

International Civil Aviation Organization**ICAO****Twenty Fourth Meeting of the Communications/
Navigation and Surveillance Sub-group (CNS SG/24) of
APANPIRG**

Web-conference, 30 November – 4 December 2020

Agenda Item 7: Automation

- 7.1 Review the outcomes of the Seminar on Air Traffic Management Automation System and the report of the First Meeting of ATM Automation Systems Task Force (ATMAS TF/1)

**REVIEW OUTCOME OF THE SEMINAR ON AIR TRAFFIC MANAGEMENT
AUTOMATION SYSTEM, AND THE FIRST MEETING OF THE ASIA/PACIFIC AIR
TRAFFIC MANAGEMENT AUTOMATION SYSTEM TASK FORCE (ATMAS TF/1)**

(Presented by the Secretariat)

SUMMARY

This paper presents the discussion in the Seminar on Air Traffic Management Automation System and the work accomplished by the First Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (ATMAS TF/1) for review and action by the meeting.

1. INTRODUCTION

1.1 The Seminar on Air Traffic Management Automation System and the First Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (ATMAS TF/1) were held from 27 to 30 October 2020 via video teleconference.

1.2 The Seminar was attended by a total of 179 participants from 18 States/Administrations, 4 International Organizations and industry partners. The Meeting was attended by 167 participants from Australia, Cambodia, China, Hong Kong-China, Fiji, India, Indonesia, Japan, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, USA and Viet Nam. CANSO, IATA, IFATCA also participated in the meeting. A number of representatives from industries including CETC LES Information Technology, CASRI (The Second Research Institute of CAAC), Dubai Airport, Eurocontrol, Indra, THALES(BEST) contributed the Seminar, some of them also participated the meeting.

1.3 A total of 13 presentations were made by various experts under two sessions in the Seminar, covering a good spectrum of topics in air traffic management automation systems. Session 1 focused on Experience Sharing from CAA/ANSPs, while the session 2 focused on New Technology and Approach from Industry, it provided a platform for participants to exchange experience and keep abreast of the latest knowledge on the subject of air traffic management automation. There were active participation from the attendees who raised a number of questions which were discussed and clarified by the presenters. The presentations were well received by the participants. All presentations are available at website: <https://www.icao.int/APAC/Meetings/Pages/2020-ATMAS-Seminar.aspx>

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1.4 The ATM TF/1 meeting considered 8 working papers and 17 information papers. All papers for the Meeting including draft meeting report are available at website: <https://www.icao.int/APAC/Meetings/Pages/2020-ATMAS-TF1.aspx>

2. DISCUSSION**Seminar Presentations**

2.1 The Seminar has invited a number of presentations as follows:

Experience Sharing from CAA/ANSPs

- SP/01 by FAA/USA on ATC Automation System Selection and Implementation: Best-Practices and Lessons-Learned;
- SP/03 by ATMB/China on The Solution to the Centralized FDP Risks of Large ATM Automation System;
- SP/04 by ATMB/China on Application of AMAN Technology in Busy Terminal Area;
- SP/08 by Hong Kong, China on Enhanced Robustness for Provision of ATM Service;
- SP/09 by Singapore on Smart Tower Prototype at Singapore Changi Airport;
- SP/12 by AAI/India on Challenges in Implementing ATM Automation System

New Technology and Approach from Industry

- SP/02 by CETC LES on Architecture of the Next-generation Air Traffic Control System Based on Cloud Computing and Virtualization Technology;
- SP/05 by Thales BEST on Digital Transformation in ATM;
- SP/06 by CASRI on Air Traffic Integrated Tower System Solution (Revised);
- SP/07 by IATA on ATM Automation System Support to Airlines Operational Efficiency;
- SP/10 by Indra on ATM Service Oriented Architecture;
- SP/11 by Dubai Airport on Dubai Airport – A-SMGCS (L4) Implementation;
- SP/13 by EUROCONTROL on SWIM in support of ATM Automation

Election of APAC ATMAS TF Chairpersons

2.2 The secretary informed the meeting that this task force was structured to have two co-chairs with technical and operational background respectively. He introduced Ms. Xie Yu Lan, Deputy Director General of North China Regional Air Traffic Management Bureau of CAAC, and Mr. Kwek Chin Lin, Chief ATC Specialist (Systems Development) from Civil Aviation Authority of Singapore, who were both unanimously elected as the co-chairs of the ATMAS TF.

Review of the Terms of Reference and Action Items (WP/02)

2.3 Through this working paper, Secretariat presented the Terms of Reference of the Asia/Pacific Air Traffic Management Automation System Task Force for the meeting's review and invited the proposals on the list of action items for this group.

2.4 Considering the ATM automation system covered a wide spectrum of operational concepts, various technologies, projects implementation, the meeting considered it necessary to kick off the group's future works with a well-defined plan. The meeting proposed an ad hoc group to further discuss the following items:

- Review TOR of the TF;
- Identify scope of the work;
- Expected output of the TF; and
- Draft a list of action items for adoption by this meeting.

Outcome of Relevant Meetings (WP/03)

2.5 The meeting reviewed the related outcomes of the Twelfth Air Navigation Conference, the Asia/Pacific Ministerial Conference on Civil Aviation, the ICAO Asia Pacific Regional ATM Automation System Symposium, the SURICG/4, the CNS SG/23, APANPIRG/30, and ICAO 40th Assembly on ATM automation, as well as typical ICAO technical provisions relevant to ATM automation for reference by the task force.

2.6 The meeting recalled AN Conf./12 recommendations:

Recommendation 1/11 – Automation roadmap

That ICAO:

a) develop a global roadmap for the evolution of ground air traffic management automation systems in line with aviation system block upgrade implementation; and

b) develop performance-based system requirements for air traffic management automation systems so that:

1) where necessary these systems are interoperable across States and regions; and

2) the function and operation of these systems will result in consistent and predictable air traffic management system performance across States and regions.

2.7 The meeting also noted the Action Item 54/13 of 54th DGCA Conference on ATM system:

Noting the need for a risk-based approach throughout system development, testing/acceptance, system and operations transition, handling of teething issues of its safety-critical ATM system with good lessons learned, the Conference supported the initiative of States towards formation of an international Users' Group for ATM system to share operational and technical experience, and map out the future system development roadmap, which could be beneficial for the APAC Region in respect of development of the global roadmap and performance-based requirements of the ATM system.

2.8 The meeting was informed that there was no outstanding issue on ATM automation in Assembly 40, however, some of the Assembly Resolutions were relevant to CNS area with reference to Resolutions adopted by the Assembly (Provisional Edition October 2019), as well as some paragraphs relevant to CNS incorporated in Technical Commission Report of 40th Assembly (Doc10137). The

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meeting also noted the latest update of Integrated Communications, Navigation, Surveillance and Spectrum Task Force (ICNSS-TF).

2.9 The meeting noted the editorial change on air traffic automation system between the ICAO GANP (DOC 9750) edition 5 (published in 2016) and the GANP edition 6 as a portal at: <https://www4.icao.int/ganpportal/>. The meeting also noted the ICAO provisions relevant to automation, which may be used as basic reference for future work, including Annex 2, 4, 10, 11, 15, 19, PANS ATM/OPS (Doc 4444, Doc 8168), GANP Suite (Doc 9750, Doc 9854, Doc 9882, Doc 9883), Doc 7030, Doc 9985, etc., as well as APAC regional requirements mainly resided in APAC Air Navigation Plan and APAC Seamless ANS Plan.

2.10 Japan and China expressed appreciation of the Secretariat's effort on this paper and emphasized the importance of harmonization in implementing. Hong Kong China expressed its concerns on the absence of automation system roadmap in GANP edition 6, and the Philippines advised the meeting about one paragraph in GANP edition 6 to explain its *Relationship with other Documents*, could be a response on ICAO roadmap, and quoted as following:

The Global Air Traffic Management Operational Concept (GATMOC, Doc 9854) presents a vision for a common operational concept of an integrated, sustainable, harmonized and globally interoperable air traffic management (ATM) system. The operational concept is independent of technology and is a statement of the envisaged "what". The timely development of a sustainable aviation system based on the GATMOC requires a collaborative, synchronized and maintained planning tool such as the GANP. Hence, the vision, performance ambitions and conceptual roadmap embedded in the GANP refer directly to the GATMOC. The GATMOC's companion manuals, which include, inter alia, the Manual on Air Traffic Management System Requirements (Doc 9882) and the Manual on Global Performance of the Air Navigation System (Doc 9883), will continue to evolve and provide the sound conceptual basis and focus for an integrated, sustainable, harmonized and globally interoperable air navigation system.

New technologies by Industry

2.11 The sponsor of the meeting, CETC LES Information System Co. Ltd. made a presentation to the meeting to share its NUMEN3000 ATC Automation System, the Application of Smart Technology and Guidance and Routing of A-SMGCS.

ATM Automation System in Indonesia (IP/03)

2.12 Indonesia presented on the detailed information of their ATM Systems, including locations, manufacturer, main use or backup and ATS units. Indonesia adopted an phased approach to implement ATM automation system, covering System Plan and Design (meet the requirements of the airspace structure and services), System Installation and Commissioning (with reference to the instruction contained in documentation of each system), Systems Operations Management and Maintenance Practices (with respect to the SOP, site specific changes and technical personnel ratings).

