International Civil Aviation Organization

Tenth Meeting of the Air Traffic Management Sub-Group (ATM/SG/10) of APANPIRG

Video Teleconference, 17 – 21 October 2022

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

RESEARCHES ON THE APPLICATION AND INTEGRATION OF AMAN/DMAN/SMAN

(Presented by China)

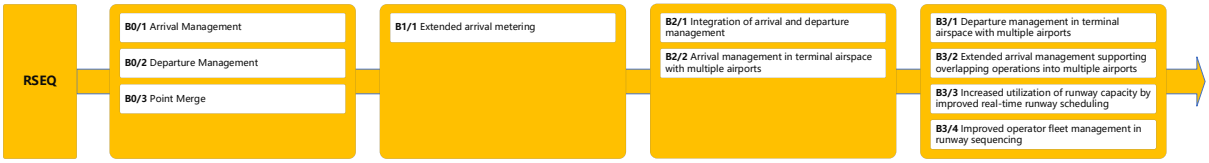
SUMMARY

Based on the exploration and practice of CAAC in the field of ASBU RSEQ performance, this paper summarizes the application strategies and practical experience in flight mode, sector delay allocation, straight approach and other aspects of the AMAN system. At the same time, it briefly introduces the achievements and progress made in the research and verification of Air Traffic Management Bureau (ATMB), CAAC in point merge programs, AMAN/DMAN/SMAN integration and other aspects.

1. INTRODUCTION

1.1 In 2021, with the world deeply affected by the COVID-19, China's civil aviation industry completed 440 million passengers, ranking second in the world. There were 96 transport airports with an annual passenger throughput of more than one million passengers and 61 transport airports with an annual cargo throughput of more than 10,000 tons. The current situations of heavy traffic flow, complex airspace organization, and competition for airspace resources among airport groups has caused bottlenecks for the operational efficiency of airports and terminal control areas.

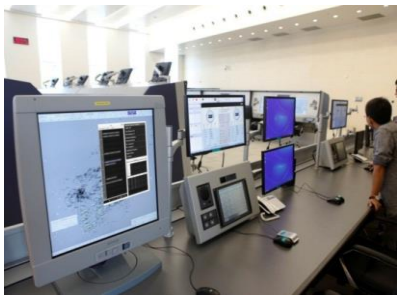
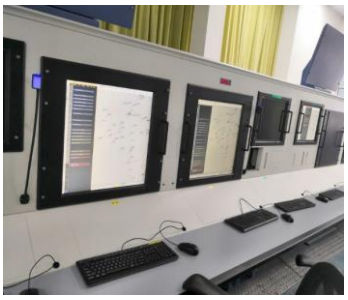
1.2 The latest ASBU document issued by ICAO has planned the development plan of AMAN/DMAN/SMAN, as shown in the figure below. CAAC has carried out a series of work around B0/1, B0/3, B2/1, B2/2 of RSEQ and other relevant blocks: 36 of the 44 airports directly providing ATC services by the air traffic management (ATM) systems of CAAC have built or planned to build AMAN systems; Shanghai Pudong Airport, Guangzhou Baiyun Airport, Shenzhen Bao'an Airport, and other busy airports have applied point merge programs. The North part of China has been equipped with A-SMGCS system conforming to ICAO Level IV surface management capabilities, and has carried out AMAN&DMAN integration and DMAN&SMAN integration. In this region, Tianjin, Shijiazhuang, Hohhot, Taiyuan, Beijing, and other cities have carried out the verification of multiple airports collaborative clearance. The rich operation experience shows that these systems and technologies have the value of promotion and application in the Asia & Pacific region.



