Applications of the BeiDou Navigation Satellite System

(December 2018)

China Satellite Navigation Office

Preface

The BeiDou Navigation Satellite System (hereinafter referred to as the BDS) has been independently constructed and operated by China with an eye to the needs of the country's national security and economic and social development. As a space infrastructure of national significance, the BDS provides all-time, all-weather and high-accuracy positioning, navigation and timing services to global users. In the late 20th century, China started to explore a path to develop a navigation satellite system suitable for its national conditions, and gradually formulated a three-step strategy of development: to complete the construction of the BDS-1 and provide services to the whole country by the end of 2000; to complete the BDS-2 construction and provide services to the Asia-Pacific region by the end of 2012; and to complete the BDS-3 construction and reach world-class standards around 2020. China has started its third step of construction, putting in place the basic system of BDS-3 at the end of 2018 and providing navigation services the world over.

"BDS is developed by China, and dedicated to the world". To benefit the world with reliable services from China, the BDS follows the basic principles of "independence, openness, compatibility and gradualness". The BDS is one of the four key GNSS suppliers recognized by the United Nations International Committee on Global Navigation Satellite Systems (ICG), and a major achievement of China in the past four decades since the country's reform and opening up. The Chinese government has placed a high premium on the construction and applications of the BDS. With the concerted efforts of our government sectors, enterprises and public institutions in all provinces (autonomous regions and municipalities), the BDS has made substantial progress in its system services and applications. Diverse application solutions are made possible by a richer portfolio of basic products and an increasingly sophisticated supply chain, highlighting its economic and social benefits. In a bid to facilitate our modernization drive and everyday life, the BDS has been widely used in every aspect of work and life, including mass consumption, smart cities, transportation, public security, disaster alleviation and relief, agriculture and fishery, precision machine control, aerological sounding, communication, electricity, and financial timing. At the same time, the BDS has

expanded its presence to countries like Russia, Pakistan, Thailand, Myanmar, Singapore, and Indonesia, where it has been used in applications. As the BDS starts to provide services worldwide, it will have more comprehensive functions and optimal performance, bringing new vitality to global economic and social development.

For an overview of BDS applications in recent years, we have shortlisted some typical cases and compiled *BDS Applications*. Many cases have not been included due to length constraints. As more innovative BDS applications are developed and progress is made internationally, this compilation will be updated accordingly so that users at home and abroad can develop a better knowledge of the BDS, allowing Chinese technology to serve the world and benefit mankind.

Contents

I. Basic BDS Products

(I) Overview

In general, the industrial chain of GNSS applications contains four parts: basic products, application terminals, system applications, and operation services. The upstream basic products, including chips, modules, cards, and antennas, build up the foundation for industry development.

As driven by major BDS projects, China's GNSS enterprises and institutions have actively introduced a series of miniaturized BDS products characterized by high performance and low cost since 2011. This has created a favorable climate and positive direction of development comprising "application, development, and verification."

As of November 2018, the BDS has rivaled major competitors across the globe in the cost performance of basic key products. More than 70 million navigation chips (modules) have been sold. High precision cards and antennas occupy a 30 and 90 percent share of the domestic market respectively. Basic BDS products have been exported to more than 90 countries and regions, more than 30 of which are along the "Belt and Road."

(II) Basic BDS Products and Recommended Manufacturers

1. Multi-mode navigation baseband chips

Unicore Communications, Inc.

Techtotop Microelectronics Technology Co., Ltd.

Hangzhou Zhongke Microelectronics Co., Ltd.

Xi'an Aerospace Huaxun Technology Co., Ltd.

Wuhan Mengxin Technology Co., Ltd.

2. Multi-mode navigation RF chips

Guangzhou Runxin Information Technology Co., Ltd.

Chongqing Southwest Integrated Circuit Design Co., Ltd.

Hangzhou Zhongke Microelectronics Co., Ltd.

Xi'an Aerospace Huaxun Technology Co., Ltd.

3. RF-baseband integrated chips

Unicore Communications, Inc.

Wuhan Mengxin Technology Co., Ltd.

Allystar Technology (Shenzhen) Co., Ltd.

Hangzhou Zhongke Microelectronics Co., Ltd.

Techtotop Microelectronics Technology Co., Ltd.

4. Multi-mode, multi-frequency high precision OEM boards

Unicore Communications, Inc.

ComNav Technology Ltd.

5. Multi-mode navigation antennas

Jiaxing Glead Electronics. Co., Ltd.

Shaanxi Haitong Antenna Co., Ltd.

Shanghai High Gain Information Technology Co., Ltd.

Anhui Sun Create Electronics Co., Ltd.

6. Multi-mode, multi-frequency high precision antennas

Harxon Corporation

Beijing Research Institute of Telemetry

Hwa Create Corporation

Shenzhen Ayia Electronics Technology Co., Ltd.

Hunan Aerospace Huanyu Communication Technology Co., Ltd.

II. Mass Applications

(I) Smartphones

1. Overview

In terms of mass applications, smartphones represent the largest market for navigation satellite systems. The BDS enjoys bright prospects in the consumer electronics market represented by smartphones. In January 2018, the Department of Electronic Information under the Ministry of Industry and Information Technology (MIIT) launched BDS applications to smartphone products by solving bottlenecks that prevented the large-scale

application of BDS services and chips in the smartphone industry, which passed the test involving tens of millions of devices.

2. Progress and prospects

By incorporating BDS functions into 27,704,500 commercial smartphones, the project has encouraged domestic chip manufacturers like HiSilicon and Spreadtrum to develop mobile communication chipsets that include BDS functions. At the same time, the relevant technical standard framework for BDS positioning on smartphones, together with complete verification testing platforms and quality inspection methods for BDS-enabled smartphones, has been developed. Statistics provided by enterprises show that around 470 smartphone models sold in the Chinese market in the first three quarters of 2018 were equipped with a positioning system, among which 298 supported BDS positioning, representing a share of over 63%.

3. Organized by

China Academy of Information and Communications Technology (CAICT), the State Radio Monitoring Center Testing Center (SRTC), Huawei Device Co., Ltd., ZTE Corporation, and Yulong Computer Telecommunication Scientific (Shenzhen) Co., Ltd.

4. Recommended by

Department of Electronic Information, MIIT.

(II) Factory-installed Car Navigation System

1. Overview

Amidst faster economic development and higher living standards, China has witnessed a rapid increase in car ownership. Smart vehicle-borne terminals featuring built-in navigation systems have grown increasingly popular and have become a major field of the application of satellite navigation in the auto industry. According to statistics, more than 20 million passenger vehicles go off the assembly lines in China each year, and the percentage of such vehicles pre-installed with GNSS keeps going up. Using the navigation and positioning services of the BDS in combination with other navigation satellite systems significantly improves the navigation performance of vehicles on complicated urban roads.

In 2013, China started its development and commercialization of smart vehicle-borne terminals with built-in BDS/GNSS, focusing on the applications of independent BDS chips

and modules in factory-installed smart terminals in passenger vehicles. The project includes: the development of BDS/GNSS integrated chips and modules in accordance with factory installation standards, the development and quantity production of smart vehicle-borne terminals compatible with BDS applications, and the development of China's first passenger vehicle with BDS. Concluded in 2016, the project registered a sales volume of more than 50,000 of the passenger vehicles.
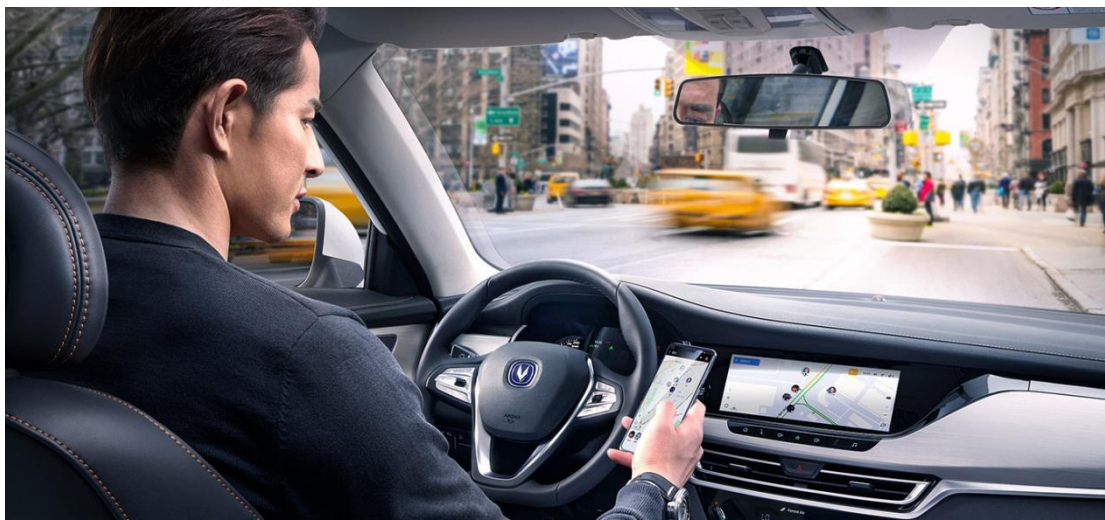
Fig. 1 Factory-installed Car Navigation System

2. Progress and prospects

Thanks to the project, nearly 2 million smart vehicle-borne terminals pre-installed with BDS/GNSS have been mass produced and installed in more than 30 models from about a dozen domestic car manufacturers.

Given the growing demand for smart vehicles, BDS-supported terminals will be pre-installed in more and more vehicles, in particular, new energy vehicles, and driver assistance and autonomous driving systems. BDS/GNSS will become a standard feature of enormous potential.

3. Organized by

Chongqing Chang'an Automobile Co., Ltd., Beijing Yuante Technology Co., Ltd., and Unicore Communications, Inc.

4. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

III. Smart Cities

(I) Online Monitoring of Sanitation Vehicles

1. Overview

Increasingly mechanized sanitation work has posed higher requirements for the operation and management of sanitation vehicles, business operations, detailed cost control, and scientific evaluation. In 2016, Beijing Environment Sanitation Engineering Group built a BDS-enabled platform to monitor its sanitation vehicles, and developed a complete online monitoring system for efficient business management and transformation.

By incorporating such advanced technologies as IoV and mobile communications, the BDS-supported platform adopts a cloud system and boasts many functions: real-time position monitoring of sanitation vehicles, scheduling control, two-way communications, historical data report, inside and outside video monitoring of vehicles, driving records, route planning, and statistical analysis. The platform which achieves centralized scheduling of multiple sanitation vehicles for different operations across businesses has been adopted by several companies within the group.

The platform has taken the management of sanitation vehicles and work to a new level, marking a shift from an extensive manual model to fine information management. Based on modern information technology, the platform seeks to build a sophisticated management system for urban sanitation practices, transform the concepts of urban sanitation management, and improve the standard of sanitation management and public services.
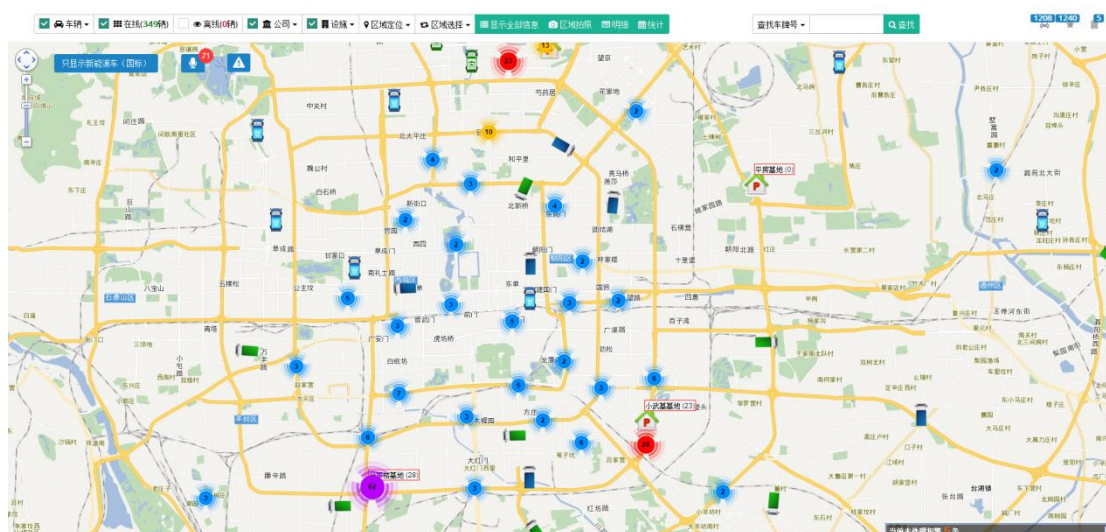
Fig. 2 Real-time Monitoring of Sanitation Vehicles

2. Progress and prospects

To date, Beijing Environment Sanitation Engineering Group has installed 1,147 BDS vehicle-borne terminals in most of its sanitation vehicles in service in Beijing. The platform has also been adopted by several companies outside of Beijing. The platform has fundamentally improved the group's capacity in scheduling and managing sanitation vehicles. With an up-to-date knowledge of vehicles in service, the group has witnessed a sharp improvement in responsiveness, management efficiency and operation quality. Since its introduction, the platform has generated considerable economic benefits, bringing manpower costs down by 4 million yuan and fuel consumption costs by 10 million yuan. At the same time, the social benefits should not be ignored given its role in work safety, having helped the group's subsidiaries achieve the target of "zero fatalities" in 2016 and 2017.

As the BDS improves its positioning accuracy, BDS terminals get smaller and the battery life gets longer, and IoT technologies are better commercialized, the group will explore more scenarios for BDS applications, and continue the digital, smart, and information-based transformation of its sanitation business.

3. Organized by

Beijing Environment Sanitation Engineering Group Co., Ltd.

4. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

(II) Real-time Bus Information Systems

1. Overview

Buses feature prominently in the development of urban transport systems. However, in reality bus services in most cities fail to meet the transport needs of residents, with problems including low service quality, insufficient capacity and a low appeal.

As part of its smart city drive, Shanghai will build a bus-centered public transport system. For this purpose, Shanghai will incorporate BDS high-precision applications into buses on the ground, and developing systems for smart BDS vehicle-borne terminals, real-time bus information, electronic passenger information panels, and intelligent evaluation services. BDS navigation and positioning technology is combined with 3G/4G wireless communication, GIS, big data analysis, cloud computing, and automated control to build a comprehensive BDS-based bus information system that takes into account the features of bus operations.

The system allows the connection of more than 10,000 electronic passenger information panels for real-time status monitoring, access from major smartphone platforms on a large scale, and extensive connection of electronic passenger information panels in mega cities. The accuracy rate of estimated arrival times of up to 95% is a great boon to the public.

2. Progress and prospects

In consideration of diverse transport needs, Shanghai has intensified efforts in data collection. The new information modes and platforms enable the public to obtain transport information timely. In terms of information content, the system can signal the stop where a bus is at and estimate its arrival time.

To date, the system has covered 4,367 buses and more than 5,000 electronic panels along 449 routes in Pudong, serving over 10 million commutes per day. Thanks to the system, Shanghai residents can enjoy the conveniences of a technology-supported bus system and a smart city.

3. Organized by

Shanghai Industrial Technology Institute (SITI).

4. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

(III) Official Car Management

1. Overview

To execute the CPC Central Committee's directive on reforming official cars as required in the *Guiding Opinions on the Comprehensive Promotion of the Reform of the Official Car System*, *Reform Plan for the Official Car System Reform of the Central and State Organs*, etc., issued by the General Office of the CPC Central Committee and the General Office of the State Council, a combination of BDS positioning and monitoring, identity verification, data analysis, and other technologies are utilized to build an Information-based Official Car Management and Supervision System for official cars guided by the ideas of "smooth progress of official affairs, clear public-private division, and transparent operations." The system supports such functions as official car identification, license plate anti-counterfeiting, vehicle management, regional traffic control, emergency dispatch, etc., to ensure the efficient management of official cars. At the same time, it effectively eliminates the chances to exploit official vehicle management loopholes. In a word, it enables efficient, safe and reliable information-based management of official cars for government organs.

The system takes advantage of BDS positioning technology to locate the cars and transmits the car information to the vehicle information management platform via the 4G network, so as to monitor the cars in a real-time manner.

2. Progress and prospects

By 2018, BDS terminals have been installed in more than 80,000 official cars in Beijing in four phases, and 30,000 cars in Guangdong.

Through big data mining, the system has carried out statistical analysis in multiple dimensions such as usage, maintenance, intended use, fuel consumption, insurance, and real-time alarms for violations, and calculated the running cost of official cars. The technical support and basis have been provided for developing proper rules for official car management.

3. Organized by

Guangzhou Haige Communications Group Incorporated Company and Hwa Create Corporation.

4. Recommended by

Department of Industry and Information Technology of Guangdong Province and Beijing Municipal Bureau of Economy and Information Technology.

(IV) 120 First Aid Control Center

1. Overview

By properly allocating medical resources by the principles of proximity and the degree of urgency, a 120 first-aid control center based on BDS allows the centralized scheduling and management of vehicles and first responders. Backed by BDS and Internet communication technology, the center boasts functions including real-time positioning, route monitoring, medical resources scheduling, and video monitoring.

To provide medical response proactively rather than reactively, a personal emergency terminal device, which collects data like the current location, pulse, and blood pressure of the wearer, is also provided to patients with critical health issues. With the device, patients can have their location reported to the center simply by pressing the "Emergency Call" button, a great boon to the seniors in poor health and those who have trouble speaking. At the same time, the control center, based on changes in the data of patients, can proactively provide medical services to the wearers.

2. Progress and prospects

The center has been built in Yan'an, involving 18 first aid stations and 74 emergency vehicles in the city. In 2017, the center has handled 16,473 calls, 18,752 dispatches, and 30 major incidents.

As BDS technologies develop, Shaanxi will develop a comprehensive three-level (province, city, and station) first-aid platform based on the center in Yan'an to deliver smart, flexible emergency services through centralized control, planning, and scheduling, and information sharing.

3. Organized by

BDJK Technology Co., Ltd.

4. Recommended by

Industry and Information Technology Department of Shaanxi Province.

(V) Gas Industry

1. Overview

Gas is a basic energy source supplied in cities and towns through an expanding pipe network. By the end of 2017, the total length of gas pipelines in China has reached 760,000 km, and their safe operation represents a big challenge. Statistics show that more than 50% of pipeline accidents involve third-party damage due to the lack of accurate location information. In this light, accurate location information is necessary for enhanced management and control.

By applying GIS technology, web technology, IoT, and big data technology to gas pipeline operations, and leveraging precise BDS spatio-temporal data, we can effectively manage the construction and operation of gas pipelines, for example, construction management, intelligent inspection, anti-corrosion detection, leakage detection, and emergency digging. In this way, potential safety hazards in the pipelines and management process will be identified in a timely manner, so that safety accidents are well prevented.

Fig. 3 BDS Applications Throughout the Operations in the Gas Industry

2. Progress and prospects

In 2013, BDS precise location services were first adopted with good results by Beijing Gas Group. So far, the service has been extended to more than 500 cities and towns in 24 provinces

(municipalities and autonomous regions). By taking action within the golden half-an-hour for emergency maintenance, the service has raised the detection rate of gas leakage from 70% to 90%. More innovative applications for BDS precise location services are being explored in the gas industry, and extended to municipal pipelines for heat supply, water supply, and drainage. In a word, BDS enjoys bright prospects in the management of municipal pipelines.

3. Organized by

Beijing Gas Group Co., Ltd. and Beijing CNTEN Smart Technology Co., Ltd.

4. Recommended by

Beijing Municipal Bureau of Economy and Information Technology, GNSS & LBS Association of China, and China Gas Association.

IV. Transportation

(I) Monitoring and Management of Key Transportation Processes

1. Overview

Transport, one of the biggest civilian users of the BDS, has a huge demand for location-based services as it involves numerous units, long transportation units and wide areas. According to statistics, the passenger volume and freight tonnage of cargo turnovers by road transportation in China each year are respectively up to 10 billion and 1 trillion. Regarding issues such as frequent road accidents and traffic jams, BDS provides accurate vehicle locations for transport management departments with its navigation and positioning service. Combining with technologies like network transmission, BDS effectively improves road transportation surveillance and enhances the ability of transport management departments in congestion control, accident prevention and emergency rescue, thus protecting human life and property safety.

In 2011, the demonstration project for the monitoring and management of key transportation processes was launched to promote the application of BDS in the road transportation area on a large scale. The project includes application systems for daily operation monitoring on key operating vehicles and public safety supervision and services for road cargo freight, as well as platforms for video exchange, mobile information services in vehicles and region/route alarms.

Through the joint efforts of the Ministry of Transport and pilot provinces, a three-level management model involving the national ministry, provinces, and enterprises has been established. 79,000 BDS terminal devices have now been installed in nine provinces and cities including Tianjin, Hebei, Jiangsu, Anhui, Shandong, Hunan, Guizhou, Ningxia, and Shaanxi.

2. Progress and prospects

Led by the demonstration project, more than 6 million BDS-supported vehicle-borne terminals have been installed in vehicles (over 5 million of which are freight vehicles) across the country, effectively facilitating the application of BDS in the road freight area. The project has created hundreds of millions of yuan output value, effectively accelerated the scale production and application of BDS terminals, sharply brought down the price of BDS terminals and chips, and laid a solid basis for the extensive application of BDS in civilian areas. The project also improves the dynamic monitoring mechanism of road freight in China, greatly enhances the road freight supervision, and lowers down the accident rate, establishing a complete system consisting of terminals, platforms, standards and policies. According to the statistics, the number of major and extraordinary serious accidents in road freight and consequential dead and missing people both decrease by 50% from 2011 to 2017.
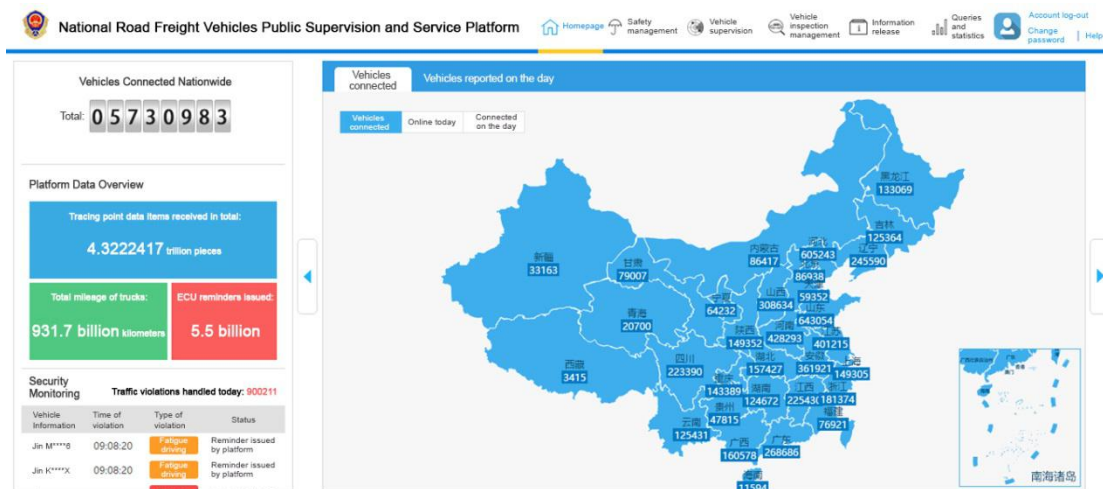

Fig. 4 Homepage of the National Road Freight Vehicles Public Supervision and Service Platform

3. Organized by

China Transport Telecommunications & Information Center and Beijing SINOIOV Information Technology Co., Ltd.

4. Recommended by

Comprehensive Planning Department of the Ministry of Transport

(II) EMS Logistics

1. Overview

BDS technologies are utilized in the monitoring and dispatch management of transportation vehicles in the EMS network. With BDS positioning, navigation and timing services, and new-generation information communication technology, BDS smart vehicle-borne terminals can enable total supervision of EMS vehicles, personnel and cargoes. The perfect combination of location and information overcomes difficulties in managing EMS vehicles, couriers and mail in a standardized, information-based manner. It boasts three major functions: firstly, it allows complete route tracking, in-transit supervision and scheduling of EMS transportation vehicles; secondly, it supports precise, information-based management of postal routes and stations, with accurate information such as vehicle departure & arrival time, arrival estimates, and route deviation alarms; thirdly, it allows analysis and statistics of EMS network operation quality and assists in decision making, including indicators such as vehicle alarms, on-time rate, unloading delays, vehicle journey details, vehicle mileage utilization rate, and vehicle cost.

2. Progress and prospects

The EMS BDS Information Management System has been completed, and more than 30,000 vehicles installed with BDS terminals have been connected to the system, covering postal arteries in 31 provinces and municipalities directly under the Central Government.

Next, the BDS will see widespread application in EMS across China, to position and schedule EMS vehicles and 300,000 couriers. By integrating the BDS with radio-frequency technology (RFID), it will be possible to track and control goods throughout routes in a visual manner. Correspondingly, the BDS will see fast adoption by China's modern logistics field.

3. Organized by

Hunan Copote Science & Technology Co., Ltd.

4. Recommended by

Industry and Information Technology Department of Hunan Province.

(III) JD Group BDS Logistics

1. Overview

With BDS technologies as its core, JD Group has developed the BDS E-commerce Cloud Logistics Information System powered by wireless communications, modern logistics and distribution planning, and other advanced technologies. The system enables total management of logistics processes, product transactions and delivery vehicles to ensure secure transactions. At the same time, it brings down logistics costs, boosts logistics and distribution efficiency, and allows delivery within 100 minutes of an order. It helps take the industry's services and operations to the next level, and drives its upgrade. The system consists of the BDS JD Logistics and Distribution Management System and smart vehicle-borne/handheld terminals.

2. Progress and prospects

JD Group has put in place the BDS E-commerce Logistics Information System and equipped 1,500 logistics vehicles and 20,000 couriers with BDS E-commerce smart vehicle-borne/handheld terminals. This has greatly boosted its capabilities in logistics and distribution management and reduced manpower, resource, and financial costs. In addition, it enables smart logistics location services supported by the BDS.

The BDS e-commerce logistics services hold great promise. JD Logistics network of large, and medium and small commodities has covered all administrative districts and counties in the Chinese Mainland. It has more than 300,000 end stations and more than 5 million logistics personnel. That means a huge market for the BDS. As JD's self-developed autonomous vehicles, UAVs, and robots for distribution and delivery are gradually implemented, this will pave the way for innovative applications of the BDS in logistics.

Fig. 5 BDS JD Logistics Vehicles

3. Organized by

Beijing Jingdong Shangke Information Technology Co., Ltd.

4. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

(IV) Dongting Lake Ship Monitoring and Management

1. Overview

The water bodies of Yueyang include Dongting Lake (2.65 million mu), the Yueyang section of the Yangtze River (163 km long), and the Yueyang section of the Xiang River (more than 100 km long). There are more than 5,500 families (nearly 20,000 people) and over 4,000 ships engaged in fishing and sand mining there.

