APSAPG/4 WP07
Attachment A

INTERNATIONAL CIVIL AVIATION ORGANIZATION

D R A F T

ASIA/PACIFIC SEAMLESS ATM PLAN

DRAFT Version 0.9b, June 2013

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

Approved by APANPIRG/24 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 incorporates and builds upon 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 within Air Traffic Services (ATS) communications and surveillance coverage dependent on a third-party Communication Service Provider (CSP); or

b) Category S: serviced (or potentially serviced) en-route airspace – by direct (not dependent on a 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 **Appendix E** provides an example of a Seamless ATM planning framework, **Appendix H** provides a map of ASBU Elements to Plan references, and **Appendix I** provides a List of References.

Plan Review

1.7 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.

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

1.9 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.

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.

Plan Development

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.

2.5 This Plan addresses the full range of ATM stakeholders, including civil and military ANS providers, 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 2018, 2023 and 2028 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 and PASL are expected to be implemented in two phases, Phase I by 12 November 2015 and Phase II by 08 November 2018. Phase II was determined by referencing the charting AIRAC (Aeronautical Information Regulation and Control) cycle for the ASBU Block 1 commencement year. 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.

2.10 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.

2.11 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, in accordance with consultation with all stakeholders.

2.12 Prior to implementation, each State should verify the applicability of PARS and PASL by analysis of safety, current and forecast traffic demand, efficiency, predictability, cost effectiveness and environment to meet expectations of stakeholders.

Seamless ATM Definition

2.13 The objectives 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.*

2.14 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.*

2.15 The ICAO Twelfth Air Navigation Conference (AN-Conf/12) 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 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 1 and Figure 2** indicating the projected air traffic growth which has necessitated the Seamless ATM approach.

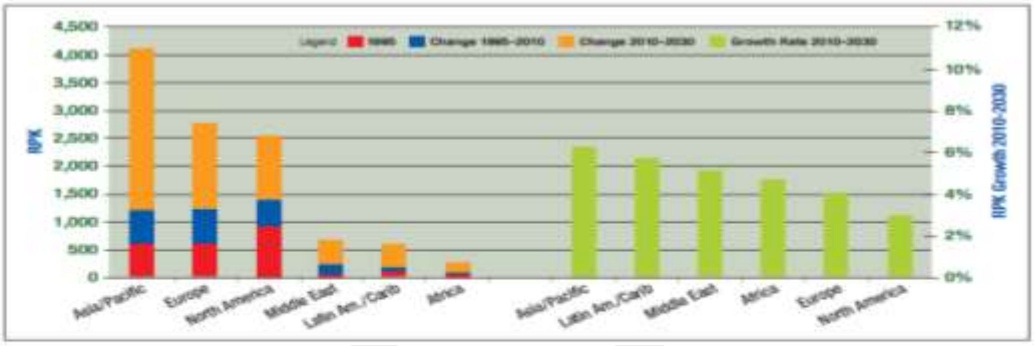

Figure 1: Passenger Traffic Forecasts – Top Traffic Flows in 2030 (ICAO 2010)

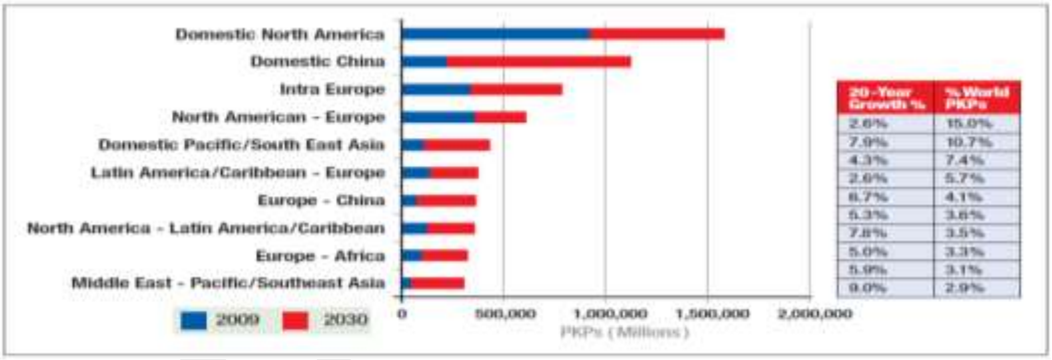

Figure 2: Top 10 Traffic Flows in 2030 (ICAO 2010)

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 12^{th} Air Navigation Conference (Montreal, 19-30 November 2012) endorsed the ASBU concept and the consequential changes to the GANP. The Air Navigation Conference 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 but this has to be supported by appropriate regulations and institutional arrangements that will incentivise ANSPs to deliver the performance expected and to empower them with the autonomy and financial independence to plan ahead and invest in infrastructure and human capital.

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 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 including 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 enroute 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
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-link Communications
AIM	Aeronautical Information Management
AIRD	ATM Improvement Research and Development
AIS	Aeronautical Information Service
AIXM	Aeronautical Information Exchange Model
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
AOC	Assumption of Control (AIDC)
AOM	Airspace Organization and Management
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
ATS	Air Traffic Services
ATM	Air Traffic Management
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
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
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	GNSS Landing System
GNSS	Global Navigation Satellite System
HF	High Frequency
ICAO	International Civil Aviation Organization
IMC	Instrument Meteorological Systems
INS	Inertial Navigation Systems
IO	International Organizations
IPACG	Informal Pacific ATC Coordinating Group
ISPACG	Informal South Pacific ATS Coordinating Group
ITP	In-Trail Procedure
KPA	Key Performance Area
LNAV	Lateral Navigation
LVO	Low Visibility Operations
MET	Meteorological
METAR	Meteorological Aerodrome Report
MLAT	Multilateration
MSAW	Minimum Safe Altitude Warning
MTF	Major Traffic Flow
OPMET	Operational Meteorological
OLDI	On-Line Data Interchange
OTS	Organised Track System
PARS	Preferred Aerodrome/Airspace and Route Specifications
PASL	Preferred ATM Service Levels
PBN	Performance-based Navigation
PVT	Passenger Value of Time
RAIM	Receiver Autonomous Integrity Monitoring
RAM	Route Adherence Monitoring
RANP	Regional Air Navigation Plan
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	Space Based Augmentation System
SCS	South China Sea
SESAR	Single European Sky ATM Research
SHEL	Software, Hardware, Environment and Liveware
SID	Standard Instrument Departure
SIGMET	Significant Meteorological Information

SPECI	Special Weather Report
STAR	Standard Terminal Arrival Route or Standard Instrument Arrival (Doc 4444)
STCA	Short Term Conflict Alert
SUA	Special Use Airspace
SUR	Surveillance
SWIM	System-Wide Information Management
TAF	Terminal Area 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
VNAV	Vertical Navigation
VAAC	Volcanic Ash Advisory Centre
VMC	Visual Meteorological Systems
VOR	Very High Frequency Omni-directional Radio Range
VSAT	Very Small Aperture
WAFC	World Area Forecast Centre

TO BE COMPLETED ON FINAL EDIT

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 (**Attachment 1**).

5.7 **Table 1** provides a summary of the Block 0 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 is considered necessary to determine whether to implement B0-SURF, B0-ATSA, B0-ASUR and B0-FRTO.

PIA	**Element**	**Economic Analysis**	**Priority**
PIA 1	B0-APTA Optimization Of Approach Procedures Including Vertical Guidance	-	2
	B0-WAKE Increased Runway Throughput Through Optimized Wake Turbulence Separation	-	3
	B0-RSEQ Improve Traffic Flow Through Runway Sequencing (AMAN/DMAN)	-	2
	B0-SURF Safety and Efficiency Of Surface Operations (A-SMGCS)	Yes	3
	B0-ACDM Improved Airport Operations Through Airport-Collaborative Decision-Making (A-CDM)	-	2
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
	B0-ASUR Initial Capability For Ground Surveillance	Yes	1
	B0-ATSA 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
	B0-ACAS ACAS Improvements	Yes	2
	B0-SNET Increased Effectiveness Of Ground-based Safety Nets	-	2
	B0-AMET Meteorological Information Supporting Enhanced Operational Efficiency and Safety	-	2
PIA 4	B0-TBO Improved Safety And Efficiency Through The Initial Application Of Data Link En-Route	-	1
	B0-CDO Improved Flexibility And Efficiency In Descent Profiles (Continuous Descent Operations - CDO)	-	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

5.8 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.

