International Civil Aviation Organization

Twenty Ninth Meeting of the Communications/ Navigation and Surveillance Sub-group (CNS SG/29) of APANPIRG

Bangkok, Thailand, 16-20 June 2025

Agenda Item 6: Aeronautical Mobile Communications Service and Aeronautical electromagnetic spectrum utilization

6.3 Update on status of datalink applications and VHF capability sharing by States

RESEARCH AND APPLICATION OF AIRPORT SURFACE SAFETY TECHNOLOGY BASED ON AEROMACS

(Presented by China)

SUMMARY

This paper introduces the implementation of the new-generation AeroMACS 2.0 technology at Shanghai Hongqiao Airport, focusing on its application in runway incursion prevention and visualized aircraft taxiing guidance. These implementations aim to enhance operational safety and efficiency in airport surface operations, providing valuable experience for promoting AeroMACS technology across the Asia-Pacific region.

1. INTRODUCTION

1.1 In accordance with the plans of the Civil Aviation Administration of China (CAAC), since 2022 China has launched pilot projects for the new-generation aviation broadband communication system (AeroMACS 2.0) at airports in Shanghai, Chengdu, Guangzhou, and Ezhou. These projects involve constructing AeroMACS 2.0 communication networks to support airport operations, alongside conducting test validations for key application scenarios. These scenarios include Aircraft Taxi Guidance Systems, Runway Incursion Prevention Systems, Wireless Control Systems for Regional Airfield Ground Lighting, Emergency Management Systems, and Site Facility Link Transmission Systems.

1.2 This paper introduces the research conducted by the East China Air Traffic Control Bureau on the application of the new generation of AeroMACS technology in the field of surface safety, aiming to further improve the safety and efficiency of airport surface operations, with a focus on surface surveillance, runway safety, vehicle management, taxiing guidance and other aspects.

2. DISCUSSION

2.1 In 2023, Shanghai Hongqiao International Airport experienced longer taxi-out compared to other major domestic airports. As a narrow-spacing dual runway airport, its flight handling capacity is approaching operational saturation. Hongqiao Airport faces frequent flight queuing during peak hours. Shanghai Hongqiao Airport has been designated as a pilot site for AeroMACS 2.0 to validate critical functionalities, such as visual aircraft taxi guidance and runway incursion prevention, thereby enhancing aircraft operational safety, efficiency, and apron management capabilities.

2.2 AeroMACS Application Scenario Construction Flowchart is provided as follow:

Airport AeroMACS Network: AeroMACS 2.0 network spans entire runway/taxiway areas and apron zones at Shanghai Hongqiao Airport, serving as the core data transmission channel. Tripartite Collaboration Platform: Integrate ATC tower automation system, Airport AOC & A-CDM system and Airline FOC system, offer real-time data exchange like SWIM.

Runway Incursion Prevention System (Scenario 1): Preventing vehicles from intruding into the runway.
Visual Aircraft Taxi Guidance System (Scenario 2): Provide visual aircraft taxi guidance.

2.3 Scenario 1: Preventing vehicles from intruding into the runway:

This application integrates Tower Automation Systems, BeiDou high-precision positioning terminals, a tripartite data exchange platform, and AeroMACS 2.0 networks. It enables digital communication between controllers and vehicle drivers, real-time vehicle positioning (updated every second), and virtual fence for runway areas. Reduce interference between vehicles and aircraft, significantly improving surface safety.

