Development of the BeiDou Navigation Satellite System

（Version 3.0）

China Satellite Navigation Office

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Preface

The BeiDou Navigation Satellite System (hereinafter referred to as “BDS”) has been independently constructed and operated by China with an eye on the needs of the country’s national security as well as economic and social development. As a space infrastructure of the national significances, BDS provides all-time, all-weather and high-accuracy positioning, navigation and timing services to global users.

China attaches great importance to the BDS construction and development, started to explore a path to develop a navigation satellite system suitable for its national conditions since 1980s, and gradually formulated a three-step development strategy: namely, completing the BDS-1 construction to provide services to the whole country by the end of 2000; completing the BDS-2 construction and provide services to the Asia-Pacific region by the end of 2012; and completing the BDS-3 construction to provide services worldwide by around 2020. With BDS as the core, a comprehensive positioning, navigation and timing (PNT) system, which is more ubiquitous, integrated and intelligent, will be established and perfected before 2035,.

Many Chinese administrative departments have been involved in the BDS construction, operation and application management. The China Satellite Navigation Committee and the China Satellite Navigation Office have been jointly established by related national departments of China, to take the management responsibilities on the BDS construction, application promotion industrialization, and international cooperation. Meanwhile, the expert committee and expert teams have also been set up to bring into full play of the expert experiences, to make scientific management and decisions, to steadily construct BDS, to promote global applications of satellite navigation systems, and to extensively carry out international cooperation and coordination.

China applies the principle that “BDS is developed by China, and dedicated to the world”, and adheres to the BeiDou spirit of “independent innovations, unity and collaboration, overcoming difficulties, and the pursuit of excellence”. BDS provides the significant time and space information guarantee for economic and social development, and is one of the important achievements in the past 40 years of China’s reform and opening-up, and serves as a public resource contributed by China to the world. China is willing to share the outcome of BDS construction and development with all other countries, to promote global satellite navigation development and make Global Navigation Satellite Systems (GNSS) better serve the world and benefit mankind.

I. The BDS Overview

Based on its national conditions, China upholds the principles of "independence, openness, compatibility and gradualness", to steadily push forward the BDS construction and development.

(I) The Development Goals

Building a world-class navigation satellite system to meet the needs of the country's national security as well as economic and social development, and to provide continuous, stable and reliable services for global users; developing BDS-related industries to support China's economic and social development, as well as to improve people's living standards; and enhancing international cooperation to share the fruits of development in the field of satellite navigation, to increase the comprehensive application benefits of global satellite navigation systems.

(II) The Development Principles

Independence: to uphold independent construction, development and operation of BDS, and to possess the capability to independently provide satellite navigation services to global users.

- Openness: to provide open satellite navigation services free of charge, and to encourage all-scale, multi-level and high-quality international exchanges and cooperation.

- Compatibility: to enhance BDS compatibility and interoperability with other navigation satellite systems, and to encourage international exchanges and cooperation, so as to provide better services to users.

- Gradualness: to carry out the BDS project in a phased approach, to enhance the BDS service performance, and to boost the development of satellite navigation industry in a comprehensive, coordinated and sustainable manner.

(III) The Main Architecture

BDS is mainly comprised of three segments: a space segment, a ground segment and a user segment.

- The space segment. The BDS space segment is a hybrid navigation constellation consisting of Geostationary Earth Orbit (GEO), Inclined Geosynchronous Satellite Orbit (IGSO) and Medium Earth Orbit (MEO) satellites.
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- The ground segment. The BDS ground segment consists of various ground stations, including master control stations, time synchronization/uplink stations, monitoring stations, as well as operation and management facilities of the inter-satellite links.

- The user segment. The BDS user segment consists of various kinds of basic BDS products, including chips, modules and antennae as well as the BDS terminals, application systems and application services, which are compatible with other systems.

(IV) The Three-Step Development Strategy

- The first step is to construct BDS-1. The project started in 1994, and in 2000, with the launch of two GEO satellites, the system was completed and put into operation. With an active-positioning scheme, the system provided users in China with positioning, timing, wide-area differential and short message communication services. The third GEO satellite was launched in 2003, which further enhanced the system performance.

- The second step is to construct BDS-2. The project started in 2004, and by the end of 2012, a total of 14 satellites, including5 GEO satellites, 5 IGSO satellites and 4 MEO satellites, had been launched to complete the space constellation deployment. Besides a technical scheme which was compatible with BDS-1, BDS-2 added the passive-positioning scheme, and provided users in the Asia-Pacific region with positioning, velocity measurement, and timing as well as short message communication services.

