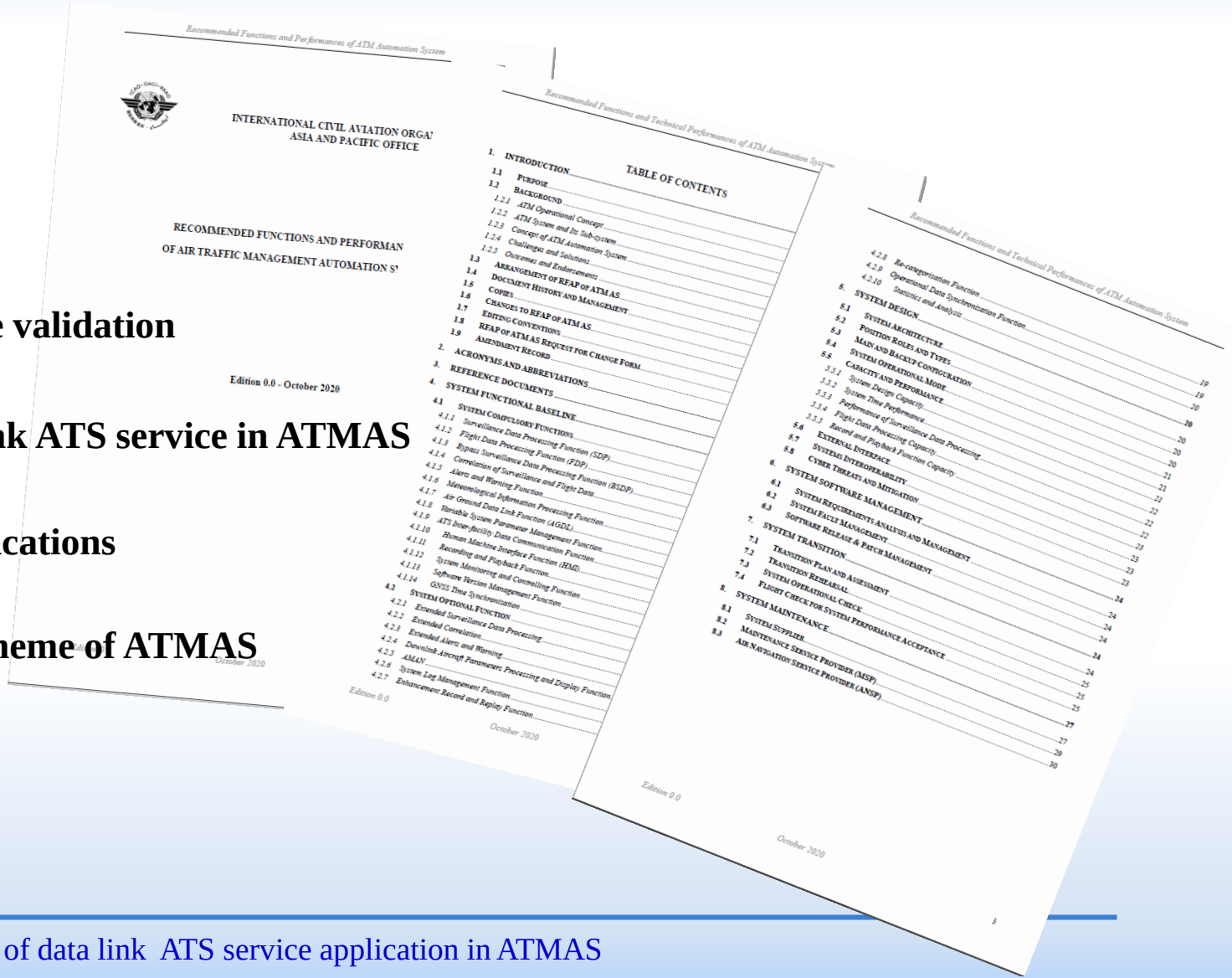
中国民用航空局
空中交通管理局
Air Traffic Management Bureau .CAAC

Validation of Data Link ATS Service Application in ATM Automation System

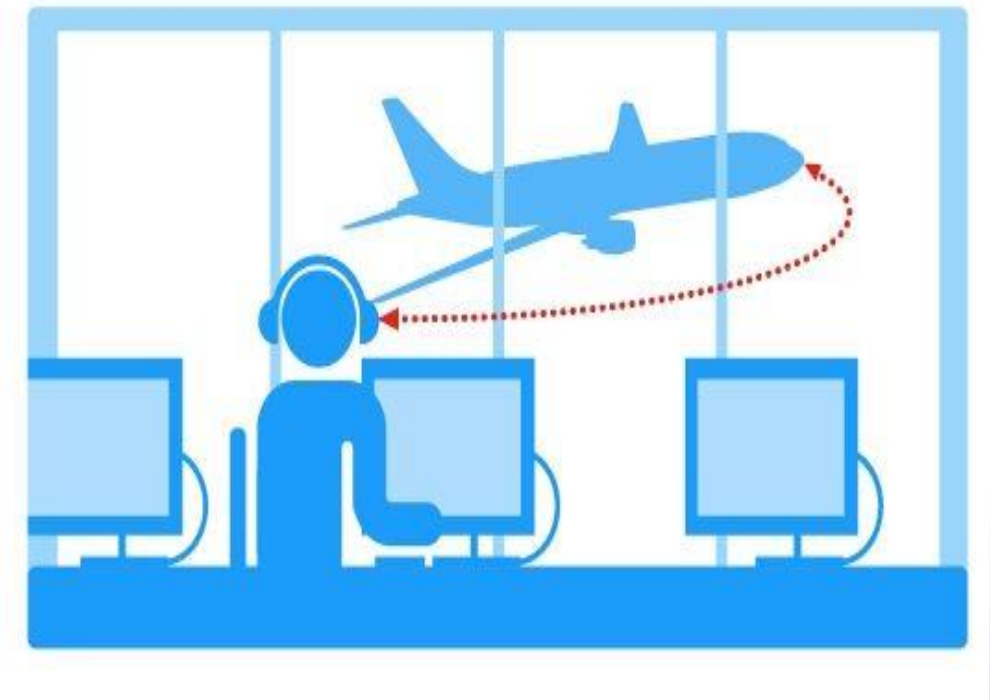
(Presented by China)

Contents



Overview of the Validation

According to CAAMS, data link ATS service is one of the key technologies in the development of ATC in CAAC.



