International Civil Aviation Organization

Fifth Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (APAC ATMAS TF/5)

Chengdu, China, 5 – 7 June 2024

Agenda Item 4: ATM Automation System Implementation Experience by States

4.5 Development of New Technology

OPTIMIZATION OF ARRIVAL MANAGEMENT SYSTEM BASED ON PBN

(Presented by China)

SUMMARY

This paper presents the problems of the implementation of Arrival Management System (AMAN) in Chengdu China. Then the solutions have been proposed based on PBN in the TMA area. At last, the future plan is put forward to enhance the architecture and performance of AMAN.

1. INTRODUCTION

1.1 Chengdu is the third city in China with dual airports after Beijing and Shanghai. The Tianfu International Airport was put into operation on June 28, 2021, with an average daily departures and landings volume of about 1,100 flights. Figure 1 shows the daily departures and landings of Tianfu Airport in February 2024. Tianfu Airport consists of "two vertical and one horizontal" three runways, two parallel runways are used for both take-off and landing, and the vertical runway is only used for take-off.

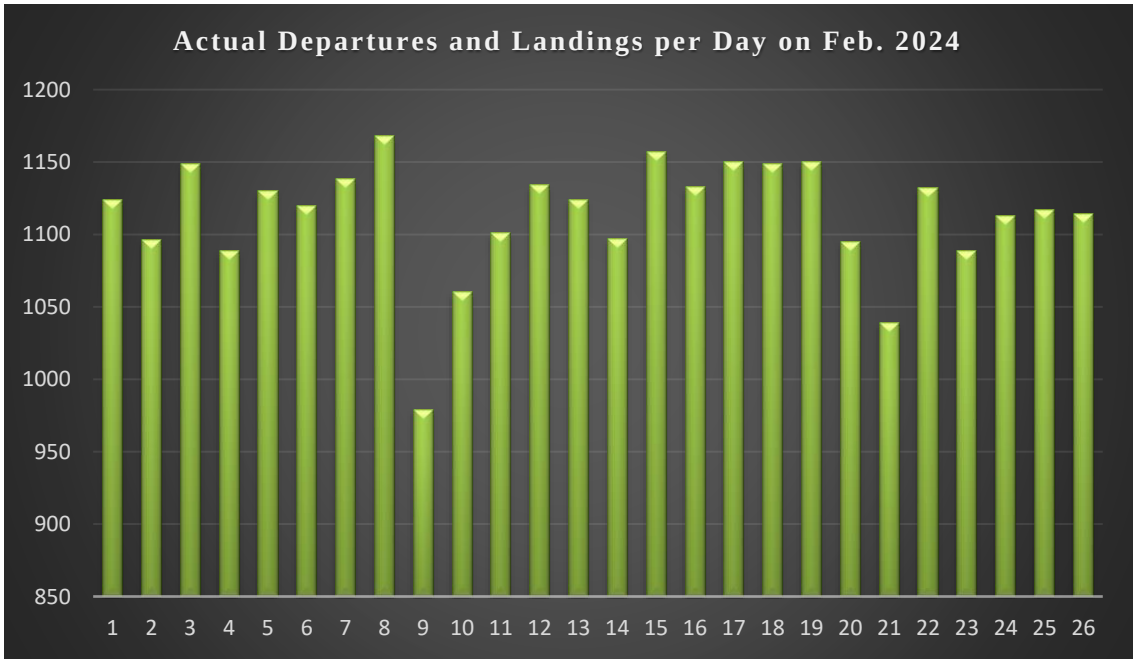

Figure 1 Actual Departures and Landings per Day on Feb. of Tianfu Airport

1.2 Figure 2 shows the departures and landings per hour of Tianfu International Airport on February 8, 2024. In order to optimise the runway capacity, AMAN function of ATM-AS in Chengdu was put into operation in December 2022.

