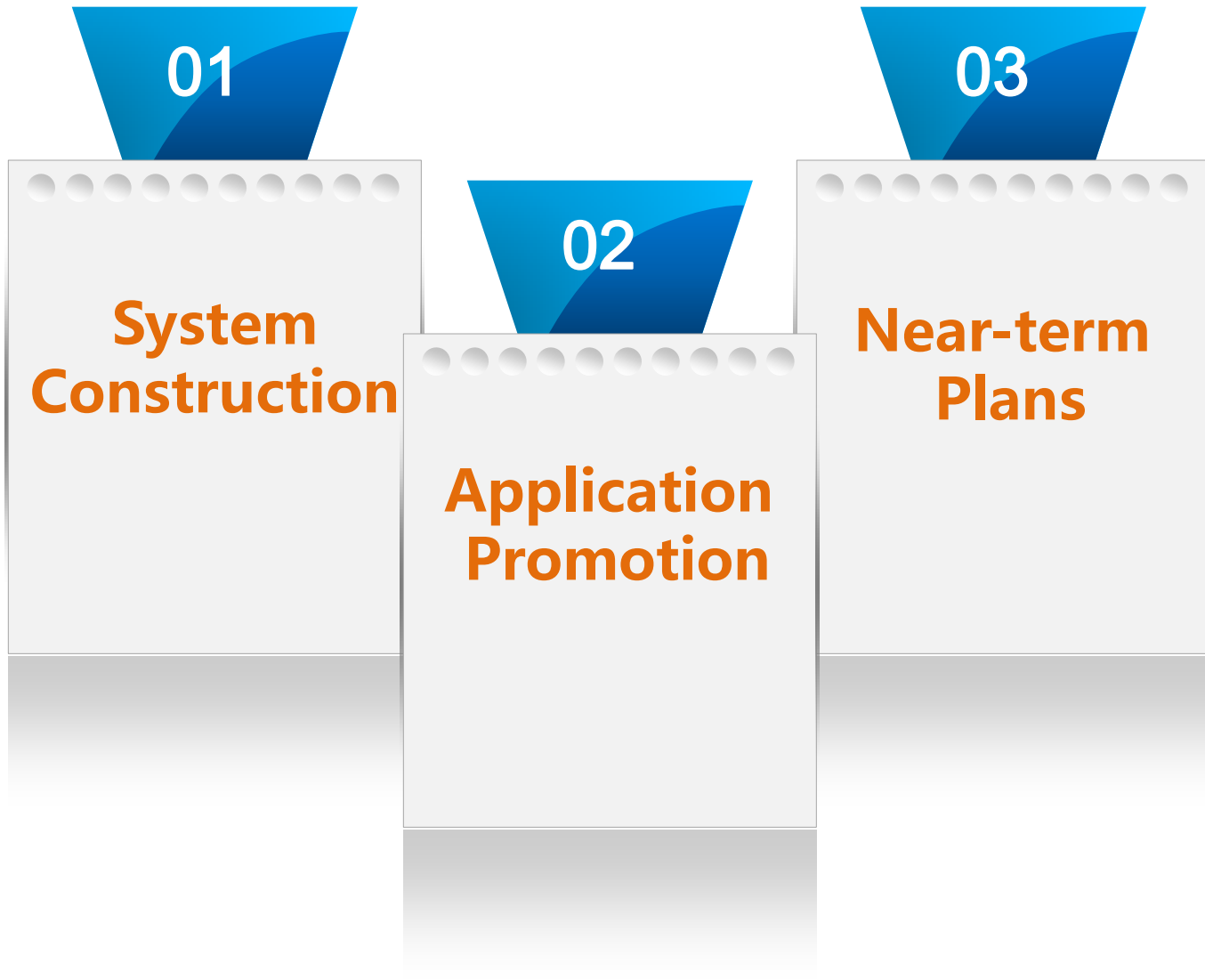




Development and Applications of BeiDou Navigation Satellite System (BDS)

China Satellite Navigation Office

March 19, 2018



01

System Construction

- (I) Development Plan**
- (II) Development Steps**
- (III) System Components**
- (IV) System Status**

(I) Development Plan

Development Objectives

The BDS is committed:

- To provide continuous, stable and reliable positioning, navigation and timing services to global users;
- To meet the requirements derived from national security, economic and social development sectors, to accelerate IT applications and the transformation of economic development methods, and to improve both economic and social benefits;
- To serve the world and benefit the mankind through joint efforts with other navigation satellite systems across the globe.

(I) Development Plan

Basic Principles

Openness

The BeiDou System will offer open services free of charge for global users.

