



14th Meeting of the International Committee on
Global Navigation Satellite Systems



Update on BeiDou Navigation Satellite System (BDS)

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China Satellite Navigation Office

2019-12-09



CONTENT

01

System Construction

02

Application Promotion

03

International Cooperations

04

Future Prospects



01

PART ONE

System Construction

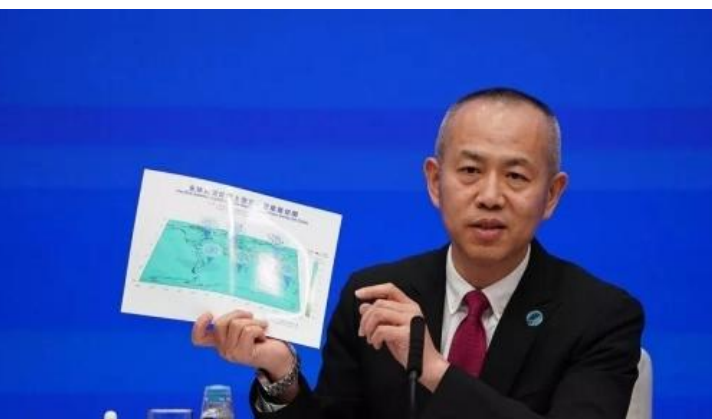
01 System Construction



1. BDS enters into the global era



By the end of 2018, the construction of BDS-3 preliminary system has been completed to provide global services.



The BDS basic navigation service performance standards are as follows:

System service coverage: global

Positioning Accuracy: 10 meters horizontally

10 meters vertically (95%)

Velocity measurement accuracy: 0.2 m/s (95%)

Timing accuracy: 20 nanoseconds (95%)

System service availability: better than 95%

01 System Construction

2. BDS will complete the constellation deployment soon

26 BDS-3 navigation satellites have been launched successfully, and the global constellation deployment will be accomplished soon.

Satellite	Launch Time	Orbit
42th,43th	2018.11.19	MEO
44th	2019.04.20	IGSO
45th	2019.05.17	GEO
46th	2019.06.25	IGSO
47th,48th	2019.09.23	MEO
49th	2019.11.05	IGSO
50,51th	2019.11.23	MEO

10 navigation satellites have been successfully launched since ICG-13, and there are 44 operational BDS satellites in orbit currently.

