



Committee on the Peaceful Uses of Outer Space: 2023
Sixty-sixth Session

Development of BeiDou Navigation Satellite System

CHEN Ying

China Satellite Navigation Project Center

June, 2023

Constellation Status



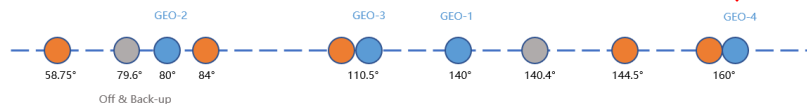
A total of 46 satellites operational in orbit

The 1th BDS-3 back-up satellite launched on May 17, 2023

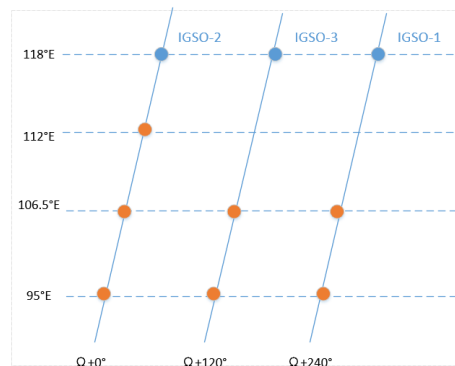
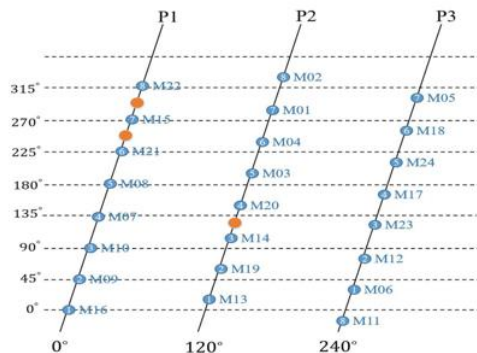
Including:

15 BDS-2 Satellites

31 BDS-3 Satellites (30 networking satellites and 1 back-up satellite)



The 56th satellite for China's BeiDou Navigation Satellite System (BDS) was launched at Xichang



- To promote the network's availability and stability
- To expand the communication capacity of the system's regional short-messaging function by 1/3
- To enhance positioning accuracy of satellite-based augmentation and precise point positioning and realize quick high-accuracy positioning

Diversified Services



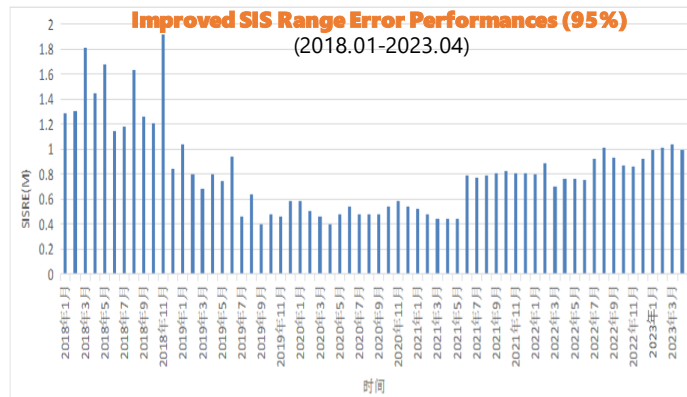
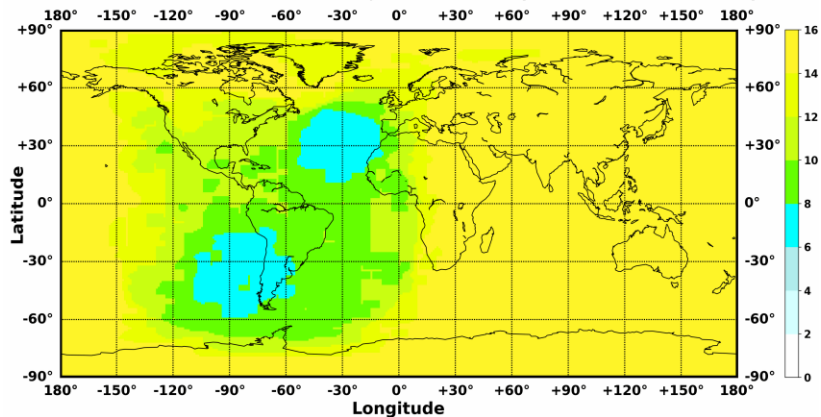
	RNSS	GSMC	SAR	RSMC	PPP	SBAS	GAS
Channel	24MEO+3GEO O+3IGSO	Up:14MEO Down: 3IGSO+24MEO	Up: 6MEO Down: 3IGSO+24MEO	3GEO	3GEO	3GEO	Mobile Communication & Internet
Frequency	B11,B31,B2a, B1C,B2b	L, B2b	UHF, B2b	L, S	B2b	B1C, B2a	
Information Provided	GNSS	Short Message	Alarming Message	Short Message	Corrections	Error Corrections and integrity	Differential Corrections
Functions	Positioning, Navigation, Timing	Location Reporting, Emergency Rescue, Short Message Communication	Warning & Alarming	Communication	Precise Positioning Point	Augmentation and Integrity	RTK
Performances	Horizontal 9m Vertical 10m	Maximum length of a single message: 560 bits	Return link delay: ≤2mins Return link success rate: ≥95%	Maximum length of a single message: 14000 bits	Horizontal 0.3m Vertical 0.6m Convergence time 30 mins	Positioning, warning time, integrity risk	Real-time cm- level, post- processing mm-level
Service Area	Global			Asia-Pacific Region			