2.13 There are three phases for the Operational Transition: Dry Shadow Phase, Wet Shadow Phase and Cut Over. Contingency Plan was also introduced for Transition Period, Operational period while considering various system configuration and the scope of the failure.

2.14 The meeting thanked Indonesia's sharing of information of their ATM Systems, and recalled the proposal by ATM automation System Symposium held in 2018 to establish a repository of

the ATM automation systems implemented by States. The meeting agreed to develop this further with inputs with States as an action item for this task force.

Challenges in Implementation of ATM Automation System (IP/13)

2.15 With the successful commissioning for a new ATM Automation system at Delhi International Airport and Delhi ACC recently, India shared the challenges faced during the implementation in different phases of project, as well as suggestions to address the challenges.

2.16 There are mainly two phases of project i.e. Pre-Contract stage and Post Contract phase. Well drafted operational and system requirement specifications for ATM Automation system can very well reduce the number of challenges as the level of scope changes in both the stages of project.

2.17 India highlighted some key activities in the Pre-Contract Phase of the project:

- a) **Definition of Scope of Work:** System Architecture, level of redundancy and recording, mode of communications with external Stake holders, Power distribution requirement etc. A mandatory requirement in terms of “Quality assurance level requirement” in accordance with ISO-9001-20XX specifications or DO-278A/ED-109A assurance level or Valid CMMI Level xx as per requirement.
- b) **Project Cost Estimation:** A well-defined scope of work helps in preparing a more accurate estimate of the project. Prospective suppliers will ascertain the estimated cost in a more realistic manner.
- c) **Project Time-Line:** be framed in a realistic manner with consideration of Site-readiness, additional manpower during shadow mode of operation, fixing software issues and thorough test.
- d) **Tender Evaluation and Selection of Bidder:** to depute the same team of officers who have finalized the Technical and Operational requirements of the system to evaluate and conduct Technical discussion on methodology of fulfilment of critical requirements with prospective bidders.

2.18 These were the key activities in the Post Contract Phase:

- a) **Project Monitoring Group:** to create a dedicated Project Monitoring group (PMG) drawn from all the concerned stakeholders, be responsible for monitoring various activities, Time lines, scheduling activities, and reporting to Higher Management.
- b) **System Evaluation, HMI Customization & Prototype Testing:** Group of ATCOs and ATSEPs be involved in finalizing the HMI of the system in coordination with supplier under sufficient time line to cover System Design Review (SDR), System Requirement Review (SRR), and Factory Acceptance Test (FAT).
- c) **External Interface Integration & Installation:** prerequisite may cover Dust free environment, Power supply source, Availability of External systems, ASMGCS, AMSS, MET etc., available Surveillance data & ATC Consoles. Detailed ICD for various interconnected systems.
- d) **Database Creation:** start as early as possible in coordination with supplier, and conduct FAT based on the Database.

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- e) Training & Testing Phase: Training to ATSEPS and ATCOs before FAT as well as after installation of the System. Hands on Training is important. Supplier provides the training to Trainers who will further provide the training to other Officers.

2.19 The meeting appreciated the sharing of valuable experience by India, and suggested that the information provided in this paper may be considered as inputs to develop a checklist for ATM automation system project management to be added an Appendix for the ATM Automation System Guidance Material.

Maintenance Management and Practice of Air Traffic Management System in Hong Kong, China (WP/06)

2.20 Hong Kong, China presented its maintenance management and practice on ATM Automation System which was fully commissioned in November 2016. The meeting was informed that under the maintenance framework for ATM Automation System, the System Supplier, Maintenance Service Provider (MSP) and Air Navigation Service Provider (ANSP) form a close coordination trio in operating and supporting the maintenance framework.

2.21 The role and responsibility of each party in the trio is summarized as follows:

- a) The System Supplier, as required under the contract, should provide sufficient maintenance documentation and training to ANSP and MSP, respond to requests from ANSP or MSP to provide timely assistance in dealing with and rectifying all faults or deficiencies, and provide a list of obsolete equipment and its replacement models on regular basis.
- b) The MSP, was engaged to perform front-line maintenance under supervision of ANSP. This can leverage the skill sets and latest technology available in private sector. The services to be provided by MSP include watch-keeping of equipment, preventive/corrective maintenance, and system/equipment minor modification/replacement works, etc.
- c) The ANSP has to ensure the services provided by MSP and System Supplier are in compliance with ICAO standards and international best practice. ANSP can also share experience and best practice gained from ICAO and international meetings/symposia/seminars with MSP and/or System Supplier with a view to enhancing the maintenance regime.

2.22 The meeting agreed that the relevant contents shared in this paper could be considered for incorporation into the “Recommended Functions and Performances of ATM Automation System” chapter of the ATM Automation System Guidance Material.

Software Management and Technical Support in ATM Automation System (WP/08)

2.23 China has more than 90 sets of ATM Automation System and established the software management and technical support system. It covers all system construction and operation stages, including many actives, such as system requirements analysis, system fault management, software release, test and evaluation, parameter configuration management. It essential to the safe and regular operation of the system in the whole life cycle.

2.24 The benefits gained are significant, especially involved multi-sites. Requirements management ensures the quality and effectiveness of software requirements implementation, promoting new technologies to meet the development needs. By sharing fault information and tracking status, software fault management prevents the defect from occurring in related-site and improving system safety frontiers. Software release and patch management maintain baseline software stability, reduce potential operational risks caused by software changes, and ensure the system's robust and quality. These processes are linked and promoted to form a closed-loop management.

2.25 China organizes relevant works at three levels: The national-level software management and support organization, responsible for coordinating software management in multiple regions and managing third-party software testing; The regional-level software management organizations, responsible for coordinating the software management in multi-sites in the relevant area; The field-level software support units responsible for software management and testing of a single site.

2.26 In the system operation stage, the system realizes the improvement of functional requirements and repairs faults through software patches. Before upgrading the system, China conducts factory testing, third-party testing, and on-site adaptability testing to discover potential defects as much as possible. Software release requires corresponding test reports.

2.27 The future-oriented software testing environment should be flexible deployment through software configuration instead of a hardware-dependent platform. Virtualization and cloud computing will be key technologies to realize this approach, and China is carrying out related research and testing work. In response queries, China explained the software management and technical support were carried out mainly by ATMB technical center under the supervision of CNS division of ATMB.

2.28 meeting was informed that there was no outstanding issue on surveillance in Assembly 40, however, some of the Assembly Resolutions were relevant to CNS area with reference to Resolutions adopted by the Assembly (Provisional Edition October 2019), as well as some paragraphs relevant to CNS incorporated in Technical Commission Report of 40th Assembly (Doc10137). The meeting also noted the latest update of Integrated Communications, Navigation, Surveillance and Spectrum Task Force (ICNSS-TF).

2.29 The DGCA/56 Conference developed 35 Action Items among which 14 Action Items were identified by SURICG/5 as relevant to implementation of CNS and services including 56/2; 56/3; 56/6; 56/11; 56/12; 56/15; 56/16; 56/21;56/29; 56/30; 56/32; 56/33; 56/34; 56/35. The meeting was informed that CNS SG/23 also reviewed the outcome of DGCA/56.

2.30 The meeting noted the Conclusions/Decisions related to surveillance implementation adopted by APANPIRG and follow-up actions taken by the Secretariat. In particular, through Conclusion APANPIRG/30/15 (CNS SG/23/14-SURICG/4/6), Revised Surveillance Strategy for the APAC Region was adopted, and the Edition 12 of the ADS-B Implementation and Operations Guidance Document (AIGD) and the first edition of Mode S DAPs Implementation and Operations Guidance Document were also adopted by the Twenty Third Meeting of CNS Sub-group on behalf of APANPIRG. The adopted documents were posted on the ICAO APAC website under e-Document. The Asia/Pacific ATM Automation System Task Force (ATMAS/TF) was established through Decision CNS SG/23/13 (SURICG/4/5). The First Meeting of ATMAS/TF was held from 28 to 30 October 2020.

2.31 The meeting noted the Proposal for Amendment (PfA) to the Regional Supplementary Procedure (SUPP Doc 7030) from SURICG/2 has been processed in accordance with established procedure, and the approved PfAs were circulated to States on 18 June 2020 through a State Letter with

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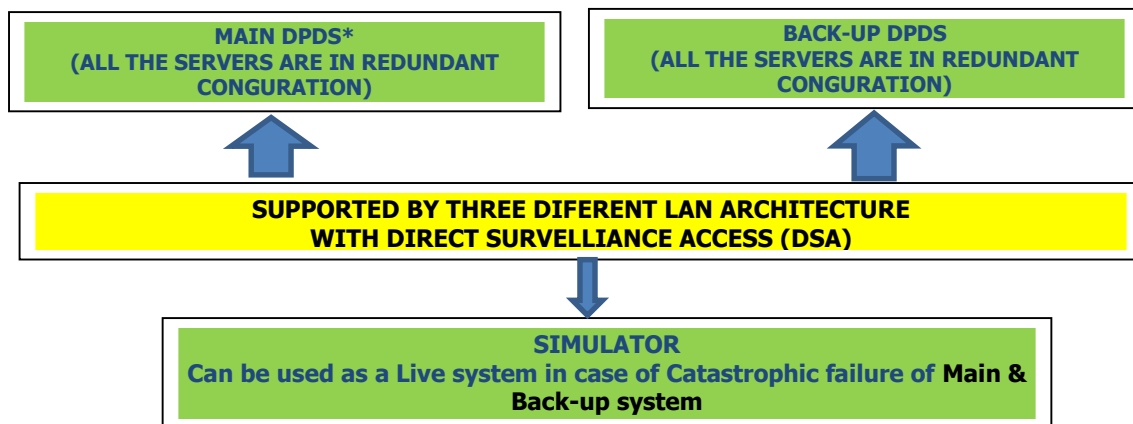
reference: T8/11.2 – AP130/20 (CNS), and this change will be incorporated in the new Sixth Edition of Doc 7030/6 as part of the restructuring process of Doc 7030.