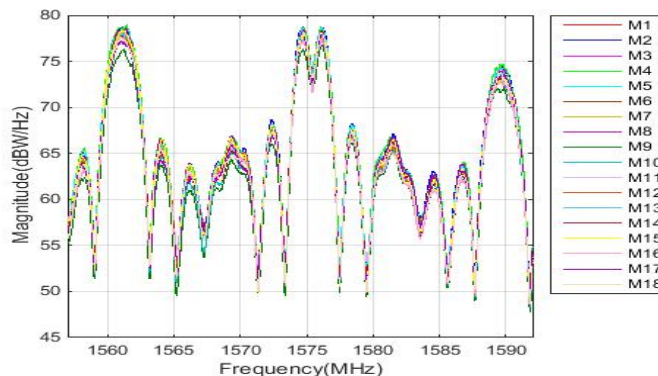


01 System Construction

3. BDS operates continuously and stably

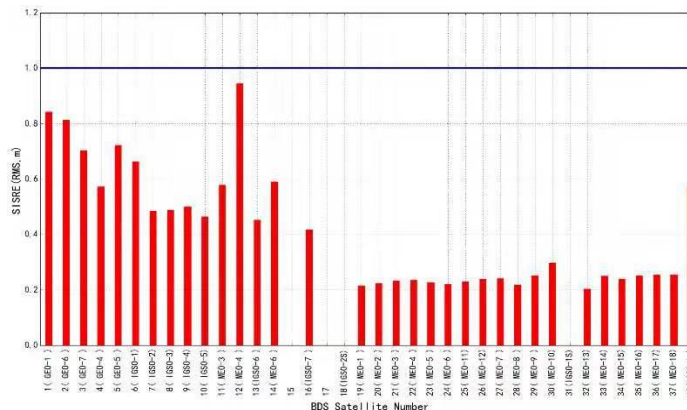
① SIS quality

Figure 1 Power Spectral Density of the BDS Satellites



② SIS Accuracy

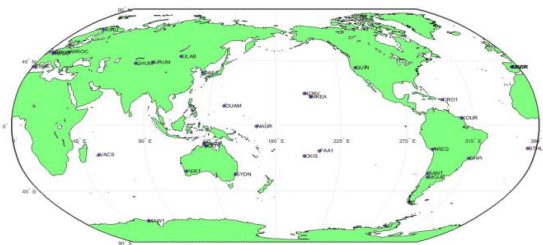
Figure 2 URE of the BDS Satellites



Meet the requirements of the public and international users

3. BDS operates continuously and stably

③ Reference frame accuracy



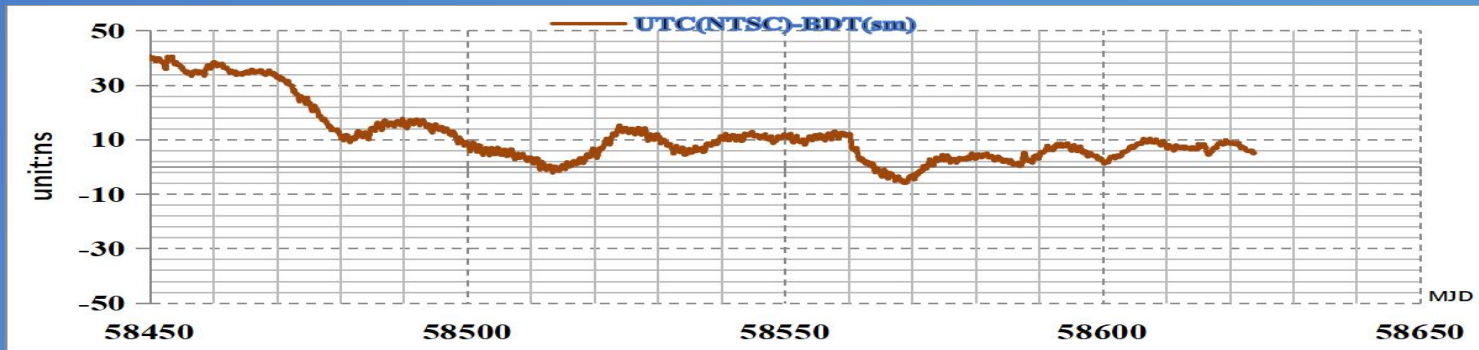
	Trans_x mm	Trans_y mm	Trans_z mm	Rotate_x mas	Rotate_x mas	Rotate_x mas	Scal ppb
Estimation	-0.37	1.12	-0.55	0.01	-0.02	0.05	0.011
Sigma	0.74	0.74	0.74	0.03	0.03	0.04	0.012
3*Sigma	2.22	2.22	2.22	0.09	0.09	0.11	0.037

Figure3 The stations adopted to evaluate the alignment accuracy between BDCS and ITRF

Table 1 Transformation parameter conversion between BDCS to ITRF

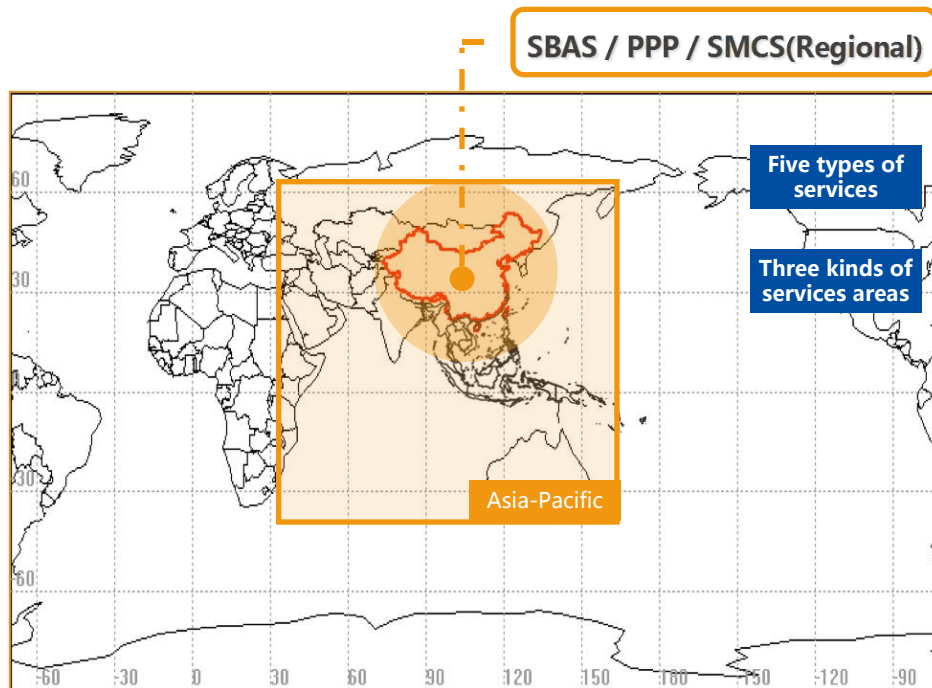
④ Time Stability

Figure 4 Difference between BDT and UTC(NTSC)