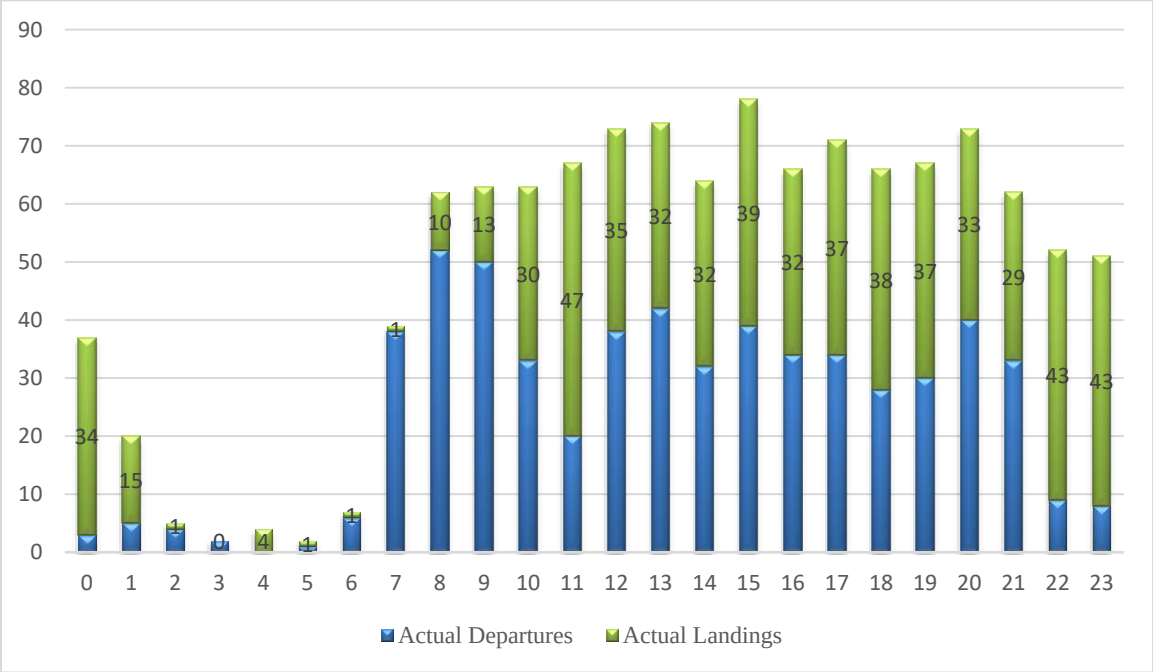

Figure 2 The Actual Departures and Landings Per Hour

2. DISCUSSION

General Issues of AMAN

2.1 Blank Time Slots of AMAN

At the beginning of the operation, a large blank time slots before landing will be reserved in AMAN timeline, as shown in Figure 3. The blue line in Figure 3 is the ETA (Estimated Time of Arrival) calculated by 4D trajectory of the ATM-AS. The yellow timeslot is the CTA (Calculated Time of Arrival) assigned by the AMAN. The left part of the Figure 3, is AMAN sequence of Runway 01, which each landing aircraft will occupy 2 mins. The right part of the Figure 3, is AMAN sequence of Runway 02, which each landing aircraft will occupy 1 min. It is obviously there are blank time slots before landing.

2.2 TTL (Time to Lose) jump

As shown in Figure 3, the first landing aircraft CSC6918 of Runway01, and the first landing aircraft CSN3767 of Runway02, when the aircrafts are guiding to the glide path, there will be a big time jump of TTL time. The amount of TTL time jumping is the length of the AMAN blank time slots.

