

Development of BeiDou Navigation Satellite System (BDS) – An Application Prospective



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Tenth Meeting of
the International Committee on Global Navigation Satellite Systems (ICG)

November 1-6, 2015

The background is a composite image. The top half shows a blue-toned space scene with two satellites in orbit, a rocket launching from the bottom right, and a night view of the Great Wall of China. The bottom half shows a night view of the Great Wall of China. The text "Introduction and Background" is centered in the middle of the image.

Introduction and Background

Unique BDS Features



- **Unique BDS features include**
 - With 14-20 BDS satellites, the users can track 25-30 GNSS satellites in the BDS coverage area;
 - BDS offers at least 3 different signals (B1, B2, and B3) which are compatible and interoperable with other GNSS systems;
 - With the unique space segment architecture (with satellites in GEO, IGSO and MEO), BDS signals offer better elevation angles.
- **Those features would provide significant improvement and enhancements for the system performance (for example, positioning accuracy, system reliability, convergence time, interference mitigation, etc.).**



The image is a composite graphic. The top half shows a blue-toned space scene with two satellites in orbit, a rocket launching on the right, and a stylized globe on the left with orbital lines. The bottom half shows a night view of the Great Wall of China illuminated in orange and yellow. The text 'BDS Application Development' is centered in yellow.

BDS Application Development

BDS Application Development: Project Architecture

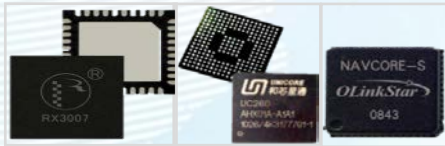
- ❑ **Policies and standards** (Industrial policy, intellectual property rights, domestic and international standards)
- ❑ **Fundamental products** (ASIC chips, modules, antennas, simulators, and navigation software, etc.)
- ❑ **Fundamental facilities** (Ground-based argumentation systems, testing and certification systems)
- ❑ **Application demonstration** (at industrial, regional demonstration, and international level)
- ❑ **Industrialization** (BDS-based GNSS industrial chain)





1. Basic Product Industrialization

- Comprehensively push forward the R&D and industrialization processes of BDS/GNSS fundamental products, such as chips, module, antennas, simulators, navigation software, etc.



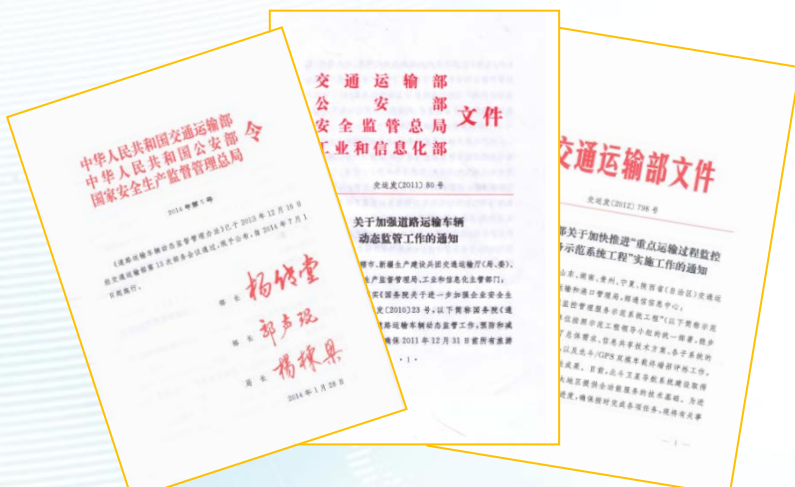
- The sales volume of BDS/GNSS navigation chips and modules has surpassed 6 million
- The sales volume of high-precision surveying boards has surpassed 85,000 sets, which counts for 1/3 of the domestic market share
- The sales volume of navigation antenna is approximately 3 million sets
- The sales volume of high-precision antenna is approximately 280,000 pieces, which counts for 90% of the domestic market share

Application Development and Popularization



2. Industrial /Regional Application Demonstration

Transportation

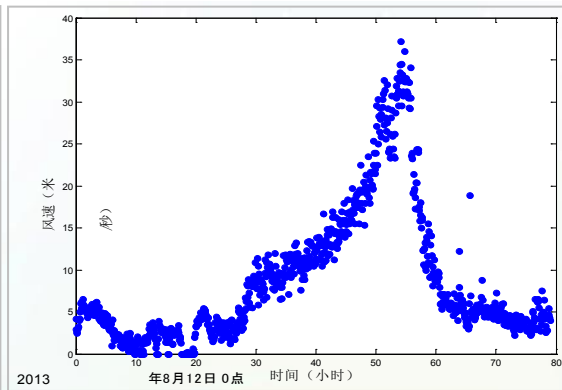
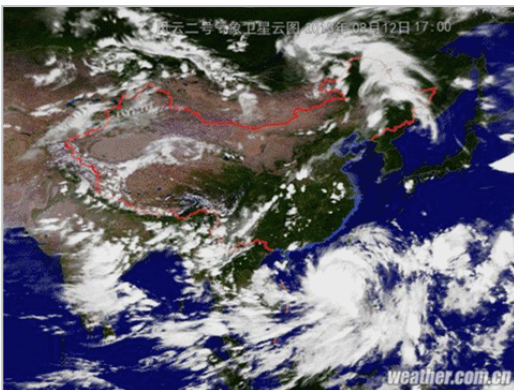
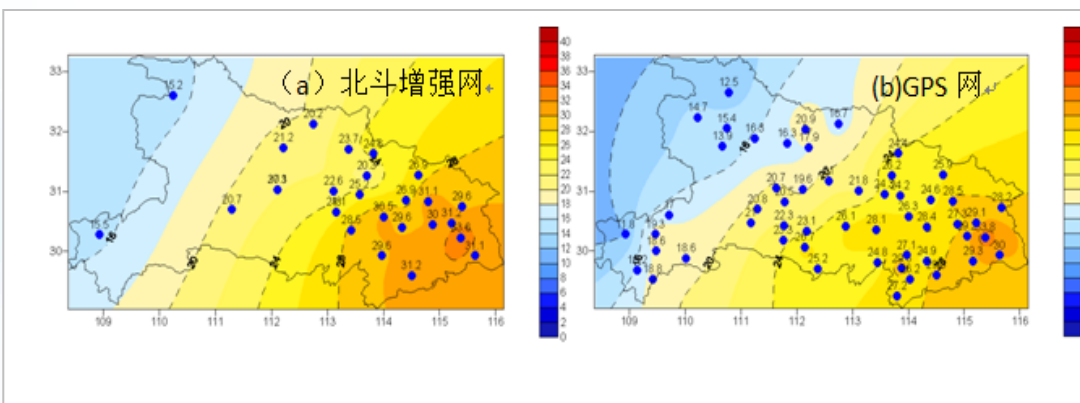


Application Development and Popularization



2. Industrial /Regional Application Demonstration

○ Metrology





2. Industrial /Regional Application Demonstration

- **Metrology – BDS-based Atmosphere, Ocean and Space Monitoring and Warning System**
 - Achieve technical breakthroughs for BDS applications on metrology.
 - Construct BDS-based applications in the following areas:
 - Meteorological sounding
 - Water vapor ionosphere remote sensing and detection
 - Ocean wave and wind detection
 - Metrological early warning
 - Develop a completed set of industrial standards.

