International Civil Aviation Organization

The Second Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (ATMASTF/2)

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Agenda Item 4: ATM Automation System Implementation by States

4.4 Integration and Interoperability with External Systems
Including: ATFM, AMAN/DMAN/SMAN, UTM, A-CDM, A-SMGCS etc.

THE IMPLEMENT OF A-SMGCS IV OPERATION IN DAXING INTERNATIONAL AIRPORT

(Presented by China)

SUMMARY

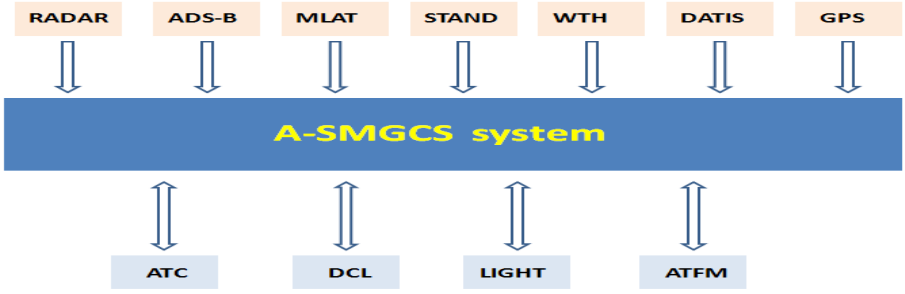
The Daxing A-SMGCS system was put into operation in September 2019. It provides the airport with light control and guidance services twenty-four hours a day. The system has surveillance, alert, routing and guidance functions. This paper will explain these functions in detail.

1. SYSTEM INTRODUCTION

1.1 The functions of the Daxing A-SMGCS system can meet the level 4 operation standard which is defined in the "Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (ICAO 9830)". It can realize the surveillance, alert, routing and guidance functions for ground targets in airport.

1.2 The system architecture utilizes the A/B/C network design, while the core function servers are redundantly configured. The scale of the system is 39 positions, and the position types include ground position, tower position, clearance position, supervisor position, coordination position, technical position and remote situation position.

1.3 The system accesses and processes surveillance data, flight plan data, weather information, gate data and D-ATIS data, in order to exchange data with other external systems (such as ATC system, light system, DCL system and flow management system). The highly integrated HMI provides controllers with electronic strip processing, alert, aircraft guidance and various airport information display functions.



2 SURVEILLANCE AND ALERT FUNCTION

2.1 The surveillance and alert function lays the key foundation for A-SMGCS system's level 4 operation. Currently, Daxing Airport has opened 4 runways, and the system accesses 3 surface movement radars and 1 multilateration system (including 44 stations) in order to track aircraft and provide full coverage of the important areas of the aerodrome surface.

2.2 The surveillance data processing adopts Kalman filter algorithm and variable fusion window. According to target position and optimization calculation, the system takes the weight of each fusion factor into account, and generates a more accurate system track.

2.3 Based on surveillance data processing, the system implements these alert functions, including runway infringement alert, target loss alert, restricted area infringement alert, over-speeding alert and taxiway conflict alert, etc. The above functions can provide the controllers with a reference and basis about target monitoring and conflict resolution.

3. ROUTIONG FUNCTION

Working mode

3.1 According to routing definition in ICAO 9830 manual and operational requirements, there are three routing modes in system:

- **Automatic routing:** The system uses off-line data (such as key points, taxiways, and restrictions) to plan the routing results according to the optimal path principle.
- **Default routing:** The system plans the specified routing result according to the pre-defined taxi route.
- **Manual routing:** The system plans the routing results according to route points and taxiways which are selected manually.

3.2 At the initial stage of operation, the system mainly uses manual routing and default routing methods, which both require all routing data to be entered manually. With the continuous improvement of system function and operational rules, the success rate of automatic routing has increased to more than 95%. Therefore, automatic routing has now replaced manual routing and default routing. This section will focus on the introduction about automatic routing.

Trigger condition

3.3 For arrival flights, automatic routing will be performed when the flight is landing or, the stand or crossway is changed.

3.4 For departure flights, automatic routing will be performed when the flight is pushed back or, the runway, entrance or crossway is changed.