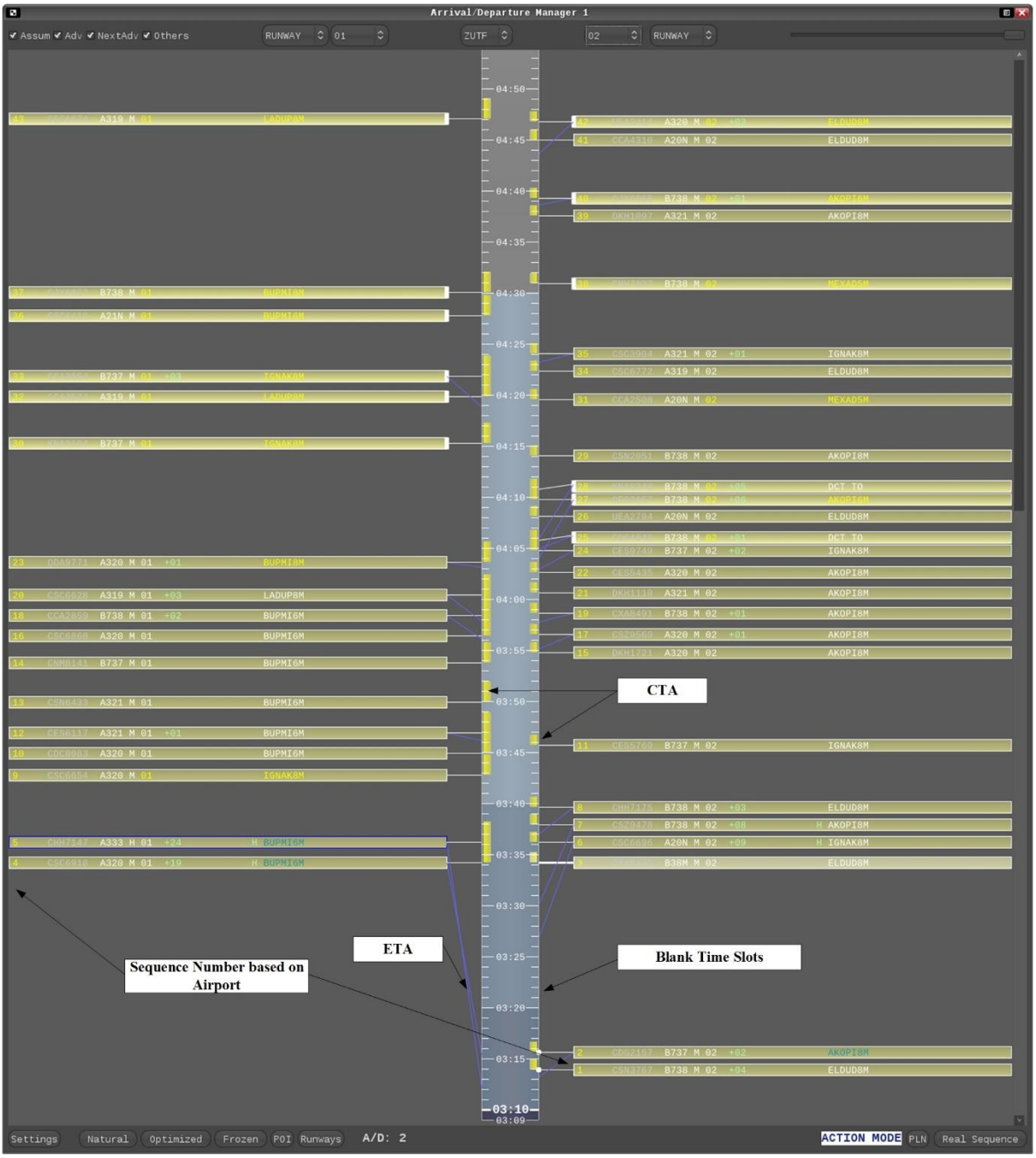

Figure 3 AMAN Timeline

Analysis of Causes

2.3 The Design of the AMAN

AMAN function of Chengdu is integrated in the ATM-AS. AMAN is based on the ETA calculated by the 4D trajectory of FDP (Flight Data Processing). Taking into account the situation of the runway, terminal area environment, based on the air proximity principle, CTA will be assigned by AMAN. The difference between CTA and ETA is TTL or TTG (Time to Gain).

2.4 The Default Final Approach

The 4D trajectory is based on the real track and the performance of the aircraft type, is constructed from route + STAR (The Standard Arrival Procedure) + final approach procedure + runway. Due to the long final approach procedures are assigned by default in ATM-AS of Chengdu, there is a large blank time slots of AMAN before landing, as shown in figure 4.