The Yueyang Fishery Administration Department has developed the Dongting Lake BDS Ship Monitoring and Management System, which provides all-weather real-time positioning, navigation and other services of all kinds for ships operating in Dongting Lake. The system offers interfaces with system data such as AIS, radar and video for integrated monitoring of mobile targets in the waters. The fishery authorities can monitor and give commands for the waters in an all-round and all-weather manner without any blind spots. This is of great help in safeguarding law enforcement, improving law enforcement efficiency, and strengthening law enforcement supervision.

2. Progress and prospects

More than 4,000 vessels for fishing, law enforcement, cruising and sand mining have been registered with the Dongting Lake Ship BDS Monitoring and Management System. Yueyang has since seen a big step forward in its capabilities for providing public service and management. An in-depth application of the system will later be extended to the rest of Hunan Province for lake management.
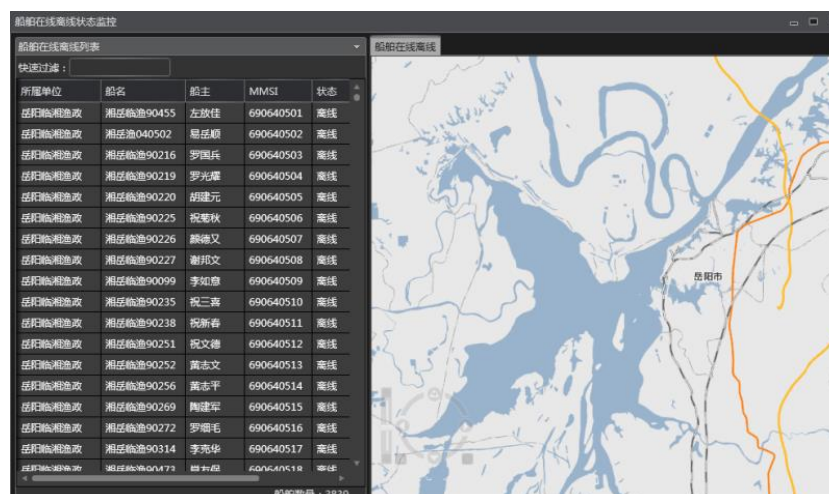
Fig. 6 Dongting Lake Ship Monitoring and Management by BDS

3. Organized by

Guoxin Junchuang (Yueyang) 6906 Technology Co., Ltd.

4. Recommended by

Industry and Information Technology Department of Hunan Province.

(V) Smart Ship Lock Operation and Scheduling

1. Overview

Stepped ship locks in the Xijiang River Basin are poorly coordinated and inefficient. The BDS Smart Lock Scheduling System provides efficient, quality lock transit services for ship owners, who "need only report once to clear all locks and need not to go ashore to pay the fees." With functions such as remote joint scheduling and data sharing, the system has put an end to the long-standing data islands among the various ship locks in the Xijiang River Basin.

Figure 7 Guangxi Xijiang Ship Lock Operation and Scheduling Center

2. Progress and prospects

The BDS Smart Lock Scheduling System consists of joint lock scheduling, cloud ship monitoring platforms, lock and ship databases, and navigation terminals, and it has completed the trial operation. "Smart clearances" and "smart voyages" have been made possible for 1,634 ships, and there has been a total of 77,000 smart clearances to date.

In the future, extensive applications of BDS technology will be seen in joint lock scheduling, lock infrastructure monitoring and multi-modal transport. A number of BDS ship networking solutions with outstanding results will be developed, thus advancing the use of smart technology in inland shipping in Guangxi and even throughout China.

3. Organized by

Guangxi Xijiang Development & Investment Group Co., Ltd.

4. Recommended by

Department of Industry and Information Technology of Guangxi Zhuang Autonomous Region.

(VI) Smart Online Monitoring of Bridge Integrity

1. Overview

Bridges are key to a public transport network, and are vital for smooth regional traffic and socio-economic development. As large spans and viaducts are designed, there are higher requirements for bridge stability, stiffness and strength. Monitoring the integrity of bridges during construction and operation phases has become increasingly important.

The BDS-Based Bridge Integrity Online Smart Monitoring System combines BDS high-precision positioning with other technologies such as diversified sensors, bridge structure analysis technology, and web technology. It features flexible selection of monitoring points, high accuracy, unattended operations, and all-weather access to real-time data. Real-time monitoring of bridge integrity can support state assessment, performance prediction and maintenance decision-making for bridges, and enables smart, digital operation of bridges. At the same time, it can help bridge maintenance departments make reasonable maintenance plans, strengthen maintenance for bridges with major integrity problems, and respond timely to potential dangers to avoid incidents.

2. Progress and prospects

The BDS-Based Bridge Integrity Online Smart Monitoring System has been put into use for more than 20 bridges, including Dongchuan River No. 2 Bridge of Xinzhou-Baode Expressway in Shanxi Province, Kunming Guangfu Overpass, Shaojiwan Bridge in Beichuan, and Hutong Yangtze River Bridge. The system targets all kinds of bridges for expressways, municipalities, roads, and railways, and enables the continuous monitoring of a bridge throughout its life cycle by the department responsible for building, managing and maintaining. The system can provide on-site data acquisition for bridge constructors during the bridge construction period, daily monitoring and auxiliary maintenance planning for bridge authority and owners during the bridge service period, and early warning and assistant decision-making information during the bridge aging period.

The System promotes the concept of "equal emphasis on construction, administration, maintenance, and service" and the sustainable development of road maintenance. A smoother, safer, more intelligent and greener road network can be built, to achieve intelligent transport featuring "Prevention First, Safety First."

Fig. 8 Application of BDS-Based Bridge Integrity Online Smart Monitoring System

3. Organized by

Hwa Create Corporation.

4. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

V. Public Security

(I) Emergency Communication and Command by the Police

1. Overview

The BDS plays a critical role in the emergency communication and command by the police. Through the BDS Police Location Service System and the BDS Public Security Emergency Short Message Service System, the accurate positioning and short message communications of the BDS enable public security agencies to schedule police resources and activate emergency communications when conventional means of communication fail, effectively boosting the capabilities of the police in responding to emergencies.

The BDS Police Location Service System can receive, gather, and share location information, and a three-level (Ministry - Province - City) connected system is in place to allow location

data sharing among public security agencies at all levels. At the same time, it supports joint dispatch and command across regions and different law enforcement officers.

The BDS Public Security Emergency Short Message Service System supports emergency communications in remote regions or those with complex terrains when the mobile communication network and Public Security Communication Network fail. Field information can be sent back to the headquarters timely, in order to secure proper all-weather communications for emergency command at all times.

2. Progress and prospects

Both the BDS Police Location Service System and the BDS Public Security Emergency Short Message Service System have been put into use, and a National Location Map and SMS Network have been built for comprehensive location services, enabling a flat hierarchy of command and dispatch and cross-regional and cross-law-enforcement linkages. As BDS navigation achieves synergies with the Tiantong satellite, dynamic video recognition, fast video retrieval and other new technologies, the emergency communications of the police will be better secured.
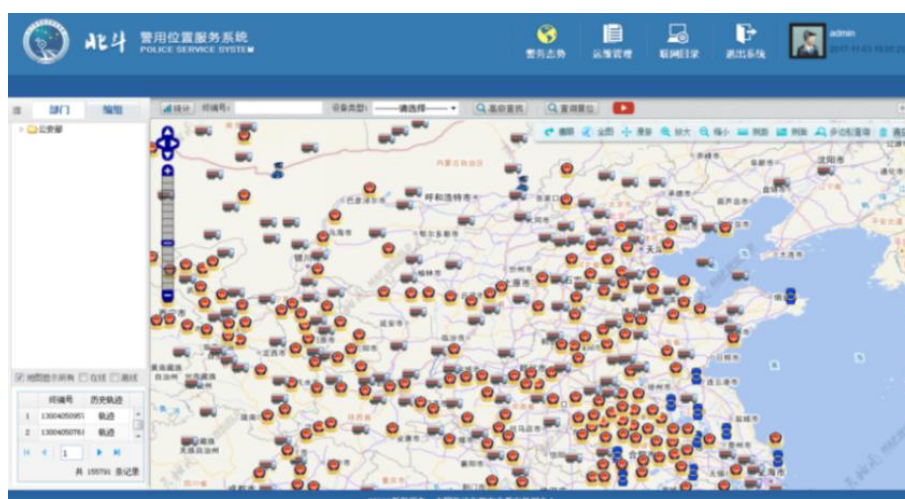

Figure 9 BDS Police Location Service System, Monitoring Screen

3. Organized by

China Security Document Research and Production Center (formerly China Motor-Vehicle Safety Appraisal & Inspection Center), and Beijing SateNav Navigation Technology Co., Ltd.

4. Recommended by

Technology and Informatization Bureau at the Ministry of Public Security.

(II) Police Timing Services

1. Overview

Law enforcement work such as handling traffic violations, tracking down evidence and solving cases involves a large number of surveillance cameras, digital video recorders, data servers and other equipment, so a unified time reference is critical. BDS timing functions enable police timing services in police information communication networks and video networks at both the ministry and the province level. Visual and standardized time synchronization and supervision services effectively boost the reliability and accuracy of police work.

The BDS Police Timing Service System builds on the China Public Security Information and Communication Network. It provides timing services and supervises millions of terminals at different levels on the China Public Security Information and Communication Network, and enables an accuracy of about 100 ms throughout the network thanks to the NTP service.

2. Progress and prospects

The BDS Police Timing Service System has been serving the police information communication networks and some video networks at both the ministry and the province level. More than 110,000 police network equipment operating in sync, and an effective time reference enables accurate results in police work such as information collection, intelligence analysis and video investigation. Going forward, we will capitalize on China's comprehensive PNT service system to further applications of the BDS Police Timing Service System and provide services for law enforcement work that is integrated across time and space.

3. Organized by

China Security Document Research and Production Center (formerly China Motor-Vehicle Safety Appraisal & Inspection Center) and Beijing Time & Frequency Technology Co., Ltd.

4. Recommended by

Technology and Informatization Bureau at the Ministry of Public Security.

(III) Grid Patrol and Control

1. Overview

Powered by a grid management model and high-accuracy BDS positioning, IoT perception and other information technology, the BDS Grid Patrol and Control System can collect location information such as urban risk source distribution, the position of patrol personnel, and emergency events. It lays the foundation for the grid patrol system and urban risk prevention and control system, which makes the management of patrol forces by community areas more efficient and crackdowns on crime more precise. The system encompasses five functions: data management, personnel management, patrol management, risk management and event management.

2. Progress and prospects

The BDS Grid Patrol and Control System has been implemented for Pukou District, Qixia District and Jiangbei New Area in Nanjing, and local areas have trained professional patrol teams with the help of the system. Various sources of risk are brought under control, which benefits the society in many ways.

Grid management is an innovative approach to eliminating the shortcomings of traditional urban management systems. The BDS Grid Patrol and Control System offers an effective solution for urban grid management and supports urban management as cities seek diversification and integrated development. It will promote widespread applications of the BDS system in comprehensive urban management.

Figure 10 BDS Grid Patrol and Control

3. Organized by

Jiangsu BDS Application Industry Institute.

4. Recommended by

Industry and Information Technology Department of Jiangsu.

(IV) E-bike Theft Prevention

1. Overview

Faced with the huge challenge of thefts in e-bikes, Huangpi District of Wuhan has adopted the BDS E-bike Theft Prevention System for round-the-clock monitoring of e-bikes and seamless links between people and their modes of transport to ensure vehicle security. Positioning by the BDS and communication base stations allows the provision of real-time information on vehicle status, position, speed and other information to the supervision system. Connection with the 110 hotline of Municipal Public Security Bureaus provides a new solution for preventing thefts of e-bikes.

2. Progress and prospects

More than 3,000 e-bikes have been registered with Huangpi District Public Security Sub-Bureau. The BDS E-bike Theft Prevention System integrates advanced technologies such as big data and smart security, and better assists the police in handling thefts of e-bikes by providing the real-time status and position of e-bikes. It enables a new model of smart security management for comprehensive e-bike management, alarm, and event handling. A number of e-bike thefts have been solved and the stolen bikes have been returned to the owners quickly, thanks to the BDS E-bike Theft Prevention System.

3. Organized by

China Mobile Group Hubei Co., Ltd.

4. Recommended by

Department of Natural Resources of Hubei Province (formerly Hubei Provincial Bureau of Surveying and Mapping).

(V) Anti-Narcotics Operation and Command

1. Overview

The BDS "Cloud+Terminal" Anti-narcotics Combat and Command System utilizes BDS positioning and short message communication services, as well as mobile communications technology, video technology and law enforcement geographic information technology, for lead collection, case investigation, intelligence analysis and the final operation in narcotics cases. It enables real-time positioning and returning of the location of anti-narcotics command vehicles, comprehensive deployment of law enforcement on the ground, and command and dispatch. This improves the public security's overall capabilities in "overall discovery, blocking & interception, precision strike and prevention & control" of drug and terrorist activities.

2. Progress and prospects

The anti-narcotics system has been implemented in Guangxi Zhuang Autonomous Region, and an integrated intelligence and operations platform has been built, encompassing functions such as intelligence and lead collection, analysis and communication, warnings and surveillance, and implementation of arrest. Numerous crucial cases have been solved in Pingxiang with the help of the system, greatly contributing to Pingxiang's anti-narcotics efforts. Prospects for applications of the system are broad.

Fig. 11 BDS "Cloud+Terminal" Anti-narcotics Operations

3. Organized by

Beijing UniStrong Science & Technology Co., Ltd.

4. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

VI. Disaster Alleviation and Relief

(I) General Disaster Alleviation and Relief

1. Overview

When a major natural disaster occurs, ground network connections are disrupted or unavailable, and disaster information cannot be reported timely. In cooperation with pilot disaster management departments at the provincial level, the National Disaster Relief Center has built and deployed the BDS Integrated Disaster Alleviation and Relief System, based on China's existing disaster administration framework. The system integrates such functions as interconnectivity between BDS short messages, and SMSes and WeChat, remote dynamic monitoring of the current position, operation status and emergency activities of disaster relief personnel and vehicles in a single screen. It allows timely reporting of disaster information and remote all-weather monitoring of emergency and rescue activities.