- The third step is to construct BDS-3. The project started in 2009, and by the end of 2018, a total of 19 satellites had been launched to complete a preliminary system for global services. It is planned to comprehensively complete the deployment of BDS-3 with the launching of 30 satellites by around 2020. BDS-3 has inherited the technical

schemes of both active and passive services, and can provide basic navigation (including positioning, velocity measurement and timing), global short message communication, and international search and rescue services to global users. Users in China and surrounding areas can also enjoy regional short message communication, satellite-based augmentation, and precise point positioning services, etc.

(V) The BDS Characteristics

The BDS construction practice has been realized with a development path of rapidly forming the regional service capabilities followed by gradually expanding into global services, enriching the development models of the satellite navigation industry in the world

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BDS possesses the following characteristics: first, its space segment is a hybrid constellation consisting of satellites in three kinds of orbits. In comparison with other navigation satellite systems, BDS operates more satellites in high orbits to offer better anti-shielding capabilities, which is particularly observable in terms of performance in the low-latitude areas. Second, BDS provides multi-frequency navigation signals with which can be combined to improve service accuracy. Third, BDS integrates navigation and communication capabilities, and has multiple service functions including basic navigation, short message communication, satellite-based augmentation, international search and rescue, and precise point positioning, etc.

II. The Construction Progress

By the end of 2018, the BDS-3 preliminary system has been completed to provide global services. The BDS services are available worldwide, including countries and regions participating in the "Belt and Road Initiative" (Silk Road Economic Belt and the 21st Century Maritime Silk Road).

(I) System Deployment

- The space segment has accomplished the global constellation deployment. Currently, BDS-1 is already retired. 15 BDS-2 satellites have been in continuous and stable operation. Before the formal deployment of the BDS-3 constellation, 5 BDS-3 experimental satellites were launched, to carry out in-orbit the test and verification work. The BDS-3 satellites equip with the higher-performance rubidium atomic clocks with stability of 10^{-14} and hydrogen atomic clocks with stability of 10^{-15}, which has further improved the performance and the satellites lifetime. At the present, 19 BDS-3 constellation satellites (including 18 MEO satellites in operation and 1 GEO satellite under in-orbit test) have been successfully launched, stable and reliable inter-satellite links have been established. As the result, the deployment of the preliminary BDS-3 constellation has been successfully completed.

- The ground segment has been upgrade and improved. The BDS-3 has established high-precision time and space references, added operation and management facilities of inter-satellite links, realized measurement and processing of satellite orbits and clock offsets, based on joint observation of satellite-ground and inter-satellite links. Basic global navigation services capabilities have been achieved, including positioning, velocity, and timing measurement, etc. At the same time, the ground facilities for short message communications, satellite-based augmentation, international search and rescue, and precise point positioning services have been built.

(II) System Operation

- Constantly improving the management mechanism for the stable operation. Perfecting a normalized multi-level response mechanism for the BDS space segment, ground segment and user segment. Improving the satellite's autonomous health management, fault response and handling capabilities. Continuously enhancing the

capability of assurance to manage the operation of large-scale constellations, and promoting the stable system operation to become more intelligent.

- Realizing smooth transition of the system services. BDS-3 is forward compatible with BDS-2, and can provide users with continuous, stable and reliable services.

- Innovating risk prevention, control and management measures. Adopting a satellite backup strategy both in-orbit and on-ground to reduce and to avoid the effects of emergent in-orbit satellite faults affecting service performance. Adding redundant and backup design to enable ground facilities to eliminate weak links, and to enhance system reliability.

- Maintaining high-precision time and space references, and improving interoperability with the time and coordinate framework of other satellite navigation systems. The BeiDou Navigation Satellite System Time (BDT) is used as the time reference for BDS. BDT adopts International System of Units (SI) second as the basic unit, and accumulates continuously without leap seconds. The BDT epoch was 00:00:00 on January 1, 2006 Coordinated Universal Time (UTC). BDT is related to UTC through UTC (NTSC), which is maintained by National Time Service Center, Chinese Academy of Sciences. The offset between BDT and UTC is less than 50 ns (modulo 1 second). The leap second information between BDT and UTC is broadcasted in the navigation message. BDS uses the BeiDou Coordinate System (BDCS). The BDCS definition is in accordance with the International Earth Rotation Service Organization (IERS) specification and is consistent with the definition of the China Geodetic Coordinate System 2000 (CGCS2000) with the identical reference ellipsoid parameters, aligned with the latest International Earth Reference Framework (ITRF), and is updated annually.