Maritime Weather Observation



❖ BDS/GNSS Maritime Weather Observation System

To build a BDS/GNSS system for:

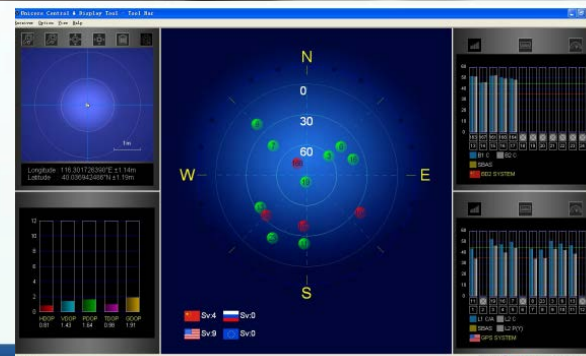
- ❑ Monitoring the changes on ocean surface
- ❑ Reflecting the amount of water vapor in the air



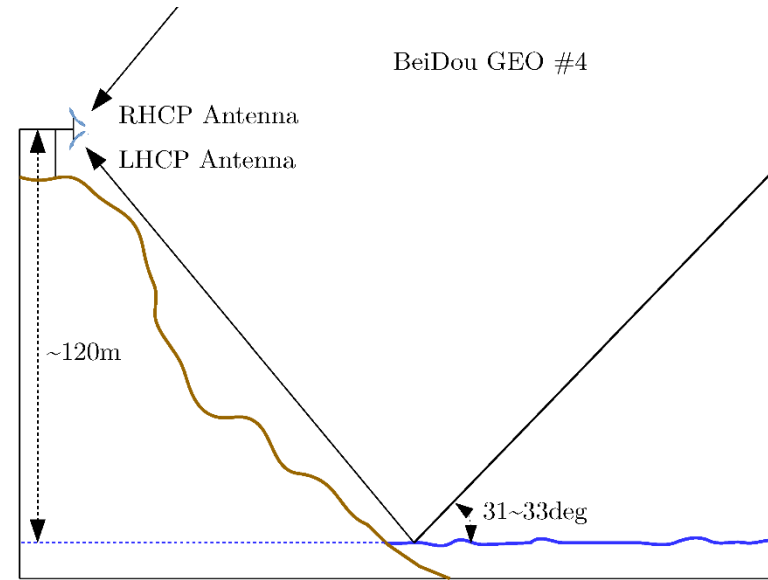
BDS/GPS Dual-mode Terminals



China Satellite Navigation Office



Yangjiang Experimental Demonstration Station



Reflection geometry

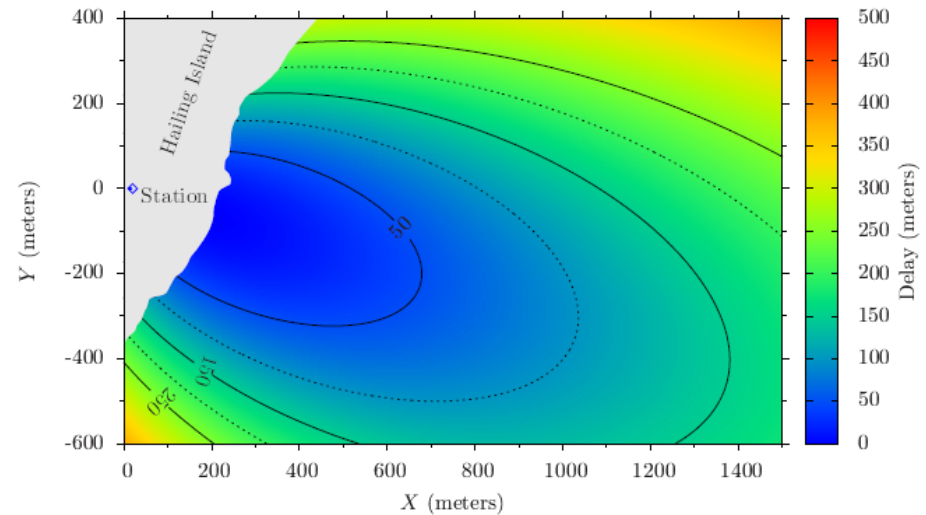
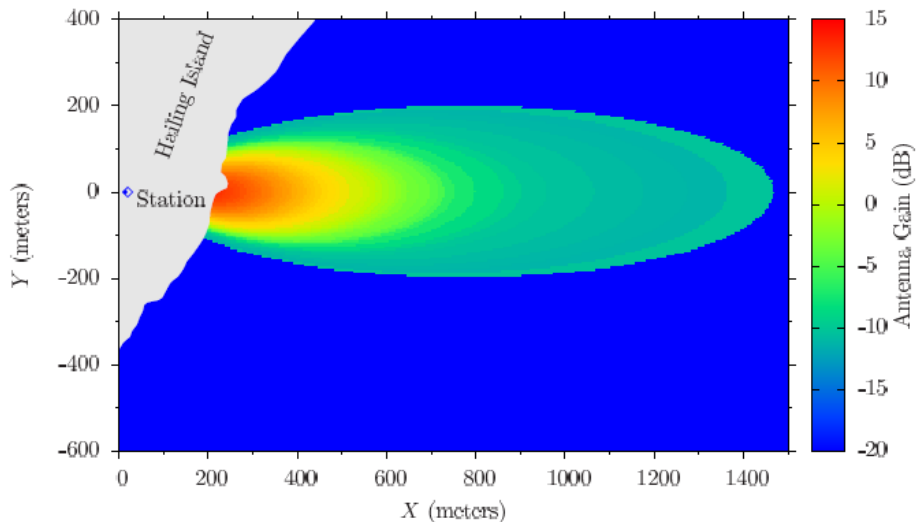


Satellite Selection



BDS GEO 04 Satellite:

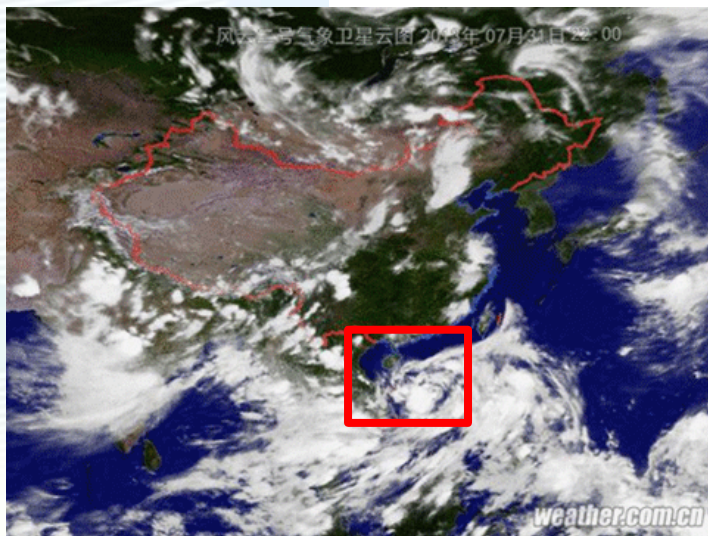
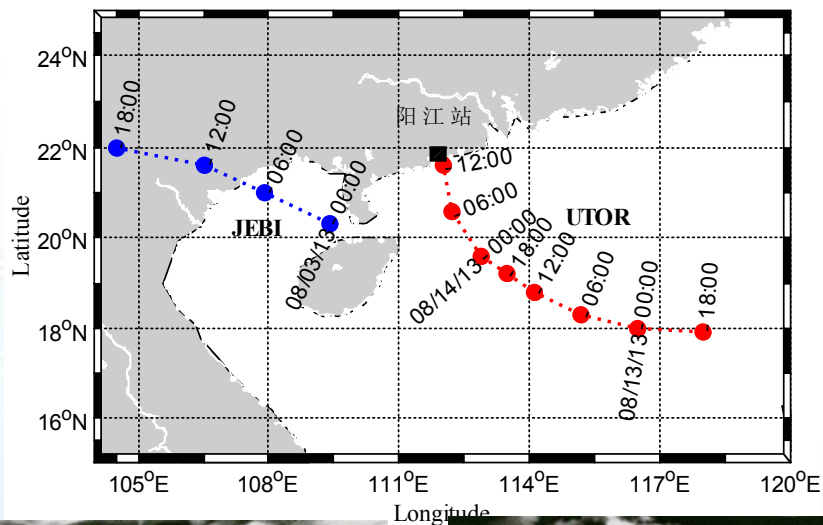
- Providing a stable geometry
- High spatial resolution
- Good visible continuity



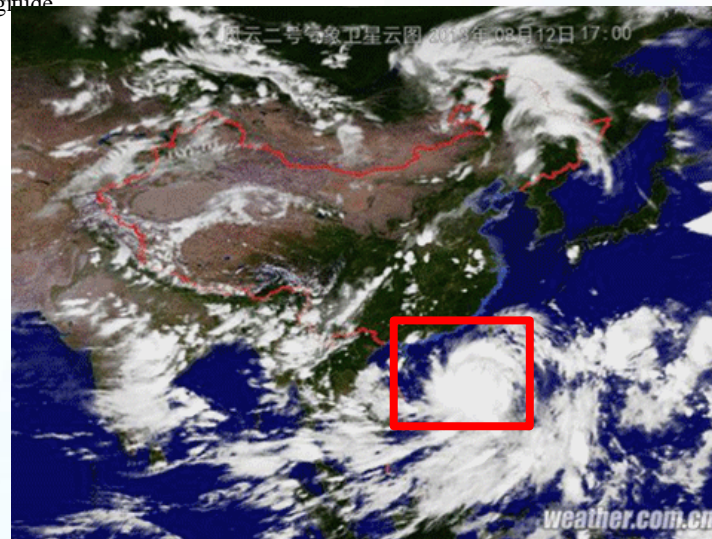
Antenna footprint and reflection zone of GEO 04



Test Results



JEBI



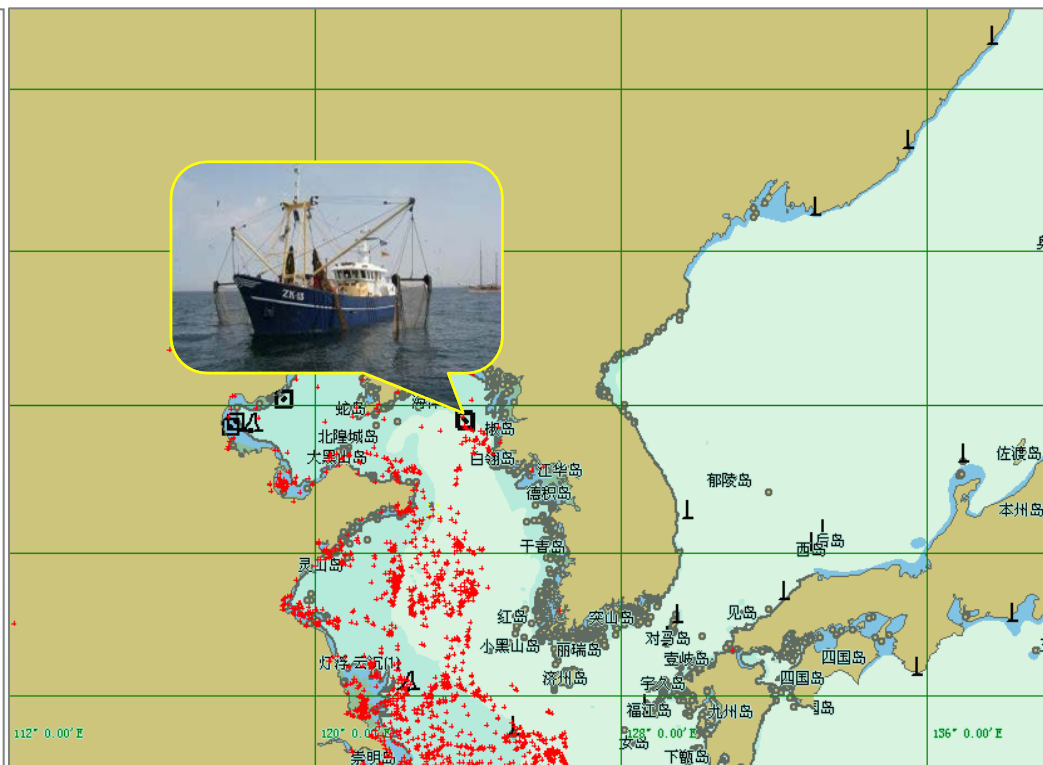
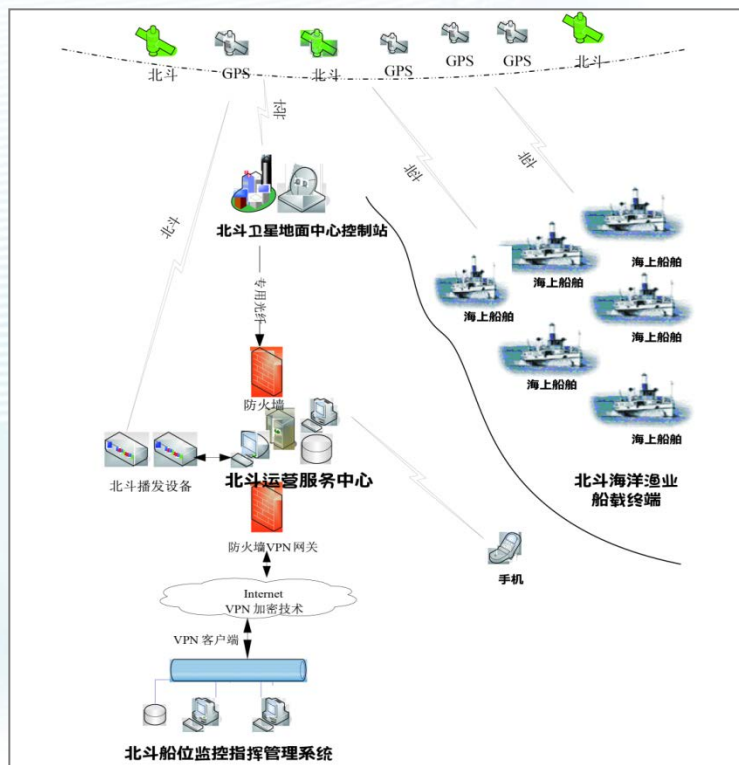
UTOR



