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

INTRODUCTION OF FUNCTION DESIGN AND OPERATION MODE OF TOWER ATM AUTOMATION SYSTEM

(Presented by China)

SUMMARY

This paper introduces the functional design, operation mode, application situation, and main problems encountered in implementing a new-type Tower ATM Automation System based on overall planning and integrated construction. It also discusses the future development of the system.

1. INTRODUCTION

1.1 Traditional control towers usually have multiple sets of independent information systems, such as ATMAS, A-SMGCS, and Electronic Flight Strips (EFS), which mainly present the following problems:

1) Computer displays and keyboards make the control tower environment crowded.
2) Many pieces of equipment are isolated and redundant in function, with information scattered and lacking in communication and sharing. There is a risk of information barriers and data inconsistency, making it difficult to obtain information accurately.
3) Complex cables increase maintenance risks.
4) Redundant operations distract controllers' attention, reducing operational efficiency and safety.

1.2 To solve the above problems and realize the intelligent operation of the control tower, the construction of an integrated and new-type Tower ATM Automation System has been included in the development plan of ATM in China. CAAC has issued the "Opinions on Promoting the Construction and Application of Tower ATM Automation Systems" and the "Technical Requirements and Configuration Standards for Tower ATM Automation Systems" in 2020 that provide unified planning, design, research and development, acceptance, and usage guidance for the construction of Tower ATM Automation Systems nationwide. According to the documents, construction of Tower ATM Automation Systems can be considered comprehensively instead of separately building A-SMGCS and EFS for newly built control towers.

2. DISCUSSION

2.1 System Function Design

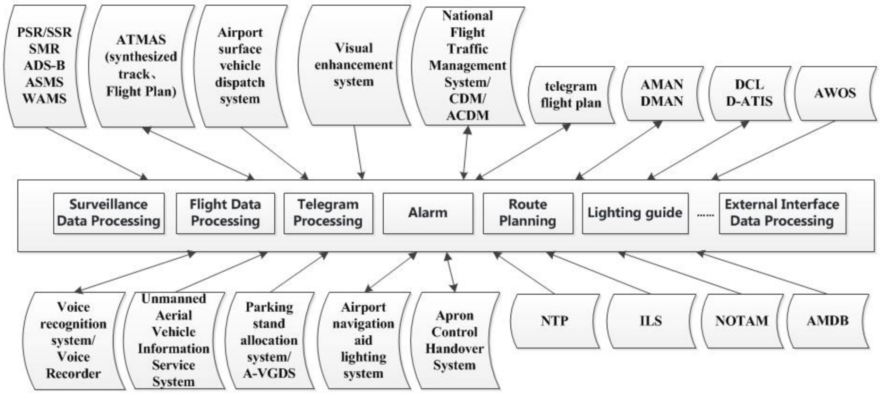

Figure 1 Tower ATM Automation System Architecture

This paper takes the Guangzhou Tower ATM Automation System as an example. The system mainly integrates ATMAS, A-SMGCS, EFS, D-ATIS and other systems. It integrates external information such as weather, aeronautical information, parking stands, flow and instrument landing.

2.1.1 Primary Function

Primary functions refer to the fundamental core functions within the system, including surveillance data processing, flight data processing, EFS, alerting, route planning, and lighting guidance and control. This part of the system is relatively mature, and a brief supplementary explanation is as follows:

1) The system can process video-based data as a supplement to target monitoring and positioning and enhance situational awareness.

2) The EFS and the radar label maintain synchronization and linkage. Operating EFS or the radar label can complete the command and handover of the flight.

3) The system provides a rich set of alert functions based on surveillance data, control intentions, flight status, runway operation modes, etc. There are a total of 48 types of alerts designed in the system.

4) The system has automatic and manual route planning and conflict resolution functions, which can meet the ICAO A-SMGCS IV taxi guidance by interoperating with the navigational light monitoring system.

2.1.2 Enhanced Processing Function

The processing function refers to receiving external data, integrating and processing it within the system, which can provide more enriched featured applications.

1) Electronic Service of National Aeronautical Information

- The system has the functions of data parse, import and export of the National Aeronautical Information Publication (NAIP) data from the official CD, reducing repeated input and verification work in multiple systems.
- The system can receive and process the navigation notification information.
- The system reserves interfaces that can receive and process static navigation information from Aeronautical Information System in the future, such as flight airway, SID/STAR, etc.

2) Operational Conflict Prevention Based on Voice Recognition

- The system can processes data from the voice recognition system, including flight numbers, runway numbers, command intentions, taxiing paths, etc. It will alert the controller when the obtained information conflicts with the current data in system, such as target states, or target movement trends.
- The system can output EFS information and fusion radar track data to the voice recognition system.
- The system can receive alert information provided by the voice recognition system and display it on the human-machine interface.

3) Airport Digital Map Application Based on AMDB

- The system integrates the AMDB interface, which is used for digital system map invocation and flight route planning.
- The system can obtain confirmed airport temporary construction plan information through the AMDB interface and display the construction areas graphically at relevant positions. When an aircraft is about to enter an active construction area, the system can give an alert.

4) Digital Control Based on Narrowband and Broadband Data Links

- The system interacts with the digital air traffic control system. It can complete digital clearances and broadcasting, and issue digital control instructions and information based on ACARS and CPDLC data links.
- The system reserves a broadband data link interface, based on network technologies such as 5G AeroMACS, to transmit map change information, taxiing paths, target-related alarm information, control command information, and surface element status data, etc. This interface realizes the intelligent interconnection of "aircraft -vehicle-air traffic controller", building a unified operational scene with cooperative operation, and provides visual and efficient taxi guidance.

