

# Update on the BeiDou Navigation Satellite System (BDS)

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# 01

System Status



## BDS Enters A Global Era

📡 The BDS-3 space constellation, consisting of 30 satellites (24MEOs+3GEOs+3IGSOs), were successfully deployed between November 5, 2017 and June 23, 2020.

📡 Many state of art technologies, such as more reliable atomic clocks, inter-satellite links, and new navigation signals are added.

📡 In addition to the fundamental PNT services, new services are implemented.

📡 BDS enters a global era.

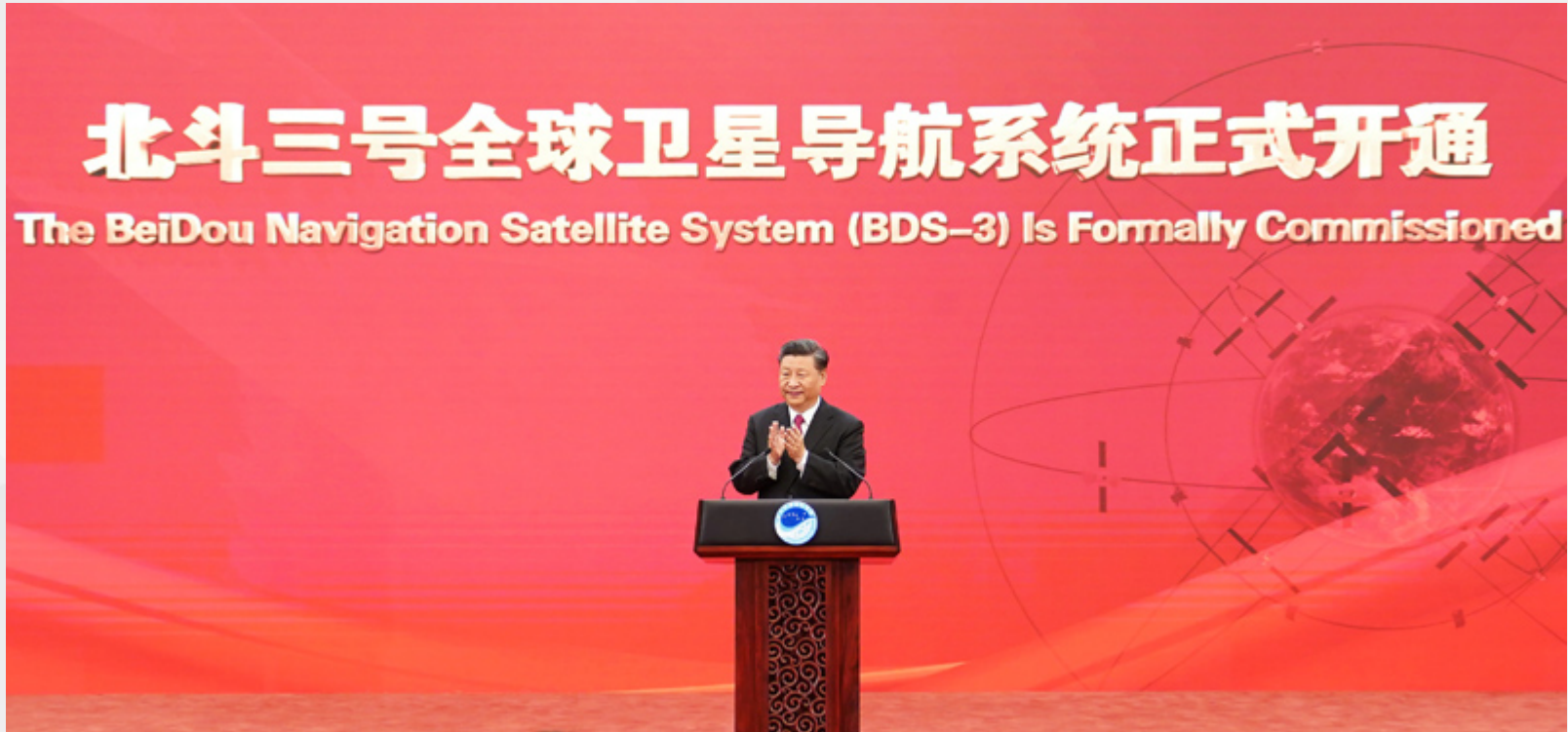


The BDS-3 GEO-3 satellite was successfully launched from XSLC on board a LM-3B rocket.





# BDS-3 Was Formally Commissioned on July 31, 2020





# System Status

## The BDS Operational Satellites



There are 15 operational BDS-2 satellites (5GEOs + 7IGSOs + 3MEOs), with open service navigation signals B1I/B2I/B3I, using PRN from 1 to 15, at the moment.



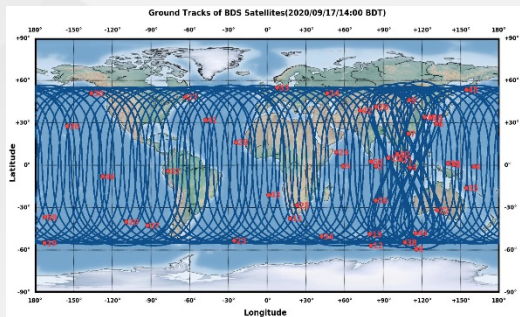
There are 27 operational BDS-3 non-GEO satellites (24 MEOs + 3IGSOs) providing open service for global users with signals B1C/B2a/B1I/B3I/B2b, using PRN from 19 to 61.



There are 3 BDS-3 GEO satellites providing open service for global users with signals B1I/B3I, BDSBAS-B1C/BDSBAS-B2a and B2b-PPP.

