Scientific and Technical Subcommittee:
2024
Sixty-first session

Development of BeiDou Navigation Satellite System

DU Juan

National Time Service Center, Chinese Academy of Sciences

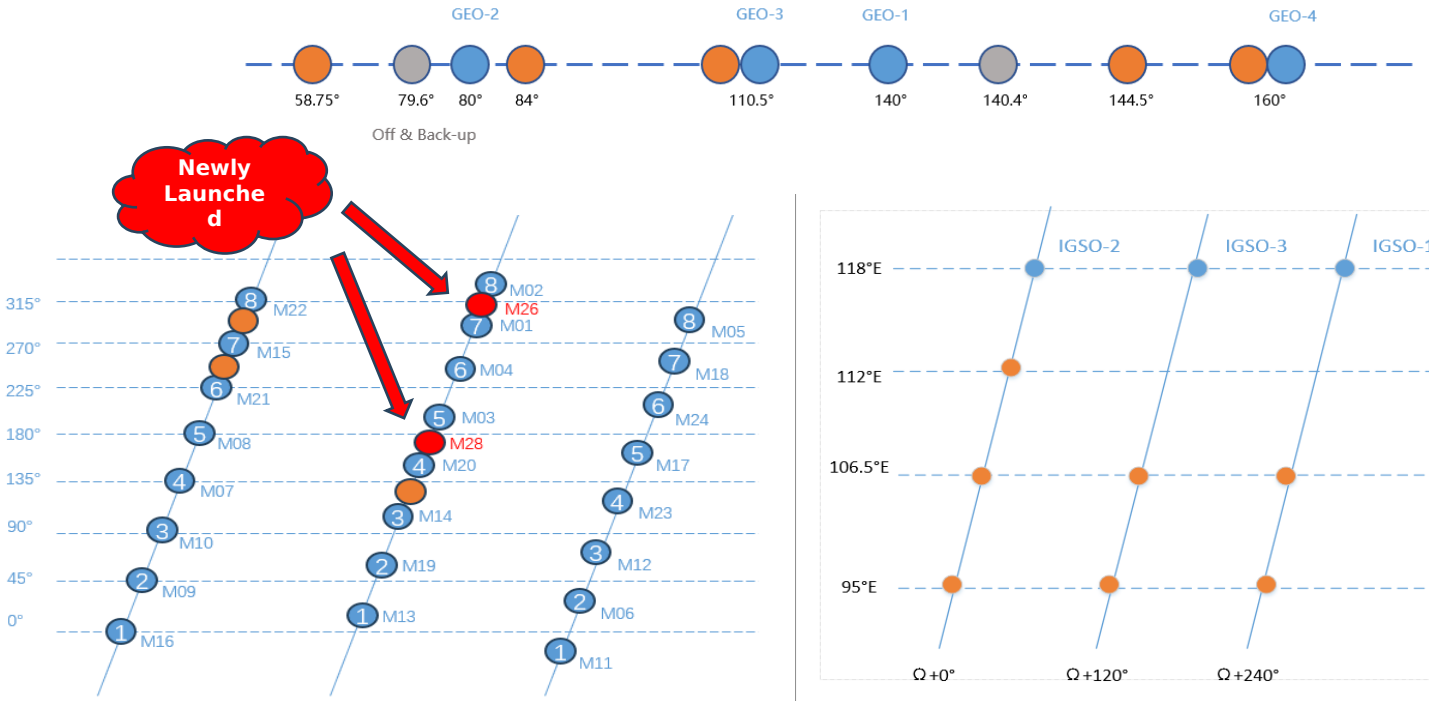
Feb 2024

Constellation Status

A total of 48 satellites operational in orbit

15 BDS-2 Satellites

33 BDS-3 Satellites (30 networking satellites,1 back-up satellite, 2 satellites under in-orbit testing)