5.9 **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 and less congestion, resulting in reduced flight time and fuel burn. The applicable Global Plan Initiatives related to this element are GPI-1 (FUA), GPI-7 Dynamic and Flexible ATS Route Management, and GPI-8 Collaborative Airspace Design and Management.

5.10 **B0-FICE** *Ground – Ground Integration and Interoperability*: ATS Inter-facility Data-link 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. While there is no related GPI, this element has been considered to be a high priority to support GPI-7 Dynamic and Flexible ATS Route Management, and is also a key enabler to reduce Air Traffic Control (ATC) coordination errors as a result of human factors.

5.11 **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.

5.12 **B0-NOPS** *Network Flow Management* ATFM: GPI-6 ATFM. The related GPI is GPI-10 Terminal Area Design and Management. 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*). At APSAPG/3, India stated that:

The development of pan-national, sub-regional ATFM systems eventually collaborating with each other and the emergence of a regional ATFM system will greatly enhance seamless ATM services across the region. This will also facilitate cross-regional traffic imbalances, and as such India advocates that the issue should be considered in the immediate time horizon rather than leaving it to a future date.

5.13 **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. The CONOPS states that in areas where the provision of direct ATS surveillance is possible, ATC separation must 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).

5.14 **B0-ASUR** *Ground-Based ATS Surveillance*: ADS-B, MLAT. The related GPI is GPI-17 Data-Link Applications. 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 and associated Very High Frequency (VHF) communications to enhance safety, increase efficiency, achieve seamless surveillance and work closely together to harmonize their ADS-B plans to optimize benefits.

Recommended ASBU Upgrades

5.15 **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. The related GPI is GPI-11 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 meanings.

5.16 **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.

5.17 Point Merge PBN procedures (Section 6, **Appendix F**) are examples of procedures that may be used to assist sequencing until the following ASBU modules were implemented, to ensure more accurate Trajectory Based Operations (TBO):

- **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** (*weather information supporting automated decision support or aids*).

5.18 **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. The related GPI is GPI-11 (RNP and RNAV SIDs, STARs).

5.19 **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), Space Based Augmentation System - SBAS avionics (TSO C145/146); and
  - GBAS receivers (TSO C161/162).

5.20 **B0-ACDM** *Airport CDM*: the relevant GPI is GPI-13 Airport Collaborative Decision-Making. 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). A template that clarifies issues such as data types, communication, software and review processes based on the Bangkok – Singapore – Hong Kong A-CDM Trial project may be developed in the future..

5.21 **B0-ATSA** *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. The applicable GPI is (GPI-9) Situational Awareness.

5.22 **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. An economic analysis should be conducted by States to establish whether version 7.1 was required, given the extra cost implications. 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.

5.23 **B0-SNET** *Ground-Based Safety Nets*: Short Term Conflict Alert (STCA), Area Proximity Warning (APW), Minimum Safe Altitude Warning (MSAW). The standard ground-based data-link systems are 1090ES with DO-260/260A and 260B capability. Universal Access Transceiver (UAT) is an optional link when additional general aviation data-link services could be provided.

5.24 **B0-AMET**: *Meteorological Forecasts, Warnings and Alerts*: Aerodrome warnings, including windshear. World Area Forecast Centre (WAFC), Volcanic Ash Advisory Centre (VAAC), and Tropical Cyclone Advisory Centre (TCAC) forecasts. The relevant GPI is GPI-19: improving the availability of meteorological (MET) information in support of a seamless global ATM system.

5.25 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, and decision-making through free-flowing information exchange (ASBU B1-AMET).

5.26 The first evolutionary step in the improved provision of MET information includes the provisions in Amendment 76 to Annex 3 – Meteorological Service for International Air Navigation (applicable November 2013). This will facilitate the exchange of OPMET information (specifically METAR, SPECI, TAF and SIGMET) in a digital form (XML/GML), accompanied by the appropriate metadata, in accordance with the globally interoperable information exchange model. These developments were designed to foster the future SWIM environment, which would include meteorological, aeronautical and flight information, amongst others.

5.27 Amendment 77 to Annex 3 (intended applicability in November 2016) was expected to upgrade these particular provisions to a recommendation, while Amendment 78 to Annex 3 (intended applicability in November 2019) was expected to make it standard practice for States to exchange such OPMET information in digital form. During Amendments 77 and 78 of Annex 3, and beyond, a significant portion of current MET products would transition to supporting digital information exchange within SWIM. In addition, there would 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

5.28 **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 (6 category system), and necessary for Block 1 (pair-wise system).

5.29 **B0-SURF**: *Improved Runway Safety*: Advanced Surface Movements Guidance Control Systems (ASMGCS) and Cockpit Moving Map (CMM), where weather conditions and capacity warranted. Implementation of ASMGCS and Cockpit Moving Map may not be a high priority in the Asia/Pacific except at high density aerodromes where the cost benefits of mandating this were positive. The related GPI is GPI-9 (Situational Awareness: **o**perational implementation of data link-based surveillance), and GPI-15 (Match Instrument Meteorological Systems - IMC and Visual Meteorological Systems - VMC Operating Capacity: improve the ability of aircraft to manoeuvre on the aerodrome surface in adverse weather conditions).

5.30 **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).

Global and Regional Elements

5.31 **Aerodrome Certification**. GPI-13 *Aerodrome Design and Management* promoted, i*nter alia*, 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.

5.32 **Aerodrome Capacity Analysis**. GPI-14 *Runway Operations* establishes requirements 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.

5.33 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 through formal agreements and regular meetings, irrespective which party actually provides Apron Management Services. Such agreements should ensure that the planning, operation and review of aerodrome services are conducted collaboratively between relevant ANSPs and aerodrome operators.

5.34 **Flight Information Regions** (FIRs). The CONOPS states that FIR boundaries should not limit the delivery of surveillance 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)*

5.35 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.

5.36 **Airspace Classification.** The applicable GPI is GPI-4 *Alignment of Upper Airspace Classifications*, which supports the harmonization of upper airspace and associated traffic handling through application of a common ICAO ATS Airspace Class above an agreed division level.

5.37 **Reduced Vertical Separation Minimum** (RVSM). The applicable GPI is GPI-2: the optimization of the utilization of airspace and enhanced aircraft altimetry systems. GPI-3 *Harmonization of Level Systems*: the adoption by all States of the ICAO Flight Level Orientation Scheme (FLOS) based on feet as contained in Appendix 3a to Annex 2. China is the only State that has not adopted Appendix 3a 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 are commonly based on metres.

5.38 **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).

5.39 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.

5.40 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).

5.41 **ATS routes**. The CONOPS establishes 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. The applicable GPI is GPI-5: RNAV and RNP: the incorporation of advanced aircraft navigation capabilities into the air navigation system infrastructure.

5.42 The Plan advocates 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.

5.43 **ATC Separation**. The CONOPS 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 reinforces this by encouraging the provision of communication, navigation, and data management capabilities necessary to make optimal use of surveillance systems. Moreover, States are expected to enhance ATM automation tools and safety nets through the use of aircraft-derived data such as flight identification, trajectories and intentions.

5.44 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.

5.45 There should be no requirement for radio reports at procedural waypoints when operating within ATS surveillance coverage, unless specifically requested by controllers on a tactical basis (Doc 4444, paragraph 4.11.1.3). When utilising ADS-C with waypoint event contract functionality, there should be no requirement for CPDLC waypoint reports, which should be stated in the State AIP.

5.46 **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.

Human Performance

5.47 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*.

5.48 The 12th Air Navigation Conference 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.

5.49 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

5.50 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 nets (airborne and ground).

5.51 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.

5.52 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.

5.53 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.

5.54 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.

5.55 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.

<u>Civil/Military Cooperation</u>

5.56 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.

5.57 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, <u>above the land areas or territorial waters</u> of a State, which means that restricted areas must not be designated over the high seas or in airspace of undetermined sovereignty

5.58 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.

5.59 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.

5.60 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.

5.61 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.

5.62 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.

5.63 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.

5.64 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.

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 The results of the Major Traffic Flow (MTF) and busy city pair route study are at **Appendix D**. A summary spreadsheet of the implementation status of Seamless ATM elements (ASBU, global/regional and civil/military) is provided at **Attachment 1**.

6.4 As a result of the 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.

6.5 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.

6.6 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.

