International Civil Aviation Organization

Eleventh Meeting of the Air Traffic Management Sub-Group (ATM/SG/11) of APANPIRG

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Agenda Item 5: ATM Systems (Modernization, Seamless ATM, CNS, ATFM)

RESEARCH AND PRACTICE OF AMAN-DMAN-SMAN INTEGRATION IN CHINA

(Presented by China)

SUMMARY

This paper introduces the present situation and business difficulties of approach management, departure management, surface management and traffic management of CAAC, and puts forward the extended method and function of E-AMAN, AMAN and DMAN integration method, DMAN and SMAN integration method, the preliminary application of CAAC and the lower work initiative of ICAO Asia-Pacific region.

1. INTRODUCTION

Existing problem

1.1 With the recovery of the world epidemic, the demand for air traffic is increasing, while the existing civil aviation support capacity is limited, and the contradiction between demand and supply is becoming increasingly prominent. With the application of new technologies and new ideas, air traffic management is undergoing profound changes. Using intelligent auxiliary tools to assist ATC controllers is also an important solution, such as AMAN, DMAN, SMAN, etc.

1.2 In recent years, in China, we build a set of innovative can be integrated in ATC automation AMAN, SMAN tools, to explore the approach management, departure management, surface management, traffic management and so on ATM demand fusion through one operation concept, preliminary break each tools isolated island, difficult to play a synergistic role, to reduce the comprehensive flight delays, reduce operating costs, improve the passenger travel perception and acquisition effect.

Overview of AMAN / DMAN / SMAN in China

1.3 **In terms of AMAN tool**, in 2018, Civil Aviation Administration ATMB issued ***the Minimum Control Functional Requirements Specification for Air Traffic Control AMAN System*** (IB-ATMB-2018-001), which regulates the technical specifications of air traffic control approach management system. The AMAN project construction mode is divided into the basic integration type and the fusion type. The basic integrated AMAN system is an independent external system with the background and the automation system, with the interface and data integration with the automation system. Fusion means that AMAN operates as a functional module of the automation system. China ATC has carried out AMAN tools in Xi'an, Shenyang, Nanning, Beijing, Shanghai, Guangzhou, Zhuhai, Guiyang, Hangzhou, East China automation System (Nanjing, Hangzhou, Nanchang), Chongqing and

other airports, and updated them iteratively according to the feedback. At present, there is a temporary lack of AMAN and DMAN integration, deep fusion of the interconnection function.

1.4 **In terms of SMAN tool,** SMAN tools mainly include realizing its functions in the tower automation system / A-SMGCS, providing taxi path planning and taxi time prediction, surface monitoring and early warning, surface resource optimization and other functions. In terms of implementation and deployment, the tower automation system / A-SMGCS with SMAN function has been put into operation in the Capital Airport, Daxing Airport and other places.

1.5 **In terms of DMAN tool,** there has been theoretical research. DMAN is responsible for the refined surface ranking of the shutdown to the runway head, multi-stage optimization of the start time and takeoff time of flights, parking lot, standard departure program SID and other functions, etc. The prototype system is being developed for verification test.

1.6 In general, AMAN, SMAN, DMAN and other tools have been deployed or gradually operated as separate ATM tools. Universities and scientific research institutions have studied and explored the integrated method of AMAN-DMAN-SMAN at the theoretical level, but the technical specifications of information system development and internationalization need to be further improved. The concept of operation needs to be standardized and internationalized, and the technical aspects such as data interface need to form international technical specification documents.

