International Civil Aviation Organization

The Second Meeting of the Asia/Pacific Air Traffic Flow Management Steering Group (ATFM/SG/2)

Hong Kong, China, 1 - 4 October 2013

Agenda Item 5: Development of a Regional ATFM Framework

REGIONAL FRAMEWORK FOR COLLABORATIVE ATFM DEVELOPMENT METHODOLOGY

(Presented by the Secretariat)

SUMMARY

This paper proposes a methodology that could be used to develop the Asia/Pacific Region Framework for Collaborative Air Traffic Flow Management (ATFM).

This paper relates to –

Strategic Objectives:

A: ***Safety*** *– Enhance global civil aviation safety*

C: ***Environmental Protection and Sustainable Development of Air Transport*** *– Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment*

Global Plan Initiatives:

GPI-6 Air traffic flow management

1. INTRODUCTION

1.1 The First Meeting of the Asia/Pacific Regional Air Traffic Flow Management Steering Group (ATFM/SG/1, Tokyo, Japan, 08 – 10 December 2010) was tasked by the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) with the development of an Asia/Pacific Regional ATFM Concept of Operations. The Concept of Operations was subsequently published, and there were no further tasks assigned to or arising from the Steering Group meeting.

1.2 APANPIRG/24 (Bangkok, Thailand, 24 – 26 June 2013) adopted version 1.0 of the Asia/Pacific Seamless Air Traffic Management Plan. The meeting also adopted three ATFM-related Conclusions, including among them the requirement that ATFM/SG develops a common regional ATFM framework.

1.3 This paper discusses these and other considerations which should be addressed in developing the framework, and proposes a development methodology.

2. DISCUSSION

APANPIRG/24 ATFM-Related Conclusions

2.1 APANPIRG/24 adopted the following Conclusion re-convening the ATFM Steering Group, and tasking it to develop a regional ATFM framework:

Conclusion 24/15: Asia/Pacific ATFM Steering Group

That, States participate in, and support the Asia/Pacific ATFM Steering Group to develop a common Regional ATFM framework, which addresses ATFM implementation and ATFM operational issues in the Asia/Pacific region.

2.2 Two further Conclusions were adopted, urging States to establish capacity assessment and adjustment mechanisms and share capacity assessment and traffic demand information. These Conclusions should be considered when determining in the methodology for development of the regional ATFM framework:

Conclusion 24/13: Air Traffic Flow Management Capacity Assessments

That States be urged to establish capacity assessment and adjustment mechanisms, and regular review for all aerodromes and ATC sectors where traffic demand is expected to reach capacity, or is experiencing traffic congestion, and to report the assessment outcomes to the Asia/Pacific Regional Office prior to 1 May 2014.

Conclusion 24/14: Air Traffic Flow Management Information Sharing

That States, where ATFM processes are in place, including within adjacent airspace, be urged to share information, which may include:

a) capacity assessment: including factors of interest affecting capacity, such as special use airspace status, runway closures and weather information;

b) traffic demand information: which may include flight schedules, flight plan, repetitive flight plan data as well as associated surveillance updates of flight status; and

c) ATFM Daily Plan.

Hierarchy of Regional Planning Documents

2.3 Regional air navigation planning documents including the Asia/Pacific Region Air Navigation Plan (Doc 9763), Asia/Pacific Seamless Air Traffic Management (ATM) Plan and other Regional guidance material or framework documents fall within a hierarchy of documents detailing global vision and strategy, and guiding regional implementation. It is envisaged that the Regional Collaborative ATFM Framework will be contributory to the Seamless ATM Plan.

2.4 The Seamless ATM 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.

2.5 The new Part III of the RANP is under development, and is expected to detail non-binding Regional guidance material, incorporating key components of the Seamless ATM Plan.

2.6 **Figure 1** illustrates the linkages between Asia/Pacific Regional implementation planning Documents, and their relationship to global vision and strategy documents