6.7 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.

6.8 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.

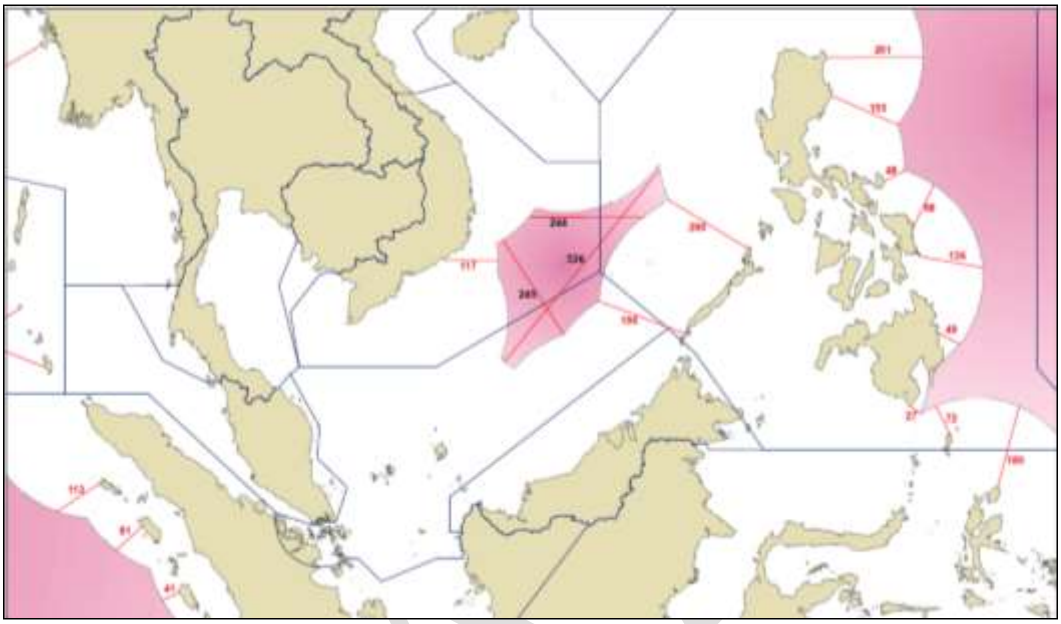

Figure 3: South China Sea ATS surveillance gaps

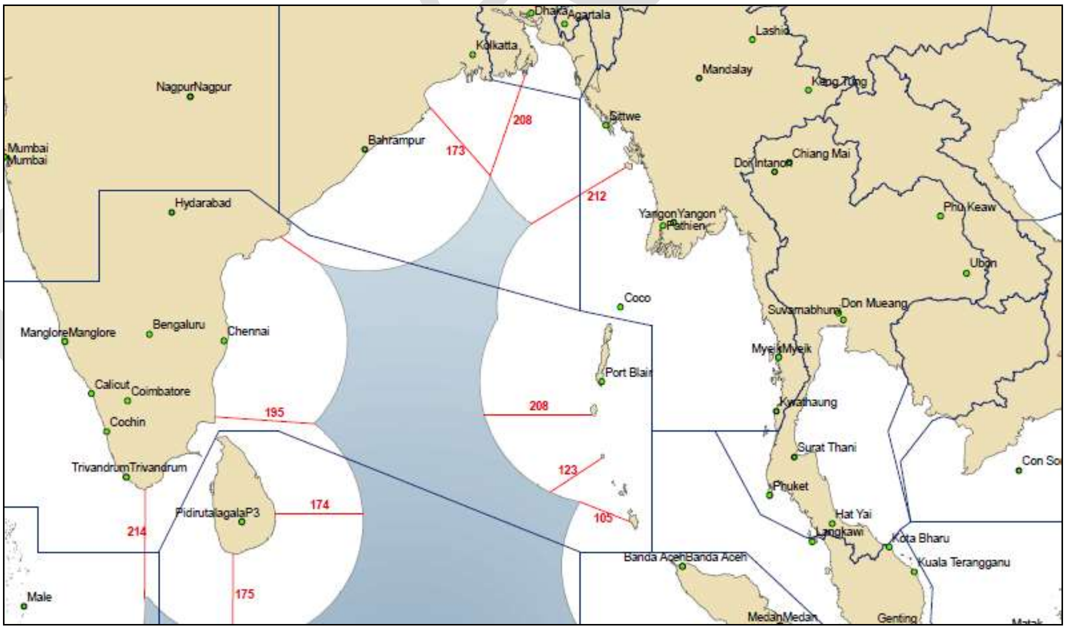

Figure 4: Bay of Bengal ATS surveillance gaps

6.9 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 3**);

b) high priority: Bay of Bengal airspace between the Indian subcontinent and the Andaman Islands (**Figure 4**);

c) medium priority:

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

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

Europe – Asia/Pacific Trans-Regional Issues

6.10 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.

6.11 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.

6.12 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.

6.13 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

6.14 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.

6.15 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.

6.16 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

6.17 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.

6.18 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.

6.19 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 3**). 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.

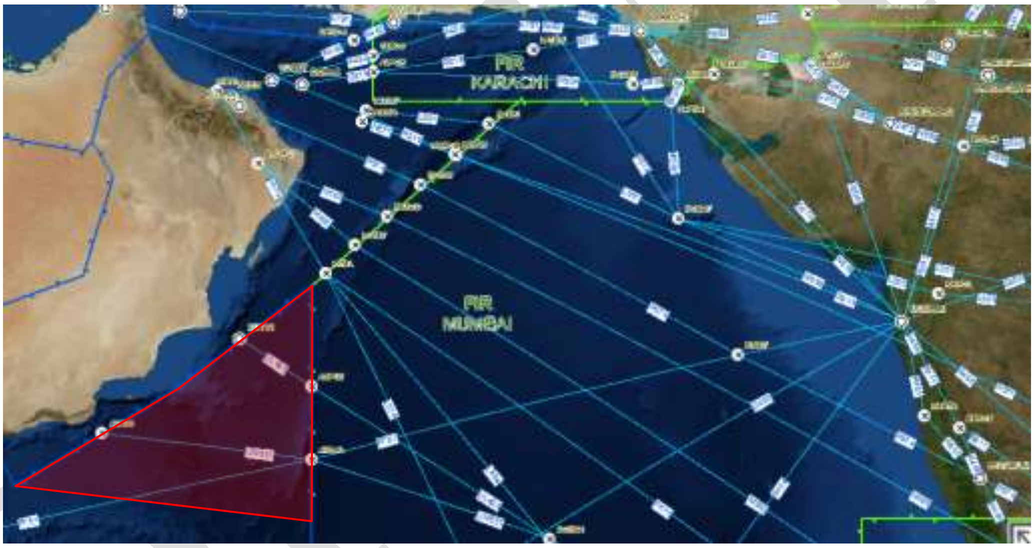

Figure 5: Middle East – Asia Trans-Regional Routes

6.20 One solution to improve Seamless ATM trans-regional operations between FIRs in this area would be to consider an amendment of the southern boundary of the Muscat Flight Information Region Boundary (FIRB) to a line joining N 15^{o} 40’, E 53 ^{o} 24’ and N 15^{o}, E 60^{o} 00’. This change would enlarge the Muscat FIR to include the area shown in red in **Figure 5**, and provide an opportunity for ATS surveillance and VHF communications (Category S airspace services) to be provided from Oman. In addition, this would reduce radiotelephone and TOCs, improving ATC workload.

6.21 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

6.22 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 12th Air Navigation Conference. 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

6.23 In 2008 CANSO and IATA agreed to conduct a cost-benefit study for the initial phase of the ADS-B project (**Figure 6**) over the South China Sea. The South China Sea (SCS) was identified for this purpose as it contained some of the highest traffic density routes that would benefit most from ADS-B. The initial phase involved ADS-B stations in Indonesia, Vietnam and Singapore. The aim was to enable radar-like separation for suitably equipped aircraft on selected routes in the area covered by the project scope.

