International Civil Aviation Organization

SEVENTH MEETING OF THE ASIA/PACIFIC AIR TRAFFIC MANAGEMENT AUTOMATION SYSTEM TASK FORCE (ATMAS TF/7)

Bangkok, Thailand 2-4 June 2026

Agenda Item 4: ATM Automation System Implementation Experience by States

4.6. Development of New Technology

OPERATION EXPERIENCE SHARING OF LIGHT GUIDANCE FUNCTION OF A-SMGCS

(Presented by China)

SUMMARY

This paper introduces the control logic and operation experience of A-SMGCS lighting guidance function. By detecting aircraft positions in real time and implementing light regulation, it ensures safe and efficient airport surface operation.

1. INTRODUCTION

1.1 At ATMAS TF/3 in 2022, China presented an Information paper titled Practice Sharing of A-SMGCS Lighting Guidance Application in China, which introduced the construction status, application effectiveness, and technical recommendations of the four-level Advanced Surface Movement Guidance and Control System (A-SMGCS) of China's Daxing Airport implements.

1.2 Based on practical operational demands, the A-SMGCS has optimized lighting control logic and system communication mechanisms. After the upgrades, the system maintains stable and reliable operation, supporting high-density aircraft taxi scheduling and fulfilling the requirements for precise taxi guidance in low-visibility environments at Beijing Daxing International Airport.

2. DISCUSSION

Hardware Architecture

2.1 The primary and standby Data Communication Processing (DCP) servers of the A-SMGCS system communicate with the primary and standby light servers of the Airfield Ground Lighting system via network devices such as switches and routers in a cross-interconnection mode. The specific physical connection is illustrated in Figure 1.

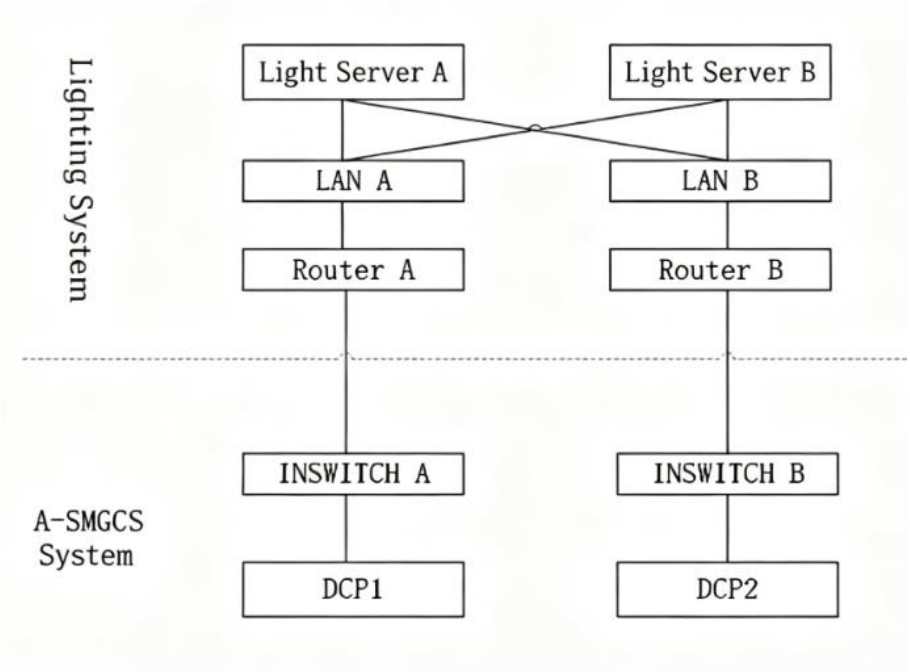

Figure1. System Hardware Architecture

Transfer Mechanism

2.2 Airfield Ground Lighting at Beijing Daxing International Airport is divided into 6 control zones: the North Runway Zone (AREA_A1), East Runway Zone (AREA_A2), West Runway 1 Zone (AREA_A3), West Runway 2 Zone (AREA_A4), Stop Bar Light Zone (AREA_B), and Taxiway Centerline Light Zone (AREA_C). The A-SMGCS system can independently request control authority for each control zone.

