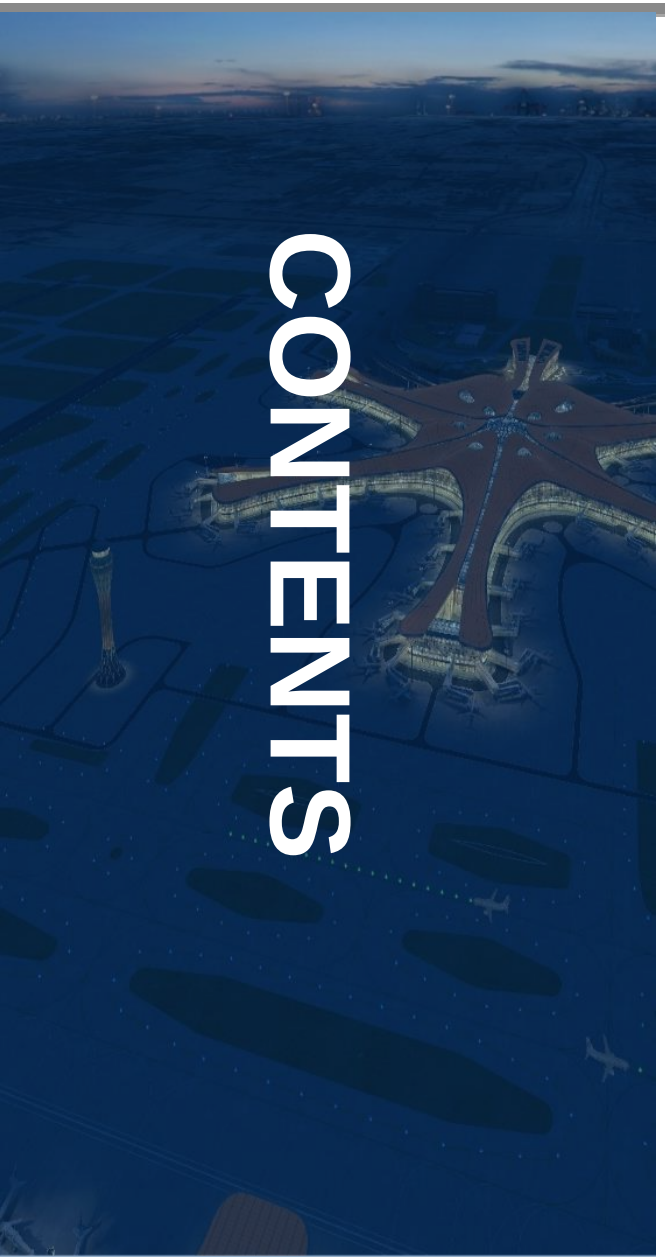
ICAO

中国民用航空局
空中交通管理局
Air Traffic Management Bureau. CAAC

Research and Validation of Digital Air Traffic Control Technology based on TBO

Presented by China



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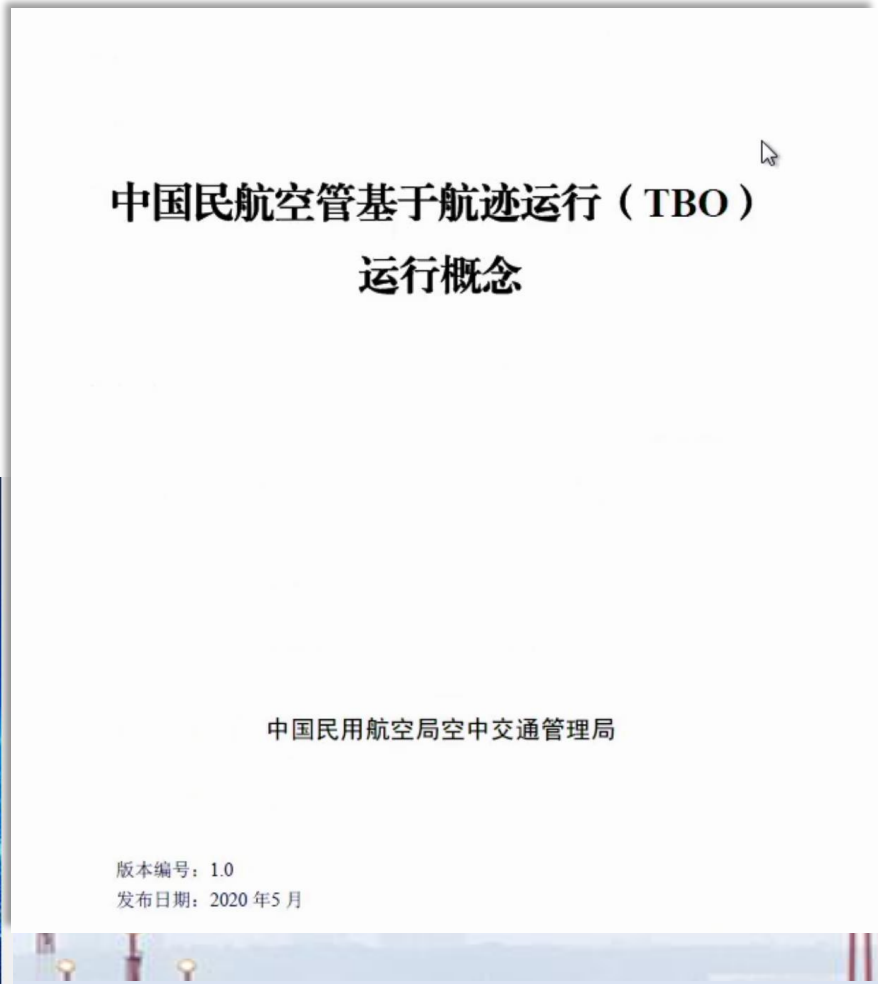
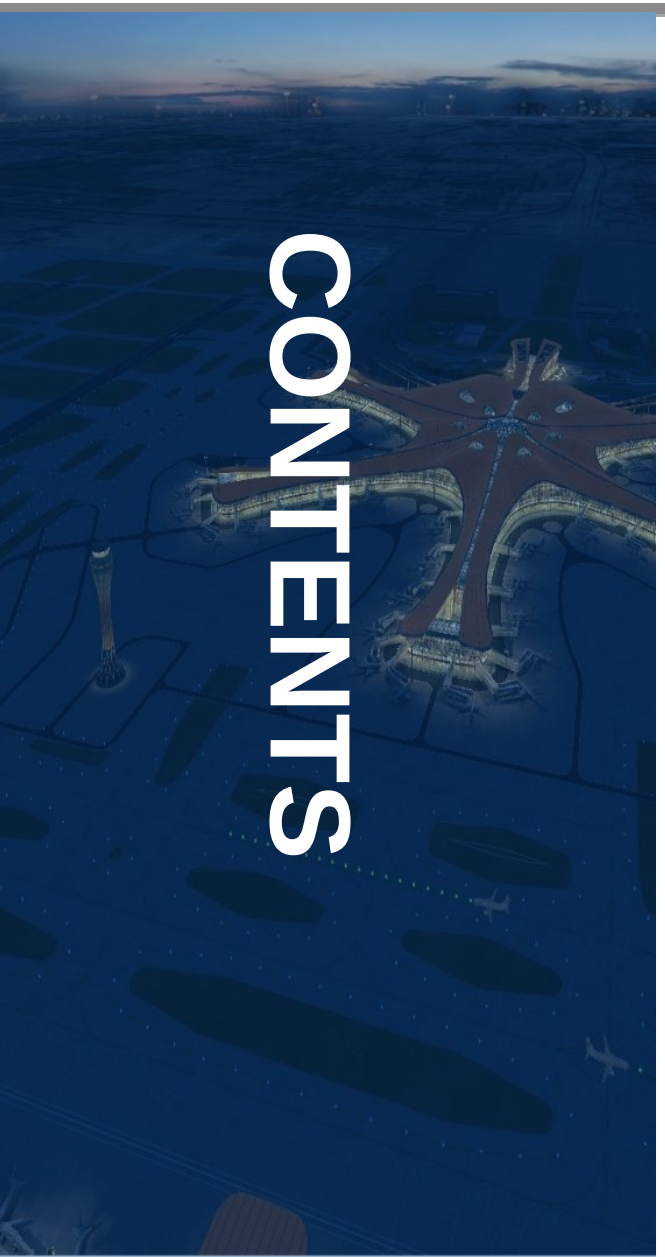
Introduction

In its 6th Global Air Navigation Plan (2019), ICAO identified Trajectory-Based Operations (TBO) as a key integration goal in operations, planning global promotion post-2031.