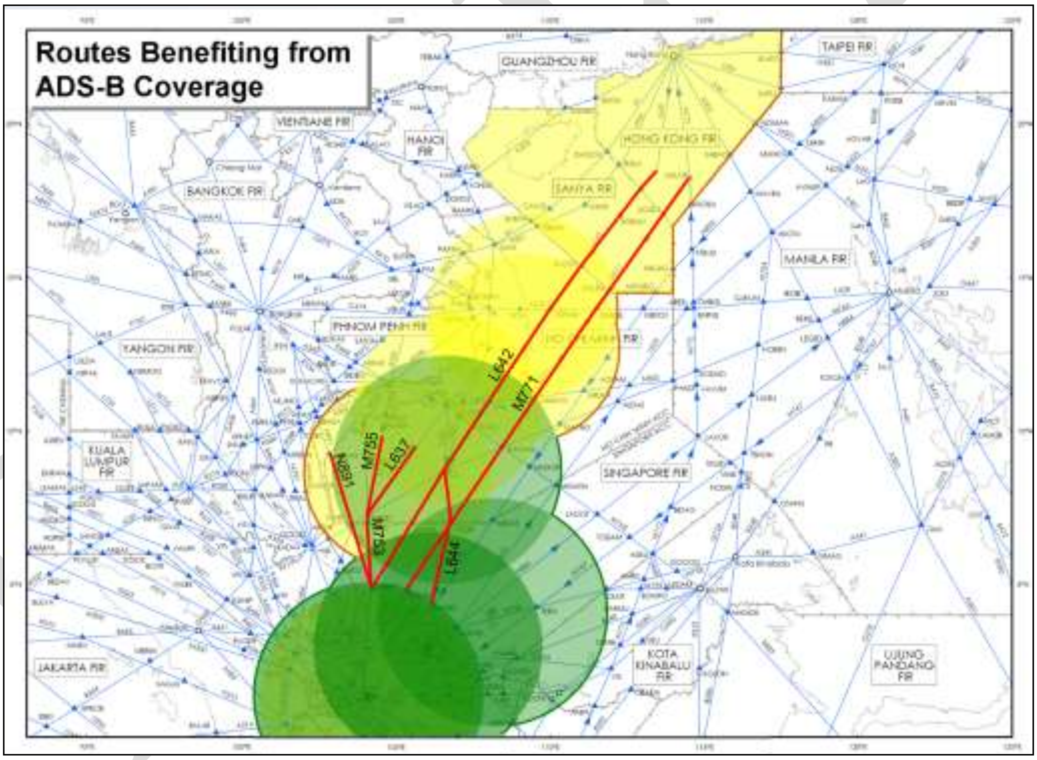

Figure 6: SCS ADS-B Study Area

6.24 The benefits that were monetized comprised the following:

a) Savings in aircraft fuel burn arising from availability of optimum flight levels and reduction in airborne and ground delays;

b) Reduction in carbon emissions; and

c) Reduction in flight delays leading to savings in Aircraft Direct Operating Cost (ADOC) and Passenger Value of Time (PVT).

6.25 The cost estimates were based on data provided by Singapore in consultation with the other ANSPs, while traffic estimates were based on an extrapolation of historical data provided by Singapore over three months in 2008. ADOC and PVT were based on FAA figures, with the latter discounted by about 40% based on the weighted GDP average for the region.

6.26 Based on data provided by Singapore from January 2008 to March 2008 for flights on airways that would benefit from the ADS-B deployment, potential savings from improved airborne efficiency and ground delay reductions were summarized in **Table 2** and **Table 3** respectively:

Airborne Efficiency – Potential Savings 2008	**3 months**	**12 months**
Fuel Burn Savings (kg)	276,585	1,106,342
Fuel Burn Savings (FY09 USD)	$177,097	$708,389
Flight time savings (hours)	117	468
Airborne ADOC w/o fuel savings (FY09 USD)	$346,283	$1,385,134
PVT savings (FY09 US $)	$292,493	$1,169,974
CO2 Emissions Savings (kg)	872,904	3,491,615
CO2 Savings (FY09 USD)	$21,777	$87,108
Total Economic Savings (FY09 USD)	$837, 651	$3,350,605

Table 2: ADS-B Airborne Efficiency

Ground Delay – Potential Savings 2008	
Fuel Burn Savings (kg)	213,531
Fuel Burn Savings (FY09 USD)	$136,724
Time savings (hours)	188
Ground ADOC w/o fuel savings (FY09 USD)	$206,132
PVT savings (FY09 US $)	$469,509
CO2 Emissions Savings (kg)	673,905
CO2 Savings (FY09 USD)	$16,812
Total Economic Savings (FY09 USD)	$829,177

Table 3: Ground Delay Savings

6.27 If it is assumed that ADS-B was 100% effective in overcoming the airborne inefficiencies and ground delays, the annual savings were nearly 1,400,000 kg of fuel burn and 4,500,000 kg of CO_2 emissions, for a relatively few number of airways.

6.28 Based on the estimated infrastructure costs, equipment life cycle of 20 years and an estimated ADS-B effectiveness of 90% and 75% in overcoming the airborne inefficiencies and the ground delays respectively, the cost benefits were calculated using three traffic growth scenarios. The results are shown in **Table 4**:

Factor	**Most Likely Estimate**		
Demand Growth	3%	5%	7%
Costs FY09 $M	$45.66	$45.66	$45.66
Benefits FY09 $M	$127.96	$200.47	$328.11
IRR	17%	22%	27%
Costs PV	$27.17	$27.17	$27.17
Benefits PV	$50.29	$73.60	$112.43
NPV	$23.12	$46.43	$85.26
B/C Ratio	1.9	2.7	4.1
Payback Year	2020	2018	2017

Table 4: Cost Benefit Estimates

6.29 The Cost Benefit Study for the initial phase of ADS-B implementation over the SCS showed clearly that there was a strong positive business case for the project.

United States NextGen Economic Benefits

6.30 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.

6.31 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. Modeling 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 (through 2020) would generate more than two-and-a-half times in benefits as costs (**Figure 7**).

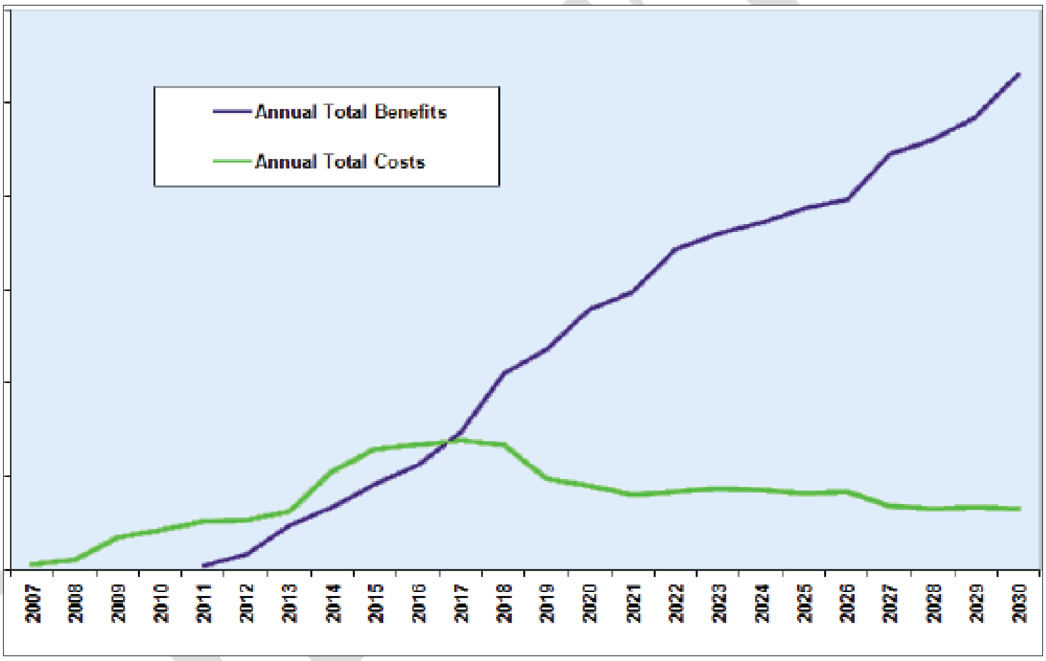

Figure 7: Annual Costs and Benefits

6.32 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).

6.33 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).