Different ATM Automation System Implementation in India (IP/12)

2.32 India has installed multiple ATM automation systems of various capabilities across the Indian airports to utilize the large network of surveillance sensors. Since each of the ATM automation system was installed in different stages, the Air Navigation Service Provider (ANSP), Airports authority of India (AAI) operates a combination of Automation systems from various vendors having different capabilities and with varied experiences. India shared the common features and differences between various Automation System architecture installed.

2.33 Common features of All Automation features

- a) Redundancy - The redundancy level has been taken care up to the sub-component level including power and data exchange lines. AAI achieved five level of redundancy which includes the DRA facility, as depicted in the following diagram.



*DPDS: Data Processing and Display System

- b) Simulator - integrated as a prime requirement for training of ATC personnel's as well to test new software builds, adaptation data modifications etc. Similar working environment for simulators to simulate the actual working conditions for training.
- c) Ability to integrate multiple sensors - able to integrate a wide range of sensors such as PSR, SSR, ADS-B, ADS-C etc. over a wide range of protocols. Multiple Sensor Tracker (MST) introduced to improve the track data using all such information.
- d) Safety Nets - basic Safety Net features built in to alert the controllers for taking appropriate steps to separate the aircrafts. The most prominent of these are Short Term Collision alert(STCA), Medium Term Collision detection(MTCD), Area Proximity Warning(APW), Minimum Safe Altitude Warning (MSAW) and Approach Path Monitoring (APM). Other normal alerting tools are SSR Code change, special Squawk code (7X00), multiple use of same SSR code, non-RVSM Flights etc. Some newer systems have additional monitoring tools such as Route deviation warning, Level burst, clearance monitoring, special flight status etc.

- e) Communication - capable to exchange information through AFTN and AIDC. However, there have been issues integrating different systems over AIDC due to difference in implementation tactics of AIDC.

2.34 Variable features across ATM Automation System

- a) Architecture - Some integrated model of Automation system having Tower, Approach, Area FIC/OCC workstations with advanced features such as AMAN, DMAN, DCL etc. While there are systems having limited featuring small airports with in the coverage of bigger Area control centers having limited capabilities to interact with adjoining centers and provide basic surveillance capabilities.
- b) Communication protocols - provider has varying idea of interoperability between systems. This has been a serious issue while trying to integrate the adjacent Automation systems, implement AIDC and exchange of data between C-ATFM and other system.

2.35 The meeting appreciated the sharing by India, in particular noted the importance of interoperability among various issues as these can provide guidance to ANSPs for consideration when deploying or upgrading ATM automation systems. The meeting agreed the information contained in this paper could be considered when developing the ATM Automation Guidance Material.

Application of Flight Data Exchange in ATM Automation System (WP/05)

2.36 In order to adapt to the rapid development of civil aviation in China and improve the safety assurance level of the Air Traffic Management Automation System (ATM AS), the Civil Aviation Administration of China (CAAC) issued the industry standard "Civil Aviation Air Traffic Control Automation System" (MH/T 4029). The third part: Flight Data Exchange (MH/T 4029.3), which defines the protocol, message type and data format for the flight data exchange between the ATM AS and related systems, the standard is mainly used for the ATM AS planning, design, construction, testing and operational use.

2.37 The ATMB of CAAC is currently promoting the application of MH/T4029.3 standard in ATM AS. The FDEXM (Flight Data Exchange Messages) and PSEXM (Primary and Standby ATM Automation System Data Synchronization Messages) are used to achieve data synchronization between the prime and standby ATM AS. FDECM (Flight Data Exchange Coordination Messages) is used to implement in different ATM AS screen handover where AIDC cannot be applied. The advantages of MH/T4029.3 standard application is to eliminate potential safety hazards and improve the safety assurance capabilities of the ATM AS, improve collaborative operation efficiency, and effectively reduce human error and workload, as well as improve controller's experience.

Implementation of Enhanced Wake Turbulence Separation and Approach Spacing Tool in Hong Kong China (WP/07)

2.38 Hong Kong, China has conducted a safety case study for the implementation of ICAO "enhanced Wake Turbulence Separation" (eWTS) at Hong Kong International Airport (HKIA). The study involved a 12-month wake study and analysis on the real-time data collection, generation and dissipation rates of wake vortices of different aircraft types in the local Hong Kong environment. The wake vortex data was analyzed by international experts, and a safety case was prepared to demonstrate with evidence that the safety assurance arguments supported the implementation of eWTS in HKIA operations, and that the wake encounter risk for each aircraft pair under eWTS would remain with the current acceptable safety risk level.

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2.39 Based on the study of historical traffic data at HKIA, it is anticipated that the overall arrival spacing on final approach would be reduced safely under the application of eWTS. Additional arrival slots would be generated by Arrival Manager (AMAN) dynamically according to actual traffic mix. As a result, an increase in runway capacity is anticipated through the implementation of the eWTS scheme.

2.40 To assist the controllers in handling air traffic under eWTS and improve controllers' consistency in delivering the traffic according to the intended runway capacity, a distance-based Approach Spacing Tool (AST) is being implemented at the Final Approach Director position. The AST will determine the required spacing between aircraft along the approach sequence and provide advisories, in the form of graphical indicators on the Air Situation Display, to indicate the optimal positions of aircraft along the final approach path. Using the graphical advisory indicators, controllers can focus on positioning the aircraft at the optimal distance from the leader and ensure the required spacing is delivered at the runway threshold. In addition, AST will provide safety net features to detect catch-up scenarios, separation infringement events, speed discrepancies and incorrect approach sequence to alert controllers on abnormal conditions so as to allow early resolution of possible conflict situations.

2.41 The meeting is encouraged to consider the benefits of implementing AST in ATM Automation System, for improving the consistency in delivering air traffic according to the intended runway capacity by the ANSPs.

Recommended Functions and Performances of ATM Automation System (WP/04)

2.42 The development of a guidance material of implementation of ATM automation system is one of the key deliverables of ATM automation system task force (ATMAS/TF) as per the Terms of Reference. This working paper was jointly prepared by China, Hong Kong China and Singapore to explore the Recommended Functions and Performances of ATM Automation System (RFAP of ATM AS) and proposed a draft as edition 0.0 for future formulation and development by the task force, as the guidance material for systems planning, design, testing and implementation of ATM automation system in the Asia and Pacific Regions.

2.43 China took the lead in preparing the initial draft of the RFAP of ATM AS, explained to the meeting about the main points of the edition 0.0 through a presentation. The meeting appreciated the excellent job done by China, Hong Kong China and Singapore, and agreed to use the edition 0.0 as the basis for future work of a specialized ad hoc group of volunteered experts from member States/Administrations. The meeting supported China to lead this ad hoc group, and consolidated a list of focal point of this ad hoc group to facilitate the various tasks shared by group members, which include China, Hong Kong China, India, Indonesia, Japan, Malaysia, Myanmar, Nepal, Philippines, Singapore, Thailand and Vietnam. The Rapporteur of this ad hoc group is Ms. Cao Su Su from China.

2.44 The meeting also suggested the ad hoc group to consider to rearrange the cybersecurity as a separate chapter, explore to use ICAO APAC ADS-B avionics problem reporting database to accommodate this issues about ATM automation system implementation shared by States/Administrations, and study the feasibility to share Chinese solution MH/T 4029.3 to the region or adopted as an appendix to the guidance material for reference in future.

2.45 The meeting was reminded to consider the present draft as provisional status, and further alignment with ICAO provisions, international standards or EUROCONTROL may be required. The meeting also proposed to carefully balance the stability and currency by adopting a well-defined

structure with main body with appendices and attachments. The Recommended Functions and Performances of Air Traffic Management Automation System (Edition 0.0) is provide as **Appendix A** to the Paper.

Develop initial list of action items for APAC ATMAS TF

2.46 The meeting discussed various action items, proposed by brainstorming, on developing an initial list of action items for the Task Force.

2.47 A suggestion was raised in the Meeting to approach ICAO TCB to see feasibility for any viable support to the development of the Guidance Document, and the Secretariat will coordinate with TCB contact and report back to this task force.

2.48 The meeting further discussed the action items on the introduction of new/additional capabilities to operational/existing automation system, development of decision support tools, cyber security issue, etc. The revised List of Action Items is provided as Appendix B to the Report of ATM AS/TF/1.