01 System Construction

4. Five types of the BDS-3 services



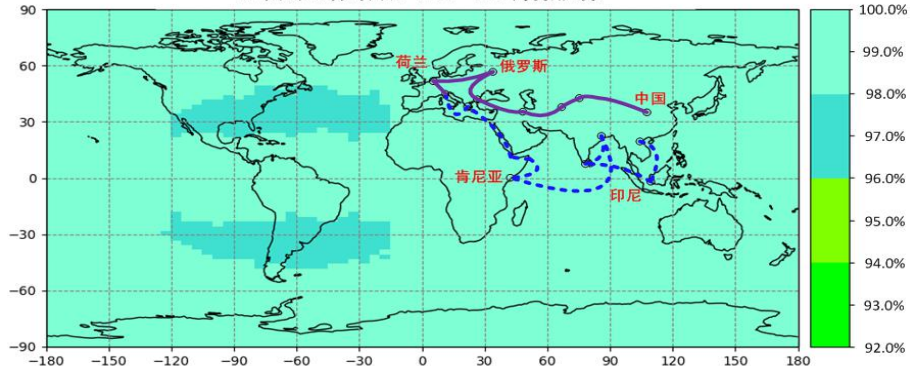
Navigation, Positioning and Timing / SMCS(Global) / SAR

Type of service	Signal frequency	Satellite
Basic navigation services	B1I, B3I, B1C, B2a	3IGSO+24MEO
	B1I, B3I	3GEO
SBAS	BDSBAS-B1C, BDSBAS-B2a	3GEO
Short-message communication services	Regional L (uplink) S (downlink)	3GEO
	Global L (uplink) B2b (downlink)	14MEO 3IGSO+24MEO
International search and rescue services	UHF (uplink)	6MEO
	B2b (downlink)	3IGSO+24MEO
Precise Point Positioning service	B2b	3GEO

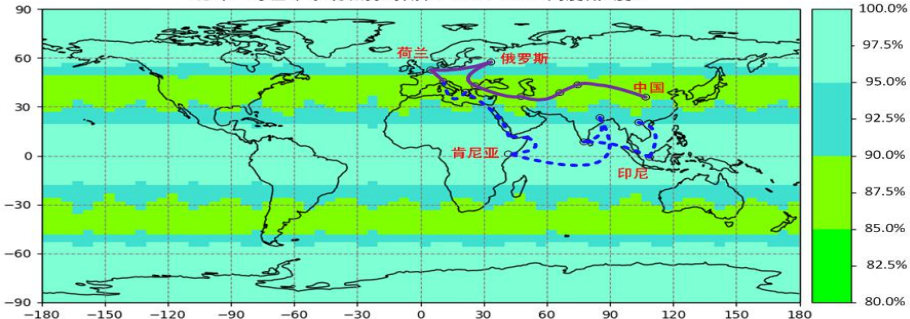
01 System Construction

4.1 The BDS performance

北斗系统服务可用性 (PDOP≤6、高度角5度)



北斗三号基本系统服务可用性 (PDOP≤6、高度角5度)



B1I and B3I signals

- System Service Availability : > 99%
- Positioning Accuracy: 3.6 meters horizontally, 6.6 meters vertically (95%)
- Velocity Measurement Accuracy: 0.05m/s , Timing Accuracy: 9.8ns (95%)
- In the Asia-Pacific region, the positioning accuracies:increased about 30% availability: increased 5%

B1C and B2a signals

- Global Coverage, System Service Availability:>87%
- Positioning Accuracy: 2.4 meters horizontally, 4.3 meters vertically
- Velocity Measurement Accuracy: 0.06m/s Timing Accuracy: 19.1ns (95%)