Ref.: China's BeiDou Navigation Satellite System in the New Era (scio.gov.cn)

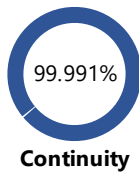
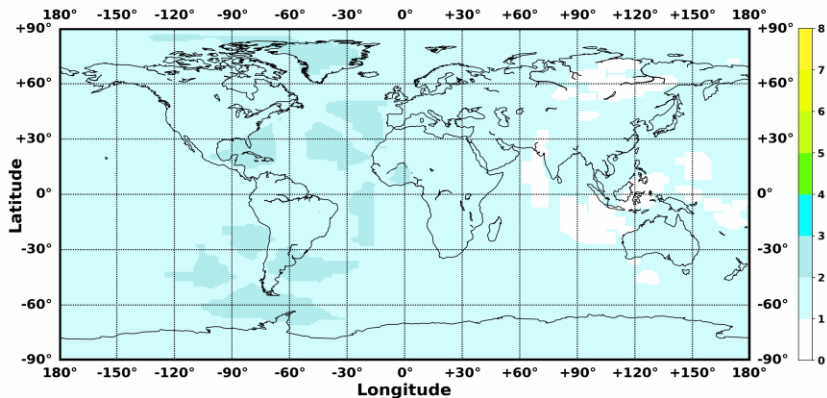
RNSS service performance



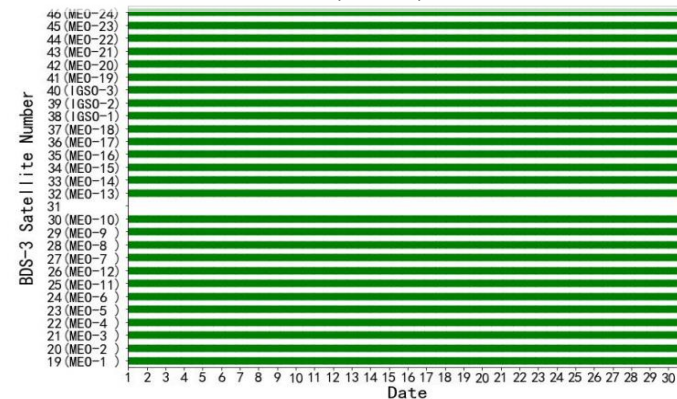
Number of Visible BDS Satellites, elevation $\geq 5^\circ$ (2023/05/29/02:00 BDT)



BDS PDOP, elevation $\geq 5^\circ$ (2023/05/29/02:00 BDT)



B1C/B2a signal health conditions
(2023.04)



Short Message Communication Service



4 semi-turnable 16m-tall antennas, information processing, information service platforms established can receive and process BDS signals and improve relevant service capabilities.



A sub-system of operation services has been established, including functions such as user management, transaction management, customer service and operation analysis, to support the provision of standard telecom carrier-level services to users.



A user-oriented business model was established, and provide diversified services based on the short message communication service capability and platform function.

Global Short Message Communication

- Coverage: Global
- Space Segment: 14 MEO satellites support up link; 3 ISGO and 24 MEO support down link;
- Maximum length of a single message: About 560 bits (40 Chinese characters per message)

Global Short Message Communication

- Coverage: China and surrounding area
- Space Segment: 3 GEO satellites at 80°E, 110.5°E, 140°E
- Maximum length of a single message : 14,000 bits (around 1,000 Chinese characters)
- Main functions: search & rescue, location report, short message communication, etc.



