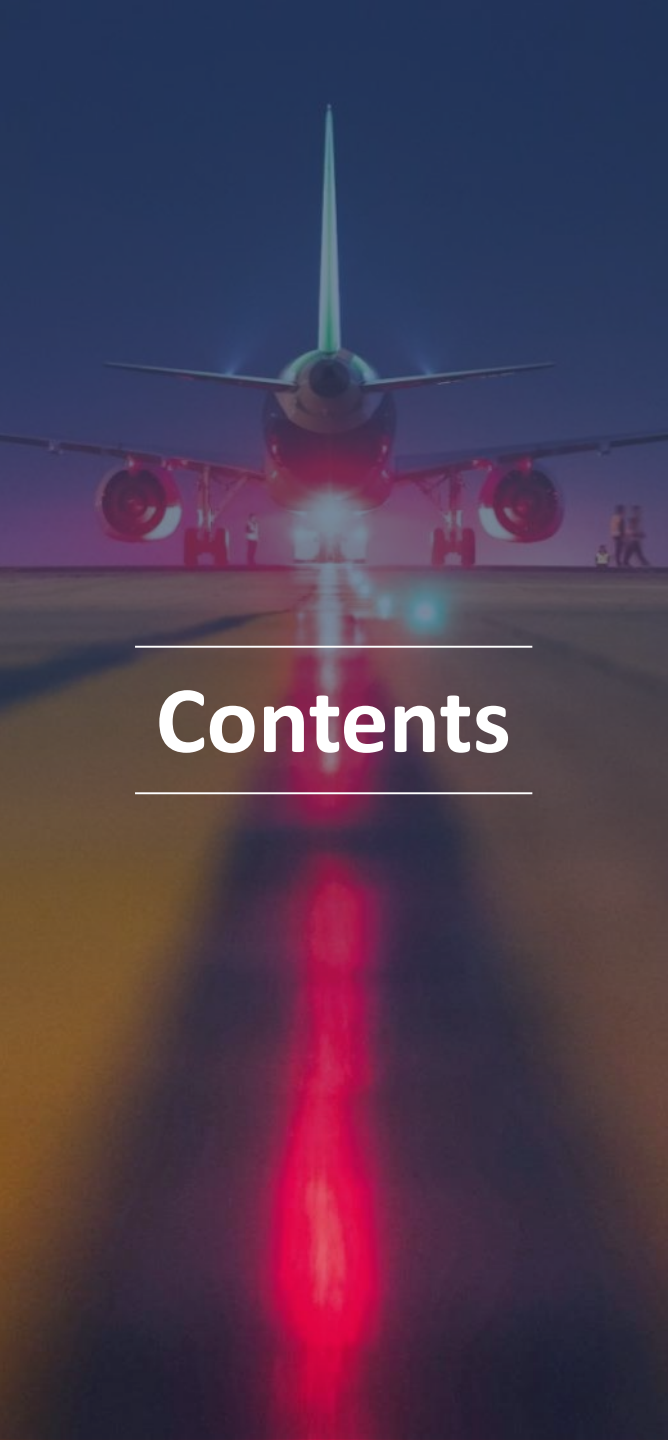
THE BDS APPLICATIONS ON CIVIL TRANSPORT AIRCRAFTS

Commercial Aircraft Corporation of China (COMAC)

JIANG, Xin

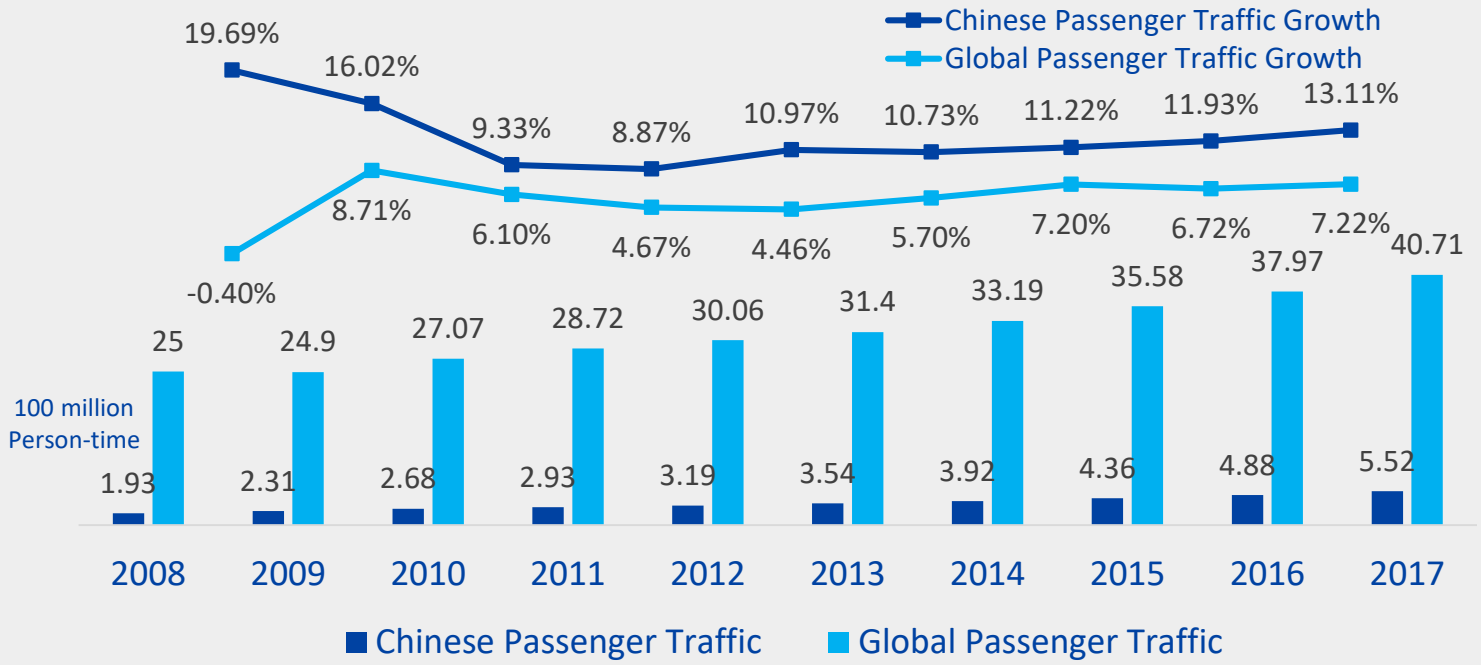
November, 2018



Contents

1 Requirements

- **Rapid growth of civil aviation requires safe & efficient navigation technologies**



Global

4.5 billion person-times in 2020

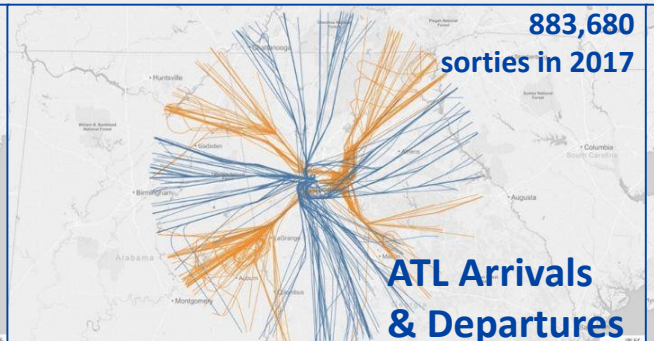
7.2 billion person-times in 2035

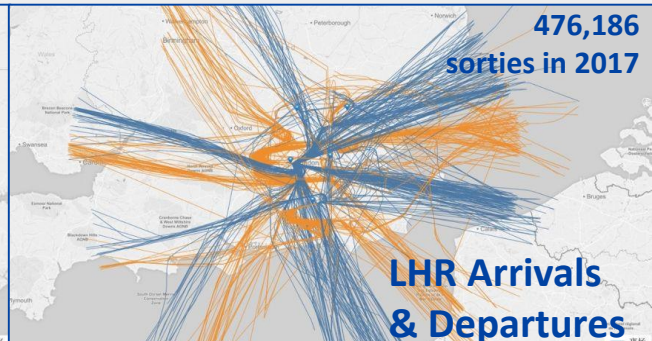
China

720 million person-times in 2020

1.3 billion person-times in 2035

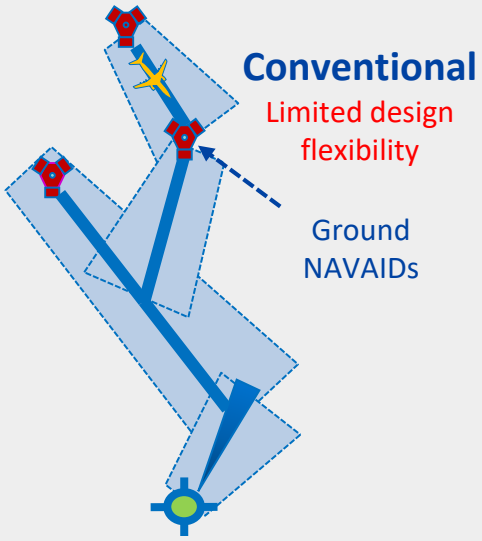
Data from:
- CAAC Civil aviation industry development statistics bulletins
- ICAO Annual Reports
- IATA 20 Year Passenger Forecast