01 System Construction

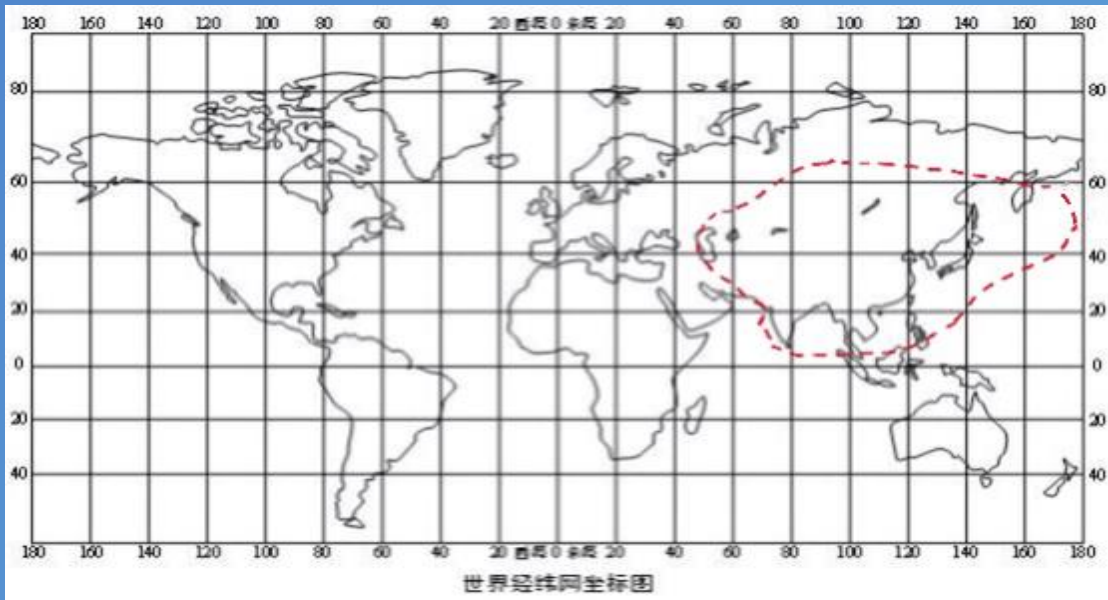
4.2 Short-message communication services (regional)

Service Planning:

- 3 GEO satellites
- Serve China and the surrounding regions
- System capacity increased by 10 times compared to BDS-2
- 1000 Chinese characters per message
- User power reduced to the previous 1/10 (1-3w)

Construction Progress:

- Launched: 1 GEO
- Underway: in-orbit tests



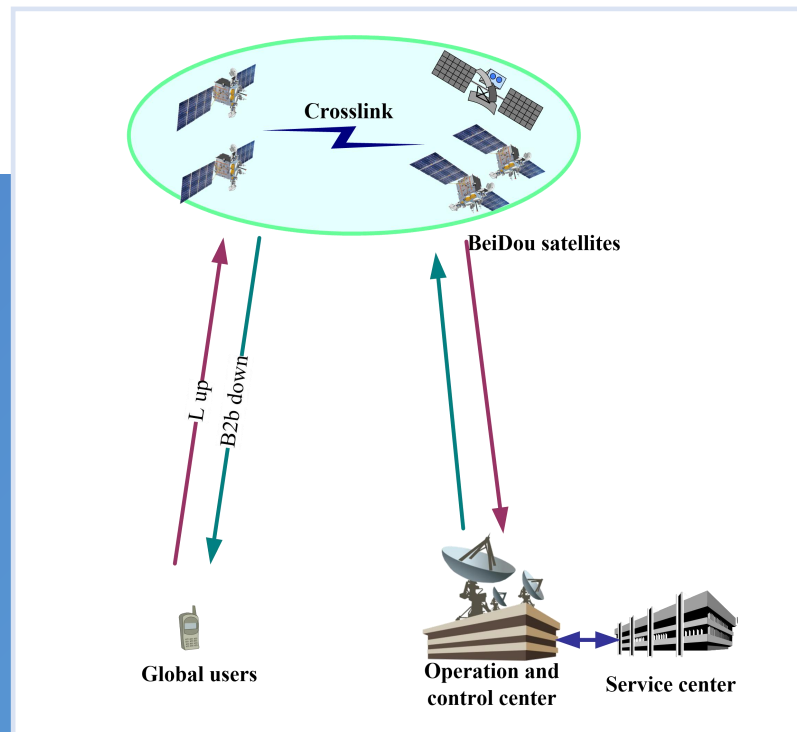
4.2 Short-message communication services (global)

Service Planning:

- 14 MEO satellites
- Global access
- 40 Chinese characters per message

Construction Progress:

- Launched: 12 GEO
- Underway: in-orbit tests



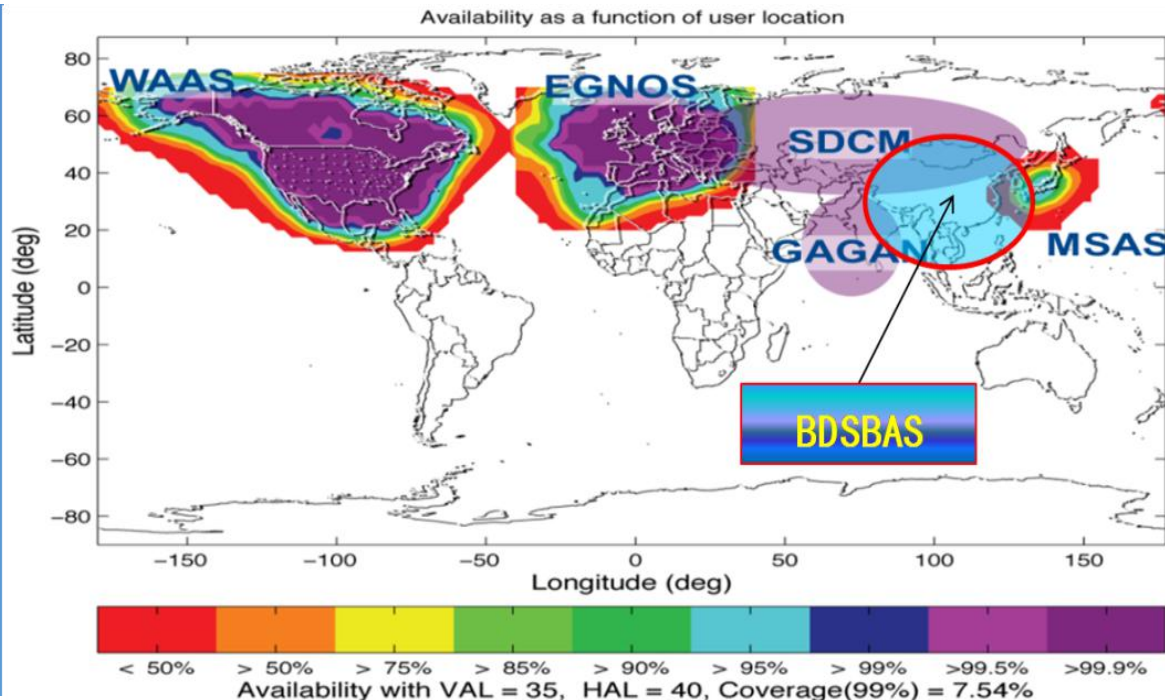
4.3 Satellite-based augmentation services

Service Planning:

- 3 GEO satellites
- Follow ICAO standards
- Serve China and the surrounding regions

Construction Progress:

- Launched: 1 GEO
- Underway: in-orbit tests



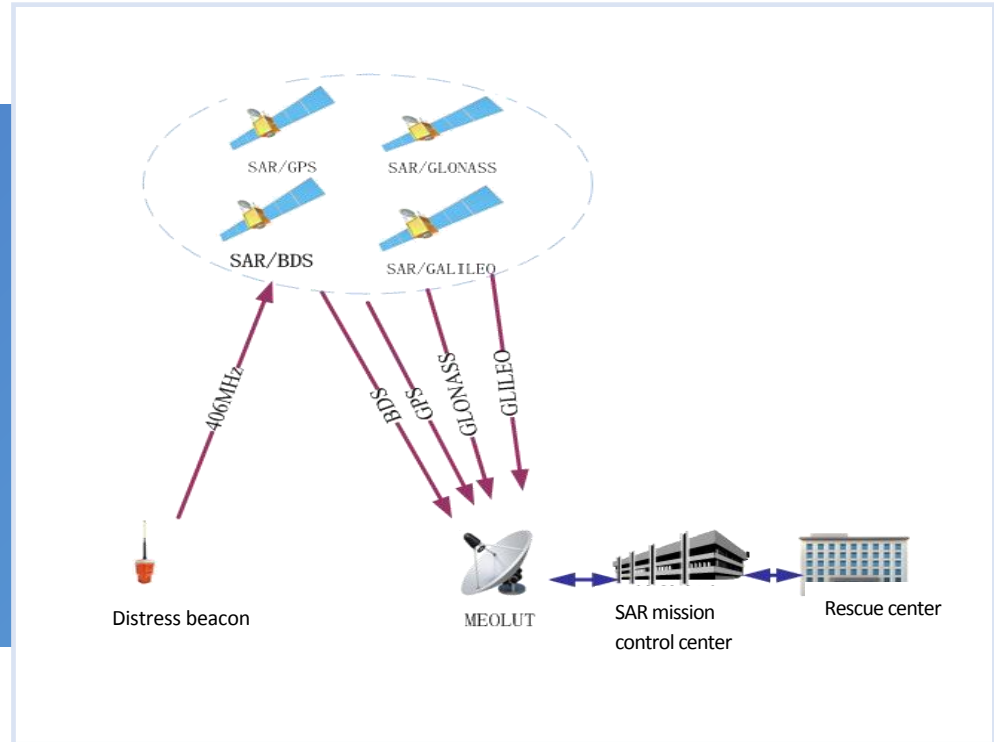
4.4 International search and rescue services

