, with a view to promoting harmonization, and consider leading this effort with the support of States and industry;

c) develop guidance material on using field experience and scientific knowledge in human performance approaches through the identification of human-centred operational and regulatory processes to address both current safety priorities and the challenges of future systems and technologies;

d) assess the impact of new technologies on competencies of existing aviation personnel, and prioritize and develop competency-based provisions for training and licensing to attain global harmonization;

e) establish provisions for fatigue risk management for safety within air traffic services operations;

f) develop guidance material on different categories of synthetic training devices and their respective usage;

g) provide human performance data, information and examples of operational and regulatory developments to ICAO for the benefit of the global aviation community;

h) support all ICAO activities in the human performance field through the contribution of human performance expertise and resources;

i) adopt airspace procedures, aircraft systems, and space-based/ground-based systems that take into account human capabilities and limitations and that identify when human intervention is required to maintain optimum safety and efficiency; and

j) investigate methods to encourage adequate numbers of high quality aviation professionals of the future and ensure training programmes are in line with the skills and knowledge necessary to undertake their roles within a changing industry.

9 Recommendation 6/12 – Prioritization and categorization of block upgrade modules

That States and PIRGs:

a) continue to take a coordinated approach among air traffic management stakeholders to achieve effective investment into airborne equipment and ground facilities;

b) take a considerate approach when mandating avionics equipage in its own jurisdiction of air navigation systems provision, taking into account of burdens on operators including foreign registry and the need for consequential regional/global harmonization;

That ICAO:

a) continue to work on guidance material for the categorization of block upgrade modules for implementation priority and provide guidance as necessary to planning and implementation regional groups and States;

b) modify the block upgrade module naming and numbering system using, as a basis, the intuitive samples agreed by the Conference; and

c) identify modules in Block 1 considered to be essential for implementation at a global level in terms of the minimum path to global interoperability and safety with due regard to regional diversity.

Appendix C: Seamless ATM Principles

People: Cultural and Political Background

1. High-level political support (including development of educational information for decision-makers) to support Seamless ATM initiatives, including military cooperation and AIM.
2. Education and implementation of non-punitive reporting and continuous SMS improvement systems.

Aviation Regulations, Standards and Procedures

3. Harmonised regional or sub-regional rules and guidelines, modelled on the regional application of common regulations incorporated by reference into local legislation.
4. Shared ATM operational standards, procedures, guidance materials through common manuals and templates.
5. The promotion of mutual recognition of ATM qualifications between States.
6. An emphasis on delivery of ATM services based on CNS capability, resulting in flexible, dynamic systems.
7. The use of high-fidelity simulators to train controllers on the optimal application of ATC separations and procedures that support Seamless ATM applications, emergency and contingency responses, testing of software releases, and may serve as a backup ATM platform.

ATM Coordination

8. Sub-regional ATFM based on system-wide CDM serving the busiest terminal airspace and MTF.
9. Cross-border/FIR cooperation for use of aeronautical facilities and airspace, collaborative data sharing, airspace safety assessment and ATM Contingency planning.
10. Encouragement of military participation in civil ATM meetings and in ATS Centres where necessary.

Airspace Organisation

11. Promoting flexible use airspace arrangements and regular review of airspace to ensure it is appropriate in terms of purpose, size, activation and designation.
12. The optimisation of airspace structure through amalgamation and use of technology.

Facilities: Aerodromes

13. To encourage aerodrome operators to actively participate in ATM coordination in respect of Airport CDM development and operational planning, including aerodrome complexity and capacity.
14. Planning and coordination with local authorities and government agencies to take into account environmental issues, obstacles, aerodrome and PBN development.

ATS Units

15. Collaboration by ANSPs for evaluation and planning of ATM facilities.
16. Optimization of ATM facilities through amalgamation and the use of technology, including automation, satellite-based systems and remote facilities.

Navigation Aids

17. The continued rationalisation of terrestrial navigation aids to satellite-based procedures, while retaining a minimum network necessary to maintain safety of aircraft operations.
18. Support for a GNSS-based global PBN approval standard.
19. Regional cooperation for augmentation systems in terms of interoperability and increased service areas, and a GNSS ionospheric monitoring network.

Telecommunication

20. Encouragement of the use of ground-ground ATN/AMHS and diverse satellite communication systems.
21. Enhancement of data-link capabilities (VHF including VDL M2, SATCOM).
22. Where cost beneficial and appropriate, the implementation of:
    - SATVOICE technologies and standards;
    - HF data-link;
    - VSAT networks in support of COM and SUR.
23. The prioritisation of AIDC systems to alleviate ATC coordination issues.