PRN	IGS-SVN	NORADID	SVN	SatelliteType	ClockType	Manuf	LaunchDate	SatStatus
01	C020	44231	GEO-8	BDS-2	Rubidium	CASC	2019-05-17	Operational
02	C016	38953	GEO-6	BDS-2	Rubidium	CASC	2012-10-25	Operational
03	C018	41586	GEO-7	BDS-2	Rubidium	CASC	2016-06-12	Operational
04	C006	37210	GEO-4	BDS-2	Rubidium	CASC	2010-11-01	Operational
05	C011	38091	GEO-5	BDS-2	Rubidium	CASC	2012-02-25	Operational
06	C005	36828	IGSO-1	BDS-2	Rubidium	CASC	2010-08-01	Operational
07	C007	37256	IGSO-2	BDS-2	Rubidium	CASC	2010-12-18	Operational
08	C008	37384	IGSO-3	BDS-2	Rubidium	CASC	2011-04-10	Operational
09	C009	37763	IGSO-4	BDS-2	Rubidium	CASC	2011-07-27	Operational
10	C010	37948	IGSO-5	BDS-2	Rubidium	CASC	2011-12-02	Operational
11	C012	38250	MEO-3	BDS-2	Rubidium	CASC	2012-04-30	Operational
12	C013	38251	MEO-4	BDS-2	Rubidium	CASC	2012-04-30	Operational
13	C017	41434	IGSO-6	BDS-2	Rubidium	CASC	2016-03-30	Operational
14	C015	38775	MEO-6	BDS-2	Rubidium	CASC	2012-09-19	Operational
16	C019	43539	IGSO-7	BDS-2	Rubidium	CASC	2018-07-10	Operational

## BDS-2 Satellites



[www.csno-tarc.cn](http://www.csno-tarc.cn)

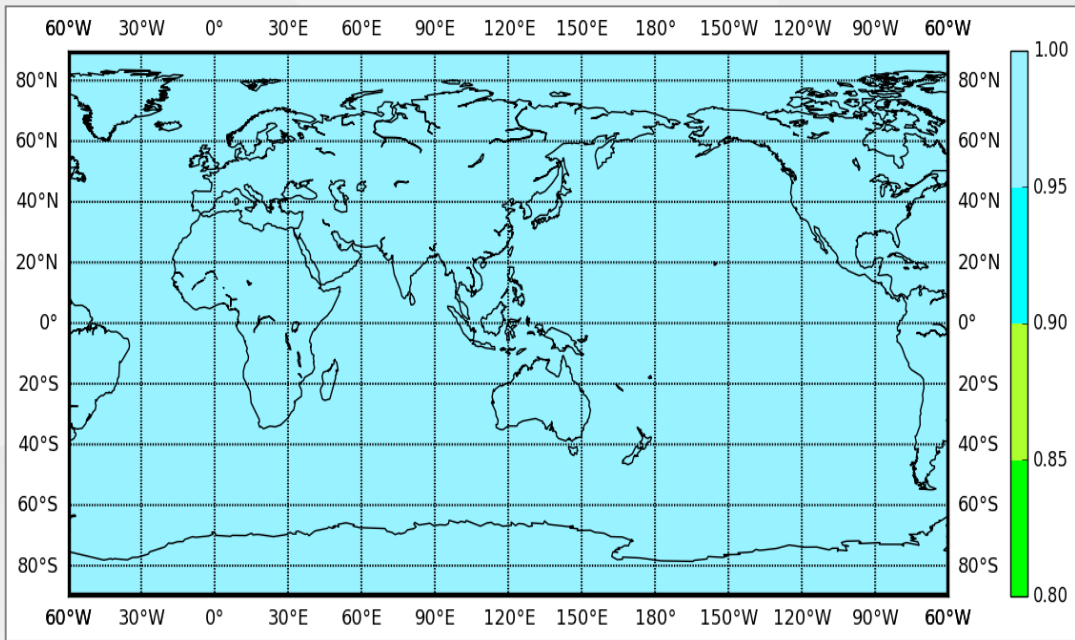
PRN	IGS-SVN	NORADID	SVN	SatelliteType	ClockType	Manuf	LaunchDate	SatStatus
19	C201	43001	MEO-1	BDS-3	Rubidium	CASC	2017-11-05	Operational
20	C202	43002	MEO-2	BDS-3	Rubidium	CASC	2017-11-05	Operational
21	C206	43208	MEO-3	BDS-3	Rubidium	CASC	2018-02-12	Operational
22	C205	43207	MEO-4	BDS-3	Rubidium	CASC	2018-02-12	Operational
23	C209	43581	MEO-5	BDS-3	Rubidium	CASC	2018-07-29	Operational
24	C210	43582	MEO-6	BDS-3	Rubidium	CASC	2018-07-29	Operational
25	C212	43603	MEO-11	BDS-3	Hydrogen	SECM	2018-08-25	Operational
26	C211	43602	MEO-12	BDS-3	Hydrogen	SECM	2018-08-25	Operational
27	C203	43107	MEO-7	BDS-3	Hydrogen	SECM	2018-01-12	Operational
28	C204	43108	MEO-8	BDS-3	Hydrogen	SECM	2018-01-12	Operational
29	C207	43245	MEO-9	BDS-3	Hydrogen	SECM	2018-03-30	Operational
30	C208	43246	MEO-10	BDS-3	Hydrogen	SECM	2018-03-30	Operational
31	C101	40549	IGSO-15	BDS-3S	Hydrogen	SECM	2015-03-30	Experiment
32	C213	43622	MEO-13	BDS-3	Rubidium	CASC	2018-09-19	Operational
33	C214	43623	MEO-14	BDS-3	Rubidium	CASC	2018-09-19	Operational
34	C216	43648	MEO-15	BDS-3	Hydrogen	SECM	2018-10-15	Operational
35	C215	43647	MEO-16	BDS-3	Hydrogen	SECM	2018-10-15	Operational
36	C218	43706	MEO-17	BDS-3	Rubidium	CASC	2018-11-19	Operational
37	C219	43707	MEO-18	BDS-3	Rubidium	CASC	2018-11-19	Operational
38	C220	44204	IGSO-1	BDS-3	Hydrogen	CASC	2019-04-20	Operational
39	C221	44337	IGSO-2	BDS-3	Hydrogen	CASC	2019-06-25	Operational
40	C224	44709	IGSO-3	BDS-3	Hydrogen	CASC	2019-11-05	Operational
41	C227	44864	MEO-19	BDS-3	Hydrogen	CASC	2019-12-16	Operational
42	C228	44865	MEO-20	BDS-3	Hydrogen	CASC	2019-12-16	Operational
43	C226	44794	MEO-21	BDS-3	Hydrogen	SECM	2019-11-23	Operational
44	C225	44793	MEO-22	BDS-3	Hydrogen	SECM	2019-11-23	Operational
45	C223	44543	MEO-23	BDS-3	Rubidium	CASC	2019-09-23	Operational
46	C222	44542	MEO-24	BDS-3	Rubidium	CASC	2019-09-23	Operational
56	C104	40938	IGSO-25	BDS-3S	Hydrogen	CASC	2015-09-30	Experiment
57	C102	40749	MEO-15	BDS-3S	Rubidium	CASC	2015-07-25	Experiment
58	C103	40748	MEO-25	BDS-3S	Rubidium	CASC	2015-07-25	Experiment
59	C217	43683	GEO-1	BDS-3	Hydrogen	CASC	2018-11-01	Operational
60	C229	45344	GEO-2	BDS-3	Hydrogen	CASC	2020-03-09	Operational
61	C230	45807	GEO-3	BDS-3	Hydrogen	CASC	2020-06-23	Testing