Arrival Management

1.3 Arrival Manager (AMAN) fully considers restrictive factors such as airport runway configuration, separation requirements, airspace resources, and meteorological conditions, and it dynamically calculates the optimal aircraft landing sequence and time. By comparing the calculation results with the suggested arrival time, combining with the flight location, decision-making suggestions such as time-to-lose(TTL), time to gain(TTG), rerouting, and holding are automatically given for the arriving flight, so as to reduce the ATC workload, improve the level of safe operation, and reduce fuel consumption. The system is an important tool to improve the safety and efficiency of airport and terminal area operations. According to the assessment results of the Central-south part of China after the official operation of the AMAN system, the airport arrival capacity has increased by 8%; The arrival operation efficiency has been improved by 5%; The total and average monthly arrival delays have decreased by 26.94% and 30.61% respectively; The landing on the nearby runway has increased by 37.75% on average. The average taxi-in time and taxi-out time of the airport have decreased by 2.86 minutes and 1.95 minutes respectively. All evaluation indicators show that the AMAN system has a great effect on the improvement of operation efficiency. It is recommended to promote the construction and application of AMAN system in the Asia & Pacific region.

1.4 In April 2018, ATMB of CAAC issued document of *Minimum Control Function Specification for Air Traffic Control Arrival Manager System*. It has also successively carried out the construction and test operation of the AMAN system in Xi'an, Shenyang, Nanning, Beijing, Shanghai, Guangzhou, Zhuhai, Guiyang, Hangzhou, and other cities, and explored and improved the AMAN function in combination with practical experience and operating characteristics.

Stability of Flight Sequence

1.5 The AMAN system supports the classification of flight status according to the time and space range, so as to protect the stability of the flight sequence queue during the optimization calculation of flight sequence. A typical case, i.e. the Nanning site, is divided into four states: being unstable, being stable, being super stable, and being frozen. The arrival flight in UNSTABLE status has not yet flown over the feeder fix, and the sequence, arrival time and control suggestions of the flight will be updated with the flight 4D trajectory prediction results. After entering the terminal control area, the flight will switch to STABLE state. By this time, the relative position of the flight will remain unchanged. A clear flight arrival sequence has been formed, and there is still a large time and space adjustment margin, which is convenient for the implementation of time-to-lose (TTL), time to gain (TTG), rerouting, holding, and other delay absorption actions. During the previous time period before the flight lands, the flight will switch to the SUPERSTABLE status. By this time, the flight sequence has become fixed, and there must be an available time period even if the flight is manually inserted, otherwise the manual flight insertion is not allowed. Flights in FROZEN status are flights about to landing or have established an instrument landing. By this time, the position of the flight in the queue will not be updated. For go-around flights, the landing time and runway of the flight are manually designated, the flight mode is not set, and the flight sequence calculation is not performed.

Flight Delay Allocation

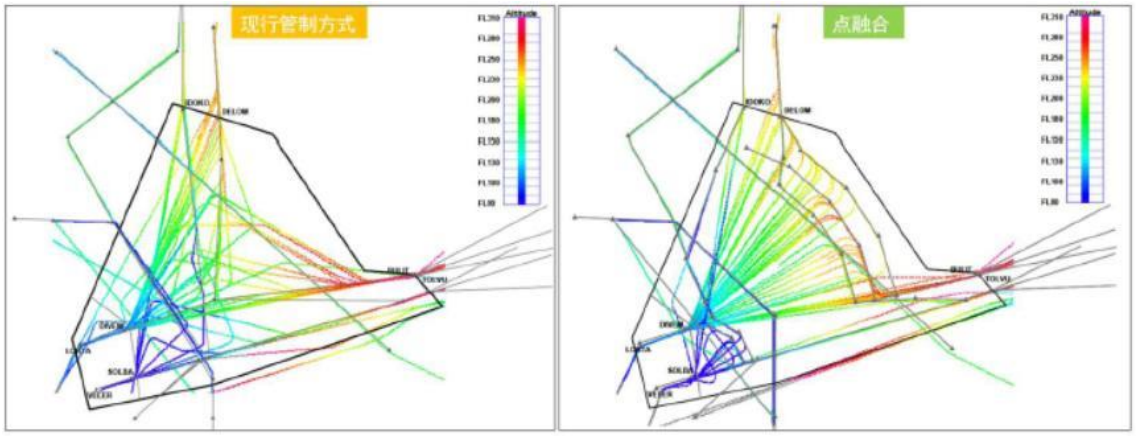
1.6 AMAN system supports offline definition of sector information and calculates the delay time of flight plan in each sector. Taking Guiyang site as an example, the terminal/approach control area (TMA/APP) is configured with the delay absorption value of each sector traversed by the STAR. The Area Control Centre (ACC) is configured with delay absorption value of each sector traversed by the route between the boundary fix and feeder fix. Generally, the outer sector has more time and space for adjustment. When the flight is delayed, it is usually preferred to absorb delays in the outer sectors. After the delay absorption value of outer sectors is filled, it is placed in the inner sectors to further eliminate the delays. When allocating the flight delays between ACC and TMA/APP, the strategy of proportionally allocating delays is adopted. When allocating the delays, the system first counts the total absorption capabilities of TMA/APP and ACC, and then divides flight delays into TMA/APP and ACC departments in proportion. At the same time, the system establishes the starting threshold for delay allocation, which accomplishes the coordinated absorption of arrival flight delays between the ACC and TMA/APP.