- Establishing a GNSS monitoring and assessment network. Extensively exploiting international resources, constructing a network of monitoring and assessment stations and various types of centers, carrying out monitoring and assessment of the constellation status, signal accuracy, signal quality and service performance of major GNSS providersincluding BDS at every scale, and providing references for users' applications.

(III) Service Performances

By December 2018, BDS provides global services with 33 operational satellites (5 GEO + 7 IGSO + 21 MEO) in orbit, including 15 BDS-2 satellites and 18 BDS-3 satellites.

Current basic navigation service performance standards of the BDS 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%.

In the Asia-Pacific region, the positioning accuracies are 5 meters horizontally and 5 meters vertically (95%).

(IV) Future Development

In the future, BDS will continue to improve the service performance, to expand the service functions, and to enhance continuous and stable operation capability. Before the end of 2020, BDS-2 will launch 1 backup GEO satellite, BDS-3 will launch another 6 MEO, 3 IGSO and 2 GEO satellites, to further improve the global basic navigation and regional short message communication service capabilities, and to realize the global short message communication, satellite-based augmentation, international search and rescue, and precise point positioning service capabilities, etc. BDS plans to provide following services through various types of satellites in 2020.

Table: Services to be provided by the BDS in 2020

Services		**Signal Frequencies**	**Satellites**
Basic navigation services	Open	B1I, B3I, B1C, B2a	3IGSO+24MEO
		B1I, B3I	3GEO
	Authorized	B1A, B3Q, B3A	
Short message communication services	Regional	L (uplink), S (downlink)	3GEO
	Global	L (uplink)	14MEO
		B2b (downlink)	3IGSO+24MEO
Satellite-based augmentation service (regional)		BDSBAS-B1C, BDSBAS-B2a	3GEO
International search and rescue service		UHF (uplink)	6MEO
		B2b (downlink)	3IGSO+24MEO
Precise Point Positioning service (regional)		B2b	3GEO

- Basic navigation services. Basic navigation services are available for global users, with the signal-in-space (SIS) accuracy to be superior to 0.5m. The global positioning accuracy will be better than 10 meters, the velocity measurement accuracy is better than 0.2 m/s, the timing accuracy is better than 20 nanoseconds. The overall performance will be greatly improved in the Asia-Pacific region, with positioning accuracy better than 5 meters, velocity measurement accuracy better than 0.1 m/s, and timing accuracy better than 10 ns.

- Short message communication services. As for the short message communication services in China and surrounding areas, the service volume will be increased by 10 times and the user's transmit power will be reduced to 1/10 than that of BDS-2, with capability as 1000 Chinese characters per message (14000 Bytes). As for the global short message communication services, the service capability is 40 Chinese characters per message (560 Bytes).

- Satellite-based augmentation services. The satellite-based augmentation services will be provided to users in China and surrounding areas, in accordance with the standards of the International Civil Aviation Organization (ICAO), supporting both single frequency and Dual Frequency Multi-Constellation (DFMC) schemes, and meeting the ICAO performance requirements.

- International search and rescue services. The international search and rescue services will be provided to global users, in accordance with the standards of the International Maritime Organization (IMO) and COSPAS/SARSAT. BDS is incorporated into the global satellite search and rescue system, to provide distress alert services with return-links, and to greatly enhance the efficiency and capability of search and rescue services together with other satellite navigation systems.

- Precise Point Positioning service. The precise point positioning service will be provided to serve the users in China and surrounding areas, with the dynamic precise position service accuracy at decimeter level and static precise position service accuracy at centimeter level.

III. Application and Industrialization

China strives to enhance the BDS application development in an effort to build a BDS industrial chain, which comprises the basic products, application terminals, application systems and operational services, keeps strengthening the BDS-related industrial supporting, promotion and innovation systems, continuously improves the industrial environment, expands the application scale for integrated development, and increases the economic and social benefits of the satellite navigation industry.