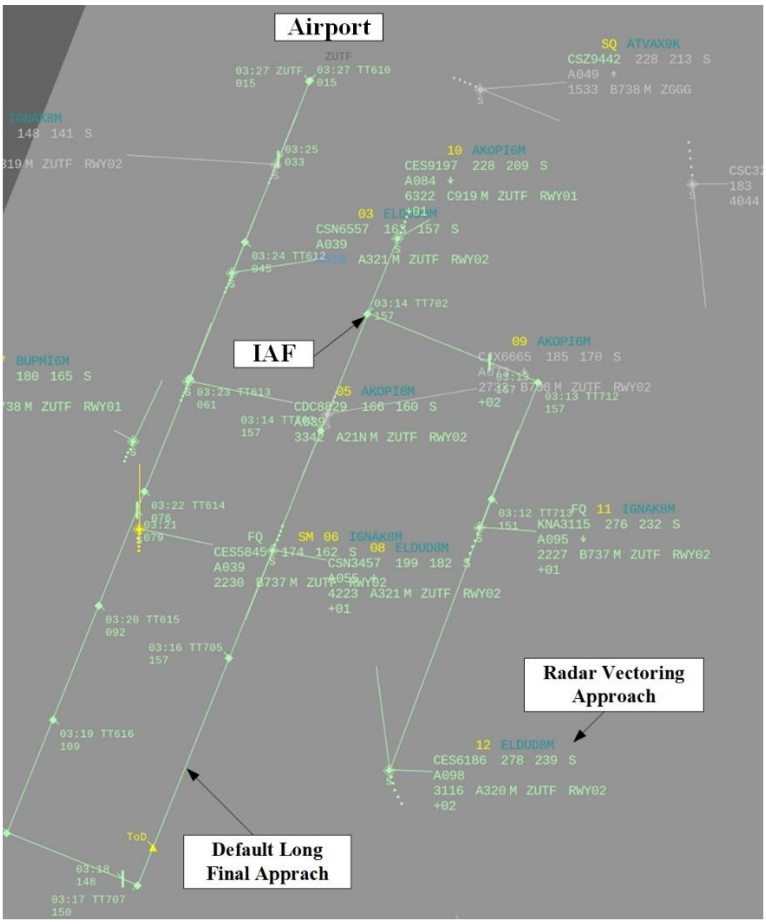

Figure 4 Default Long Final Approach of CES6186

2.5 Radar Vectoring Approach

Based on the actual navigation performance within the terminal area, STARs will match traditional procedures or PBN procedures. At the end of the STAR is the beginning of the final approach procedure. After the initial approach fixpoint (IAF), radar vectoring approach will be implemented by the controller, as shown in Figure 5.

Chengdu TMA was approved to implement Area Navigation (RNAV) 2. But there is none PBN configurations for all the STARs in ATM-AS of Chengdu, so the distance off-route is still 6nm according to the traditional procedure.