Update on ATM automation systems Implementation in the Region

2.49 Last but not least, a number of updates were reviewed by the meeting and recorded in the meeting report including:

- IP/02 by Indonesia on Preparation of Tailored MET–ATM Implementation in Indonesia;
- IP/04 by China on Application of Flight Plan Centralized Processing System in ATM Automation System;
- IP/05 by China on Junior Application of CRACP in Flow Management System;
- IP/06 by China on Application of AMAN Technology in Busy Terminal Area;
- IP/07 by China on Application of DAPs Data in ATM Automation System (Revised);
- IP/08 by China on Cybersecurity Control for ATM Automation System in the Interconnection Environment (Revised);
- IP/09 by China on Application of MTCDF Function in ATM Automation System;
- IP/10 by Hong Kong, China on Progressive Implementation of Safety Net Functions in Hong Kong, China;
- IP/11 by Hong Kong, China on A Proactive and Systematic Approach in Protecting Digitised Air Traffic Services Against Cyber Threats in Hong Kong, China;
- IP/14 by India on ATFM-ACDM Integration;
- IP/15 by China on Radar Access Risks and Solutions to ACC ATM Automation System;
- IP/16 by Singapore on Challenges in the implementation of DMAN;
- IP/17 by Singapore on Application of DAPs in ATM automation system in Singapore

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note the information contained in this paper;
- b) provide details of ATM Systems of their States/Administrations;

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- c) encourage States/Administrations to contribute to the development of the guidance material *Recommended Functions and Performances of ATM Automation System*, as provided in **Appendix A**; and
- d) discuss any relevant matters as appropriate.



**INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE**

**RECOMMENDED FUNCTIONS AND PERFORMANCES
OF AIR TRAFFIC MANAGEMENT AUTOMATION SYSTEM**

Edition 0.0 - October 2020

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1. Introduction

1.1 Purpose

Since the Air Navigation Conference held in 2012, ICAO has been exploiting a global roadmap in the aviation system block upgrades (ASBU) under its Global Air Navigation Plan (GANP) , with a focus on harmonization and interoperability leading to a global air traffic management (ATM) system.

Following the framework of GANP and the timeline of ASBU, the Asia/Pacific Seamless ATM Plan, was adopted by the 24th Meeting of the Asia/Pacific Planning and Implementation Regional Group (APANPIRG/25) in 2013. It defines goals and the means of meeting State planning objectives for a Regional seamless ATM performance framework, with a focus on technological and human performance.

Along with carrying out of the Asia/Pacific Seamless ATM Plan, and many times' meeting discussion, it is getting more and more clear, a specific recommendations and developing guidance material related to Air Traffic Management Automation System (ATM AS) is necessary, which aim at facilitating the implementation or provision of robust, safe, efficient and orderly ATM services by the use of existing and/or new procedures, facilities and technologies.

This Recommended Functions and Performances of ATM AS (RFAP of ATM AS) provides guidance for systems planning, design, testing and implementation of ATM automation system in the Asia and Pacific Regions, with the purpose of ensuring continuous and coherent development of the ATM automation systems that is harmonized with adjacent regions.

The system requirements and operational procedures for ATM automation system are detailed in the relevant States' projects and AIP. This RFAP is intended to provide the basic and the most important functions and performances of ATM automation system, based on the operations and maintenances practices.

1.2 Background

1.2.1 ATM Operational Concept

The global air traffic management (ATM) operational concept presents the ICAO vision of an integrated, harmonized and globally interoperable ATM system. The planning horizon is up to and beyond 2025. The baseline against which the significance of the changes proposed in the operational concept may be measured is the global ATM environment in 2000.

Vision Statement

To achieve an interoperable global air traffic management system, for all users during all phases of flight, that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable and meets national security requirements.

While the operational concept is visionary and even challenging, many of the current practices and processes will continue to exist through the planning horizon. In this sense, this operational concept document should be seen as evolutionary.

A key point to note is that the operational concept, to the greatest extent possible, is independent of technology; that is, it recognizes that within a planning horizon of more than twenty years, much of the technology that exists or is in development today may change or cease to exist. This operational concept has therefore been developed to stand the test of time.

Air Traffic Management
 Air traffic management is the dynamic, integrated management of air traffic and airspace — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties.

1.2.2 ATM System and Its Sub-system

The mission of ATM is to effectively maintain and promote the safety, order and smooth of air traffic. ATM includes Air Traffic Service (ATS), Air Traffic Flow Management (ATFM) and Airspace Management (ASM), as shown in Figure 1-1.

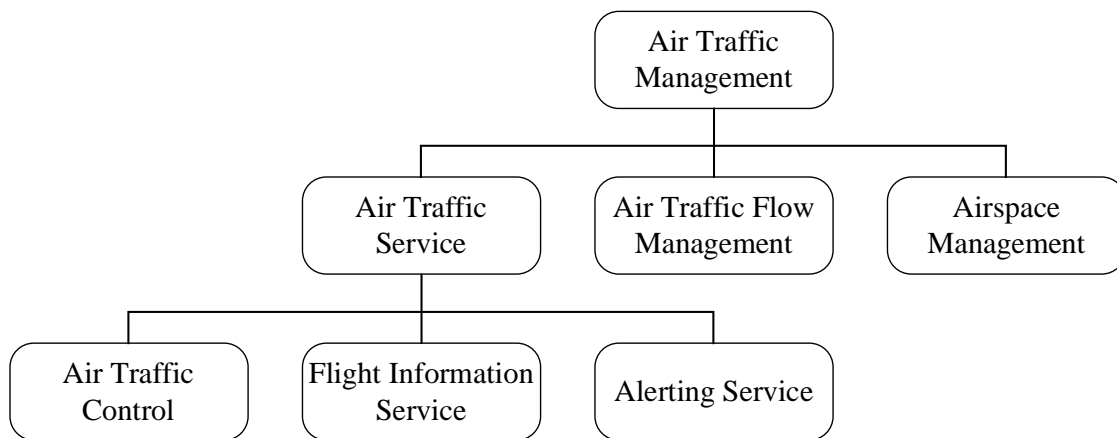


Figure 1-1 Composition of air traffic management.

ATS is the main part of ATM, which includes air traffic control (ATC), flight information service (FIS) and alerting service (ALS).

ATC is to prevent collision between aircraft and aircraft, and collision between aircraft and obstacle in maneuvering area. The object of FIS is to provide advice and intelligence helpful for flight safety and effectiveness to the aircraft in flying. ALS is to issue notices of searching for and rescuing aircraft to relevant organizations, and to assist these organizations or coordinate this work if necessary.

1.2.3 Concept of ATM Automation System

The ATM automation system mentioned in this document is mainly applied in ATC service, as well as offering assistance for ALS and ATFM. It comprises a group of processing sub-systems dedicated to specific functions, which are integrated as an air traffic management system to provide functional capabilities to air traffic controllers in the Area Control Centers (ACC), Approach (TCUs and TMAs) and towers. The ATM automation system helps controllers keeping conformance monitor, hazard monitor, and assuring safety separation to air traffic flow.

Normally, the ATM automation system has a modular design and has a distributed architecture to ensure robustness under adverse operating conditions. The modularity enables modifications to the baseline product to be made with relative ease. The principle of distributed processing ensures the safe, uninterrupted provision of Air Traffic Services by controllers.

All processing and display sub-systems are interconnected via a high capacity redundant LAN. Computers providing common services (e.g. Flight Data Processing) may be duplicated with each individual computer connected to each LAN providing a high degree of redundancy. Fail soft operation of the dual computer groups is achieved by multiple computation redundancy, (parallel operation of the computer), or hot stand-by redundancy, in order to provide an uninterrupted service to the controllers.

Popularly, considering about the safety and redundancy requirements, the ATM automation system has two individual LANs. Two of the LANs are called working LAN, where the redundancy computers connected. The working LANs keep sharing information all the time and work as main and backup mode. Besides, for the air traffic control airspace with high flight flow, it is recommended to build the third LANs. The third LAN is called service LAN, its mainly function is collecting system's trace and handle recording and playback functions, etc.

1.2.4 Challenges and Solutions

Considering about the framework for global ATM roadmap requirements and the current world situation, the ATM automation system is facing following challenges:

The system functions are stacking huge, and the system is getting more and more complex. These problems result in that the new ATM automation system is taking more time and much more effort to develop, some system functions are seldom used, the system is getting hard to maintain and spending much more money to deploy.

The outbreak of COVID-19 has a devastating impact on the economy and the aviation industry worldwide. It will not be surprising that the ICAO members, including those in the APAC Region, have to review and even reduce both their capital and operational expenses (CAPEX and OPEX) in coming years, including the expenditure in ATM automation system.

The seamless ATM Plan requires the individual ATM automation systems sharing a common set of accurate information in a timely manner, which need to interface each other seamless, and work interoperability.

To meet the above challenges, it is important to work out a specific recommendation and guidance materials of ATM automation system in main functions/performances, which aim at facilitating the implementation or provision of the robust, safe, efficient ATM automation systems. This will help the APAC regional ATM automation systems share common/core functions/performances, and achieve seamless easily. At the same time, rather than encouraging the APAC CAAs/ANSPs to invest more CAPEX/OPEX to cope with future increase in air

traffic, it is important for the APAC members to put focus on (a) application of new/innovative technologies would help making good business cases, (b) incorporating baseline/key optional features into their system design at early stage, and (c) getting ready/completing system changes during low air traffic periods, with lower costs and risks, before full traffic recovery.