Introduction

In 2020, the Civil Aviation Administration of China began to organize research and verification work on digital air traffic control technology based on trajectory operations.





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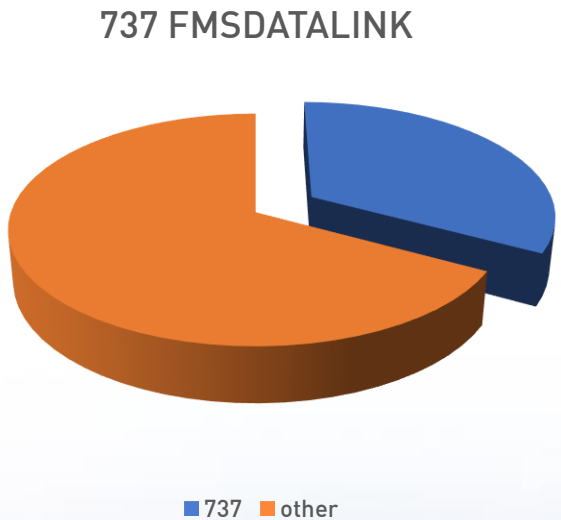
Status of Domestic Onboard Equipment

- ❑ **Aircraft Equipped with Support for Downlink Data Items Related to Estimated Arrival Time at Subsequent Points**

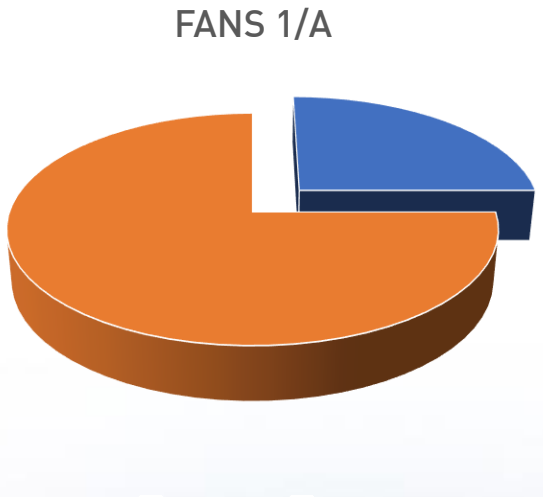
- **All 737 series that have activated the FMS DATALINK function support this feature, approximately 33%.**



Status of Domestic Onboard Equipment

- **Aircraft Equipped with Support for Downlink Data Items Related to Estimated Arrival Time at Subsequent Points**

  - **Aircraft equipped with the FANS 1/A protocol ADS-C function all support this feature, about 25% of the aircraft.**



Status of Domestic Onboard Equipment

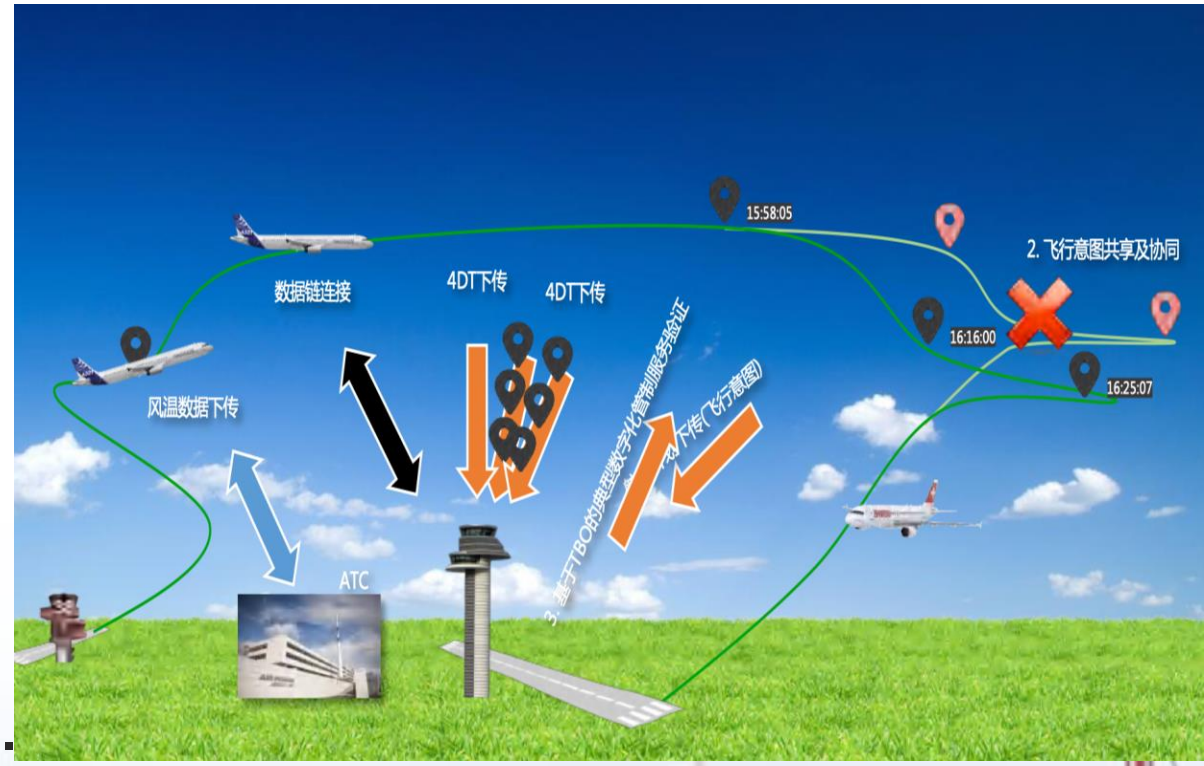
❑ Aircraft Equipped with Support for Downlink Data Items of Activated Flight Routes