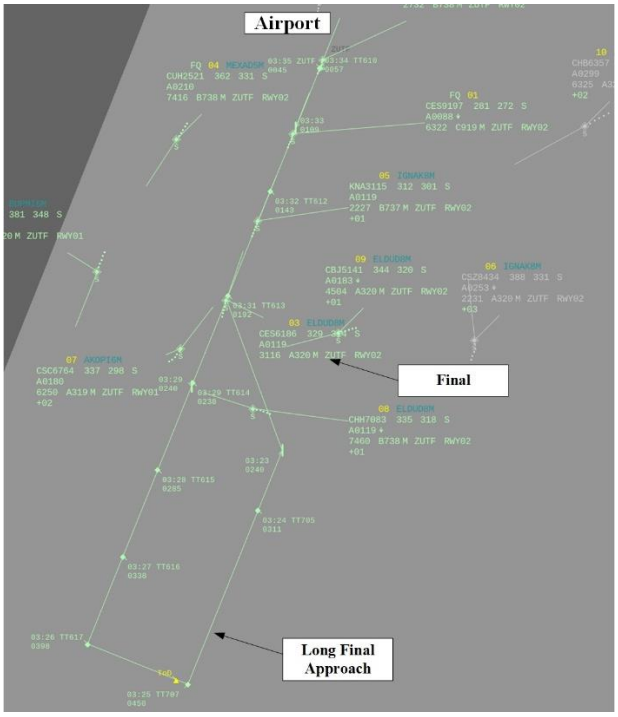

Figure 5 Radar Vectoring Approach of CES6186

Optimization Based on PBN

2.6 PBN Precision Setting

According to the approvement, PBN procedures of Tianfu airport were configured to RNAV2. If there is more than 2nm distance off-route, route deviation and direct course will be generated by ATM-AS. This kind of measurement is used to improve the accuracy of ETA. As shown in Figure 6, when the PBN deviation procedure of CBJ5115 is triggered, the direct course and the reroute proposal will be immediately generated by the ATM-AS.

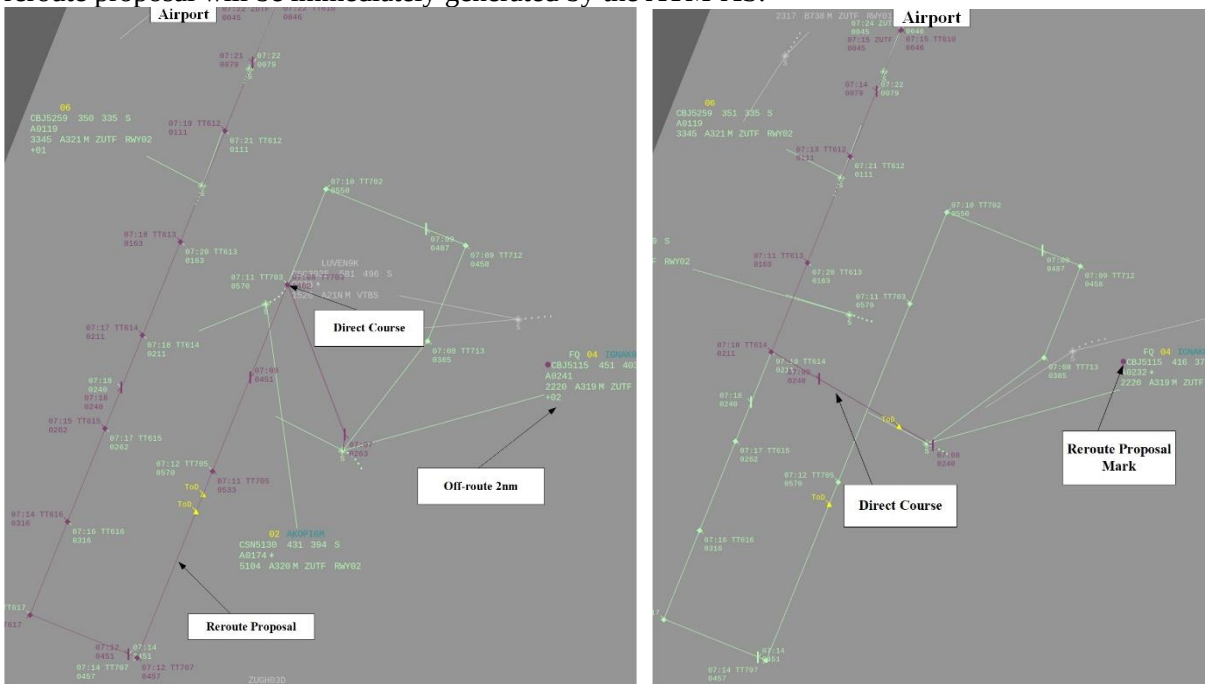

Figure 6 4D Trajectory Based on PBN

2.7 Default Short Final Approach Procedure Assignment

The Stable zone before landing of AMAN is designed to ensure the stability of landing sequencing. When the aircrafts are in the stable region, it should be considered the overall delay time cost due to the CTA changes of a single arrival aircraft. If long final approach was assigned by default, the CTA will be fixed according to the long downwind. Even if there is a large jump of ETA, even there are still idle time slots before CTA, AMAN will keep the CTA relatively stable. As shown in Figure 7, there is a big ETA jump of CHH7147, also there are still idle time slots before CHH7147, AMAN will keep the CTA stable until ILS procedure start.

