International Civil Aviation Organization

**Twenty Eighth Meeting of the Communications/
Navigation and Surveillance Sub-group (CNS SG/28)
of APANPIRG**

Bangkok, Thailand, 01 July - 05 July 2024

Agenda Item 5:   Aeronautical Mobile Communications Service and Aeronautical electromagnetic spectrum utilization

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

RESEARCH AND VALIDATION OF DATA LINK TECHNOLOGY BASED ON THE INTEGRATION OF CPDLC AND ACARS ATS

(Presented by China)

SUMMARY

In 2023, ATMB of CAAC conducted the testing and validation of data link technology in oceanic and continental airspace. This paper will share the research and validation experience of data link technology based on the integration of CPDLC and ACARS ATS.

1.   INTRODUCTION

1.1   According to the ICAO ASBU plan and relevant plans of CAAC, data link services are the focus of the air navigation technology. Aircraft Communication Addressing and Reporting System Air Traffic Service (ACARS ATS) and Controller Pilot Data Link Communication (CPDLC), as two common datalink ATS technology currently in use, can be used to transmit various types of information between controllers and pilots, which will significantly reduce the workload of controllers and pilots, improve the shortage of voice communication frequency resources, and enhance the safety operation.

1.2   Currently, in China，the VDL Mode 2 network of civil aviation covers most of the major airports and routes in East of China, while the ACARS network has covered major transportation airports and routes of civil aviation. At present, more than 50% of the Chinese aircraft with more than 99 seats supports VDL MODE2, and 100% supports ACARS.

1.3   By 2019, CAAC had provided digital clearance (DCL) and digital automatic terminal information service (D-ATIS) in 44 airport towers and provided CPDLC and ADS-C services in accordance with PBCS (performance-based communication and surveillance) operational specifications for air routes such as L888 in west of China.

1.4   Since 2019, ATMB of CAAC and CSP (ADCC) have successfully carried out datalink ATS technology validation in all flight phases based on CPDLC and ACARS ATS protocols in Zhengzhou, Guangzhou, and other regions. Zhengzhou mainly uses ACARS ATS protocol to send similar call signs warning information in May 2021, and to send flight-related turbulence and other air route hazardous weather warning information in 2023. Since August 2022, the trail operation of flight information service has been launched in the Guangzhou control area, sending instructions such as expected STARs and landing runway.

2.   DISCUSSION

2.1   Validation ZJSA FIR

In 2023, ATMB of CAAC collaborated with various industry units such as airlines and ADCC to conduct research and validation of the integration of CPDLC and ACARS ATS in ZJSA FIR. According to operational requirements, the verification team designed application scenarios including 18 CPDLC application scenarios and 11 ACARS ATS application scenarios. Meanwhile, considering the airspace characteristics of the ZJSA FIR (SANYA ACC), scenarios also covered applications for tower, approach and enroute (oceanic). The validation, performed on Boeing B787 and Airbus A350, was performed successfully.

2.2   Introduction of the standard

ACARS ATS is based on the ARINC protocol, which send the latest ATS information to specified aircraft. CPDLC instructions allow pilots and controllers to exchange relevant message information through data links. Compared to ACARS ATS, CPDLC contains a set of uplink and downlink control instructions, enabling two-way communication between controller and pilot.

2.3   Technical Scheme of the Test

For safety reasons, a data link verification platform was established, and include four main parts.

2.3.1   Data Link Verification Platform

The data link verification platform mainly includes: ATMAS Verification Platform of CDATC, Data Exchange Platform, Air Traffic Control Digital Assistant (ADA) and Air-ground data link system. The functions of each system are as follows:

    a) Middle South Region Data Exchange Platform: Responsible for data connection of FPL and trajectory.
    b) Air Traffic Control Digital Assistant (ADA): Primarily responsible for message exchange between the local systems and the network control center. Air-ground data link system: Responsible for the exchange of air-ground data.
    c) Air-ground Data Link System: Responsible for the exchange of air-ground data.
    d) ATMAS Validation Platform: providing a human-machine interface for editing and sending test instructions, and checks the execution status of the aircraft.
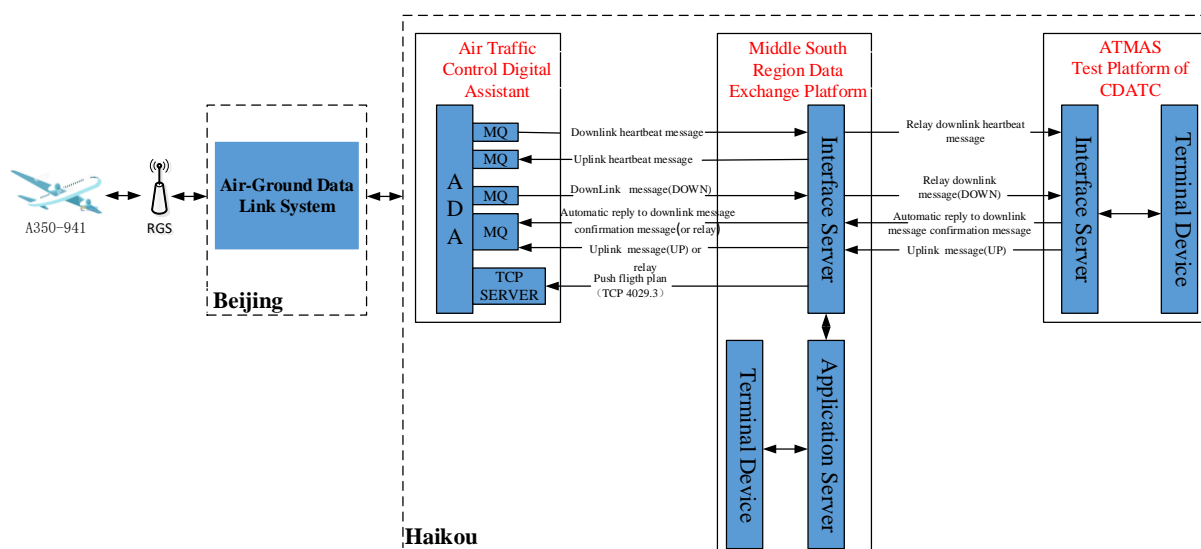
Figure 1 Illustration of Verification Platform