reduce voice communication time

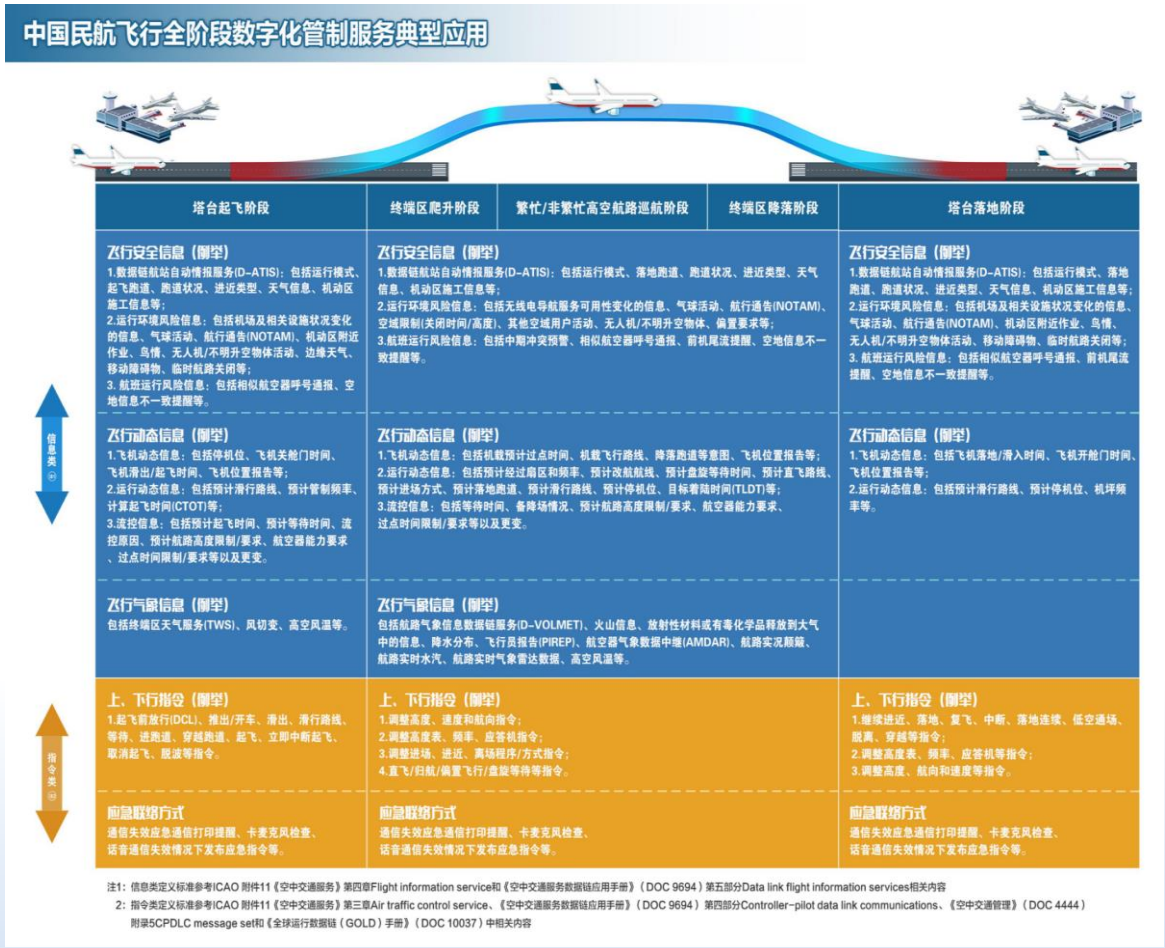
Improve the safety, reliability and accuracy

ATMB is committed to promoting the application of data link technology.

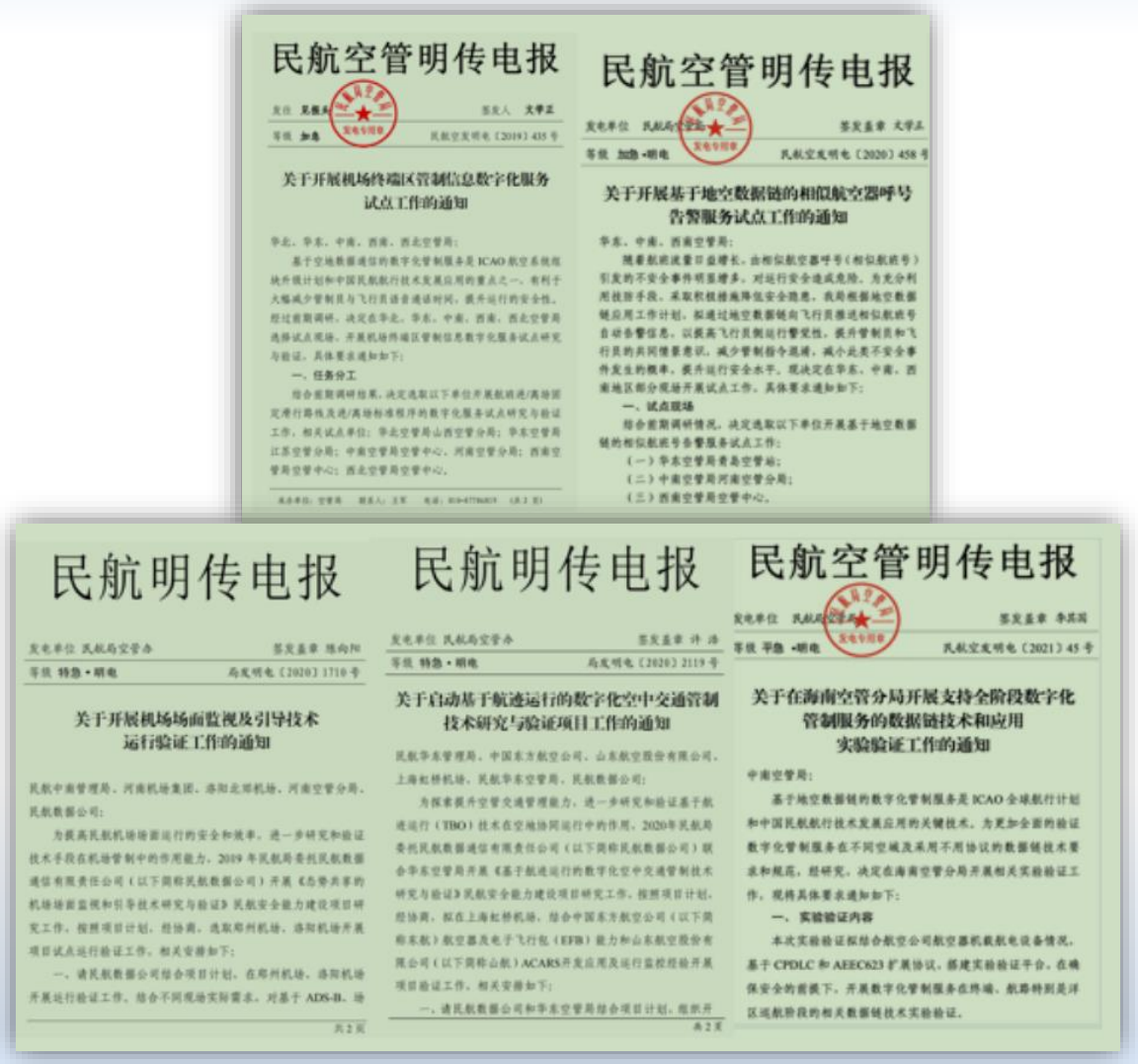
- DCL and D-ATIS at nearly **60 airports**
- D-CDM service at **134 airports**
- D-VOLMET service **in all airspace**
- CPDLC and ADS-C service **in L888**