Short Message Communication Service



HUAWEI Mate X3



HUAWEI P60 系列



HUAWEI Mate50 系列



HUAWEI Mate Xs 2

In 2023, Huawei successively realized two-way BDS short message communication service on the newly-launched P60, MATE X3, nova 11 Ultra, and Huawei smartwatch Ultimate. "Directly-connected to satellite" has become the standard of Huawei series products, and the number of social units has exceeded 10 million.



In February 2023, in Gonger Grassland in Chifeng, Inner Mongolia, the missing people sent distress messages and positioning coordinates through the short message communication function and were successfully rescued.

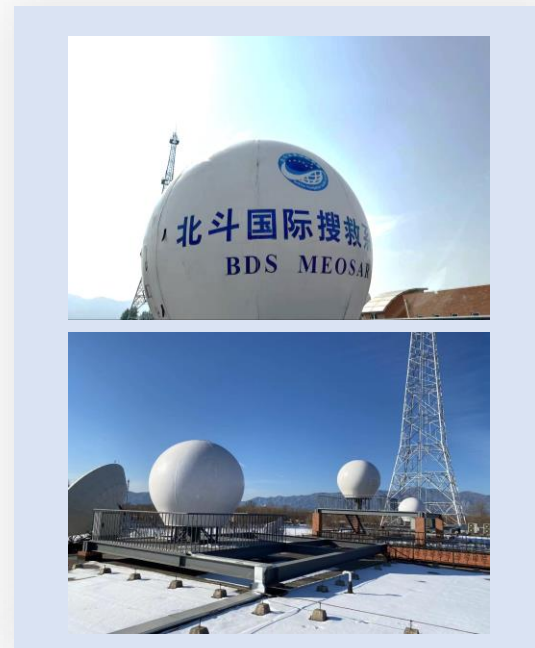
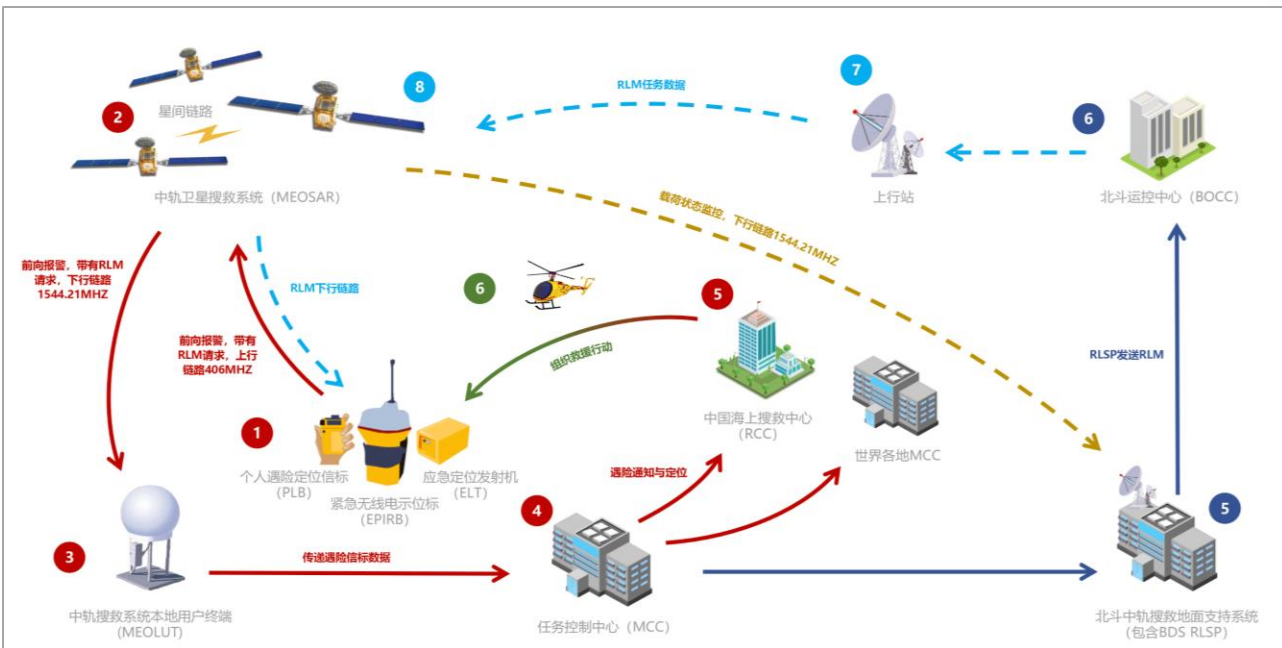


In April 2023, a netizen posted on his microblog that he was rescued by sending location information through the short message communication function of P60 mobile phone when his car was stalled and it was difficult to call for help due to poor signal.