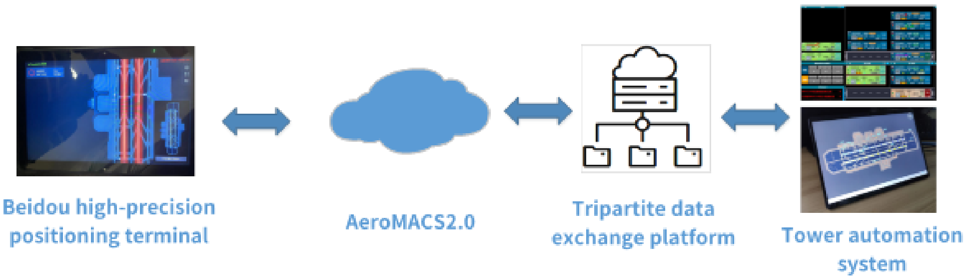

Figure 1 System architecture of runway incursion prevention scenario

The overall coordination process is shown in Figure 2:

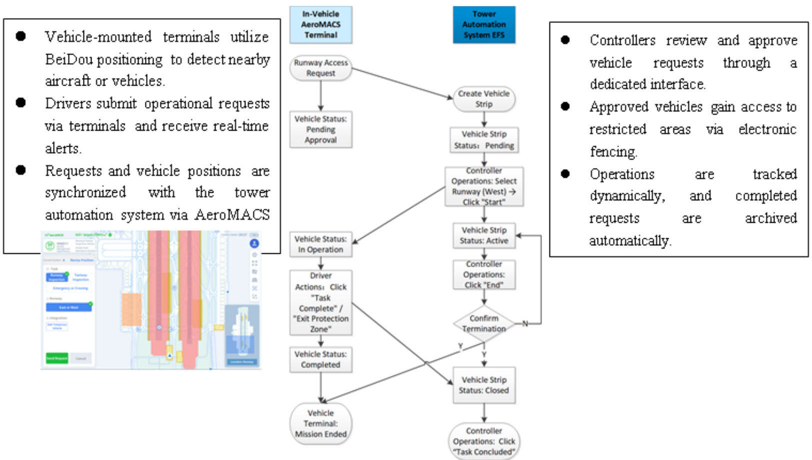

Figure 2 The Process of the Interaction Scheme

Taking vehicle VA0001's inspection of the West Runway as an example, as shown in the following figure.

Figure 3 Vehicle application display in tower automation system

The controller can monitor the vehicle's real-time position via surface surveillance display in the tower automation system, enhancing oversight of vehicles operating within the runway and taxiway areas.

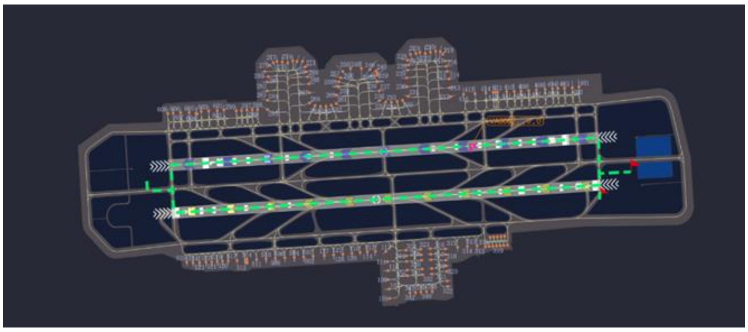

Figure 4 Vehicle information display in the tower automation surface surveillance display

When the tower automation system receives a vehicle operation alert (e.g., unauthorized entry into the runway protection zone), the alert is highlighted in the EFS notification panel (as illustrated below).

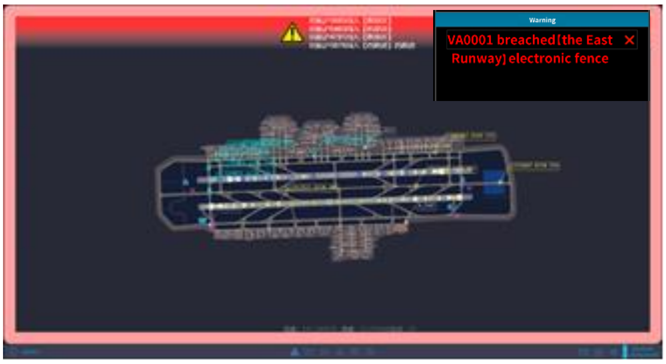

Figure 5 Vehicle alarm displayed in the tower automation surface surveillance display and in Tower Automation EFS