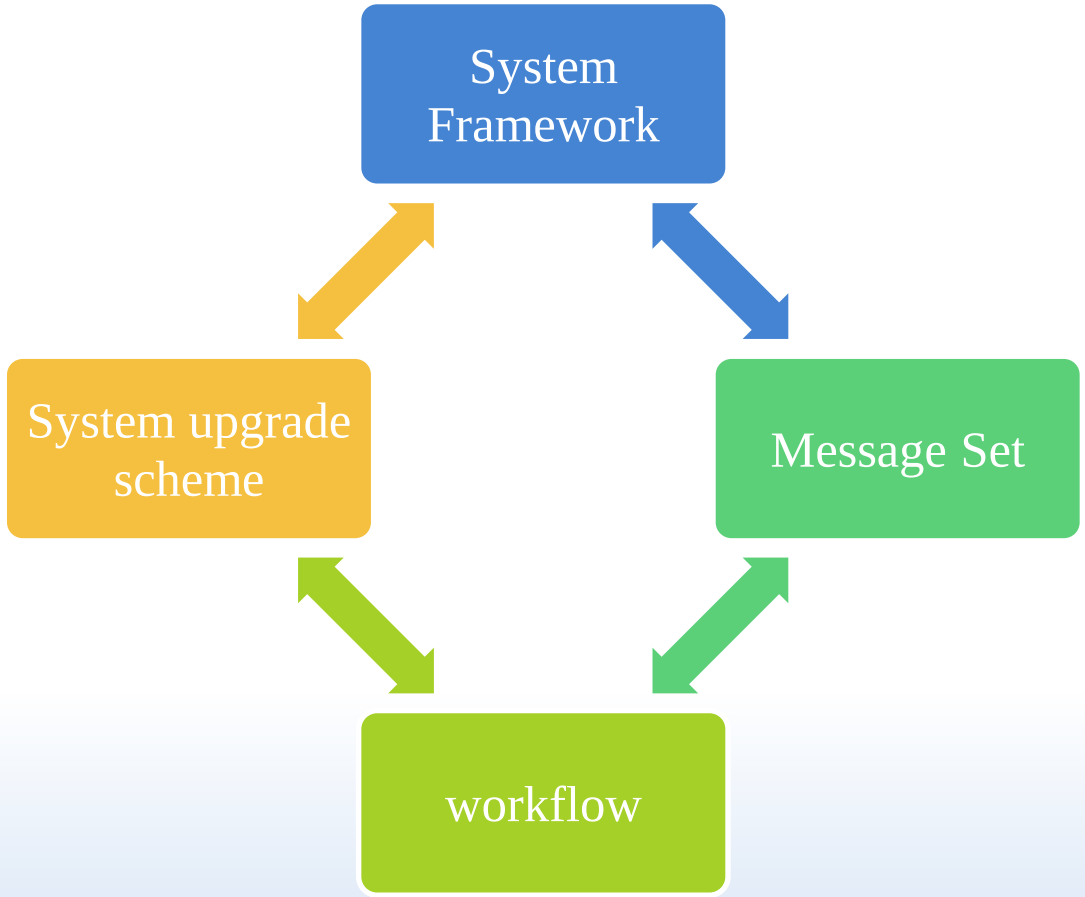
Verification of datalink ATS service at all flight phases began in 2018.

- Fully exploiting the capability of the existing datalink system of China's civil aviation.
- Study the feasibility of applying data link service at all phases of a flight in busy airspace.
- Verification work was carried out in multiple busy airspace over eastern China.
- The content of this paper comes from the work of Beijing, Zhengzhou, Guangzhou and Haikou.



Overview of the Validation

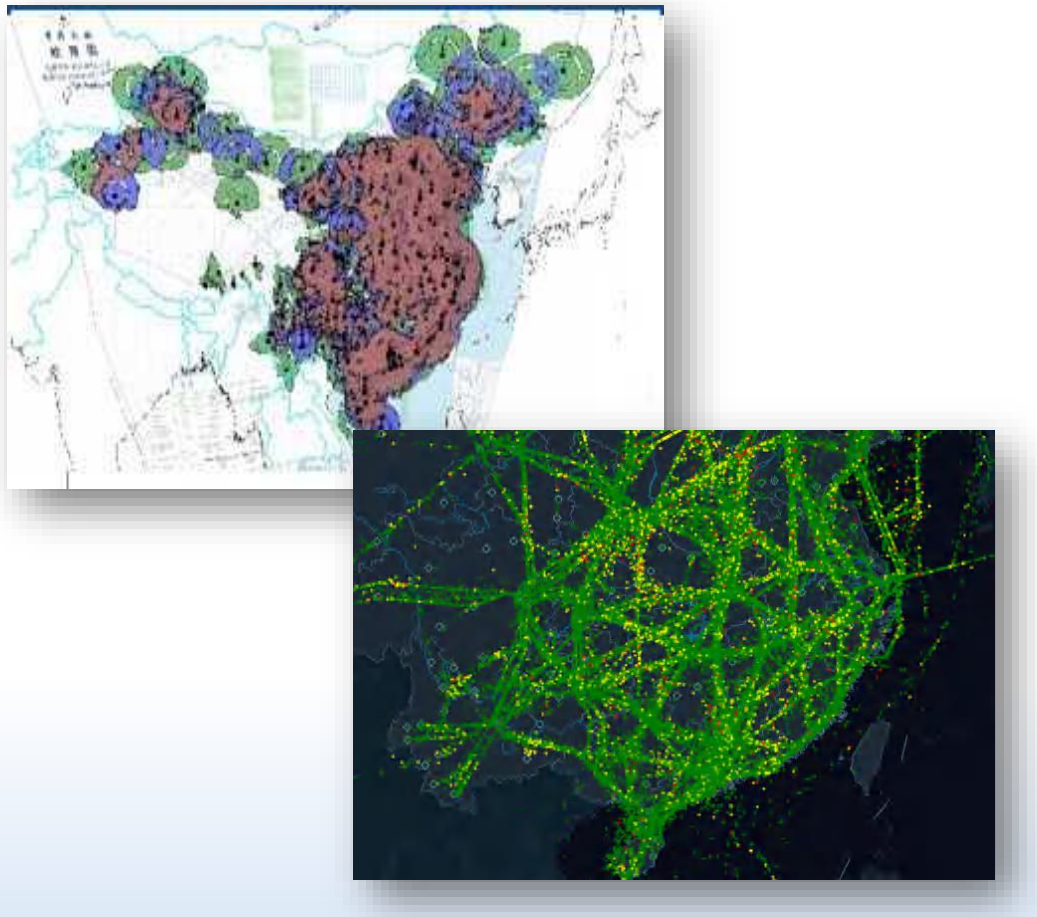




225 RGS, including 146 VDL Mode2 stations.

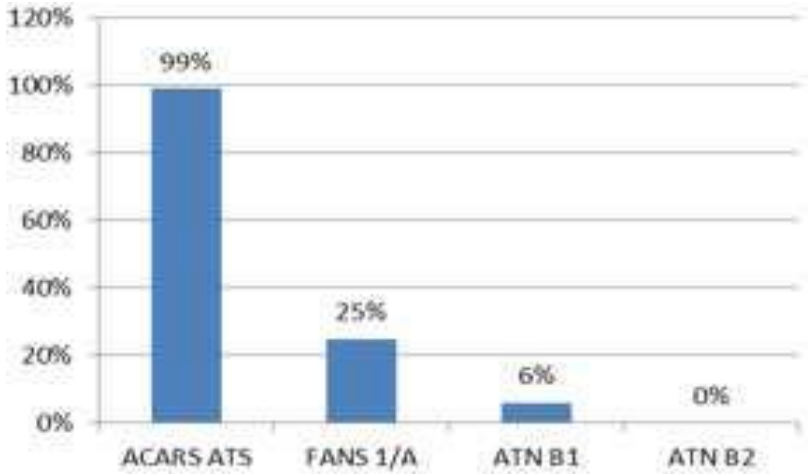
ACARS network covers major airports and air routes.