Search and Rescue Service



BDS Search and Rescue service provides long-term, continuous and stable testing and monitoring of the performance parameters and in-orbit service capabilities of the six search and rescue payloads carried, and reports the working status of the BDS search and rescue payloads to the COSPAS-SARSAT. It is used for the processing and transmission of the BDS return link information, and sends the BDS return link information to users in distress through the ground operation control system to provide alarm confirmation and other services for people in distress.



Search and Rescue Service



In Nov. 2022, China formally becomes the provider of COSPAS-SARSAT space segment



Monitoring and assessment was carried out on time in accordance with the guidelines for monitoring and assessment of the service performance and operation status of BDS-3 and Rules for monitoring and assessment of search and rescue service. The assessment results in May showed that:

MEO SAR meets technical requirement, six BDS SAR payloads meet standards, and have the ability to transmit distress signals

The return-link service meets the technical requirements. Within 2 minutes, 99% of the return-link messages should be broadcast.

The construction of main body of the international search and rescue ground system has been completed, capable of receiving and analyzing 406.05MHz signals transmitted by BDS search and rescue payload.

MEOSAR

MEOSAR	
Positioning Accuracy	4.38km
Detection Probability	99.2%
Availability	99%

RLS

RLS	
Time Delay	15s
Service Success Rate	99%

MEOSAR

Ground Service of Search and Rescue	
Monitoring Data Efficiency	Efficiency of RF monitoring data 100% Processing efficiency of telemetry data 100%
Link Connection Rate	99.9%
Operation Status	100% healthy

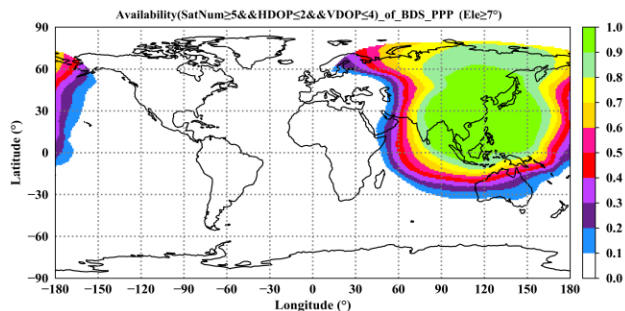


On May 16, 2023, the China Mission Control Center (CNMCC) of COSPAS-SARSAT and BDS MEOSAR Supporting System immediately forwarded the distress warning information to the search and rescue coordination center after receiving the distress warning information of a Chinese deep-sea fishing vessel "Lupeng Yuanyu 028" in the middle of the Indian Ocean, helping coordinate international maritime search and rescue assistance and carrying out rescue efforts.