1.2.5 Outcomes and Endorsements

To ensure continuous and coherent development of the ATM automation systems that is harmonized with adjacent regions to enhance systems interoperability, and to keep abreast of the latest developments in ASBU and ATM automation systems, topics pertaining to ATM automation system has been focusing and fruiting in APAC Region since 2018.

The ICAO Asia Pacific Regional ATM Automation System Symposium (APAC RATMS) was held in Nanjing, China, from 22 to 23 November 2018. The symposium successfully addressed the Action Item 54/13 of 54th DGCA Conference on ATM automation system, and it also suggested States/Administrations to consider establishment of a regional working group/task force under the ICAO CNS Sub-group of APANPIRG to deal with matters arisen from this symposium in regard to ATM automation systems. The symposium agreed to formulate an action item for the 23rd meeting of CNS Sub-group in 2019 to review and consider whether such regional working group/task force is needed.

The SURICG/4 was held in Nanjing, China from 9 to 12 April 2019. The meeting reviewed and further discussed the outcome of the ICAO APAC Regional ATM Automation System Symposium (APAC RATMS) and other SURICG/4 papers relevant to ATM automation system, and endorsed the draft Decision of **“Draft Decision SURICG/4/5 - Establishment of ATM Automation System Working Group (ATMAS/WG)”** for consideration by CNS SG.

The Twenty Third Meeting of the Communications, Navigation and Surveillance Sub-group (CNS SG/23) of Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG), was held at the ICAO Regional Office, Bangkok, Thailand, from 2 to 6 September 2019. The meeting considered the report of SURICG/4 with some other CNS SG/23 working papers, and noted that a briefing on the proposal on establishing a working group to deal with ATM automation system issue was also provided to ATM SG/7 meeting. A number of States/Administration expressed their willingness to support the work of the Task Force including: China, Hong Kong-China, India, Indonesia, Nepal, Singapore, Thailand and USA. Hence, the meeting adopted the **“Decision CNS SG/23/13 (SURICG/4/5) - Establishment of ATM Automation System Task Force (ATMAS/TF)”**.

APANPIRG/30 meeting was held from 4-6 November 2019 at ICAO APAC Office, Bangkok, Thailand, The APANPIRG/30 meeting noted with appreciation the work done and achievements by the CNS SG and the contributory bodies reporting to APANPIRG through the SG pertaining to ATM automation system. The meeting noted that CNS SG/23 meeting had adopted 9 Conclusions and 4 Decisions on technical and operational matters, including the **“Decision CNS SG/23/13 (SURICG/4/5) Establishment of the Asia/Pacific ATM Automation System Task Force (ATMAS/TF)”**.

1.3 Arrangement of RFAP of ATM AS

This Recommended Functions and Performances of Air Traffic Management Automation System consists of the following parts:

Section 1	Introduction
Section 2	Acronyms and Abbreviations

Section 3	Reference Documents
Section 4	System Functional Baseline
Section 5	System Design
Section 6	System Software Management
Section 7	System Transition
Section 8	System Maintenance

1.4 Document History and Management

The framework of this document was first introduced in the first Working Group Meeting of ATM Automation System Task Force (ATM AS TF/1) of video conference, which is held in Oct. 2020. The Meeting agreed to further develop based on the proposed framework to a complete document for approval as regional guidance document. A working team, consisting of volunteers from **member states (names of member states will be listed after decided)**, was established by the Meeting to contribute to the content of the document.

The aim of this document is to supplement SARPs, PANS and relevant provisions contained in ICAO documentation and it will be regularly updated to reflect evolving provisions. To support the ICAO in making specific recommendations and developing guidance materials, such as minimum functional/performance requirements and additional/local requirements, which aim at facilitating the implementation or provision of robust, safe, efficient and orderly ATM services by the use of existing and/or new procedures, facilities and technologies in relation to ATM automation systems.

1.5 Copies

Paper copies of this RFAP of ATM AS are not distributed. Controlled and endorsed copies can be found at the following web site: <http://www.icao.int/APAC/Pages/edocs.aspx>

Copy may be freely downloaded from the web site, or by emailing APANPIRG through the ICAO Asia and Pacific Regional Office who will send a copy by return email.

1.6 Changes to RFAP of ATM AS

Whenever a user identifies a need for a change to this document, a Request for Change (RFC) Form (see Section 1.6 below) should be completed and submitted to the ICAO Asia and Pacific Regional Office. The Regional Office will collate RFCs for consideration by the ICAO Communications, Navigation, Surveillance (CNS) Sub-group of APANPIRG.

When an amendment has been agreed by a meeting of the ICAO CNS Sub-group of PANPIRG, then a new version of the RFAP of ATM AS will be prepared, with the changes marked by an “|” in the margin, and an endnote indicating the relevant RFC, so a reader can see the origin of the change. If the change is in a table cell, the outside edges of the table will be highlighted; e.g.:

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Final approval for publication of an amendment to the RFATP of ATMAS will be the responsibility of APANPIRG.

1.7 Editing Conventions

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1.8 RFAP of ATM AS Request for Change Form

RFC Nr:	
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Please use this form when requesting a change to any part of this RFAP of ATM AS. This form may be photocopied as required, emailed, faxed or e-mailed to ICAO Asia and Pacific Regional Office

+66 (2) 537-8199 or APAC@icao.int

1. SUBJECT:				
2. REASON FOR CHANGE:				
3. DESCRIPTION OF PROPOSAL: [expand / attach additional pages if necessary]				
4. REFERENCE(S):				
5. PERSON INITIATING:			DATE:	
ORGANISATION:				
TEL/FA/X/E-MAIL:				
6. CONSULTATION RESPONSE DUE BY DATE:				
	Organization	Name	Agree/Disagree	Date
7. ACTION REQUIRE :			DATE REC'D :	
8. AIGD EDITOR			DATE :	
9. FEEDBACK PASSED				

1.9 Amendment Record

Amendment Number	Date	Amended by	Comments
0.0	Feb 2020	China	The framework of this document is firstly work out by China.
0.1			First completed draft based on the agreed document framework in XXX for review and comment by States
0.2			Based on Version 0.1 draft, States make a full comment on the XXX. This is a revised document according to those comments.

2. ACRONYMS AND ABBREVIATIONS

(To be developed)

3. REFERENCE DOCUMENTS

Id	Name of the document	Edition	Date	Origin	Domain
1	Annex 2 - Rules of the Air	10th Edition	2005	ICAO	
2	Annex 12 - Search and Rescue	8th Edition,	July 2004	ICAO	
3	Annex 11 — Air Traffic Services	15th Edition	2018	ICAO	
4	Annex 17 - Security	10th Edition	2017	ICAO	
	11th Edition	March 2020	ICAO		
5	“PANS-ATM, or Procedures for Navigation Services – Air Traffic Management (DOC 4444)	16th Edition	2016	ICAO	
6	Global Air Navigation Plan (GANP) (Doc 9750)	6th Edition	2020	ICAO	
7	Global Air Traffic Management Operational Concept (Doc 9854)	First Edition	2005	ICAO	
8	Manual on Air Traffic Management System Requirements (Doc 9882)	First Edition	2008	ICAO	
9	Manual on Global Performance of the Air Navigation System (ICAO Doc 9883)	First edition	2009	ICAO	
10	Doc 10031 Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes	First edition	2014	ICAO	
11	Restricted — Air Traffic Management Security Manual(Doc 9985)	First edition	2013	ICAO	
12	Air Traffic Services Planning Manual (Doc 9426)	4th Edition	2007	ICAO	
13	Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive (Doc 9574)	4th Edition	2013	ICAO	
14	Performance Based Navigation (PBN) Manual (Doc 9613)	4th Edition,	2013	ICAO	

15	Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689)	2nd Edition	2007	ICAO	
16	Manual of Air Traffic Services Data Link Applications (Doc 9694)	5th Edition	2010	ICAO	
17	Manual on Flight and Flow — Information for a Collaborative Environment (FF-ICE) (Doc 9965)	First edition	2012	ICAO	
18	Manual on Simultaneous Operations or Parallel or Near-Parallel Instrument Runways (SOIR) (Doc 9643)	2nd Edition	2020	ICAO	
19	Asia/Pacific Regional Interface Control Document (ICD) for ATS Interfacility Data Communications (AIDC)	Version 3.0	2007	ICAO APAC	
20	The Revised ADS-B Implementation and Operations Guidance Document (AIGD) Adopted by CNS SG/23 September	Version 12.0	2019	ICAO APAC	
21	The Mode S DAPs Implementation and Operation Guidance Document Adopted by CNS SG/23 September 2019	Edition 1.0	2019	ICAO APAC	

4. SYSTEM FUNCTIONAL BASELINE

The functional baseline, forming the core of the ATM automation system, are broadly described as those which are involved with the processing and display of operational information that will be used in providing an alerting, flight information and separation service to aircraft.