1 Requirements

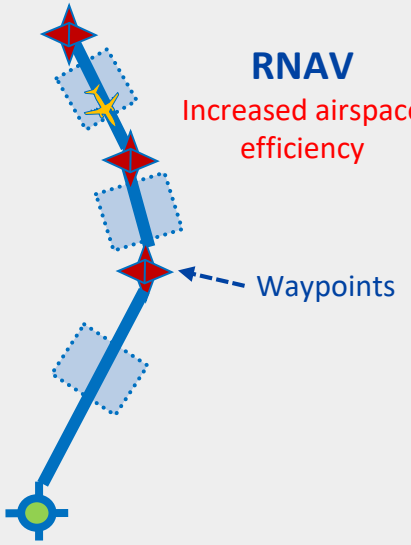
- **Performance Based Navigation (PBN)**



Conventional

Limited design flexibility

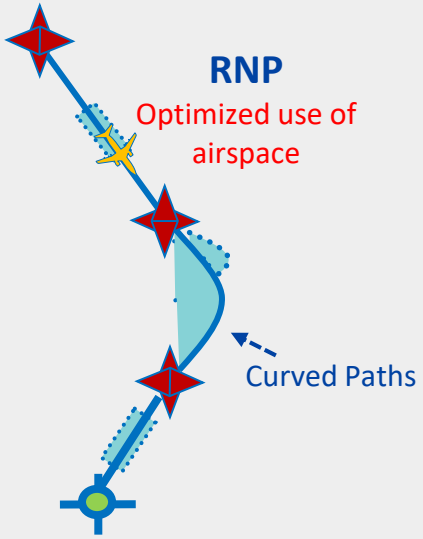
Ground NAVAIDs



RNAV

Increased airspace efficiency

Waypoints



RNP

Optimized use of airspace

Curved Paths

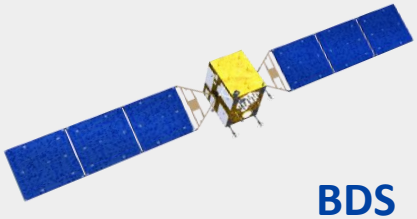
* CAAC PBN Roadmap

	Departure	En Route	Arrival	Approach
Performance Standard	RNAV 1 RNP 1	RNAV 2,5,10 RNP 4	RNAV 1 RNP 1	RNP APCH RNP AR APCH
Navigation Source	GNSS DME INS/IRS	GNSS DME,VOR INS/IRS	GNSS DME INS/IRS	GNSS/GLS VOR DME

The PBN Space-based navaids include GNSS elements as defined in ICAO Annex 10 - Aeronautical Telecommunications.

-Doc 9613 PBN Manual

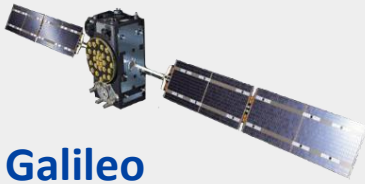
1 Requirements



BDS

GPS

GLONASS



Galileo

- **Onboard Navigation Equipment**

Onboard Navigation	Pros	Cons	Equipment
Satellite-based	**Global coverage High accuracy**	**Vulnerability from interference**	**GNSS**
Ground-based	High reliability	Limited coverage Low accuracy	NDB, VOR, DME, ILS…
Inertial navigation	Work without external signal source	Error accumulation	IRS

- **Advantages of Multi-constellation GNSS**

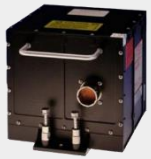
Redundant backup	Reduced signal acquisition time
Improved position and time accuracy	Ability to resist single GNSS system fail