6.34 The resulting benefit estimates are shown in **Figure 8**:

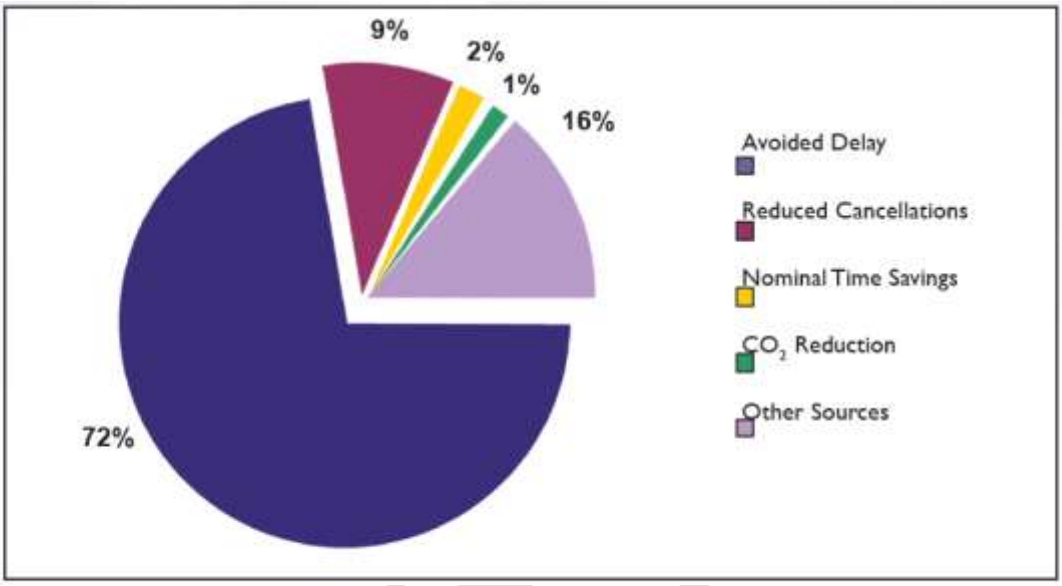

Figure 8: Types of NextGen Benefits until 2030

IATA Seamless ATM Cost-Benefit Analysis

6.35 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.

6.36 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.

6.37 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.

6.38 Earlier in 2013 IATA conducted an initial economic analysis which was tabled at APSAPG/3.

6.39 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.

6.40 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.

6.41 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.

6.42 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.

6.43 Although a "worst case" scenario this would represent a Regional potential economic benefit **loss** of **USD16.63 billion per annum** (based on 2012 data), which will reach an accumulated loss of **USD502 billion by 2030**. Upgrading the existing operational environment of ATM is essential in order to enhance the region's economic growth.

6.44 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.

6.45 The IATA Economic Study is provided at **Attachment 2**.

Point Merge Procedure Efficiency Analysis (Republic of Korea)

6.46 An analysis of the efficiency and effectiveness of terminal airspace using the Point Merge method based on PBN is at **Appendix F**.

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 air transport 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 (ASBU Priority 3).

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 (ASBU Priority 2)[1].

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[1] Based on 2012 ICAO data, the 21 busiest Asia/Pacific aerodromes were:

- Australia (Sydney, Melbourne);
- China (Beijing, Shanghai Pudong and Hongjiao, Guangzhou, Hong Kong, Xi'an, Shenzhen, Chengdu, Kunming);
- India (New Delhi, Mumbai);
- Indonesia (Jakarta);
- Japan (Haneda, Narita);
- Malaysia (Kuala Lumpur);
- Philippines (Manila);
- Republic of Korea (Incheon);
- Singapore (Changi); and
- Thailand (Suvarnabhumi).

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 (ASBU Priority 2).

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 (ASBU Priority 2):

a) precision approaches; or

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

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

En-route Operations

7.6 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 9**) 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, Kota Kinabalu, Manila, Sanya, Singapore, Vientiane; and

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

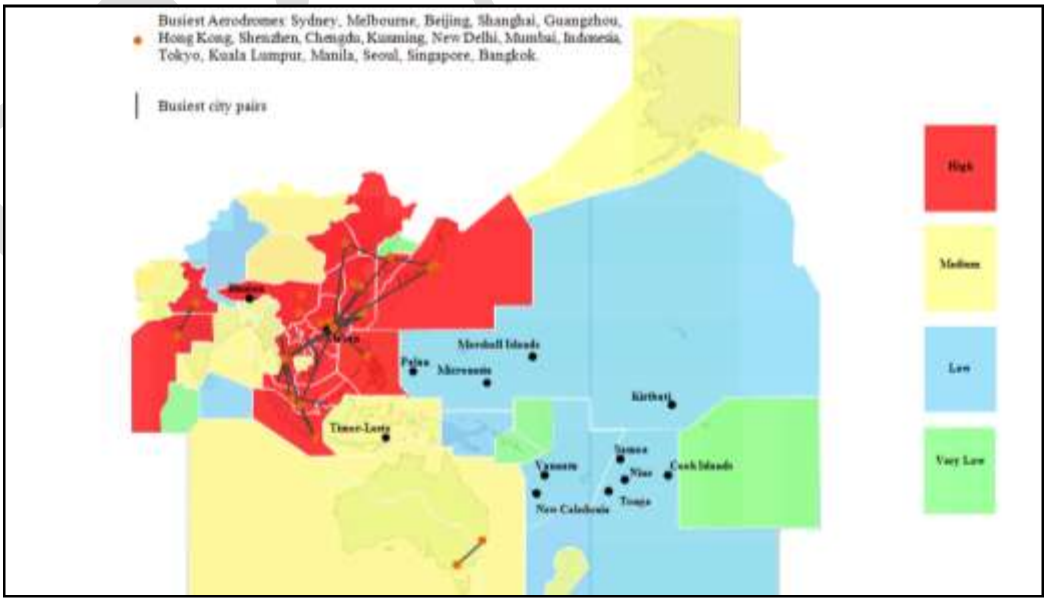

Figure 9: High Density FIRs

Note 1: in areas where ADS-B based separation service was provided, the carriage of ADS-B OUT using 1090ES with DO260/60A and 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;, ACAS and Terrain Awareness Warning Systems (TAWS), unless approved by ATC (ASBU Priority 2).

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. ATS routes should be established in accordance with the following PBN 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 and ATC separation standards 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 (ASBU Priority 1); 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 08 November 2018)

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 G**.

Terminal Operations (Category T airspace)

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

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

Note: the Asia/Pacific PBN Plan Version 3 required RNAV 1 SID/STAR for 50% of international airports by 2010 and 75% by 2012 (priority should be given to airports with RNP Approach); and RNAV 1 or RNP 1 SID/STAR for 100% of international airports and 70% of busy domestic airports where there are operational benefits by 2016.

7.16 Where practicable, all aerodromes with instrument runways serving aeroplanes should have (ASBU Priority 2):

a) precision approaches; or

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

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

Note: PBN Plan V3- RNP APCH (with Baro-VNAV) for 30% of instrument runways by 2010 and 50% by 2012 (priority should be given to airports with operational benefits); and RNP APCH with Baro-VNAV or APV in 100% of instrument runways by 2016.

7.17 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 GNSS 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.

7.18 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.

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

7.20 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.

En-route Airspace

7.21 All Category R and S upper controlled airspace, and Category T airspace should, unless approved by the State, require the carriage of an operable:

a) mode S transponder within airspace where Mode S radar services are provided; and

b) ACAS and TAWS (ASBU Priority 2).

7.22 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. ATS routes should be established in accordance with the following PBN specifications:

- Category R airspace – **RNP 2 oceanic**; and
- Category S airspace – **RNP 2**.

7.23 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 and 260B capability.

7.24 In areas where ADS-B based separation service is provided, the mandatory carriage of ADS-B OUT using 1090ES with DO260/60A and 260B should be prescribed (ASBU Priority 2).

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

7.25 All high density aerodromes should have AMAN/DMAN facilities (ASBU priority 2).

Terminal Operations

7.26 Within Category T controlled airspace, subject to Annex 11 State safety assessments, an ATC minimum horizontal separation standard not greater than **5NM** in accordance with the provisions of Doc 4444 should be applied during normal operations, including Transfer of Control (TOC) points.

Note: Within Category T airspace serving high density aerodromes, transition to a minimum separation standard of 3NM at the earliest opportunity is recommended.

7.27 All high density aerodromes should provide meteorological forecasts, aerodrome warnings and alerts that support efficient terminal operations (ASBU Priority 2).

En-route Operations

7.28 High density FIRs (refer **Figure 9**) 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 (ASBU Priority 1).

7.29 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**.