## BDS-3 Satellites



# System Status

The overall BDS performance



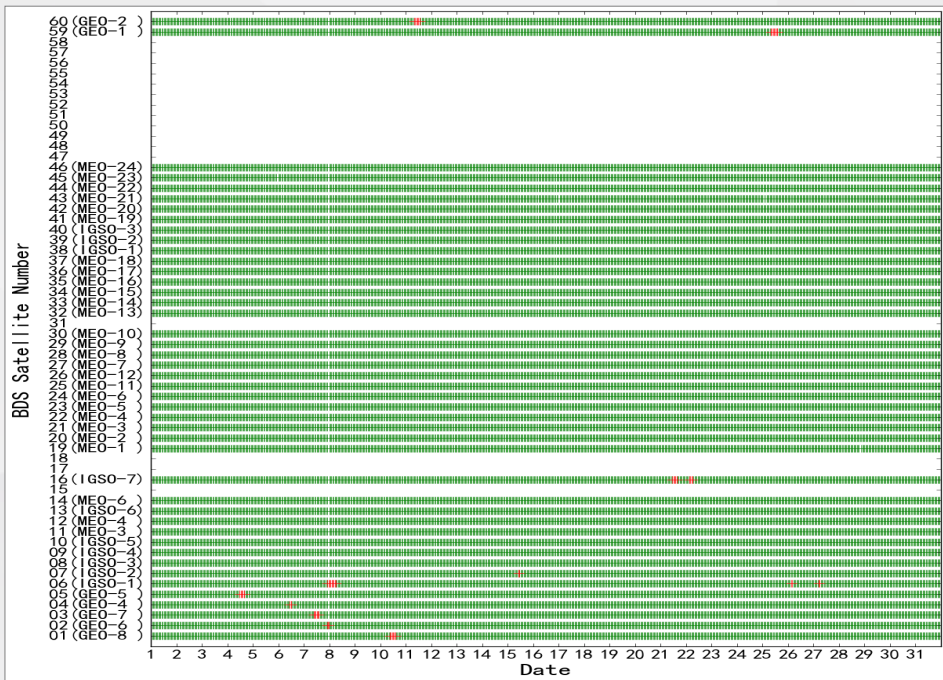
PDOP Availability

- Realize global coverage capability, with PDOP availability ( $PDOP \leq 6$ ) 100%
- Horizontally positioning accuracy is about 1.5m, vertical positioning accuracy is about 2.5m (global average, B1C single frequency), velocity accuracy is about 0.05m/s and timing accuracy is 9.8ns (95%)