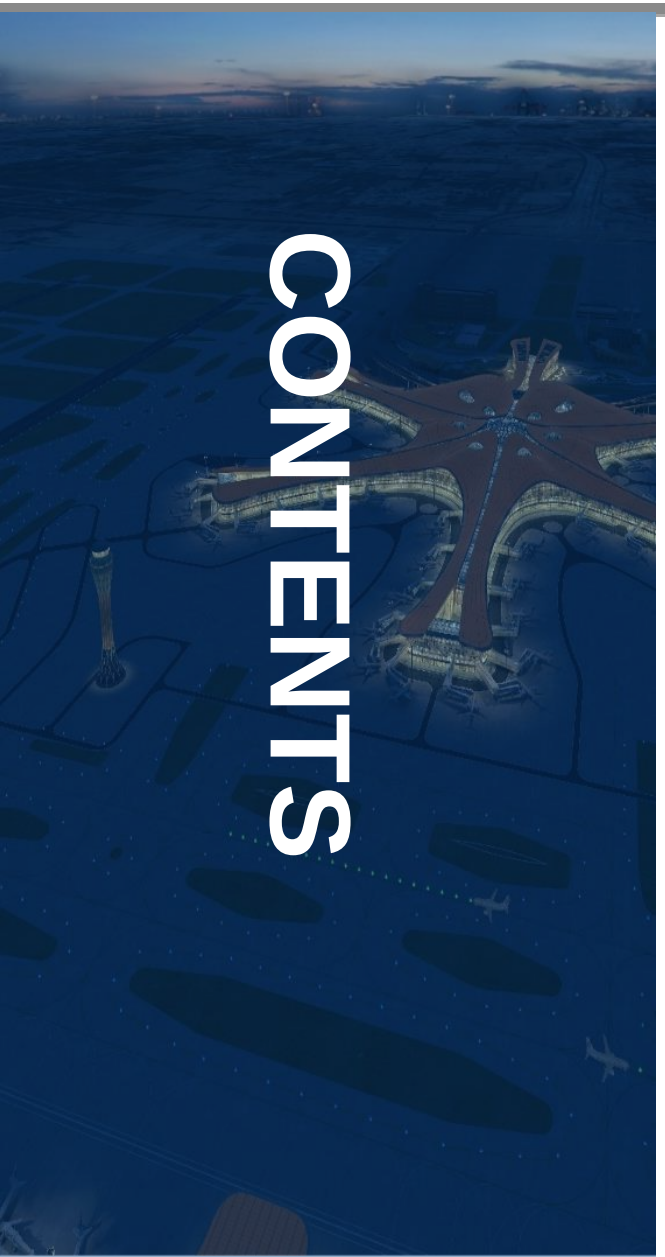
- **Boeing/Airbus wide-body aircraft, 737 series, and some airlines' A320s that have activated the FMS DATALINK function support the downlink of this data item, accounting for nearly 56% of the aircraft in CAAC**

Verification Purpose

Within the East China region and the scope of Shanghai's approach airspace, flight tests of two typical new digital air traffic control technologies based on the TBO operating concept are carried out.

The purpose is to verify the technical feasibility of implementing TBO operations on a preliminary scale using existing onboard avionics capabilities.





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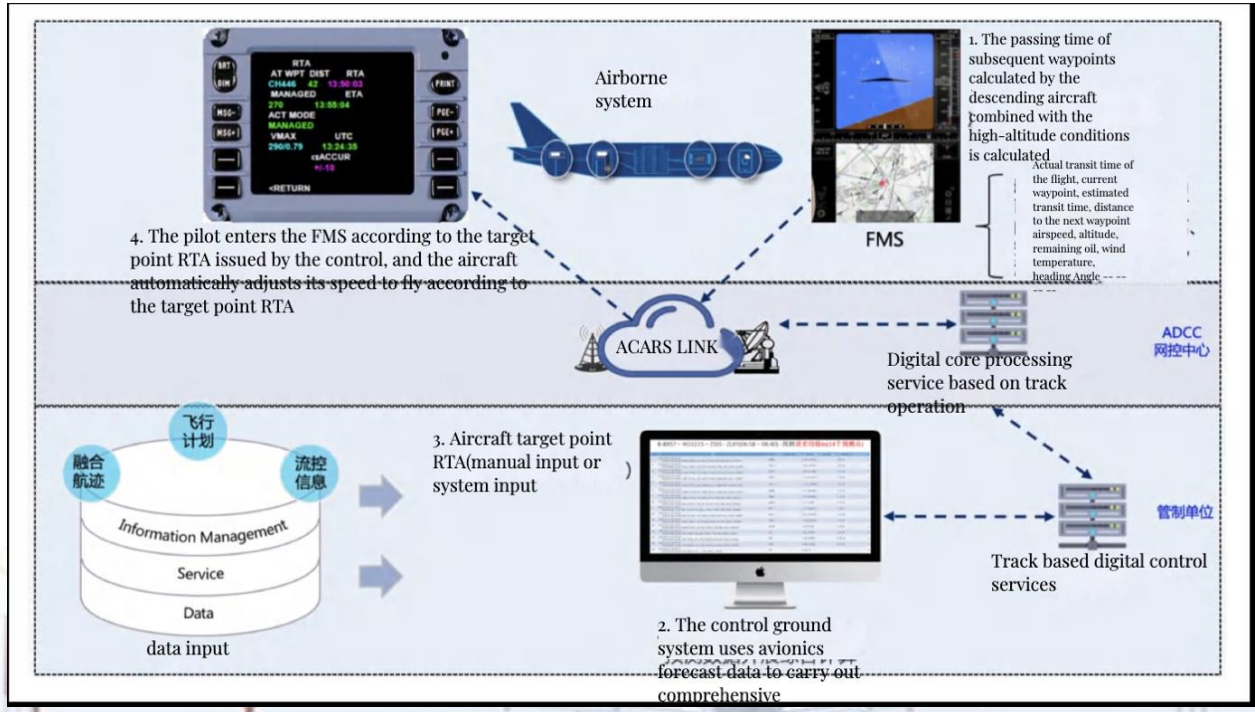
Verification Scenarios 1

- **Scenario One: Research on Precise Control of Integrated Air-to-Ground Flight Trajectory Based on Data Link Technology**

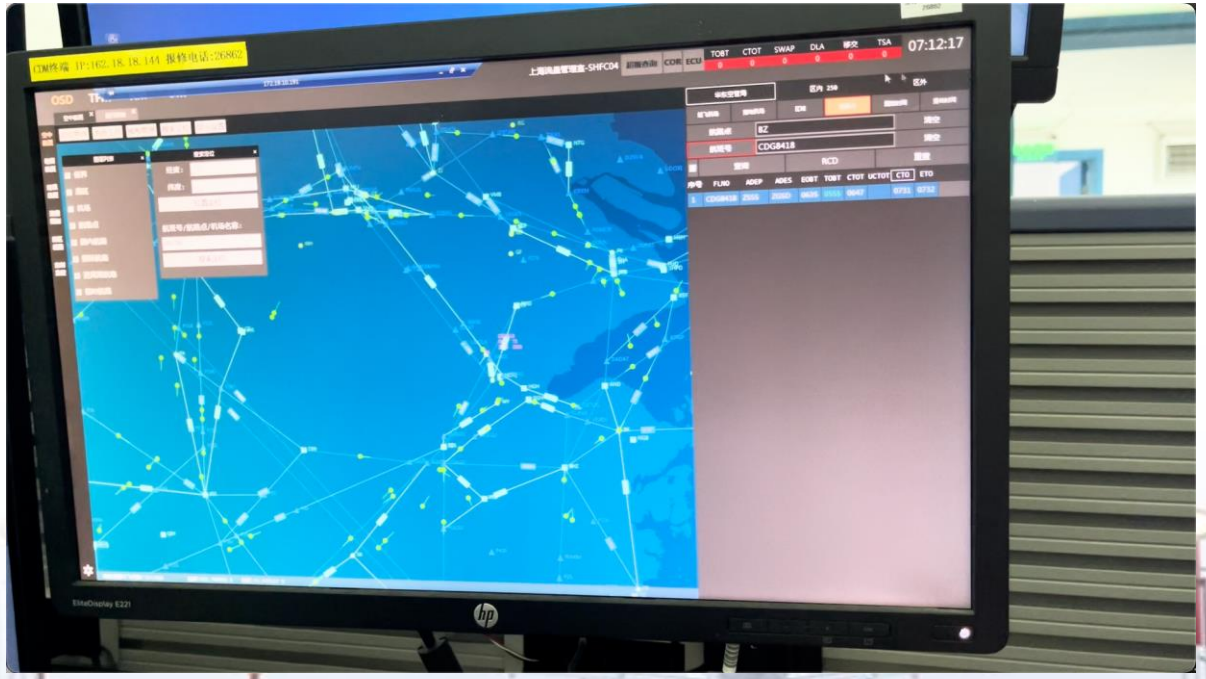
1. The ground testing system sends an ETA request through TBO digital control service.
2. The aircraft receives and issues the RTA for the aircraft's target point.
3. The ground system calculates based on the data sent by the airborne avionics.
4. The calculated time is sent to the onboard MCDU through the TBO digital control service.
5. If the crew believes the time is achievable, they can directly click "ACCEPT"; otherwise, they click "REJ".