Straight Approach

1.7 At some congested airports, AMAN has reserved the function of straight approach, to improve the operational efficiency of arrival flights in the TMA/APP. On system processing, taking the straight approach path as a non-standard arrival route, the system first considers the straight approach path and calculates the target landing time (TLDT) of the flight when sequencing and calculating flights. When the TLDT is not in conflict with other flights and meets the runway spacing requirements, the straight approach is preferred. The use of straight flight in all directions can increase the arrival efficiency of flights in the TMA, but factors such as restricted areas and flight performance should also be fully considered.

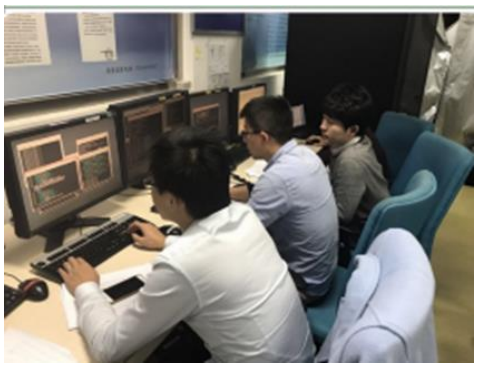
Point Merge

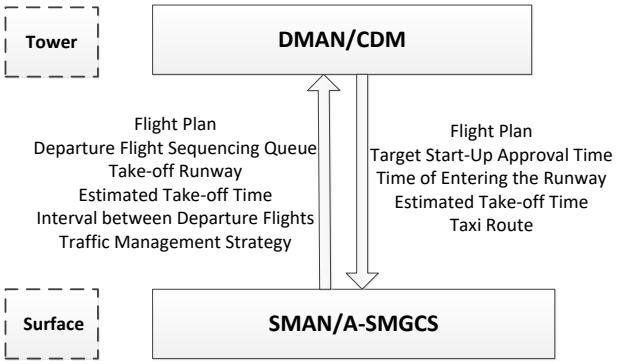
1.8 Shanghai Pudong International Airport in China started to operate Point Merge System (PMS) on December 5, 2019, which is the first airport in China to operate PMS. Subsequently, Guangzhou Baiyun International Airport officially operated PMS on January 2, 2020. Shenzhen Bao'an International Airport officially operates PMS on December 3, 2020. Taking Shenzhen as an example, the point merge system of Shenzhen Airport is planned to be located on the west side of the airport runway, supporting the southward and northward operation of inbound flights at Shenzhen Airport. In the point merge sector, the flight will be programmed to fly at a set altitude and speed. According to the previous simulation verification, radar vector was reduced by 60% to 70%, the ATC instructions were reduced by about 20%, and the heading instructions were reduced by about 60%. On the first day of operation, the point merge program was open for use for 6 hours. About 150 flights landing at Shenzhen Airport took the lead in using the program, and the overall operation was safe and efficient.