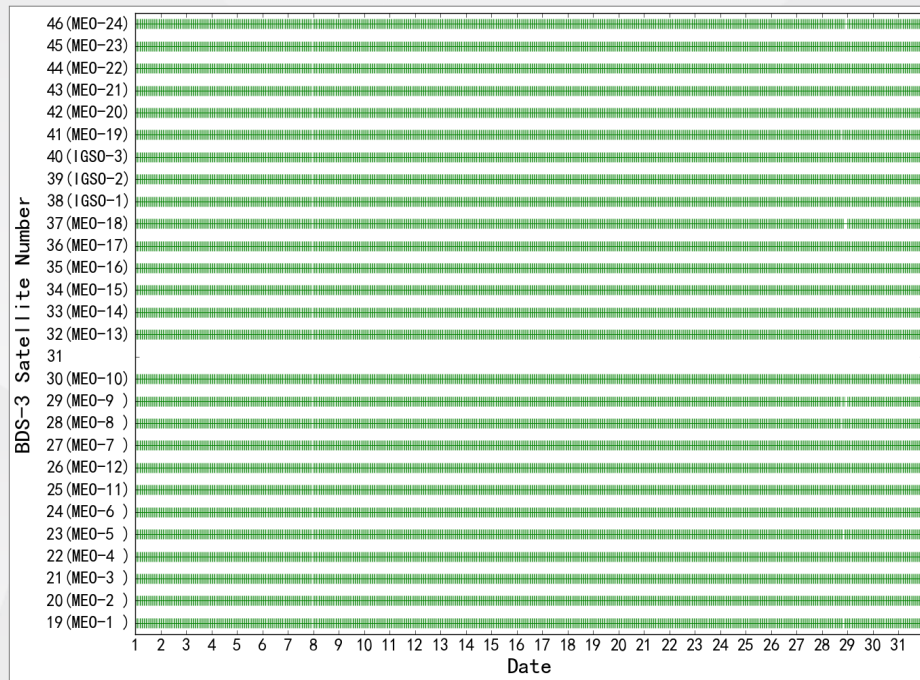


# System Status

## The BDS Signal Availability in August 2020



B1I/B3I



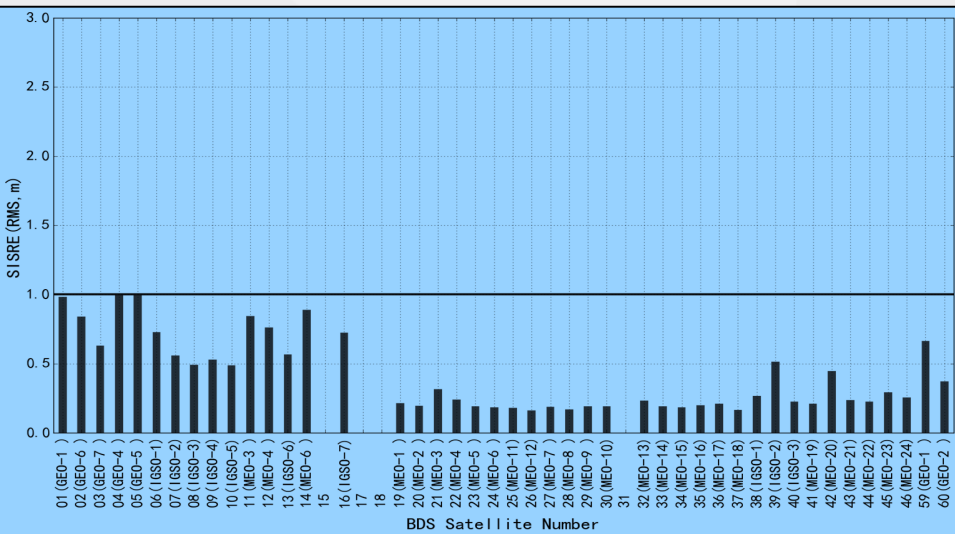
B1C/B2a



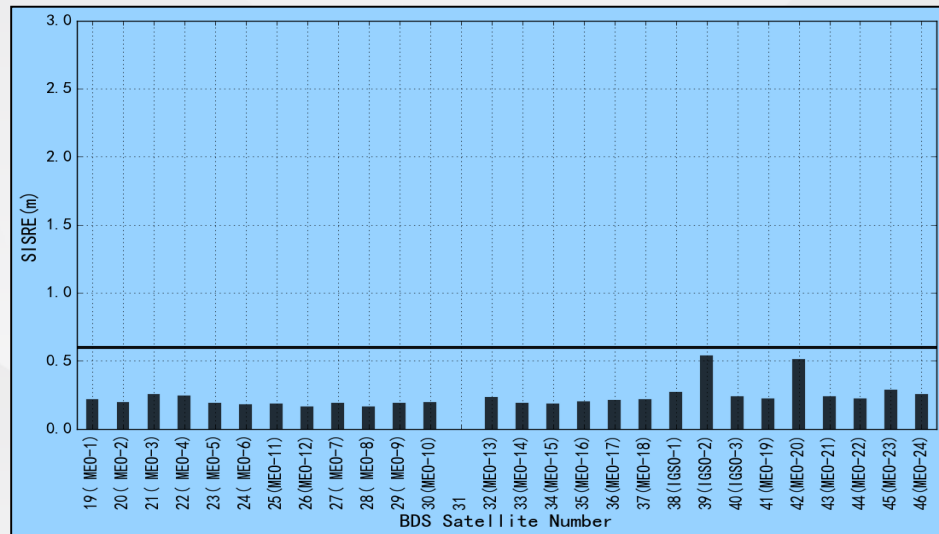


# System Status

## The BDS SISRE in August 2020



B1I/B3I



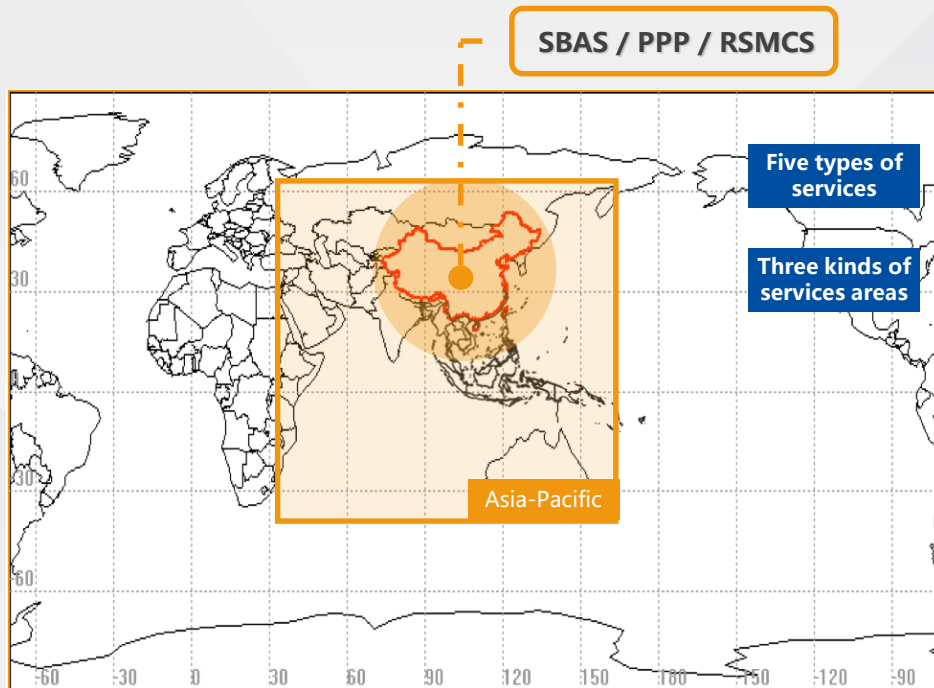
B1C/B2a



# System Status

## The BDS-3 Featured Services

Type of service		Signal frequency	Satellite
Basic navigation services		B1I, B3I, B1C, B2a	3IGSO+24MEO
		B1I, B3I	3GEO
BDSBAS		BDSBAS-B1C, BDSBAS-B2a	3GEO
Short-message communication services	Regional	L (uplink) S (downlink)	3GEO
	Global	L (uplink)	14MEO
		B2b (downlink)	3IGSO+24MEO
International search and rescue service		UHF (uplink)	6MEO
		B2b (downlink)	3IGSO+24MEO
