

*International Civil Aviation Organization*



ICAO

**Twenty Fifth Meeting of the Communications/  
Navigation and Surveillance Sub-group (CNS SG/25) of  
APANPIRG**

Video Tele-Conference, 18 – 22 October 2021

**Agenda Item 12:** Discuss and share experience and application of new technologies, including big data analysis, artificial intelligence, Digital Tower, counter UAS detection and identification system, UTM, etc.

**THE IMPLEMENTATION OF A-SMGCS LEVEL IV OPERATION  
IN BEIJING DAXING INTERNATIONAL AIRPORT**

(Presented by China)

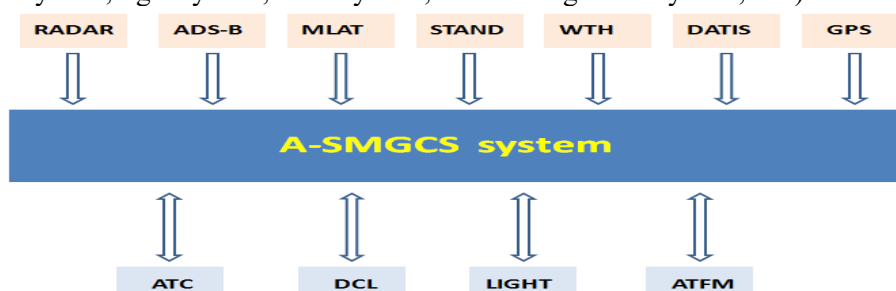
**SUMMARY**

The Beijing Daxing A-SMGCS level IV system provides the airport with light control and guidance services twenty-four hours a day from September 2019. The system has realized the surveillance, alert, routing and guidance functions.

**1. INTRODUCTION**

1.1 The Beijing Daxing A-SMGCS system was put into operation in September 2019. The Light control and guidance service is available 24x7. The A-SMGCS satisfies the level IV operation standard which is defined in *Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (ICAO 9830)*. The surveillance, alert, routing and guidance functions for ground targets in the airport are as well supported.

1.2 The system architecture utilizes the A/B/C network design, while the core function servers are redundantly configured. Surveillance data, flight plan data, weather information, gate data and D-ATIS data are collected by the A-SMGCS, in order to achieve data exchanging with other external systems (ATC system, light system, DCL system, flow management system, etc.).



**2. SYSTEM FUNCTIONS**

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**2.1 Surveillance and Alert Function**

2.1.1 The surveillance and alert function lay the key foundation for A-SMGCS level IV operation. Currently, Beijing 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 and provide fully coverage of aircrafts in important areas of the aerodrome surface.

2.1.2 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.

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

**2.2 Routing Function****2.2.1 Working mode**

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

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

At the initial stage, the system mainly uses manual routing and default routing modes, which 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 replaced manual routing and default routing.

**2.2.2 Trigger condition**

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

For departure flights, automatic routing will be performed when the flight pushback or the runway, entrance.

**2.2.3 Display mode**

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

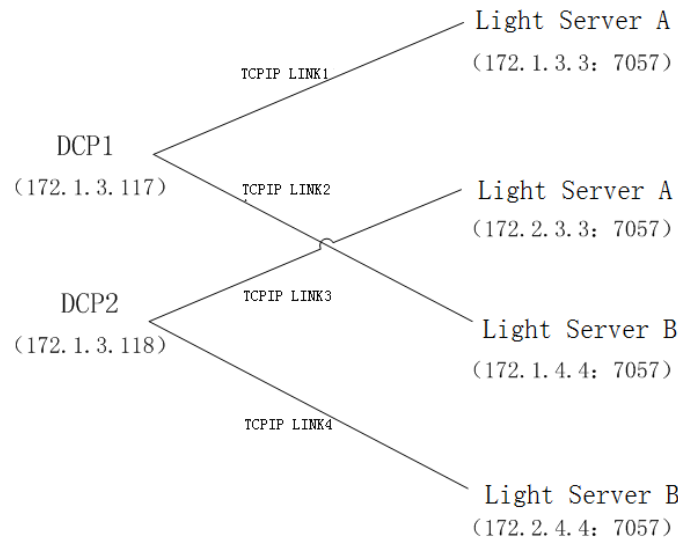
**2.3 Guidance Function****2.3.1 Brief introduction**

Beijing Daxing A-SMGCS can control taxiway centerline lights and stop bar lights. The control unit is the light segment (the light segment consists of 1 to 7 single lights). Under the operation condition at present, about 22,000 taxiway centerline lights and stop bar lights in Beijing Daxing Airport are divided into more than 4000 light segments.