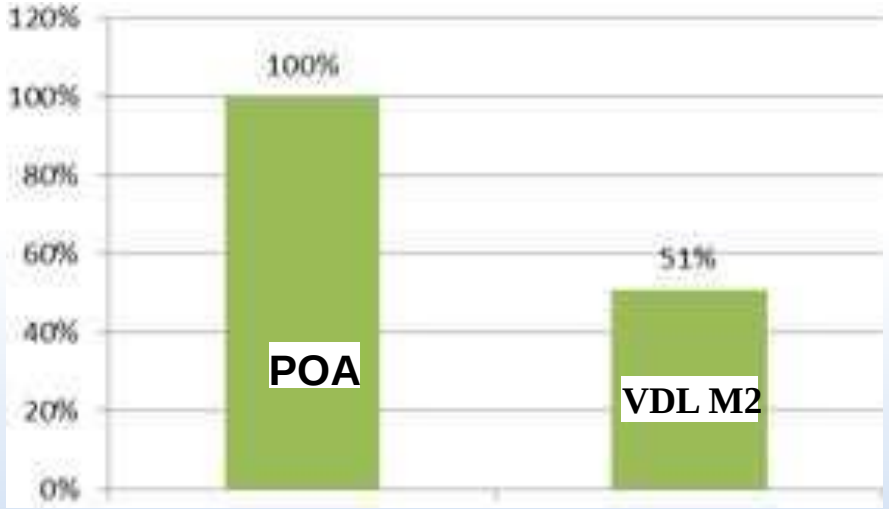
VDL Mode 2 network covers major airports



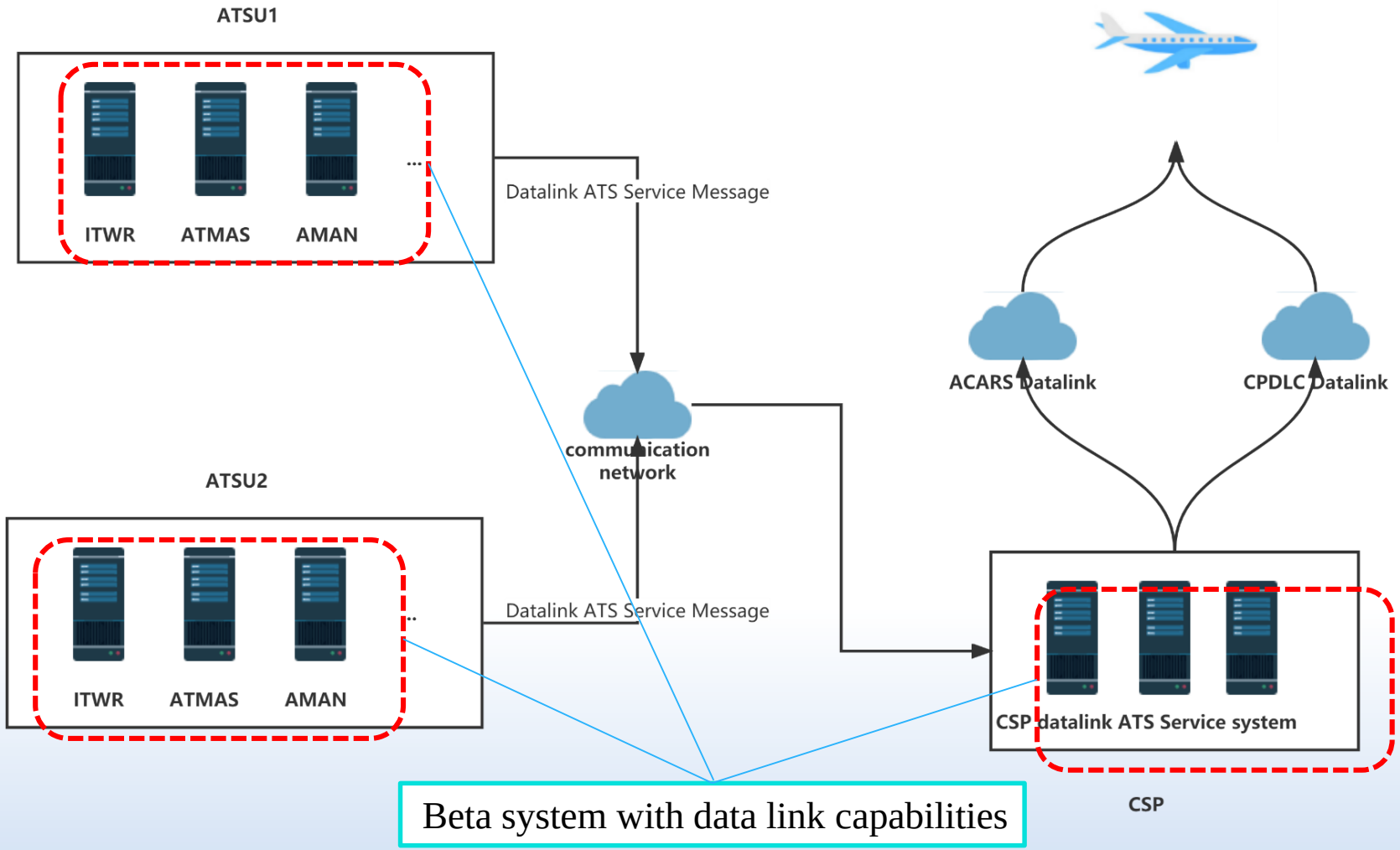
Passenger aircraft with over 99 seats in China

- **Over 99% support ACARS ATS;**
- **25% support FANS1/A;**
- **100% support POA(ACARS);**
- **51% support VDL Mode 2.**