Precise Point Positioning service		B2b	3GEO



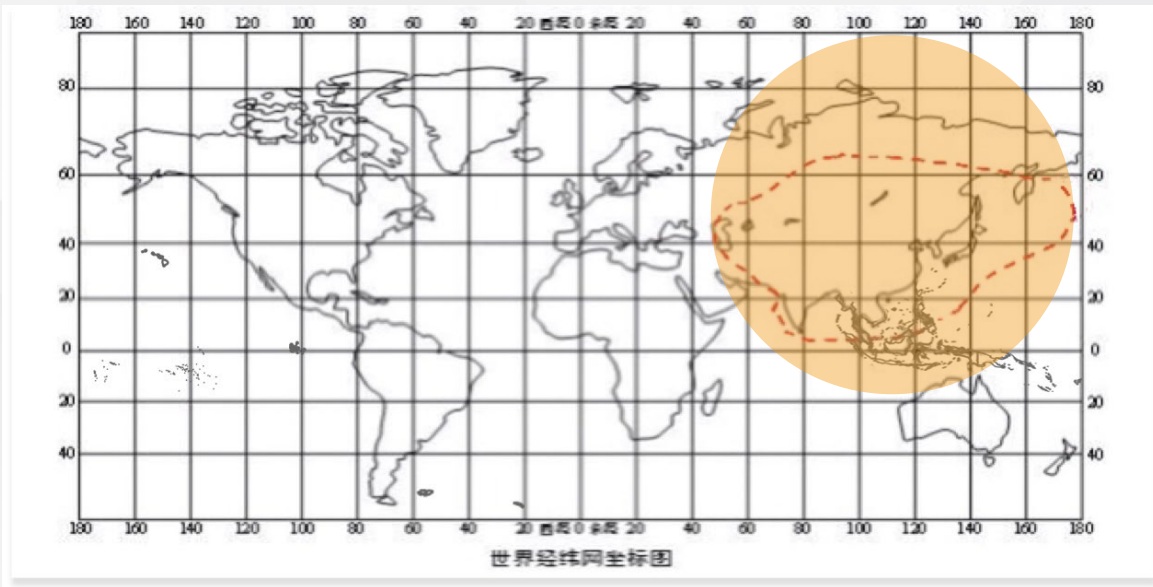
Navigation, Positioning and Timing / GSMCS / SAR



# System Status

## Short-message Communication Services (Regional)

- Offered by 3 GEO satellites
- Serve China and the surrounding regions
- System capacity is increased by 10 times:
  - System processing capacity of more than 12M/hour concurrent service requests.
  - 1,000 Chinese characters per message..
  - The user uplink transmission power is reduced by 90%.

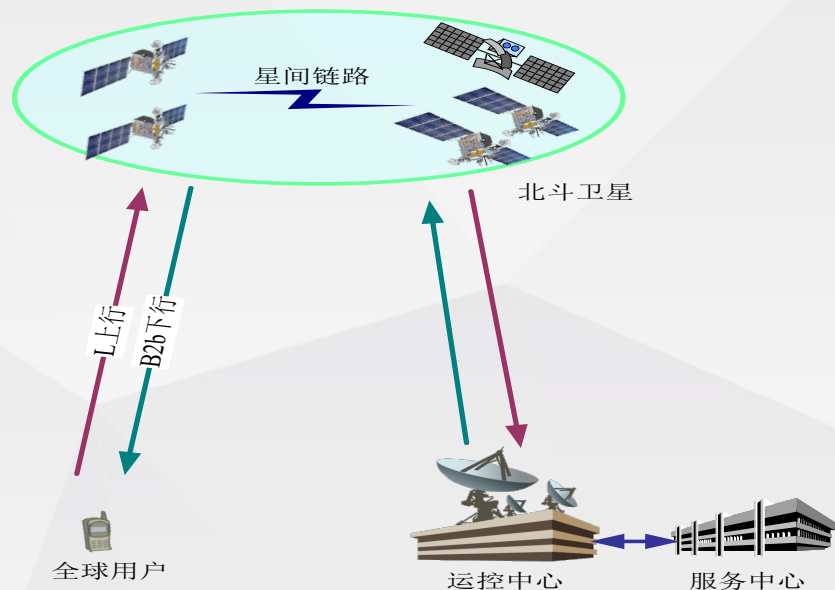




# System Status

## Short-message Communication Services (Global)

- 14 MEO satellites
- Global coverage
- 40 Chinese characters per message
- Service capacity of more than 300,000/hour concurrent service requests..