Service Planning:

-  Follow international standards
-  6 MEO satellites
-  Return-links




Construction Progress:

- Launched: 6 MEO
- Underway: in-orbit tests



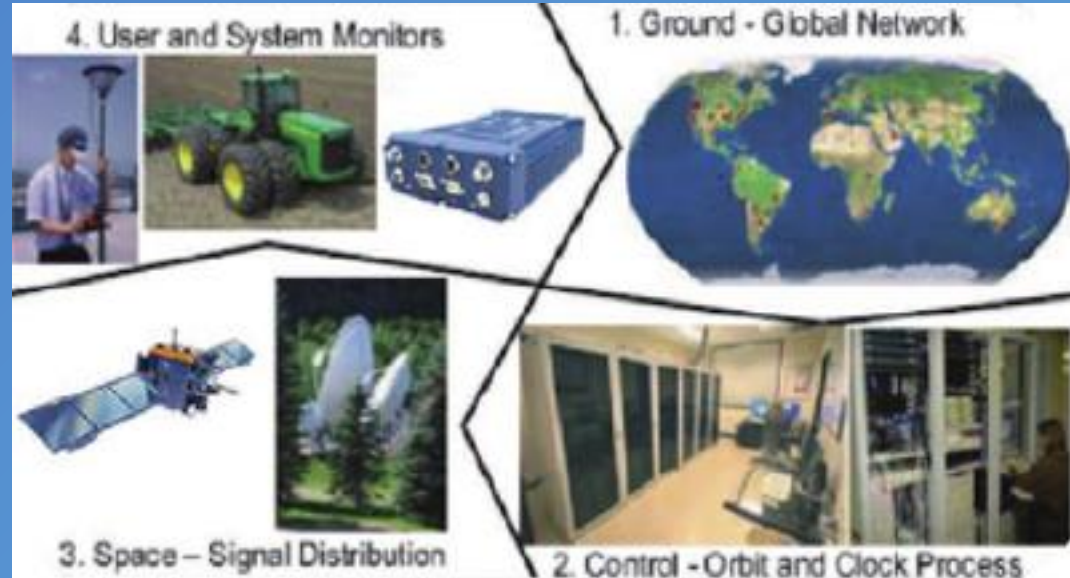
4.5 Precise Point Positioning Service

Service Planning:

-  3 GEO satellites
-  Serve China and the surrounding regions
-  Positioning precision: dynamic decimeter-level , static centimeter-level

Construction Progress:

- Launched: 1 GEO
- Underway: in-orbit technical tests



5. Information Dissemination

- The latest released documents of Open Service Performance Standard, Signal In Space Interface Control Document, System Time, and Reference Frame Template are shown as followings.
- More information is available at: en.beidou.gov.cn



Document	Date
BeiDou Coordination System Temple	2019.12
Space Weather Payloads Observation Data Onboard BDS Satellites	2019.12
Definitions and Descriptions of BDS/GNSS Satellite Parameters for High Precision Application	2019.11
BDS SIS ICD Open Service Signal B1I (V 3.0)	2019.02
BDS Open Service Performance Standard(V 2.0)	2018.12
BDS SIS ICD Open Service Signal B3i(V 1.0)	2018.02
BDS SIS ICD Open Service Signal B2a(V 1.0)	2017.12
BDS SIS ICD Open Service Signal B1C (V 1.0)	2017.12
BDS Timescale Description Reference Document	2016.11

6. Future Plan

2019

2 BDS-3 satellites

2020

2 BDS-3 satellites

Before the
end of
2020

Possess Full
Operational Capability



02

PART TWO

Applications Promotion

1. Fundamental Products

- The mass-production of the 22nm SoC chips integrated with the BDS RF and baseband has been initialized
- High-precision OEM boards and antenna have been sold to over 100 countries and regions



2. Industrial and Mass Applications

BDS has been widely used in traffic & transportation, agriculture, forestry & fishery, and many other fields



- The world's largest dynamic monitoring system operational vehicles has been built
- operational vehicles: **7 million**
- Postal and delivery vehicles: **30,000**
- Buses: **80,000**
- Inland waterway navigation facilities: over **3,200**
- Marine navigation facilities: over **2,900**
- Major accidents: **decreased by 50%**
- Deaths and disappearances: **decreased by 50%**