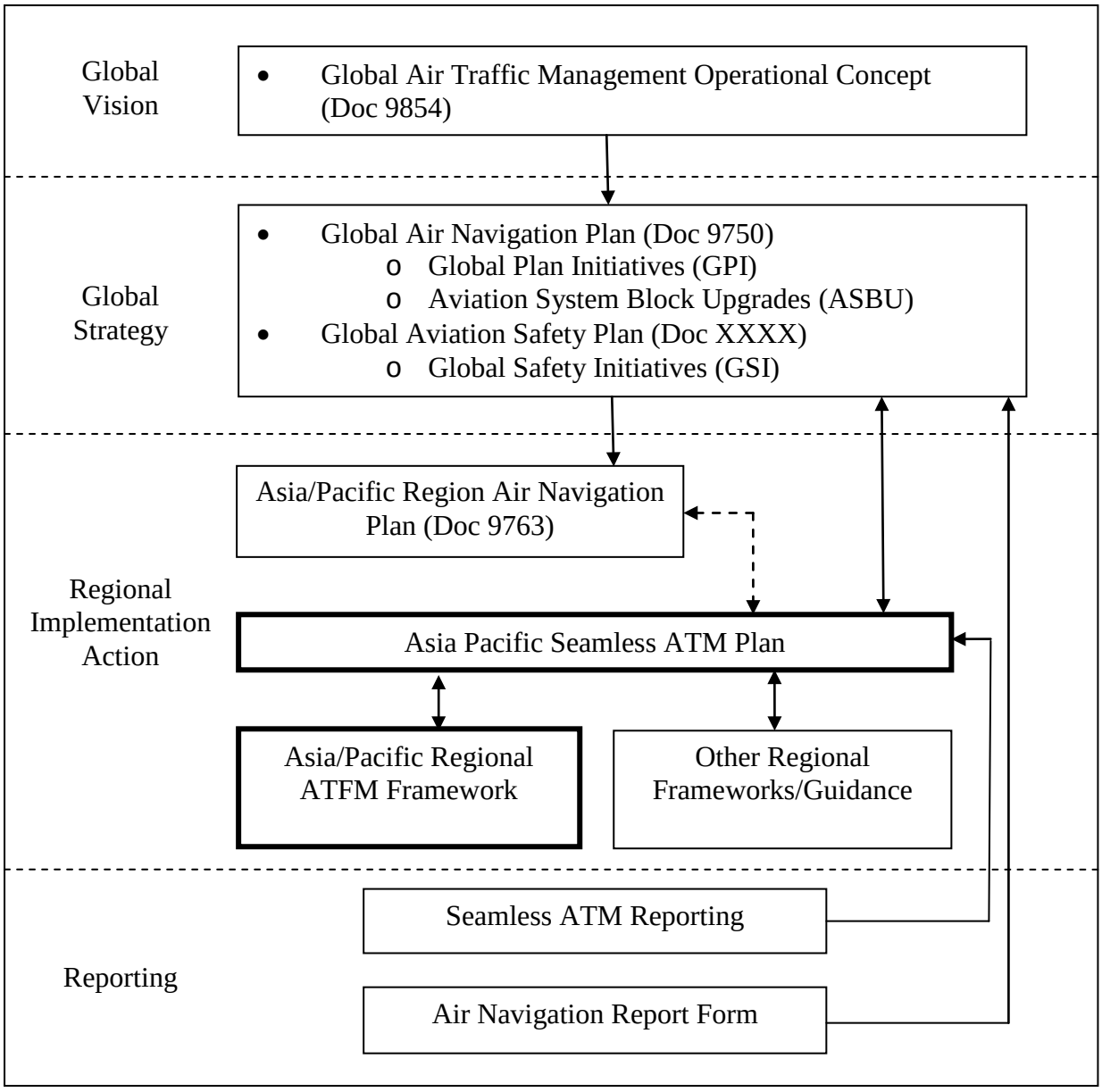

Figure 1: Regional Planning Documents and Linkages

Schedule of Meetings and Work Plan for ATFM/SG

2.7 While no schedule of meetings was specified by APANPIRG, the need for a regional ATFM framework to guide ATFM implementation to manage the rapid growth of Asia/Pacific Region traffic indicate that an aggressive timeline should be pursued. The urgency of the need for guidance notwithstanding, there is also the need for sufficient intervals between meetings to permit the effective collection, collation and analysis of data and coordination between Co-Chairs, Subject Matter Experts and the Secretariat for the drafting and editing of the Framework document as it develops.

2.8 It is proposed that the regional ATFM framework is developed over the course of three further meetings, held at intervals of approximately five or six months as follows:

- ATFM/SG/3 – March 2014;
- ATFM/SG/4 – September 2014; and
- ATFM/SG/5 – March/April 2015.

ATFM/SG/4 scheduling is dependent on APANPIR/25.

2.9 The following work plan is proposed for ATFM/SG:

ATFM/SG/2 - Conceptualizing

- Discuss, develop and agree to the Draft Framework for Collaborative ATFM concept and methodology
- Construct the initial draft of the framework document; including
  - Table of Contents
  - ATFM principles;
  - ATFM service capability elements including ATFM services, tools and procedure levels;
  - Preferred ATFM Service Categories (PAS) based on airspace complexity and traffic density, and defining the minimum suite of capability elements required for each category of PAS.
- Discuss a process for collection, analysis and reporting of demand and capacity data;
- Agree to the concept and deliverables for a draft Interim Collaborative Framework document (paragraphs 2.23 – 2.27 refer)
- Form a group of 4 to 6 appropriately skilled and experienced ATM specialists from ATFM/SG participants for the development, review and circulation of the framework and the interim framework document between meetings, coordinated and assisted by the Secretariat

ATFM/SG/3 - Analyzing

- Conduct Analysis and further development of:
  - Demand and capacity data and related information;
  - ATFM service capability elements; and
  - Preferred ATFM Service Categories.
- Agree to the final draft of a Preliminary Framework for Collaborative ATFM for approval by the 2nd Meeting of the Air Traffic Management Sub-Group (ATM/SG/2).