Independency

Develop and operate BeiDou system independently.

Basic Principles

Compatibility

The BeiDou System is devoted to pursue compatibility and interoperability with other navigation satellite systems, and enable users to obtain better services.

Gradualness

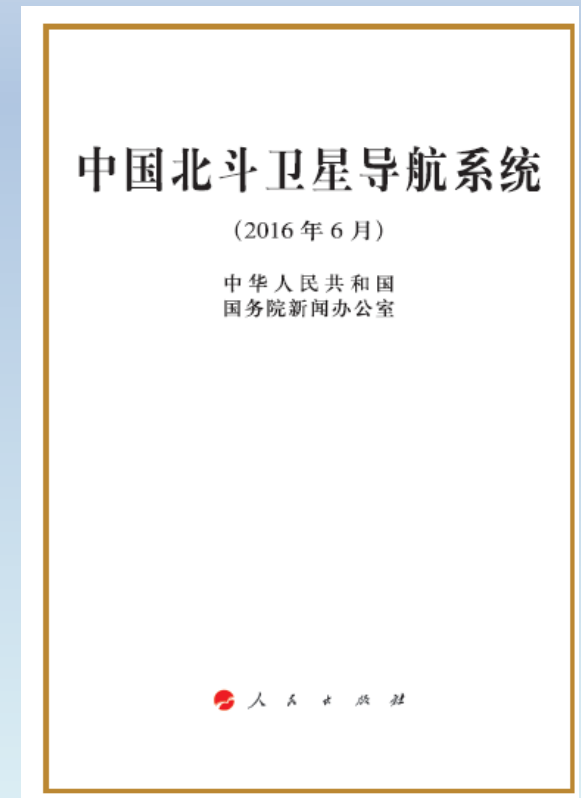
The establishment of BeiDou System follows a stepwise manner in the light of Chinese actual technical and economic conditions.

(I) Development Plan

Fundamental Policies

In June 2016, Chinese government officially published a BDS white paper explaining the development concepts and policies:

- Provide open services free of charge for users
- Maintain and perfect the system constantly, improve service performance continuously, and offer services with higher quality
- Release open service performance specifications on schedule, bring the function of government and market to full play, promote innovation, popularization and internationalization of BDS/GNSS applications, and lay foundation for the national strategic emerging industries
- Adhere to the concept of development and win-win cooperation, realize compatibility and interoperability between BDS and other GNSS, give the system efficiency into full play and increase users' benefits

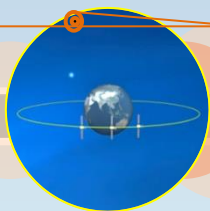


(II) Development steps

The BDS development has been in line with the “three-step” roadmap and the thinking of “from regional to global, and from active to passive” , and forms a path as world-oriented, region-highlighted, with its own features.

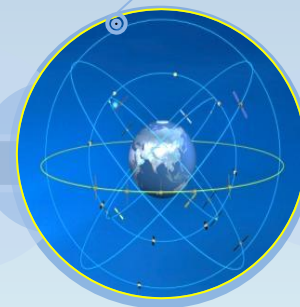
The 1st step:

1994~2000, provide regional active services



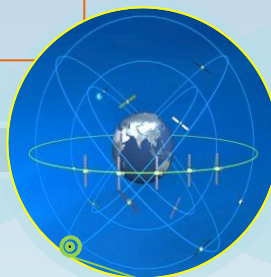
The 3rd step:

2013~2020, provide global passive services



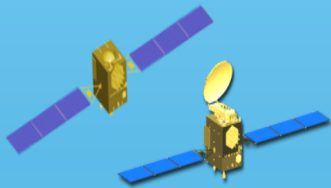
The 2nd step:

2004~2012, provide regional passive services



(III) System Components

Space Segment



- **3 GEO**
- **3 IGSO**
- **24 MEO**

Ground Segment



- **Master Control Station**
- **Uplink Stations**
- **Monitoring Stations**

User Segment



- **BDS terminal**
- **Terminal compatible with other navigation systems**

BDS provide RDSS, RNSS, SBAS, short-message communication services, and international SAR services, as well as the ability to support the transmission of precise positioning information.

(IV) System Status

Stable Operation of the BDS-2 System

A total of 18 BDS-2 satellites have been launched, among which 15 satellites are operational in orbit.