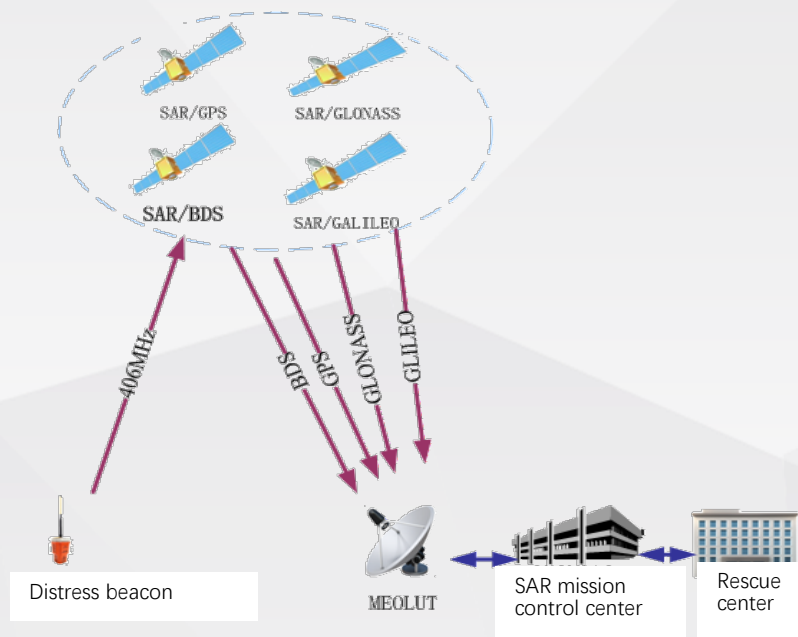




# System Status

## International Search and Rescue Services

- Follow international standards
- 6 MEO satellites with the SAR payload
- Return-link capacity is proposed to COSPAS-MEOSAR.
- In July 2020, tests were conducted with the COSPAS-SARSAT ground station in Maryland and achieved satisfactory results.

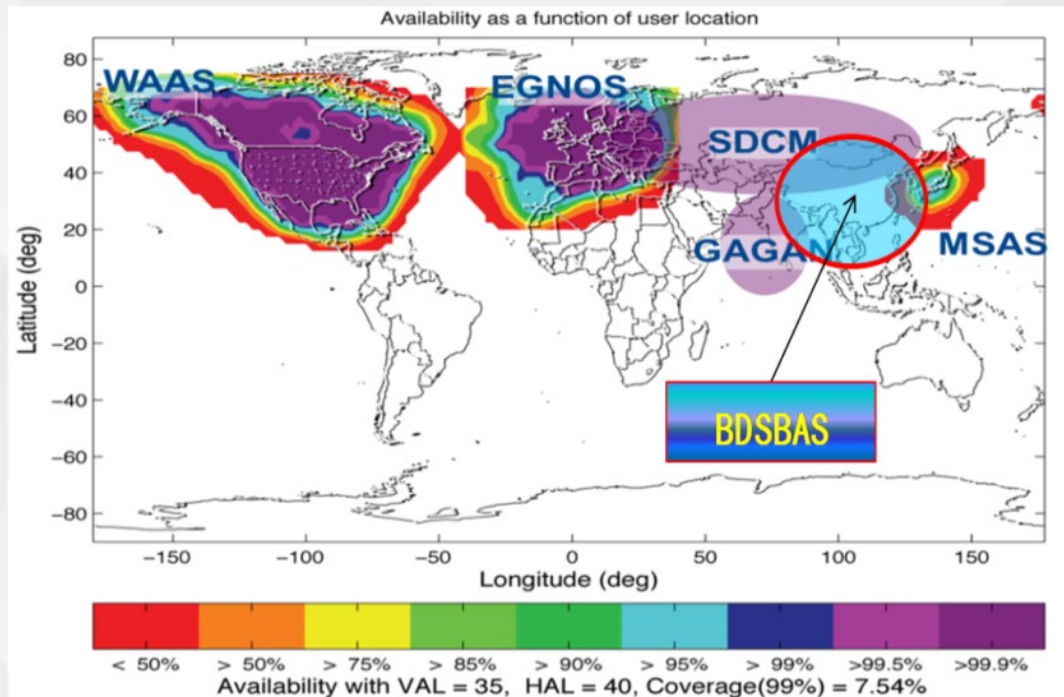




# System Status

## Satellite-based Augmentation Services


- 3 GEO satellites
- Follow ICAO standards
- Serve China and the surrounding regions






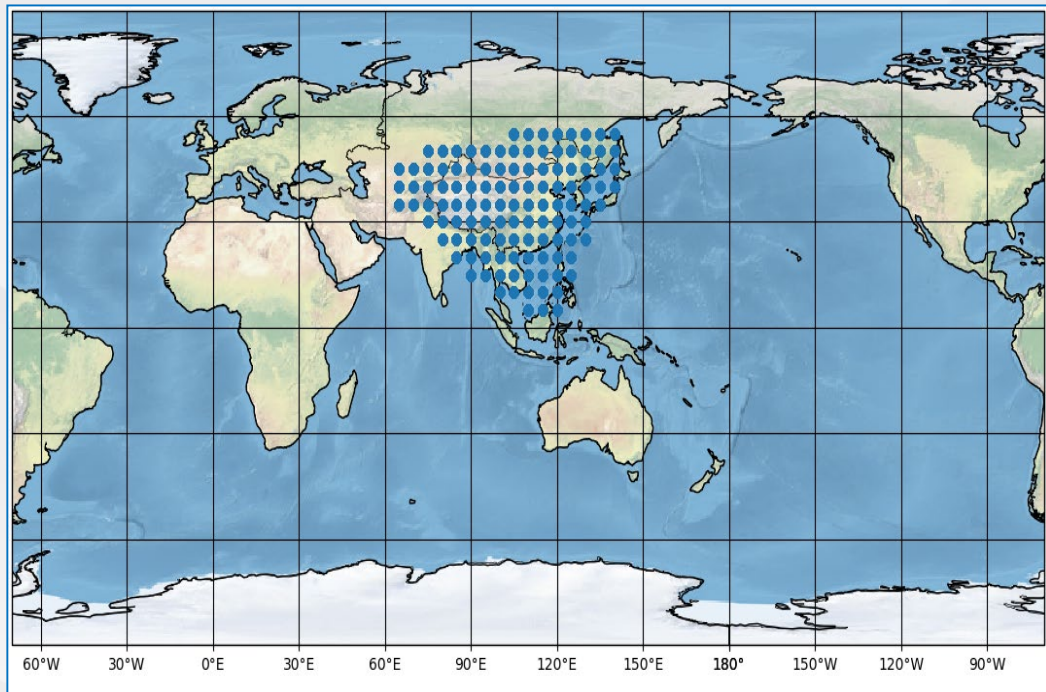
# System Status

## Satellite-based Augmentation Services

 BDSBAS-B1C(1574.42MHZ)  
signal for the single frequency  
SBAS service.