Application Development and Popularization

2. Industrial / Regional Application Demonstration

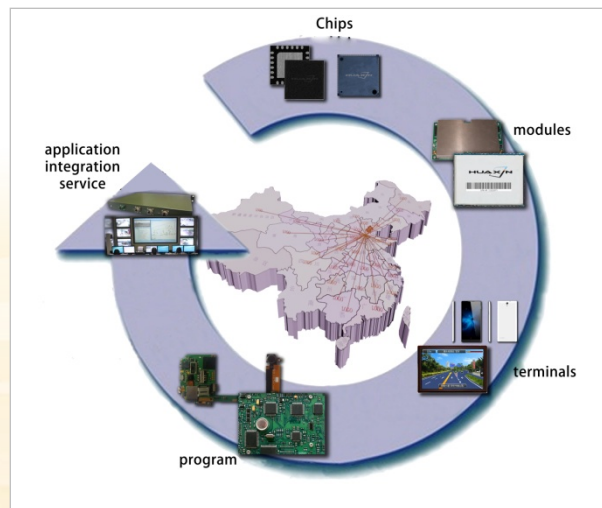
○ Fishery



Application Development and Popularization

2. Industrial / Regional Application Demonstration

Guangdong Province



Application Development and Popularization

2. Industrial / Regional Application Demonstration

Shanghai



Architecture of Satellite navigation demonstration application project in Yangtze River Delta

Application Development and Popularization



2. Industrial / Regional Application Demonstration

- Implement projects in fields of disaster reduction, public security, maritime search and rescue, in Hunan, Shaanxi, Beijing and Guizhou Provinces.
- Initiate projects in fields of terrestrial resources, tourism, electric power, in Jiangsu, Xinjiang, Hubei, Yunnan provinces and Chengdu-Chongqing region.