The ICAO ASBU AMAN-DMAN-SMAN Integration Profile

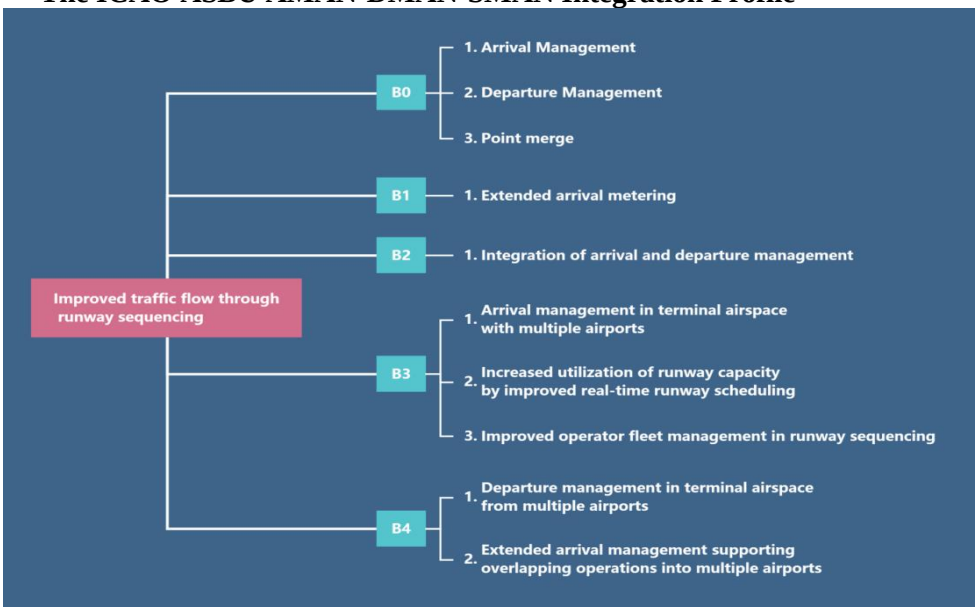


Figure 1 Blocks related in ICAO ASBU

Block 0

The incoming flight is ATC, and the controller "calculates" and ranks the incoming traffic forecast information to optimize the runway utilization. In addition, the exits are sorted to improve driving / roll-out clearance, reduce taxi time and ground waiting, provide a more efficient departure sequence, and reduce ground congestion.

Block 1

Integration of extended to port computing and airport surface management with departure sorting to improve runway operation management.

Block 2

Integrated approach management and departure management that supports dynamic scheduling and runway configuration to better accommodate the approach / departure mode and integrate approach and departure management. Furthermore, integrated arrival management and departure management extend the scope from single airport operations to consider multiple airports within the airspace of the same terminal zone.

Block 3

Extend computing in integrated AMAN, SMAN, and DMAN environments for dynamic scheduling and support an air traffic network based on a complete FF-ICE including multiple national Air traffic control administrations (ANSP). Flight information exchange system and the ATC controller operating protocol. Flight transition operation, including flight arrival and departure management, is supported by ATC automation and related tools, and is displayed on the interface to support the operation. Within this time frame, full life cycle management of consolidation point, departure airport and arrival airport can be performed.

2. DISCUSSION - AMAN and SMAN Integrated Method and Application

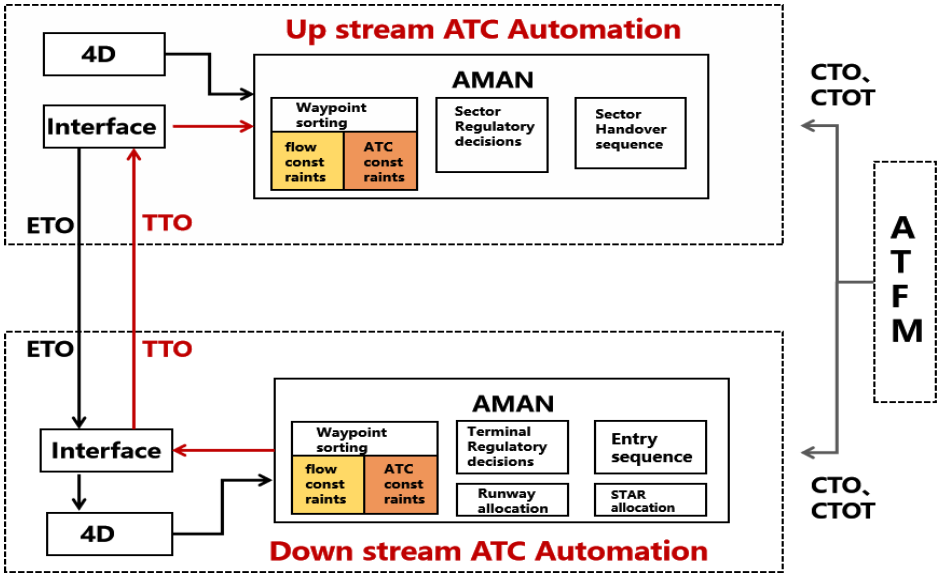
E-AMAN/XMAN

2.1 AMAN is an approach management decision-making tool that supports multi-airports and multi-runways. It uses computer intelligent algorithm to assist decision-making for future incoming flights. According to the data analysis and evaluation of the AMAN system in China, the airport / terminal capacity increased by approximately 10%; the approach flight management efficiency increased by approximately 5%; the total delay and average monthly delay decreased by approximately 27% and 31%, respectively; and the average landing on the nearest runway increased by approximately 38%. The evaluation index shows that the AMAN system has a significant impact on improving the operational efficiency. It is suggested to promote the construction and application of the AMAN system in the Asia-Pacific region.