System Framework for Datalink ATS Service of All Phases of a Flight

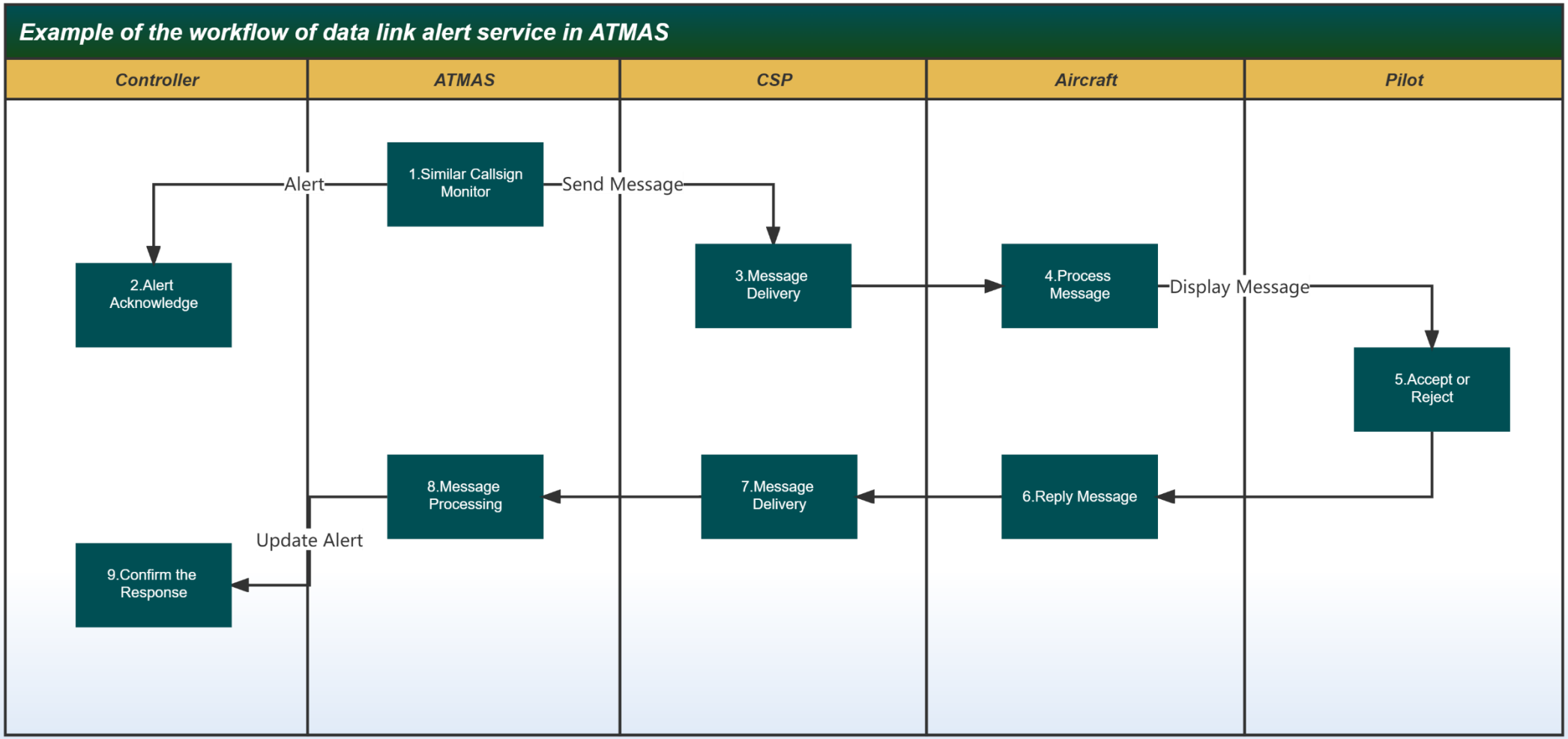


Works related to ATMAs

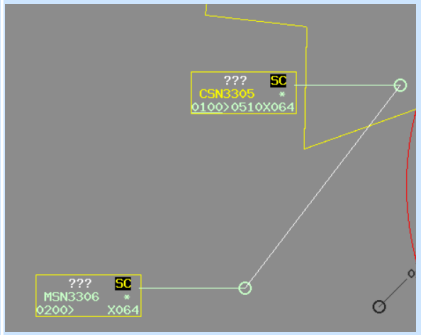
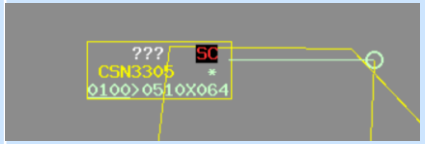
- **Workflow for the implementation of data link services in ATMAS;**
- **Message set suitable for integration into ATMAS;**
- **Upgrading scheme of ATMAS**

- Example of the workflow of data link alert service in ATMAS
- Message sets suitable for integration into ATMAS
- Research on upgrading scheme of ATMAS

Example of the Workflow of Data Link Alert Service in ATMAS



Example of the Workflow of Data Link Alert Service in ATMAS

Service Stage	Alert for Controller	Note
• An alert has been detected • ATS Message has been sent		The label displays a yellow "SC", and if two flights are involved, the two symbols are connected
The message that pilot accepts the alert has been received		The "SC" in the label turns green
Abnormal conditions (failure to send, pilot reject, timeout, etc.)		The "SC" in the label turns red

Example of Message Display for Pilot

The pilot can see the service message on the screen of onboard data link terminal

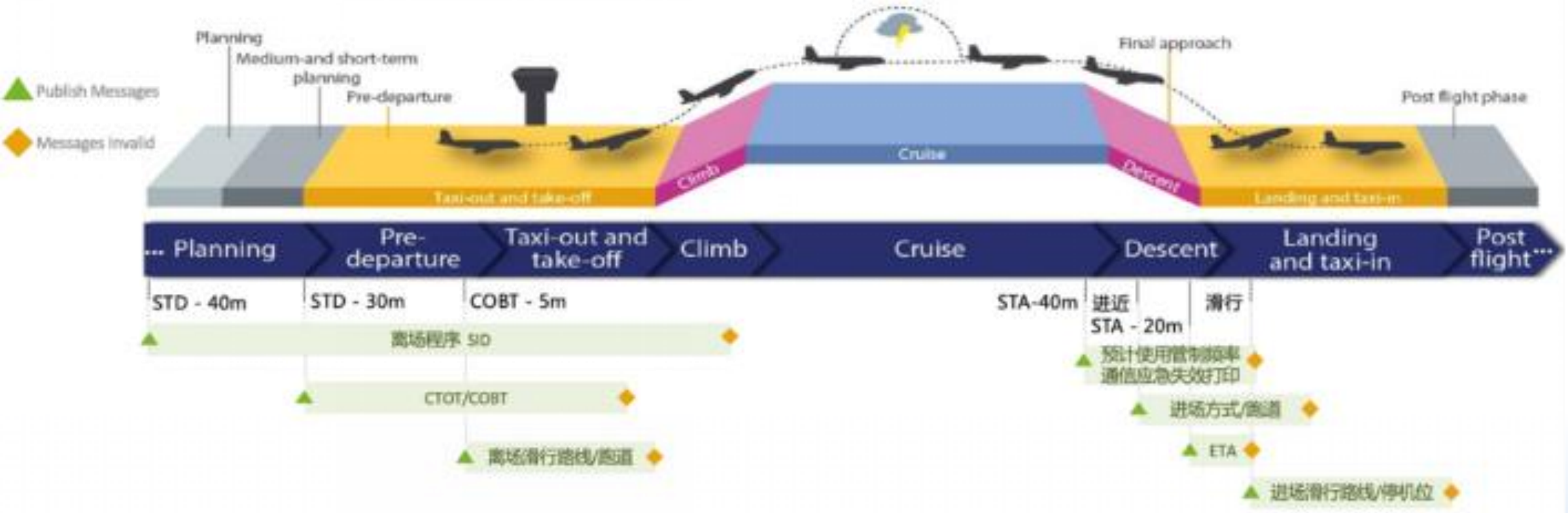
ATS Service Display On MCDU

Example of the workflow of data link alert service in ATMAS

Message sets suitable for integration into ATMAS

Research on upgrading scheme of ATMAS

The Results of the Verifications



The Results of the Verifications

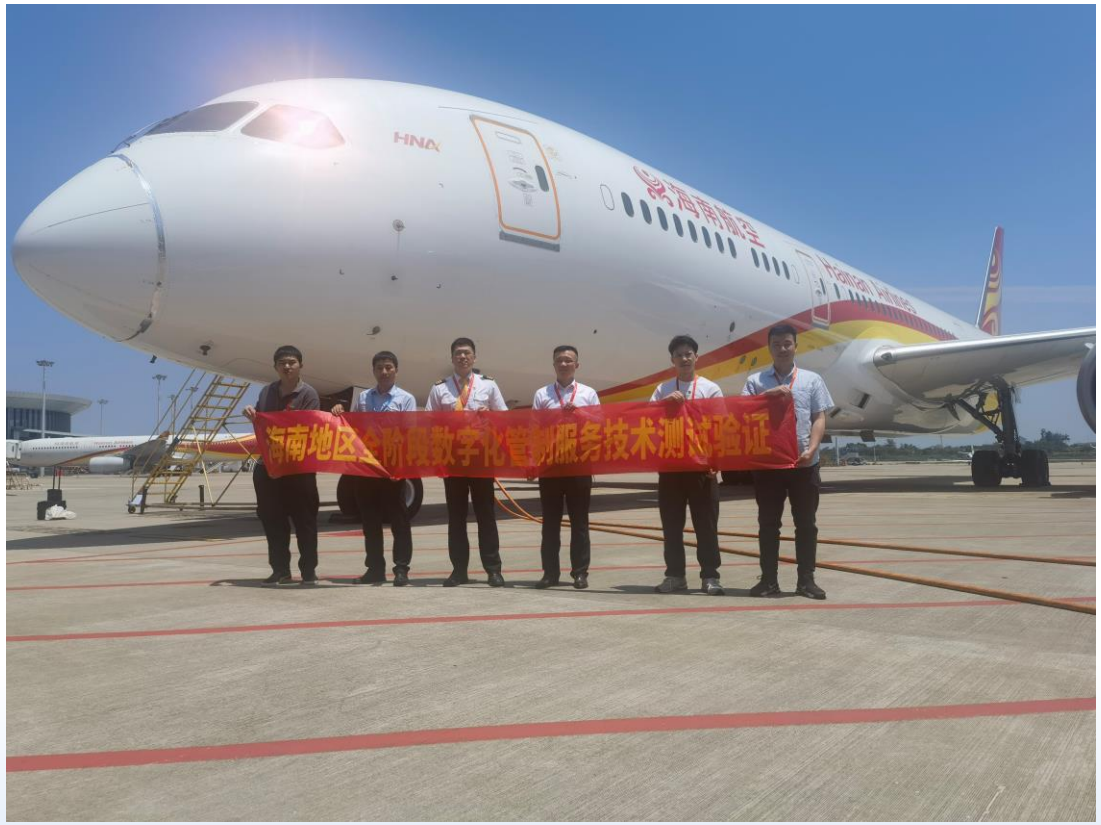
Application Scenario	Flight Phase	Is integrated into AMTAS
SID Notification	40 minutes before departure	NO
CTOT/COBT Notification	30 minutes before departure	NO
Departure Runway and Taxi-out Route Notification	After departure clearance (or 5 minutes before COBT)	NO
Expected frequency Notification	Airborne phase (climb, cruise, descent)	YES
Emergency communication when voice communication fails	Airborne phase (climb, cruise, descent)	YES
Similar Callsign Alert	Airborne phase (climb, cruise, descent)	YES
Callsign Inconsistency Alert	Airborne phase (climb, cruise, descent)	YES
STAR and landing runway Notification	Approach phase	YES