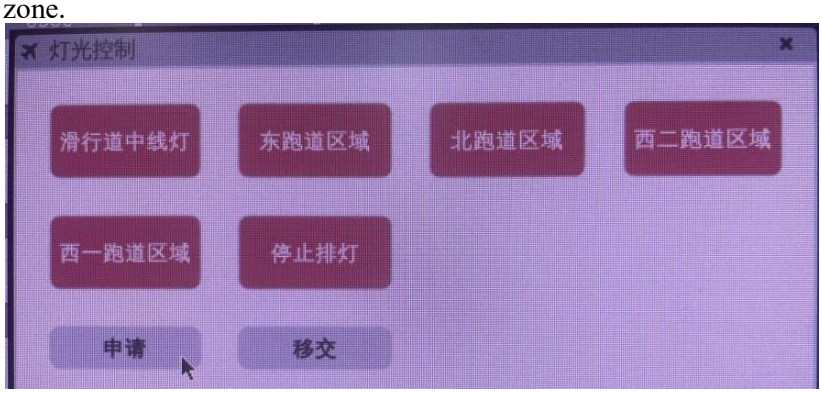

Figure2. Application for Lighting Control Authority

2.3 After the controller selects a control zone and clicks the Apply button in the A-SMGCS lighting control window, the system sends a control authority request to the Airfield Ground Lighting system. Once the lighting system operator confirms the transfer, the A-SMGCS obtains control authority for the selected zone, and the zone background color changes from red to green.

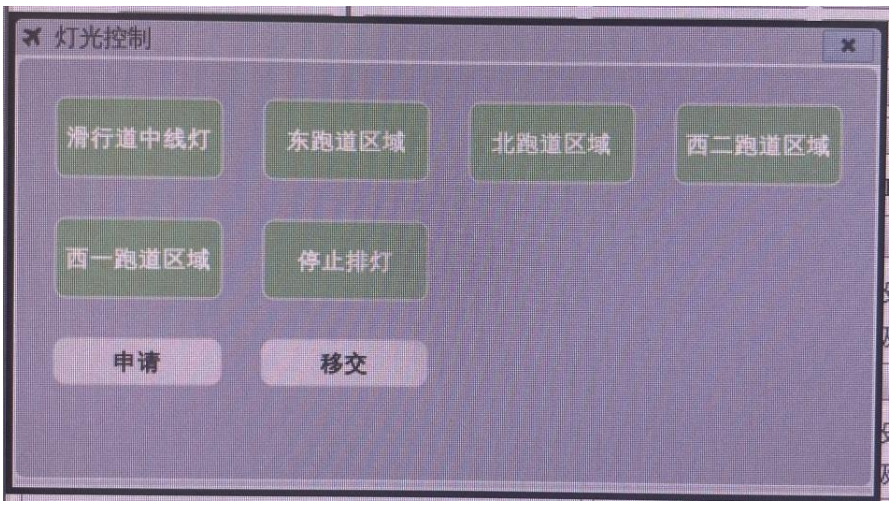

Figure 3. Acquisition of Lighting Control Authority

2.4 Airfield Ground Lighting system adopts a six-zone divided management and control mode for two purposes:

a) Independent operation and maintenance by zone: When a lighting fault occurs in a single zone, the A-SMGCS will release its control authority, without affecting normal taxi guidance in other zones.

b) Lightweight communication interaction: Lighting control messages are transmitted separately to each zone, reducing communication load and improving overall system operational stability.

Operational Performance

2.5 Daxing International Airport is equipped with approximately 22,000 individual lights. The A-SMGCS system divides these lights into 2312 lighting segments, which serve as the minimum control unit for on-off operations. All feedback information from the lighting management system is issued on a per-lighting-segment basis. Each status message contains the name of the lighting segment, on/off state, brightness level, number of constituent individual lights, and fault information.

2.6 The operational overview of the A-SMGCS lighting guidance function over the past five years is presented in Table 1. The airport's annual aircraft movements have increased year by year, rising from 211,400 movements in 2021 to 345,800 movements in 2025, while the lighting system has remained stable in operation.

Year	Total Lighting Issues	Flight Movements (10,000 Flights)
2021	132	21.14
2022	93	10.67
2023	172	29.32
2024	220	32.52
2025	210	34.58

Table1.Five-Year Operation Data of A-SMGCS Lighting Guidance Function

2.7 The lighting-related issues of the A-SMGCS system over the past five years are shown in Table 2. The system has remained stable, with no large-scale coordinated failures occurring over the past three years. The proportion of individual lamp faults increased from 23% in 2021 to 43% in 2025.