4.1 System Compulsory Functions

The compulsory functions are the necessary functions of ATM automation system.

4.1.1 Surveillance Data Processing Function (SDP)

The Surveillance Data Processing function receives and processes surveillance data, including single and multiple radar data can form a single radar track and conduct tracking processing, and also can process multi-radar coupling, multi-radar target data fusion.

4.1.2 Flight Data Processing Function (FDP)

The Flight Data Processing Function receives and processes flight information data from different sources including AFTN line, SITA line, database, Human Machine Interface Function input and so on. This function follows the progress of a flight through the system, and use relevant data to dynamically optimize 4-D trajectory planning and operation, provides accurate flight information to controllers, and interacts with Human Machine Interface Function.

4.1.3 Bypass Surveillance Data Processing Function (BSDP)

The Bypass Surveillance Data Processing Function receives and processes bypass radar data. This function distributes bypass surveillance data to the system in case of failure of the Surveillance Data Processing Function, acting as a redundancy in the system.

4.1.4 Correlation of Surveillance and Flight Data

The Correlation of Surveillance and Flight Data Function combines surveillance data and flight data, establishing an association between a surveillance track and a flight plan, based on the surveillance track's and the flight plan's identification codes, as well as the surveillance track's position in relation to the plan's route.

4.1.5 Alerts and Warning Function

The Alerts and Warning Function provides many alerts and warnings to controllers that are mandatory features of a safe operational system. The presentation of alerts and warnings to controllers occurs through audible alarm, color change and warning text.

MSAW: The Minimum Safe Altitude Warning function detects and advises controllers of impending penetrations of hazardous airspace by aircraft (aircraft to ground conflict).

STCA: The Short-term Conflict Alert function detects and advises controllers of impending violation of separation standards between two aircraft (aircraft to aircraft conflicts).

APW: The Area Proximity Warning function detects and advises controllers of impending penetrations of danger areas to aircraft traffic, (aircraft to airspace conflict).

Approach Path Monitoring Warning Function (APM) : The Approach Path Monitoring Warning Function informs the controller the aircraft detected to be outside the predefined approach path profile

Departure Path Monitoring Warning Function (DPM) : The DPM monitors the flight trajectory of departing aircraft from each runway and generates visual and audio warning when a departing associated track leaves the required track keeping tolerances.

4.1.6 Meteorological Information Processing Function

The Meteorological Information Processing Function receives and processes meteorological information, including QNH and GRIB. This function takes meteorological messages into flight computation, when necessary.

4.1.7 Air Ground Data Link Function (AGDL)

The Air Ground Data Link Function manages dialogue between pilots and controllers by the PILOT-CONTROLLER two-way data link, and handles ADS-C reports to establish ADS-C tracks. The Functions support ATS applications, such as Controller–Pilot Data Link Communications (CPDLC), Automatic Dependent Surveillance - contract (ADS-C) and departure clearance (DCL).

4.1.8 Variable System Parameter Management Function

The Variable System Parameter Management Function enables the system optimized by the use of Variable System parameter (VSP) settings that can be handled offline and online by specific position.

4.1.9 ATS Inter-facility Data Communication Function

The ATS Inter-facility Data Communication Function receives and processes AIDC messages, enabling flight handover between different ATM Automation systems.

4.1.10 Human Machine Interface Function (HMI)

The Human Machine Interface Function provides an environment whereby the controller is able to comfortably use the hardware and software technology as tools to enhance the air traffic control service.

4.1.11 Recording and Playback Function

The Recording and Playback Function enables the recording of operational data and allows playback of air traffic situations for subsequent analysis. Normally, the playback function is required to be synchronized with voice.

4.1.12 System Monitoring and Controlling Function

The System Monitoring and Controlling Function provides monitoring and control facilities for the system.

4.1.13 Software Version Management Function

The Software Version Management Function provides a tool to manage software patch and version, for system upgrade and rollback.

4.1.14 GNSS Time Synchronization

The GNSS Time Synchronization Function enables the system to synchronize with external GNSS time signals, and ensures that all components of the system are time synchronized.

4.2 System Optional Function

For the air traffic control airspace with high flight flow, the ATM automation system optional functions can be added according to the requirements of the air control operation. The optional functions, playing a decisive and strategic role in system, enhance the operational and technical capacity of the ATM automation system.

4.2.1 Extended Surveillance Data Processing

ATM automation system should be capable of processing multi-source surveillance data such as ADS-B, WAM, MODE S RADAR, etc.

The system should also be capable of processing DAPs in surveillance data.

4.2.2 Extended Correlation

The extension correlation function should use the ICAO 24-bit aircraft address, aircraft identification and the Mode 3/A code to correlate an aircraft's track with flight plan.

4.2.3 Extended Alerts and Warning

Multi Runway NTZ Alert Function : The Multiple Runway NTZ Alert Function informs the controller if a track is predicted to infringe an NTZ area within a predefined time interval, or has already infringed an NTZ area in multiple runways mode.

Medium Term Conflict Detection Warning Function (MTCD) : The purpose of the MTCD function is to provide information on present and future loss of separation between two aircrafts for executive controllers, at a tactical time horizon. MTCD facilitates a more pro-active air traffic control, thereby balancing more evenly the workload of tactical and planning tasks, enhancing sector team efficiency and providing an even safer and better service to airspace users. By maximizing the opportunity of pro-actively solving problems during sector planning especially between smaller and highly-sectorized airspaces, it is hoped to reduce tactical workload of air traffic controllers.

Route Adherence Monitoring (RAM): Route Adherence Monitoring (RAM) capability shall check if an aircraft (i.e. surveillance track) is following the planned route, as stated in the associated flight plan.

Cleared Level Adherence Monitoring (CLAM) checks the conformance of the actual flight level of a surveillance track with respect to the Cleared Flight Level.

Departure No Transgression Zone (DTZ) Warning. This function informs the controller if a track is predicted to infringe a Departure No Transgression Zone area within a predefined time interval, or has already infringed a Departure No Transgression Zone area.

Similar Callsign Warning Function (SC) : The Similar Callsign Warn Function informs the controller if aircraft carries similar callsign with other one in sector.

Reduced Vertical Separation Minimum Warning Function (RVSM) : The Reduced Vertical Separation Minimum Warning Function inform the controller if the aircraft competent of RVSM capacity.

Position Report Monitoring (PMON) Warning. The PMON alerts the controller when the ATO and/or ETO next point stated in the position report differ from that calculated by the flight trajectory by more than a defined time interval.

4.2.4 Downlink Aircraft Parameters Processing and Display Function

Downlink Aircraft Parameters can be obtained from Mode S data link or ADS-B broadcast data. The former Application is called Mode S DAPs, and the latter Application is called ADS-B derived data (ADS-B ADD). All these data come from different registers of aircrafts' avionics system, which include aircraft identification, flight status, operation and etc. These data can be used by ATM AS to improve many functions.

24-Bit Code Mismatch Warning: When the 24-bit code of the coupled surveillance track does not match the 24-bit code of the FDR, an ICAO 24-bit code mismatch warning shall be presented to the responsible controller.

Callsign Mismatch Warning: When the callsign of the coupled surveillance track, if available, does not match the callsign of the FDR, a callsign mismatch warning shall be presented to the responsible controller.

SFL/CFL Mismatch Warning: The Predicted Level Mismatch (PLM) function Should be continuously monitored the consistency of Selected Altitude from the airborne equipment and the Cleared Flight Level from controller and notify the controller of inconsistency.

Resolution Advisory (RA) alert indication: When a RA alert is established by airborne ACAS system for a risk of collision, on the ATM automation system, RA report via DAPs is gained and processed, and a RA notification is presented on the track label to the responsible controller.

Downlink Aircraft Parameters (DAPs) display window : The Downlink Aircraft Parameter Function provides downlink aircraft parameters from Mode S Radar or ADS-B.

4.2.5 AMAN

The Arrival Management Function generates advisories for the controller and provides functions including automatic runway allocation and separation calculation to properly expedite the incoming traffic to the managed airports and runways, aimed at reducing the workload of the supported sector controllers, as well as minimizing the aircraft delays and excessive fuel consumption.

4.2.6 System Log Management Function

The System Log Management Function manages system hardware and software logs.

4.2.7 Enhancement Record and Replay Function

The Air Traffic Situation Scenario Record and Replay Function enables controller position screen recording in common video file format (MP4, WMV, MOV, AVI ,etc) and

corresponding video-replaying. This function provides exact human machine interface recording and replaying.

4.2.8 Re-categorization Function

The Re-categorization Function provides wake turbulence re-categorization function to optimize the separation minimum between aircraft, based on safety as priority.

4.2.9 Operational Data Synchronization Function

In order to provide continuous ATM service in case of the working ATM AS suffering with technical problems, system failures or other critical anomalies, some ATM centers are configured with two types ATM automation systems, which works in main and backup mode.

The Operational Data Synchronization Function serves for both master and backup ATM automation systems deployed in the same ATM center. This function enables the system to synchronize operational data to backup system when in master mode. This function also synchronizes the system when in backup mode with operational data from other master system.

4.2.10 Statistics and Analysis

Statistical Analysis Function provides statistical analysis based on surveillance and flight data originated or utilized by ATM automation system. This function involved tabulating and depicting of ATC operational data, based on flexible time slot.