7.30 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

7.31 The delivery of CNS/ATM services should be based primarily on the CNS/ATM capability. All ATC units should authorise the use of the minimum horizontal separation standard stated in ICAO Doc 4444 (PANS ATM), or as close to the minimum standard 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.

7.32 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.

7.33 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 (ASBU Priority 1). 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).

7.34 Within Category R airspace, ADS-C surveillance and CPDLC should be enabled to support PBN-based separations, as well as UPR and DARP (ASBU Priority 1).

7.35 Subject to appropriate filtering, ATS surveillance data, particularly from ADS-B, should be shared with neighbouring ATC units within high density FIRs (refer **Figure 5**). Direct speech circuits and appropriate handoff procedures should be implemented between controllers providing ATS surveillance in adjacent airspace.

7.36 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 (ASBU Priority 1). 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 Urumqi and Lahore FIRs; and Beijing and Ulaan Baatar FIRs.

7.37 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.

7.38 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.

7.39 ATM systems should be supported by digitally-based AIM systems (using Aeronautical Information Exchange Model version 5.1 or later) through implementation of Phase 1 and 2 of the AIS-AIM Roadmap in adherence with ICAO and regional AIM planning and guidance material (ASBU Priority 1).

7.40 ATM systems should be supported by implementation of appropriate meteorological information reporting systems, providing, *inter-alia*, observations, forecasts, warnings and alerts, and also provide for information to meteorological authorities or offices where required.

Priority

7.41 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

7.42 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 ANSP managers, including:
    - assessment and management of risks related to human capabilities and limitations;
    - effective participation in a team and team management
    - effective safety reporting systems;
    - human factors in air safety investigation;
    - fatigue management approaches;

b) enhancement and improved application of ATC simulators;

c) safety teams comprising multidisciplinary operational staff and managers which review safety performance and assess significant proposals for change to ATM systems;

d) human performance-based training and procedures for staff providing ATS, including:
    - the application of tactical, surveillance-based ATC separation;
    - control techniques near minimum ATC separation;
    - responses to ATM contingency operations and safety net alerts; and
    - the importance of an effective safety reporting culture.

Civil/Military Cooperation

7.43 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 08 November 2018)

Aerodrome Operations

7.44 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

7.45 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 G****.*

7.46 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

7.47 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.

7.48 All FIRs supporting Major Traffic Flows should implement ATFM incorporating CDM to enhance capacity, using bi-lateral and multi-lateral agreements (ASBU Priority 1).

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

7.50 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 (ASBU Priority 1).

7.51 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 enroute ATC sectors..

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

ATM Systems

7.52 ATM systems should be supported by complete implementation of AIM Phase 3.

7.53 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.

7.54 Electronic flight progress strips should be utilised wherever practicable.

Safety Nets

7.55 ATS surveillance systems should enable STCA, APW and MSAW (ASBU Priority 2). 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

7.56 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*.

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 must 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 12th Air Navigation Conference endorsed Recommendation 1/9 regarding space-based ADS-B systems being included in the GANP (**Appendix 2**);

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 plannin*g) and 15 (*Collaboration by ANSPs for evaluation and planning of ATM facilities*). The 12th Air Navigation Conference 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 2**);

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. Harmonised Rules and Standards - This is consistent 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 09 November 2018 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 ensure 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, a possible timeline for Seamless ATM improvements beyond 2018 until 2028. In accordance with the Review requirements of this Plan, this timeline is expected to be amended as appropriate.

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 necessitates a number of implementation actions, which were consolidated into recommendations in the accompanying Working Paper to this Plan, for consideration by APANPIRG. Agreed actions in the form of Conclusions and an Implementation Strategy Guide (**Attachment 3**) would be followed up. It is expected that each Asia/Pacific State and administration develop a Seamless ATM Implementation Plan based on applicable parts of the Implementation Strategy Template, and implementation progress be reported to APANPIRG.

9.7 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.

9.8 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.

9.9 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 1/9 – Space-based automatic dependent surveillance — broadcast

That ICAO:

a) support the inclusion in the Global Air Navigation Plan, 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.

2 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.

3 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).

4 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.

5 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.

6 **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.

7 **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;

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.

8 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.

<u>**Facilities**: Aerodromes</u>

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.

<u>ATS Units</u>

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.

<u>Navigation Aids</u>

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.

<u>Telecommunication</u>

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.

<u>ATS Surveillance</u>

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.

<u>**Technology and Information**: Flight Operations</u>

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.

<u>Aeronautical Data</u>

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

<u>ATM Systems and Safety Nets</u>

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.

<u>ATM Modernisation Projects</u>

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: Asia/Pacific Performance Analysis

1 The following tables provide an assessment of the delta between current capabilities and practices of administrations that serve FIRs and Phase 1 of the PARS/PASL (12 November 2015), within Category R, S and T airspace. An ‘X’ indicates that there is a requirement to upgrade to meet the PASL, while a tick indicates current compliance.

South Asia

Afghanistan	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	√	
ATS surveillance		? (in progress)	√	
Horizontal Separation		X	X	
TOC separation		X		
AIDC		X		
FLAS		X		

Table D1: Kabul FIR Assessment

Bangladesh	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	X	
ATS surveillance		X	X	No en-route service above FL150
Horizontal Separation		NA	X	
TOC separation		X		
AIDC		X		
FLAS		NA		

Table D2: Dhaka FIR Assessment

India	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	
Navigation	X	X	√	
ATS surveillance	√	X	√	
Horizontal Separation	X	√	√	
TOC separation	X	X		
AIDC	X	X		
FLAS	X	X		Indian Ocean FLAS

Table D3: **Chennai**, Delhi, Kolkata, Mumbai FIR Assessment

Maldives	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	
Navigation	X	X	√	
ATS surveillance	√	√	√	
Horizontal Separation	X	√	√	
TOC separation	X	X		
AIDC	X	X		
FLAS	√	NA		

Table D4: Male FIR Assessment

Nepal	Category R	Category S	Category T	Remarks
Communication		√	√	
Navigation		X	√	
ATS surveillance		√	√	
Horizontal Separation		X	√	
TOC separation		X		
AIDC		X		
FLAS		√		

Table D5: Kathmandu FIR Assessment

Pakistan	Category R	Category S	Category T	Remarks
Communication		√	√	
Navigation		X	√	
ATS surveillance		√	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		X		

Table D6: Karachi, Lahore FIR Assessment

Sri Lanka	Category R	Category S	Category T	Remarks
Communication	√	√	√	CPDLC Unreliable
Navigation	X	X	X	
ATS surveillance	X	√	√	ADSC Unreliable
Horizontal Separation	X	√	X	
TOC separation	X	X		
AIDC	X	X		
FLAS	X	X		

Table D7: Colombo FIR Assessment

<u>Southeast Asia</u>

2 Southeast Asian airspace had a number of features that worked counter to Seamless ATM:

- fragmented FIRS not aligned with the direction of the main traffic flows;
- wide differences in the level of development in ATM infrastructure and capability;
- infrastructure development at national level with little consultation among neighbouring FIRs, resulting in limited or no integration with each other;
- inadequate ATS surveillance cover in some busy traffic junctions, resulting in greater reliance on vertical restrictions as a means of ensuring a safe traffic flow;
- obstacles to the development of ADS-B and data sharing, although regional efforts were underway (a concerted effort is required to accelerate these programs);
- conservative application of horizontal separation standards at TOC points with surveillance, which should be addressed by focus groups; and
- un-coordinated and limited use of AIDC.