<i>BDS-2 Satellites – System Log</i>																		
<i>NO.</i>	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
<i>Orbit</i>	MEO	GEO	GEO	GEO	IGSO	GEO	IGSO	IGSO	IGSO	IGSO	GEO	MEO	MEO	MEO	MEO	GEO	IGSO	GEO
<i>Date</i>	2007. 4.14	200 9.4. 15	2010. 1.17	2010 .6.2	2010.8 .1	201 0.11 .1	2010. 12.18	2011. 4.10	2011. 7.27	2011. 12.2	2012. 2.25	2012. 4.30	2012. 4.30	2012. 9.19	2012. 9.19	2012 .10.2 5	2016 .3.30	2016 .6.12
<i>Status</i>	Testing	Maintenance	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Operational	Maintenance	Operational	Operational	Operational

 Operational

 Testing

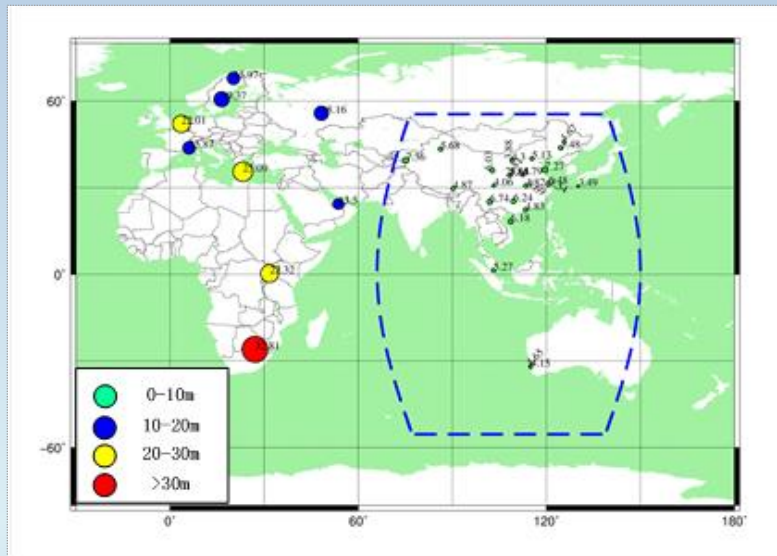
 Maintenance

(IV) System Status

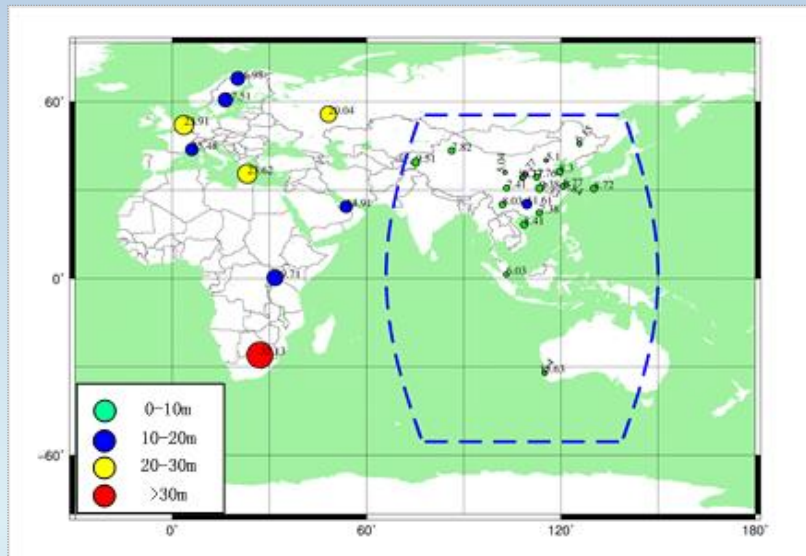
Stable Operation of the BDS-2 System

The BDS-2 performance has been steadily enhanced. Since 2012, the system has been operating in a continuous and stable mode.

- positioning accuracy has been optimized from 10 meters to 6 meters
- 4 more backup satellites have been ordered, among which 2 have been launched.



B1I 平面定位精度



B1I 高程定位精度

(IV) System Status

Development of the BDS-3 System

Five BDS-3 testing satellites were successfully launched. New navigation signal systems, inter-satellite links, high-precision satellite clocks and other key technologies have been verified.



(IV) System Status

Development of the BDS-3 System

- The BDS-3 System has entered an intensive launch phase.
- Since November 5, 2017, three pairs of BDS-3 Satellites have been successfully launched.