(I) Fundamental Products and Facilities

- The BDS-enabled fundamental products have developed with independent intellectual property rights, and the key technologies such as domestic BDS chips and modules have made comprehensive breakthroughs, with performance comparable to that of overseas products at the same class. A variety of BDS-enabled chips have been used in large-scale applications. The independently developed domestic chips have entered the 28-nanometer category. As of November 2018, the sales volume of domestically produced BDS-enabled navigation chips and modules has exceeded 70 million pieces. The domestic high-precision OEM boards and antenna account for 30% and 90% of the domestic market share respectively.

- Constructing the BeiDou ground-based augmentation system. As of December 2018, more than 2300 reference stations have been constructed nationwide for the BeiDou ground-based augmentation system, providing basic services for users in the fields of transportation, earthquake forecast, meteorological forecast, surveying and mapping, land and resources management, scientific research and education, etc., including real-time precision positioning and navigation services at meter, decimeter and centimeter level, and post-processed services at millimeter-level.

(**II**) Industrial and Regional Applications

Since provision of services, BDS has been widely used in transportation, agriculture, forestry, fisheries, hydrological monitoring, meteorological forecasting, communication, power dispatching, disaster relief, public security and other fields, and has been

integrated into the national significant infrastructures, thereby resulting in remarkable economic and social benefits.

- In the field of transportation, BDS has been extensively used in the monitoring and management of priority transportation, highway infrastructure safety, port scheduling, and real-time high-precision positioning. By the end of 2018, the BDS technologies have been applied on more than 6 million road operating vehicles, 30 thousand postal and express delivery vehicles, 80 thousand buses in 36 central cities, 3.2 thousand inland navigation facilities, and 2.9 thousand marine navigation facilities. The world's largest dynamic monitoring system for road operating vehicles has been set up, which has effectively improved the monitoring efficiency of road operating vehicles and the safety of road transportation. Between 2011 and 2017, both the amount of major accidents and the death toll in the field of road transportation have been decreased by 50%.

- In the fields of agriculture, forestry and fishery, based on the BDS high-precision services, the remote management and precise operation of agricultural machinery have been realized. More than 50 thousand sets of the BDS-enabled agricultural machinery, terminals and equipments have been deployed in the country. The domestic output of precision agricultural industry has increased by 5%, and the oil consumption by agricultural machinery has decreased by 10%. The BDS positioning and short message communication functions are playing a prominent role in forest fire prevention and other scenarios. BDS is providing services for ship positioning and monitoring, emergency rescue, information release, and fishing vessel management. The BDS-enable terminals have been installed by more than 70 thousand fishing boats and law enforcement vessels across China. With the BDS-based maritime applications, more than 10,000 lives have been saved.

- In the field of hydrological monitoring, BDS has been successfully applied at the real-time transmission of hydrological forecast information in mountainous regions, which has improved the accuracy of the disaster forecasting, and helped the planning and scheduling programs for the flood and drought control.

- In the field of weather forecasting, a series of the BDS-based terminals and equipment have been developed for weather forecast, and various application solutions have been worked out, to improve the observation accuracy as well as the level of automation and the emergency response capabilities.

- In the field of the time synchronization for telecommunication systems, the successful implementation of a BDS two-way timing demonstration program has

achieved breakthroughs in some key technical areas such as long distant fiber technology, and an integrated satellite-based timing system has been developed.

- In the field of power distribution, a power system time synchronization mechanism has been implemented based on BDS, which has created the basis for high precision applications such as the electric accident analysis, the electricity early warning and protection systems.

- In the field of disaster relief and reduction, the navigation, positioning, short message communications and position reporting capabilities of BDS have provided services for the nationwide real-time disaster relief commanding and dispatching, emergency communications, rapid reporting and sharing of disaster information, which has significantly improved the rapid response of the disaster emergency relief and decision-making capability.

- In the field of public security, more than 400 thousand terminals for the policemen have been connected to a location service platform. BDS has played an important role in safeguarding major events, such as the Asia-Pacific Economic Cooperation (APEC) meeting and the G20 Summit, etc.

(III) Mass Applications

The BDS mass applications enjoy broad prospects. The BDS-based navigation services have been widely adopted by e-commerce enterprises, manufacturers of intelligent mobile terminals and location-based services providers. The services have extensively entered into the fields of mass consumption, share economies, and those related to people's livelihood, which are profoundly changing people's production and livings.

- In the field of e-commerce, logistics trucks and deliverymen of many e-commerce companies in China are using the BDS-based vehicle-borne and handheld terminals, to dispatch vehicles, delivery personnel and goods at real time.