5. SYSTEM DESIGN

5.1 System Architecture

Considering about the safety and redundancy requirements, the network of ATM automation system is recommended to build with A and B dual network structure. Besides, for the air traffic control airspace with high flight flow, it is recommended to build a large scale ATM automation system and add service network C to provide a higher level support. Network A / B are the redundant working LAN, which is used to transmit surveillance data, flight plan and other operational data. Network C is a separate service LAN, which is used to transmit bypass surveillance data, system log and replay data.

The system software should adopt modular designation and distributed architecture to ensure robustness under adverse operating conditions. Different software functions should be deployed on independent servers, and each individual sever connects to the redundancy network. For the key function modules, such as FDP and SDP, should be deployed on dual redundancy servers. Hot stand-by redundancy is achieved by the dual computer groups to ensure the safe, uninterrupted provision of Air Traffic Services by controllers

5.2 Position Roles and Types

The system positions may include: controller position, tower position, supervisor position, backup controller position, flight plan position, system monitoring position, technical supervisor

position, software data management position, flow management position, coordination position, military coordination position, search and rescue position, operational supervisor position, NTZ monitor position. The position types and quantity can be configured according to the operational situation on each site.

5.3 Main and Backup Configuration

For the air traffic control airspace with high flight flow, the operational site requiring a higher level of support, it is recommended to build two sets of ATM automation systems (Main and Backup) simultaneously as the baseline. The Backup system should keep the consistent position scale, system configuration and software function with the Main system. In addition, the Main/Backup data synchronization function should be provided to ensure controllers can switch to the Backup system seamlessly in case of Main system failures.

For the ATM Automation systems handling busy and high density airspaces, it was recommended provision of the main and fallback ATM automation systems with same functions, capability and capacity but in separated systems in order to enhance robustness and continuity in provision of safe, efficient and orderly ATM services. In the APAC Region with high growth in air traffic, disruption to air traffic is not an option. As a best industry practice, the main and fallback systems with compatible data synchronization scheme should be able to switch their main and fallback roles seamlessly once required and regularly for use by ATC controllers and air traffic engineers. To further enhance resilience and mitigate risks for users handling high air traffic demands, if main and fallback systems were with same functions, capability and capacity provided under the same manufacturer, an ultimate fallback system provided from different manufacturers could be a necessity. All in all, avoiding common software failure across main / fallback / ultimate fallback systems should be a critical consideration for system configuration design.

Should the ATM Automation systems of States/Administrations have not yet equipped with ultimate fallback systems, States/Administrations may consider to take chance of low traffic before traffic recovery by 2024. Likewise, if States/Administrations already have ultimate fallback systems, it could be a chance to plan to upgrade it with same capacity as Main/Fallback to cope with anticipated traffic recovery by 2024.

5.4 System Operational Mode

The system should have normal and degraded working modes. When the whole system key functions work normally, the HMI shows system in normal mode. When the system key function (such as FDP or SDP) is failure, the system should automatically change from normal mode to degraded mode. Therefore, the user could be noticed in HMI.

For the site which equipped with Main/Backup systems, the system should also have Main and Backup modes. In the Main operation mode, the system can process AFTN messages, assign SSR codes, and output flight plan data to the Backup system. In the Backup operation mode, the system does not carry out the above processing, but receives and processes the flight plan information from the Main system. It is suggested that the Main/Backup modes should be manually switched by the user at the special position.

5.5 Capacity and Performance

5.5.1 System Design Capacity

The technical indicators of system design capacity can also be distinguished according to the volume of air traffic control airspace flow, such as high level indicator requirements and low level indicator requirements can be proposed.

The technical indicators shown in the table are the minimum recommended values.

Indicator name	high level requirements	low level requirements
System coverage	4096km*4096km	2048km*2048km
Maximum number of sectors	48	20
Maximum number of UCS	120	40
Simultaneously controlled aircraft	1500	750
Number of restricted areas	256	128
Maximum adjacent AIDC control centers	40	20
Server, workstation CPU load average	20%	20%
Server, workstation CPU maximum load	40%	40%

5.5.2 System Time Performance

The system time performance indicators shown in the table are the minimum recommended values.

Performance parameter name	high level requirements	low level requirements
Single workstation cold start time	5min	5min
Cold start time of the entire system station	10min	10min
MTBF of surveillance data processing	100000hours	100000hours
MTBF of a single workstation	10000hours	10000hours
Maximum clock synchronization error	100ms	100ms

5.5.3 Performance of Surveillance Data Processing

The performance of surveillance data processing indicators shown in the table are the minimum recommended values.

Surveillance data processing performance indicators		high level requirements	low level requirements
Root Mean Square Error of Aircraft Position	Straight flight	200m	200m
	Turn flight	450m	450m
Maximum aircraft position error	Straight flight	500m	500m
	Turn flight	1100m	1100m

The maximum number of tracks in the system	2048	1024
Maximum number of radar inputs	48	16
Maximum number of ADS-B inputs	8	8
System track refresh cycle	≤5s	≤4s

5.5.4 Flight Data Processing Capacity

The capacity of flight data processing indicators shown in the table are the minimum recommended values.

The capacity of flight data processing	high level indicator requirements	low level requirements
Number of flight plans	10000	3000
Activate the flight plan Simultaneously	3000	1000

5.5.5 Record and Playback Function Capacity

The record and playback function capacity indicators shown in the table are the minimum recommended values.

The record and playback function capacity	high level indicator	low level requirements
Minimum time for data retention in the system	31d	31d
Record historical flight plans and AFTN messages	3months	3months

5.6 External Interface

The ATM automation system shall be able to receive and process data from radar sensor, ADS-B, WAM, AFTN, GRIB. Besides, the system shall provide interfaces to Voice Replay System interface, Adjacent ATC centers, Time Signals from GNSS, etc.

5.7 Systems Interoperability

The systems interoperability function enables ATM automation system to exchange data and interact with other ATM automation system, A-SMGCS, Tower electronic strip system, etc.

5.8 Cyber Threats and Mitigation

Cyber threats and mitigation prevent system from suffering cyber-attacks, intrusions, data theft, and the other potential risks in the interconnection environment.

With the extensive deployment and closer interconnection of Commercial-Off-The-Shelf (COTS) Information and Communications Technology (ICT) Systems which is built on common standards rather than on the conventional proprietary equipment, Air Navigation Service Providers (ANSPs) have been facing increasing challenges to manage potential risks arising from cyber security threats. To address the growing concerns on cyber security threats, ICAO published Doc 9985 “ATM Security Manual” in 2013 setting out the principles and guidelines for protecting ATC system infrastructure. States are encouraged to pursue appropriate level of compliance to the cyber security control requirements as stated in the ICAO Doc 9985 ATM Security Manual and make collaborative efforts to effectively address cyber security threats.

Experience from States and Administrations, such as presented in *WP19 of APANPIRG/27 Implementation of Effective Cyber Security Measures to Achieve a Safe, Secured and Efficient Air Traffic Control System by Hong Kong, China*, could be referred on the establishment of management framework in addressing challenges from cyber security threats. This Paper shared the key elements of an effective cyber security management framework for a safe and secured ATC system as well as the latest status achieved by Hong Kong, China in pursuing the ICAO’s ATM Cyber Security Manual.

From experience from Hong Kong, China, it is suggested to establish relevant Committee and Working Group to steer for proactive implementation of effective cyber security measures for their ATC system in Hong Kong. In preparing the transition to the new ATC Centre, a series of verification tests and inspections on the design and implementation of the new ATC system were conducted over the past few years both internally by the subject matter experts, as well as independent cyber security audits carried out by the external consultants from different perspectives.

6. SYSTEM SOFTWARE MANAGEMENT

The ATM automation system software management consists of system requirements analysis and management, system fault management, software release & patch management, etc. The purpose of system software management is to build a robust and practical ATM automation system, and keep it in the good operative mode in whole lifecycle.

6.1 System Requirements Analysis and Management

The objective of system requirements analysis and management is to ensure the quality, effectiveness and consistency of ATM automation systems’ requirements, building robust and practical system with updated technologies to meet the challenge of civil aviation development.

6.2 System Fault Management

The ATM automation system fault management includes fault recording, fault diagnosis, fault handling, troubleshooting, etc.

6.3 Software Release & Patch Management

Software release & patch management focuses on software modification and test management to ATM automation system, in order to maintain system software stability in multi-sites, reduces system running risks.

7. SYSTEM TRANSITION

System Transition is the switch of automation system from old version to the new one. There are two types of transition. One is the software transition in which case there are almost no changes of the hardware. The other one is overall transition. The whole system will be transit to the new one with new hardware and new software.

7.1 Transition Plan and Assessment

Before the transition, the technical department and controller department should map out a scheme including the next information at least:

- The preconditions of transition;
- The necessary cooperation between technical department, controller department and other support departments;
- Operational procedure;
- The emergency plans.

7.2 Transition Rehearsal

To make sure the success of transition, rehearsals are necessary before implementation. During these rehearsals, all the departments should act according to the operational procedure. The purpose of rehearsal is to find out whether the operational procedure is smooth and the cooperation between departments is perfect.