In order to avoid this kind of issue, The default long final approach procedures assignment has already changed to the short one. AMAN of Chengdu is still in the experimental operation period. There is a long way to become the "brain" of area control, terminal control, tower control and flow control. The most important thing for AMAN to move forward is to give stable, credible and usable delay advice.

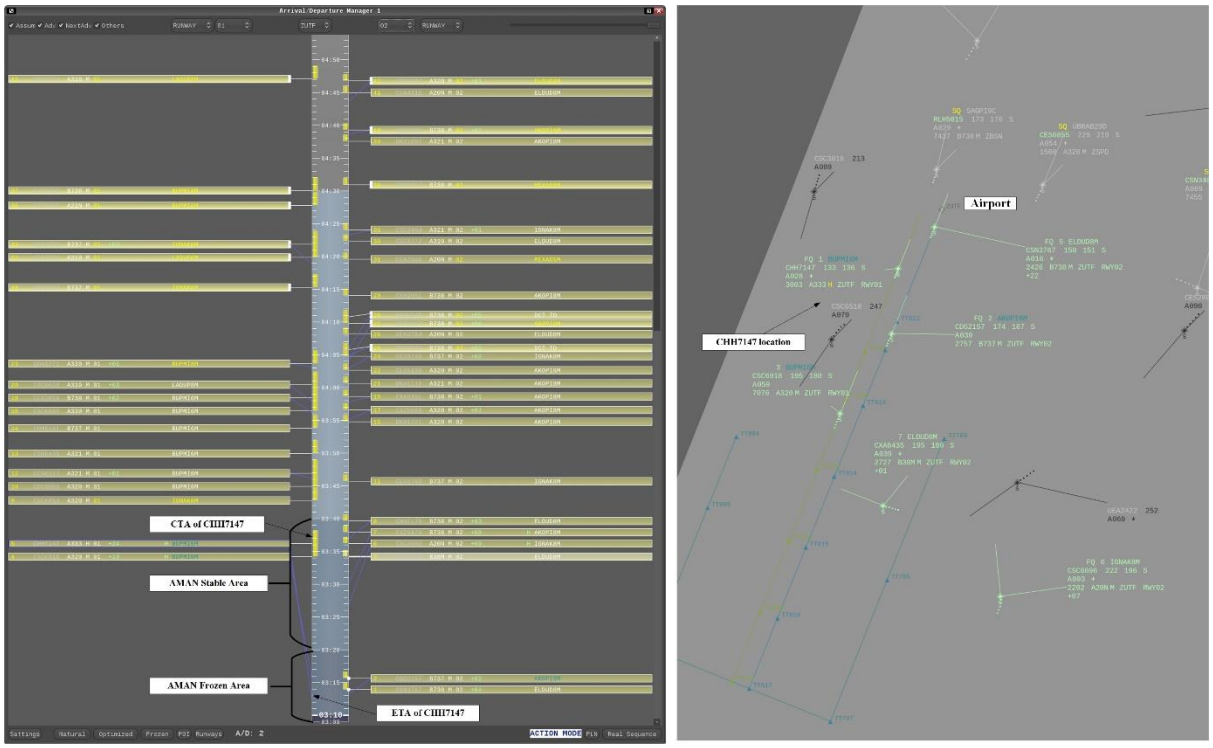

Figure 7 AMAN Stable Area

2.8 Departure Slots

Although DMAN has not yet been deployed, the flight data exchange between the ATM-AS and the tower ATM-AS has already done. When the DCL is accomplished in Tower ATM-AS, the departure time slot will insert to the AMAN landing sequencing according to the A/D ratio set. The take-off time slot is reserved to improve the accuracy of AMAN calculation. As shown in Figure 8, blue time slots are the take-off time slots occupied 5 mins. The left picture shows the AMAN sequence with landing/take-off A/D= 10:1, and the right picture shows the AMAN sequence with landing/take-off A/D= 1:1.