Verification Result- Scenarios 1

- **Scenario One: Research on Precise Control of Integrated Air-to-Ground Flight Trajectory Based on Data Link Technology**

- Test System: CDM System
- Test Units: ADCC, East Region of ATMB
- Cooperating Airline: Shandong Airlines
- Test Aircraft TYPE: B738



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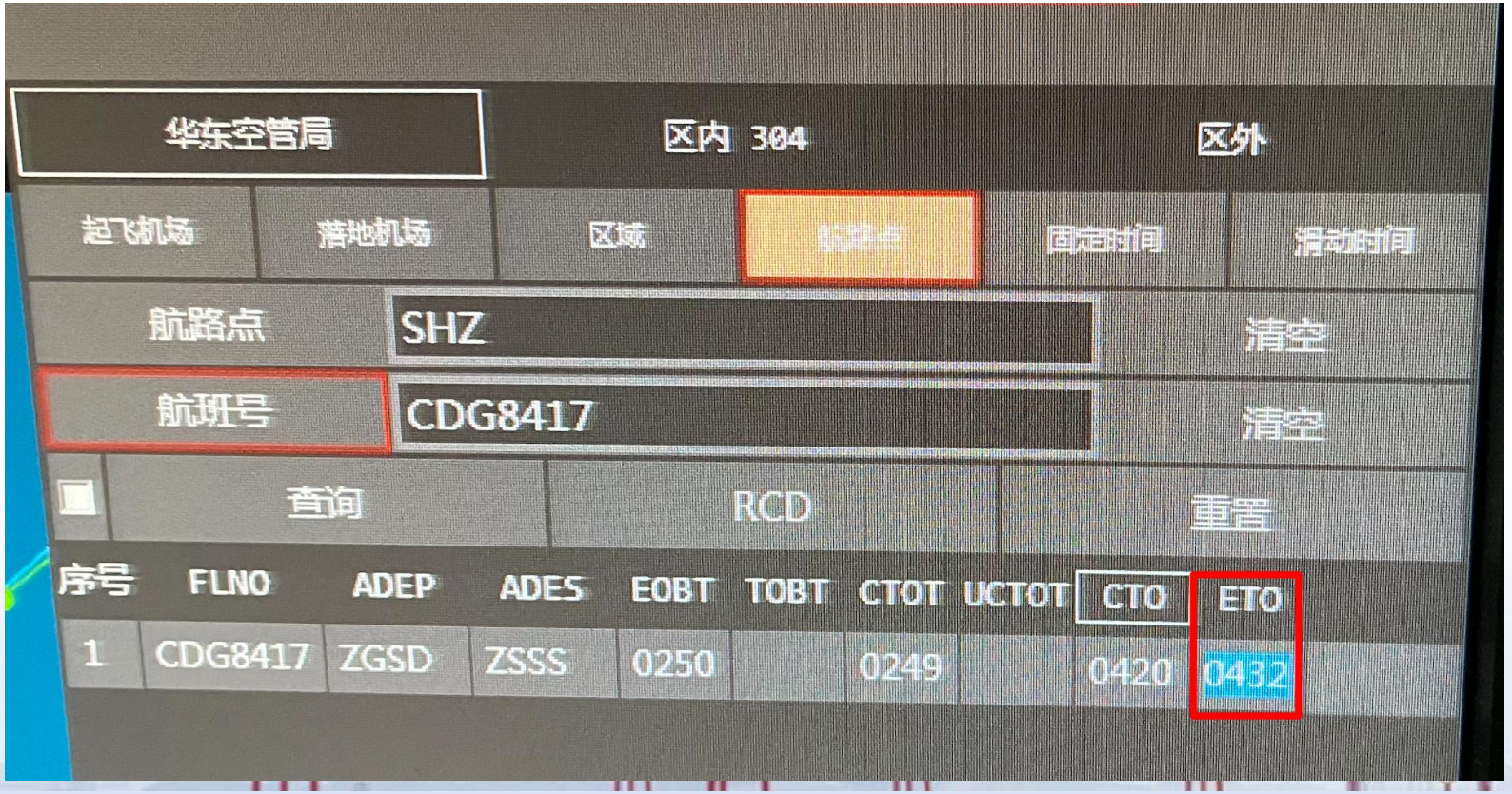
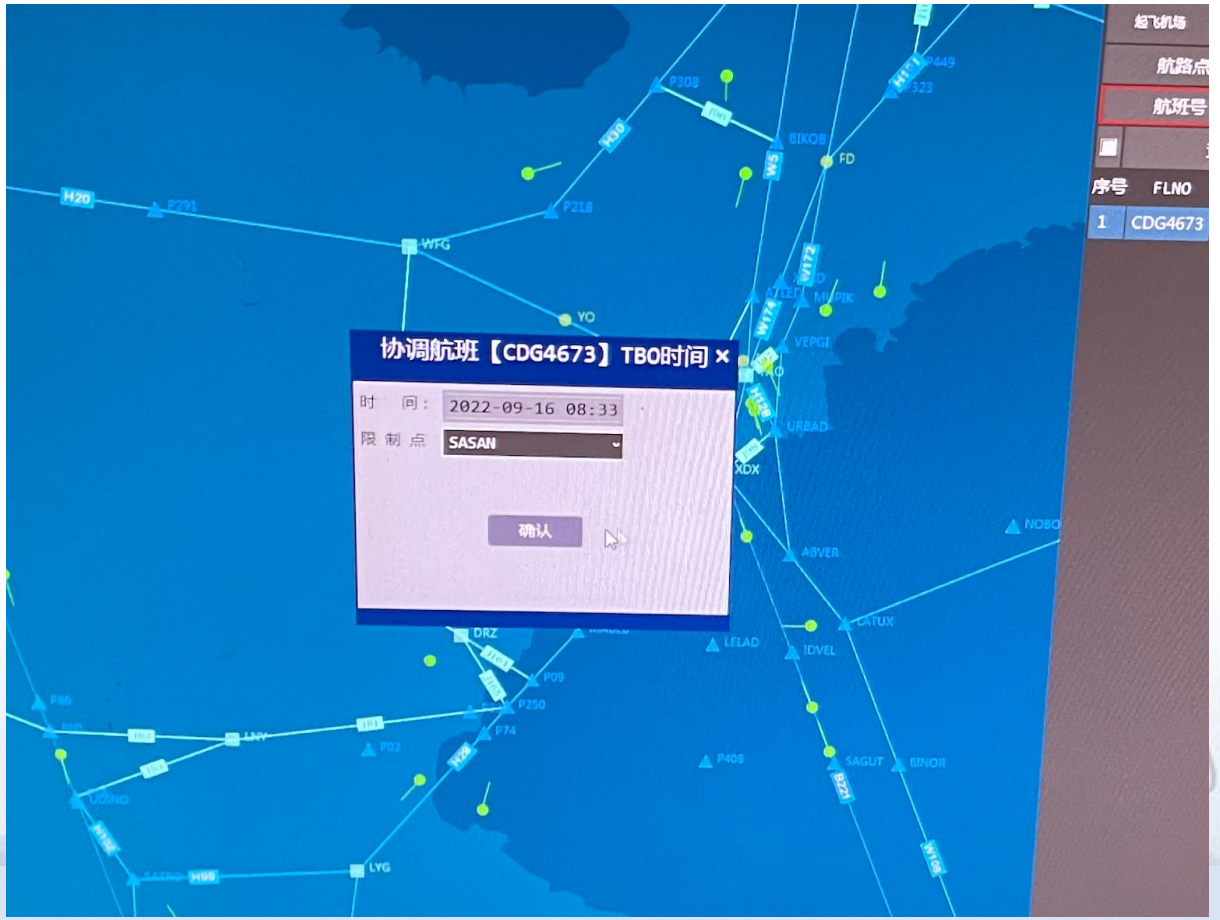