The BDS Integrated Disaster Alleviation and Relief System boasts a three-level deployment (Ministry - Province - Site) and covers 32 provincial nodes across the country. A six-level disaster reporting and monitoring architecture, "Ministry - Province - City - County (District) - Township (Town) - Urban and Rural Community," enables the monitoring of the location of disaster relief resources across the country in a single screen.

2. Progress and prospects

Large-scale construction and application of the BDS Integrated Disaster Alleviation and Relief System has been started in 10 provinces (autonomous regions and municipalities directly under the Central Government) such as Tianjin, Liaoning, Shanghai, Jiangsu, Shandong, Hubei, Shaanxi, Gansu, Qinghai and Ningxia. Based on a distributed architecture of "1 + 32", the BDS Disaster Relief Operation Service Center was built, along with 10 provincial-level BDS Integrated Disaster Relief Node Platforms were deployed, and 45,000 BDS Disaster Relief Information Terminals were equipped. A well-working model has been established to utilize the BDS Integrated Disaster Alleviation and Relief System for disaster reporting, on-site verification, on-site emergency rescue, emergency search and rescue, and disaster information services. The system has achieved stable and smooth operations in general, and has significant results when scaled up.
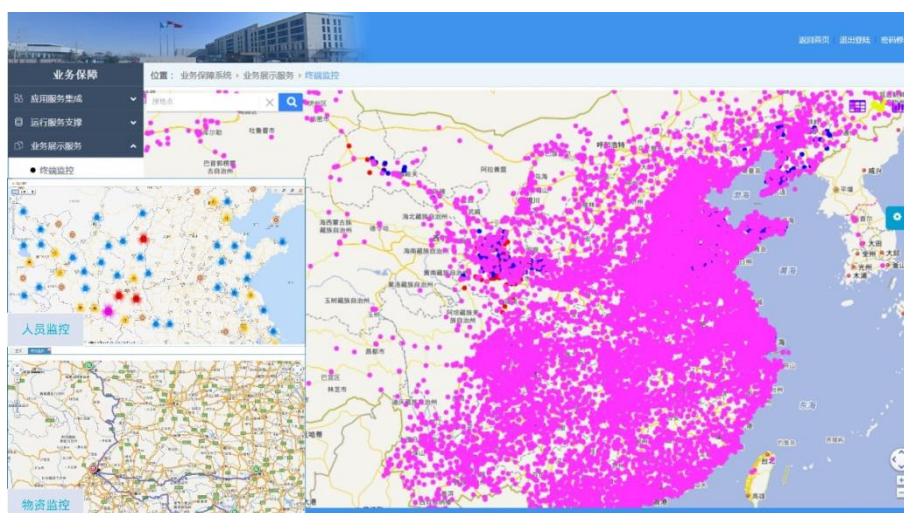
Fig. 12 Dynamic Monitoring of National Disaster Relief Resources (Flood Season) in a Single Screen

3. Organized by

Beidou Tianhui (Beijing) Technology Co., Ltd.

4. Recommended by

National Disaster Relief Center, Ministry of Emergency Management.

(II) Marine Distress Signal Management and Search & Rescue Command

1. Overview

Most of China's vessels and individuals engaged in marine operations lack the technological means to sound a distress signal and locate themselves, which results in low efficiency during search and rescue, and poor coordination of rescue efforts. For this reason, the Ministry of Transport initiated the construction of the BDS Marine Distress Signal Management and Search & Rescue Command System in 2015. The system utilizes the BDS positioning, navigation, short message communication functions, along with satellite communications and mobile communications, and offers integrated functions including signal verification, hazard tracking, formulation and simulation of search and rescue plans, management of search and rescue efforts, and smart deployment, and enables three-level signal reception, handling and supervision at the ministry, provincial and city levels.

2. Progress and prospects

The system has been deployed by the Ministry of Transport in the Marine Search and Rescue Center of China, provincial maritime search and rescue centers, rescue bureaus, salvage

bureaus and other relevant departments. In addition, BDS smart short message onboard terminals have been installed in both maritime affair ships and rescue ships. More than 400,000 BDS signal devices have been introduced to users in the marine sector. The system significantly improves the efficiency of searching for people facing hazards at sea and reduces the number of casualties. As such, human life and property are protected at sea.

As the BDS is developed globally and technology constantly advances, the system will extend its services beyond Chinese waters to the rest of the world and support interfacing with more signals. BDS marine distress signal equipment will become more popular among users in the marine sector, promoting widespread applications of BDS in maritime search and rescue.

3. Organized by

Shanghai Advanced Avionics Co., Ltd., Beidou Tianhui (Beijing) Technology Co., Ltd., and Techtotop Microelectronics Technology Co., Ltd.

4. Recommended by

China Transport Telecommunications & Information Center.

(III) Hydroelectric Dam Deformation Monitoring

1. Overview

There are about 80,000 reservoir dams in China. The BDS Hydroelectric Dam Deformation Monitoring System utilizes BDS multi-frequency high-accuracy carrier phase differential processing technology to provide millimeter-level monitoring data of hydroelectric dam slopes at all times. It allows automated acquisition, analysis, solving and storage of dynamic monitoring data, which minimizes labor intensity in the field, and high-precision 3-D point monitoring data can be collected quickly to monitor any potential safety hazards of the dam timely.

2. Progress and prospects

The BDS Hydroelectric Dam Deformation Monitoring System has seen successful applications in Xiluodu Hydropower Station (No. 3 globally and No. 2 domestically by scale), Changheba Hydropower Station, and many others. There are more than 150 monitoring points for the above two stations. Monitoring information collected can back decision making for the project design, on-site construction, operation monitoring, and long-term maintenance of

various hydropower stations. This has also been utilized to power technologies for safe production and operation, smart sites and information systems. The BDS Hydroelectric Dam Deformation Monitoring System has expanded its applications to areas including bridges, landslides, and high-rise buildings, and has broad prospects for applications.

Fig. 13 BDS Hydroelectric Dam Deformation Monitoring

3. Organized by

ComNav Technology Ltd.

4. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

VII. Agriculture and Fishery

(I) BeiDou Agricultural Machinery Auto-steering Application

1. Overview

The BDS was introduced in autopilots for agricultural machineries, for the purposes of boosting agricultural mechanization and work efficiency, and reducing production costs. It has been applied in large- and medium-sized tractors and various agricultural machinery for harvesting, muddy fieldwork (rice transplanting for example), and other purposes. A combination of the BDS, precise control of large-torque motors, and steering control for agricultural machineries ensures its presence throughout agricultural production from plowing and sowing, to managing and harvesting, to be specific, raking, rotary tilling, ridging, sowing, spraying, harvesting, furrowing, transplanting and precision fertilization. BDS dual-antenna positioning and orientation and high-precision difference feature can provide real-time

attitude information, coordinate information and heading information of agricultural machineries vehicles. At the same time, the steering wheel can be controlled to automatic steering of the machineries at an accuracy of ±2.5 cm.

Fig. 14 BDS Applied for Auto-steering of Agricultural Machineries

2. Progress and prospects

The system has been applied in large scale in Xinjiang, Inner Mongolia, Heilongjiang, Guangxi, Hebei, Shandong, Shaanxi, Hubei, Anhui and other provinces and cities. Applicable machineries include 30-350 horsepower tractor, rice transplanter, reaper and pesticide sprayer of all kinds.

3. Organized by

ComNav Technology Ltd., Shanghai AllyNav Technology Co., Ltd., Beijing UniStrong Science & Technology Co., Ltd.

4. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM), and Beijing Municipal Bureau of Economy and Information Technology.

(II) Supervision over Agricultural Machineries

1. Overview

Powered by BDS positioning, Internet of Things, information fusion and other technologies, the BDS Agricultural Machinery Supervision Platform brings together real-time operation status from all sources and production big data to present an integrated solution that encompasses Internet of Things, safety supervision and information-based management. It

allows managing agricultural machineries in a digital, visualized, intelligent, and precise manner, and real-time supervision is available via APP and WeChat official account. Applicable operations include rotary tilling, transplanting, rice & wheat harvesting, subsoiling, plant protecting, sowing, traditional tilling, deep plowing, baling, no-till sowing, stubble cleaning, straw returning, sugar cane harvesting and planting, large-scale pest prevention and control, banking, fertilizer producing, raking, drying, and others.

The BDS Cloud Service Platform for Mechanized Agriculture targets users at the province, city, county and cooperative level, and focuses on plowing, sowing, managing and harvesting. It allows intelligent monitoring and scheduling for agricultural machineries throughout the production process, and combines functions such as positioning and tracking, operation supervising, remote scheduling, operation and maintenance management, big data analysis, subsidy settlement, information release, and cooperative management. That is how it contributes to the Chinese strategy of large agricultural machineries and large-scale agriculture.
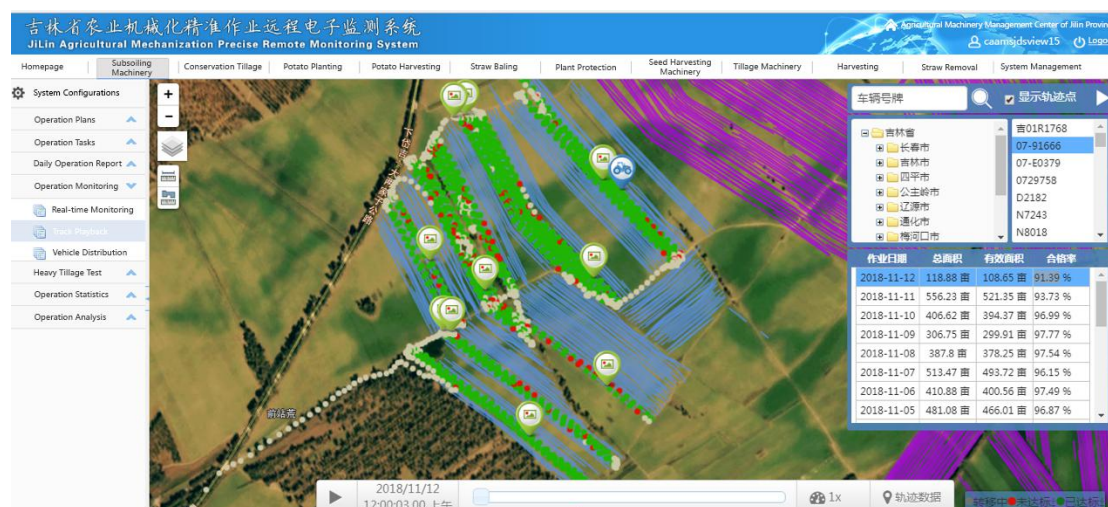

Fig. 15 BDS Used for Supervising Agricultural Machinery Operation

2. Progress and prospects

The supervision platform has been spread widely in most parts of China including Jiangsu, Hubei, Zhejiang, Liaoning, Sichuan, Shanxi, Xinjiang, Ningxia, Inner Mongolia, and Sichuan, serving more than 50,000 agricultural machineries. The cloud service platform has been launched in 22 provinces including Jilin, Inner Mongolia, Shandong, Guangdong and Yunnan. It has connected more than 12,000 sets of terminals. 7,680 electronic remote monitoring devices have been installed for subsoiling, 380 for potato seeding, 462 for potato harvesting,

578 for corn harvesting, 1,800 for straw baling, and 1,300 for high-efficiency plant protection. A total area of 23.8 million mu has been brought under supervision, and more than 20,000 machinery operators and management personnel have been trained, along with financial subsidy totaling 480 million yuan.

The above platforms take both the operation quality and management efficiency of agricultural machineries to the next level and reduce labor and labor intensity needed for agricultural production. These new BDS applications have broad prospects.

3. Organized by

China National Machinery Industry Corporation Ltd., Chinese Academy of Agricultural Mechanization Sciences, Jiangsu BDS Application Industry Institute Co., Ltd., Agricultural Mechanization Technology Promotion Station of Hubei Province.

4. Recommended by

State-owned Assets Supervision and Administration Commission of the State Council, Industry and Information Technology Department of Jiangsu, and Department of Natural Resources of Hubei Province.

(III) Life-Cycle Management in the Sugar Industry

1. Overview

Lack of information-based smart operation in cane sugar industry has resulted in issues such as poor information flow among stages such as planting, cutting, transporting and producing, chaotic harvesting and transporting, and inadequate management. Supported by geomatics technology, the BDS Production and Transportation System offers a one-stop platform that brings together sugar competent authorities, sugar factories, sugarcane farmers, managers, and drivers, for a life-cycle traceability management from planting to processing. This helps standardize transportation practices, regulate market transactions, reduce production and management costs for enterprises, and promote intelligent, information-based management of the industry.