NDB

VOR/DME

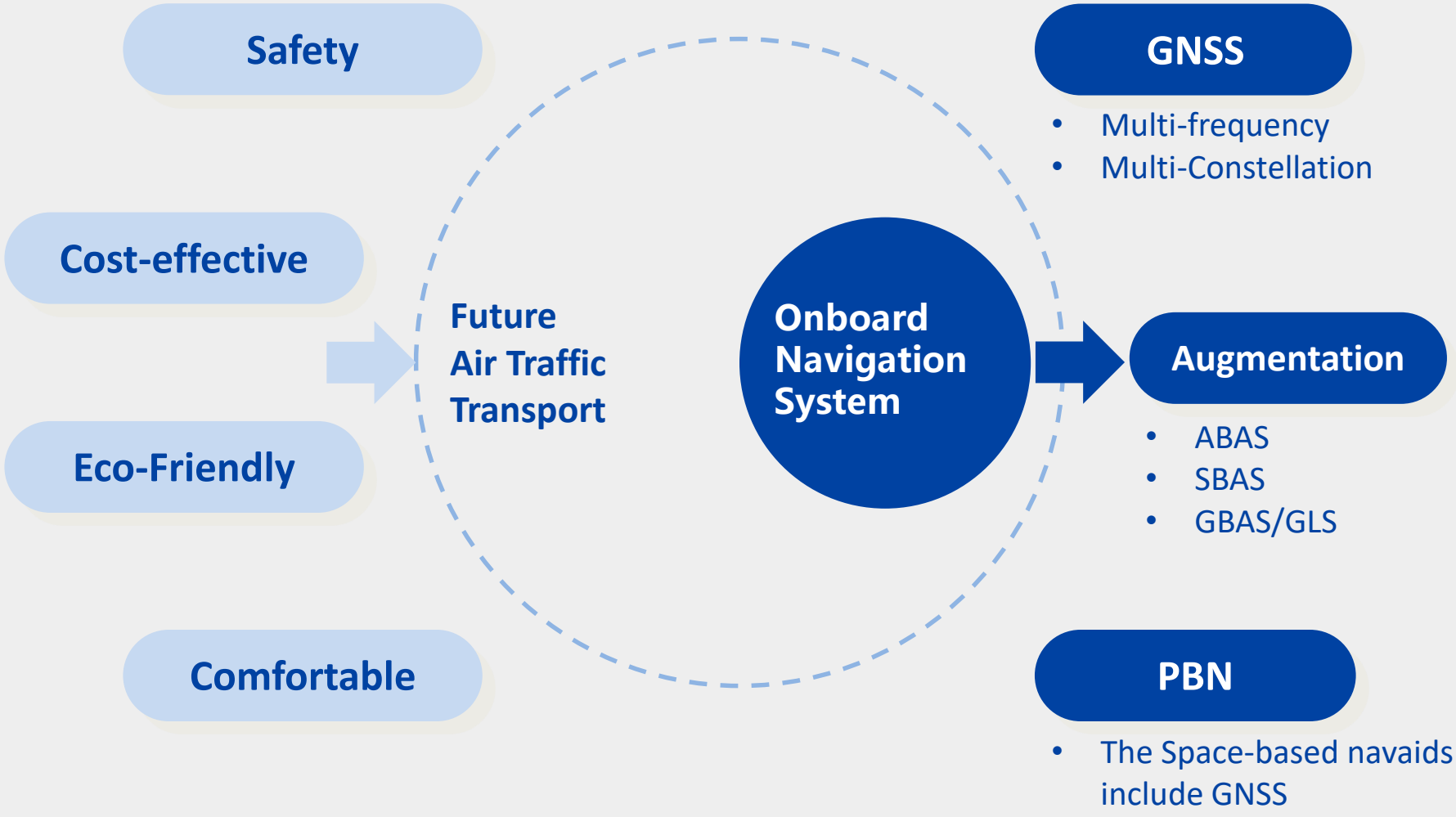
Instrument Landing System

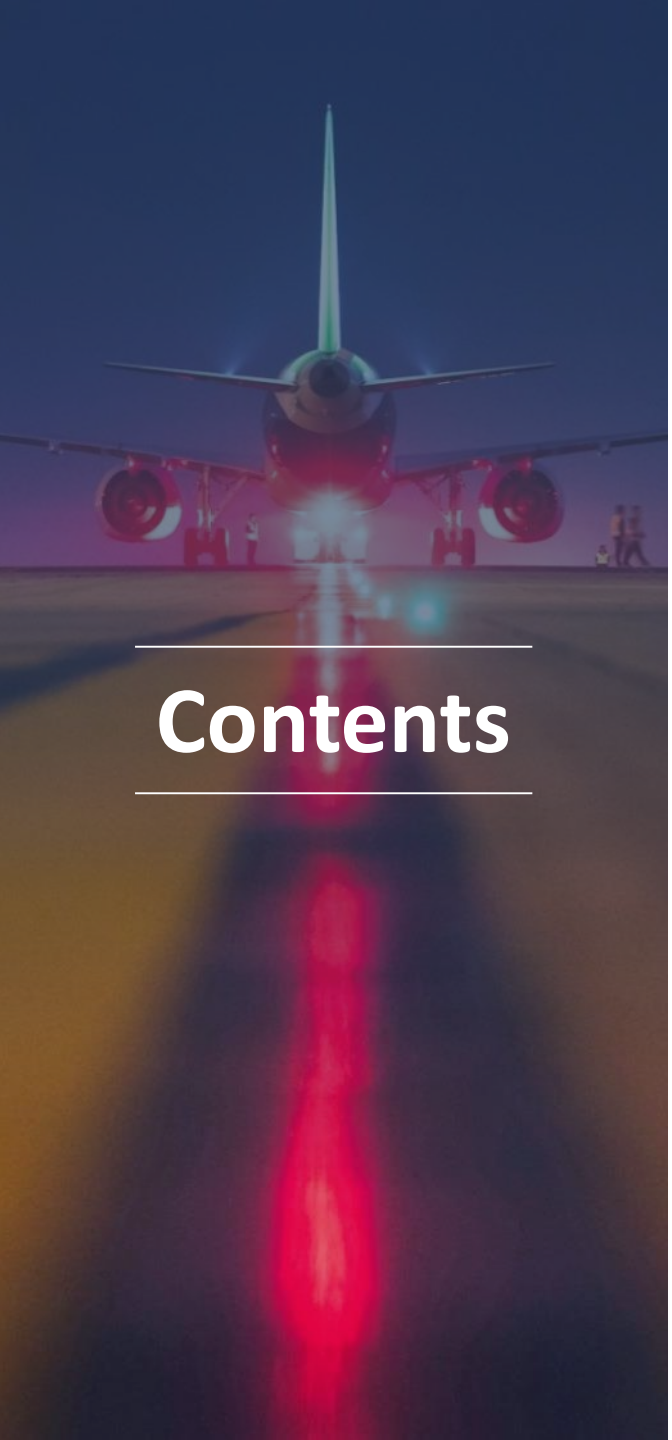
Inertial navigation



1 Requirements

- **Aviation Requirements for Multi-constellation GNSS**





Contents

2.1 The BDS Applications in COMAC

- **COMAC Civil Transport Aircrafts**

ARJ21

A turbofan regional aircraft

- **Layout: 78 to 90 seats**
- **Range: 2225 to 3700 KM**
- **Production Certificate (PC) from CAAC**
- **Route operation**

C919

A large civil jet aircraft

- **Layout: 158 to 168 seats**
- **Range: 4075 to 5555 KM**
- **Finished the first test flight**
- **Will be delivered in 3 to 4 years**

CR929

A dual-aisle civil aircraft

- **Layout: 280 seats**
- **Range: 12000 KM**
- **The Joint Conceptual Development Program of CR929 has been initiated**

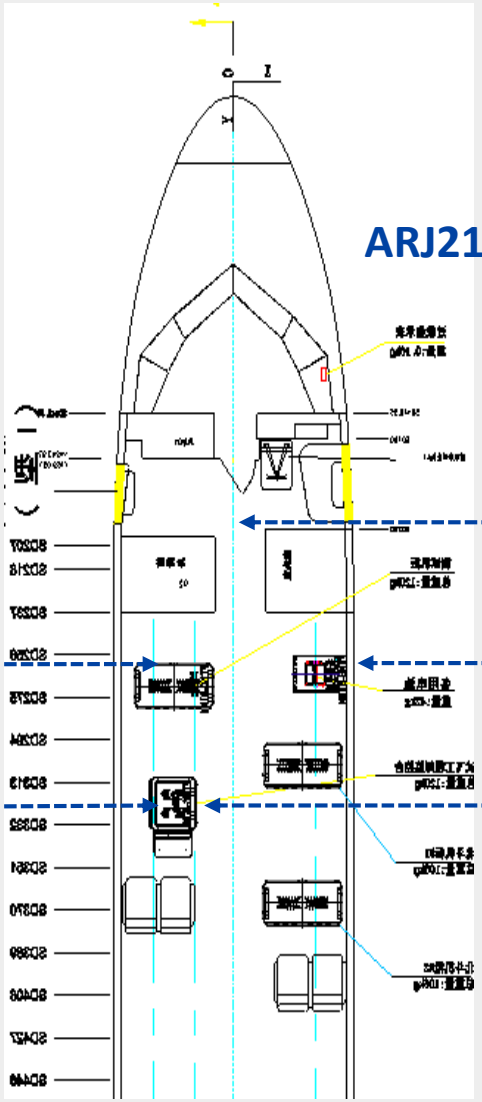
2.1 The BDS Applications in COMAC

- New Multi-Mode Receiver (MMR) Prototype Development and Flight Experiment Modification