Application Development and Popularization

3. Mass Market Applications

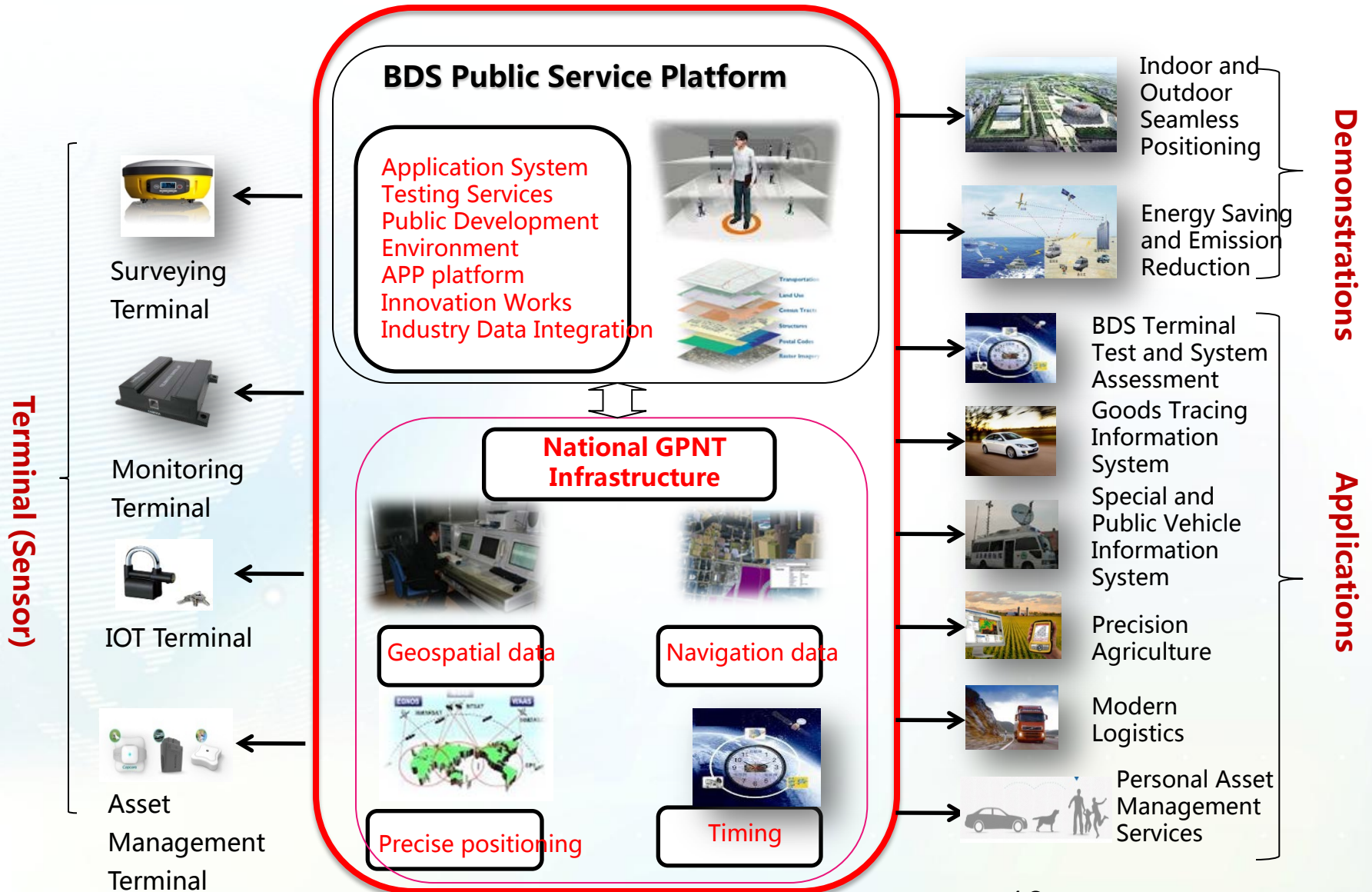
Smart phones



Vehicle Navigation



Promotion of Mass Market - Public Service Platform



Mass Market Applications



Application Development and Popularization

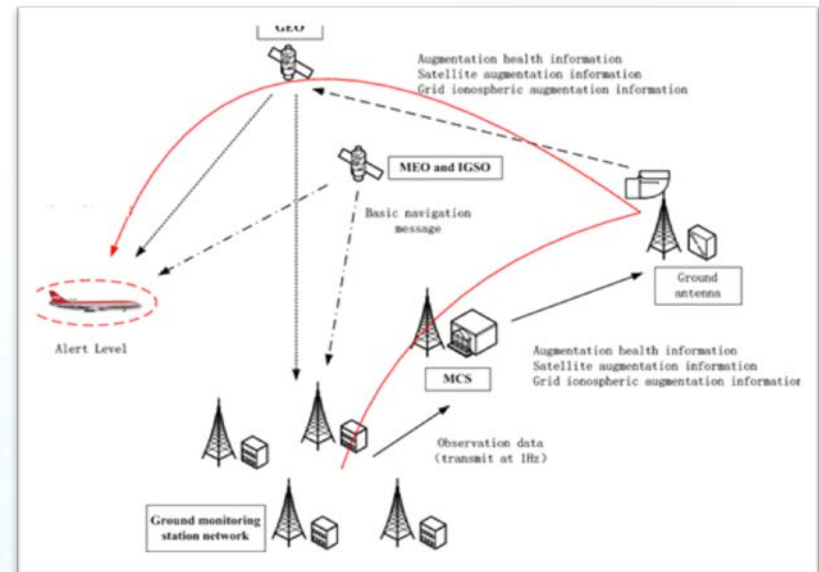
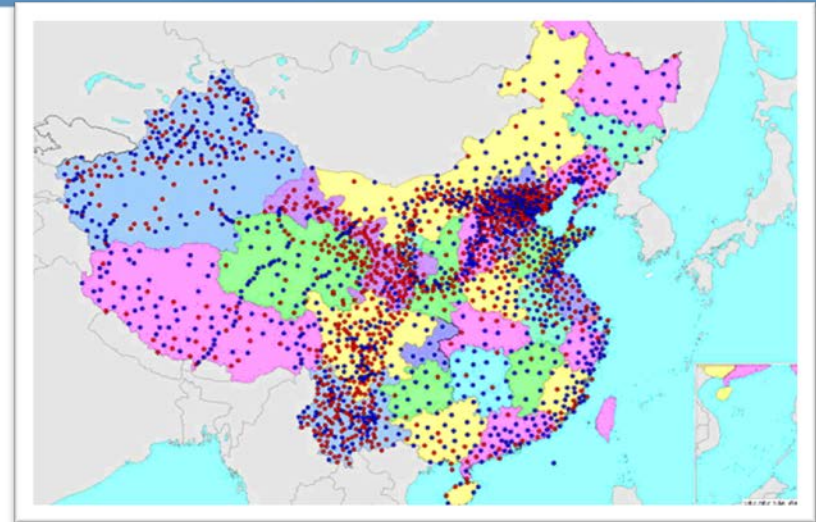
4. Augmentation Systems

National Differential BDS System (NDBDS)

- NDBDS will provide meter/decimeter-level wide area navigation and positioning services as well as centimeter-level real time regional positioning services for China and its neighboring areas.

BeiDou Satellite-based Augmentation System (BDSBAS)

- In order to meet the demands of civil aviation users for CAT-I services, design for a dual-frequency multi-system augmentation system in line with international conventions is underway.



5. Industry Environment

- The State Council published "*Several Advisory Opinions of the State Council on Promoting Information Consumption to Expand Domestic Demands*" and "*The Mid- and Long- Term National Development Plan for Satellite Navigation Industry*".
- The Development and Reform Commission, the Ministry of Agriculture and the National Administration of Surveying, Mapping and Geoinformation have issued policy recommendations.
- The National Technical Committee on BeiDou Satellite Navigation of Standardization Administration of China has been established.



5. Industry Environment

- **On June 14, 2015, State Council released “Promoting Platform for National Integrated Circuit Industry Development”**
 - Coped with the implementation of state key science and technology implementation, breakthrough on some critical integrated circuits and innovative mechanism for promoting cooperative work and business model will be achieved “
 - Gradually develop the IC applications and embedded software in the fields of smart card, intelligent power network, intelligent transportation, satellite navigation, industrial control, financial electronics, automobile electronics, medical electronics.
- **Jointly developed by State Development and Reform Commission, MIIT, MOST, etc, “The Policy on the Promotion of the BeiDou Satellite Navigation Industry Development (Draft)” is in the final review process.**

6. Standardization

- **Design and Implementation of “State BDS Satellite Navigation Standard Architecture”**
 - Include 571 standards
 - Organized in a leveled structure of “fundamental, system construction, system operation, and applications”
 - An open system architecture for further expansion
- **Eight standards have been submitted for national standard approval and twenty BDS project standards will be released soon.**
- **Support and promote BDS to be included in the international standard systems such as ICAO, IMO, 3GPP, etc.**



BDS Application Development for International Markets

Application Areas for the Asia-Pacific Market

- The following five pivotal BDS application areas have been identified for the Asia-Pacific market:
 - a) High-precision positioning
 - b) Mass market
 - c) Tourism and intelligent transportation
 - d) Disaster prevention and relief
 - e) Maritime applications



Application Areas for the Asia-Pacific Market

- Dual-frequency applications and establishment of augmentation systems



Forrest Pest Control



Precision Agriculture



BDS CORS Application in Laos (Courtesy of ComNav)



BeiDou CORS Application in Pakistan (Courtesy of BDNST)



BeiDou CORS Application in Thailand (Courtesy of Optics Valley BeiDou)