2017.11.5



2018.1.12

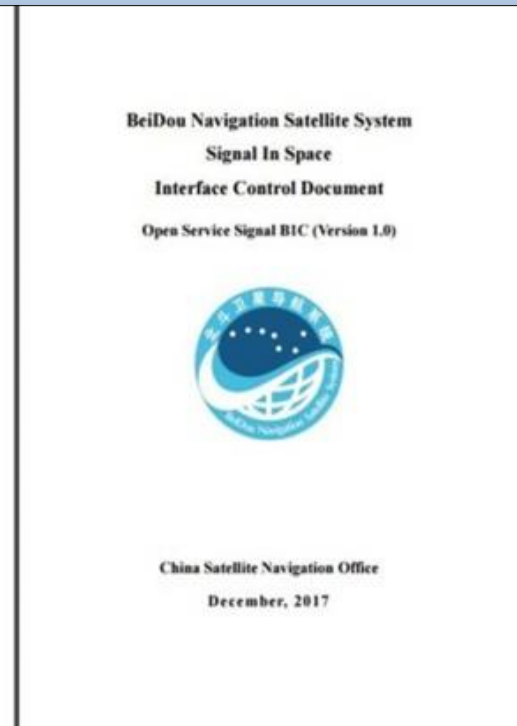
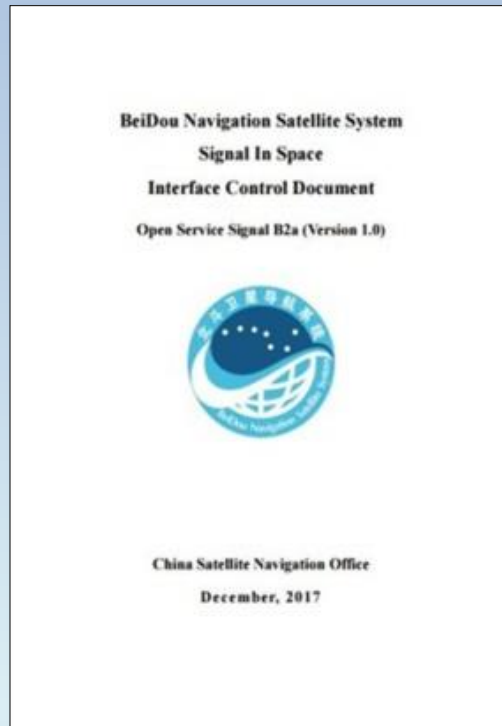
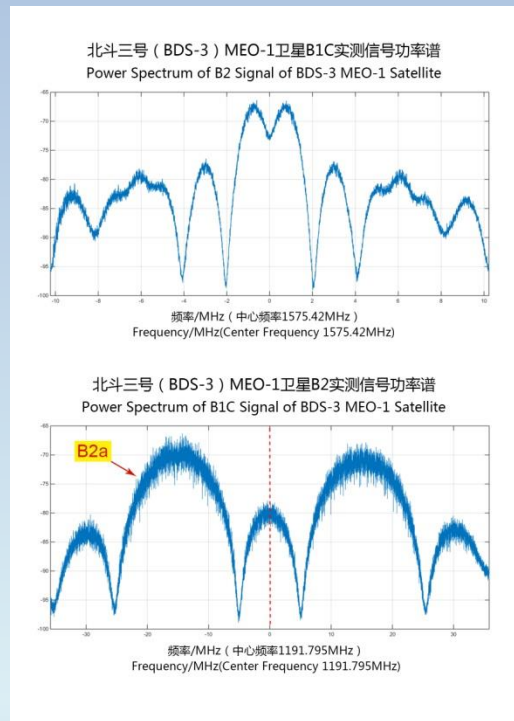


2018.2.12

(IV) System Status

Development of BD-3 System

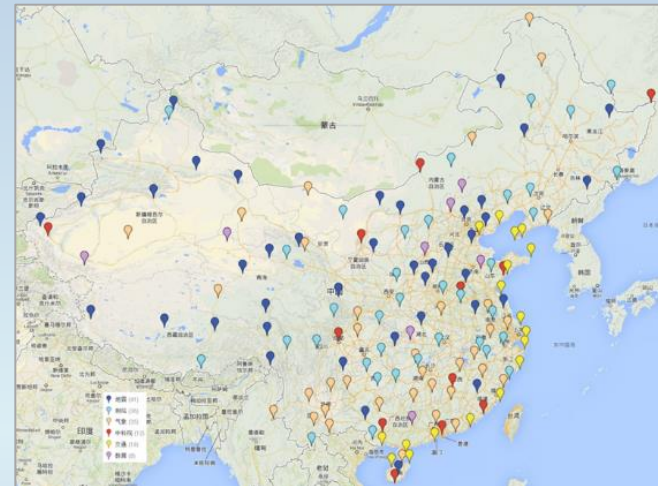
The BDS Signal In Space Interface Control Document Open Service Signals B1C, B2a and B3I (1.0 version) has been released on website <http://en.beidou.gov.cn>