2.3.2   Test Items

18 CPDLC application scenarios and 11 ACARS ATS application scenarios are shown in Table 1.

No	Test Items	Application scenario	Uplink/Downlink
1.	Establish link	CPDLC	downlink
2.	Adjust the course	CPDLC/ ACARS ATS	uplink
3.	Over-point Limitation	CPDLC/ ACARS ATS	uplink
4.	Route Offset	CPDLC/ ACARS ATS	uplink
5.	Frequency test	CPDLC/ ACARS ATS	uplink
6.	Communication Failure	CPDLC/ ACARS ATS	uplink
7.	Check stuck microphone	CPDLC/ ACARS ATS	uplink
8.	Contact frequency	CPDLC	uplink
9.	Radar contact lost	CPDLC/ ACARS ATS	uplink
10.	Accelerate	CPDLC/ ACARS ATS	uplink
11.	Deceleration	CPDLC/ ACARS ATS	uplink
12.	Departure taxiway route	CPDLC/ ACARS ATS	uplink
13.	Parking stand	CPDLC/ ACARS ATS	uplink
14.	Emergency (PAN)	CPDLC	downlink
15.	Emergency (MAYDAY)	CPDLC	downlink
16.	Complex instructions	CPDLC	downlink, uplink
17.	Ground-initiated communication disruption	CPDLC	uplink
18.	Crew-initiated communication disruption	CPDLC	downlink

Table 1 CPDLC and ACARS ATS application scenario

2.3.3   Validation Phase

From March to May 2023, the tests were conducted with a Boeing 787 on the ground in ZJSA FIR. The validation verified the reliability, accuracy and delay of the data link message interaction between the test platform.

In July 2023, the tests were conducted with An Airbus A350 on the ground and in flight in ZJSA FIR. This validation verified datalink ATS technology involving the tower, approach, and en-route.

2.4   Process of the Test

Technical verification and testing process of datalink ATS in all flight phases in ZJSA FIR is introduced below:

In July 2023, the CPDLC+ACARS ATS application scenario test between the air-ground data link verification platform and the Airbus A350 aircraft was completed. Through this test, the reliability, accuracy, and timeliness of the air-ground data link were well verified.

The designed flight route is shown in Figure 2. Different test subjects were prepared based on the command characteristics of each phase of the aircraft's flight. During the test process, 12 CPDLC tests were completed, including establishing a link, adjusting the route, etc. Additionally, two ACARS ATS application scenario tests were conducted for frequency testing and radar contact lost.

Figure 2 Illustration of Flight Route and Test Subjects

2.5   Analysis of the Verification and Test Result

    During the testing period, all systems of the air-ground data link verification platform operated stably, and the result shows messages are transmitted accurately between air and ground.

2.5.1   Analysis of Data Link Coverage

With total of six RGS built in the ZJSA FIR, data link signal coverage is shown in Figure bellow and the designed flight route could be effectively covered.
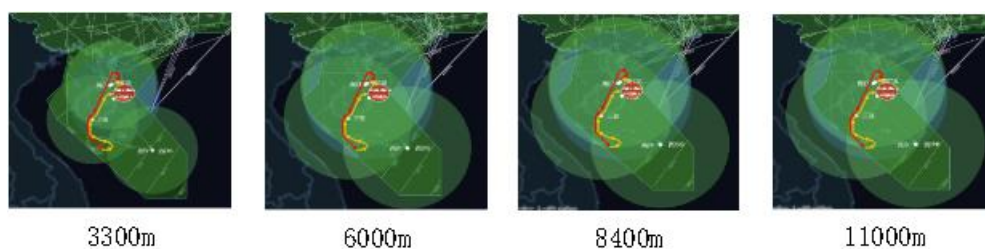

Figure 3 Flight Route and Coverage

2.5.2   Analysis of Time Delay

According to statistics, the average duration of two-way communication in CPDLC application scenarios (the time difference between sending instructions and receiving MAS logical confirmation messages from aircraft) is less than 5 seconds, while the average duration of two-way communication in ACARS ATS application scenarios is at the same level.

2.5.3   ATMAS Functional Design

According to the test results of the test in ZJSA FIR, ATMB of CAAC will further optimize the data link function and HMI of the ATMAS, revise and improve the technical specifications for the digital air traffic control function and interface of the ATMAS; and carry out more research with airlines to further promote the application of data link technology.

2.5.4   Test Result

The test result shows the CSP network is proved to be stable, all ground equipment operated normally during the test, and function of ATMAS worked within expectation.

2.6   Promotion of Data Link Application

The successful validation of this research on data link technology based on the integration of CPDLC and ACARS ATS has laid a solid foundation for promoting ATS applications in China. The following work will be carried out in the future:

   a) Improving the specifications for the digital service interface.
   b) Optimizing design of the functionality of the ATMAS.
   c) Carrying out more experimental verifications according to the plan of CAAC.

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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