2. Progress and prospects

The system has been adopted by Guangxi Yuegui Guangye Holdings Co., Ltd., Guangxi Ningming East Asia Sugar Co., Ltd., Guangxi Chongzuo East Asia Sugar Co., Ltd., and

Guangxi Tuolu East Asia Sugar Co., Ltd., with 546 sets of BDS high-precision mobile collection terminals applied for precise measurement and management of sugarcane fields. As sugarcane planting relies more on information management, the system will be rolled out in the sugarcane industry, covering production services, transportation supervision and services, and industry regulation.
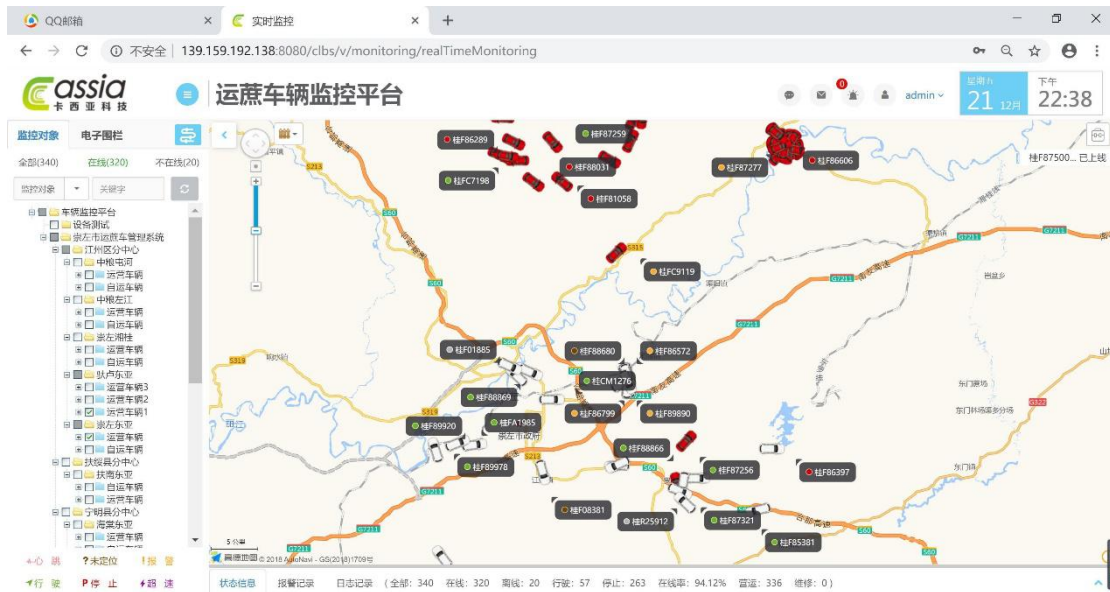

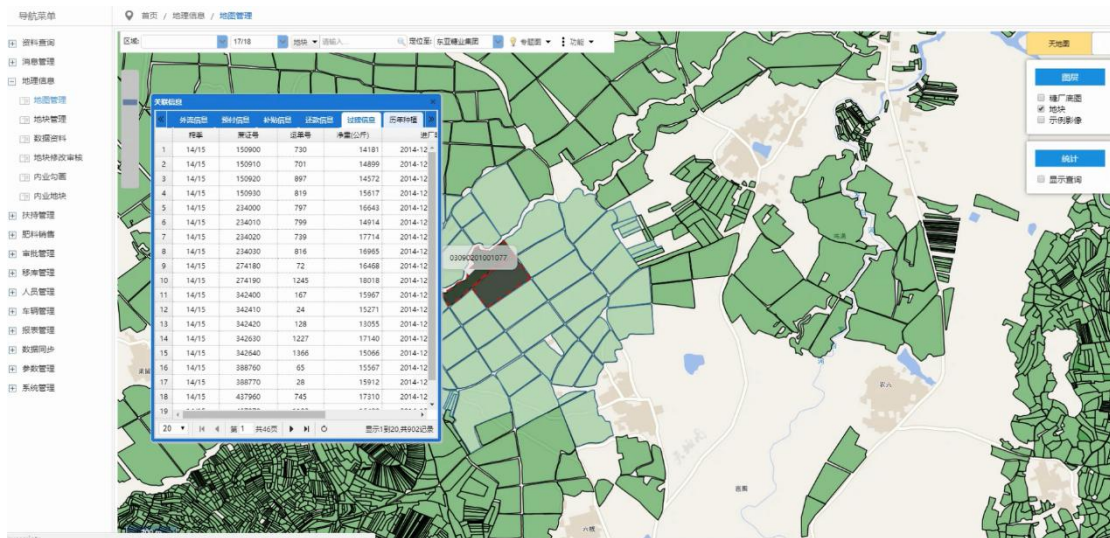Fig. 16 Vehicle Monitoring Platform

Fig. 17 BDS Difference Land System Tailored for Sugar Enterprises

3. Organized by

Guangxi Rungui Science & Technology Co., Ltd., and Guangxi Cassia Science & Technology Co., Ltd.

4. Recommended by

Department of Industry and Information Technology of Guangxi Zhuang Autonomous Region.

(IV) BDS Comprehensive Services for Marine Fishery

1. Overview

The BDS Comprehensive Information Service System for Marine Fishery integrates such communication information technologies as BDS short messages, SMSes, and Internet, and it allows exchange between BDS short messages and SMSes. It features functions including distress alerting, coordination and communication for search and rescue, on-site searching, maritime security information broadcasting, and general public communication services. The system can offer digital message exchange services between ships and shores to fishers engaged in open sea fishery and stakeholders; fishery management, ship position monitoring, and emergency rescue information services to fishery authorities; fishery transaction and logistics information services to fishing operators; and to fishing ships positioning, navigation, marine operation notices, distress calls, and value-added information services, such as the weather, waves, fisheries, fishing seasons, and fish markets.
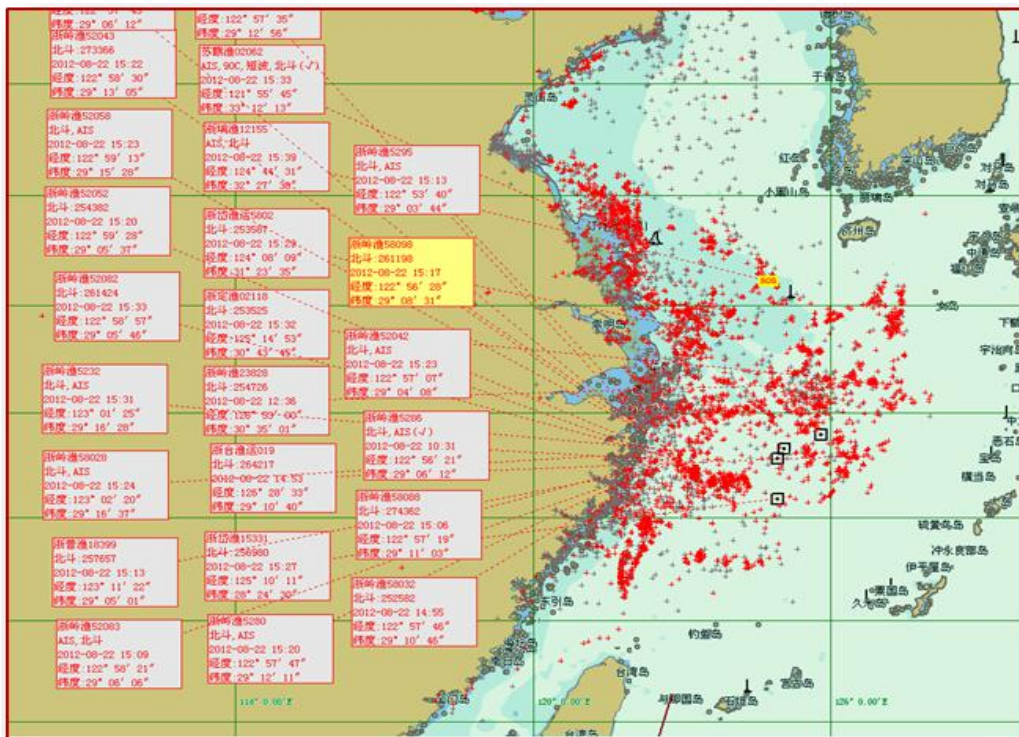

Fig. 18 BDS Comprehensive Information Services for Marine Fishery

2. Progress and prospects

By far, BDS maritime communication terminals have been installed in vessels engaged in fishing in the open sea, 50 nautical miles away from China's southeast. A sea-air-ground monitoring system with more than 1,300 ships has been built to allow fishery authorities at all levels to monitor and manage in a centralized manner. Nearly 70,000 users have registered in the system, along with about 150,000 mobile users. It can generate 8 million pieces of location data and send more than 60,000 short messages every day. In the past three years, more than 210 fishing vessels (4 foreign ones) and 3 tourist vessels have been rescued, along with over 30 injured and sick and more than 1,500 fishers. It also avoids a total economic loss of over 1 billion yuan.

3. Organized by

Beijing BDStar Navigation Technology Co., Ltd., and Beijing SateNav Navigation Technology Co., Ltd.

4. Recommended by

Bureau of Fisheries and Fisheries Law Enforcement, Ministry of Agriculture and Rural Affairs.

VIII. Precise Machine Control

(I) Driver Training and Examination

1. Overview

China's driver training and examination is troubled by many problems including inconsistent devices, opaque information, inefficient examination process, repeated investment, nontransparent examination mechanism, and frequent device failures. To address these problems, BDS high-precision positioning and orientation technology is leveraged to build a new-generation driver training and examination system that digitized and visualized the entire training and examination process. This will make driver training and examination much more efficient and scientific.

The system consists of a three-dimensional visualized monitoring system, vehicle-borne subsystem, exam monitoring platform, wireless network, surveying & mapping subsystem, etc. Backed by high-precision RTK technology and the technology that combines satellite

navigation and inertial navigation, it can accurately measure the vehicle's motion gestures, so as to timely, accurately grasp all dynamic information of the driver, the vehicle and the field, and utilize the network to enable functions such as information exchange and sharing, comprehensive research and judgment, whole-process traceability, and supervision.

2. Progress and prospects

The system has been installed in a number of driving schools and training institutions in Beijing, Tianjin and Hebei. Its first application took place in August 2016, including 5,000 test vehicles and 3,000 training vehicles. By far, its sales totaled around 50,000 sets, being able to serve 3.6 million drivers in examination and 1.08 million in training each year.

It provides drivers with sufficient time to study effectively, and the driver exam can progress in a fair manner. In this light, it can improve drivers' skills, reduce traffic accidents, ensure traffic safety, and upgrade road safety in China. Next, the focus will be placed on autonomous positioning, automatic mapping and automatic control solutions, and to develop next-generation smart driver training and examination system and its service management platform, active braking system for safety protection, and AI-assisted training system.

Fig. 19 BDS Driver Training and Examination

3. Organized by

Beijing StarNeto Technology Corporation Limited, and ComNav Technology Ltd.

4. Recommended by

Beijing Municipal Bureau of Economy and Information Technology, and Science and Technology Commission, Shanghai Municipality (STCSM).

(II) Engineering Machinery

1. Overview

The engineering machinery industry is of strategic importance as it provides technical equipment for economic development. Predicting and warning against faults, changing from passive repair to active maintenance and from extensive construction to fine construction, minimizing failure during key construction periods, extending the service life of equipment, improving the speed and accuracy of fault diagnosis and maintenance and innovating the leasing model have all become urgent problems to be solved now.

To make engineering machinery smart, BDS positioning and navigation are integrated in the engineering machinery terminals, to combine control, display and communication all in one. Technical breakthroughs, such as high-precision signal processing and protecting, wireless transmission for remote intelligent monitoring, and condition monitoring and fault diagnosis, support access to real-time status of the engineering machineries, which can back fault diagnosis and early warning; real-time access to environment parameters of engineering machineries, which makes refined construction possible; real-time tracking of machinery position, which lays the foundation for financial leasing of engineering machineries. All in all, the engineering machinery industry now features smart, information-based operation.

2. Progress and prospects

The terminals have been widely used in the engineering machinery industry. As of 2018, over 50,000 units of BDS integrated display and control terminals have been installed in almost all kinds of engineering machineries such as concrete pump trucks, crane trucks, concrete mixers, and aerial platform vehicles.

Engineering machineries and vehicles often work in outdoor conditions, thus being frequently exposed to harsh conditions such as smoke and dust. With reliable and smart anti-theft design, the BDS engineering machinery terminal combines BDS/GNSS positioning, remote intelligent monitoring and remote fault diagnosis technologies all in one. It features high-

precision positioning and stable performance with fast control, timely response, and reliable CAN bus communication. It can satisfy customers' needs for remote communication and fault diagnosis, and address safety monitoring of products which are remotely operating in harsh environment. Next move will be to optimize positioning accuracy and enrich functions, and spread the terminals to more fields.

Fig. 20 BDS Terminals for Engineering Machineries

3. Organized by

Greatwall Information Industry Co., Ltd., and Sany Automobile Manufacturing Co., Ltd.

4. Recommended by

Industry and Information Technology Department of Hunan Province (Hunan Provincial Administration of Science and Technology Industry of National Defense).

IX. Meteorological Detection

(I) Aerological Sounding

1. Overview

In 2013, the China Meteorological Administration (CMA) launched the construction of "BDS-based Atmosphere, Ocean and Space Monitoring and Warning Project". The home-grown BDS sounding system combines temperature sensor with vacuum aluminum brazing, a new generation of humidity-sensitive sensor, silicon piezoresistive pressure sensor and

BDS/GNSS receiving modules, has significantly improved our aerological sounding system in observation accuracy, automation and emergency observation.
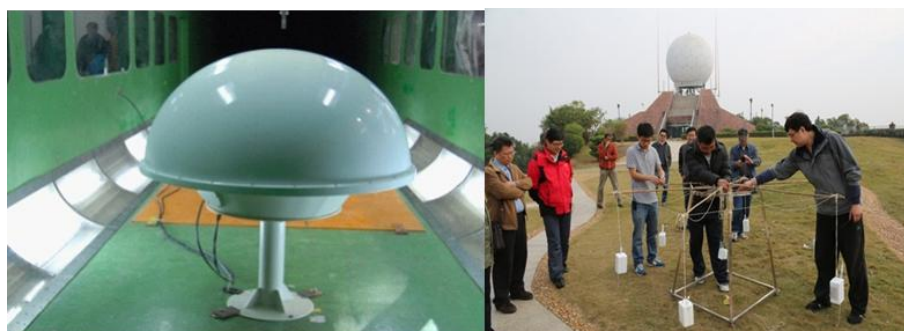

Fig. 21 BDS in Aerological Sounding

2. Progress and prospects

The system has been built and put into operation in Beijing, Xilinhot, Wuhan, Yangjiang, and Haikou. As tested and evaluated by CMA Meteorological Observation Center, the system, in terms of detection performance, outstrips the former radiosonde, and reaches the world-class level.