ATFM/SG/4 – Early Draft Framework

- Early Draft Regional Framework for Collaborative ATFM.

ATFM/SG/5 – Completion

- Completion of the final draft of the Regional Framework for Collaborative ATFM, for submission to APANPIRG through its Air Traffic Management Sub-Group (ATM/SG)

2.10 While the scheduled dates for meetings will be dependent on the ICAO Regional Office meetings program, scheduling considerations should take into account the Asia/Pacific Seamless ATM Plan and its Performance Improvement Plan objectives and milestones. In particular, the ATFM/SG/5 meeting should be scheduled to ensure the framework document is in its final draft form and ready for consideration by the ATM/SG/3, tentatively scheduled for late July or early August 2015, and subsequent adoption by APANPIRG/26 in September 2015.

Alignment of Regional Collaborative ATFM Framework and Seamless ATM Plan

2.11 The Seamless ATM plan sets the overarching requirements for ATFM in the Asia/Pacific Region. In order to ensure a standardized approach and the alignment of the Regional ATFM Framework with policy direction provided by the Seamless Plan, the objectives, principles, and implementation timelines of the ATFM Framework should be based on those of the parent document.

2.12 ATFM-Related Elements of the Seamless ATM Plan are provided in **Attachment A**.

Framework for Collaborative ATFM Document

2.13 As the ATFM framework document will be contributory to the Seamless ATM Plan, it should be presented in the same structure and format. The framework should therefore include:

a) scope of the framework;
b) objectives;
c) executive summary;
d) abbreviations and acronyms;
e) background information (Principles, Elements);
f) current situation;
g) plan for performance improvement;
h) research and development, and future possibilities;
i) milestones, timelines, priorities and actions; and
j) appendices.

2.14 A skeletal draft of the ATFM Framework Document is provided in **Attachment B**. The document, as amended by ATFM/SG/2, should be further developed offline before it is again presented in draft form to ATFM/SG/3 for approval and further direction.

Draft Regional ATFM Principles

The ICAO Twelfth Air Navigation Conference (AN-Conf/12, Montreal, 19-30 November 2012) endorsed 10 High Level Air Navigation Policy Principles in the GANP. The Asia/Pacific Seamless ATM Principles are aligned with these high level principles. The Asia/Pacific Region ATFM Concept of Operations also included policies and principles developed by ATFM/SG/1. While this document is now superseded, its principles could also provide guidance to the ATFM/SG for formulating principles for the Framework for Collaborative ATFM.

2.15 The ATFM/SG should therefore consider relevant principles from the following documents for inclusion in the Framework:

i. Seamless ATM Plan;
ii. Asia/Pacific Region ATFM Concept of Operations; and
iii. Final Draft of the Manual on Collaborative Air Traffic Flow Management (Doc 9971)

2.16 Draft principles for the Regional Framework for Collaborative ATFM are provided at **Attachment C**.

2.17 The ATFM/SG should define sufficient principles to ensure completeness of the framework document, while avoiding where practicable the duplication of principles already stated in related higher level documents or in global guidance. The draft principles include those from the above documents only where they are specific to ATFM, or where modification or elaboration was required in order to render them more ATFM-specific.

ATFM Capability Elements (Tools/Procedures)

2.18 It should be recognized that most if not all ATC units in the Region currently provide some form of ATFM service, whether they be aerodrome control towers providing services in low-density control zones, high density TMA or en-route radar sectors in an AACC environment, or something in between. The actual service may in many cases be simple, such as merely queuing arriving aircraft into a holding pattern at the primary approach navigation aid or ad-hoc traffic metering. In high density airspace the ATFM service may be provided through a well-developed and coordinated, automated CDM/ATFM system, or by manual flow control process, or by far less developed ad-hoc traffic management techniques applied by individual sector controllers. In other cases rudimentary ATFM outcomes may be achieved by applying a single large and longitudinal spacing no matter the level of demand, or use of non-surveillance separation standards within areas of contiguous surveillance coverage.

2.19 A central task for the ATFM/SG should be the definition of the minimum ATFM service capability applicable to particular types of airspace, using a tailored selection of *capability elements* from a suite of tools, procedures and practices to flexibly and efficiently manage demand. This requires the definition of a comprehensive list of ATFM capability elements.

2.20 An example draft suite of ATFM tools, practices and procedures is appended at **Attachment D** to provide a starting point for the ATFM/SG to commence development of a suite of capability elements for inclusion in the ATFM framework.

Preferred ATFM Service Categories

2.21 To correctly define the ATFM service capability applicable to any particular airspace sector it is necessary to also define categories of airspace sector within which a minimum set of service capability elements should be provided. Such categories should be determined by traffic density and airspace complexity, where complexity measurement includes such factors as traffic mix (IFR and VFR traffic, jet v non-jet, military activity, general aviation activity), airspace constraints, environmental factors, meteorological factors, etc.