(IV) System Status

Ground-Based Augmentation System

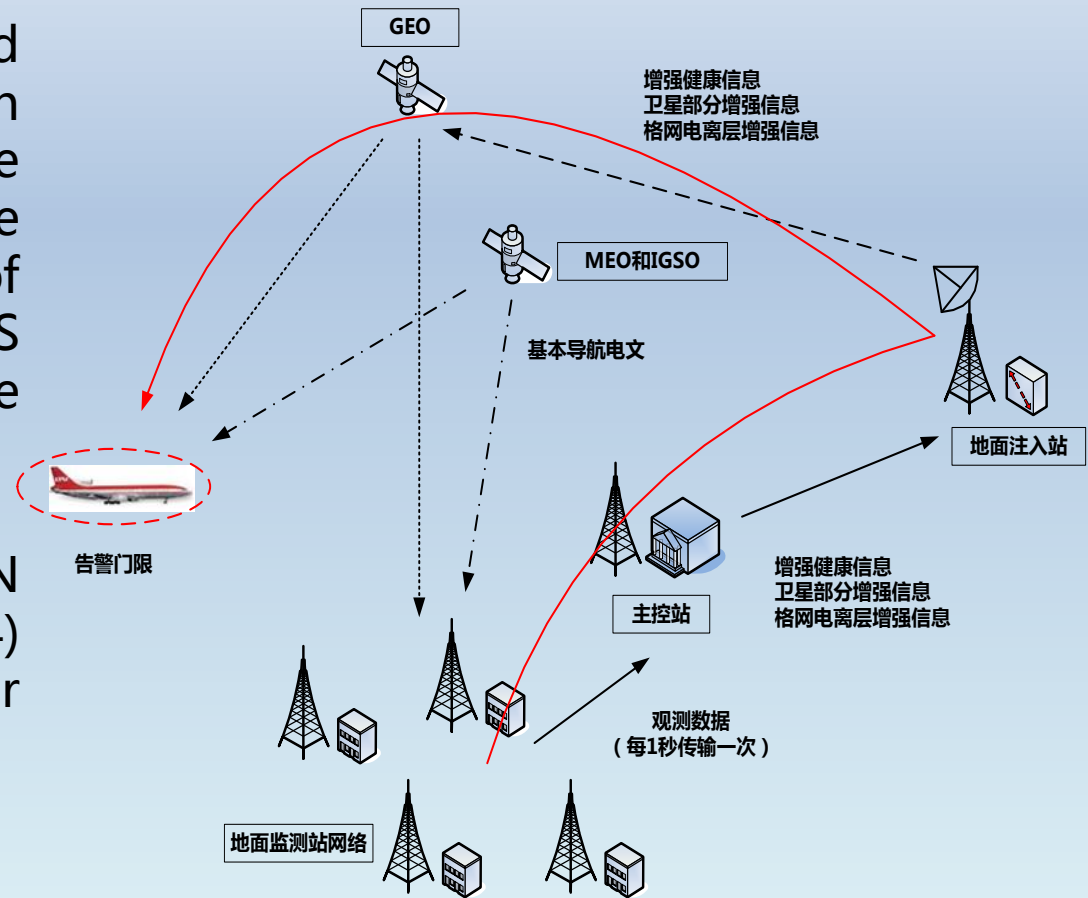
- A BDS Ground-based Augmentation System, which is compatible with other satellite navigation systems, has been established to provide real-time meter-level, decimeter-level, centimeter-level, and after-thousand-mm-level services.
- It has been applied to O2O addressing, driving assistance, precision agriculture, autopilot, driving test driver training, drones and other scenes.



(IV) System Status

BDS Satellite-Based Augmentation System (BDSBAS)

- System demonstration and validation work has been completed. It solidifies the technical status of the system in accordance of the next-generation SBAS Dual Frequency Multiple Constellation(DFMC) standards.
- In October 2017, 3 PRN codes (No. 130, 143, 144) at L1C/A and L5 for BDSBAS were assigned.



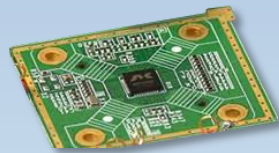
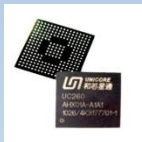
02

**Application
Promotion**

- (I) Fundamental Products**
- (II) Application Cases**
- (III) International Cooperation**

(I) Fundamental Products

- The BDS chips entered a new era of 28 nanometers , achieved the upgrade from fundamental products toward the high-end industry.
- The minimum cost for a single BDS chip is less than 6 yuan, and the overall performance meets the specifications of similar international products.