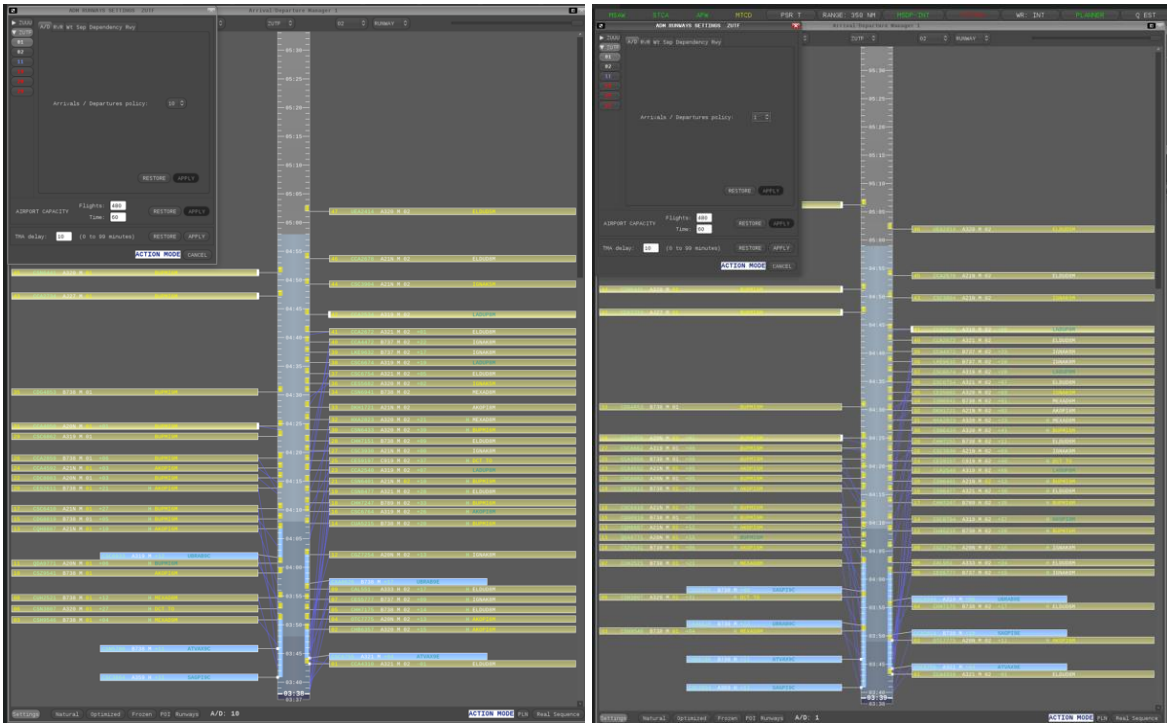

Figure 8 Departures Time Slots in AMAN

Prospect

2.9 Flexible Final Approach.

In future, AMAN will be used for ACC, TMA, Tower, and flow control to work together. Reducing circling in the air, speed regulation by ACC, long-medium-short final approach adjustment by TMA, will become common means for deployment. There will be long, medium and short modes can be set online in the ATM-AS in future. According to the flight flow, three different modes are set to achieve more accurate perception of the future situation by AMAN.

2.10 The Principle of Proximity

The principle of proximity in the air gradually evolves to the principle of proximity on the ground. At present, AMAN calculation mostly adopts the principle of air proximity. The landing runway shall be selected nearest to the gate points. The ground proximity principle needs to consider airport environmental factors such as aircraft parking stands, ground taxiways, and airline position deployments. The evolution of the air proximity principle to the ground proximity principle will inevitably lead to more complexity of AMAN considerations and make AMAN recommendations more accurate.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matter as appropriate.

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