PPP-B2b Service Performance

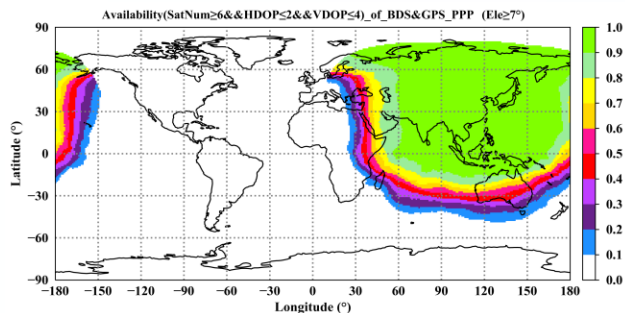


Coverage



BDS PPP service availability

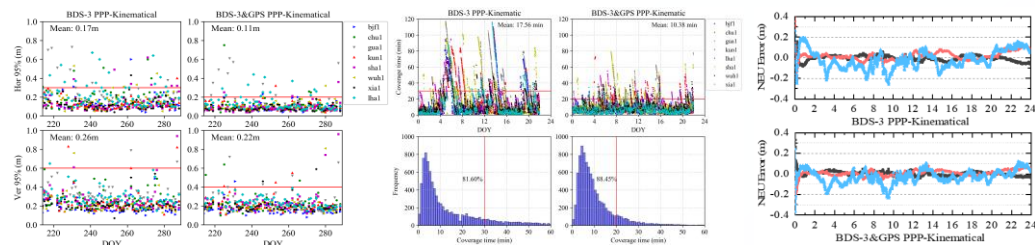
Sat numbers ≥ 5 , HDOP ≤ 2 & VDOP ≤ 4



BDS+GPS PPP service availability

Sat numbers ≥ 6 , HDOP ≤ 2 & VDOP ≤ 4

Positioning accuracy and convergence time



Station	BDS-3 PPP			BDS-3&GPS PPP		
	Hor/m	Ver/m	convergence time/min	Hor/m	Ver/m	convergence time/min
BJF1	0.14	0.19	15.6	0.09	0.17	11.2
CHU1	0.21	0.30	18.7	0.13	0.26	12.8
GUA1	0.23	0.30	22.0	0.14	0.25	13.2
KUN1	0.12	0.25	18.1	0.10	0.25	9.8
LHA1	0.24	0.30	22.8	0.14	0.24	10.9
SHA1	0.15	0.27	12.7	0.10	0.23	9.4
WUH1	0.16	0.21	15.8	0.11	0.19	8.1
XIA1	0.13	0.22	14.5	0.09	0.20	8.8
Mean value	0.17	0.26	17.5	0.11	0.22	10.4

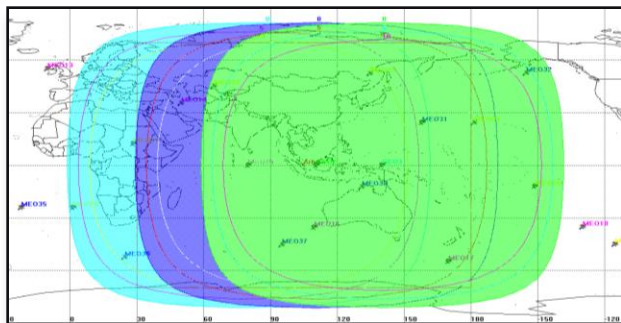
BDS

- **Positioning accuracy:** Horizontal (95%) 0.17m, Vertical (95%) 0.26m
- **Convergence time:** 17min (H $\leq 0.3m$, V $\leq 0.6m$)

BDS+GPS

- **Positioning accuracy:** Horizontal (95%) 0.11m, Vertical (95%) 0.22m
- **Convergence time:** 10min (H $\leq 0.2m$, V $\leq 0.4m$)

Satellite-Based Augmentation Service



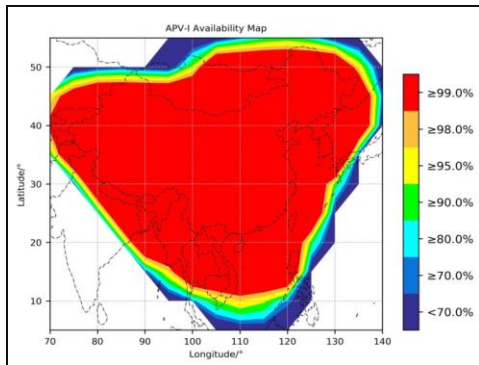
GEO Satellite Information

Satellite	PRN	Orbit	Launch Date
GEO-1	130	140E	2018.11.01
GEO-2	144	80E	2020.03.09
GEO-3	143	110.5E	2020.06.23

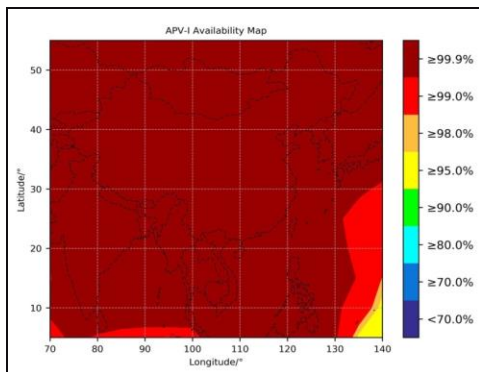
Service Performance Indicators

Performance Indicators		Public Services	
		Single-Frequency	Double-Frequency
Coverage		China and Surrounding Area	
Augmented Signals		GPS L1C/A	BDS B1C/B2a GPS L1C/A/L5
Frequency		BDS GEO B1C	BDS GEO B2a
Positioning Accuracy 95%		H: 1.5m, V: 2.0m	H: 1.0m, V: 1.5m
Integrity	Warning time	10s	6s
	Integrity Risk	$2 \times 10^{-7}/150s$	
	Alarming Threshold	HAL: 40m VAL: 50m	HAL: 40m VAL: 10m
Continuity		$1-8 \times 10^{-6}/15s$	
Availability		≥99%	≥99.9%