2.2 Agriculture, Forestry and Fishery

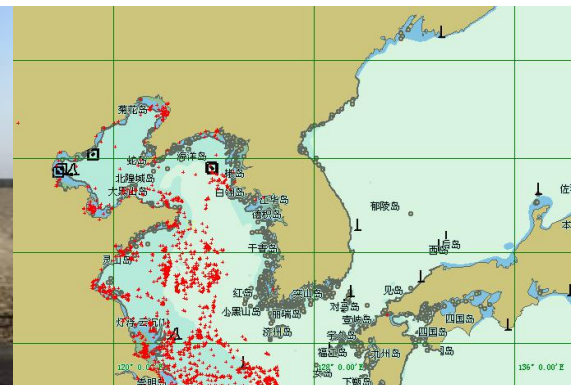
Serve agricultural equipment:
120,000+

Labor cost for precision farming: **reduced by around 50%**

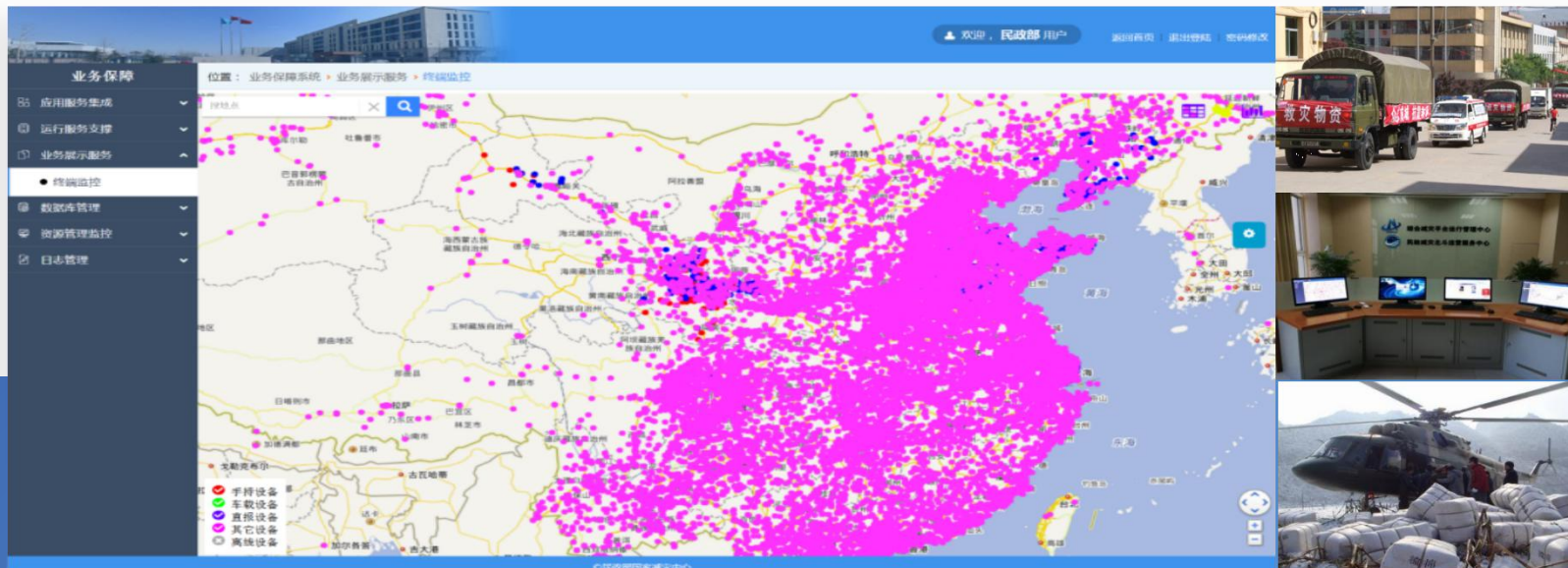
income growth of Per Mu per peasant household: **RMB 60-90**

Networked boats: **70,000+**

Rescued people: **10,000+**



2.3 Disaster Response and Relief



BDS/GNSS terminals promotion : **45,000+**



Relevant disaster response information has been enhanced



Disaster relief materials management has been improved

3. Emerging Applications



Integration of BDS and 5G mobile communication networks.

Integration of BDS positioning technology and NB-IoT low-power WAN technology.

Integration of BDS and artificial intelligence technology .



4. International Applications

- BDS has been adopted in many international applications, such as land rights confirmation, precision agriculture, warehouse logistics in ASEAN countries, building construction in West Asian countries, time service in airports, marine piling in South Asian countries, electricity patrolling and checking in Eastern European countries and homeland testing in African countries.