New MMR prototype supporting BDS/GNSS

BDS/GNSS Cabinet#1

BDS/GNSS Cabinet#2

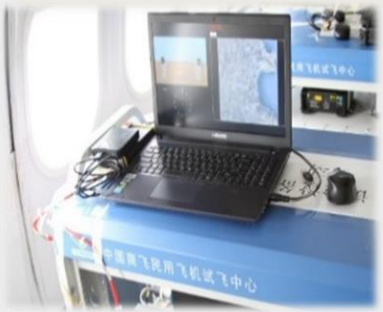


ARJ21-700 #103

Antenna

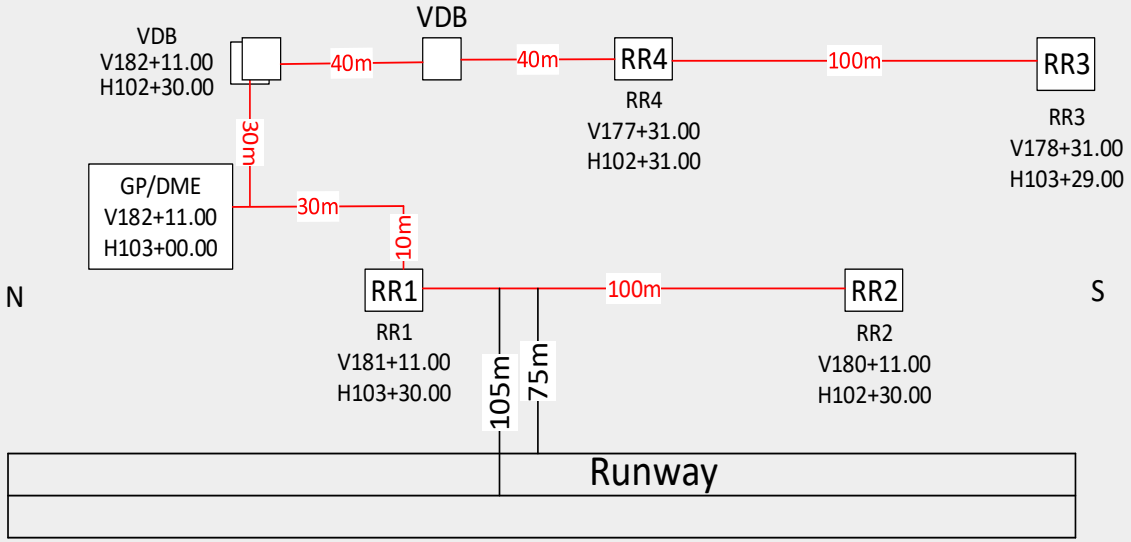
Data Collecting

Monitor Platform



2.1 The BDS Applications in COMAC

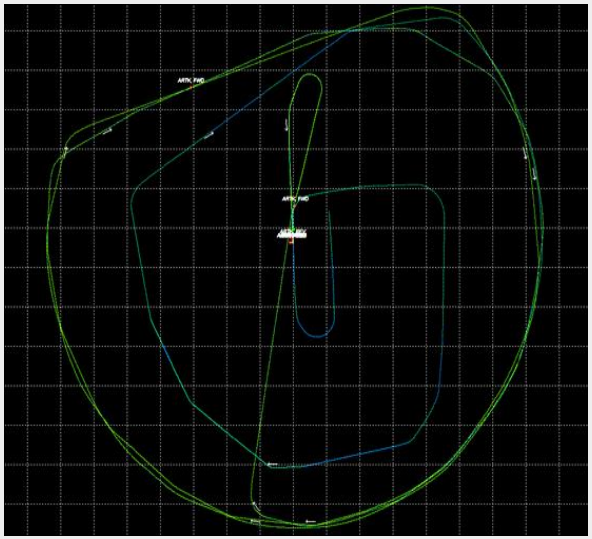
- **BDS/GNSS Based GBAS Installation in Dongying Airport**

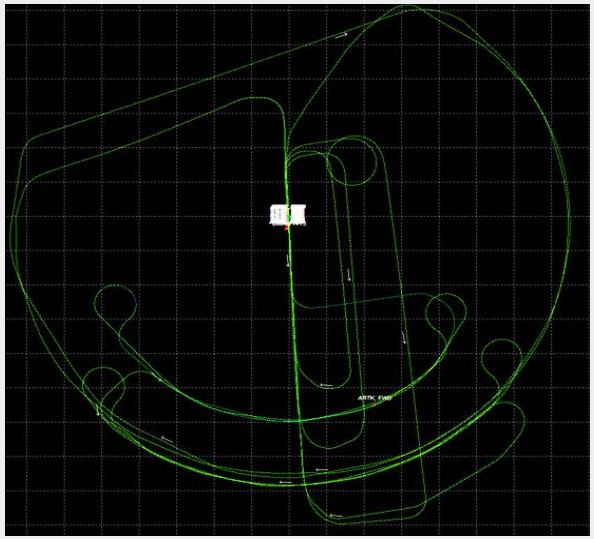


2.1 The BDS Applications in COMAC

- **Flight experiment at Dongying airport (Oct. 2017)**
  - **5 days**
  - **4 sorties**
  - **10 hours data**

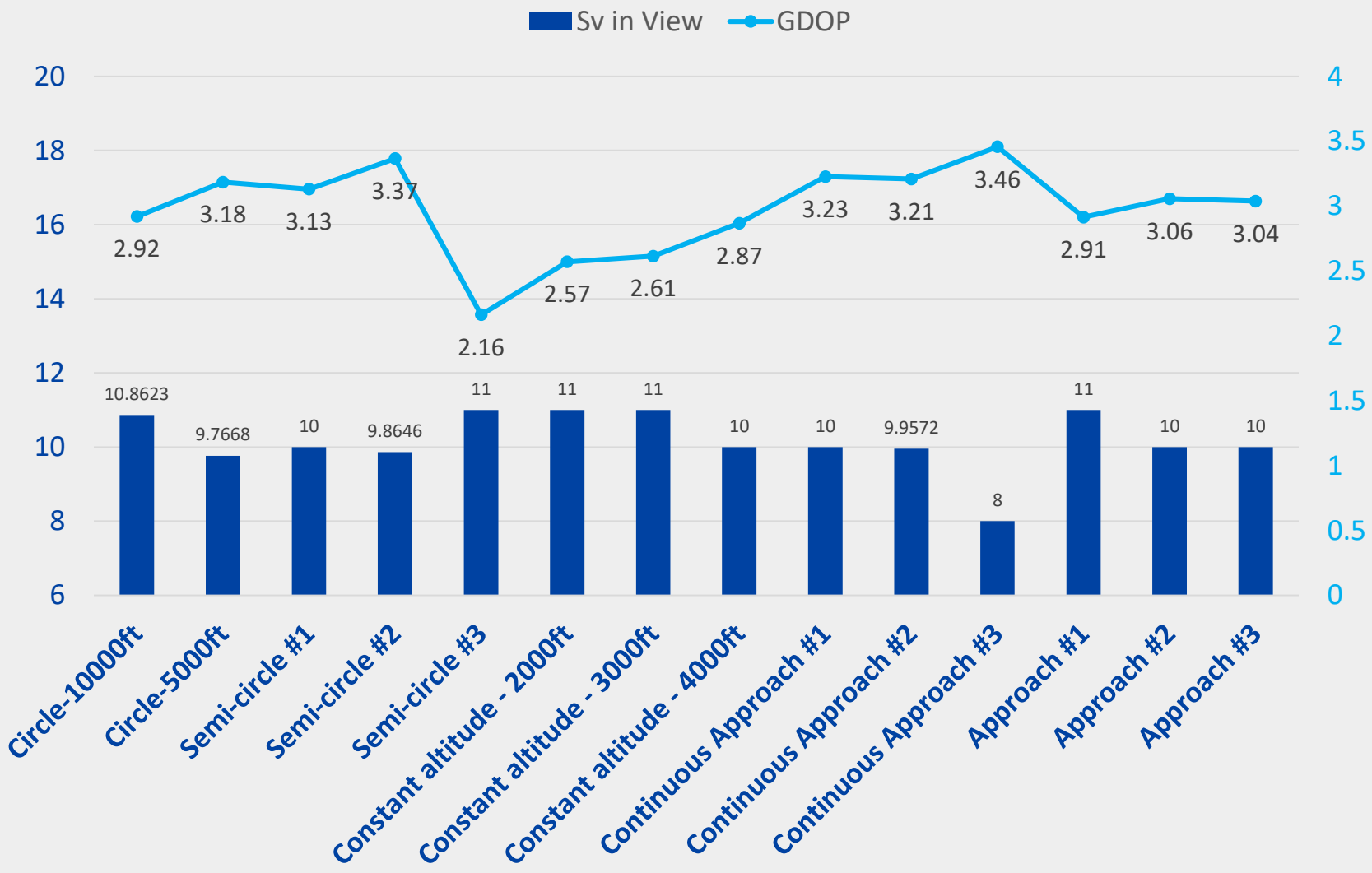
No.	Test subjects	Altitude
1	Circle Flight	10000ft
2	Circle Flight	5000ft
3	Arc Flight	2000ft
4	Level Flight	2000ft
5	Level Flight	3000ft
6	Level Flight	4000ft
7	Approach/ Continuous Approach	As required