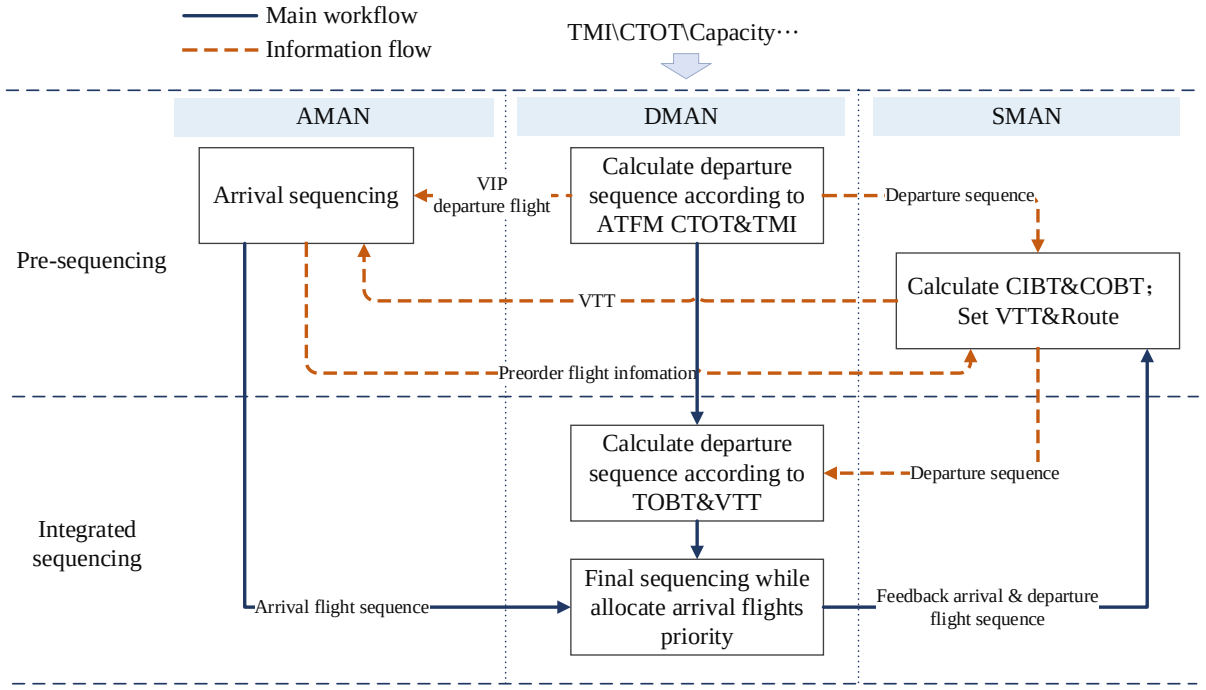
Integration of Arrival and Departure Management

1.9 The integration of AMAN and DMAN has been preliminarily considered in the currently deployed AMAN system, which has the function of runway GAP setting. It can be set to make sure that the runway is only used for departure or landing in a certain period of time in the future, and has the ability to reserve time slots for departing flights. At the same time, the ATMB of CAAC has carried out operational verification on the integration of DMAN and SMAN, and organized ATMB, airports and airlines to conduct joint testing and verification in thunderstorm season, including the verification of interfaces, functions, operational processes, etc.





1.10 At present, China is exploring the integrated management of AMAN, DMAN, and SMAN. The basic interaction logic of the three systems is shown in the following figure:



1.11 The Air Traffic Flow Management (ATFM) system predicts the flow of arrival and departure flights, and gives the capacity value based on the runway service ability. AMAN dynamically calculates the arrival flights sequence, and combines with manual intervention to complete the arrival flight sequence. The ATFM system provides the calculated take-off time (CTOT) and positive and negative margin of CTOT. DMAN completes departure flights sequencing, and combines the arrival flights sequencing results of the AMAN system to complete the arrival flights and departure flights integrated sequencing calculation, and finally calculates the target take-off time (TTOT) of the departure flights. SMAN calculates COBT and CIBT according to CLDT, CTOT and TSAT, provides variable taxi time VTT, and proposes taxi route, etc.

2. ACTION BY THE MEETING

2.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.

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