03

PART THREE

International Cooperation

1. Bilateral Cooperation



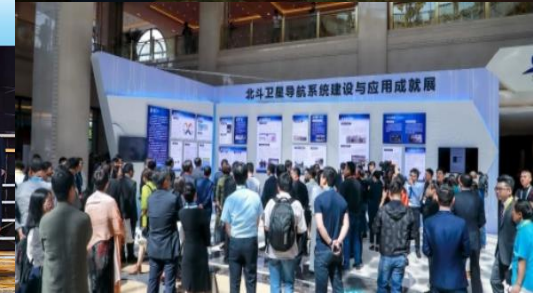
- China-Russia cooperation has achieved many breakthroughs. The inter-governmental cooperation agreement has been signed and entered into force.
- China and the United States have been discussing B2/L5 signal interoperability after reaching consensus on the B1/L1 signal .
- China and the EU have actively promoted cooperation between BDS and Galileo systems and conduct frequency coordination.

2. Multilateral Cooperation

- Hosted the ICG-13, the 10th China Satellite Navigation Conference, and many GNSS international training courses.
- Actively participated in international academic exchanges, such as Munich Satellite Navigation Summit, International Navigation Forum, etc.
- Held China Ancient Navigation Exhibition during 61th COPUOS meeting in UNOOSA



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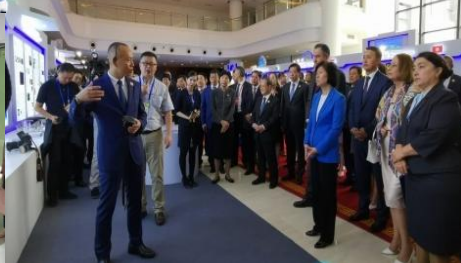


2. Multilateral Cooperation

Jointly held the 2nd China-Arab States BeiDou Cooperation Forum.

Held the first China-Central Asia Cooperation Forum.

Established the China-ASEAN BDS /GNSS (Nanning) Center.



- Positive efforts have been devoted to advance the BDS ratification in various international organizations and standards.

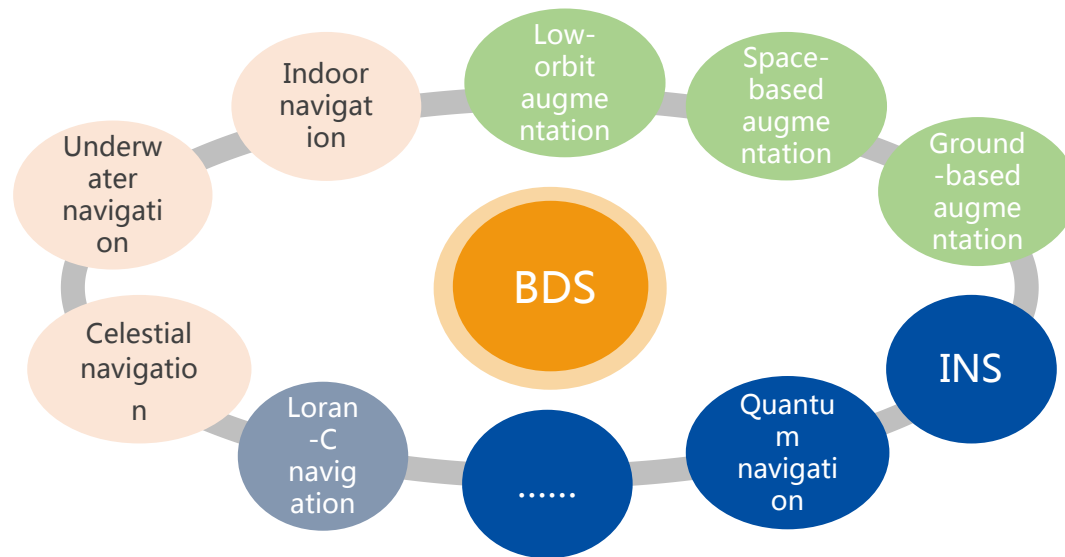


04

PART FOUR

Future Prospects

- A more ubiquitous, integrated and intelligent PNT system will be established.
 - In 2020, BDS will be fully completed. Besides RNSS, it will provide more high-quality services.
 - In 2035, with BDS/GNSS as a core, a positioning, navigation, and timing system (PNT) with the supplement, backup, augmentation, and other multiple methods will be built.





Thank you
For your attention and support to BDS.

<http://en.beidou.gov.cn>