3. Organized by

CMA Meteorological Observation Center, Beijing Institute of Radio Measurement (BIRM), Nanjing Daqiao Machinery Co., Ltd., Shanghai Changwang Meteotech Co., Ltd., and Beijing Huayun Tianyi Technology Co., Ltd.

4. Recommended by

China Meteorological Administration.

(II) Water Vapor and Ionospheric Sounding

1. Overview

The China Meteorological Administration has built BDS water vapor and ionospheric sounding system that consists of BDS base station network, data collection center, and processing center, in order to ensure smooth, reliable operation of the water vapor and ionosphere sounding system which faces key problems such as acquisition of satellite orbits and satellite clock parameters. Through BDS/GNSS high-precision receivers, the system can acquire high-temporal-resolution data of water vapor and ionospheric electron density. The

frequency of water vapor observation increases from 2 times a day to 24 times a day, which enhances the stability of the ionosphere monitoring. In addition, it is of high reference value for making weather forecasting more accurate, and optimizing the early warning and forecasting of sudden disastrous weather and space weather.

2. Progress and prospects

With the support of the CMA Meteorological Information Network, a BDS reference station network of 12 stations and two comprehensive data collection & processing centers have been built and put into use in Hubei and Guangdong. By observing water vapor in the atmosphere in high-time-space density and effectively capturing the change of water vapor, the network greatly enhances the accuracy of short-term heavy precipitation forecast within 24 hours (e.g. rainstorm).

Next, CMA plans to use BDS/GNSS high-precision receivers to upgrade the existing GNSS meteorological station network. New receivers can provide water vapor and ionospheric electron density data in high-time resolution, thus elevating meteorological observation ability of China's navigation satellites, which will provide observational data featuring high-precision, high-temporal-resolution, high-reliability for weather forecasting.

3. Organized by

CMA Meteorological Observation Center, and Unicore Communications, Inc.

4. Recommended by

China Meteorological Administration.

X. Timing Services

(I) BDS Timing Services in Communication

1. Overview

The upcoming era of 5G mobile communication includes diversified scenarios, and that means extremely high requirements on time synchronization for all indexes. The requirement of time synchronization in current 4G network is ±1.5μs; the requirement of time synchronization for future 5G network is ±130ns and 1E-13 for frequency synchronization. The requirement of time synchronization in network PRTC equipment is ±30ns and the long-

term frequency accuracy is 1E-13. All these bring great challenges in securing the smooth operation for 5G systems and various value-added services.

Through the BDS, the China Standard Time is incorporated in the communication system to build a nanosecond timing service network. It can offer hierarchical timing service for all nodes in the communication synchronization network and satisfy all terminals in time synchronization. Time synchronization accuracy between any nodes is maintained below 30 ns, and time synchronization of all nodes can be monitored through the central or regional nodes. In a word, it offers an integrated time synchronization solution for 5G communication.

2. Progress and prospects

Time synchronization devices based on the BDS have been utilized in 4G communication base stations for China Mobile Communications Group Xinjiang Co., Ltd. and Henan Telecom Co. Ltd.; and those for 5G communication base stations have been successfully tested in the existing network of China Mobile Communications Group Shanghai Co., Ltd., which means they will be adopted in 5G synchronization network and deployed in large scale as 5G becomes commercially available.

Next step, we will rely on the construction of national integrated PNT service system, deepen the application depth and breadth of nanosecond level standard time remote service, provide more accurate and reliable time service in the field of communication, and help the formation of one uniform time and frequency network in China.
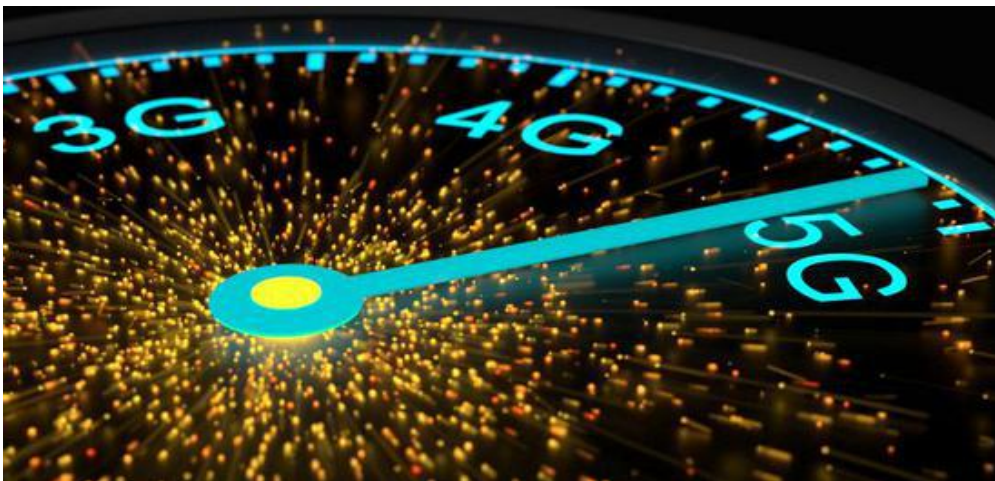

Fig. 22 BDS Timing Application in Communication

3. Organized by

National Time Service Center of Chinese Academy of Sciences, China Academy of Information and Communications Technology, ZTE Corporation, China Mobile Communications Group Shanghai Co., Ltd.

4. Recommended by

Chinese Academy of Sciences.

(II) BDS Timing Services in Power Supply

1. Overview

The electricity industry is growing at a fast pace in China, and power grids are embracing smart operation. A smooth and stable grid requires extremely high accuracy on time synchronization. For example, a unified time reference of high accuracy is needed for time sequence recording, relay protection, fault recording, electricity billing, and real-time information collection. Time synchronization is a must for modern smart grids.

In September 2009, China has officially established the "BDS timing service system for electric power supply, with space-based and ground-based mutual standby timing systems". The National Time Service Center applies BDS common-view timing to smart grids. On one hand, unified time reference and high-precision time synchronization are enabled through traceability & comparison system. On the other hand, an evaluation system is established to assess the timing of electricity applications, so as to ensure that China Standard Time can apply reliably in the power supply system.

2. Progress and prospects

The smart grid time synchronization system powered by the BDS common-view timing has found successful application in more than 100 grid users, including State Grid Northwest Dispatching Center, Beijing Electric Power Research Institute, East China Power Grid Co., Ltd., China Southern Power Grid Co., Ltd., Guizhou Power Grid Co., Ltd., Guangdong Power Grid Co., Ltd., Yunnan Power Grid Co., Ltd., Shanxi Electric Power Industry Bureau, Shanghai Xujiahui Power Dispatching Bureau, State Grid Shaanxi Dispatching Center,

Gezhouba Hydropower Plant, Qingtongxia Hydropower Plant, Daya Bay Nuclear Power Plant, Guangdong Honghaiwan Thermal Power Plant, Shaanxi Weihe Power Plant, and Shaanxi Baoji No. 2 Power Plant. More than 1,300 sets of various time synchronization products and boards have been deployed.

Next, the pilot units will rely on BDS navigation system and apply China Standard Time to all electricity equipment, which can secure accuracy for wide-area grid analysis, traceability of power events, and reasonable design of power billing. Also, it will lay a technical foundation for the total coverage of China Standard Time in the electricity industry.
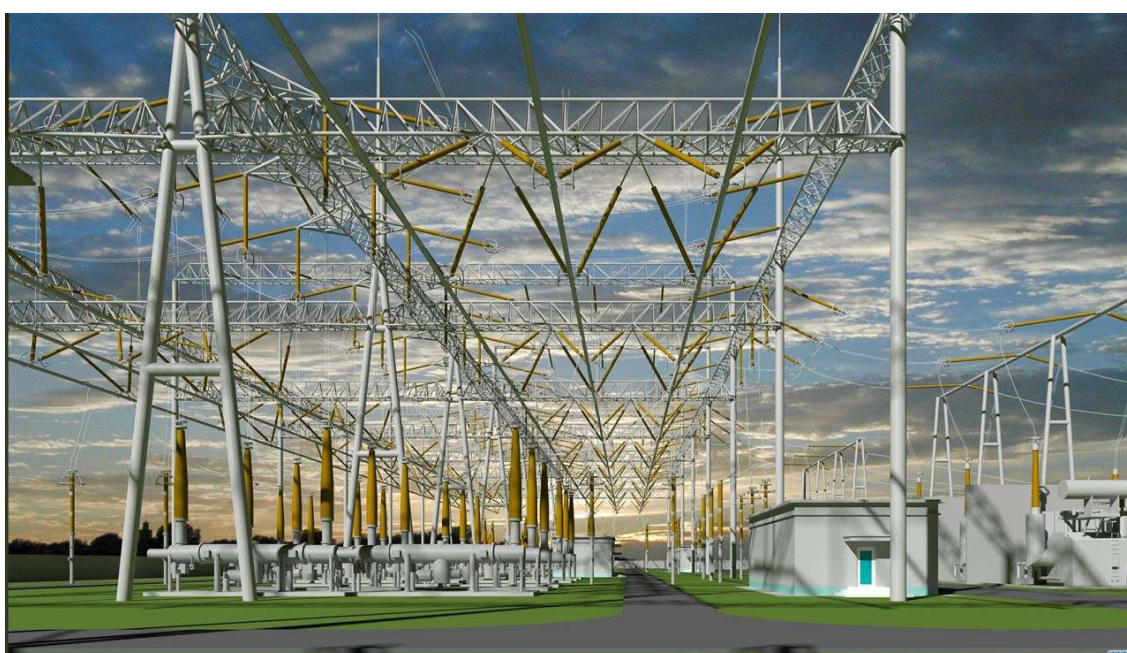

Fig. 23 BDS Timing in Electric Power Supply

3. Organized by

National Time Service Center of Chinese Academy of Sciences, Electric Power Research Institute, East China Power Grid Co., Ltd., China Southern Power Grid Co., Ltd., etc.

4. Recommended by

Chinese Academy of Sciences.

(III) BDS Timing Services in the Financial Field

1. Overview

Financial institutions engaged in businesses such as banking, insurance, finance, security, and future trading have to deal with countless real-time transaction data, electronic receipts, electronic statements and other electronic transaction vouchers. These electronic documents should be unique and certifiable, and unable to be tampered, and only trusted time stamp services can secure safe, reliable and effective technical support for them.

The financial system time was incorporated into the national time-frequency system, and the BDS timing system was adopted to offer standard time. That means safe time information and indigenous high-precision timing. BDS infrastructure will be further improved to form a timing service industry chain that is highly competitive.

2. Progress and prospects

China Standard Time has been referenced by financial institutions including CCB Headquarter, CCB Wuhan Data Center, Beijing Municipal Bureau of Finance, Department of Finance of Guangdong Province, and Department of Finance of Hebei Province, and more than 800 sets of timing terminals have been installed, to ensure safe, reliable, and indigenous timing that is under control.

Next, we will apply BDS financial timing to more fields, which will be of great significance as an example to promote China Standard Time in China's financial market.

Fig. 24 BDS Timing Services in the Financial Field

3. Organized by

National Time Service Center of Chinese Academy of Sciences, CCB Headquarter, CCB Wuhan Data Center, Department of Finance of Guangdong Province, Department of Finance of Hebei Province, Department of Finance of Yunnan Province, Shanghai Stock Exchange, etc.

4. Recommended by

Chinese Academy of Sciences.

XI. Overseas Application

(I) Land Right Confirmation in Indonesia

1. Overview

In 2018, the National Land Agency of Indonesia utilized BDS high-precision GNSS receivers to confirm land rights, including the surveying and construction of land, road, railway, and water conservancy projects. A total of 1,046 high-precision GNSS receivers powered by the BDS, were used, and their performance have been highly praised and recognized by the National Land Agency of Indonesia. They will continue to support Indonesia's infrastructure construction and mapping.

Fig. 25 BDS High-precision Receivers Used for Land Right Confirmation in Indonesia

2. Organized by

ComNav Technology Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM)

(II) Skyscraper Deformation Monitoring in Kuwait

1. Overview

BDS high-precision receivers were used in the construction of a 300-meter-high headquarters for the National Bank of Kuwait in 2015. BDS/GNSS high-precision receivers were used for ground control point monitoring. Receiving BDS signals ensures sufficient visible satellite data in case of obstructions and millimeter-level measurement error in the vertical direction during the construction. This is the first time BDS navigation and positioning technology was applied to high-rise building monitoring overseas.

Fig. 26 BDS High-precision Receivers Used for Constructing the Headquarters Building for the National Bank of Kuwait

2. Organized by

ComNav Technology Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

(III) Land Surveying and Mapping in Uganda

1. Overview

BDS/GNSS high-precision receivers were introduced to the African market in 2015, and they were trusted by African customers for reliable and stable performance. Uganda land surveying and mapping department has built 15 reference stations using BDS/GNSS high-precision receivers, which cover its major cities and towns, and economic and cultural hubs. High-precision positioning services can help Uganda in not only land surveying and mapping, but also water conservancy, transportation, agriculture, forestry and other industries.

Fig. 27 BDS High-precision Receivers Used for Land Surveying and Mapping in Uganda

2. Organized by

ComNav Technology Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

(IV) Agriculture Application in Myanmar

1. Overview

Starting from 2013, Myanmar has adopted BDS/GNSS receivers to collect agricultural data and manage land across the country. Both officials and professional surveyors have approved and praised their excellent performance. This is the first ever batch application of BDS high-precision products in Southeast Asian countries such as Myanmar.