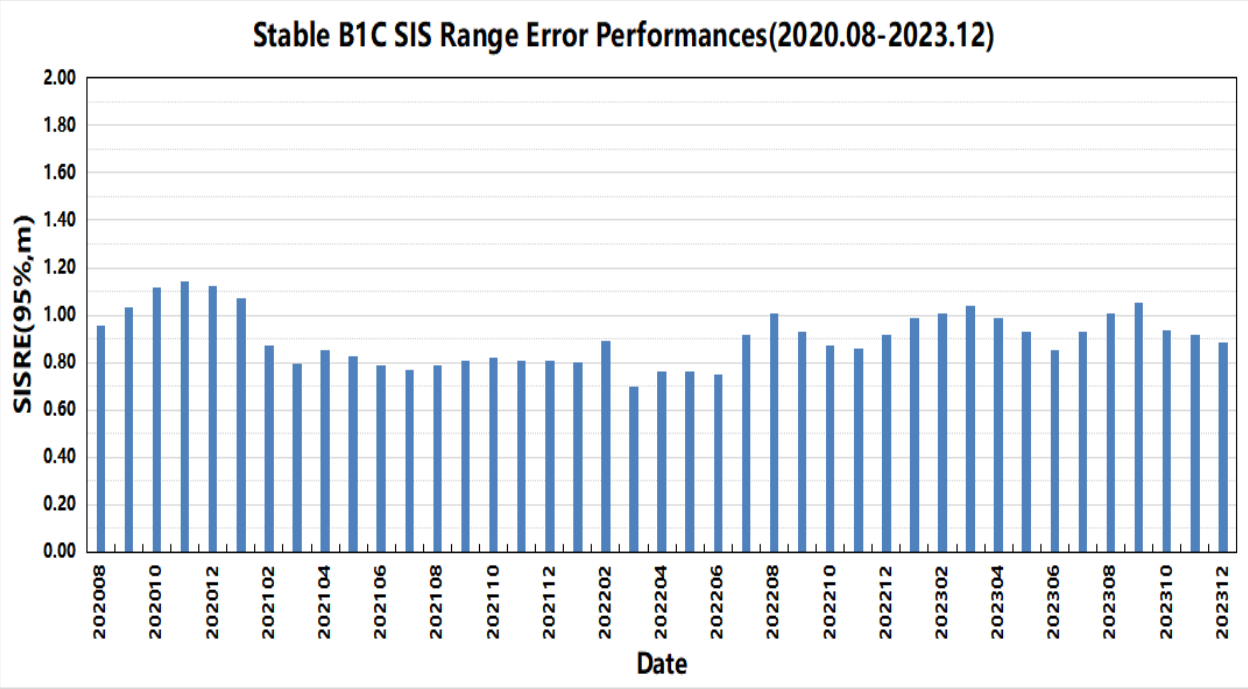
The 57th and 58th satellites for BDS were launched at Xichang on Dec 26, 2023

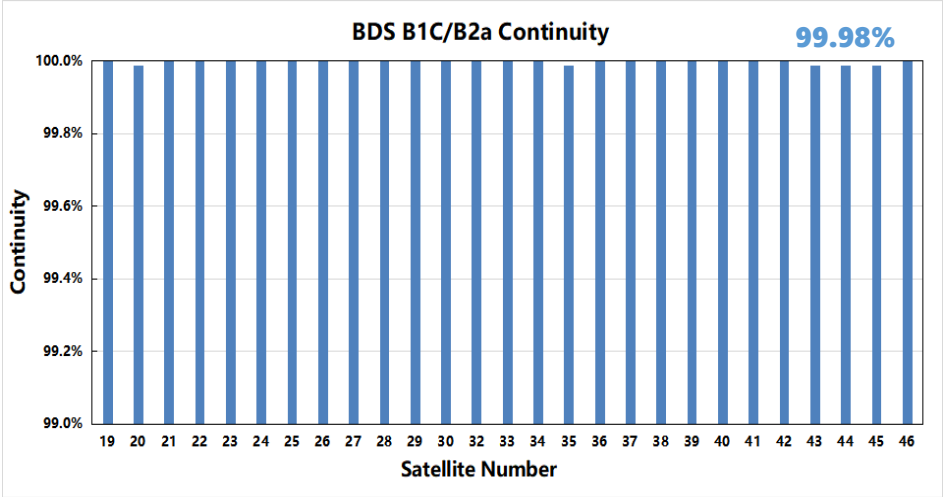
- Upgraded functions and performance in various areas, including global short message communication capacity, onboard atomic clock technology, and intelligent payloads
- Improved reliability and service capabilities