 BDSBAS B2a(1176.45MHZ)  
signal for the DFMC SBAS  
service.

Both signals are being  
broadcast to support non-  
safety applications (with  
Message Type 0 being  
broadcast in every 6s or less).



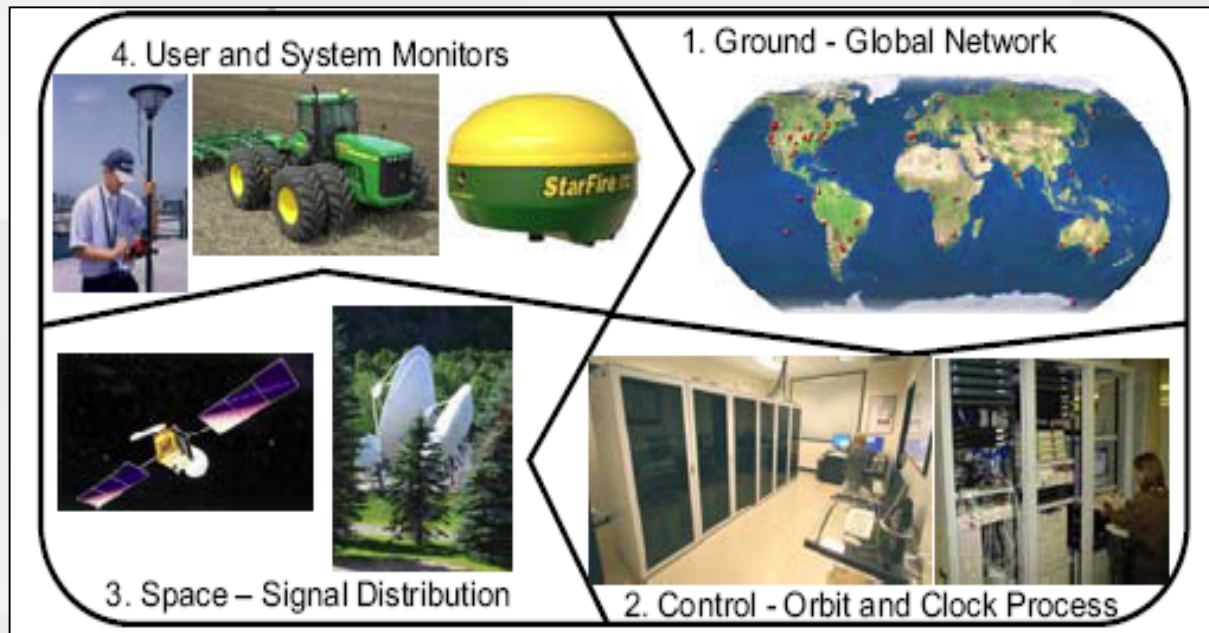
**Ionosphere grids of BDSBAS-B1C**



# System Status

## Precise Point Positioning Services

- 3 GEO satellites
- Serve China and the surrounding regions
- PPP-RTK in China and surrounding regions in the future
- Global PPP broadcast by MEO satellite in the future



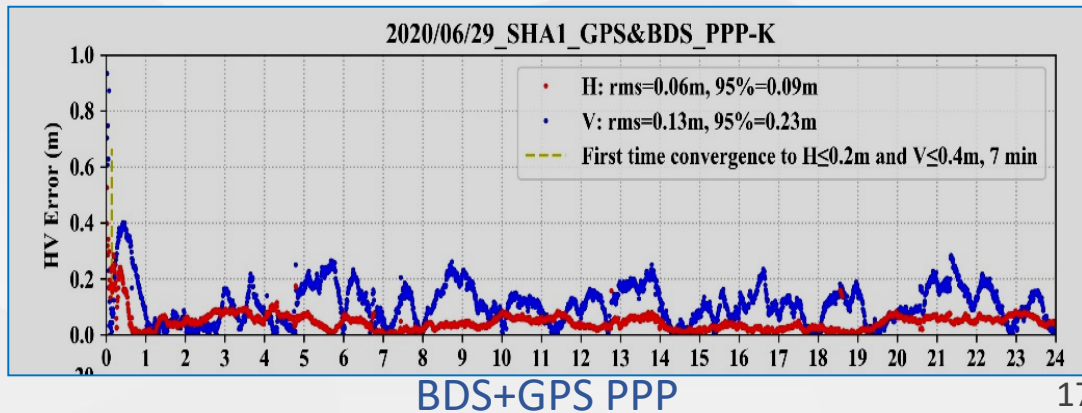
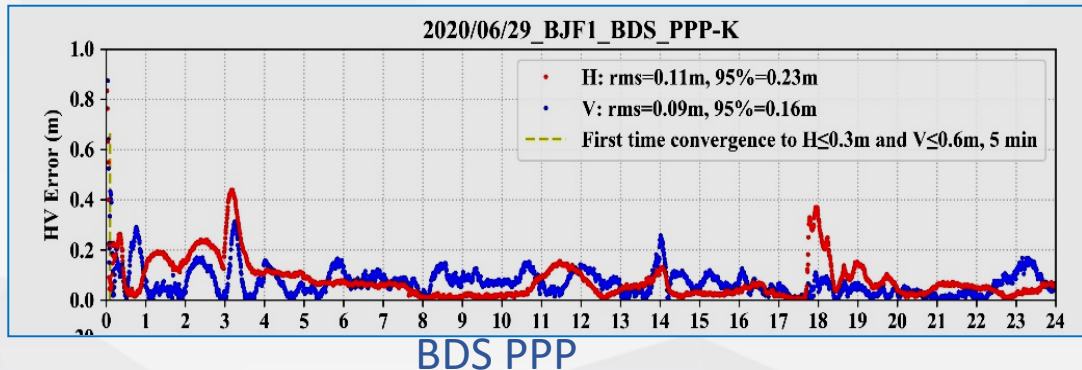