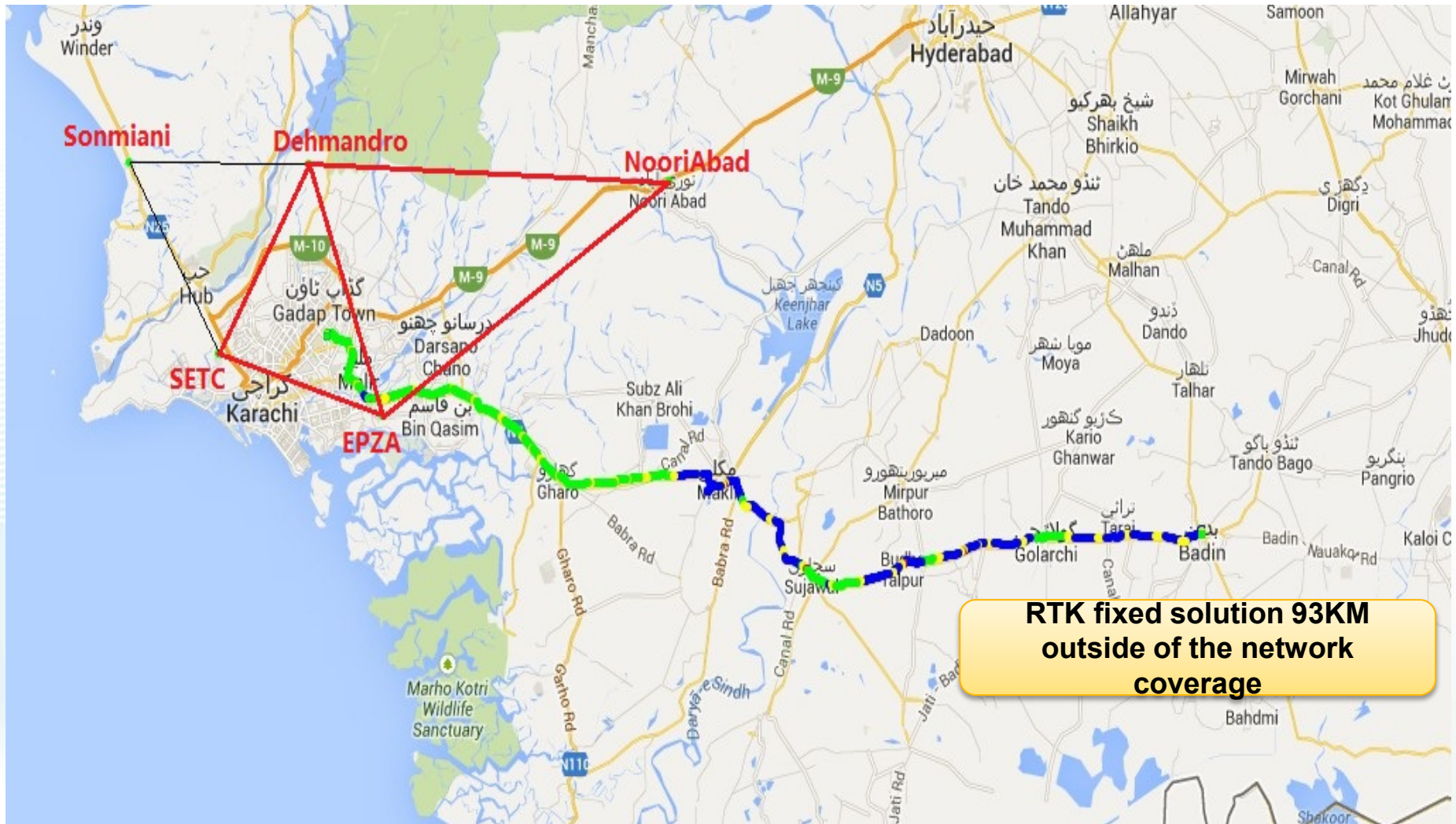
Pakistan National Positioning Service Network Project Phase I (Source: UniStrong/BDNST)



Pakistan National Positioning Service Network Project Phase I (Source: UniStrong/BDNST)



Pakistan National Positioning Service Network Project (Phase I) - RTK Test Results



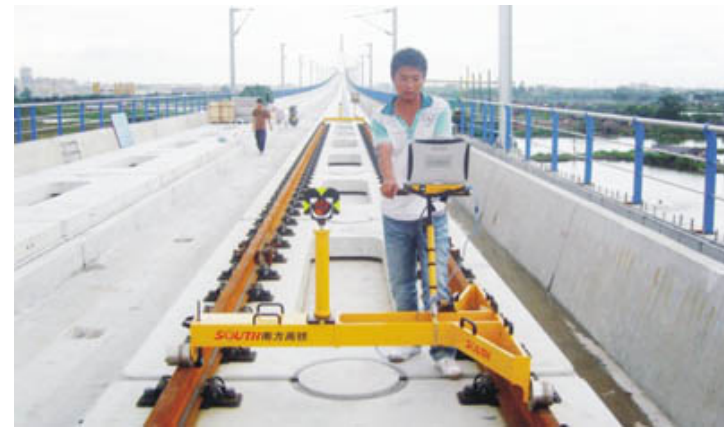
Pakistan National Positioning Service Network

Project Phase I (Source: UniStrong/BDNST)



| Items | Content | Technical Specification | |
|---|-----------------------|---|---------------|
| Scope | Navigation | Within and extendable to 100KM away from coverage area | |
| | Position | Within and extendable to 30KM away from valid coverage area | |
| Service | Navigation | Navigation, GIS information collection and update | |
| | Position | Mapping & Surveying, cadastral inventory, urban planning, construction, deformation monitoring | |
| System Accuracy 1σ normal condition | Real-time | Horizontal≤2cm | Vertical≤5cm |
| | Post-processing | Horizontal≤3mm | Vertical≤10mm |
| | Navigation | Horizontal≤2m | Vertical≤3m |
| Latency | Real time | <500ms | |
| Usability | Navigation | 95.0% (in 365 days) (exclude internet unavailability, power supply, ionospheric scintillation) 99.0% (in one day) | |
| | Position | 95.0% (in 365 days),99.0% (in one day) | |
| Completeness | Warning time | <6 seconds | |
| Compatibility | Navigation & Position | It is able to generate international RINEX data and compatible with standard differential format RTCM, so it's compatible with all kinds of post processing software and third party receivers(GPS and GLONASS only) | |
| Note: Above accuracy index is based on WGS-84 coordinate system | | | |

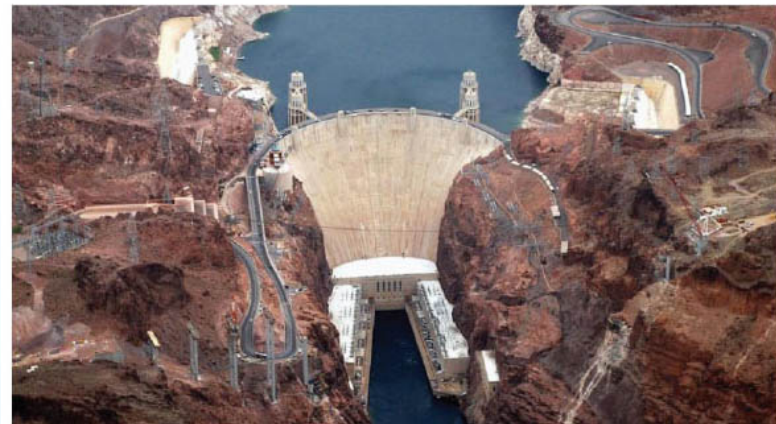
BDS/GNSS Applications on Surveying and Measurements