2.22 Once the ATFM service categories are determined, the ATFM Capability Elements applicable to each category should be defined. An example of a matrix of Preferred ATFM Service Categories and the associated ATFM capability elements is provided at **Attachment E**.

Functional Airspace Blocks

2.23 Contiguous sectors of airspace falling into the same Preferred ATFM Service Category level should form a functional airspace block, sharing common ATFM procedures and processes, with CDM/ATFM decisions and coordination provided from a common ATFM Unit, Centre or Virtual Centre. **Figure 3** illustrates the concept of Functional Airspace Blocks served by a networked, virtual ATFM Centre.

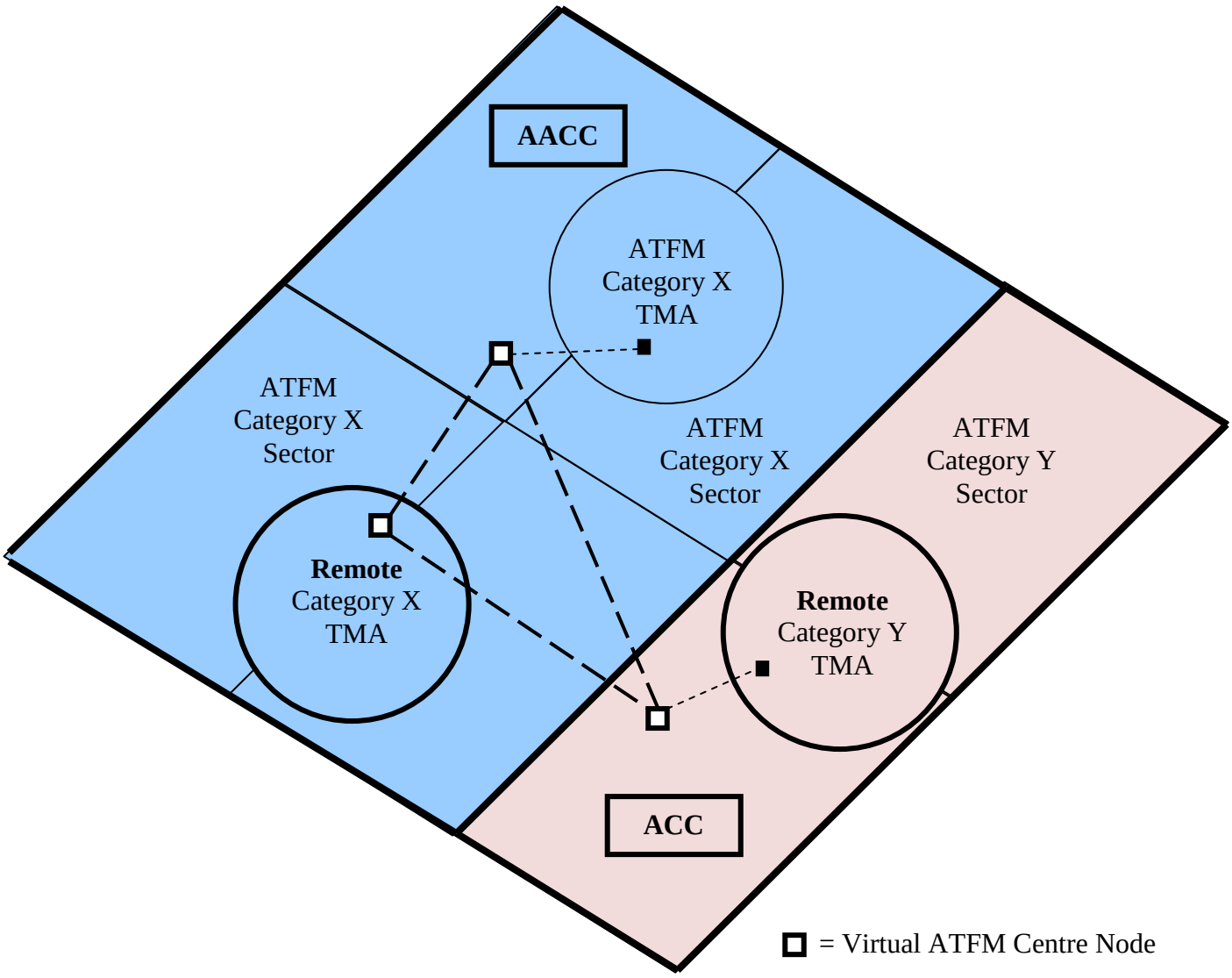

Figure 3: Functional Airspace Blocks

Interim Asia/Pacific Regional Framework for Collaborative ATFM

2.24 The time required for development of the regional ATFM framework notwithstanding, there is also the need to develop within a shorter timeframe guidance material for the implementation of interim ATFM procedures, particularly in cases where little or no organized or targeted ATFM is currently in place.

2.25 Development and promulgation of Regional guidance for interim ATFM solutions would not only provide earlier benefit to airspace users, but would also provide States having little experience in ATFM the opportunity to gain knowledge and experience before embarking on the more detailed implementation that will be driven by the broader ATFM framework.