Satellite-Based Augmentation Service



SF APV-I Availability Map

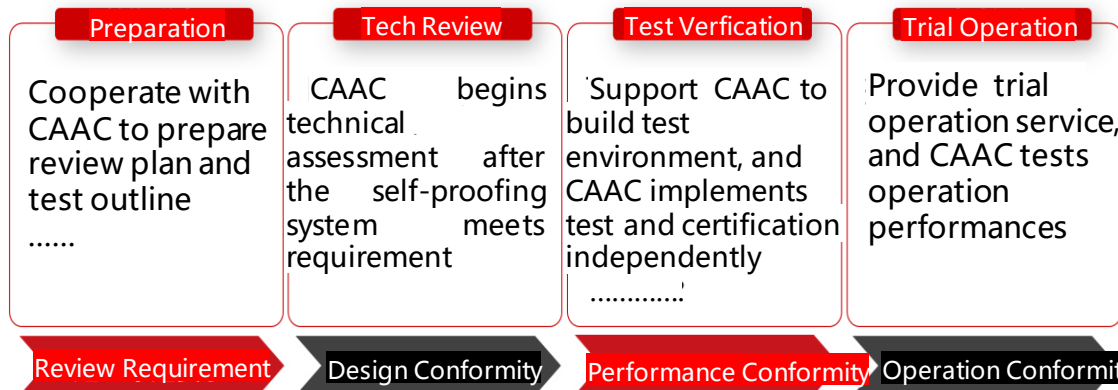


DF APV-I Availability Map



民航局正式启动北斗星基增强系统民航应用验证评估工作

- Civil Aviation Assessment of the BDSBAS service underway and in technical review. Single-frequency augmentation assessment to be finished in 2024

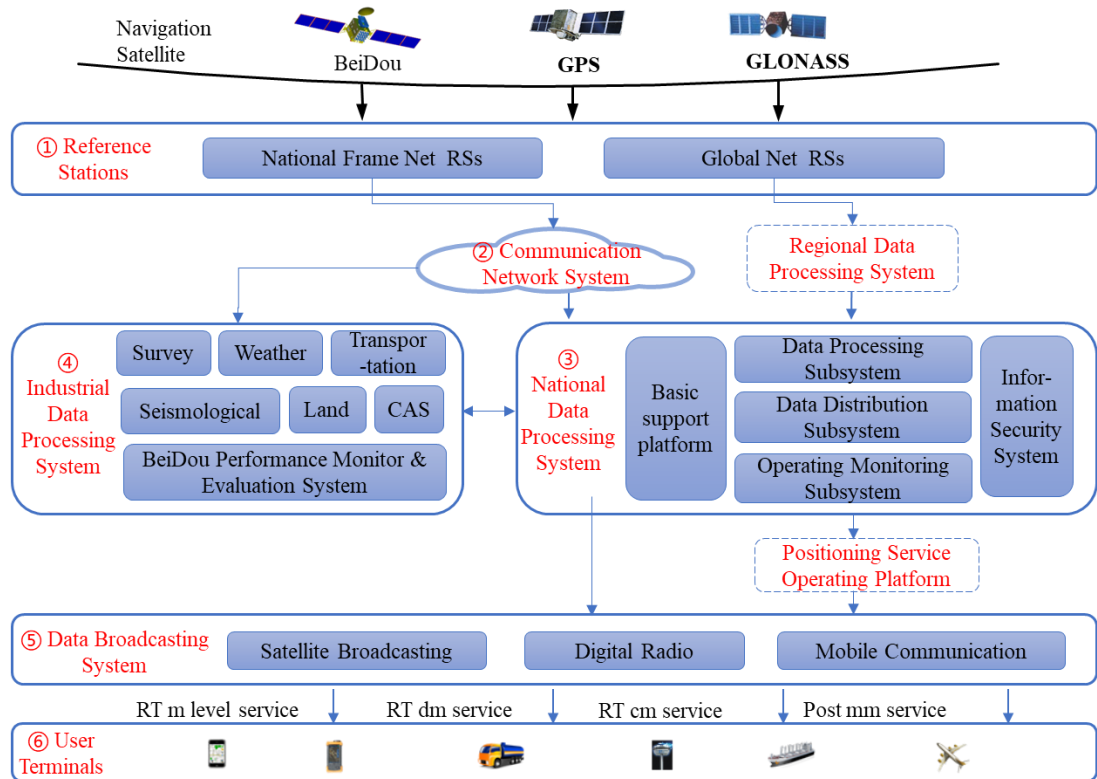


Ground-Based Augmentation Service



155 national frame net reference stations and 3700 global net reference stations

Three broadcasting ways: satellite broadcasting, digital radio, mobile communication