Cambodia	Category R	Category S	Category T	Remarks
Communication		√	√	
Navigation		X	X	
ATS surveillance		√	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		X		

Table D8: Phnom Penh FIR Assessment

Indonesia	Category R	Category S	Category T	Remarks
Communication	√	√	√	
Navigation	X	X	X	
ATS surveillance	√	√	√	
Horizontal Separation	X	√	√	
TOC separation	X	X		
AIDC	X	X		
FLAS	X	X		

Table D9: Jakarta, Ujung Pandang FIRs Assessment

Lao PDR	Category R	Category S	Category T	Remarks
Communication		√	√	
Navigation		X	X	
ATS surveillance		√	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		X		

Table D10: Vientiane FIR Assessment

Malaysia	Category R	Category S	Category T	Remarks
Communication		√	√	
Navigation		X	√	
ATS surveillance		X	√	Requires ADS-B
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		√		

Table D11: Kuala Lumpur, Kota Kinabalu FIR Assessment

Myanmar	Category R	Category S	Category T	Remarks
Communication		X	√	
Navigation		X	X	
ATS surveillance		X	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		X		

Table D12: Yangon FIR Assessment

Philippines	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	X	√	√	Unreliable HF
Navigation	X	X	X	
ATS surveillance	X	X	√	ATM automation upgrade required
Horizontal Separation	X	√	√	
TOC separation	X	X		
AIDC	X	X		
FLAS	√	√		

Table D13: Manila FIR Assessment

Singapore	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	√	
ATS surveillance		X	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		√		

Table D14: Singapore FIR Assessment

Thailand	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	√	
ATS surveillance		√	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		√		

Table D15: Bangkok FIR Assessment

Viet Nam	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	Waypoint reports not required with ATS surveillance
Navigation	X	X	X	
ATS surveillance	√	√	√	
Horizontal Separation	X	√	√	
TOC separation	X	X		
AIDC	X	X		
FLAS	X	X		Domestic v. A1

Table D16: Hanoi, Ho Chi Minh FIR Assessment

East Asia

China	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	√	
ATS Surveillance		√	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		Partial AIDC HKG
FLAS		√		Appendix 3b FLOS

Table D17: Beijing, Guangzhou, Kunming, Lanzhou, Sanya, Shanghai, Shenyang, Urumqi, Wuhan FIRs Assessment

Hong Kong, China	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	√	
ATS Surveillance		√	√	
Horizontal Separation		√	√	
TOC separation		X		
AIDC		X		Partial AIDC Sanya
FLAS		√		

Table D18: Hong Kong FIR Assessment

DPR Korea	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	X	
ATS surveillance		√	√	
Horizontal separation		√	X	
TOC separation		X		
AIDC		X		
FLAS		X		Metre FLOS ≤FL290

Table D19: Pyongyang FIR Assessment

Japan	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	
Navigation	√	X	√	
ATS surveillance	√	√	√	
Horizontal Separation	√	√	√	
TOC separation	X	X		
AIDC	√	X		
FLAS	√	X		

Table D20: Fukuoka FIR Assessment

Mongolia	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	X	
ATS surveillance		X	√	Partial coverage
Horizontal separation		√	√	
TOC separation		X		
AIDC		X		
FLAS		√		

Table D21: Ulaan Baatar FIR Assessment

Republic of Korea	**Category R**	**Category S**	**Category T**	**Remarks**
Communication		√	√	
Navigation		X	√	
ATS surveillance		√	√	
Horizontal Separation		√	√	B467, B332, L512 FLAS. AKARA Corridor procedures require review
TOC separation		X		
AIDC		X		
FLAS		X		

Table D22: Incheon FIR Assessment

Note: the Taibei FIR was not assessed.

Pacific

Australia, Nauru, Solomon Islands	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	
Navigation	√	X	√	
ATS surveillance	√	√	√	
Horizontal Separation	√	√	√	
TOC separation	√	√		
AIDC	√	√		
FLAS	√	√		

Table D23: Brisbane, Honiara, Melbourne, Nauru FIRs Assessment

Fiji	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	
Navigation	√	X	√	
ATS surveillance	√	√	√	
Horizontal Separation	√	√	√	
TOC separation	√	√		
AIDC	X	NA		
FLAS	√	√		

Table D24: Nadi FIR Assessment

French Polynesia	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	
Navigation	√	X	√	
ATS surveillance	√	√	√	
Horizontal Separation	√	√	√	
TOC separation	√	X		
AIDC	X	√		
FLAS	√	√		

Table D25: Tahiti FIR Assessment

New Zealand	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	
Navigation	√	X	√	
ATS surveillance	√	√	√	
Horizontal Separation	√	√	√	
TOC separation	√	√		
AIDC	√	√		
FLAS	√	√		

Table D26: Auckland Oceanic, New Zealand FIRs Assessment

Papua New Guinea	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	X	√	√	
Navigation	X	X	X	
ATS surveillance	X	X	√	
Horizontal Separation	X	X	X	
TOC separation	X	X		
AIDC	X	X		
FLAS	√	√		

Table D27: Port Moresby FIR Assessment

United States	**Category R**	**Category S**	**Category T**	**Remarks**
Communication	√	√	√	Cat S/T for islands
Navigation	√	X	√	
ATS surveillance	√	√	√	
Horizontal Separation	√	√	√	
TOC separation	√	√		
AIDC	√	√		
FLAS	√	√		

Table D28: Oakland, Anchorage Oceanic FIRs Assessment

Appendix E: New Zealand Seamless ATM Planning Framework

Background

1 A performance-based planning framework, derived from ICAO planning frameworks, has been adopted for the New Zealand project. The Plan brings together airspace, CNS, ATM, aerodromes, AIM, and meteorology work streams. The Plan also considers over-arching issues, such as regulatory requirements (including rules, operational approvals, etc.), aircraft requirements, licensing and training requirements, security and environmental matters.

2 The following factors are drivers for change from equipment-based to performance-based system:

- many airline and modern general aviation aircraft have been equipped for GNSS navigation;
- RNP approaches have been established;
- the establishment of enhanced ATS surveillance such as MLAT to assist in the situational awareness of air traffic; and
- a single aeronautical database that allows the Aeronautical Information Publication and aeronautical charts to be produced from one database, thereby reducing errors.

3 Considerable effort has been undertaken in recent years on improving individual elements of the New Zealand national airspace and air navigation system, including:

- Airspace Policy;
- a PBN Implementation Plan;
- Aeronautical Information Service (AIS) to AIM Roadmap which includes development of the AIXM database for AIM;
- plans for improved ATM and ATS surveillance.

4 However, a much greater degree of coordination is needed between government and the industry in order to manage change in the airspace and air navigation system effectively, efficiently and safely. In particular, changes are needed to reduce the risk of inappropriate and wasted investment in technologies and equipage, and to reduce any risk of disruption due to lack of coordination between industry, the air navigation services provider (ANSP), the regulator, and government. Five key policy areas that would need to be addressed to enable these changes were identified:

a) implementation of a suitable planning approach to facilitate the changes in the airspace and air navigation system;

b) effective management by phasing the system changes;

c) establishment of principles for the designation of airspace in the future system;

d) better integration of decision-making on airspace and land use management (which involves coordination with local authorities and increasing awareness of aviation requirements); and

e) streamlining of changes to regulatory requirements wherever possible.

5 As part of the Plan development, New Zealand will coordinate with neighbouring States in accordance with the concept of Seamless ATM.

Appendix F: Point Merge Procedure Efficiency Analysis (Republic of Korea)

1 Existing STARs, usually designed to provide the shortest transition, provide information on the expected arrival track to the pilot, allowing planning for the approach to include CDO. However, it was not applicable if the traffic volume exceeded the maximum capacity of the STAR. In this situation, radar vectors were used to accommodate the increased traffic. However, radar vectors increased air traffic controller workload and reduced pilot situational awareness, even when following ATC instructions.

2 To overcome the disadvantages of radar vectors and to improve efficiency and effectiveness of terminal airspace, the Point Merge method based on PBN was implemented at Incheon International Airport on 3 May 2012 (**Figure F1**). The Point Merge method allowed improved:

- safety (due to the reduction of controller-pilot radio communication and enhanced surveillance capability);
- fuel efficiency (mainly through use of CDO); and
- capacity management (with better information on aircraft position supporting 4D Trajectory-Based Operations and enhanced wake turbulence management).