- In the field of smart phone applications, mainstream chip manufacturers at both home and abroad have introduced communication and navigation integrated chips, which are compatible with BDS. In the first three quarters of 2018, about 470 kinds of smart phones sold in China are supporting positioning functions, of which 298 kinds are supporting the BDS, with a ratio of percentage above 63%.

- In the field of smart portable devices, a variety of BDS-enabled smart wearable devices such as watches, bracelets, and smart cards, are emerging in social services

and caring for vulnerable groups, and have already been widely used by students, the seniors and many others.

(IV) Policies and Industrial Development

The Chinese government attaches great importance to and comprehensively accelerates the rule of laws in the field of satellite navigation, actively promotes to enact satellite navigation regulations, and facilities the development of satellite navigation industry.

- Formulating policies and plans at the national level. In 2013, “the Medium and Long-Term Development Plan for the National Satellite Navigation Industry” was released, to make overall arrangement for medium and long-term satellite navigation industrial development, and to provide the guidance of macro polices. In 2016, “China’s BeiDou Satellite Navigation System”, a governmental white paper, was released, to introduce the BDS development methods and policies.

- Releasing guidance documents for the industrial and regional applications. The National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Industry and Information Technology, the Ministry of Public Security, the Ministry of Transport, the Ministry of Agriculture and Rural Affairs, and administrations in more than 30 provinces, autonomous regions, independent municipalities and regions, have introduced a series of policies and specific initiatives to advocate the BDS applications.

- Satellite navigation is an important area for the development of China's strategic emerging industries. China will further promote the technological integrations of BDS and mobile communications, cloud computing, Internet of Things and big data, promote the integration between the satellite navigation industry and high-end manufacturing, software, integrated data and modern service industries, and continue to promote the BDS applications and industrial development, so as to serve the country's modernization construction and daily life of the people, and to make contributions to the global scientific, technological, economic and social development.

IV International Exchanges and Cooperation

As one of the four major GNSS providers, BDS persists in open cooperation and resource sharing, actively carries out international exchanges and cooperation, and promotes the global satellite navigation development.

(I) Coordination and Cooperation with Other Navigation Satellite Systems

BDS continuously carries out coordination and cooperation with other navigation satellite systems, and promotes compatibility and interoperability among multiple systems, to jointly provide higher quality service for global users.

- The Chia-Russia cooperation on satellite navigation. Within the framework of the China-Russian Prime Ministerial Regular Meeting Committee, the China-Russian satellite navigation cooperation project commission has been established, and a series of milestone documents have been signed, including “the Agreement between the Government of the People’s Republic of China and the Russian Federation on Cooperation in the Field of the Use of BDS and GLONASS for Peaceful Purposes”, “Joint Statement on Compatibility and Interoperability of China’s BDS and Russia’s GLONASS”, as well as “the Joint Statement on Navigation Technologies Applications Cooperation based on Peaceful Use of the BDS and GLONASS”. Joint working groups have been established in the areas of compatibility and interoperability, augmentation systems, construction of ground stations, service monitoring and assessment, joint applications, to carry out practical cooperation, and to push forward 10 typical cooperation projects to achieve progresses. The China-Russian satellite navigation monitoring and assessment platform has been built and put into operation. BDS and GLONASS will facilitate the complementarity and integrated development.

  China-US cooperation on satellite navigation. China and the United States have set up a dialogue mechanism for cooperation in the field of satellite navigation, and signed a joint statement on civil GNSS cooperation between BDS and the Global Positioning System (GPS); the Joint Statement of BDS and GPS Signal Compatibility and Interoperability was signed in November 2018, which indicated that the two systems are radio-frequency compatible within the framework of ITU, and the BDS B1C civil signal and the GPS L1C civil signal have achieved

interoperability. Joint working groups have been be set up in the areas of compatibility and interoperability, augmentation systems and civil services, etc., to promote exchanges and cooperation.

- China-Europe cooperation on satellite navigation. A working group on compatibility and interoperability between BDS and Galileo has been set up, to hold several rounds of meetings, and to continuously promote frequency coordination. Extensive exchanges have been carried out under the China-EU dialogue mechanism on space science and technology cooperation.

(II) Multilateral Cooperation on Satellite Navigation

China has taken part in international activities organized by the United Nations and other relevant international organizations, within the framework of relevant multilateral mechanisms.