The Results of the Verifications

Application Scenario	Flight Phase	Is integrated into AMTAS
ETA Notification	Airborne phase (climb, cruise, descent)	YES
Speed Confirmation	Airborne phase (climb, cruise, descent)	YES
Course Clearance	Airborne phase (climb, cruise, descent)	YES
Crossing Position Restrict	Airborne phase (climb, cruise, descent)	YES
Route offset Clearance	cruise	YES
Frequency Testing	Airborne phase (climb, cruise, descent)	YES
Radar Target Loss Alert	Airborne phase (climb, cruise, descent)	YES
Taxi-in Route and Parking Bay Notification	Landing, Taxi-in	NO

Ground verification at Haikou Airport

- Most of the scenarios were verified.
- By a B787-9 aircraft on the tarmac.
- ATS service messages were sent using CPDLC and ACARS links respectively for each scenario.



- All verified messages were successful. (B787-9's avionics has high level of support for data link services)

- The delay of the same instruction transmission through the ACARS and CPDLC link is not much different, and the average delay is about 3±0.5s. It seems that most of the communication delay comes from the air-ground transmission

Statistics of verification results under actual operation of Zhengzhou Airport(A few scenario)

Duration	3 month	Number of flights	13199	Number of aircrafts	1906

Total MSG 15252	Non-VDL M2:7172 VDL M2:8080

Message COMM Success Rate	95.15%

*Most Message communication failure is because the RGS station switchover is encountered

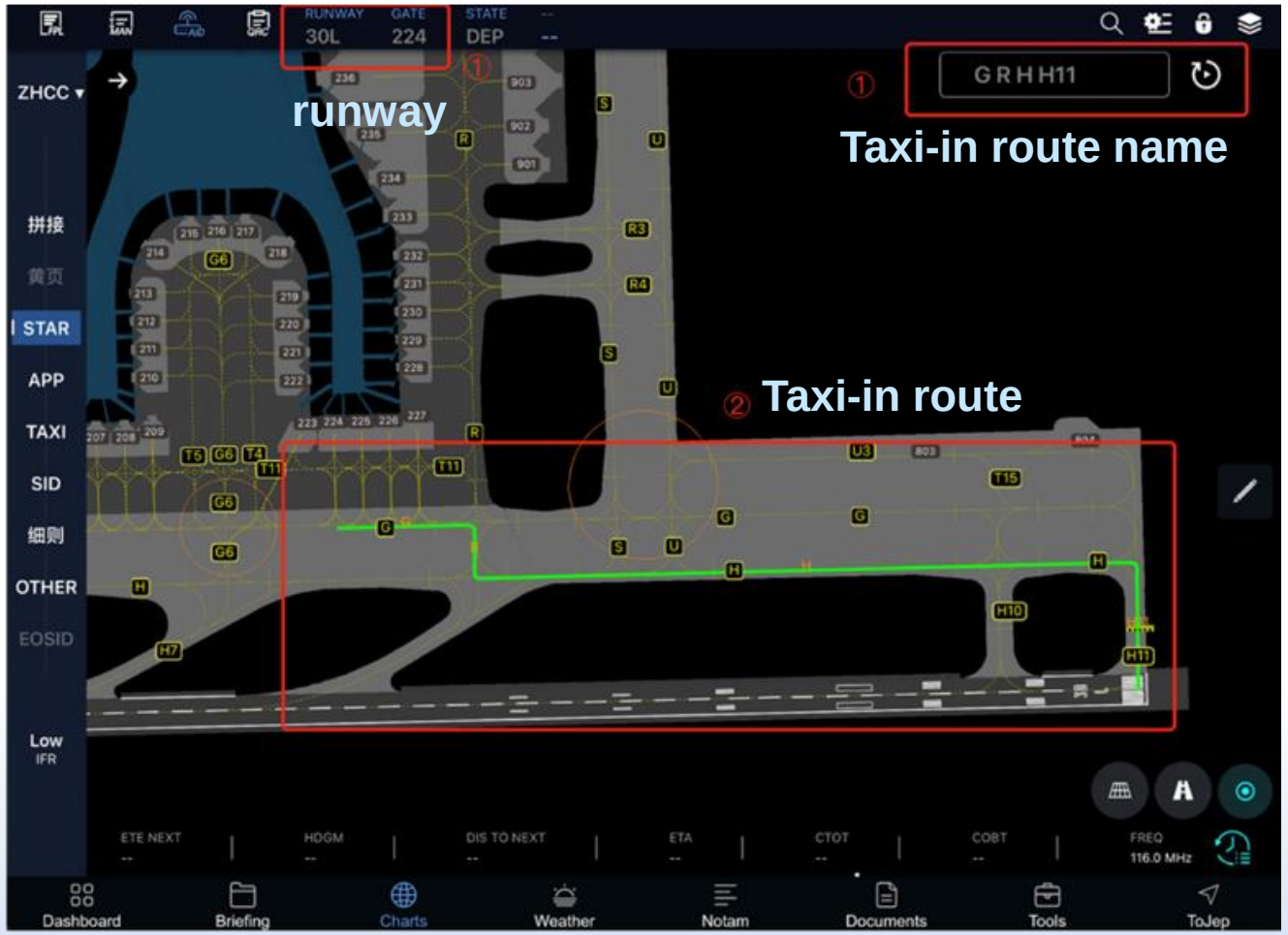
Average Delay (MAS receive time – Message send time)	1037 aircrafts supports VDL M2 Non-VDL M2: 7.63 Sec VDL M2: 4.29 Sec

*According to the delay statistics, ensure adequate RGS coverage, even through the None VDL M2 network, the message delay is basically less than 10 seconds, which can meet the requirements of most ATS services.