After receiving the routing result of a flight, the light guidance function will compare the current position of the track calculated by the surveillance function with the position of each light segment. When the position difference is within a threshold, the guide lights ahead of the track will turn on automatically.

### 2.3.2 Interaction with the lighting system

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



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

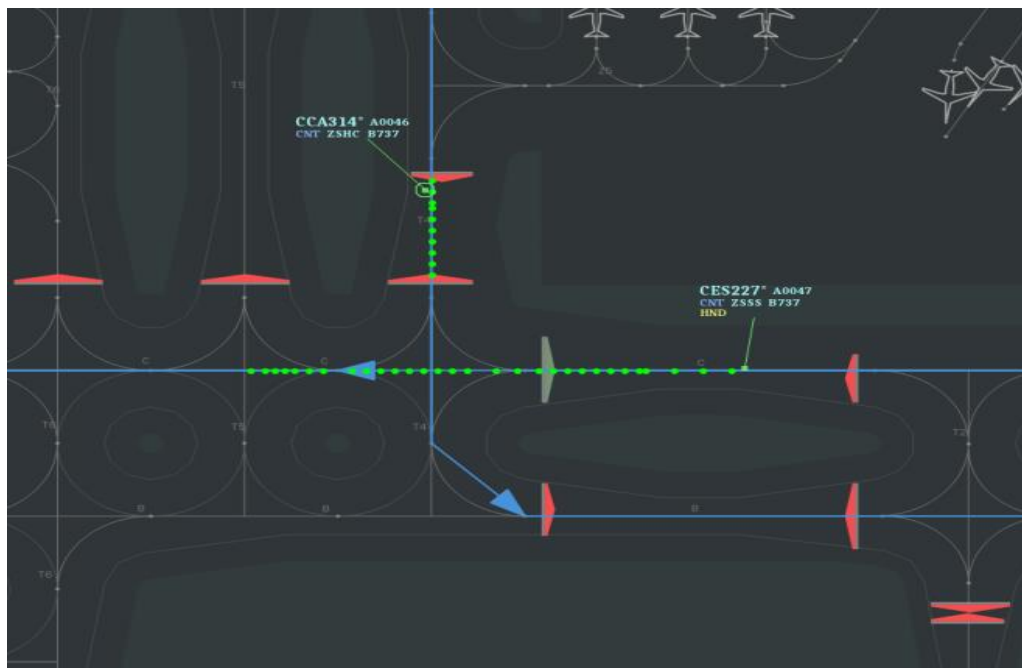
### 2.3.3 Conflict resolution

The system determines conflicts according to whether there are ground targets, opened taxi center lights and open stop bar lights confronted with the aircraft.

When there is a conflict between different aircrafts at the intersection, the system will automatically control the stop bar lights at the intersection. During 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 arrives 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 lit on to release target A first.

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**3. SUMMARY OF OPERATION EXPERIENCE**

3.1 The accuracy of surveillance data and light delay time are of vital importance to achieve the level IV operation of A-SMGCS, which need to be paid extra attention to in system construction and testing.

3.2 At the beginning of the system operation, a delay occurred in the lighting system of Beijing Daxing Airport, and the delay time has reached up to 8 seconds. After the lighting manufacturer optimized the system processing and removed less important information (such as light intensity), the light delay has been controlled to less than 3 seconds to meet the operational requirements.

3.3 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.

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

**4. NEXT STEP**

4.1 The main purpose of this paper is to share the level IV operation experience of Beijing Daxing A-SMGCS in the past two years, to provide the reference for other site construction and operation.

4.2 In the next stage, based on the successful experience of Beijing Daxing Airport, A-SMGCS level IV operation function will be promoted in other airports in China.

4.3 In addition, CAAC will compile domestic standards for A-SMGCS level IV operation. Technical documents will be submitted to ICAO for reference and further discussion.

**5. ACTION BY THE MEETING**

5.1 The meeting is invited to:

- a) note the information contained in this paper.
- b) discuss any relevant matters as appropriate.

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