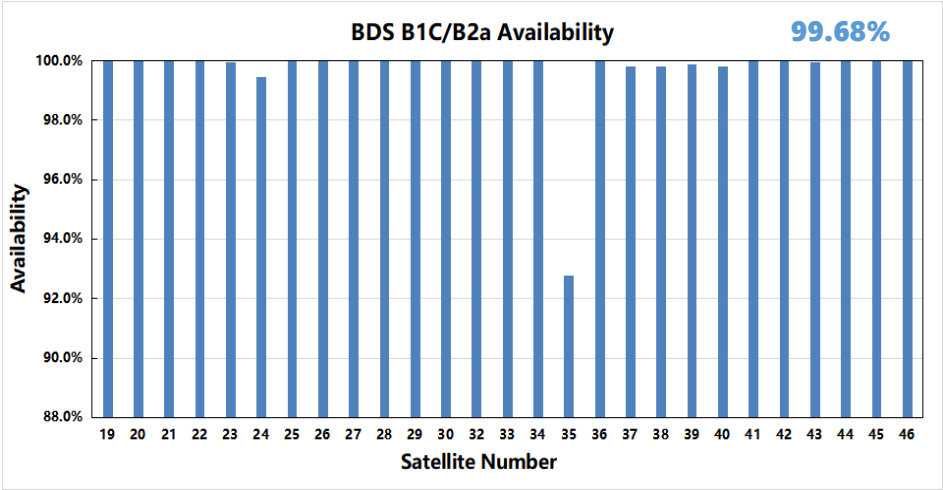
Diversified Services

	RNSS	GSMC	SAR	RSMC	PPP	SBAS	GAS
Channel	24MEO+3GEO +3IGSO	Up:14MEO Down: 3IGSO+24MEO	Up: 6MEO Down: 3IGSO+24MEO	3GEO	3GEO	3GEO	Mobile Communication & Internet
Frequency	B1I,B3I,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			

Stable Operation and RNSS Service Performances







- Intelligent operation and management
- In-orbit software refactoring
- Real-time monitoring and assessment
- Stable operation and better performances

BDS-3 service performances fully better than indicator requirements by ICD

Short Message Communication Service

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)

Regional 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.

Available for Authorized Users

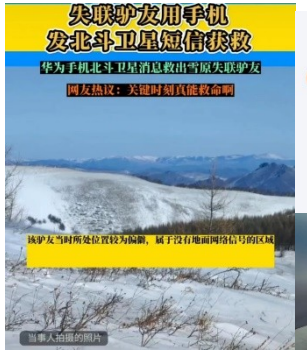

HUAWEI Mate X3

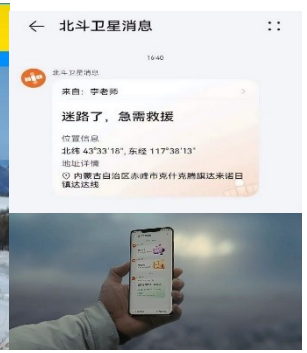

HUAWEI P60 系列


HUAWEI Mate50 系列


HUAWEI Mate Xs 2

In 2023, two-way BDS short message communication service is realized on some domestic smart phone brands. "Directly-connected to satellite" has become the standard of some domestic series products, and the number of social units has exceeded 10 million.





Missing people sent distress messages and positioning coordinates through the short message communication function on mobile phone and were successfully rescued.

Search and Rescue Service

BDS has been adopted as the third RLS operator in the COSPAS-SARSAT standards

- In June 2023, BDS RLS proposal was adopted at the 37th Meeting of Joint Committee of COSPAS-SARSAT.
- In October 2023, the revised proposal related to the BDS RLS was considered and adopted at the 69th Meeting of Open Council of the COSPAS-SARSAT.