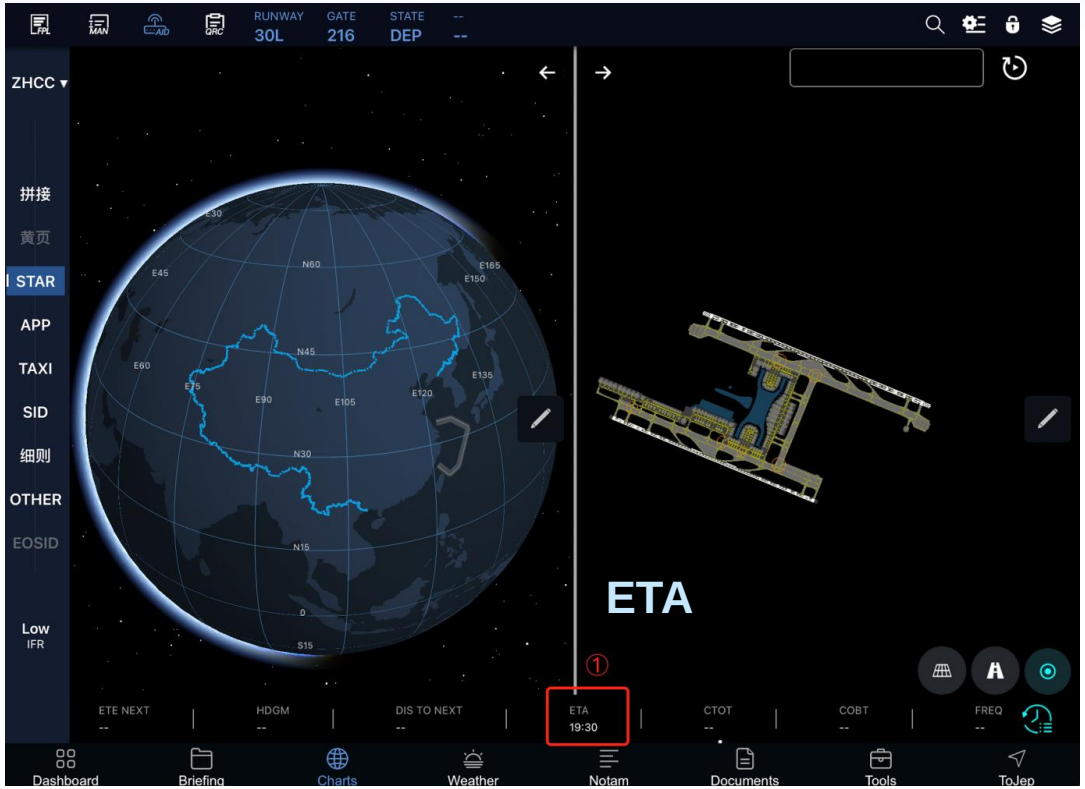
The Results of the Verifications

地面TIMES系统

机载EFB显示



The Results of the Verifications



Some application scenarios use a specific instruction set, such as emergency communication

Phase 1: Initial emergency communication
(aircraft identification) CONTACT ZGGG ACC ON 121.5
(aircraft identification) CHECK STUCK MICROPHONE

Phase 2: Confirm flight status
(aircraft identification) CONFIRM VOICE RADIO COMMUNICATION FAILURE
(aircraft identification) CONFIRM RADIO FAILURE EMERGENCY
(aircraft identification) CONFIRM OPERATION NORMAL

Phase 3:Emergency operation
(aircraft identification) SQUAWK (SSR code)
(aircraft identification) PROCEED DIRECT TO (position)
(aircraft identification) CONTINUE PRESENT HEADING (aircraft identification) FLY HEADING (degrees)
(aircraft identification) MAINTAIN (level)(aircraft identification) CLIMB TO (level)(aircraft identification) DESCEND TO (level)

- Example of the workflow of data link alert service in ATMAS
- Message sets suitable for integration into ATMAS
- Research on upgrading scheme of ATMAS

Research on Upgrading Scheme of ATMAS

Connection Management

- AFN_Logon and CPDLC Connection management and ADS-C contract management functions

Message Support

- Supports the message set required to implement the datalink ATS service, which is A subset of the FANS1/A Message

Human Interface

- Improve the HMI, including track label, track symbol, electronic flight strip, message editing window, message query window, warning message window, etc.

Functional integration

- Integrate the data link ATS service with the existing functions of ATMAS, including safety net functions, planning processing, and so on

Datalink Connection management in ATMAS following Doc.10037, RTCA 258A

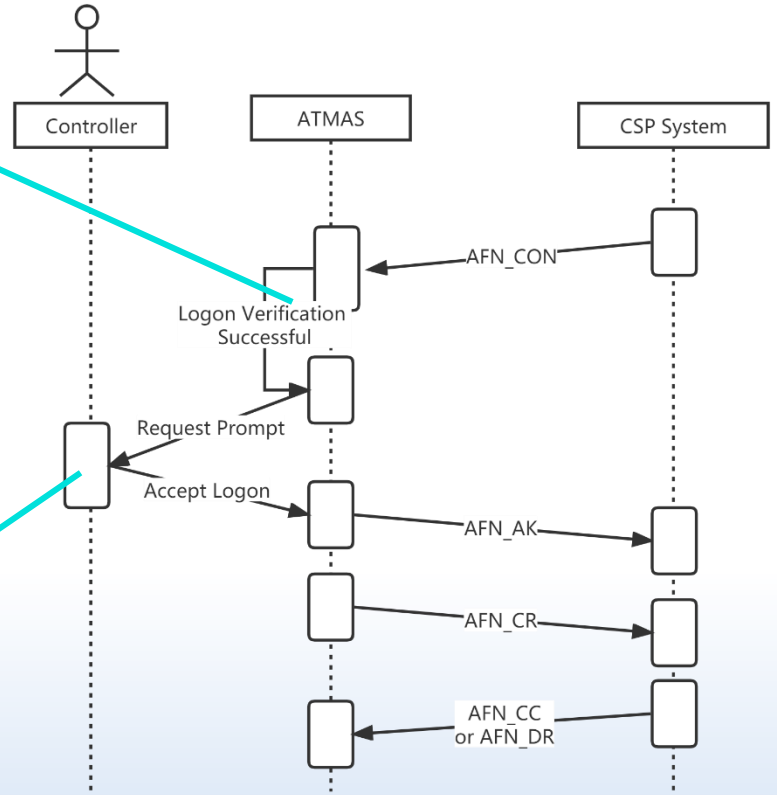
Login and initial CPDLC Connection establishment Process

When the aircraft logon request(AFN_CON) is received, ATMAS first performs login verification.

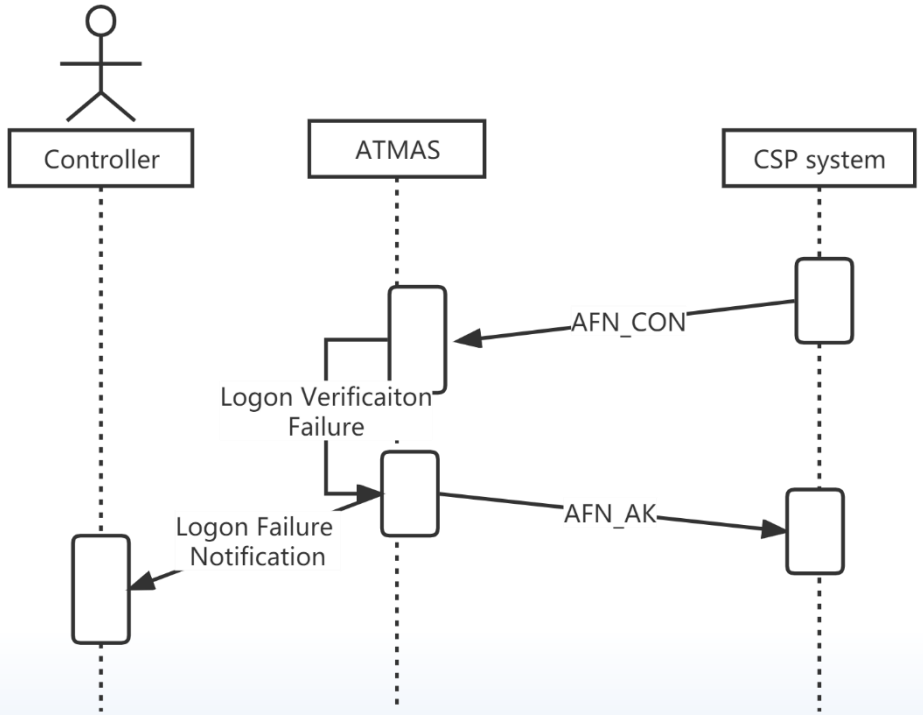
- Data link service authorization
- Check for flight plan correlation
- Whether the logged aircraft exceeds system capacity
- ……

When the logon verification is successful, the system prompts the controller to handle the logon request.