2.26 It is envisaged that interim ATFM framework may include fundamental, introductory Tactical and Strategic ATFM guidance such as:

- Demand and Capacity Analysis:

- Tactical ATFM Implementation:
  - procedure development;
  - Training Development
  - Initial ATFM implementation
  - Review of outcomes

- Tactical ATFM Optimisation:
  - airspace and ATS route re-design;
  - procedure re-design
  - training development
  - optimized tactical ATFM implementation

- Strategic ATFM
  - Arrival slot program.

2.27 The Interim Asia/Pacific Regional Framework for Collaborative ATFM will be primarily based on the guidance provided in the *Manual on Collaborative Air Traffic Flow Management* (Doc 9971), once adopted by Council. The guidance material developed will later be included in or appended to the regional collaborative ATFM framework.

ATFM/SG Specialist Team

2.28 In order to progress the work of the ATFM/SG it is necessary to form a small team ATFM experts, primarily from an operational ATM and ATFM background but also including industry representation, and having access to technical/engineering advice on network communications technology and applications. The primary task of this team would be the initial drafting of the ATFM framework and ongoing, between-meetings development of its Principles, Capability Elements and Preferred ATFM Service Categories before wider circulation to the Steering Group.

2.29 In parallel to this work the team would be also develop the Basic Level ATFM Implementation Guidance Material, using similar work methods and supplemented where necessary by ad-hoc meetings.

2.30 ATFM/SG is invited to consider the following (draft) Decision:

Decision ATFM/SG 2/X: ATFM Specialist Team

That, ATFM/SG forms a team of experienced ATM/ATFM specialists which, communicating by electronic means and, where necessary, holding ad-hoc meetings, to draft, develop and circulate with the assistance of the Secretariat:

i) the Asia Pacific Regional Framework for Collaborative ATFM; and
ii) the Interim Framework for Collaborative ATFM.

Parallel Implementation Programs

2.31 A number of Asia/Pacific States and/or associations of States have commenced the analysis, development and implementation of ATFM solutions, either independently or assisted by other States, international organizations, industry partners and/or ATM and ATFM systems vendors. While it is in the interests of all parties to recognize the importance of this work, and that the initiation and progress of these programs continues, it is also important to ensure these programs and the regional framework are compatible. This is particularly so in the context of the envisaged collaborative ATFM network.

2.32 The sharing of information between States and the ATFM/SG would provide valuable opportunity for the Steering Group to benefit knowledge and experience gained by States, and for the inclusion of beneficial aspects of State plans in the regional framework. Conversely, the deliberations and decisions of the Steering Group may provide useful guidance for States to adapt their ATFM programs to align with the framework. Accordingly, the following draft Conclusion is proposed:

Draft Conclusion: State ATFM Implementation Plans

That, considering that some Asia/Pacific States are developing and implementing ATFM programs independently from the development of the Regional Framework for Collaborative ATFM, and recognizing that sharing ATFM implementation information between States and the ATFM/SG will lead to compatible development of State programs and the framework, States are urged to:

a) divulge their ATFM plans to ATFM/SG, to allow the development of the regional ATFM framework in the full knowledge of State capability and the compatibility or otherwise of State plans; and

b) ensure the adaptability of their ATFM implementation programs in order to align them with the regional ATFM framework as it develops.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) agree to the schedule of meetings and work plan for the ATFM/SG;

c) agree to adopt the initial draft Collaborative ATFM Framework document for further development, and propose any changes or inclusions;

d) discuss, amend as necessary and agree to the draft ATFM Principles and ATFM Capability Elements;

e) draft a matrix of Preferred ATFM Service Categories;

f) agree to the concept of Functional Airspace Blocks

g) agree to the concept of an Interim Regional Framework for Collaborative ATFM;

h) agree to the draft Decision forming an ATFM Specialist Team and Draft Conclusion on State Implementation Plans; and

i) discuss any other relevant matters as appropriate.

…….

ATFM-Related Elements of the Seamless ATM Plan

BACKGROUND INFORMATION

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, reducing 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 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*).

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. In areas where the provision of direct ATS surveillance is possible, ATC separation should be based on these surveillance systems (i.e. radar, multilateration and ADS-B), and that ADS-C and CPDLC with backup provided by High Frequency (HF) and/or Satellite Voice Communications (SATVOICE) were necessary elsewhere. Moreover, the Regional Surveillance Strategy states that ADS-C should be used where technical constraint or cost benefit analysis did not support the use of Automatic Dependent Surveillance-Broadcast (ADS-B), SSR or Multilateration (MLAT).

5.14 **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 to enhance safety, increase efficiency, achieve seamless surveillance and work closely together to harmonize their ADS-B plans to optimize benefits. The provision of communication capability such as Very High Frequency (VHF) to support ATS surveillance is also necessary. Furthermore, APANPIRG/22 urged States to support provision of Very High Frequency (VHF) radio voice air/ground communication infrastructure for use by adjacent States to enable a reduction of ATS separation based on surveillance.