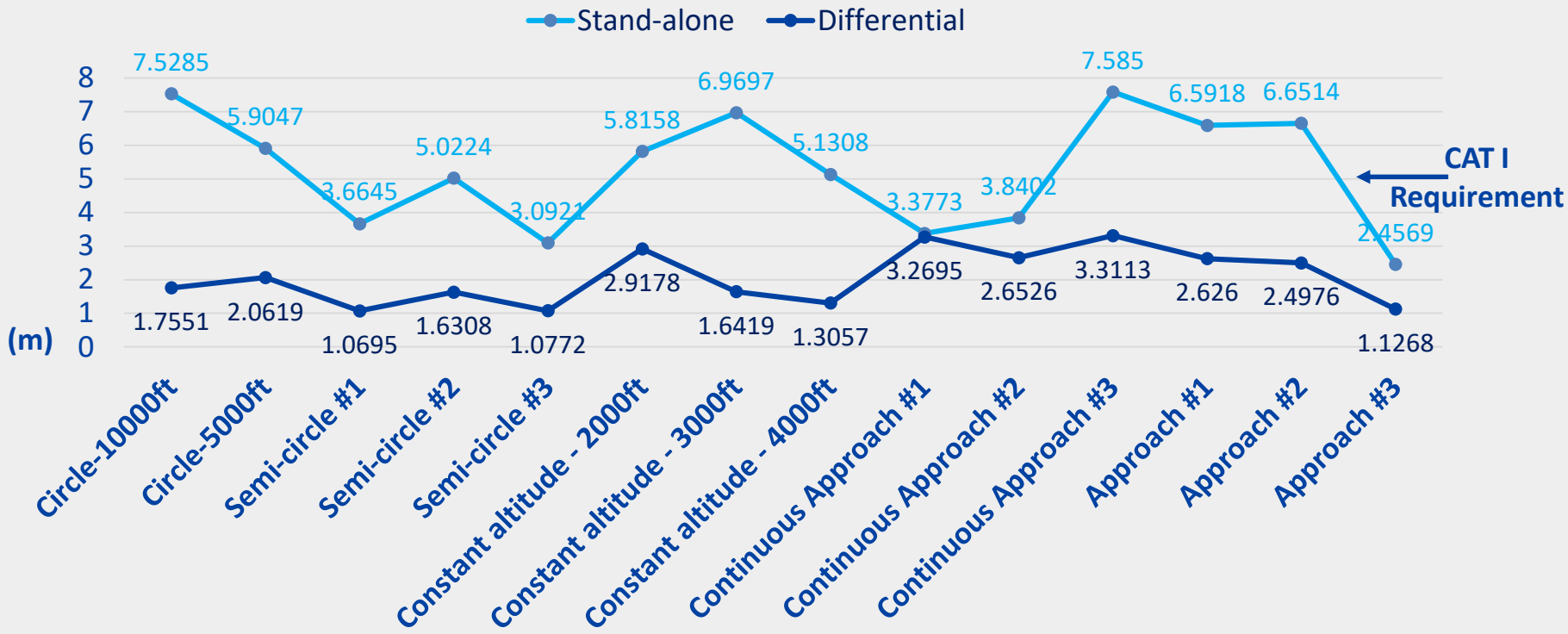
2.1 The BDS Applications in COMAC

- **Average number of BDS satellites in view & GDOP**



2.1 The BDS Applications in COMAC

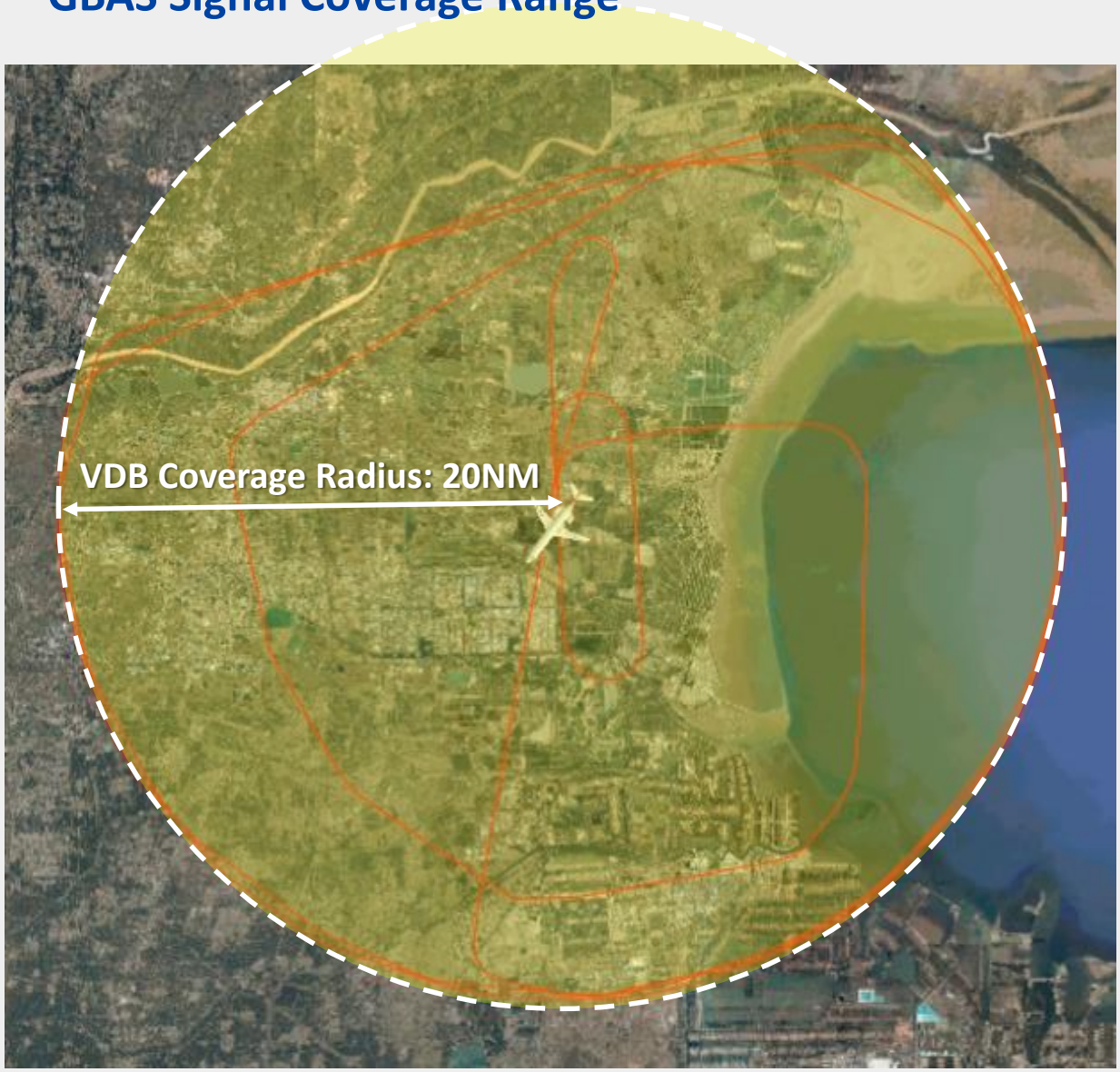
- **BDS vertical positioning accuracy of every sortie**



GPS & BDS Accuracy (95%)		GPS	BDS
Stand-alone	Horizontal Positioning Accuracy	1.2~3.9m	1.1~3.2m
	Vertical Positioning Accuracy	1.2~7.5m	2.1~8.5m
Differential	GLS Horizontal Positioning Accuracy	0.3~2.0m	0.6~2.0m
	GLS Vertical Positioning Accuracy	0.8~3.0m	1.1~3.3m