1Figure 2 Deployment of AMAN in China

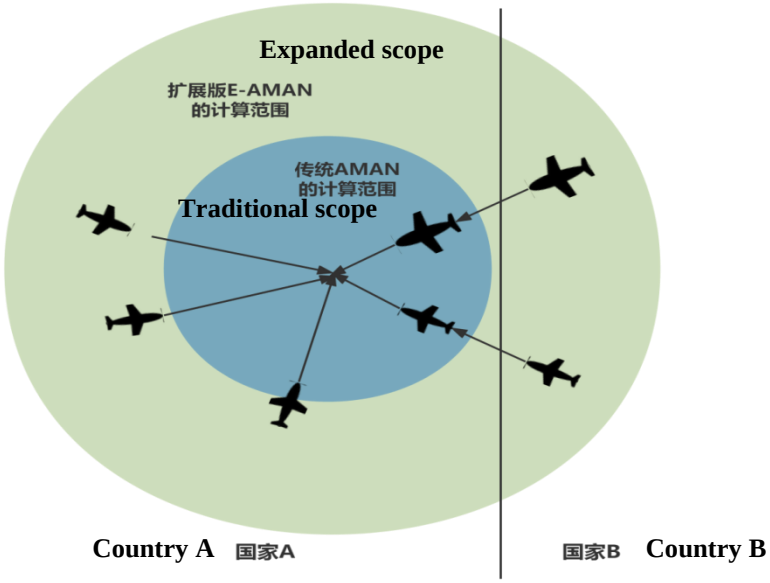
2.2 Extended version of E-AMAN, Also known as cross-border Management XMAN, in Chinese terminal areas, Such as Hangzhou approach APP, etc., the airspace resources are always insufficient, where difficult to consume all delays in TMA area. To deal with it, China developed prototype tools which enhance data exchange between Area automation system(upstream) and TMA automation/AMAN system(downstream) to achieve coordination in delay consumption. besides, China is promoting a validation to test these mechanism and tools, Mainly include: the new upstream AMAN, Deploy to the upstream automation systems, Provide control advice to assist the operation command;

Design the interaction between upstream and downstream AMAN, From downstream sending target handover time TTO to upstream, The data interaction principle of related system / tool interconnection is shown in below.



2Figure 3 AMAN upstream and downstream interconnection framework diagram

2.3 Extended computing range of AMAN will improve predictability and compliance with ATM decisions, and extended computing will enable ATS units to continue computing during high-flow traffic and will improve computing accuracy. This will also contribute to the synchronization between adjacent flight information regions. Through extended calculations, delays can be transferred to higher heights and can be more effectively absorbed by incoming flights. This calculation will provide extended approach management, improve the effectiveness and efficiency of approach management (e. g., in reducing waiting times) while reducing the workload of approaching ATC. The aircraft reduce waiting times at congested airports by reducing their cruise speed during the final flight phase, hundreds of miles from the airport. Flight efficiency can be improved by reducing overall fuel consumption and carbon dioxide emissions. Reducing air congestion in the terminal area will also help to improve operational safety by reducing pilot / controller workloads and reduce noise to residents.

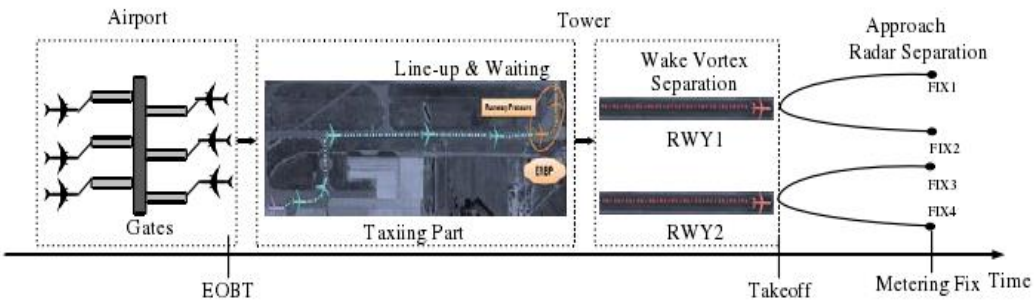


3**Figure 4** Schematic diagram of the calculated range of the extended version E-AMAN

2.4 The expansion of AMAN involves data interaction on cross-border flights, which requires Asia-Pacific member states to discuss agreed operational procedures and data connectivity testing of prototype tools. In this area, it is suggested that ICAO Asia-Pacific organization may consider selecting an appropriate international airport as a pilot to discuss and formulate ICAO Asia-Pacific guidance documents such as "ICAO Asia-Pacific E-AMAN Operating Procedure Specification" and "ICAO Asia-Pacific E-AMAN Data Interface".To promote tool research and development among member states, and conduct interconnection testing and trial operation. Suggested relevant parties: China, Hong Kong China, Japan, ROK, Singapore, Thailand, etc.