- The delivers BDS/GNSS navigational baseband and RF chip/module exceeded 50 million
- high-precision board and antenna account for 30% and 90% of the domestic market respectively
- satellite navigation IP core used in mobile communication, approximately 18 million

(II) Application Cases

- Industrial and regional exemplary application projects have been carried out.
- Until now, projects in 11 industries have been completed, including transportation, maritime search and rescue, meteorology, fishery, public security, civil disaster reduction and disaster relief, forestry, and
- 17 regional projects, such as the Pearl River Delta, Beijing, Shaanxi, Hunan, Guizhou, Hubei, and Suzhou are being implemented.



(II) Application Cases

Transportation Industry

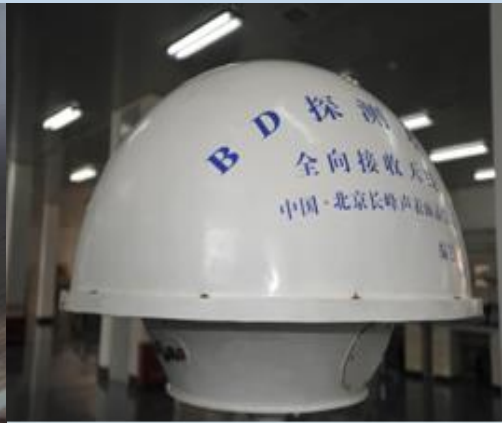
- More than **5 million** commercial vehicles have been installed with BDS-compatible terminals and connected to the national platforms.
- A complete dynamic monitoring and management system for operational vehicles including testing, review, data access, management, and assessment has been established.
- The monitoring and management system has effectively strengthened the monitoring efficiency of road commercial vehicles and improved the safety on transportation. According to the data released by the Department of Transportation, in the field of road transport, the number of serious accidents and missing deaths in 2016 fell by 50% and 51.6% respectively.



(II) Application Cases

Weather detection industry – BDS-based Meteorological Sounding System

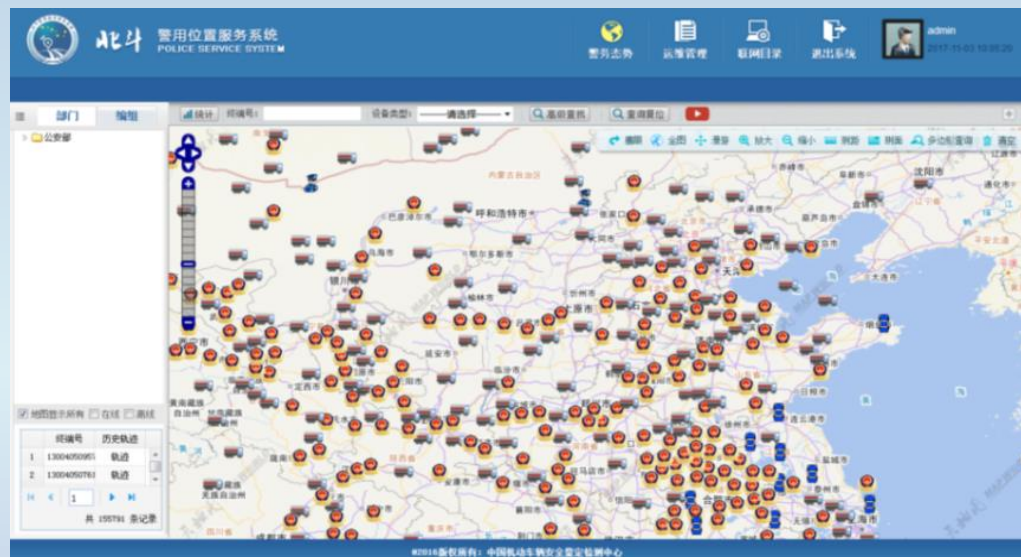
- Detect temperature, air pressure, humidity, wind direction, wind speed and other meteorological elements at 35 kilometer above the ground, to provide high-altitude weather observing data for weather forecast, climate analysis and scientific research.
- Currently, **the BDS Meteorological Sounding System has replaced the existing L-band sounding system**. The accuracy of high-altitude wind speed has been improved from 1m/s to 0.3m/s, the accuracy of wind direction has been improved from 5° to 3°, and the accuracy of atmospheric pressure above 500mb has been exceeded by one order of magnitude.