Recommended ASBU Upgrades

5.15 **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 meaning.

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).

5.20 **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).

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).

Global and Regional Elements

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 in order to ensure that the planning, operation and review of aerodrome services are conducted collaboratively.

Civil/Military Cooperation

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.

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).

En-route Operations

7.27 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).

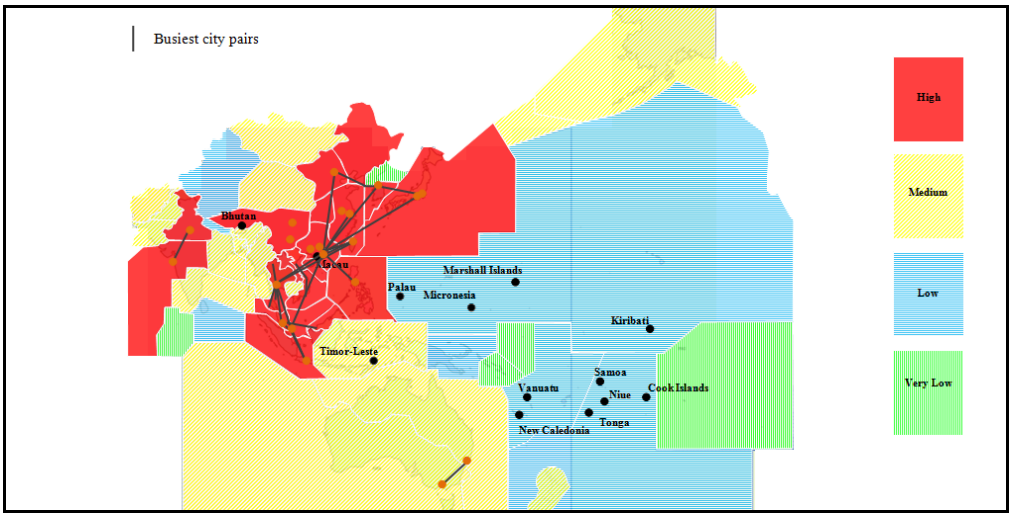

Figure 9: High Density FIRs

PASL Phase II (expected implementation by 08 November 2018)

Aerodrome Operations

7.43 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

7.1 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**.*

7.45 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 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 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**.*

RESEARCH AND FUTURE DEVELOPMENT POSSIBILITIES

Research and Development

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

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*;

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 figures in varying Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC) circumstances.

Australia

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 √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 arrival rate runway arrival capacity at selected USA aerodromes. It should be noted that multiple runway combinations or whether runways were used for arrivals, departures, or both yielded a number of permutations from the data.

Aerodrome	Runways	IMC	VMC
ATL	5	104	126
ORD	5	84	112
DFW	5	90	96
ATL	4	92	112
DEN	4	-	114
LAX	4	64	80
ORD	4	-	92
ATL	3	76	96
DEN	3	-	96
IAD	3	72	100
ATL	2	68	82
JFK	2	-	58
SDF	2	40	52
ATL	1	34	42
SDF	1	20	26
SFO	1	25	27

Table G3: Capacity at selected US airports

12 Average aerodrome arrival capacity expectations (range):

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

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	**61**	**95**	**150**	**177**	**211**	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

INTERNATIONAL CIVIL AVIATION ORGANIZATION

D R A F T

ASIA/PACIFIC REGIONAL FRAMEWORK FOR COLLABORATIVE AIR TRAFFIC FLOW MANAGEMENT

DRAFT Version 0.1, MONTH YEAR

This Plan was developed by the Asia/Pacific Air Traffic Flow Management Steering Group (ATFM/SG)

Approved by APANPIRG/XX and published by the
ICAO Asia and Pacific Office, Bangkok

CONTENTS

SCOPE OF THE PLAN

Framework Structure

1.1 The Asia/Pacific Region Air Traffic Flow Management Framework (hereinafter referred to as "the Framework") forms part of a range of regional planning documents which, together with other regional documents is contributory to the Asia/Pacific Seamless Air Traffic Management (ATM) Plan.

1.2 Global vision and strategy perspectives are provided by 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 the Seamless Plan together with its contributory documents (including the Framework) and other guidance material, to define goals and the means of meeting State planning objectives.

1.3 The Framework references the *Manual on Collaborative Air Traffic Flow Management* (Doc 9971)

1.4 Implementation timelines for ATFM service levels defined in the Framework are aligned with the Seamless Plan's Preferred ATM Service Levels (PASL).

1.5 XXXXXXXX

Plan Review

1.6 As the Framework is contributory to the Seamless Plan it is intended that it is reviewed each three years, or at more frequent intervals as determined by APANPIRG, coincident with the regular review of the Seamless Plan.