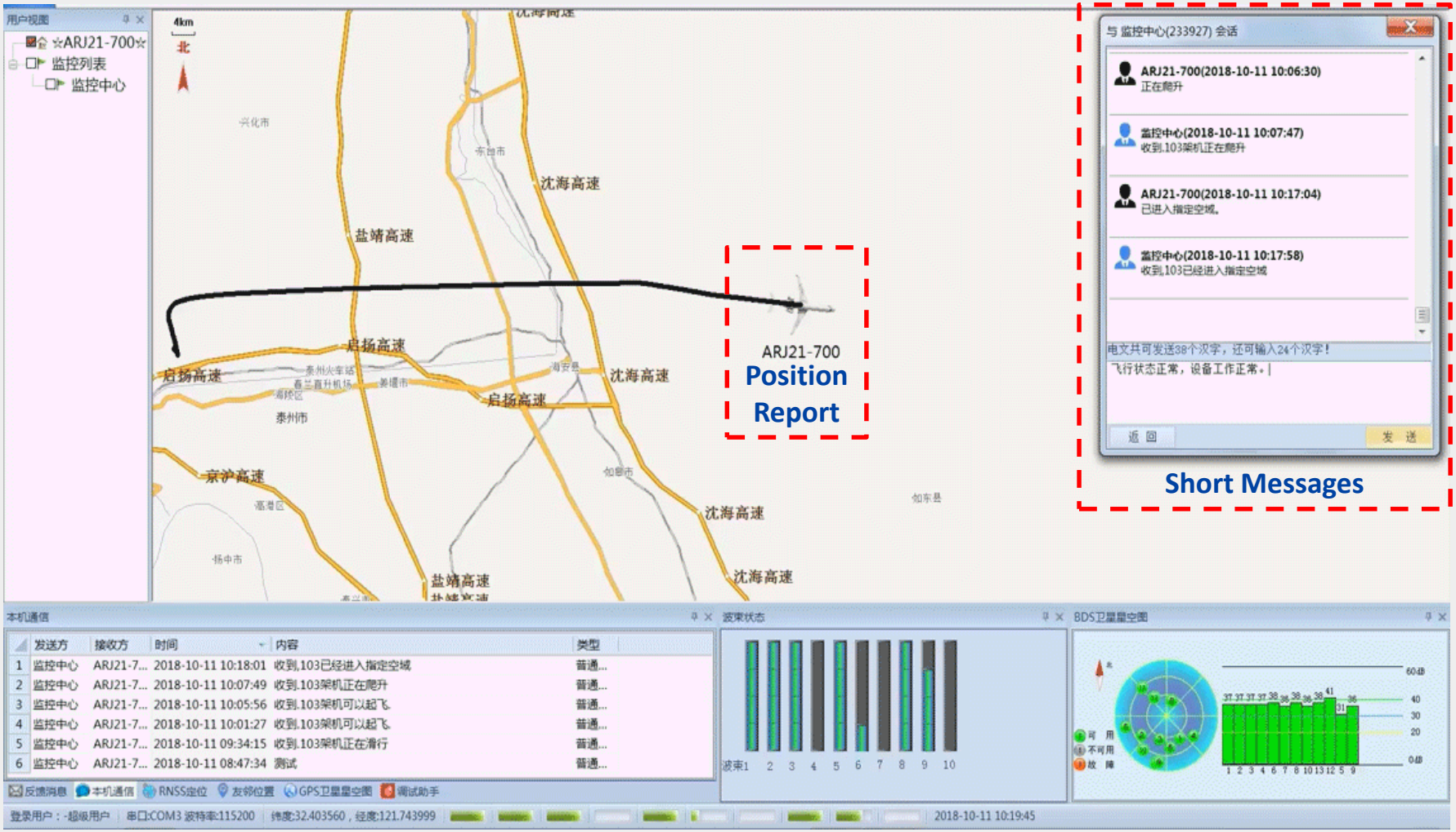
2.1 The BDS Applications in COMAC

- **GBAS Signal Coverage Range**



2.1 The BDS Applications in COMAC

- **BDS short message flight tracking experiment at Yangtai airport (Oct. 2018)**



- The unique short message function of BDS provides a new technological approach of real-time flight surveillance, tracking and emergency communication.

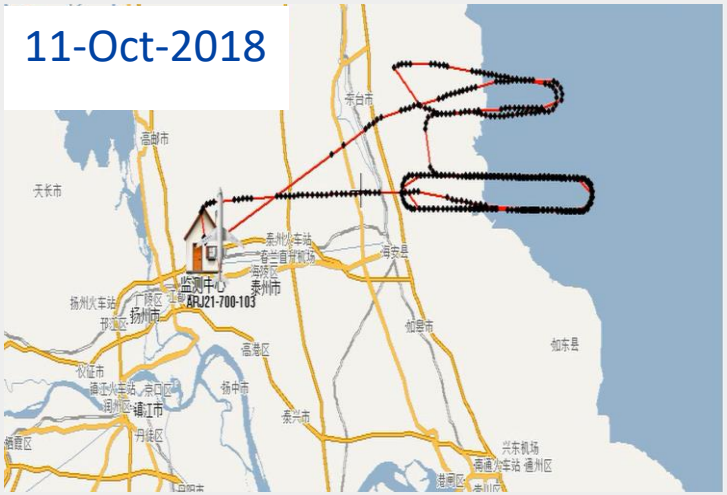
2.1 The BDS Applications in COMAC

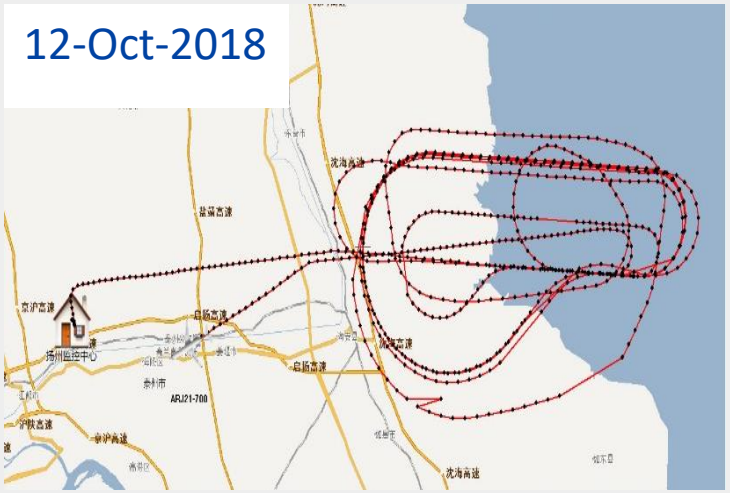
- **BDS short message flight tracking experiment at Yangtai airport (Oct. 2018)**

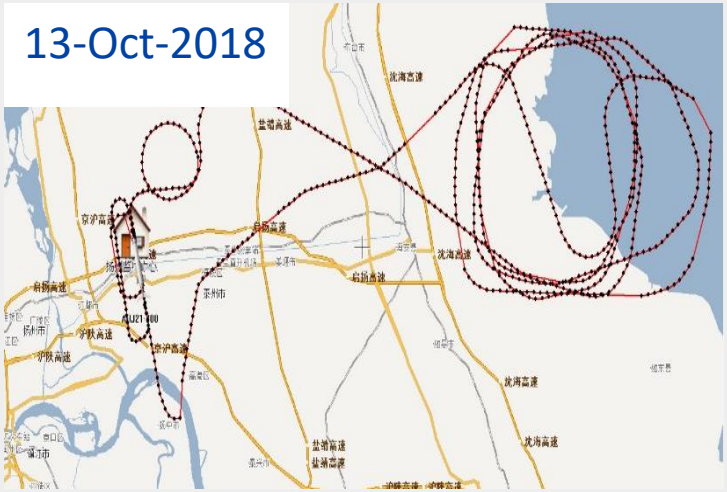
Date	Test Subjects	Time
11-Oct-2018	Taxiing & Circle Flight (10000ft)	3 hours
12-Oct-2018	Circle Flight (30000/32000/35000ft) Through Field (600ft)	3 hours
13-Oct-2018	Circle Flight (10000ft) Through Field (600ft)	2.5 hours

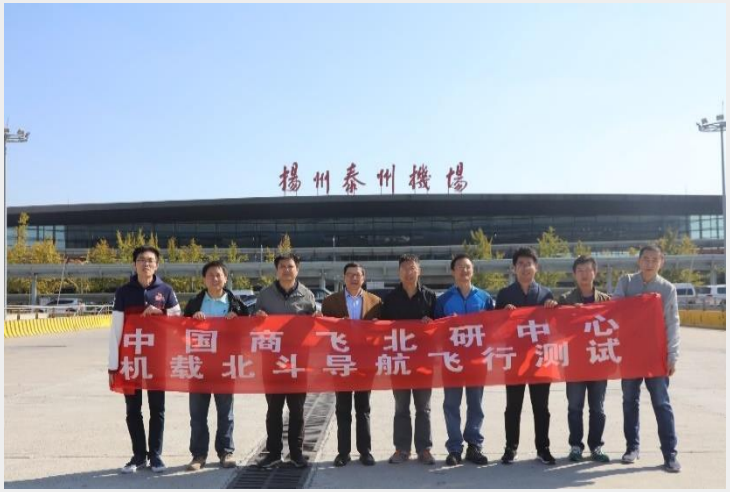
2.1 The BDS Applications in COMAC

- **BDS short message flight tracking experiment at Yangtai airport (Oct. 2018)**