2. Organized by

Shanghai Huace Navigation Technology Co., Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM)

Fig. 28 BDS High-precision Receivers Used for Collecting Agricultural Data Across Myanmar

(V) Offshore Piling in Maldives

1. Overview

A smart pile guidance and control system powered by BDS/GNSS was utilized for a high-precision piling project in Aarah, Maldives. The system boasts about all-weather operation, high precision and easy management. Controlling via this piling system and real-time processing and display can minimize the number of on-site surveyors and the labor intensity of field workers. The system offers a feasible solution for real-time positioning operations, which means shorter construction period, lower construction costs, and no need for pre-operation. At the same time, offshore piling can be conducted in a visible, high-precision manner under smart monitoring.

Fig. 29 BDS High-precision Receivers Used for Maldives Offshore Piling

2. Organized by

ComNav Technology Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

(VI) Piling in Singapore

1. Overview

The BDS silent piling system was applied in Singapore. The system allows for pile management, and the operator only needs to look at the screen and move left and right as guided by the navigation system. The hydraulic pile driver will be automatically navigated to the piling location, and the drilling location can be quickly located, with a piling accuracy of centimeters. The system greatly accelerated the operation of the drilling rig, which means less oil consumption, safety hazards, and noise pollution, and higher work efficiency. It boasts a vast potential market.

2. Organized by

Shanghai Huace Navigation Technology Co., Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

Fig. 30 BDS High-precision Receivers Used for Piling in Singapore

(VII) Land Right Confirmation in Laos

1. Overview

BDS/GNSS receivers have been successfully used to confirm land rights across Laos. This application gradually replaced the market of using total-station instruments in Laos, and offers a new method for control survey like stakeout, mapping and measurement. In addition, it drives a big increase in field operation efficiency. Meanwhile, it also lays an original and scientific foundation for Laos' cadastral survey, land management and the formulation of relevant laws and regulations. This solution has been popularized across the country, with rave comments from all insiders.

Fig. 31 BDS High-precision Receivers Used for Land Right Confirmation in Laos

2. Organized by

Shanghai Huace Navigation Technology Co., Ltd., and ComNav Technology Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

(VIII) UAV Application in Cambodia

1. Overview

In 2016, BDS/GNSS-powered UAV was promoted in Cambodia. This UAV can operate in a wider range and map with high efficiency, and it offers complete basic information to the Cambodian government to make comprehensive planning, monitor land consolidation, construct infrastructures, and monitor ecological environment. It also provides basis to make scientific decisions. In addition, the BDS has also been utilized for surveying and mapping, machine control and GIS data collection in Cambodia, and it has become a key technical method for infrastructure construction.

Fig. 32 BDS High-precision Receivers Used for UAV in Cambodia

2. Organized by

Shanghai Huace Navigation Technology Co., Ltd.

3. Recommended by

Science and Technology Commission, Shanghai Municipality (STCSM).

(IX) Warehousing and Logistics in Thailand

1. Overview

The BDS navigation service was used in Thailand Postal Service and E-commerce Platform Project to develop a logistics management service system and an integrated logistics terminal. Together with the warehouse management system and enterprise resource planning system, they can help customers deal with inbound and outbound information records, upload and download real-time information for off-site delivery. At the same time, it offers couriers functions such as code scanning management, route tracking, positioning and navigation services, and is thus extremely popular among customers.

Fig. 33 BDS Used for Postal Service and E-commerce in Thailand

2. Organized by

Beijing BDStar Navigation Technology Co., Ltd.

3. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

(X) Timing Application for Pakistan Airport Information System

1. Overview

The information integration system for Pakistan's new Islamabad International Airport commenced its construction in 2017. With steady, reliable timing services offered by the BDS, the system secures high-precision time synchronization and coordinated operation of the

application system and subsystems with high reliability and efficiency. The new Islamabad International Airport began operations in October 2018. The system will be promoted to other airports in Southeast Asia and Africa.

2. Organized by

Beijing UniStrong Science & Technology Co., Ltd.

3. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

(XI) Power Line Inspection

1. Overview

In 2017, BDS/GNSS positioning terminals were utilized for power line inspection in Siberia, Russia. BDS/GNSS mobiles terminals can: display the real-time location of inspectors; search the power poles/towers surrounding the inspector; mutually interact with the management center; present the power line operation status and surrounding environmental changes; timely spot equipment defects and potential dangers in power lines. That is how they can guarantee the safety of the transmission and distribution lines and the stability of the power system. The solution will continue to be promoted to grids across Russia in the future.

2. Organized by

Beijing UniStrong Science & Technology Co., Ltd.

3. Recommended by

Beijing Municipal Bureau of Economy and Information Technology.

XII. Ground-based Augmentation

(I) BDS ground-based augmentation system

1. Overview

The BDS ground-based augmentation system (GBAS) was built by combining existing monitoring stations guided by the principles of "centralized planning, uniform standard, and joint construction and sharing". The project was led by China Satellite Navigation Office,

with support from the Ministry of Transport, former Ministry of Land and Resources, Ministry of Education, former State Bureau of Surveying and Mapping, former China Meteorological Administration, former China Earthquake Administration, Chinese Academy of Sciences, and other relevant national departments.

BDS GBAS includes six sub-systems: base stations, communication network system, national data processing system, industry data processing system, data distribution system, and application terminal.

2. Progress and prospects

As of November 2018, more than 2,200 base stations had been built, making BDS GBAS a global leader in the number of base stations and the size of coverage across the globe, along with stable operations.

It can offer real time positioning (meter, decimeter, and centimeter-accuracy) and post-processing high-precision positioning (millimeter-accuracy) services in the Chinese Mainland.

Fig. 34 BDS GBAS

The National BDS Data Processing Center was built to enable data interconnection across industries. The data center supports BDS, GPS, and GLONASS, and can store and process data for more than 120 satellites and over 2,200 base stations. As the ecological core of the BDS industry, the data center offers such basic functions as basic resource management, data storage and mining, high-precision service production, space-time service verification, and BDS service performance evaluation.
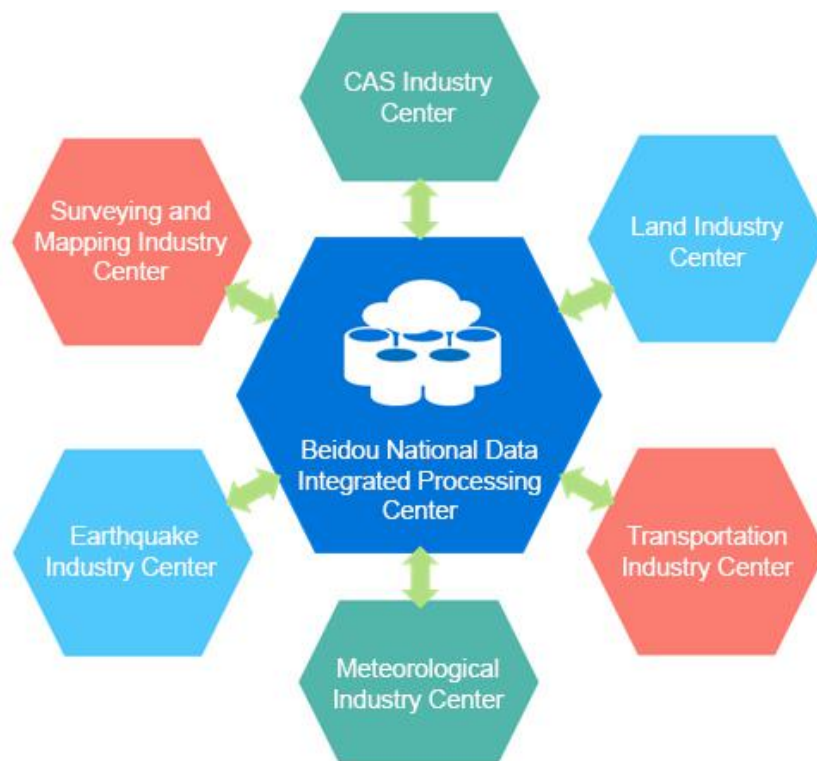
Fig. 35 BDS GBAS Data Center

3. Organized by

China North Industries Group Corporation Limited

Constructors of base stations:

China Transport Telecommunication Information Group Co., Ltd.

National Geomatics Center of China

CMA Meteorological Observation Center

China Earthquake Networks Center

Aero Geophysical Survey and Remote Sensing Center for Land and Resources

National Time Service Center of Chinese Academy of Sciences

Wuhan University

Qianxun Spatial Intelligence Inc.

BDS High-precision Receivers:

Unicore Communications, Inc.

ComNav Technology Ltd.

Shanghai Huace Navigation Technology Co., Ltd.

Hi-Target Surveying Instrument Co., Ltd.

Wuhan Navigation and LBS, Inc.

4. Recommended by

China Satellite Navigation Office.

(II) BDS High-precision Location-based Service Platform

1. Overview

BDS High-precision Location-based Service Platform aims to make BDS high-precision positioning accessible to all and build a space-time infrastructure in the IoT era. Built on the national BDS ground-based augmentation system, the platform adopts market-oriented operations and targets an ecosystem of BDS high-precision location-based services.
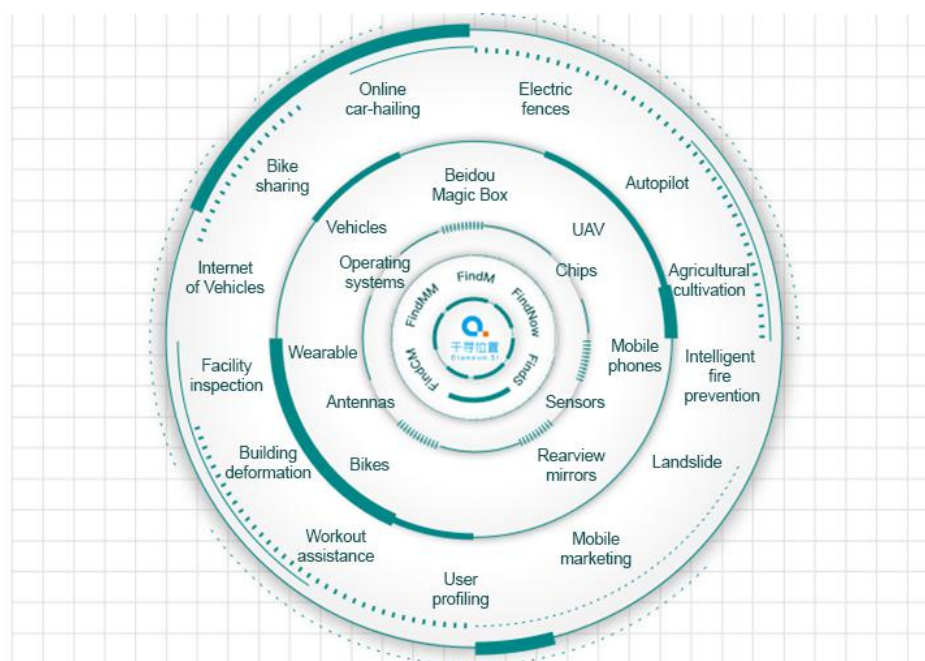

Fig. 36 Ecosystem of BDS High-precision Location-based Services

2. Progress and prospects

The platform bridges between BDS/GNSS and the Internet. By combining "Internet + Location (BDS)" and utilizing cloud computing and big data, the platform is designed as an open system offering high-precision BDS air-space location-based services, which can support the country, industry and mass market's needs for precise location services. At the same time, it remains

committed to bringing BDS/GNSS high-precision services to the world. The platform adopts innovative technologies including algorithm for new-generation network RTK high-precision multi-mode combined positioning, satellite-based augmentation technology, algorithm for multi-mode multi-frequency satellite navigation combined positioning, algorithm for multi-sensor fusion positioning, "BDS/GNSS+ artificial intelligence" fusion positioning, and AGNSS acceleration positioning. Breakthroughs have been seen in other core technologies such as context-aware smart identification, massive data access and storage, large-scale distributed computing, high concurrent real-time processing, and security service strategies and mechanisms. Over the past two years, we have applied for more than 340 related invention patents, and those secure our global leadership in BDS/GNSS precision space-time service targeting AIOT (Artificial Intelligence + Internet of Things). The platform is knocking open the door to the AIOT era as its new-generation space-time infrastructure.

The platform makes BDS high-precision value-added services commercially available, and launches location-based services of all kinds, including FindM (meter-accuracy), FindCM (centimeter-accuracy), FindMM (millimeter-accuracy), FindS, FindV, A-BeiDou, which have been applied to dangerous house monitoring, railway, precision agriculture, shared bicycle, automatic driving, smart phone, logistics monitoring, etc. BDS high-precision location-based services are becoming publicly accessible, which facilitates a BDS independent innovation ecosystem to take form.