ATS Surveillance

24. The encouragement of ADS-B and/or MLAT implementation to improve ATS surveillance coverage, redundancy and multiple tracking capability.
25. Establishment of ADS-C where radar, ADS-B (including satellite –based ADS-B) and/or MLAT is not possible.
26. Expansion of ATS surveillance data-sharing initiatives.

Technology and Information: Flight Operations

27. Implementation of UPR and DARP where practicable.
28. Implementation of CDO and CCO where possible.
29. The encouragement of appropriate technologies that support Trajectory-Based Operations.

Aeronautical Data

30. Early implementation of AIM, including cooperative development of aeronautical databases and SWIM to support interoperable operations.

ATM Systems and Safety Nets

31. Application of ground-based safety nets, which includes tactical and strategic conflict probing (such as APW, STCA) and MSAW.
32. Support for Inter-facility Flight Data Processing System capability.
33. Collaborative development of CDM, ATFM, A/MAN and D/MAN support tools.
34. Encouragement of Digital ATIS and VOLMET information systems.
35. Encourage sharing of air traffic data between military ATM systems and civil ATM systems.

ATM Modernisation Projects

36. Inter-regional cooperation (‘clustering’) for the research, development and implementation of ATM projects.
37. A focus on technologies for earliest deployment and best cost benefits.

Appendix D: Capacity Expectations

1 Capacity metrics will vary considerably, depending upon many factors such as the COM and SUR capabilities, the presence of terrain, physical attributes of aerodromes and weather. Thus the expectations outlined for the following States need to be treated with caution, however they form a useful guide as to the sort of capability being achieved with modern systems and appropriately trained controllers.

2 **Table D1** provides an indication of potential Aerodrome Arrival Rate (AAR) for a single runway, given aircraft ground speeds and aircraft spacing near the runway threshold (source: *Guide for the Application of a Common Methodology to Estimate Airport and ATC Sector Capacity for the SAM Region, Attachment 7: Calculation of the Aerodrome Acceptance Rate used by the FAA*).

Speed	3NM	3.5NM	4NM	4.5NM	5NM	6NM	7NM	8NM	9NM	10NM
140kt	46	40	35	31	28	23	20	17	15	14
130kt	43	37	32	28	26	21	18	16	14	13
120kt	40	34	30	26	24	20	17	15	13	12

Table D1: Potential Runway Arrival Rate

3 ATC capacity calculations needed to take into account the volume of airspace of each sector, which varied considerably by State, and factors such as automation, density of traffic and complexity of routes/airspace. The ICAO *Manual on Collaborative Air Traffic Flow Management* (Doc 9971) contained guidelines for ATC sector capacity assessment. **Table G2** provides simplified ATC sector calculation guidance from Doc 9971.

Average sector flight time (minutes)	Optimum sector capacity value (aircraft)
3 minutes	5 aircraft
4	7
5	8
6	10
7	12
8	13
9	15
10	17
11	18
12 minutes or more	18

Table D2: Simplified ATC Sector Capacity Table (no complexity/automation allowance)

4 Australia, Japan, New Zealand, Singapore, Thailand and the United States provided runway and airspace (ATC Sector) capacity data, to indicate potential capacity figures in varying Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC) circumstances.

<u>Australia</u>

5 Brisbane and Melbourne aerodrome capacity expectations:

- single runway: **48** (24 arrivals - 150 seconds between arrivals, 24 departures, VMC);
- single runway: **40** (20 arrivals - 180 seconds, 20 departures, IMC).

Japan

6 Aerodrome capacity expectations:

- Narita (dual runways): 56-64;
- Haneda (4 runways): 74.

New Zealand

7 Auckland aerodrome capacity expectations:

- single runway: **40** (VMC);
- single runway: **39** (IMC circling);
- single runway: **37** IMC below circling with missed approach protection for jets);
- single runway: **32** (IMC below circling with missed approach protection)

8 ATC Sector capacity expectations:

- terminal/low level Category T airspace: **12** aircraft; and
- en-route Category S airspace: **15** aircraft;
- en-route Category R airspace: **15** aircraft.

Singapore

9 Changi aerodrome capacity expectations:

- single runway: **30** (IMC); and
- two parallel/near parallel runways: **72** (IMC);
- three parallel/near parallel runways: to be confirmed, possibly 100+ (IMC).