Developed EPIRB and PLB beacons to support BDS RLS.

Carried out BDS MEOSAR and RLS delay test and verification in China, to provide data and application support.

MEOSAR and RLS Delay Test and Assessment

London

RLS (from ground-based supporting system to user terminals)

Average Delay 34s

Alexandria Egypt

RLS (from ground-based supporting system to user terminals)

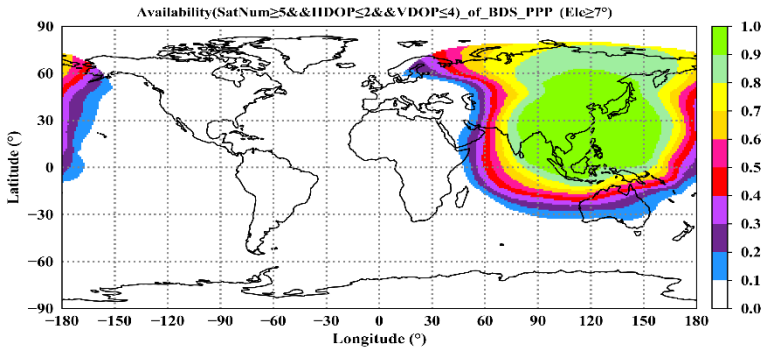
Average Delay 11.5s

	Subject	Indicator	Results
		≤2min	

BDS RLS joint test to be carried out with other national search and rescue mission control centers in the Asia-Pacific region and around the world.

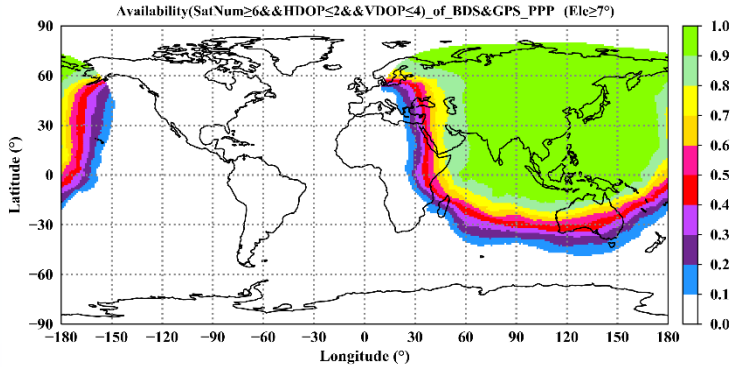
PPP-B2b Service Performance

Coverage



BDS PPP service availability

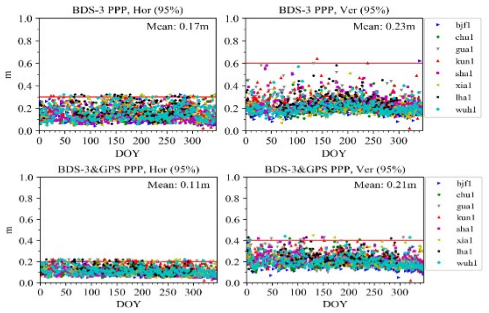
Sat numbers≥5 ， HDOP≤2 & VDOP ≤ 4

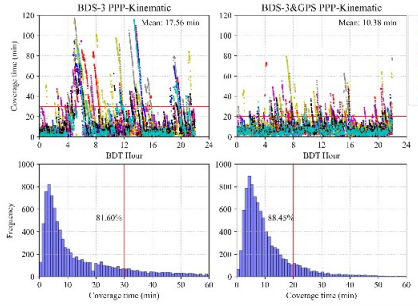


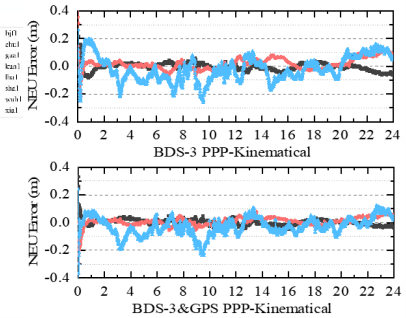
BDS+GPS PPP service availability

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	0.20	15.6	0.10	0.19	11.2
CHU1	0.15	0.21	18.7	0.11	0.21	12.8
GUA1	0.20	0.26	22.0	0.13	0.23	13.2
KUN1	0.17	0.25	18.1	0.14	0.23	9.8
LHA1	0.20	0.26	22.8	0.13	0.23	10.9
SHA1	0.13	0.25	12.7	0.09	0.21	9.4
WUH1	0.17	0.22	15.8	0.11	0.19	8.1
XIA1	0.19	0.22	14.5	0.10	0.20	8.8
					0.21	10.4