Thanks to BDS ground-based augmentation system and high-precision position service platform, we have developed the world's first "A-BeiDou" rapid assisted positioning system, which can enormously optimize the time and accuracy of first-time positioning of BDS navigation. BDS high-precision location-based service platform is shown as follows:
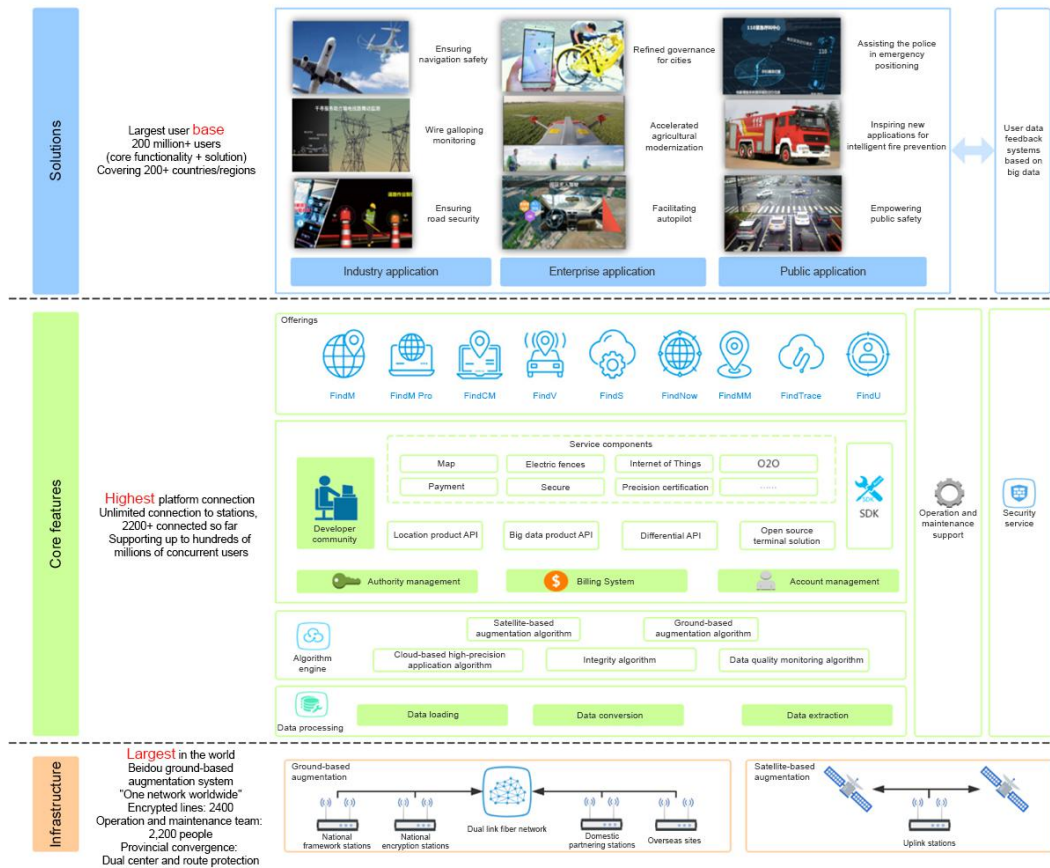
Fig. 37 BDS High-precision Location-based Service Platform

3. Organized by

Qianxun Spatial Intelligence Inc.

4. Recommended by

China Satellite Navigation Office.

(III) High-precision application of BDS ground-based augmentation system

Following the completion of BDS ground-based augmentation system, a series of BDS high-precision high-performance services and innovative solutions have been launched to solve key challenges troubling various industries. They have been playing a critical role in industries vital to the national economy and people's livelihood, such as power grid, navigation, agriculture, firefighting, railway, public security, housing and construction, and land and resources.

1. Transportation

China Transport Telecommunication Information Group Co., Ltd. has developed transportation application software and a service evaluation subsystem. It has collected and produced high-precision navigation data for highway stretching 30 km long, with lane coordinate accuracy less than 20 cm. The system can monitor traffic violations such as illegal continuous lane-changes.

Fig. 38 Lane Navigation Data and Information

By upgrading vehicle-borne terminals meeting JT/T 794 and JT/T 808 standards, the system allows lane navigation powered by high-precision positioning services supported by the BDS ground-based augmentation system.

Fig. 39 Vehicle-borne Terminals

. Land and resources**

With the BDS ground-based augmentation system, the Aero Geophysical Survey and Remote Sensing Center started, as part of a planned geological survey, works such as field navigation, location information collection, and geological body measurement in Leshan and Ya'an, Sichuan. The wide-area enhanced single-frequency pseudo-range high-precision positioning powered by BDS ground-based augmentation system can support field geological survey at a scale of between 1:150,000 and 1:250,000.
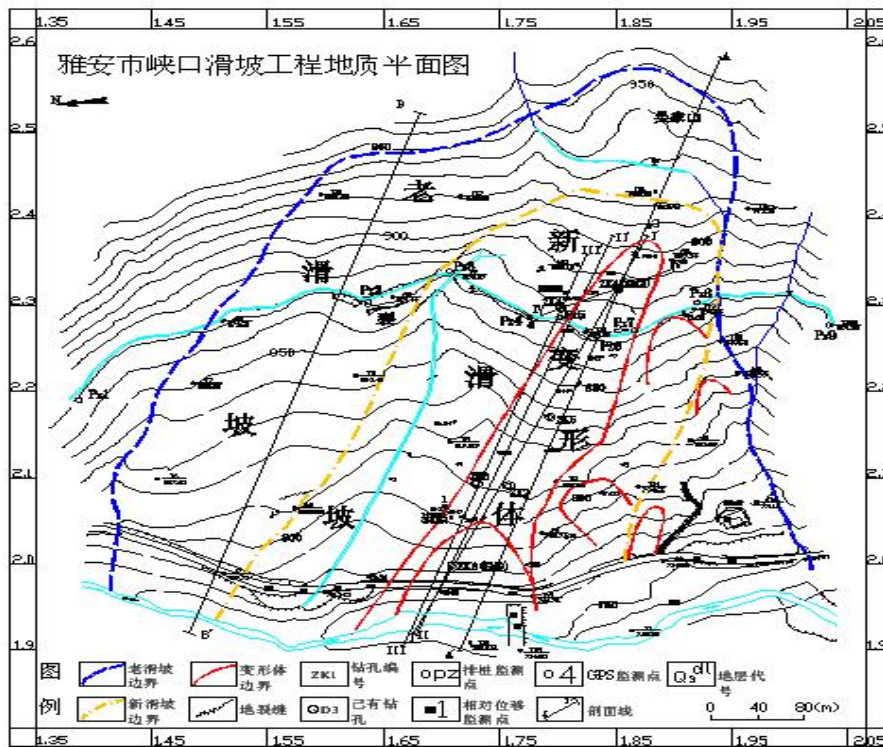

Fig. 40 Geological Plan for Landslide Engineering

3. Smart city

Thanks to high-precision positioning module "Qianxun Magic Box", Qianxun SI can enable surveillance cameras of high-precision timing and positioning to secure smooth camera management and maintenance. It can offer high-definition videos for machine intelligence to process massive videos and fuel computing by the "urban brain". That's how it can boost the transformation from traditional management model of safe city and traffic to smart city and traffic.

Qianxun SI has worked with Hikvision and DAHUA to develop precise space-time cameras based on Qianxun Magic Box, which has been put into use this November in Deqing, Zhejiang.
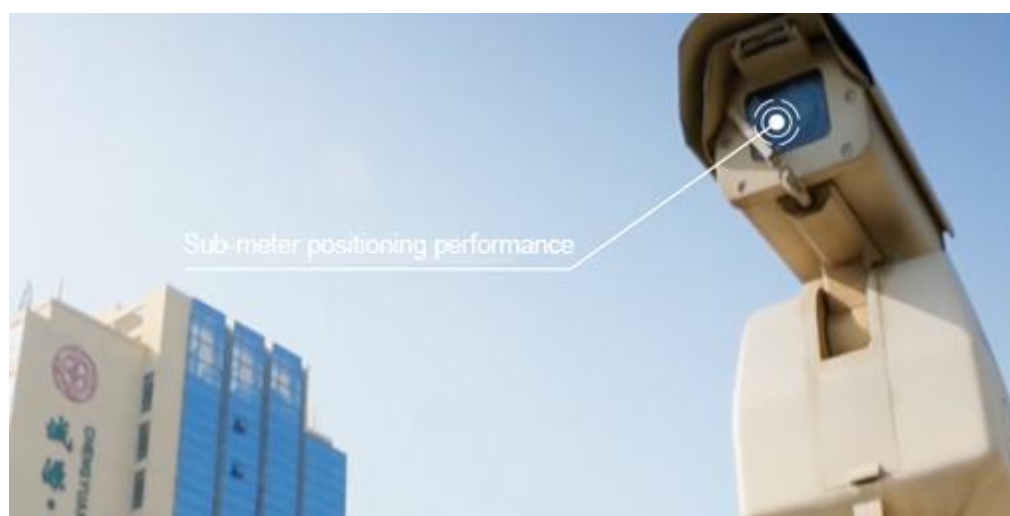

Fig. 41 BDS High-precision Application for Smart City

4. UAVs used for plant protection

Qianxun SI offers dynamic centimeter high-precision positioning that follows national unified space-time reference, and it allows customers to precisely and independently operate UAVs to undertake plant protection tasks. As a series of key technologies including the flight control system, RTK hardware terminal, and communication module are integrated in the solution, it enables standard, independent, precise operation of UAVs for plant protection, which means a huge increase in work efficiency and a much lower barrier to market entry.

Qianxun Si is cooperating with UAV manufacturers like DJI to promote automatic pesticide spraying by UAVs supported by BDS high-precision services. In addition to pesticide spraying, Qianxun BDS high-precision services have been highlighted in automatic driving and navigation of agricultural machineries, variable fertilization, and fine agricultural management, which evidence that Qianxun BDS high-precision services will play a bigger and bigger role as China modernizes its agriculture.

5. UAV inspection

Qianxun SI has developed a UAV solution for power line inspection. Customers can enjoy dynamic centimeter differential positioning service that follows national unified space-time reference. By empowering UAVs with precise flight, the solution can facilitate standard

inspection by UAVs of independent operation across the country, thus much higher efficiency. The solution has been adopted in China Southern Power Grid. BDS high-precision UAVs can cover 50 km per hour as they inspect power lines, and examine 60 towers in a day.

Fig. 42 BDS High-precision Power Line Inspection

6. Air traffic safety

Through BDS differential algorithm engineering, Qianxun SI has developed a UAV supervision and service platform by combining the BDS high-precision location-based data service platform and cloud technology with urban augmentation and scenario identification. As an open Internet platform, it has witnessed stages such as construction, operation, transition to ecosystem, perfection of the ecosystem, and finally to a platform that focuses on the precise space-time location tracking and management of UAVs.

Trial operation has started in Zhejiang. The airspace was clearly divided to establish various flightworthy areas for UAVs. It means that UAVs can have its unique routes, and UAVs can avoid no-fly or restricted areas, thus securing safety of both the UAVs and 3D flight control space. In addition, it can facilitate message communication between UAVs and supervision platforms. The UAV supervision and service cloud platform adopts an open Internet model to leverage the Internet in accelerating communication of information and promoting the clustering, opening and sharing of various element resources. At the same time, it can boost the formation and development of a UAV industrial ecology.

Fig. 43 BDS High-precision UAV

7. Monitoring and warning of geological disasters

Thanks to ground-based augmentation stations for satellite positioning, cloud integrated monitoring terminals, and post-processed high-precision positioning differential algorithms, Qianxun SI has developed a monitoring and early warning system that features intelligent data collection, timely transmission and automatic analysis of the monitoring data. It can automatically monitor safety indicators such as displacement and settlement at an accuracy of millimeters for 24 hours a day, seven days a week. At the same time, it can acquire big data related to geological disasters and make reasonable predictions, thus to support disaster relief and mitigation across the country.

Qianxun services have been adopted in the disaster prevention & monitoring system for the Ankang section of Xi'an Railway Bureau. Satellite positioning errors are corrected, and landslide displacement of the Ankang section is monitored at an accuracy of millimeters.

Fig. 44 BDS High-precision Monitoring and Warning of Geological Disasters

8. Smart driving

Qianxun SI brings down the traditional high barrier for high-precision auto positioning which requires high stability, reliability and security by introducing a smart high-precision auto position sensing solution powered by BDS Satellite-to-Ground network. Data is transmitted by online RTK to the vehicle ECU, offering auto driving customers real-time high-precision positioning services. At the same time, Qianxun SI satellite-based augmentation system enables the broadcast of dual-link data, in order to secure sufficient redundancy for future automatic driving.

In-depth cooperation has been commenced with mainstream automakers and high-caliber auto parts suppliers such as SAIC. We can offer users an all-round intelligent driving experience including AR navigation, auto parking and expressway autopilot. Mass-produced cars equipped with this service are scheduled to be launched in 2019.

Fig. 45 BDS High-precision Automatic Driving

9. Smart firefighting

Qianxun SI has been working with many partners at home to explore how precision positioning, indoor and outdoor integration, fire protection geographic information system and other technologies can be utilized in smart fire protection. Based on BDS high-precision positioning, big data, cloud computing, and IoT are combined together to upgrade the intelligence in firefighting works. A set of smart firefighting solutions has been developed, which is powered by Qianxun BDS high-precision services. It can collect high-precision data of fire hydrants, water sources, water intakes, key units, fire exits, etc., thus offering users accurate geographic information data for firefighting.

The Qianxun Smart Firefighting Solution integrates Qianxun SI terminal navigation services and mobile command to solve difficulties in navigating through the last hundreds meters of the blind zone. Firefighters can be precisely guided to locations 1 meter within the targets such as fire hydrants and sources of water. It can save precious time to rescue the victims stuck in fire and make fire rescue more efficient.

Fig. 46 BDS High-Precision Firefighting

10. Smart cone

Road construction would result in traffic accidents from time to time. For real-time sharing and docking of construction information and map data, Qianxun SI and Amap co-launched the "Road Safety IoT Solution".

Qianxun SI and Amap co-launched the "Road Safety IoT Solution". By setting "smart cones - a smart equipment designed for road work" in a reasonable manner, the system can collect real-time "dynamic high-quality data such as road construction and accidents", and seamlessly interface with Amap's data platform, which will publish such information automatically. That will guide vehicles to slow down and avoid such road work area, which can make road travel more efficient, road workers, pedestrians, and owners safer. Correspondingly, it minimizes resultant urban management issues.

Fig. 47 BDS High-precision Cone