Precise Railway Track
Measurement & Adjustment



Bridge Deformation Monitoring



Hydro-dam Monitoring

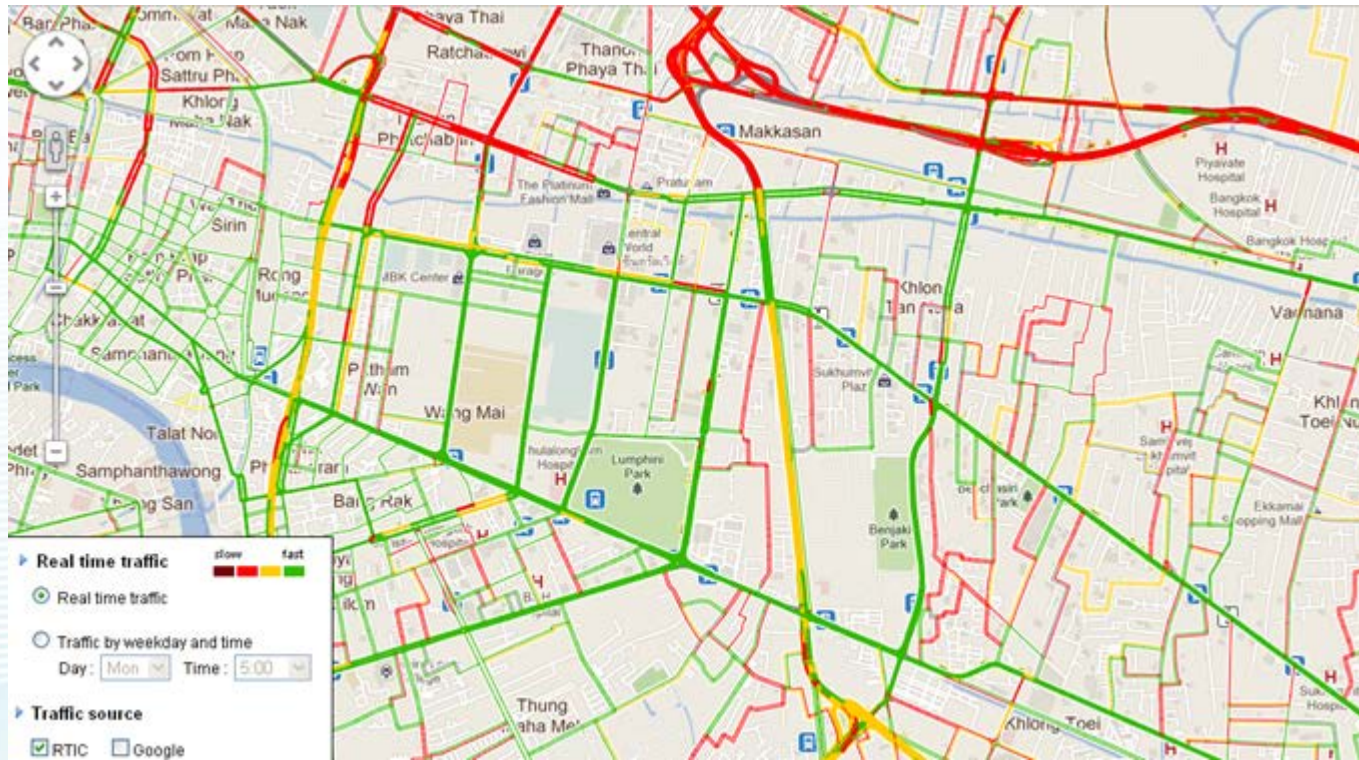


BDS Applications on Precision Agriculture

安装位置示意图



Demonstration of the Traffic Information Service in Bangkok, Thailand



In March, 2011, the PND and the Internet version of the Bangkok traffic information service demonstration was made at the 32nd Bangkok Motor Show

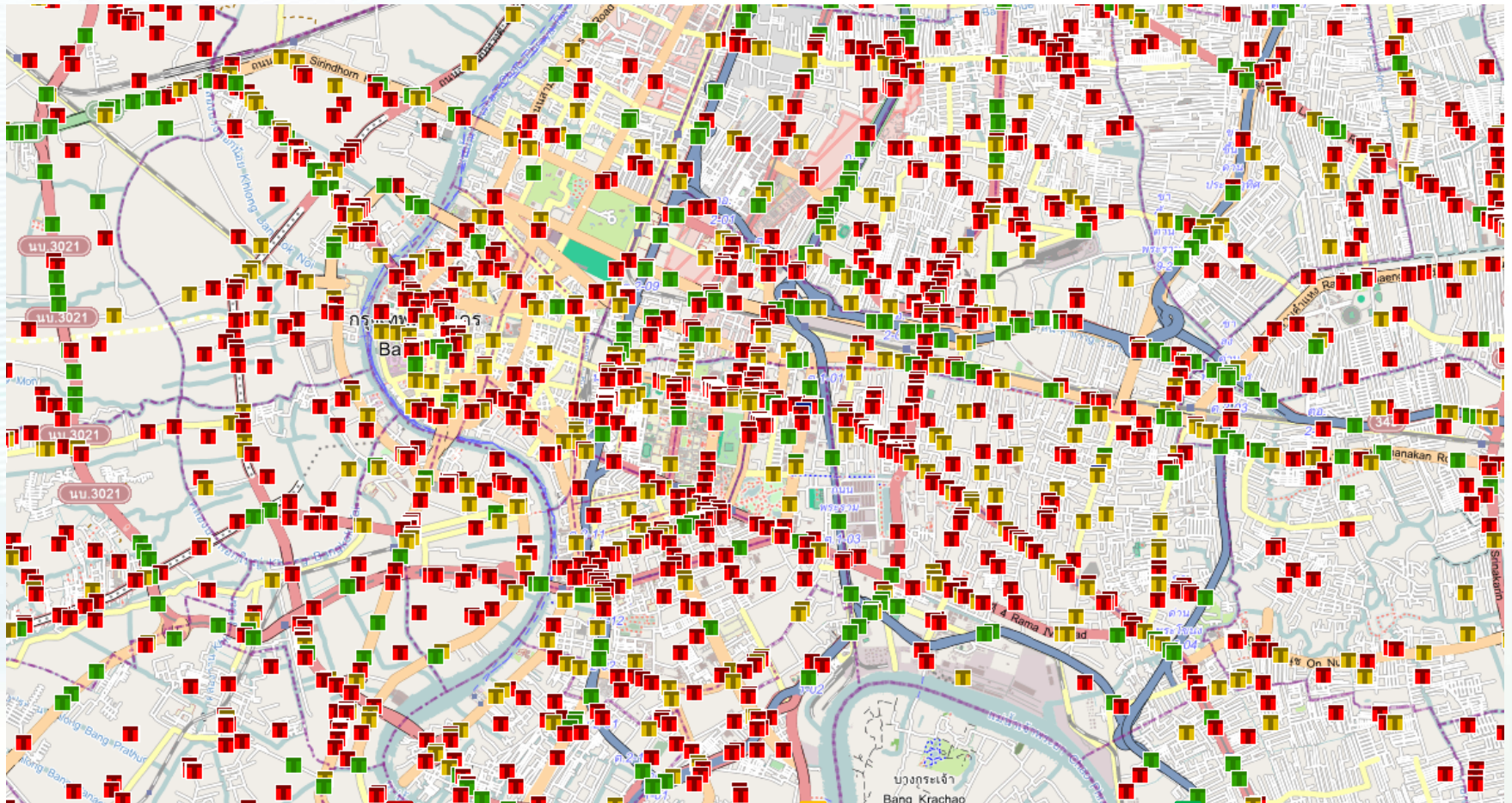


In July, 2012, the Thailand automobiles have adopted the traffic information services

Demonstration of the Traffic Information Service in Bangkok, Thailand



- Currently, the data sources are the onboard GPS terminals and some BDS terminals of nearly 10 thousand taxis. With more BDS terminals being installed, integrated BDS data will be provided for better services to the Thailand customers.