10 ATC Sector capacity expectations:

- terminal/low level Category T airspace: **14** aircraft; and
- en-route Category S airspace (sector dimension of 150NM x 100NM): 7 aircraft (extrapolated √6.66 x airspace volume = 2.58 x 7 = **18**).

Thailand

11 Suvarnabhumi aerodrome capacity expectations:

- single runway: **34** (VMC/IMC).

United States of America

12 **Table D3** provides an indication of optimal aerodrome parallel or near parallel arrival rate runway arrival capacity at selected USA aerodromes. It should be noted that multiple runway combinations or whether runways were used for arrivals, departures, or both yielded a number of permutations from the data.

Aerodrome	Runways	IMC	VMC
ATL	5	104	126
ORD	5	84	112
DFW	5	90	96

ATL	4	92	112
DEN	4	-	114
LAX	4	64	80
ORD	4	-	92
ATL	3	76	96
DEN	3	-	96
IAD	3	72	100
ATL	2	68	82
JFK	2	-	58
SDF	2	40	52
ATL	1	34	42
SDF	1	20	26
SFO	1	25	27

Table D3: Capacity at selected US airports

13 Average aerodrome arrival capacity expectations (range):

- single runway: IMC average **26** (25-34), VMC average **32** (26-42);
- two parallel/near parallel runways: IMC **55** (40-68), VMC **64** (52-82);
- three parallel/near parallel runways: IMC **74** (72-76), VMC **97** (96-100);
- four parallel/near parallel runways: IMC **78** (64-92), VMC **100** (80-112);
- five parallel/near parallel runways: IMC **92** (84-104), VMC **111** (96-126).

14 ATC Sector capacity expectations:

- terminal/low level Category T airspace: **12-18** aircraft; and
- en-route Category S airspace: **16-20** aircraft; and
- en-route Category R airspace: **17-24** aircraft.

Summary

15 **Table D4** summarises runway and airspace capacity expectations from States, with the greatest capacity achieved in optimum conditions highlighted in bold.

	Parallel or Near Parallel Runway Capacity					ATC Sector Capacity		
	1	2	3	4	5	T	S	R
Australia	40-48							
Japan		56-64		74				
NZ	32-40					12	15	15
Singapore	30	72				14	18	
Thailand	34							
USA	**61**	**95**	**150**	**177**	**211**	12-**18**	16-**20**	17-**24**
Doc 9971 Simplified Table Comparison						15	18	18

Table D4: Capacity Expectations Summary

Note: Given the unique operation environment and constraints of individual States, these figures are indicative only and do not represent the same expectation across different States in the region

Appendix E: Elements Map

ASBU Element	Global/Regional Element	Civil/Military Element	Plan	Reference/ Principle
B0-CDO: CDO, STAR			PARS I/II	28
B0-FRTO: FUA, UPR, DARP			PARS I	27, 11
B0-RSEQ: AMAN/DMAN			PARS I/II	8, 33
B0-CCO: CCO, SID			PARS I/II	28
B0-FICE: AIDC, ATN			PASL I	20, 23, 26
B0-DATM: AIM			PASL I/II	30
B0-NOPS: ATFM			PASL I	8
B0-TBO: ADS-C, CPDLC			PARS I PASL I	25, 29
B0-APTA: AIRPORT PBN			PARS I/II	17
B0-WAKE: WAKE TURB			-	3, 4
B0-SURF: ASMGCS, CMM			-	24
B0-ACDM AIRPORT CDM			PARS I/II	13
B0-ASUR: ATS SUR			PARS I PASL I	24, 29
B0- ATSA			PARS I	-
B0-OPFL ITP			-	-
B0-ACAS: ACAS			PARS I	Annex 6
B0-SNET: SAFETY NETS			PASL I/II	31
B0-AMET:			PASL I	34
	AIRPORT CERT.		PARS I	Annex 14
	AIRPORT CAPACITY		PARS I/II	GPI 14
	AIRSPACE: FIRS		PASL 1	CONOPS
	AIRSPACE: CLASS		PASL I	GPI 4
	AIRSPACE: RVSM		PARS I	GPI 2
	AIRSPACE: PRIORITY		PASL I	CONOPS
	NAV: PBN ROUTES		PARS I/II	17, 18
	SUR: ATC STDS		PASL I	CONOPS, 2, 6
	SUR: DATA SHARING		PASL I	26
		STRATEGIC LIAISON	PASL I	10
		TACTICAL LIAISON	PASL I	10
		MILITARY SUA %	PARS I	11
		SUA REVIEW	PARS I/II	11
		INT. SUA	PARS I	11
		ATM INTEGRATION	PASL I	35