- **Aircraft waypoint crossing time downlink**

Verification Result-Scenarios 1

- **Scenario One: Research on Precise Control of Integrated Air-to-Ground Flight Trajectory Based on Data Link Technology**



- **Waypoint crossing time CDM provided uploaded to the aircraft**

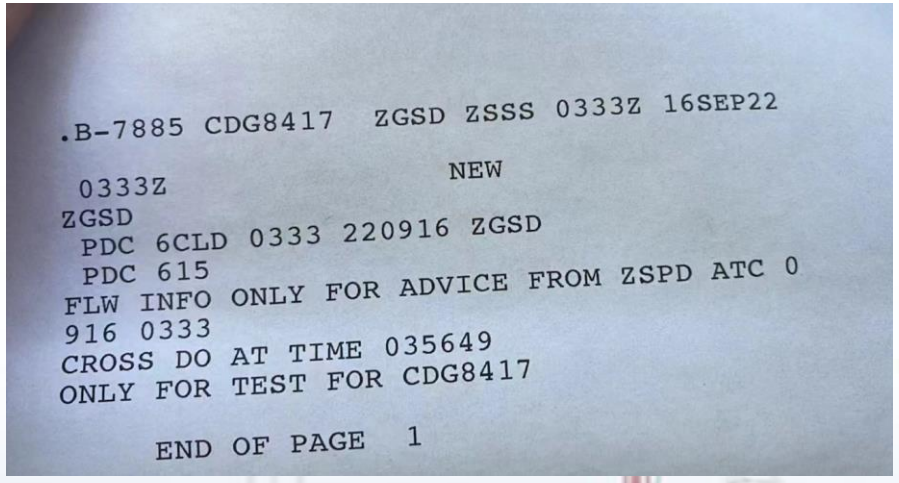
Verification Result-Scenarios 1

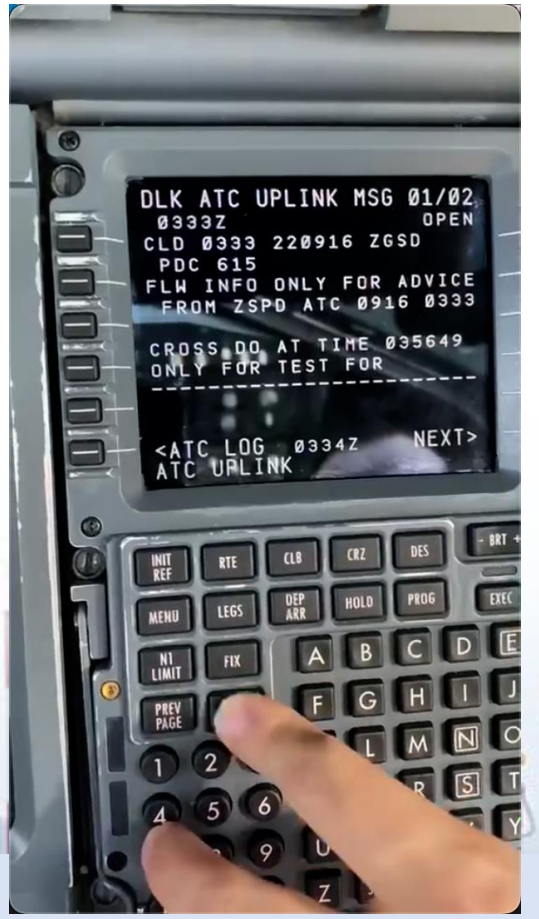
- **Scenario One: Research on Precise Control of Integrated Air-to-Ground Flight Trajectory Based on Data Link Technology**

- **Aircraft accepted the crossing time CDM provided**

Verification Result-Scenarios 1

- **Scenario One: Research on Precise Control of Integrated Air-to-Ground Flight Trajectory Based on Data Link Technology**



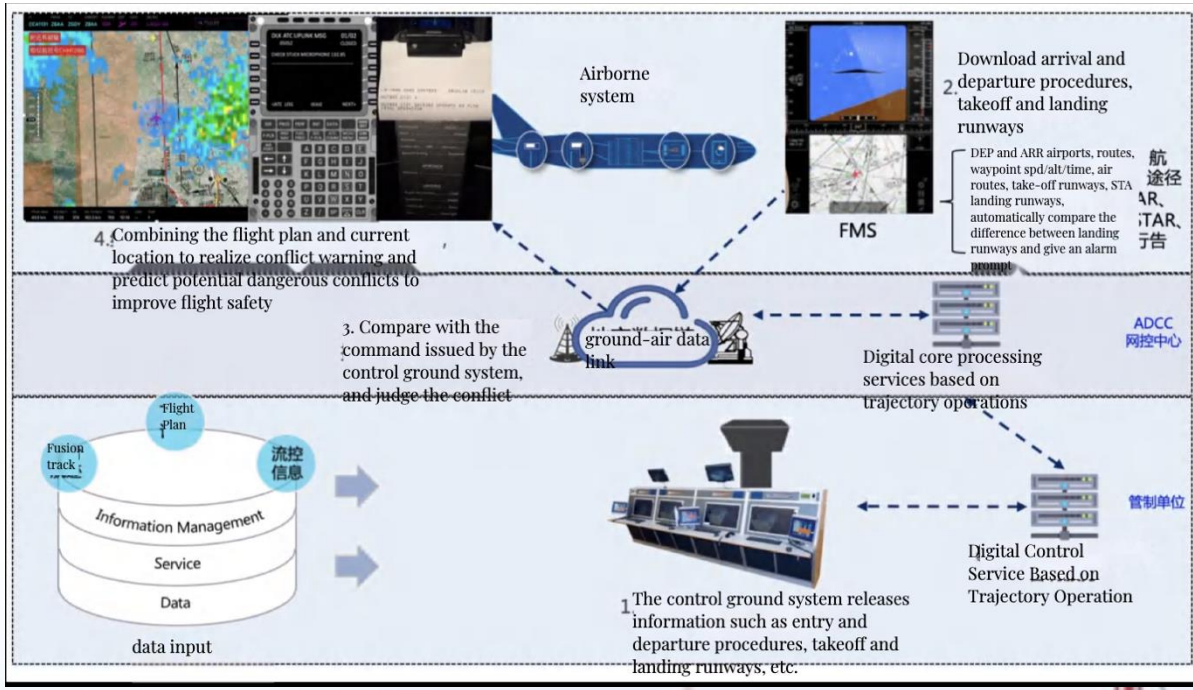


- **The aircraft on-board side received information**

Verification Scenarios 2

- **Scenario Two: Research on Flight Intent Sharing and Wrong Runway Landing Prevention Technology**

1. To solve the issue of incorrect parallel runway ILS approaches, an alarm is triggered when there is a discrepancy between the STAR and landing runway set by the crew and published by the ground system.
2. The crew's settings for STAR and RWY are transmitted to the ground system via the TBO digital control service.
3. Simultaneously, the ground system sends its settings for STAR and RWY to the crew.