BDS

•Positioning accuracy:

• Horizontal (95%) 0.17m, Vertical (95%) 0.23m

•Convergence time:

•17min (H≤0.3m, V≤0.6m)

BDS+GPS

•Positioning accuracy:

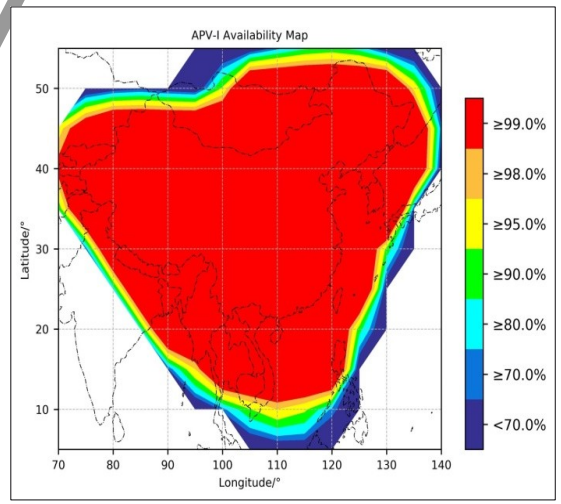
•Horizontal (95%) 0.11m, Vertical (95%) 0.21m

•Convergence time:

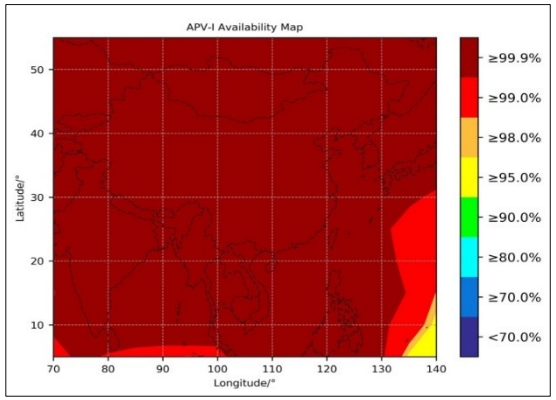
•10min (H≤0.2m, V≤0.4m)

Indicator	Requirement	
		≤30cm
		≤60cm

Satellite-Based Augmentation Service



APV-I availability of BDSBAS SF service



APV-I availability of BDSBAS DFMC service

Flight Phase	Accuracy	Integrity			Continuity	Availability
	HAL/VAL	Integrity risk	Alert limit (H/V)	TTA		
Enroute	3.7km/--	$1*10^{-7}$/h	3.7km/--	5min	$1*10^{-4}$~$1*10^{-8}$/h	0.99~0.9999
Terminal	3.7km/--	$1*10^{-7}$/h	1.85km/--	15s	$1*10^{-4}$~$1*10^{-8}$/h	0.99~0.9999
NPA	220m/--	$1*10^{-7}$/h	556m/--	10s	$1*10^{-4}$~$1*10^{-8}$/h	0.99~0.9999
LPV	16m/20m	$2*10^{-7}$/apr	40m/50m	10s	$1-8*10^{-6}$/15s	0.99~0.9999
LPV-200	16m/4m	$2*10^{-7}$/apr	40m/35m	6.2s	$1-8*10^{-6}$/15s	0.99~0.9999
CAT-I	16m/4~6m	$2*10^{-7}$/apr	40m/10~15m	6s	$1-8*10^{-6}$/15s	0.99~0.9999
CAT-II	6.9m/2m	$1*10^{-9}$/apr	17.3m/5.3m	2s	$1-4*10^{-6}$/15s	0.99~0.9999
CAT-III	6m/2m	$1*10^{-9}$/apr	15.5m/5.3m	2s	$1-4*10^{-6}$/15s	0.99~0.9999

Civil aviation verification and evaluation launched, entering the technical review stage. Verification and evaluation of SF services to be completed in 2024.