- Under the framework of ITU, the satellite network information was submitted in accordance with the BDS construction plan and progress. International frequency coordination activities have been conducted. China has taken part in the World Radio-communication Conference and the meetings of ITU study groups and working groups, promoted to extend the radio-determination satellite service (space-to-earth) allocations in the S-band, and successfully pushed forward the S-band (2483.5-2500 MHz) as another band for navigation satellites, with joint efforts with delegates from other countries.

- As a members of the International Committee on Global Navigation Satellite Systems (ICG) and the ICG Providers' Forum, China actively participated in the meetings held by the United Nations Committee on the Peaceful Uses of Outer Space, and the seminars organized by the United Nations Office for Outer Space Affairs. The BDS experts serve as co-chairs of a number the ICG working groups, sub-working groups and task forces, promoting mechanism reform, launching international initiatives, proposing Chinese proposals and offering wisdom. China successfully held the Seventh Meeting of the ICG in 2012, on which the Joint Statement of Global Navigation Satellite Systems was released for the first time. China successfully held the Thirteenth Meeting of the ICG in 2018. Chinese President Xi Jinping sent a congratulatory letter to the Meeting, and expressed that China is willing to share the BDS achievements with other countries, and to promote the development of global satellite navigation systems. The Meeting issued a booklet on the interoperability of the GNSS space service volume, and released a provider's statement to advocate joint development of satellite navigation.

- The China Satellite Navigation Conference has been held annually, with more than 3,000 attendees every year. China actively established interaction mechanisms with navigation meetings of the United States, Russia and Europe, participated in, organized and hosted international academic exchange activities of satellite navigation, so as to strengthen international exchanges and attract global intellectual resources to jointly promote the development of satellite navigation technologies.

- Under the framework of the Asia-Pacific Space Cooperation Organization (APSCO), a number of cooperative projects are being implemented in the fields of monitoring and assessment, research and applications of the BDS/GNSS compatible terminals in disaster reduction, development of BDS/GNSS software receiver, as well as education and training on satellite navigation, so as to upgrade the technologies and to strengthen fundamental capacity building of the APSCO member states.

(III) The BDS Ratification with International Standards

Positive efforts have been devoted to advance the BDS ratification in the International Civil Aviation Organization (ICAO), the International Maritime Organization (IMO, Third and the Fourth-Generation Mobile Communication Standard Partnership Project (3/4GPPP) and other organizations. BDS serves the world in accordance with international standards.

- In the field of international civil aviation, BDS has been carrying out the revision and validation of the B1I, B1C and B2a signal standards under the ICAO framework. The BeiDou Satellite-based Augmentation System (BDSBAS) has been accepted by ICAO as a provider of satellite-based augmentation services, and obtained pseudo-random code resources of the three GEO satellites, the service provider's identification number and the standard time identification identifier.

- In the field of international maritime, BDS has been recognized by the IMO as the third world radio navigation system. The performance standard of the BDS-compatible multi-constellation ship-borne receiver has been approved. BDS has been adopted into the guidelines for maritime applications related to positioning, navigation and timing.

- In the field of mobile communication, the data interface format of the BDS-enabled application terminals, the Third and Fourth-Generation Mobile Communication Standards based on BDS, and other international standards and specifications have been officially issued.

(VI) The BDS International Applications Promotion

The BDS-enabled products have been exported to more than 90 countries, providing users with a variety of choices and better application experience.

- BDS has been gradually applied in the countries and regions participating in the Belt and Road Initiative, by organizing events such as "BeiDou Asia-Pacific Tour" and "BeiDou ASEAN Tour", strengthening exchanges, and training talents on satellite navigation, etc.

- China has carried out satellite navigation cooperation with many countries in South Asia, Central Asia, ASEAN, Africa and other regions, established cooperation mechanisms, signed cooperation documents and promoted cooperation projects in a practical manner.

- China has hosted the China-Arab States BeiDou Cooperation Forum and satellite navigation seminars, established China-Arab States BDS/GNSS Center, enabled better understanding, experience and application of satellite navigation systems in Arab states, and promoted the BDS to serve the construction of Arab states.

- China has set up the BeiDou International Exchange and Training Center, supported the construction of the Regional Center for Space Science and Technology Education in Asia and the Pacific (China) Affiliated to the United Nations, and helped partner countries to train talents in the field of satellite navigation.

- The BeiDou global user experience and evaluation activity has been launched. Global users and equipment suppliers are welcome to actively participate in such an activity, to experience the services of the BDS, evaluate the BDS performance, and to provide input for the BDS improvement and upgrade.