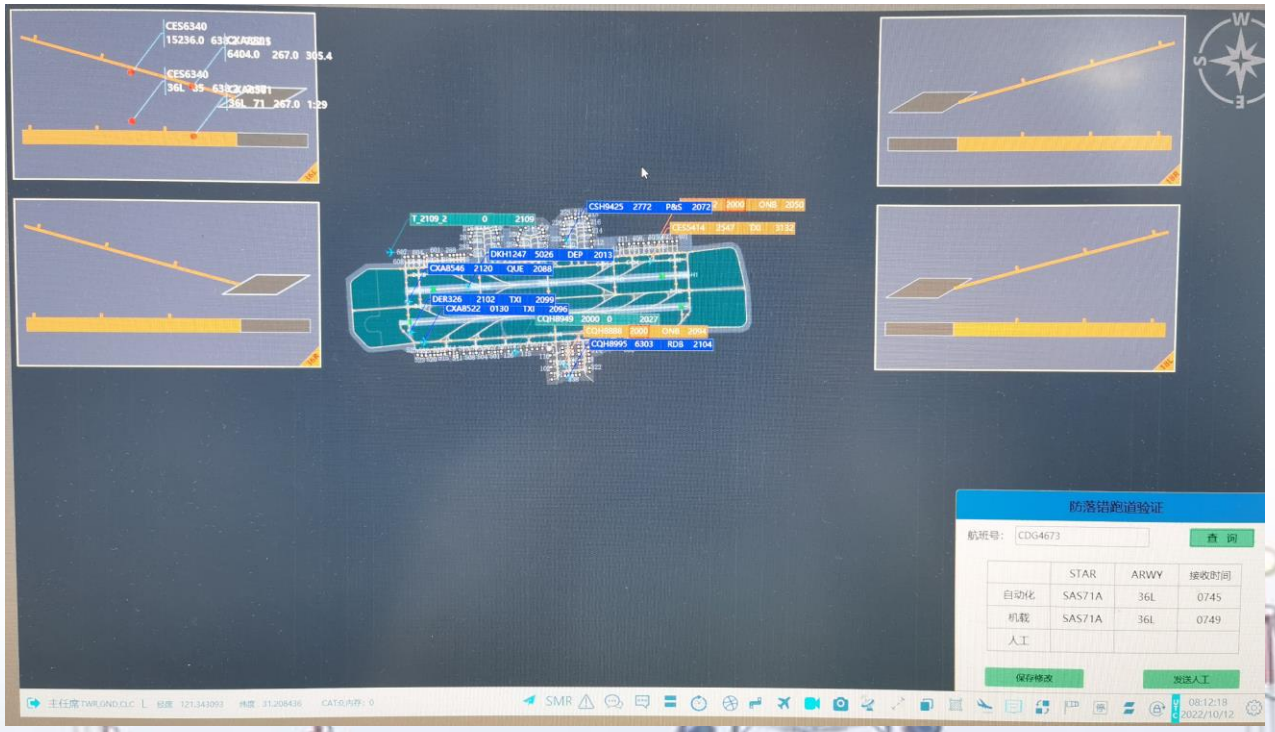


Verification Result- Scenarios 2

- **Scenario Two: Research on Flight Intent Sharing and Wrong Runway Landing Prevention Technology**

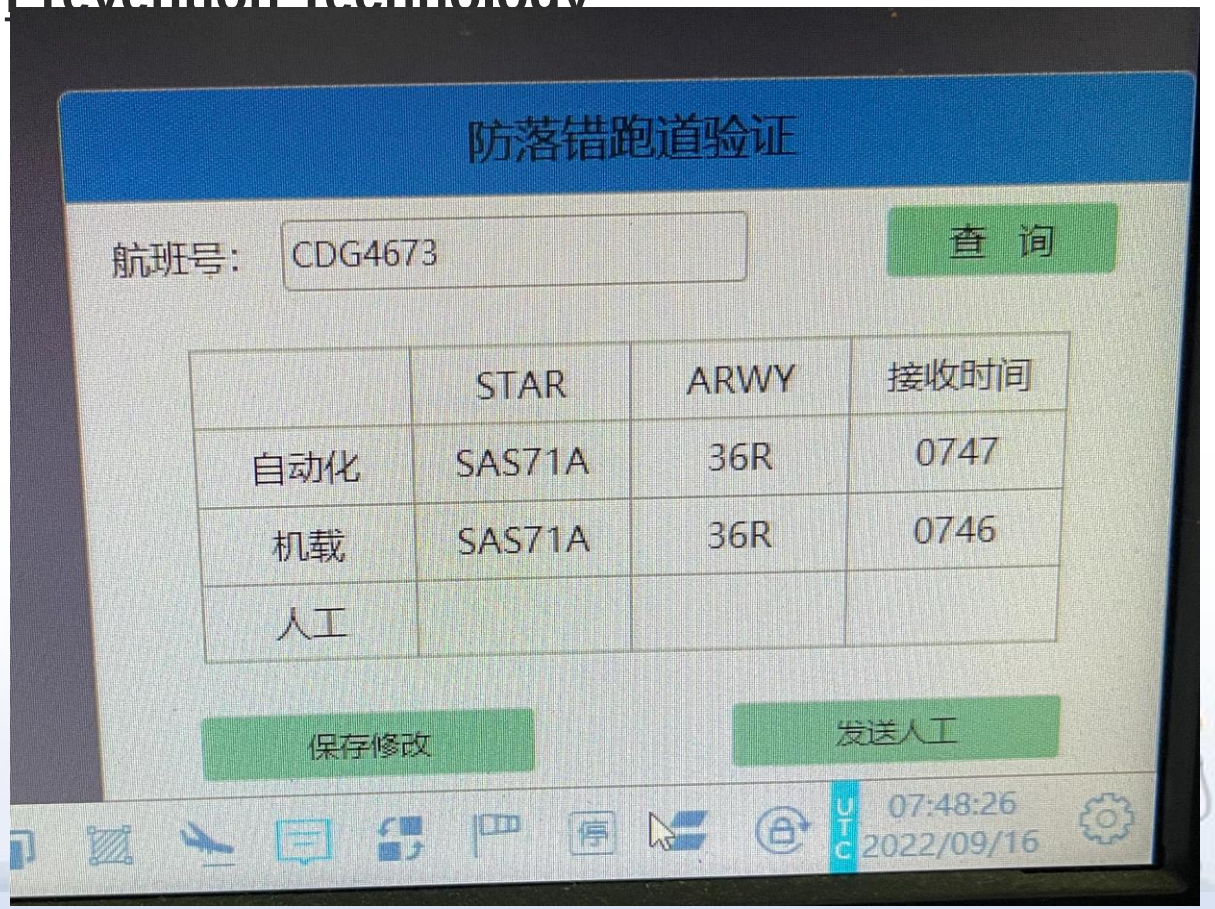
- Test System: ASMGCS TEST System
- Test Units: ADCC, East Region of ATMB
- Cooperating Airline: Shandong Airlines