Fault Type	2021	2022	2023	2024	2025
Abnormal On/Off	46	40	53	48	79
Individual Lamp Abnormality	31	19	82	87	81
Delayed or Failed On/Off	45	30	36	71	31
Status Abnormality	10	4	1	14	19
Large-Scale Abnormality	3	2	0	0	0

Table2.Variation of A-SMGCS Lighting Fault Types

Experience in preventing runway incursions

2.8 **Stop Bar Lights:** To ensure operational safety, runway access authorization requires positive manual validation by the air traffic controller. When an aircraft holds at the runway holding position, the stop bar lights shall not be automatically extinguished. Instead, upon the controller transitioning the flight status to 'LIN' on the Electronic Flight Strip, the system shall trigger the command to turn off the stop bar.

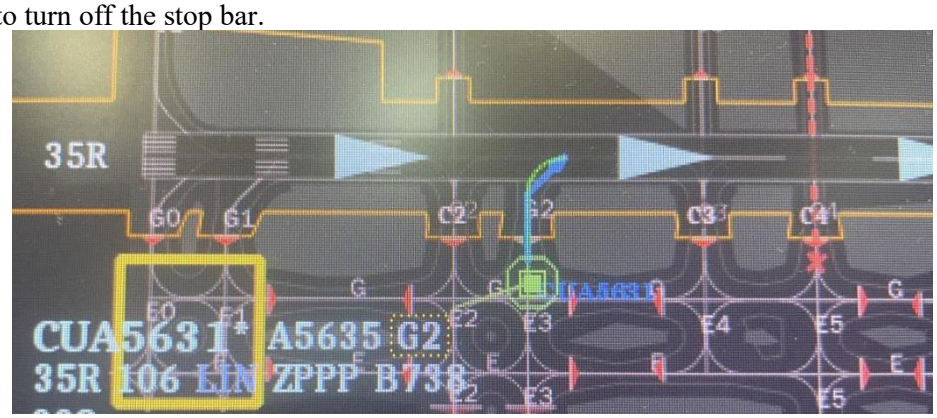

Figure4. Stop Bar Lights Off ahead of Flight CUA5631

2.9 **Runway Crossing Stop Bars:** When an aircraft holds at a runway crossing holding position, the A-SMGCS system shall not automatically deactivate the runway crossing stop bar. The deactivation command to extinguish the stop bar shall only be triggered after the controller manually updates the flight status to 'CRI' on the Electronic Flight Strip .

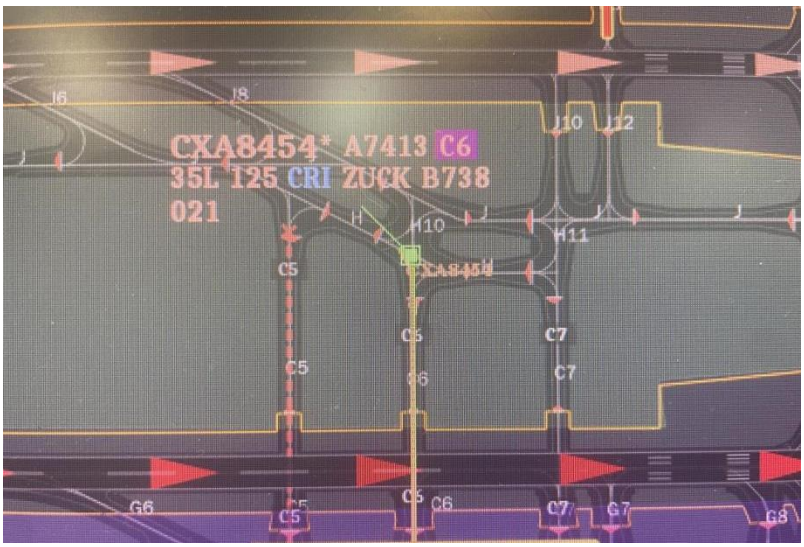

Figure5. Stop Bar Lights Off ahead of Flight CXA8454

2.10 Interlocking logic between the Electronic Flight Strip and Stop Bar Lights:

a) **For departing flights**: Upon issuing a departure clearance (DEP) to an aircraft on the runway, the system automatically locks the runway entrance for subsequent traffic. The Electronic Flight Strip (EFS) restricts controllers from executing the LIN command for waiting aircraft, while the physical stop bar lights remain illuminated (RED). Simultaneously, the runway entrance identifier on the EFS flashes a Red background with a pop-up alert: "Departure command already issued for another aircraft."