		JOINT AD/NAV AIDS	PASL I	-
		SHARED DATA	PASL I	35
		COMMON TRAINING	PASL I	4
		COMMON PROC.	PASL I	4
B1-SURF: EVS			PARS II	24
B1-RSEQ: A-SMGCS			PARS II	24
B1-ACDM: APOC			PARS II	14
B1-NOPS: ATFM, CDM			PARS II PASL II	8, 33
B1-CDO: VNAV			PARS II	28
B1-TBO: DCL			PARS II	23
B1-DATM: AXIM 5.1			PASL II	30
B1-SWIM: CRV			PARS II	30
B1-FICE: CDM			PASL II	8
B1-AMET: INT MET INFO			PASL II	34
B1-RPAS: RPAS OPS			PARS II	26
B1-SNET: APM			PASL II	31
B1-APTA: GBAS, GLS II/III			PARS II	17
B1-WAKE: WAKE			-	3, 4
B1-ASEP: ADS-B			PASL II	6
	AIRSPACE: VOICE COMMS		PARS II	21, 22
	AIRSPACE: VoIP		PARS II	22
	AIRSPACE: BALLISTIC LAUNCH AND RE-ENTRY		PASL II	9, 26
	AIRPORT MASTER PLAN		PASL II	GPI 14
		SUA REVIEW	PARS II	11
B2- ACAS			PARS III	ANNEX 6,10
B2- ASEP			PASL III	6
B2- CDO			PARS III	28
B2- FICE			PASL III	8,13,31
B2- NOPS			PARS III PASL III	8,19,31, 33
B2- RPAS			PARS III	26, 36,37
B2- RSEQ			PARS III	24, 25
B2- SURF			PARS III	24
B2- SWIM			PARS III	30
B2- WAKE			-	3, 4

Appendix F: List of References

<u>Global and Regional Framework</u>

Doc 9673 *Asia/Pacific Regional Air Navigation Plan*
Doc 9750 *Global Air Navigation Plan*
Doc 9854 *Global Air Traffic Management Operational Concept*
Doc 10004 Global Aviation Safety Plan

<u>Air Navigation Services</u>

Annex 10 *Aeronautical Telecommunications*
Annex 11 *Air Traffic Services* (particularly Chapter 2 [2.1 and 2.30], and Attachment C)
ASBU Document
ASEAN *Master Plan on ASEAN Connectivity*
Asia/Pacific Air Traffic Flow Management Concept of Operations
Asia/Pacific Air Navigation Concept of Operations
Asia/Pacific Regional Performance-Based Navigation Implementation Plan (V4.0)
Circular 330 *Civil-Military Cooperation in Air Traffic Management*
Doc 4444 *Procedures for Air Navigation Services Air Traffic Management* **(***PANS ATM)*
Doc 8071 Manual on Testing of Radio Navigation Aids Volume 2
Doc 9613 *Performance-based Navigation Manual*
Doc 9882 *Manual on ATM System Requirements*
Doc 9883 *Manual on Global Performance of the Air Navigation System*
Doc 9906 *Quality Assurance Manual for flight Procedure Design Volume 5*
Doc 9971 *Manual on Collaborative Air Traffic Flow Management*
Global Operational Data-link Document
ICAO AN-Conf/12 Yellow Cover Report on Agenda Item 1
Roadmap for the Transition from AIS to AIM

<u>Flight Operations</u>

Annex 6 *Operation of Aircraft*
Doc 8168 *Procedure for Air Navigation Service Aircraft Operations Volume I Flight Procedures*
Doc 8168 *Procedure for Air Navigation Service Aircraft Operations Volume II Flight Procedures*
Doc 9931 Continuous Descent Operations (CDO) Manual
Doc 9993 Continuous Climb Operations (CCO) Manual

<u>Human Factors</u>

Annex 1 *Personnel Licensing*
Circular 214 *Fundamentals on Human Factors*
Circular 227 *Training of Operational Personnel on Human Factors*
Circular 241 *Human Factors in ATC*
Circular 249 *Human Factors in CNS and ATM Systems*
Circular 318 *Language Testing Criteria for Global Harmonization*
Circular 323 *Guidelines for Aviation English Training Programmes*
Doc 9835 *Manual on the Implementation of ICAO Language Proficiency Requirements*
Doc 9966 *Fatigue Risk Management Systems*
Human Factors Digest No. 1