  China Eastern
- Test Aircraft TYPE: B738 B77W A359



Verification Result-Scenarios 2

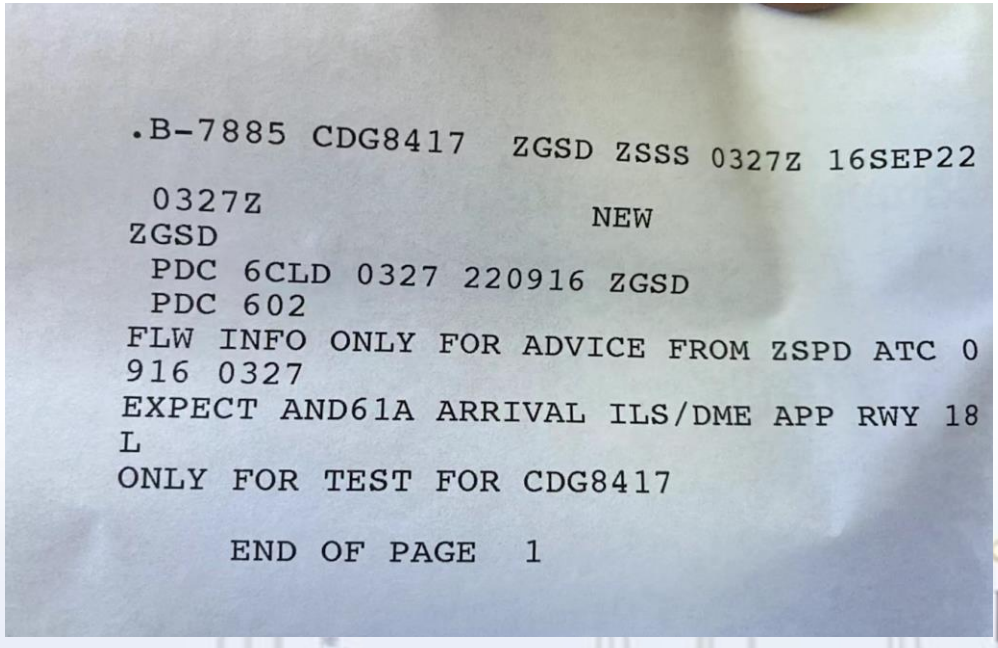
- **Scenario Two: Research on Flight Intent Sharing and Wrong Runway Landing Prevention Technology**

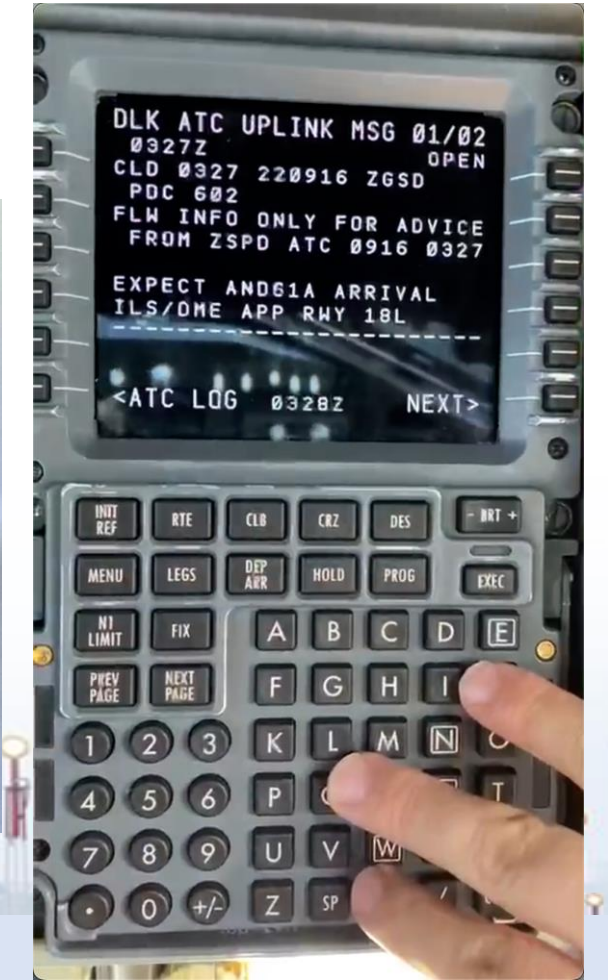


- The verification system receives the STAR and ARWY from the ATMAS, sends them after correction,
- simultaneously queries the STAR and ARWY for the corresponding flight.

Verification Result-Scenarios 2

- **Scenario Two: Research on Flight Intent Sharing and Wrong Runway Landing Prevention Technology**