Basic data and algorithms

3.5 The system calculates routing results based on the following data:

- **Routing key points:** It is the critical data in routing function, including ID, name, geographical coordinate, adjacent point, etc., which is used for the calculation of shortest path and final routing result.

- **Airport elements:** It is the auxiliary data in the routing function, including runway, exit, entrance, taxiway, stand, crossway and so on.

- **Restriction information:** It ensures that the routing results meet the airport operating rules, including restricted areas, taxiway directions, restrictions, deicing information, etc.

- **Default route:** It is used for the default routing of arrival and departure flight between runway and stand.

3.6 In the automatic routing function, the Dijkstra algorithm is used for the calculation of route between runway and stand. According to the shortest path principle and operational conditions (such as restricted areas, taxiway directions, and restrictions), the system calculates the optimal route that meets the requirements.

Display mode

3.7 Currently, the system plans all the routes of flights, then displays them in segments and refreshes them in real time. Based on the transfer point, each position only displays routing information of its own control area, so as to reduce the interference caused by the overwhelmed information on screen.

4. LIGHT GUIDANCE FUNCTION

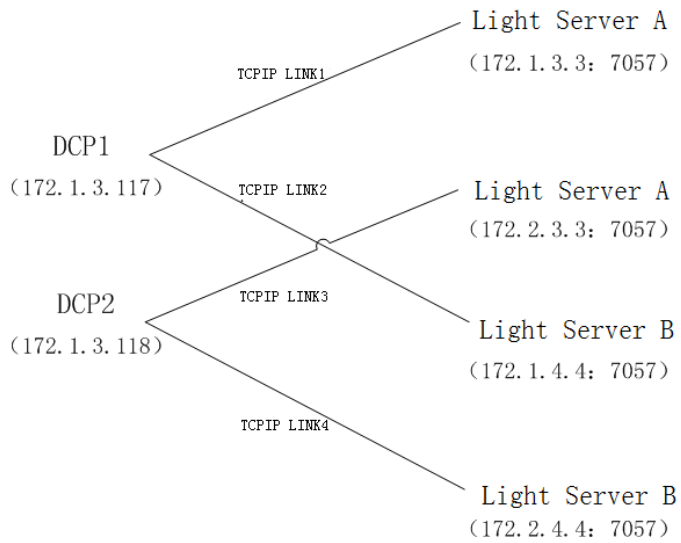
Basic data

4.1 Daxing A-SMGCS system can control taxiway centre line lights and stop-bar lights, and the control unit is the light segment (the light segment consists of 1 to 7 single lights). At present, there are about 22,000 taxiway centre line lights and stop-bar lights in Daxing Airport, which are divided into more than 4000 light segments.

4.2 The names, positions and relationships of all light segments shall be defined in offline data. In addition, the VSP parameters and airport elements used in the lighting guidance calculation should also be defined.

Interaction with the lighting system

4.3 The A-SMGCS system exchanges messages with the lighting system through TCP/IP, and establishes four TCP/IP links between the A-SMGCS DCP server and the lighting server. For each TCP/IP link, the light server is the server and the DCP is the client. The client establishes a connection with the server through the IP address and port number of the server.



4.4 The exchange messages are in XML format, including heartbeat message, control permission message, request status message, light status message, and light control message.

The basic algorithm

4.5 Trigger conditions for light guidance: For arrival flight, when it has been routed, and leaves the runway; for departure flight, when it has been routed, and starts taxiing.

4.6 After receiving the routing result of a flight, the light guidance function will pass it into light segments. Then, it will compare the current position of the track calculated by the surveillance function with the position of each light segment.