Integration of AMAN and DMAN

2.5 Aircraft departure operation is achieved through the coordination of airports, airlines and air traffic control departments, the airport provides parking information of departure aircraft, the airline provides estimated off-block time(EOBT) and target off-block time (TOBT), etc., tower/apron controllers are responsible for the push/taxi permission/time of departure aircraft, according take-off time, specific operation process as shown in the figure.



4**Figure 5** Schematic diagram of the flight departure process

2.6 DMAN departure management, like AMAN approach, aims to optimize departure operations to ensure the most efficient use of airport and terminal resources. The allocation and

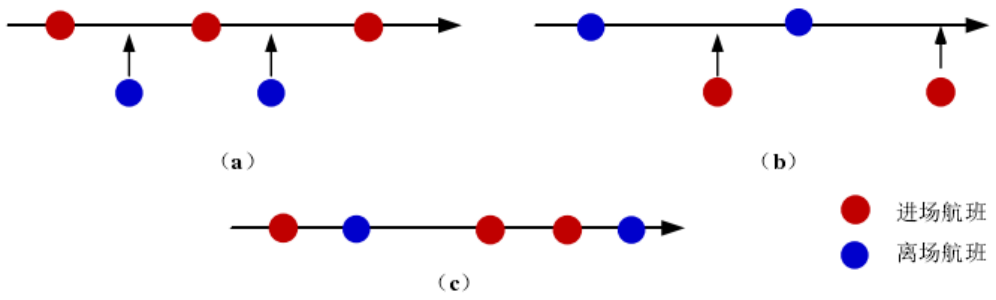
adjustment of time slots will be supported by departure management automation system, helping to improve airport throughput and compliance with flow management of takeoff time slots.

2.7 The main problem to be solved by AMAN and DMAN integration is to set up a detailed integrated flight integration sorting for the same runway. Integrate the approach and departure management sequences into a single runway or associated runway. The arrival and departure sequences, fully integrated and throughput optimized for the same runway (or associated runway), are characterized by stability. For one narrow parallel runway for arrival and the other for departure or one runway that can be used for both arrival and departure, the sorting strategy of arrival and departure flights often needs to be considered in the coordinated operation of arrival and departure flights. At present, the method of runway time slot allocation is mainly adopted in the sorting process of arrival and departure flights, including air priority, departure priority and joint arrival and departure flight ranking, as shown in the figure.

2.8 The air priority strategy means that the arrival flight preferentially occupies the runway time slot, based on which the available time slot is allocated to the departure flight. This strategy can guarantee the flight safety of the aircraft. In the actual control process, such as the evening rush hour.

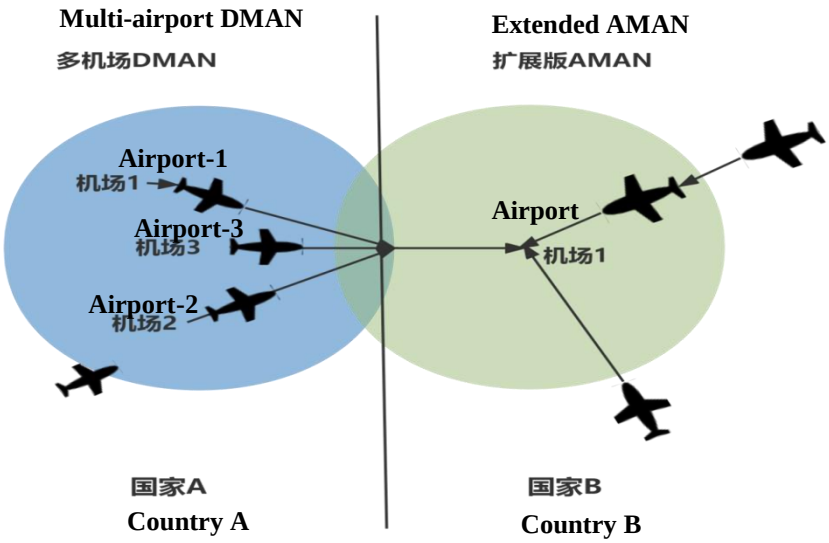
2.9 The departure priority strategy is mainly to avoid the shortage of airport resources caused by the excessive number of waiting aircraft waiting on the ground, so arrange the runway of the departure aircraft to occupy the time slot, and then arrange the arrival flight landing in the remaining time slot. However, this strategy only applies to the small number of landing aircraft.