OBJECTIVES

Framework Objective

2.1 Having considered relevant documents such as the Manual on Collaborative Air Traffic Flow Management (Doc 9971) and the Asia/Pacific Region Seamless ATM Plan, the objective of the Framework is to address ATFM implementation and operational issues in the Asia/Pacific Region by recommending appropriate guidance for:

a. capacity assessment and adjustment mechanisms;

b. regular review for all aerodromes and ATC sectors where traffic demand has reached or is expected to reach or exceed capacity, or is resulting in traffic congestion;

c. mechanisms for ATFM data gathering, collation and sharing; and

d. regionally harmonized benchmarks for airport acceptance rates (AAR) and the throughput of airspace (sector capacity);

Figure x: x

Framework Development

2.2 The Framework was developed as a contributory document to the Seamless ATM Plan, in response to the identified need for guidance in the State, Sub-Regional and Regional implementation of ATFM. The Framework has been developed in consultation with Asia/Pacific States and Administrations, and International Organizations.

2.3

- x;
- x; and
- x.

EXECUTIVE SUMMARY

x

3.1 x.

Stakeholder Summary

3.2 x

ABBREVIATIONS AND ACRONYMS

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

CPAR	Conflict Prediction and Resolution
CPDLC	Controller Pilot Data-link Communications
CPWG	Cross-Polar Working Group
CSP	Communication Service Provider
CTA	Control Area
CTR	Control Zone
DARP	Dynamic Airborne Re-route Planning
DGCA	Conference of Directors General of Civil Aviation
DMAN	Departure Manager
DME	Distance Measuring Equipment
EST	Coordinate Estimate
FAA	Federal Aviation Administration
FDPS	Flight Data Processing System
FIR	Flight Information Region
FIRB	Flight Information Region Boundary
FL	Flight Level
FLAS	Flight Level Allocation Scheme
FLOS	Flight Level Orientation Scheme
FRMS	Fatigue Risk Management System
FUA	Flexible Use Airspace
GANIS	Global Air Navigation Industry Symposium
GANP	Global Air Navigation Plan
GASP	Global Aviation Safety Plan
GBAS	Ground-based Augmentation System
GDP	Gross Domestic Product
GLS	GNSS Landing System
GNSS	Global Navigation Satellite System
GPI	Global Plan Initiative
HF	High Frequency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMC	Instrument Meteorological Conditions
INS	Inertial Navigation Systems
IO	International Organizations
IPACG	Informal Pacific ATC Coordinating Group
ISPACG	Informal South Pacific ATS Coordinating Group
ITP	In-Trail Procedure
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
NextGen	Next Generation Air Transportation System
OPMET	Operational Meteorological
OLDI	On-Line Data Interchange
OTS	Organised Track System
PACOTS	Pacific Organized Track System
PARS	Preferred Aerodrome/Airspace and Route Specifications
PASL	Preferred ATM Service Levels
PBN	Performance-based Navigation

PIA	Performance Improvement Areas
PKP	Passenger Kilometres Performed
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
STS	Special Handling Status
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
VMC	Visual Meteorological Systems
VNAV	Vertical Navigation
VAAC	Volcanic Ash Advisory Centre
VMC	Visual Meteorological Conditions
VOLMET	Volume Meteorological
VOR	Very High Frequency Omni-directional Radio Range
VSAT	Very Small Aperture
WAFC	World Area Forecast Centre

BACKGROUND INFORMATION

Principles

5.1 x.

5.2 x:

- x;
- x;
- x; and
- x.

5.3 x

CURRENT SITUATION

x Analysis

6.1 x

6.2 x:

a) x;

b) x;

c) x;

- x; and
- x.

6.3 x.

PERFORMANCE IMPROVEMENT PLAN

7.1 x:

a) x;

b) x:

- x;
- x; and

c) x.

7.2 x.

RESEARCH AND FUTURE DEVELOPMENT

x

8.1 x.

MILESTONES, TIMELINES, PRIORITIES AND ACTIONS

x

9.1 x.

APPENDICES

x

Proposed ATFM Framework Principles

People: Aviation Regulations, Standards and Procedures

1. Regional model of inter-connected sub-regional ATFM networks based on system-wide CDM, serving the busiest terminal airspace and major sub-Regional traffic flows.

2. Harmonized regional or sub-regional ATFM rules and guidelines based on the ICAO Manual on Collaborative Air Traffic Flow Management (Doc 9971).

3. Regionally harmonized methodology for the collection, analysis and ongoing monitoring of demand and capacity data.

4. Consistency between the ICAO Regional Air Navigation Plan, Asia/Pacific Seamless ATM Plan and Regional ATFM Framework.

5. An emphasis on delivery of ATFM services based on CNS capability, resulting in flexible, dynamic systems.
6. The use of high-fidelity simulators to train controllers and ATFMU personnel involved in in ATFM procedures and techniques.

ATM Coordination

7. Development of manual processes and skills to promote practical knowledge and understanding of ATFM before implementing technology based solutions, and as a contingency response capability.
8. Cross-border/FIR cooperation for use of aeronautical facilities and airspace, collaborative data sharing, airspace demand and capacity assessment and ATFM planning.

Facilities: Aerodromes

9. To encourage aerodrome operators to actively participate in ATM coordination in respect of Airport CDM development and operational planning, including aerodrome complexity and capacity.