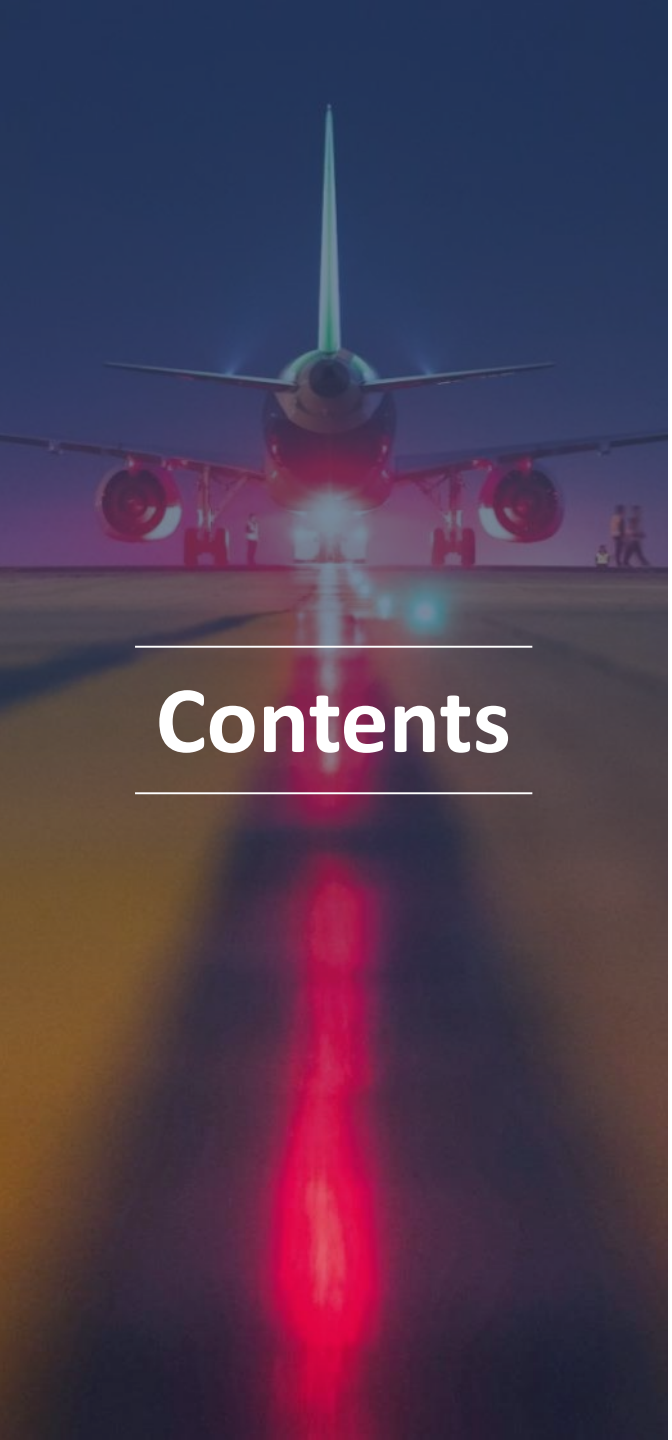








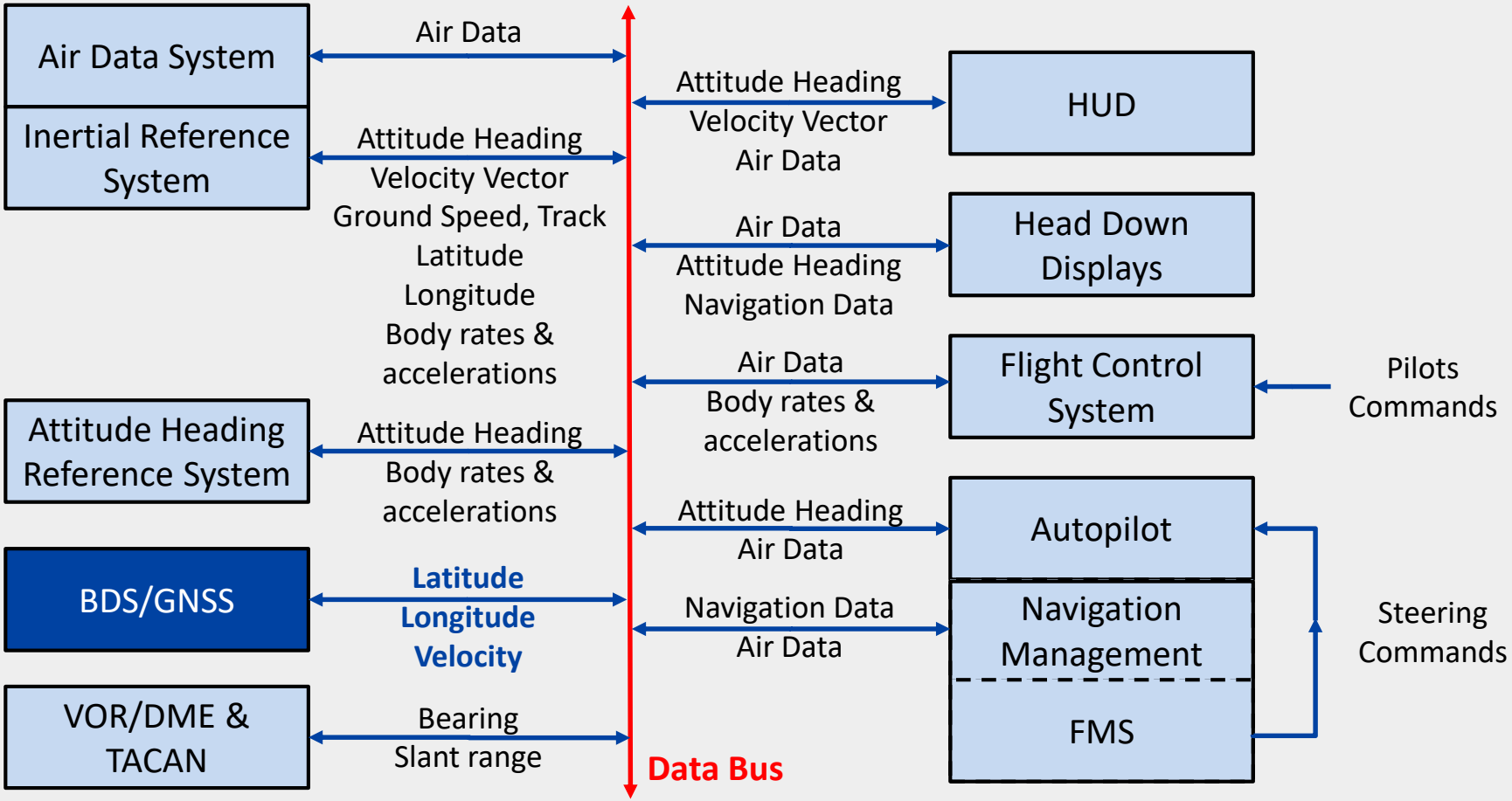
Test results show that short message success rates meet the designed objectives.