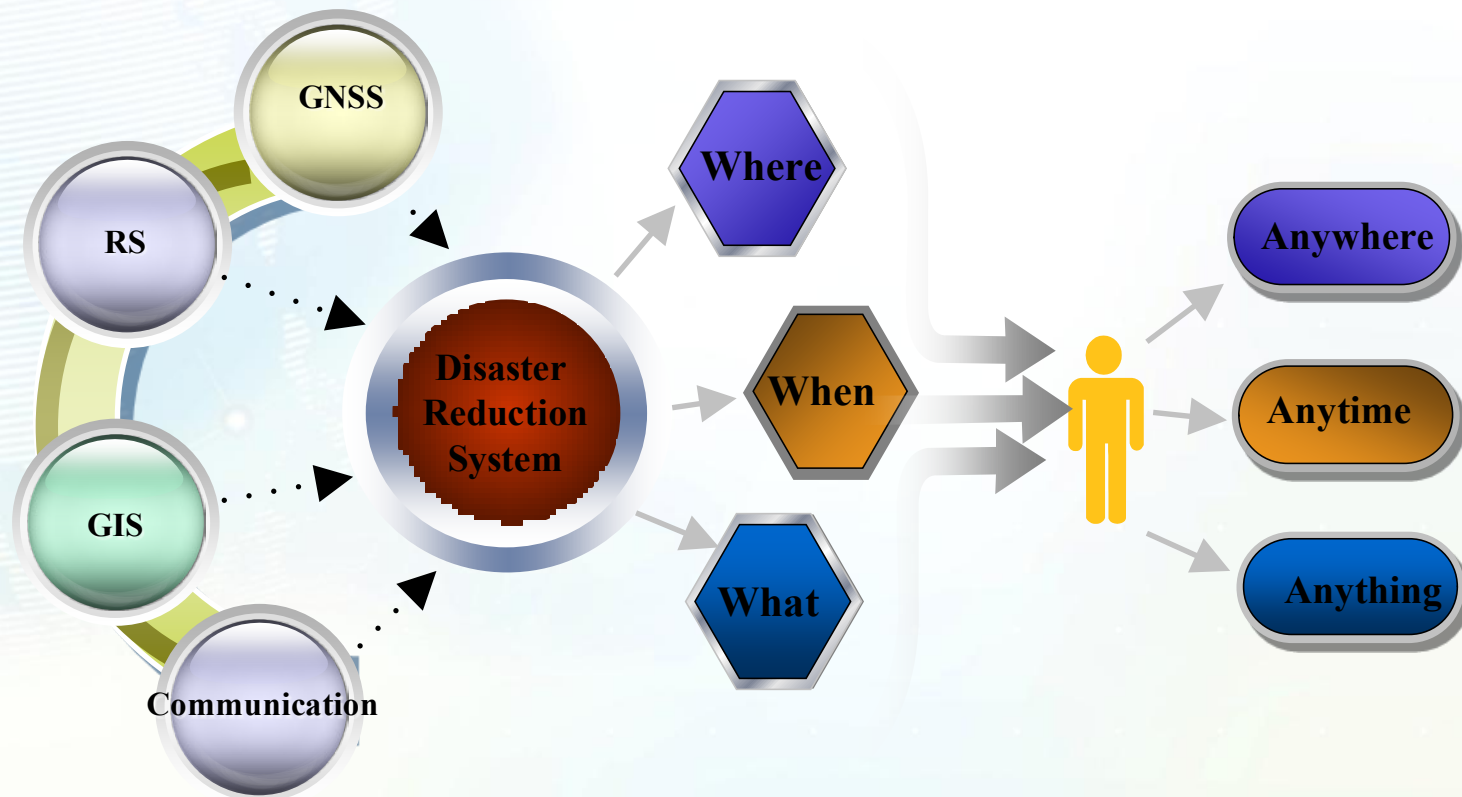
■ Red means almost in a stop. ■ Yellow means low velocity. ■ Green means high velocity.



Disaster Prediction and Mitigation System



- ❑ 3S (GNSS&RS&GIS) + Communications Integrated
- ❑ To obtain disaster prediction and relief information quickly
- ❑ Covering various business models to form a completed system



Digital Disaster Reduction Terminal



- Digital disaster mitigation terminal is designed for collecting Information when a disaster happens. In combination with GPRS/CDMA2000, BeiDou/GPS, it can be used for disaster reduction tasks, such as navigation, disaster information collecting, disaster information transmitting by satellite communications or mobile communications.
- An international project has been undertaken by China, Pakistan, Thailand, Iran, and Bangladesh under the APSCO framework.



Digital Disaster Reduction Terminal



BDS Maritime Applications



□ Offshore Operation

- Marine fishery
- Marine transportation
- Oceanographic engineering
- Rescue



□ Maritime Electronic Customs Clearance

- Customs
- Frontier inspection
- Quarantine
- Maritime affairs



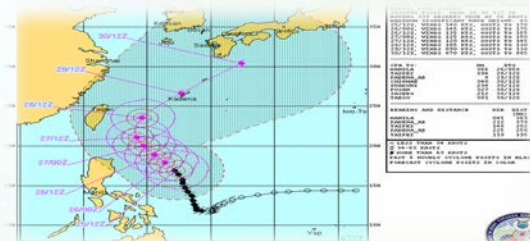
□ Port Operation

- Container
- Operation machinery
- Freighter



□ Maritime Meteorological Observation

- Sea surface observation
- Typhoon observation



Summary



- The unique BDS features directly support reliable, high-quality GNSS applications, including earth observation applications
- With the careful planning, the BDS/GNSS application development efforts have been proceeding smoothly; BDS-based products have been gaining market shares in various application areas
- Pivotal applications for international markets have been identified and developed
- The BDS/GNSS applications have been growing very rapidly; the results from early adopters are very promising – the results are comparable with those from other GNSS systems, and are superior in some application environments





Thanks!

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

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