2.4 Scenario 2: Visual aircraft taxi guidance:

The visual aircraft taxi guidance application integrates tower automation systems, onboard terminals, a data exchange platform (Similar to SWIM), and the AeroMACS 2.0 network to enable shared situational awareness between pilots and controllers. This system synchronizes real-time information throughout the entire taxi process—from route assignment to parking—while delivering objective-oriented guidance tailored to aircraft taxiing operations between pilots and air traffic controllers.

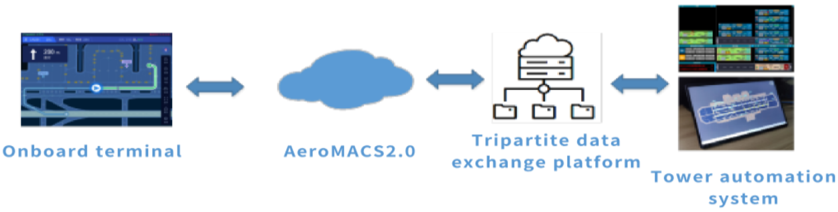

Figure 6 System architecture of visual aircraft taxiing guidance scenario

Within the tower automation system, air traffic controllers can access taxi guidance-related information through the expanded information panel of EFS. This includes:

- Pushback time/ direction (supports manual adjustment);
- Taxi route details (e.g., predefined path codes or simplified instructions).

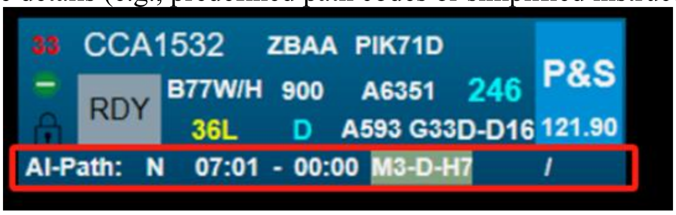

Figure 7 Extended information panel of EFS

Integrated with the surface surveillance display of the tower automation system, which displays the aircraft's taxiing route, controllers verify the route's accuracy and approve its issuance. The approved route is then synchronized to the onboard terminal via the AeroMACS 2.0 network.

Figure 8 Taxiing route in the tower automation surface surveillance display

The onboard terminal provides real-time displays of the aircraft's current position and surrounding active objects, controller-approved taxi routes, voice navigation alerts, and conflict warnings. These features significantly reduce uncertainties during taxiing, such as voice communication delays, taxiway intersection selection, and holding at junctions.

Figure 9 Aircraft taxiing guidance display at the airborne end

In December 2023, a functional validation test was conducted at Shanghai Hongqiao International Airport, covering apron areas, runways, taxiways, and bypass routes. This marked the nation's first operational validation of visual aircraft taxi guidance based on the AeroMACS 2.0 network. Tower controllers, apron controllers, and flight crews utilized the system to validate:

- AeroMACS 2.0 network coverage and signal continuity across the airport surface.
- Visual taxi guidance functionality under live operational conditions.
- Consistency of aircraft positioning data across stakeholder systems (tower, apron, and cockpit).

The test demonstrated that the AeroMACS 2.0-based visual taxi guidance system enables continuous path guidance, reduces reliance on voice instructions, and lowers taxiing error rates. While the application represents a breakthrough, challenges remain:

- Airborne system compatibility and airworthiness constraints: Retrofitting existing aircraft with new communication modules may increase weight and power consumption.
- Certification timelines: Airworthiness certification for aviation systems typically requires 3–5 years, risking technological obsolescence before deployment.

2.5 Looking ahead, leveraging the implementation experience from Hongqiao Airport, CAAC will focus on expanding the adoption of next-generation AeroMACS-driven surface safety technologies across other airports.

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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