(II) Application Cases

Public Safety Industry

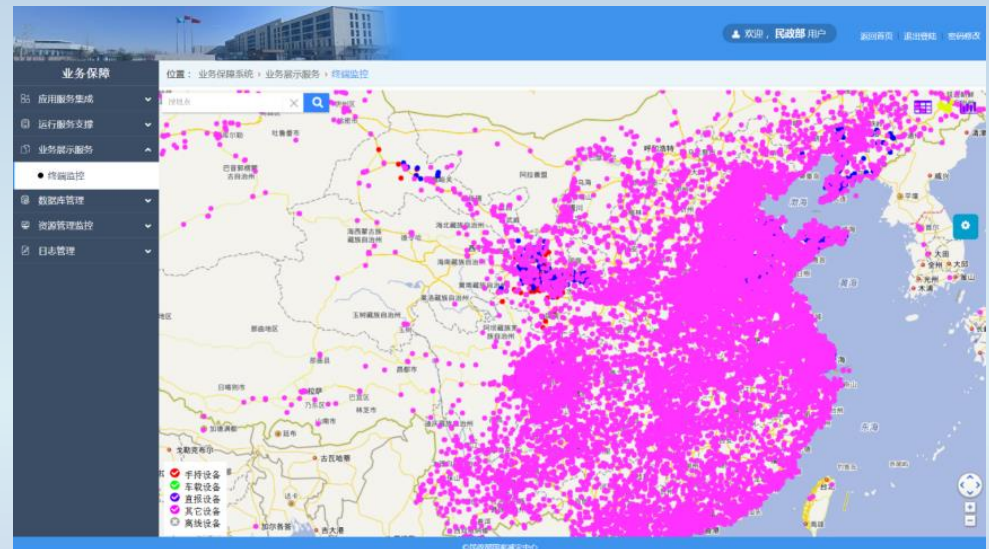
- In the public security area, a three-level location resource management system was established to achieve location resource scheduling capabilities, cross-region and inter-department functionalities.
- At present, more than 400,000 police position information of terminal have been accessed. BDS location service system displays information in real time and performs rapid temporary grouping on the map, which **reduced police time by nearly 20%**.
- It solved the problem of slow job inspections when dealing with large tasks such as mass incidents , Through one-click reporting and name-calling functions, the time of cooperating **tasks for 100 or more police officers has been reduced by 97%**, significantly improved the efficiency of command and dispatch.



(II) Application Cases

Disaster Reduction and Relief - National disaster relief personnel and vehicle monitoring system

- The BDS disaster reporting APP is seamlessly integrated into National Natural Disaster Information Management System.
- The BDS short message function may be used to automatically report location, loss and relief situation in the disaster field.
- The disaster management departments at all levels use the BDS terminals to manage and monitor their own relief materials, which significantly improve the management-transportation operation of the national relief materials.
- At present, it has been **deployed on the ministerial and provincial platforms, supporting 6-level disaster relief operation**. And more than 450,000 BDS terminals have been distributed to all-level disaster management departments.



(II) Application Cases

Precision Agriculture Applications - BDS automatic navigation driving and precision seeding system

- The BDS automatic navigation driving and precision seeding system can be used for ridging, seeding, spraying, harvest and other farm operations.
- It could improve operating quality, reduce operator fatigue, and reduce operating skill requirements.
- Using the BDS-based automated steering system for intensive cultivation, it can save 60% of labor cost and raise income by 900-1350 per hectare for the farmer, and can increase operator's income by 20%-30%.



(II) Application Cases

Driving test application - BDS Driver Examination and Training System

- The system, collects coordinate position, steering angle, speed and other information of the testing vehicle in real time,
- It achieves the automatic evaluation of the driver 's test scores, reduces the human factors and improves the driver' s test transparency



(II) Application Cases

Smart Port Application

- It Provides the precise and overall solution for the handing of container ports, **greatly improved the efficiency and safety of container port system cargo handling, and reduced production costs.**
- It has been successfully applied in more than 20 container ports in Tianjin, Shanghai, Ningbo, Shenzhen and other ports in China, Chennai, India, and Izmir, Turkey.



(III) International Cooperation

Promote the international cooperation and incorporate BDS into the Belt and Road program. At present, BDS products have been exported to more than 80 countries around the world, including more than 30 Belt and Road countries.