BDS/GNSS Applications

BeiDou Applications Empowering Various Industries

- Overall scale of BDS space-time information application steadily increasing
- Industrial applications going further and deeper
- Efforts done in applications in the key areas

Smart Transportation

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

Traffic in Airport

Reducing accident risk in airport and enhancing operation and management efficiency

Deformation Monitoring

High accuracy Safeguarding for the dam in Sarez Lake

Agriculture, Forestry and Fisheries

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

Smart Resources

Realizing smart operation and maintenance of photovoltaic hydropower stations

Mass Consumption

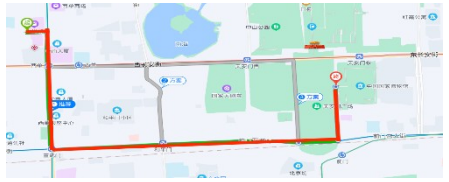
Becoming the standard configuration of smart phones, mobile phones supporting BDS accounted for 98.5%

Electric Power

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

Emergency Management

Share emergency information and upgrade emergency response efficiency

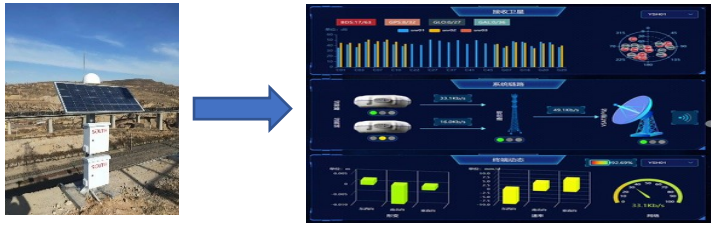


Mobile Map

Daily use of BDS positioning service exceeding 360 billion times by mainstream map applications in

Express Delivery Logistics

99% accuracy, achieving faster delivery and higher



Smart Construction

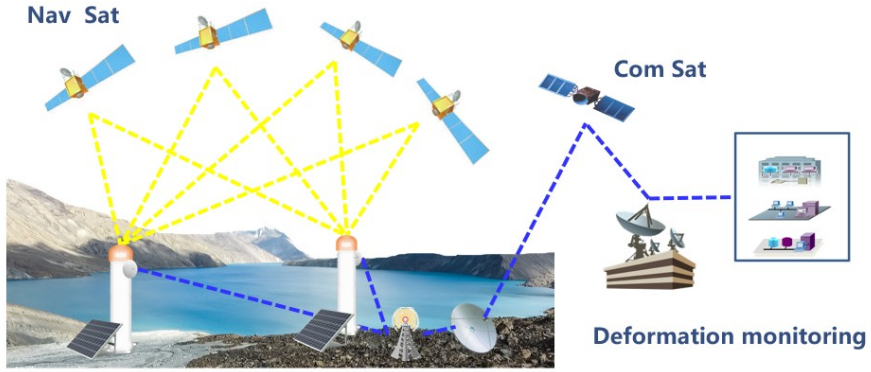
Safeguarding life security, improving the quality and efficiency of construction

International Scale Applications

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

BDS/GNSS Applications

High Accuracy Application——Terrain Monitoring



- Confronted with the threat of potential natural disaster in Sarez Lake in Tajikistan, China and Tajikistan utilized BDS to undertake the deformation monitoring and disaster warning in surrounding area in millimeter-level accuracy, providing important scientific and technological reference for the safety of the dam.

Monitoring achievement fully shown for scientific communication

- During the Second International Summit on BDS Applications in Oct. 2023, Dr. Majid Gulayozov from Dushanbe Branch Center of CAS Research Center for Ecology and Environment of Central Asia delivered a report of BDS Monitoring Systems for Safety on Lake Sarez.