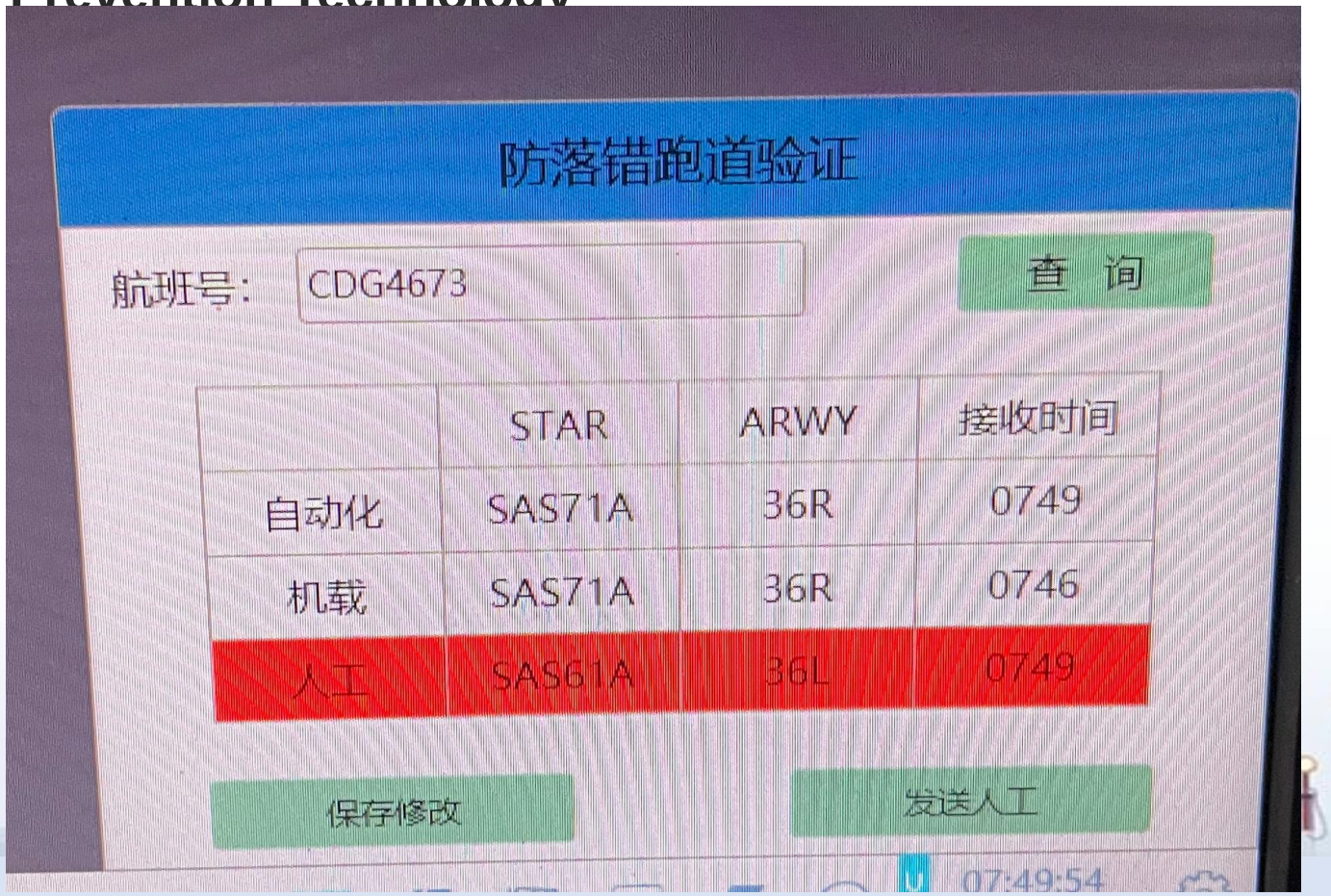




- **Aircraft received ARWY and STAR**

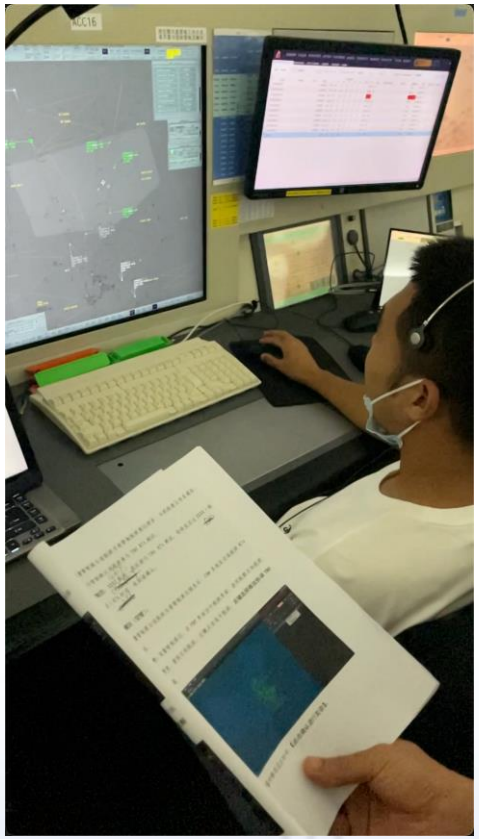
Verification Result-Scenarios 2

- **Scenario Two: Research on Flight Intent Sharing and Wrong Runway Landing Prevention Technology**



- **Test Alarm difference between Downlink from aircraft airborne and Test System provided**

Verification Result



- From September 16 to November 2, 2022, the ADCC（Aviation Data Communication Corporation）, East Region of ATMB, Shandong Airlines, and China Eastern Airlines jointly conducted validation flight tests. During this period, a total of 1604 flights were tested, covering 207 aircraft, with models including the A350, B737, B777, B787. These models covered 41.72% of the aircraft in the Civil Aviation Administration of China. The validation test situations for the two scenarios are briefly described above.

Verification Result-Scenarios 1

- **Scenario One: Research on Precise Control of Integrated Air-to-Ground Flight Trajectory Based on Data Link Technology**

- **Summary:**

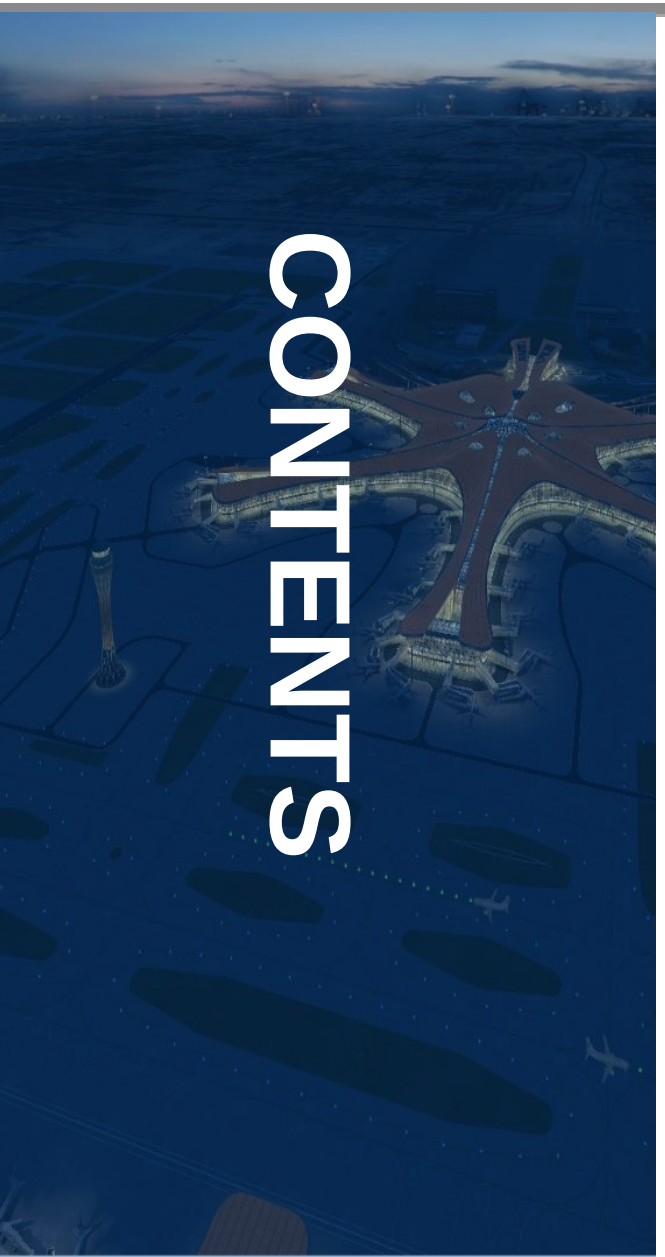
A total of 28 flights were tested, covering 20 aircraft. A total of 70 FML and ADS-C messages were received, with 64 predicted control application crossing times. The average prediction difference was 8.53 seconds.

Verification Result- Scenarios 2

- **Scenario Two: Research on Flight Intent Sharing and Wrong Runway Landing Prevention Technology**

Summary:

A total of 1,576 flights were tested, covering 206 aircraft. A total of 3,635 inbound procedure/landing runway consistency check messages were sent, 3,374 were successfully sent and the aircraft downlink FMS activated plan was received. Among them, 119 messages failed to send due to base station switching (accounting for 3.27%); 142 commands were responded with REJ on the downlink (accounting for 2.91%, involving a total of 19 aircraft, all models were B777-300ER).



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Advantages and Future Prospects

- **Time Precision Improvement**

  - **Second-Level Accuracy: The ETA-requested crossing time closely matches the actual time, within seconds, compared to the automated system's over 5-minute discrepancy.**
  - **Increased Lead Time: During departure, the TBO-capable test aircraft can provide crossing time for specific route points.**

Advantages and Future Prospects

- **Safety Redundancy Improvement**

  - **Enhanced Safety with TBO: Early landing information and cross-check with ground control, prevent wrong runway landings effectively.**

Future Prospects

- **Air-Ground Control & Safety:**

Data link technology enables precise flight control, efficient routing, and conflict prediction, enhancing automation, efficiency, sustainability, and safety without major avionics retrofitting.

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Thanks!

Looking forward to progress together !