7.3 System Operational Check

To ensure the transition successfully, a check list is necessary to make sure the new system work well. The list should include the technical tests and controller tests. The technical tests mainly focus on the interface test, network test and system monitor test. The controller tests pay attention to the controller functions including flight plan, system tracks, coupling, system warning, and HMI operations.

7.4 Flight Check for System Performance Acceptance

To ensure the performance of multi-sensor tracker for non-manoeuving and manoeuvring aircraft shall be equal to or better than system specification and global/national requirements in performance specification for surveillance applications, such as *EUROCONTROL Specification*

for ATM Surveillance System Performance, flight checks are recommended for system performance verification and acceptance.

A recommended check list is provided below to make sure the relevant items for multi-sensor tracker performance could meet the basic requirements for ATM Surveillance System, including but not limited to:

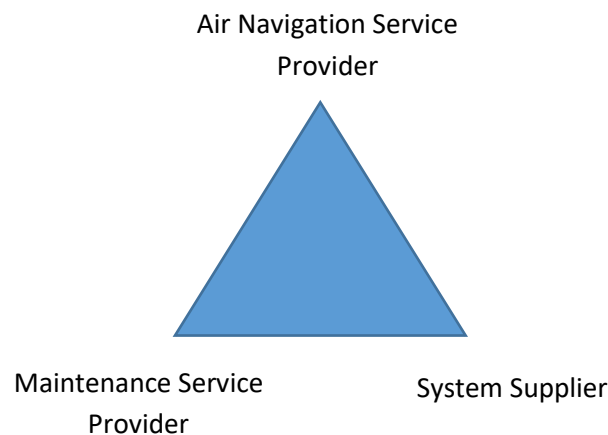
- Measurement interval for probability of update assessments
- Probability of update of horizontal position
- Ratio of missed position involved in long gaps
- Horizontal position RMS error, including
 - Total horizontal RMS error (m)
 - Ground speed RMS error (kt)
 - Course RMS error (deg.)
 - Ground speed std. dev. (stability) (kt)
 - Course std. dev. (stability) (deg.)
 - Probability of update of pressure altitude with correct value
 - Forwarded pressure altitude average data age
 - Forwarded pressure altitude maximum data age
 - Ratio of incorrect forwarded pressure altitude
 - Pressure altitude unsigned error
 - Delay of change in emergency indicator/SPI report
 - Delay of change in aircraft identity
 - Probability of update of aircraft identity with correct value
- Ratio of incorrect aircraft identity
- SSR Code Change Time in selected waypoints
- Flight Route Accuracy in Position Check in selected waypoints in flight profile, on difference combinations of sensors selectable for contributing to MST.

8. SYSTEM MAINTENANCE

As ATM automation system could comprise of provisions from different manufacturers, a robust and systematic maintenance management and practice should be set up with close cooperation with the system supplier, the maintenance service provider (MSP as the frontline maintenance agent, as well as the air navigation service provider (ANSP) as the system management authority, the contract management agent and the end-user to ensure the performance of the system.

Trio for Maintenance Management

Under the maintenance framework for ATMS, the system supplier, MSP, and ANSP form a close coordination trio in operating and supporting the maintenance framework.



8.1 System Supplier

The design of system plays a critical part for ease of maintenance in operation stage. Before system commissioning, system supplier as the entity with the most comprehensive know-how on the system, should provide sufficient maintenance documentation and training to ANSP and MSP containing complete information for the proper installation, set-up, use, operation, support and maintenance of the system.

System supplier should provide documentation to the ANSP and MSP for aiding the use, application and maintenance of the system and individual equipment. These documentation should include:

- i) operating handbooks and user manuals for operating procedures and system functionalities for use by controllers, supervisors, assistants and support specialists;

ii) technical literature for full technical description of configuration and operation in the system as well as full details of each system component, block diagrams with data flow, mechanic and wiring schematic diagrams, as-built drawings etc.; and

iii) service and maintenance manuals including system setup, optimization and parameterization, preventive maintenance procedures (system checking and rebooting, calibration, cleaning, housekeeping, etc.) with recommended frequencies, and troubleshooting procedures in hardware and software (recommended solution and flow chart to identified issues, handling of alarms and error messages, etc.).

All documentations should be reviewed and endorsed prior to use.

System supplier should prepare training plans and training course materials to ANSP and MSP for review with sufficient lead time prior to critical milestones, such as commencement of design review, factory/site acceptance tests, and ATC operational train-the-trainer course. ANSP, in coordination with MSP, has to set out the required training topics in the contract to system supplier. Training topics should be specific to different user groups.

Subject to actual needs, after ANSP and MSP have built up their own training capability, on-site maintenance review and assessment on MSP should be conducted by system supplier after commissioning on regular basis, with more frequent training/assessment as needed during the start-up and run-in period after commissioning.

As ATMS is a complex system, it is unavoidable that unexpected technical issues might emerge, especially teething issues during the early stage of operation. As such, system supplier should be required to respond to requests from ANSP or MSP to provide timely assistance in dealing with and rectifying all faults or deficiencies in software and hardware within pre-defined response time according to the criticality of such faults or deficiencies as specified in the contract. Same faults occur repeatedly should be handled with high priority by system supplier to investigate root cause and implement measures to prevent recurrences.

As technology is changing rapidly, some spare parts might become obsolete and will be difficult to source in the market. System supplier should provide a list of obsolete equipment and its replacement models on regular basis, and the replacement model should be evaluated on-site for its compatibility prior to use as a spare for operation.

The performance of system supplier has to be regularly reviewed in suitable forum, such as performance review meetings in conjunction with ANSP and MSP representatives.

System supplier should form user groups to allow sharing of users' experience and gather feedbacks. System supplier should facilitate regular hosting of user group meetings.

8.2 Maintenance Service Provider (MSP)

Engagement of a MSP to perform frontline maintenance under supervision of ANSP is a practical solution in leveraging skill sets and latest technology available in private sector in order to facilitate provision of reliable services with cost benefit.

Under the regime of compliance to all applicable ordinances and regulations, Safety Management System and Air Traffic Safety Electronics Personnel (ATSEP), the maintenance services provided by MSP should include, watch-keeping of equipment, preventive/corrective maintenance, system/equipment minor modification/replacement works, staff training, and procurement of spares and test equipment/ tools. Support services such as record-keeping on maintenance activities, preparation of statistics and reports and inventory control etc. could be provided as part of the package from MSP.

MSP needs to perform maintenance according to system supplier's established procedures at recommended intervals, including health checks on system, servers, equipment and workstations, critical data backup and log capture/review for hardware, software, user management and other activities, system parameters and user preference checks and backup, regular clean-up and reboots of hardware including servers and workstations etc. Proactive system housekeeping procedures adopting industry best practice with recommendation from system supplier and expertise from MSP, together with close monitoring of system healthiness/system resources, and housekeeping of servers/workstations on regular basis to upkeep the system performance, should be in place.

There could be cases that due to local specific environment/operational status of the ATMS, it would require extra steps or more frequent maintenance on top of recommended maintenance procedures by system supplier. MSP, who looks after the system day-by-day and is familiar with local environment, would contribute their expertise for adapting the maintenance procedures to fit into the local needs after consulting the system supplier.

In addition, like any critical systems running on round-the-clock basis, ATMS has no exception that it might encounter system fault where immediate attention from MSP is required. For example, a server breakdown after a software bug is hit with no or little pre-alerts. It is important that MSP has geared up with a full deck of operational instructions for their watch-keeping staff to handle all sorts of foreseeable system scenarios with proper initial and re-fresher trainings/drills on such scenarios. The build-up of know-how and experience for MSP in dealing with urgent scenarios is crucial to smooth operations of the ATMS.

Similar to system supplier, the service level of performance of MSP has to be constantly monitored to meet with the target levels set out in the contract and regularly reviewed in suitable forum, such as operations & maintenance review meetings in conjunction with ANSP representatives to ensure maintenance provisions could meet the service needs.

8.3 Air Navigation Service Provider (ANSP)

As the party to govern maintenance service performance by MSP and system supplier through various means discussed above, ANSP has to ensure the necessary support and resources to be provided to MSP and system supplier for fulfilling, or even exceeding, the baseline maintenance requirements set out in the contracts with these parties. For example, timely certification of invoice and payment in accordance with the contract requirements against their performance. Payment deduction might be incorporated into the contract to handle cases where performance does not meet requirements but it might bear impacts on maintaining good relationship with MSP or system supplier.

ANSP has to ensure the services provided by MSP and system supplier are in compliance with ICAO standards and international best practice. ANSP can share experience and best practice gained from ICAO and international meetings/ symposia/ seminars, as well as overseas facts-finding visits, with MSP and/or system supplier with a view to enhancing the maintenance regime.

To allow air traffic control (ATC) professionals to perform their work safely and satisfactorily, it is highly desirable for ANSP engineering professionals to understand the ATC needs such that the ATMS could fully support their work. As such, constant communications with ATC in addressing their needs via suitable steering forums and communication channels would be critical to the smooth operations on ATMS. Following the commissioning, an ATMS technical team comprising ANSP engineering professionals, system supplier and MSP was established with regular meetings with ATC to oversee system performance and deployment of software builds/system adaptation updates to ensure smooth operation of the ATMAS.