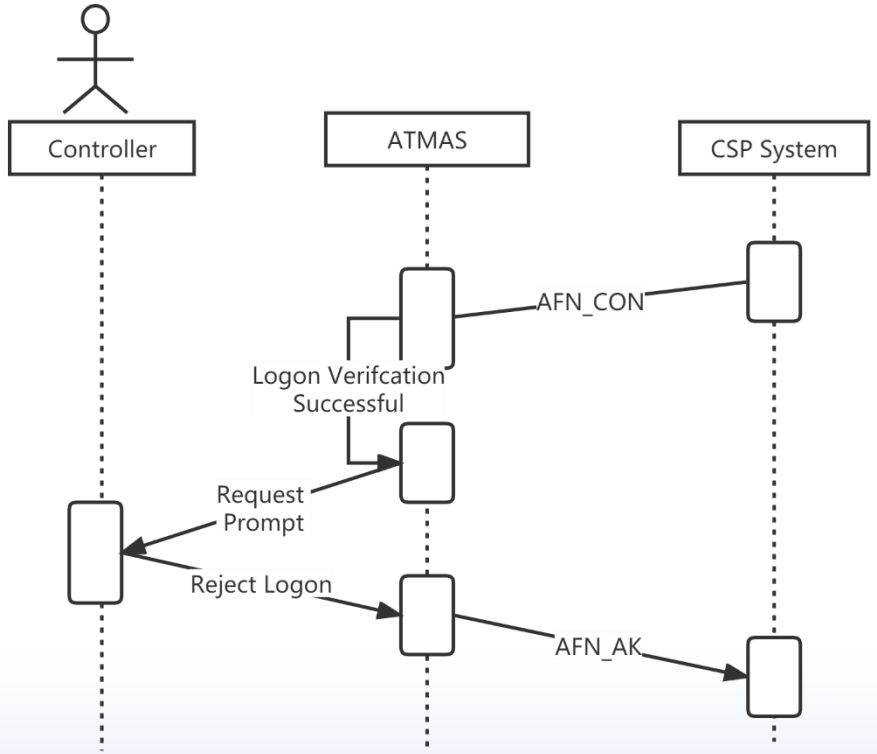
- The controller needs to handle some anomalies in the login verification, if any (ex. two flight plans are correlation),
- and decide whether to accept the logon request



Login Failure Process

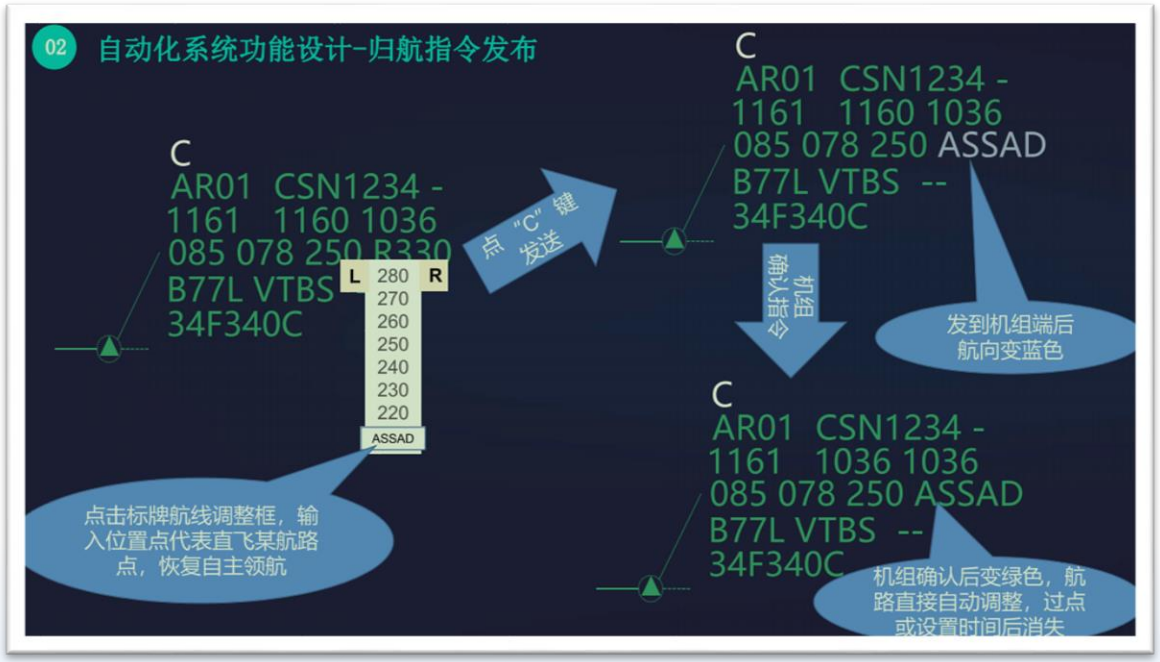


Logon Verification Failure



Controller Reject Logon

Some draft of the HMI design



Label Display	Note	Label Display	Note
M	Uplink message instruction to be sent.	M	Invalid uplink message format or parameters
M	Uplink message has been sent, waiting for reply message from aircraft.	M	Time out and no reply from the aircraft
M (twinkle)	Received downlink message (non-emergency), wait for controller's reply	M	Received negative replies such as "UNABLE" from aircraft
M	For uplink message needs reply, a positive replies such as "WILCO" has received; For uplink message doesn't need reply, a MAS message from avionic has received.	M (twinkle)	Downlink emergency such as "MAYDAY" and "PAN" were received

Summary and Future Work

It is a feasible transition scheme to implement a wide range of ATS services based on ACARS in an efficient land-based communication network.

- Lower investment to meet most of the requirements. Without large-scale upgrades of avionics.
- Under the premise of ensuring sufficient RGS coverage, the communication quality can meet the application requirements.
- Even ACARS ATS messages can only be displayed to the pilot and cannot be used as instructions for avionics, but it can still significantly reduce the load of voice communication.
- Compared with CPDLC, ACARS lacks authorization management. This can be addressed through ground systems and procedures management.

For controllers to use data link ATS service more efficiently. The following work will be carried out in the future:

- Further, clarify the required data link service message and workflow in various scenarios.

- Improve the upgrade scheme of ATMAS, especially the improvement of HMI and the linkage with existing functions.

- Carry out the research and verification of the data link service transfer scheme. This includes
  - Integrating the CPDLC transfer process with the existing AIDC handover process and 4029.3 handover process;
  - Develop data link service transfer schemes between air traffic control systems, such as data link service transfer between integrated tower and ATMAS.
  - Synchronization of data link service messages between main and standby ATMAS.

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Thank You