Conclusions

The BDS construction and development have benefited from the significant increase in China's overall national strength, sustained and stable economic development, and significant enhancements in scientific and technological innovation capacity since the reform and opening up. China will continue to promote the construction and industrial development of satellite navigation systems, encourage the use of new satellite navigation technologies, continually expand application areas to meet the ever-growing diverse needs of people, and actively promote international exchanges and cooperation, so as to achieve compatibility and interoperability with other satellite navigation systems in the world and provide global users with higher performance, more reliable and multiple services.

Annex I: The Launch Record of the BDS Satellites

Satellite	Launch Date	Type	Status
1st BeiDou Navigation Experiment Satellite	2000.10.31	GEO	Retired
2nd BeiDou Navigation Experiment Satellite	2000.12.21	GEO	Retired
3rd BeiDou Navigation Experiment Satellite	2003.05.25	GEO	Retired
4th BeiDou Navigation Experiment Satellite	2007.02.03	GEO	Retired
1st BeiDou Navigation Satellite	2007.04.14	MEO	Retired
2nd BeiDou Navigation Satellite	2009.04.15	GEO	Retired
3rd BeiDou Navigation Satellite	2010.01.17	GEO	Normal
4th BeiDou Navigation Satellite	2010.06.02	GEO	In-orbit Maintenance
5th BeiDou Navigation Satellite	2010.08.01	IGSO	Normal
6th BeiDou Navigation Satellite	2010.11.1	GEO	Normal
7th BeiDou Navigation Satellite	2010.12.18	IGSO	Normal
8th BeiDou Navigation Satellite	2011.04.10	IGSO	Normal
9th BeiDou Navigation Satellite	2011.07.27	IGSO	Normal
10th BeiDou Navigation Satellite	2011.12.02	IGSO	Normal
11th BeiDou Navigation Satellite	2012.20.25	GEO	Normal
12th and 13th BeiDou Navigation Satellite	2012.40.30	MEO	Normal
14th BeiDou Navigation Satellite	2012.09.19	MEO	Retired
15th BeiDou Navigation Satellite	2012.09.19	MEO	Normal

Satellite	Launch Date	Type	Status
16th BeiDou Navigation Satellite	2012.10.25	GEO	Normal
17th BeiDou Navigation Satellite	2015.03.30	IGSO	In-orbit Experiment
18th and19th BeiDou Navigation Satellite	2015.07.25	MEO	In-orbit Experiment
20th BeiDou Navigation Satellite	2015.09.30	IGSO	In-orbit Experiment
21st BeiDou Navigation Satellite	2016.02.01	MEO	In-orbit Experiment
22nd BeiDou Navigation Satellite	2016.03.30	IGSO	Normal
23rd BeiDou Navigation Satellite	2016.06.12	GEO	Normal
24th and 25th BeiDou Navigation Satellite	2017.11.05	MEO	Normal
26th and 27th BeiDou Navigation Satellite	2018.01.12	MEO	Normal
28th and29th BeiDou Navigation Satellite	2018.02.11	MEO	Normal
30th and 31st BeiDou Navigation Satellite	2018.03.30	MEO	Normal
32nd BeiDou Navigation Satellite	2018.07.10	IGSO	Normal
33rd and 34th BeiDou Navigation Satellite	2018.07.29	MEO	Normal
35th and 36th BeiDou Navigation Satellite	2018.08.25	MEO	Normal
37th and 38th BeiDou Navigation Satellite	2018.09.19	MEO	Normal
39th and 40th BeiDou Navigation Satellite	2018.10.15	MEO	Normal
41st BeiDou Navigation Satellite	2018.11.01	GEO	Flight Test
42nd and 43rd BeiDou Navigation Satellite	2018.11.19	MEO	Normal

Annex II: List of the Released BDS Documents

December 2011, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1C (Test Version);

December 2012, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1I (Version 1.0);

December 2013, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal (Version 2.0), BeiDou Navigation Satellite System Open Service Performance Standard (Version 1.0);

June 2016, White Paper on China's BeiDou Navigation Satellite System;

November 2016, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal (Version 2.1);

August 2017, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1C, B2a (Test Version);

December 2017, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1C (Version 1.0)

December 2017, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B2a (Version 1.0);

February 2018, BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B3I (Version 1.0);

December 2018, BeiDou Navigation Satellite System Open Service Performance Standard (Version 2.0).