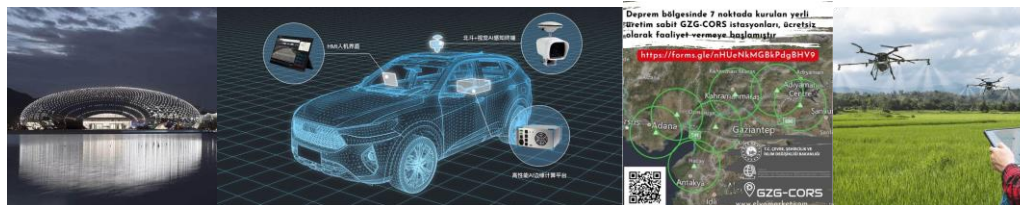


Ground-Based Augmentation Service



Performances of Ground-based Augmentation Service

Indicators	Meter-level		Dm-level	Cm-level	Post-Processing mm-level
Technology	SF Pseudo Range Standard Point Positioning	SF Carrier Phase Precise Point Positioning	DF Carrier Phase Precise Point Positioning	DF Carrier Phase Difference (Network RTK)	Post-Processing High-Accuracy Relative Baseline Measurement
Information received for User Segment	Orbit, Clock Error, Ionospheric Correction	Orbit, Clock Error, Ionospheric Correction	Orbit, Clock Error, Ionospheric Correction	Comprehensive Error Correction	Post-processing Observation Data, Precise Orbit, Clock Error, EOP
Broadcasting Requirement	One-way Broadcasting	One-way Broadcasting	One-way Broadcasting	Two-way Communication	Data access/download
Broadcasting Ways	satellite broadcasting, digital radio, mobile communication	satellite broadcasting, digital radio, mobile communication	satellite broadcasting, digital radio, mobile communication	mobile communication	Internet, mobile communication
Coverage	Whole Nation	Whole Nation	Whole Nation	Authorized Area	Whole Nation
Accuracy	H 2.0m(95%) V 3.0m(95%)	H 1.2m(95%) V 2.0m(95%)	H 0.5m(95%) V 1.0m(95%)	H ≤ 5cm(RMS) V ≤ 10cm(RMS)	H ≤ 2.5mm + 0.5ppm × D (RMS, D/M) V ≤ 5mm + 0.5ppm × D (RMS, D/M) Rele Pos Accuracy ≤ 3 × 10 ⁻⁸ (RMS, D/M)
Initialization (95%)	N/A	≤ 20 mins	≤ 40 mins	≤ 60 s	N/A
Terminals	SF Pseudo Range Receiver	SF Carrier Phase Receiver	DF/TF Carrier Phase Receiver	SF Pseudo Range Receiver	SF Carrier Phase Receiver



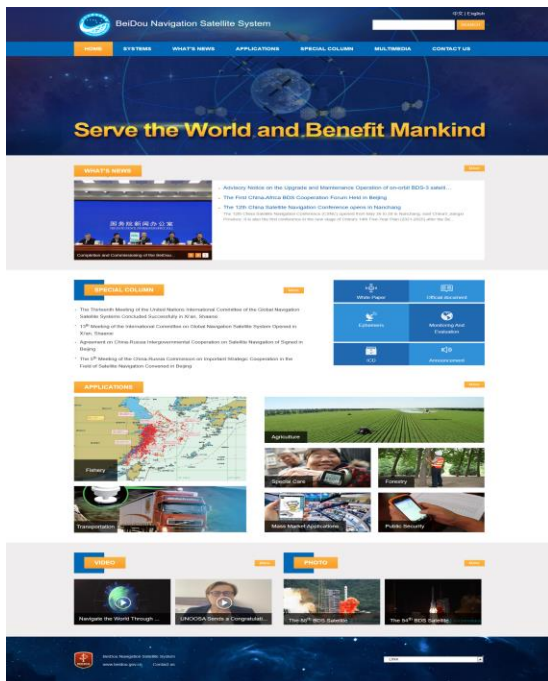
1.5 billion smart devices connected cumulatively