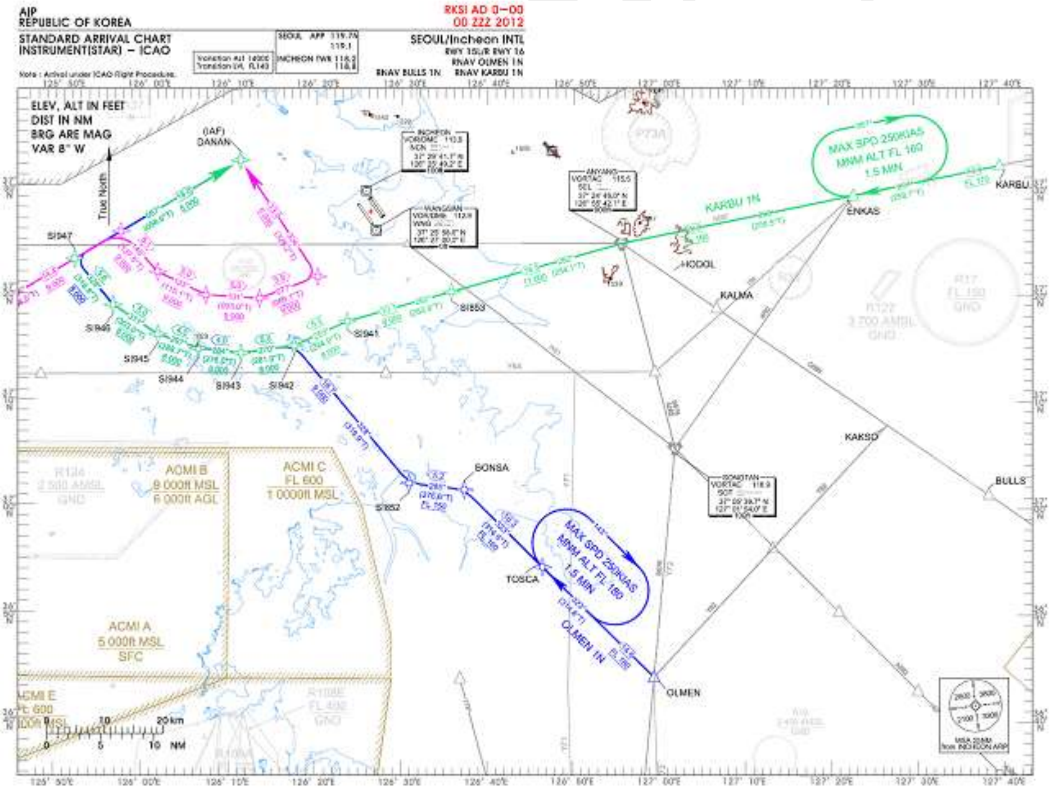

Figure F1: Incheon Airport Point Merge Procedure

3 STARs with Point Merge method were implemented at Incheon International Airport on 3 May 2012. According to the analysis of the initial phase of implementation of point merge method, the average flight distance was decreased by 2.3%, while average flying time was increased by 1.1% (due to speed control for spacing). However, variance related to flight distance and flying time decreased by 35.6% and 42.4% respectively, increasing the predictability of aircraft operations.

4 As for the vertical profiles of aircraft, analysis indicated that the aircraft following STARs with the point merge method descended from it significantly higher altitude comparing to conventional procedures including radar vectors (**Figure F2**). This meant that the Point Merge procedures were enabled to descend continuously. Based on the observed results, the new Point Merge procedures saved fuel consumption by 16%, compared to the replaced procedures.

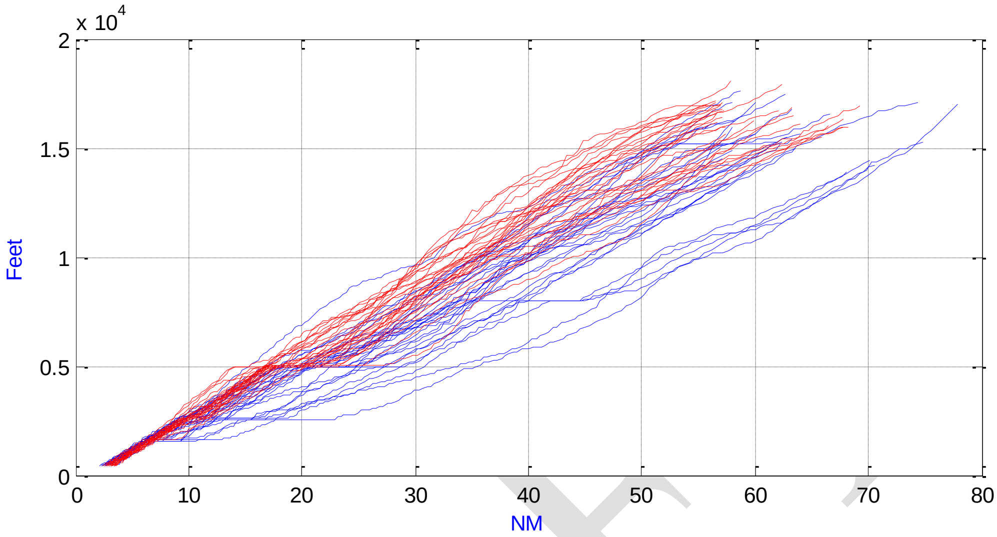

Figure F2: Vertical Profile Comparison – Blue Tracks: Radar Vectors, Red: Point Merge

5 In terms of the workloads of air traffic controllers, the Point Merge procedures reduced average communication time per aircraft and average communication frequency per aircraft by 36.6%, 10.0% respectively. This meant air traffic controllers could concentrate on traffic monitoring, and provide pilot with more information useful for situational awareness.

6 The study showed that there was no significant difference between radar vectors and Point Merge method regarding airspace capacity. However, greater capacity was expected overall due to the improvement in controller workload, and if the arrival management tool was also used, this would further increase capacity (**Figure F3**). Therefore, implementation of the Point Merge method enabled terminal airspace operations to be safer and more efficient (in terms of cost savings, less carbon dioxide, and increased airspace capacity), provided that CDO and arrival management tools were also implemented with the point merge method.

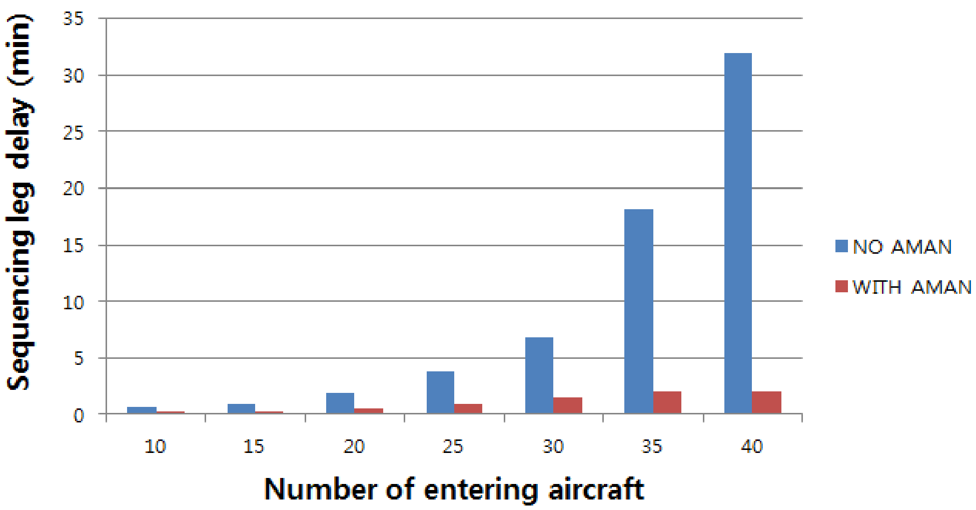

Figure F3: Point Merge Sequence Leg Delay Time

Appendix G: 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 G1** 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 G1: 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 G2: 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 targets 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

8 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).

9 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 $\sqrt{6.66}$ x airspace volume = 2.58 x 7 = **18**).

Thailand

10 Suvarnabhumi aerodrome capacity expectations:

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

United States of America

11 **Table G3** provides an indication of optimal aerodrome parallel or near parallel runway 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 G3: Capacity at selected US airports

12 Average aerodrome 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).

13 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

14 **Table G4** 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	26-32	55-64	74-**97**	78-**100**	92-**111**	12-**18**	16-**20**	17-**24**
Doc 9971 Simplified Table Comparison						15	18	18

Table G4: 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 H: 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
B0-85: ATSA			PARS I	-
B0-OPFL ITP			-	-
B0-ACAS: ACAS			PARS I	Annex 6
B0-SNET: SAFETY NETS			PASL I/II	31
B0-AMET MET WARN			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

TO BE UPDATED ON FINAL EDIT

Appendix I: List of References

Global and Regional Framework

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

Air Navigation Services

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 9613 *Performance-based Navigation Manual*
Doc 9882 *Manual on ATM System Requirements*
Doc 9883 *Manual on Global Performance of the Air Navigation System*
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

Flight Operations

Annex 6 *Operation of Aircraft*
Doc 9931 Continuous Descent Operations (CDO) Manual
Doc 9993 Continuous Climb Operations (CCO) Manual

Human Factors

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

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