- In Oct. 2023, China-Tajikistan cooperation on the Dam proudly listed one of the ten typical cases of the third Belt and Road Forum for International Cooperation

International Cooperation

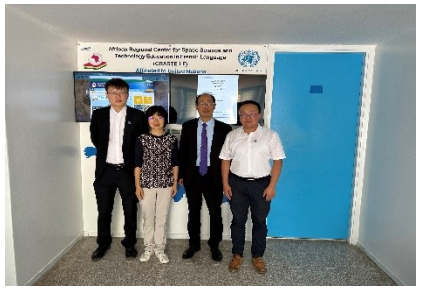
Compatibility and Openness through Bilateral and Multilateral Exchange

ICG-7 in Beijing

ICG-13 in Xi'an

ICG-17 in Madrid

ICG-17 Chinese Delegation in Madrid



Participation of ICG-17 WG-S Intersessional Meeting in Rabat

- Continuing to carry out compatibility and interoperability coordination and cooperation with providers including GPS, GLONASS, Galileo, QZSS, NavIC, etc.
- Joint discussion and platform construction with The Belt and Road countries, promoting global satellite navigation industry development together.

Deeply and continuously engaged in activities under multi-lateral framework such as UNOOSA, held ICG annual meetings twice in 2012 and 2018, participated the ICG-17 in Madrid, Spain in Oct. 2023 to promote compatibility and mutual development with other systems and better serve the world.

International Cooperation

Academic Exchange

- Participated 13th MGA meeting, Munich Satellite Navigation Summit, United Nations/Finland Workshop on GNSS Applications, etc.
- Successfully held the 13th China Satellite Navigation Conference in April 2023

International Cooperation

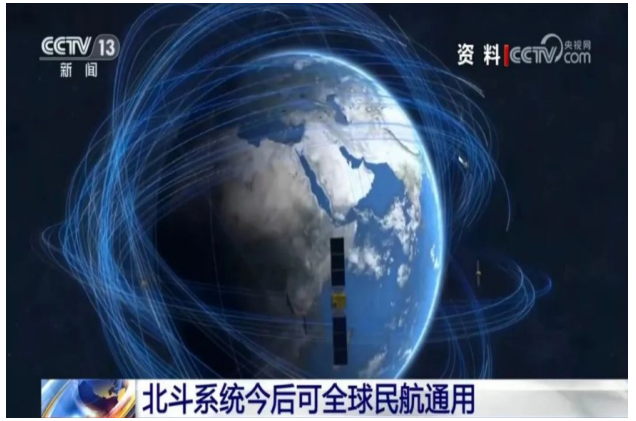
Ratification by International Standards to Better Serve the World

In Nov. 2022, BeiDou has been adopted as the third operator to provide tracking systems for ships after being given a certificate by the International Maritime Organization (IMO).

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

In June 2022, BDS B2a and B3I signal technology standard proposals passed 3GPP deliberations.

BDS positioning technology standards, which are supported by the Fourth- and Fifth-generation mobile communication system network, have been officially released



In Nov. 2023, BDS' technical standards and recommended measures have been added to the ICAO's existing standard documents in Annex 10 of the Convention on International Civil Aviation. Recognized by ICAO, BDS to become globally used satellite navigation system

Future Visions

- Two backup satellites are scheduled to be launched to strengthen the robustness and accessibility of the BDS constellation. Commitments have also been made to continuously raise the standards of intelligent BDS ground operations and maintenance to ensure stable operation and performance improvement. In addition, system management and routine assessments will be strengthened, with a comprehensive strategy for both space- and ground-based operations to optimize the operational ecosystem and enrich BDS services and user experience.

- Research on improving navigation with low-Earth orbit technologies, as well as its practical applications, will be further promoted to strengthen the precision and integrity of the system and to meet the requirements of an era characterized by ubiquitous connectivity and intelligent devices.

- The integration of BDS with innovative realms such as 5G, artificial intelligence, and big data will be accelerated steadfastly, aiming to shape a national PNT system that’s more ubiquitous, integrated, and intelligent by 2035.

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

http://www.beidou.gov.cn