170 billion calls per month

Coverage of more than 230 nations/regions

Widely used in urban governance, intelligent transportation, disaster prevention and reduction, precision agriculture and other fields

BDS User Access



URL: www.beidou.gov.cn

Official plan, strategy, documents

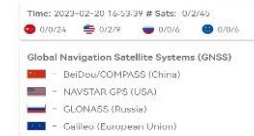
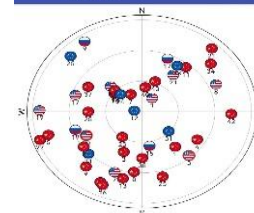


bdservices@beidou.gov.cn



URL: www.csno-tarc.cn

System status, performance, NABU



APP: [navsat](#)

For Android and Harmony OS



北斗系統用戶通告 (NABU) 20220029	通告編號: 20220029 通告日期: (UTC) 2023-01-09 01:00 通告類型: 故障通告 (RNSS_SCH_SUM)	2023.01.09
北斗系統用戶通告 (NABU) 20220028	通告編號: 20220028 通告日期: (UTC) 2022-12-19 00:00 通告類型: 互操作 (RNSS_SCH_MFN)	2022.12.19
北斗系統用戶通告 (NABU) 20220027	通告編號: 20220027 通告日期: (UTC) 2022-09-20 12:00 通告類型: 互操作 (RNSS_L1FD_MFN)	2022.09.20
北斗系統用戶通告 (NABU) 20220026	通告編號: 20220026 通告日期: (UTC) 2022-09-19 16:00 通告類型: 互操作 (RNSS_L1FD_MFN)	2022.09.19
北斗系統用戶通告 (NABU) 20220025	通告編號: 20220025 通告日期: (UTC) 2022-09-17 22:00 通告類型: 升級通告 (RNSS_L1FD_MFN)	

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BDS/GNSS Applications



BeiDou Applications Empowering Various Industries and Sectors



- World largest dynamic monitoring system on commercial vehicles with 8.14 million in total
- 100% application usage rate in public service vessel, coastal navigation equipment, etc., realizing full coverage
- More than 5 million BDS high precision positioning based shared bikes available

Smart Transportation

Comprehensively raise information level of transportation and help to smart city management



- Over 100,000 agricultural machineries with auto drive system
- Over 100,000 forestry terminals being managed on the Comprehensive BDS Application Service Platform for Forestry
- Over 20,000 sets of BDS intelligent grazing positioning collars
- Over 100,000 fishing boats with BDS shipborne terminals installed

Agriculture, Forestry and Fisheries

Realizing cross-domain operating data integration, greatly improving operation management efficiency



- BeiDou Services including PNT, Timing and Frequency, and Short Message Communication all fully applied in the field
- With more than 380000 devices and terminals

Electric Power

Continuing to contribute BDS-based wisdom to the digitization of power grid



- Integrated positioning technique of mobile terminal, Wi-Fi, and base station
- Making independent decisions in customer ordering, intelligent scheduling, transit sorting, transportation plan, delivery, and other aspects
- Realizing cargo identification, courier scheduling, and optimization of delivery routes

Express Delivery Logistics

99% accuracy, achieving faster delivery and higher efficiency

BDS/GNSS Applications



BeiDou Featured Applications Fulfilling Diversified



- In high-precision deformation monitoring, releasing landslide alerting information ahead, providing security and reference for life safety
- In digital construction, based on the high-precision service of BDS, achieving precise and real-time supervision of the construction site

High Precision Applications

Safeguarding life security, improving the quality and efficiency of construction



- BDS high-precision lane level navigation function successfully piloting in 8 cities in China and to be promoted to the whole country
- Firstly realizing short message communication service on smart phones, to be available for multiple domestic smartphone brands and provide better services



International Scale Applications

Raising the level of international application and ensuring the fruits of development benefit the whole world

- BDS basic products have been applied in more than half of the world's countries and regions, with more diverse models and constantly expanding fields. BDS products, technologies, and services are gaining more recognition from international users.

Applications in Mass Consumption

Serving everyday life, profoundly changing people's life style



- ① **Continuously improve the intelligent operation and services of BDS ground segment, to ensure the steady operation and to upgrade performance.**
- ② **Keep promoting marketization, industrialization, and internationalization development of BDS scale applications.**
- ③ **To build a more ubiquitous, more integrated, more intelligent PNT architecture before 2035**



**Thanks for your continuous attention and
support to the BDS development!**

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