Figure6. Red Background Indication for Entry Taxiway of CSN3120

b) **For runway crossing flights**: Once a departure clearance (DEP) is issued, the system automatically locks all runway crossings. EFS restricts controllers from executing the CRI command, and the corresponding runway crossing stop bars remain illuminated (RED). Simultaneously, the crossing identifier on the EFS displays a Red background with a pop-up alert: *"Departure command already issued for another aircraft."* This interlocking state automatically releases only after the departing aircraft has cleared the respective runway crossing point."

Figure7. Red Background Indication for Crossing Taxiway of CES6110

c) **For arriving flights**: When an arriving flight is **within 5 km of the runway threshold**, the system automatically locks all runway entrances of the corresponding runway. The EFS restricts controllers from executing any command to permit departing flights to enter the runway, and the corresponding stop bar lights remain illuminated (RED). This interlocking state automatically releases only after the arriving aircraft has cleared the respective runway entrance.

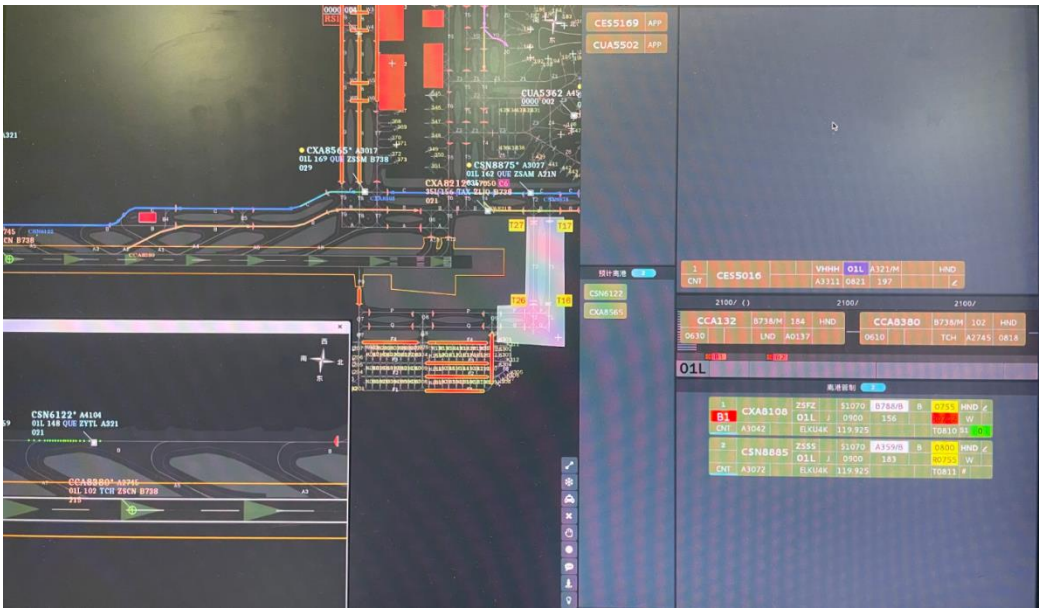

Figure8. Arrival-Departure Conflict Detection

Experience in Airfield Ground Lighting

2.11 Experience in Handling Lighting Control Delay Issues: During the initial commissioning phase of the airport, a critical 8-second control latency issue occurred in specific airfield zones, which was successfully mitigated down to a stable 2 seconds through a dual-pronged optimization strategy: first, by refining the AGL server's processing algorithms and core parameters to streamline workflows and boost execution efficiency; and second, by transitioning the control architecture from individual light addressing (ILCMS) to centralized block-segment group management, which drastically reduced command transmission volume and alleviated system network overhead.

2.12 Inconsistency between A-SMGCS displayed lighting status and actual status: The A-SMGCS lighting processing server (GCP) used to transmit thousands of lighting status messages to

HMI one by one after receiving feedback data from the lighting system. Partial data packet loss consequently caused mismatches between on-screen display and on-site actual status. This issue has been resolved by adopting unified batch data push to HMI.

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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