2.10 The arrival and departure balance strategy considers the fairness of the flights, and the optimization algorithm is used to allocate the runway time slot for the arrival and departure flights. When the number of the flight is too large, try to balance the arrival and departure flights to improve the overall operation efficiency.



5**Figure 6** Schematic diagram of the integrated strategy for the inbound flights and the outbound flights

2.11 For future work, the proposed ICAO Asia Pacific Group demonstration study: Integrated operational concept / technical framework guidance for AMAN and DMAN; the cross-border integration diagram of multi-airport DMAN and E-AMAN is shown below. ICAO Asia-border data guidance documents, such as ICAO Asia Pacific AMAN and DMAN Integration, to promote tool research and development among member states, and conduct connectivity test and trial operation. Suggested relevant parties: China, Hong Kong China, Japan, ROK, Singapore, Thailand, etc.

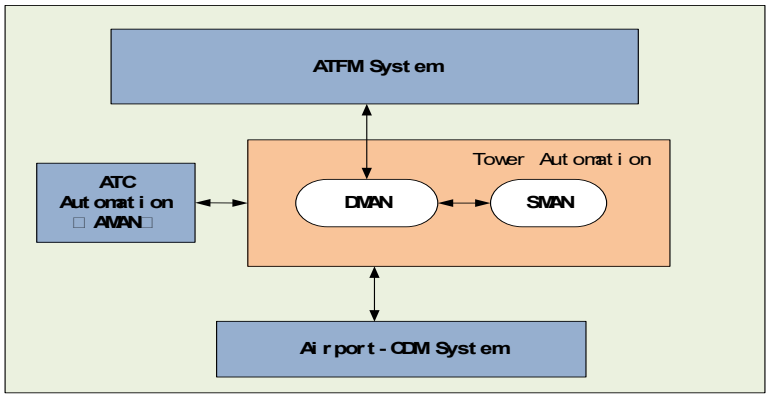


6Figure 7 Schematic of cross-border integration of DMAN and E-AMAN

Integration of DMAN and SMAN

2.12 The research and practice of DMAN in Chinese national civil aviation was developed iteratively according to the environment and conditions. In the early years, in the era when there was no national flow system, the regional CDM / flow system more or less played the function of DMAN tool. For example, since 2014, CAAC has launched the construction of CDM / flow management system in North China, considered the ranking of departure flights in multiple airports within the jurisdiction of North China Air Traffic Control Bureau, and optimized the take-off queue. For terminal airspace with multiple airports, departure management operations between relevant airports need to be coordinated in the form of traffic flow to enable more consistent and manageable handover during the en-route flight phase. In the case of predicted demand-capacity imbalance, coordination between relevant departing flights may recommend optimization of standard departure procedure SID and optimization of allocation. If other capacity cannot be used, the departure sequence can be further optimized by combining information such as CTOT and COBT of the calculated flight.

2.13 In 2018, CAAC launched an innovative research topic of "Research on Arrival and Departure Management and Surface Operation Management", and the concept of departure management and surface management was gradually clarified and focused. After research: DMAN is mainly responsible for focusing on the refined surface ordering from the apron position to the runway threshold, calculating the accurate start time and take-off time, the air limit calculation by the national flow system, and DMAN and flow system coordinate; SMAN focuses on airport surface management, providing more refined taxi route planning, conflict detection and relief. SMAN gliding path and time optimization calculation: it can refine different stages, models and weather factors to provide dynamic sliding time from down position to runway threshold and improve the prediction accuracy.



7Figure 8 Schematic integration of DMAN and SMAN

2.14 DMAN receives the internal information of tower control automation system, national flow output information, air traffic control automation AMAN information, Airport A-CDM guarantee time, and DMAN information integration display to the automatic man-machine interface of tower automation.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) note that AMAN, DMAN, SMAN tool s in China enable to optimize traffic flow in APAC region as well as each Country next task / action recommendations: E-AMAN tool Asia Pacific Guidance specification. Taking an international airport as a pilot, ICAO Asia-pacific Specification documents such as ICAO E-AMAN. Concept / technical framework guidance for AMAN and DMAN; conceptual / technical framework guidance for DMAN and SMAN;

c) discuss any relevant matters as appropriate.

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