5) Decision Support Based on AMAN/DMAN/AWOS and Flow Data

The system can receive relevant information and carry out multi-dimensional calculations to provide decision support for runway operation modes, traffic diversions, dynamic optimization allocation of runways/SIDs, controlled/uncontrolled flight launch and departure sequencing, takeoff sequencing, taxi route and time optimization calculations, flight delay analysis, and so on.

2.1.3 Auxiliary Information Display Function

The auxiliary information display function refers to the system receiving external information and displaying it to air traffic controllers.

1) The system can pop up a window to display the designated camera or designated area video for monitoring. It can also display alarm information (such as area intrusion, line crossing, etc.) provided by the visual enhancement system.

2) By interacting with the data centre/cloud platform, the system can perform multi-angle statistical analysis for situation monitoring, such as traffic distribution, operational load, delay rate, landing and takeoff ratio, and flight duration between two points within a set period.

3) The system can receive the UAV(Unmanned Aerial Vehicle) plan status, parking stand, instrument landing system status and other information for display.

2.2 System Operation Mode

2.2.1 The system can synchronize and transfer flight data with the ATMAS based on the "CAAC ATMAS Data Exchange Specification (Trial)" issued by the ATMB of CAAC in 2022. The system can be configured into associated or independent operation mode based on whether it is interconnected with ATMAS to achieve information exchange. The characteristics of the two operating modes are shown in Table 1.

Table1:Comparison of features between associated operation mode and independent operation mode

Operation Mode	Associated Operation Mode	Independent Operation Mode
Application Scenarios	Normal data communication link with the ATMAS	Disconnected data communication link with the ATMAS
Flight data and environmental data	Synchronized with the ATMAS	Unable to synchronize with the ATMAS, independently completing flight planning and flight telegram processing
Receiving ATMAS integrated track	Serve as a source of air surveillance and perform relevant consistency checks	Unable to obtain ATMAS integrated track, equipped with independent and complete surveillance data processing and auto-correlation functions

Secondary code assignment	Request assignment from an external system	Independently completed
Runway assignment	Receive external system assignment or automatically assign by this system	Independently completed
Arrival/departure procedures	Receive external system assignment or automatically assign by this system	Independently completed
Transmission of takeoff and landing telegrams	Issued by external systems or issued by this system	Independent issuance
Warning messages	The system calculates warnings and can receive warning messages from the ATMAS	Calculating warnings independently
Handover method	Screen handover	Phone handover

2.3 Operation Situation and Main Problems Encountered

2.3.1 Thirteen operating sites in China have applied Tower ATM Automation Systems, including Chengdu, Guiyang, Zhanjiang, and others. Additionally, there are 13 sites where the system is under construction, such as Guangzhou, Shenzhen, Fuzhou, and etc.

2.3.2 The new-type Tower ATM Automation System offers services covering the entire control tower business process. The system is fully integrated and unified displayed. It has improved the working environment in the control tower, enhanced electronic and intelligent operations, and enabled more efficient and accurate information acquisition. It has also reduced redundant operations and voice communications, effectively lowering the workload of air traffic controllers and the probability of operational errors. The system provides strong support for ensuring safe, efficient, and intelligent operations of the control tower all day long.

2.3.3 During the system construction process, the main problems encountered are as follows:

1) Due to the characteristics of the control tower business, the system needs to interconnect with a large number of external systems. Thirty-eight types of external interfaces have been sorted out on-site in Guangzhou. A data exchange platform should be planned and constructed to improve the efficiency and convenience of data exchange. At the same time, the system should consider network security protection.

2) Data exchange involves interface upgrades of ATMAS. Due to differences in understanding standards and implementation methods by different manufacturers, the system should improve the processing of unconventional operations, such as early handover and secondary coordination, to increase the success rate of handovers. Additionally, manufacturers should fully negotiate and establish a unified consensus, such as unified mandatory field processing.

3) As a critical system, there are many interactions with external systems and complex architectures. Therefore, it is necessary to enhance the design of system reliability. The system should isolate intelligent auxiliary functions from the primary business for fault tolerance and prioritize to ensure the stability and reliability of the primary function.

2.4 Future Prospects

With the deepening of system application and the continuous development of technology, in the future, Tower ATM Automation System can be more intelligent in the following aspects:

1) Strengthen the linkage with the video enhancement system and use the technology provided by the video enhancement system, such as video stitching, intelligent recognition, and automatic tracking, to enhance control situational awareness and runway intrusion detection.

2) In terms of voice recognition technology development, the voice recognition rate could be

improved. The voice could be segmented accurately, distinguished between different roles, and the intentions of air traffic controllers should be combined to provide more diverse alarms.

3) The integration of AMAN (Arrival Management), DMAN (Departure Management), and SMAN (Surface Management) can provide more refined taxi route planning, runway queue management, and accurate taxi time predictions, improving operational efficiency.

4) The widespread application of AMDB (Aeronautical Mobile Data Network) combined with 5G AeroMACS (Aeronautical Mobile Airport Communications System) and Beidou vehicle positioning can realize digital construction plan information of non-suspend flight operation, as well as visual and efficient taxi guidance to achieve coordinated interconnection and consistent situational awareness among control tower, airport, and airlines.

3 ACTION BY THE MEETING

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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