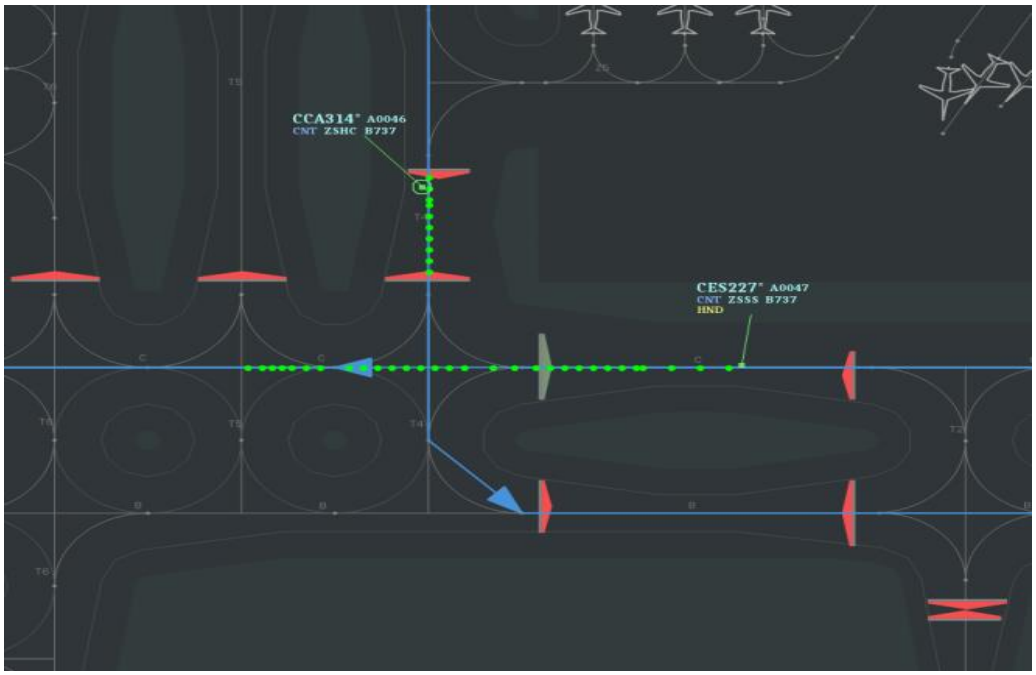
4.7 When the position difference is within a certain range, the guide lights ahead of the track will turn on automatically. The length of the guide light can be configured offline (GCP_LEADON_LENGTH). If there is no conflict, the stop-bar lights within the default length is off.

4.8 When the target passes, the guide lights behind the track will be automatically closed and the stop-bar lights will be automatically turned on.

Conflict resolution

4.9 The system determines conflicts according to whether there are ground targets, opened taxi center lights， and opened stop-bar lights in front of the aircraft.

4.10 When there is a conflict between different aircraft at the intersection, the system will automatically control the stop-bar lights at the intersection. During the period of the system's release-block operation, the first arriving aircraft will be released first. In the figure below, there is a conflict between target A (CES227) and target B (CCA314) at the intersection, and target A will arrive first. The stop-bar lights in front of target A will be turned off, and the stop-bar lights in front of target B will be turned on, therefore target A is released first.



4.11 The system also allows manual modification of the release-block sequence. In addition, the system can also handle and generate alerts for failure lights, running stop-star lights, blind areas of surveillance data, and deviation from routes.

5. SUNMMARY OF OPERATION EXPERIENCE

5.1 The accuracy of surveillance data and light delay time are the key elements to achieve the level 4 operation of A-SMGCS system, which need to be paid attention to in system construction and testing.

5.2 At the beginning of the system operation, there was a delay problem in the lighting system of Daxing Airport, and the delay time reached 8 seconds. Later, the lighting manufacturer optimized the system processing and removed useless interactive information (such as light intensity).The light delay has been reduced to 3 seconds to meet the operational requirements.

5.3 A large amount of offline data is the basis for routing and lighting guidance function. Therefore, it is recommended that a professional team modifies and maintains the data.

5.4 During the design of the routing algorithm, the operating rules of the airport and the shortest path principle should be fully considered, in order to obtain the routing results that meet the requirements. Conflict resolution can be achieved in light guidance function.

6. NEXT STEP

6.1 The main purpose of this paper is to share the level 4 operation experience of Daxing A-SMGCS system in the past two years, so as to provide the reference for other site construction and operation.

6.2 In the next step, based on the successful experience of Daxing Airport, A-SMGCS level 4 operation function will be promoted in other airports in China.

6.3 In addition, CAAC will compile domestic standards for A-SMGCS level 4 operation. In the future, technical documents will be submitted to ICAO for reference and discussed by the expert Committee.

7. ACTION BY THE MEETING

7.1 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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