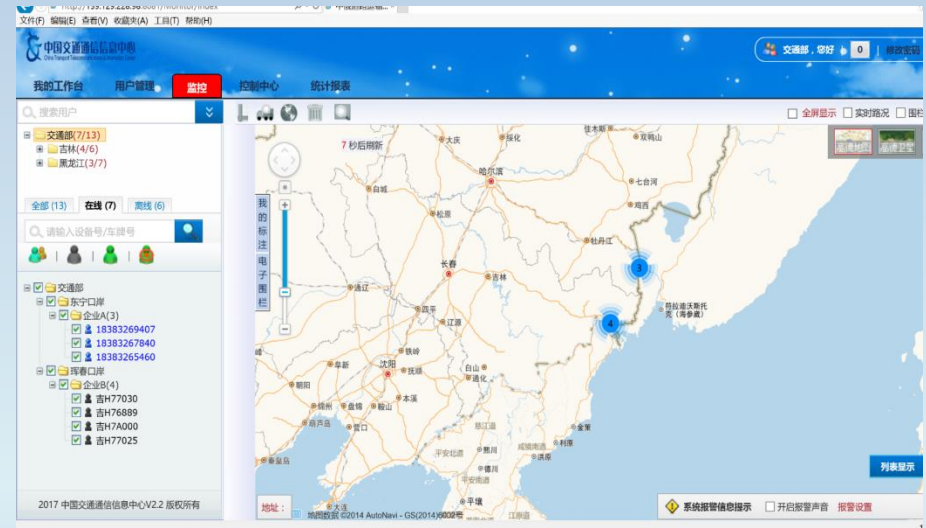
- Organize application cooperation with Thailand, Pakistan, ASEAN, Arab League and other countries and regions
- Sign a memorandum of understanding on cooperation with Saudi Arabia and the Arab League, prepare for the hosting of the first "China-Afghanistan BeiDou Cooperation Forum" , study the project of the BeiDou Arab Land
- Hold "BeiDou" promotion activities overseas and launch BeiDou/GNSS application demo experience



(III)International Cooperation

Chinese and Russian cross-border applications

- In August 2016, at the 20th Meeting of the Transportation Cooperation Subcommittee of the Sino-Russian Premiers Regular Meeting Committee, China and Russia agreed to use the BeiDou/Glonas system to serve the cross-border transportation between the two countries and incorporate the above-mentioned items into the revised plan for the China-Russia government' s auto transportation agreement.
- Currently, pilot applications for cross-border transportation vehicles between China and Russia have been carried out at Hunchun and Dongning ports.



(III) International Cooperation

BDS high-precision measurement is adopted during the construction of a large buildings (300 meters high) of the National Bank of Kuwait , which ensured the quality of construction.



(III) International Cooperation

The Pakistan National Positioning Service Project



(III)International Cooperation

Integrate BDS into the International Standards

- The confirmation of the ICAO BeiDou public service signal B1I signal standard and recommended measures has been completed. The anti-jamming test and technical coordination of the B1I signal are being carried out.
- BDS has progressed in the standardization process of International Maritime Organization (IMO). Multi-system shipborne receiver standard which is compatible with BeiDou was approved; meanwhile, BDS has been included in the PNT guidelines of maritime applications.



(III)International Cooperation

Integrate into the International Standardization

- On the standards of international mobile communication, BDS has become one of the global satellite navigation systems approved by the international mobile communication standard, and 26 international standards related to B1I have been formulated.
- The RINEX 3.03 standard which supports BeiDou was published in Jan 2016.



03

**Near-term
Plans**

- (I) System Construction**
- (II) Application Promotion**

(I) System Construction

1

Keep improving the continuous stability and service accuracy of BDS-2 system, ensuring its regional service performance maintain stable and grow better.

2

Push forward the development and construction of BDS-3 system. In 2018, 13 more satellites will be launched by this year (12MEO+1GEO) to provide basic services to the countries along the Belt and Road. In 2020, BDS will have global service capabilities and become a world-class global satellite navigation system.

3

Initiate the construction of BDSBAS , the BDS satellite-based augmentation system covering China and the neighboring areas will be operational by 2020.

Application Development

- 1 Carry out the R&D and industrialization of the new generation of BDS/GNSS basic products to improve core competitiveness such as performance, power consumption, miniaturization, and cost, and achieve universal application of billionth level of market promotion
- 2 The role of satellite navigation in industrialization and information integration will be brought into full play, combined with national plans such as the Belt and Road, Beijing-Tianjin-Hebei integration, the Yangtze River Economic Belt, and the ASEAN Information Harbor, to comprehensively promote BDS demonstration applications.
- 3 Construct a BDS-based application service ecosystem, using high-precision as a breakthrough, taking the road of integrated development, and promoting the development of BDS application innovation in line with “Four Fusion” (melting the network, merging data, financing terminals, and financing the industry).

Conclusions

- Time and space information is the basic need of people, which makes our life more intelligent.
- BDS has been leaping development from scratch to excellence, from regional to global during the past ten years.
- During the BDS development process, China applies the principle that "the BDS is developed by China, and dedicated to the world "and will surely provide global users with better services, share China's programs and benefit the world.