Contents

2.2 Future Plan in COMAC

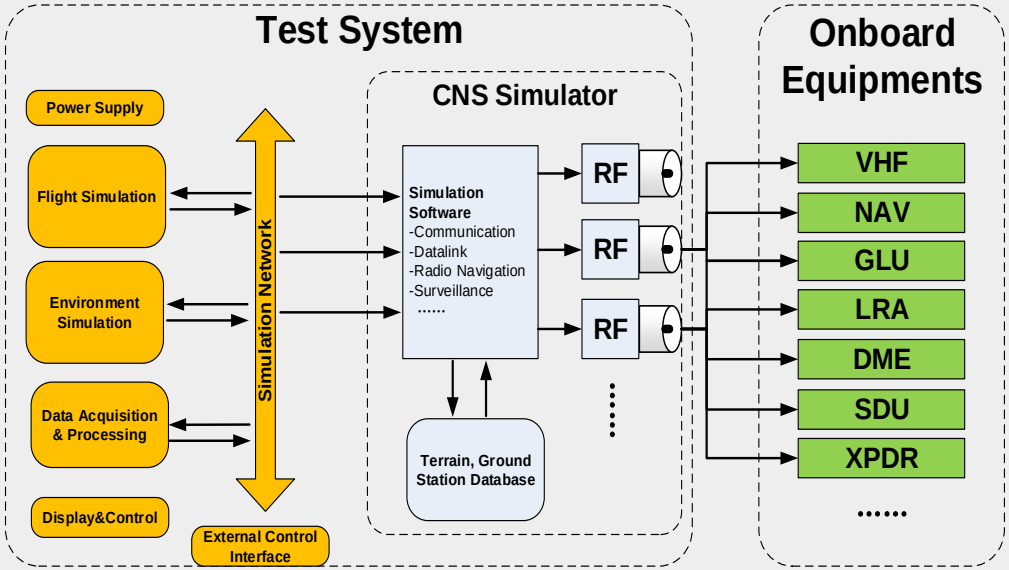
- **Future plan focus on BDS/GNSS avionics system integration**

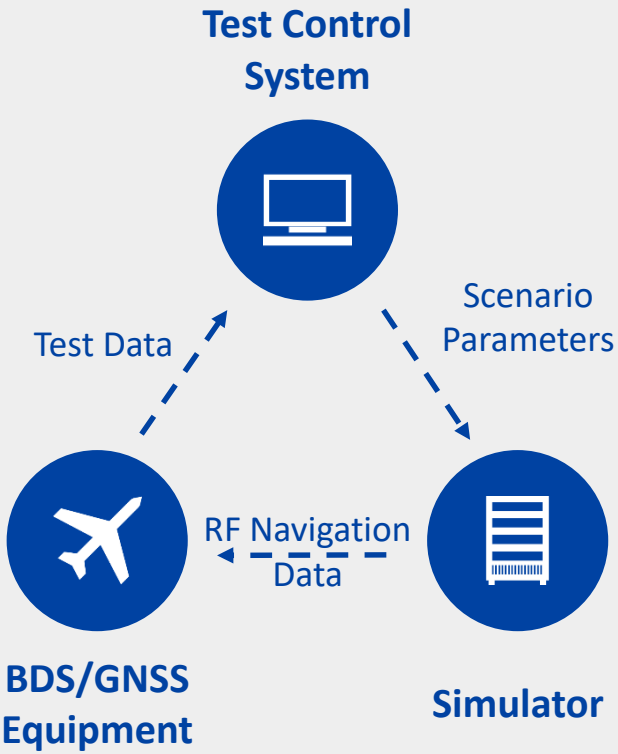


- Test the **interface**, **functions** and **performance** of onboard BDS/GNSS equipment
- Verify the **interaction** between BDS/GNSS equipment and Flight Management System (FMS) & Core Process System

2.2 Future Plan in COMAC

- **Functions and Performance Test**





What to test

Time to First Fix | Sensitivity | Reacquisition Time | Accuracy | Resilience to Interference | Integrity | ...

2.2 Future Plan in COMAC

- **Interaction Verification**

✓ **Step 1:** Use BDS as a backup navigation source, provide position and velocity information separately

✓ **Step 2:** Multi-constellation integrated navigation

BDS/GNSS

Interaction between onboard navigation equipment and FMS & Core Process System

FMS

Capability of navigation & flight guidance

Capability of surveillance

Capability of integrated navigation

Display

ADS-B

IRS

Integrated Modular Avionics (IMA)
Onboard Maintenance System (OMS)
Emergency Locator Transmitter (ELT)
…

2.2 Future Plan in COMAC

- **Flight test plan**

2017-2018

No Interactions to other system

- Installed in main cabin
- Not affect other avionics
- Verify functions and performance under real environment
- BDS short message flight tracking experiment

2018-2020

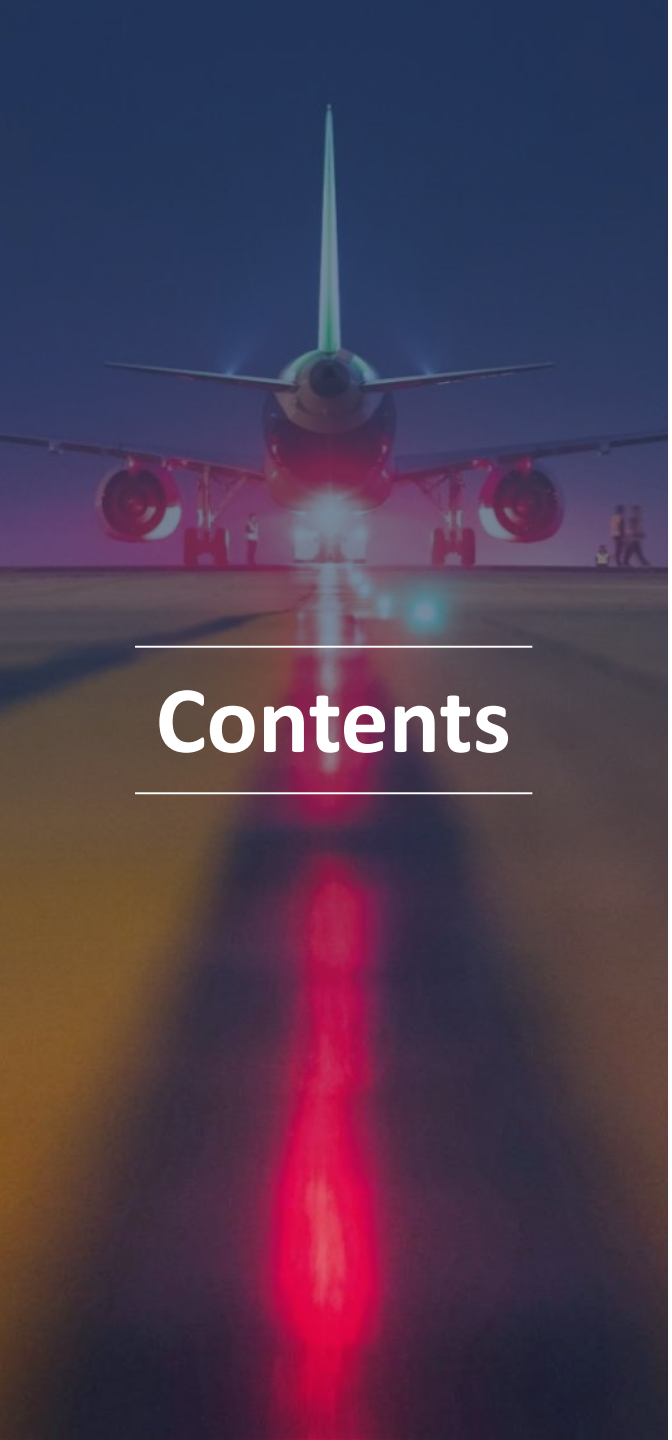
Partly integrated to other system

- Installed in forward EE cabin
- Partly integrated with avionics
- Verify integration, navigation & guidance capability

2020-

Totally integrated flight test

- Complete integration
- Verify performance of aircraft when using BDS/GNSS as navigation resource



Contents

3 Conclusions

BDS/GNSS Flight experiment at Dongying airport (Oct. 2017)

- COMAC will definitely push forward the applications of BDS/GNSS on domestic civil aircraft.
- We suggest to strengthen international cooperation, and co-ordinate resources with navigation system service providers and airborne system providers.
- We will work with international experts to make BDS onboard equipment MOPS and other related RTCA standards get approved, so BDS can provide better service to international civil aviation.


COMAC
THANK YOU !