ATS Units

10. Collaboration by ANSPs for evaluation and planning of ATFM facilities.
11. Optimization of ATFM facilities through automated, networked, central flow management centres and units or equivalent virtual platforms.
12. The prioritization of integrated AIDC systems for timely ATM and ATFM system updates of trajectory data.
13. Regional cooperation for augmentation systems in terms of interoperability and increased service areas, and a GNSS ionospheric monitoring network.

Technology and Information: ATFM Systems

14. Continuous supervision, operation, adjustment, monitoring and executive control of ATFM systems and their output by qualified ATC or ATFM personnel.

15. Encouragement of the use of dual-redundant automated ATFM processing and communications systems, supported by agreed contingency procedures and facilities including ATN/AMHS and public telephone systems.
16. Collaborative development of CDM, ATFM, A/MAN and D/MAN support tools.
17. Encourage sharing of air traffic data between military ATM systems and civil ATM/ATFM systems

ATM Modernisation Projects

18. Inter-regional and sub-regional cooperation (‘clustering’) for the research, development and implementation of ATFM projects
19. A focus on harmonized technologies for earliest deployment and best cost benefits.
20. x
21. x
22. x

Proposed ATFM Framework – Examples of Capability Elements

The following are derived from the draft ICAO Manual on Collaborative Air Traffic Flow Management (Doc 9971), and may provide a guide for the Steering Group's development of ATFM Capability Elements

Planning Tools

- Airspace design and ATS Route Planning
- Capacity Analysis and workload modelling

ATFM Unit, Centre or Virtual ATFM Centre Structure

- Strategic management unit;
- Pre-Tactical Management Unit;
- Tactical Management Unit;
- Capacity Unit;
- Operability Monitoring Unit;
- Coordination and Decision Unit; and
- Flow Management Positions (ACC, TMA positions linked to ATFM Unit or Centre)

Prediction and Monitoring Tools

- Demand and workload prediction
- weather prediction
- monitoring tools

CDM Tools

- information exchange
- collaboration
- electronic user helpdesk
- crisis management

Tactical ATFM Capability

- Segregated SIDS and STARS
- Agreed acceptance rates
- Holding patterns permitting CDO
- Agreed flow gates at uniform distances from the aerodrome
- Prioritization of landing aircraft;
- Industry notification of additional fuel for traffic delays;

ATFM Execution Tools

- Slot Allocation
- Route and Fix Balancing
- Flight Level Balancing

ATFM Measures

- Miles in Trail
- Minutes in trail
- fix balancing
- rerouting
- mandatory rerouting
- level capping
- alternative or advisory routing
- minimum departure intervals
- slot swapping
- playbook routes
- ground delay programme
- ground stop
- airborne holding

Analysis Tools

- data analysis and reporting

ATC Procedures and Practices

- standard phrases for delaying action (ICAO Doc 4444);
- early advice to pilots of expected delays;
- delays in the cruise if and where possible;
- maximized the use of speed control to achieve delays;
- optimized of separation minima;
- use of vectoring to:
  - Increase track miles to adjust time;
  - Meet set course times or Required Time of Arrival (RTA);
  - Continuous descent during vectoring.
- development of ATC skills in vectoring and holding for efficient sequencing;

- holding and vectoring for delay outside terminal airspace;
- terminal operations (re-sequencing missed approaches, speed control within terminal airspace, wind monitoring and runway change procedures, non-normal events such as short notice runway closure, rejected approaches);
- aerodrome operations (wind monitoring, runway change procedures, non-normal events);
- ATC ATFM competency measurement;

…….

	Example ATFM Capability Elements																						
	Planning			Prediction and Monitoring		CDM				Tactical ATFM Capability						ATFM Execution				ATFM Measures			
Example ATFM Service Category	Airspace Design/ATS Route Planning	Capacity Analysis and Modelling	Demand and Workload Prediction	Weather Prediction	Monitoring	Information Exchange	Collaboration	Electronic User Helpdesk	Crisis Management	Segregated SIDS and STARS	Agreed Acceptance Rates	Holding Patterns with CDO	Agreed Flow Gates at Uniform Distances	Prioritization of Landing Aircraft	Notification of Additonal Fuel for Delays	Slot Allocation	Route and Fix Balancing	Flight Level Balancing	Miles in Trail	Minutes in Trail	Fix Balancing	Reroutingq	Mandatory Rerouting
Category A - TMA - Major International Airport	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x		x		
Category A - Enroute - Major ATS Routes/City Pairs - Radar	x	x	x	x	x	x	x	x	x		x	x	x				x	x				x	x
Category B - Enroute - Major ATS Routes/City Pairs - Non-Radar	x	x	x	x	x	x	x	x	x		x							x	x	x		x	x
Category X - TWR/TMA - Regional - Radar	x	x	x	x		x	x			x							x		x		x		
Category Y - TWR/TMA - Regional Non-Radar	x	x	x	x		x	x													x			