# System Status

## Precise Point Positioning Services

- Use BDS-3 B2b signal to broadcasting orbit, clock, and DCB corrections;
- Support both BDS and GPS PPP capability;
- With accuracy of better than 0.3m(95%) in dynamic testing.
- Time to convergence for PPP is less than 30min.



The image features a large, stylized blue logo consisting of the numbers '0' and '2' positioned behind the main text. The background is a light gray geometric pattern of overlapping polygons, with a curved orange and gray gradient at the bottom.

# Application Development



# Application Development

## The BDS Industries



The BDS contribution to core industrial output value



2019  
RMB

**345 billion**

2020  
RMB

**400+ billion**



# Applications Development

## Fundamental products

The sales of domestically made BDS-enabled chips reached over 80 million, with the domestic high-precision board chips and antennas being sold to over 100 countries and regions, and accounting for 30% and 90% of the domestic market respectively.







# Applications Development

## Industrial and Regional Applications

- The BDS-enabled products have been widely used in traffic & transportation, public security, agriculture, forestry and fishing, hydrologic monitoring, weather forecast, communications system, generation dispatch and disaster response & relief, as well as national





# Applications Development

## Applications in traffic and transportation


- The world' s largest dynamic monitoring system for operational vehicles has been built
- Nearly 7 million registered operational vehicles
- **30,000** postal and delivery vehicles
- **80,000** buses
- **Over 3,200** inland waterway navigation facilities
- **Over 2,900** marine navigation facilities

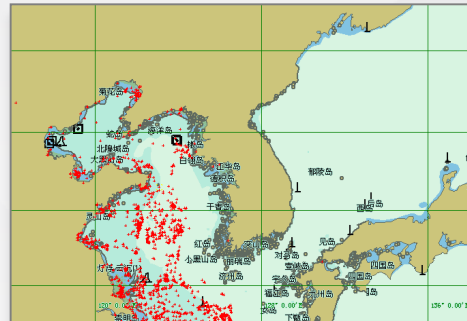




# Applications Development

## Applications in agriculture, forestry and fishing

-  The BDS-based equipment have been installed on over 70,000 sets of agricultural machinery.
-  Precision farming output has increased by 5%.
-  Income growth of RMB 60-90 per Mu. Positioning & short-message communication function helps to prevent forest fires.
-  Over 70,000 boats have been equipped with BDS terminals and over 10,000 people have been rescued.



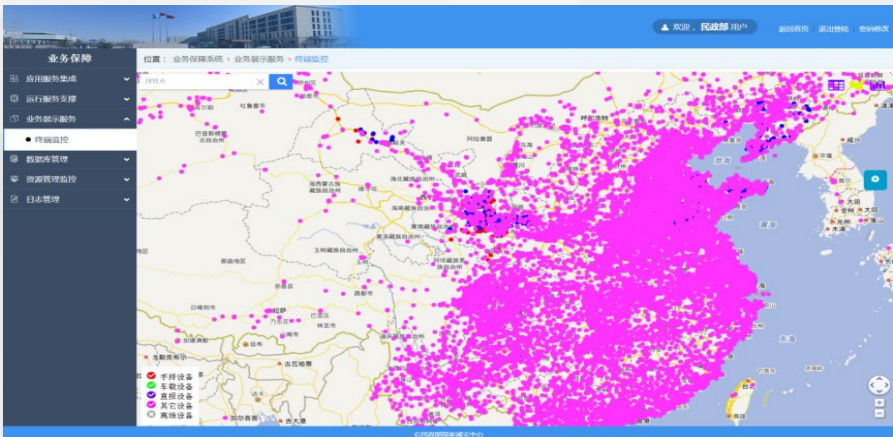




# Applications Development

## Applications in Disaster Response and Relief

- Six levels of business applications have been implemented
- Over 45,000 BDS terminals have been deployed
- Relevant disaster response information has been reported
- The resource management and logistic control capabilities for disaster relief have been improved
- The BDS-based technologies have played important roles in fighting against COVID-19.





# Applications Development

## Mass Market Applications







# Applications Development

## Mass Market Applications





# Application and Development

## The International BDS Applications



Land rights confirmation in Indonesia



Building construction deformation monitoring in Kuwait



Homeland surveying and mapping in Uganda



Agriculture in Myanmar



Marine piling in Maldives



Construction of piling in Singapore



Land rights confirmation in Laos



UAVs in Cambodia

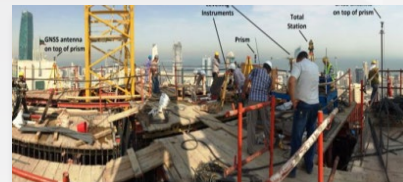


Postal services and ecommerce in Uganda



Timing service in Pakistan airports

Electricity patrolling and checking in Russia



The background features a complex geometric pattern of overlapping, semi-transparent polygons in various shades of light gray and white. A large, bold, blue '03' is centered on the page. A horizontal white bar with a thin gray border is positioned behind the text 'International Cooperation'.

# 03

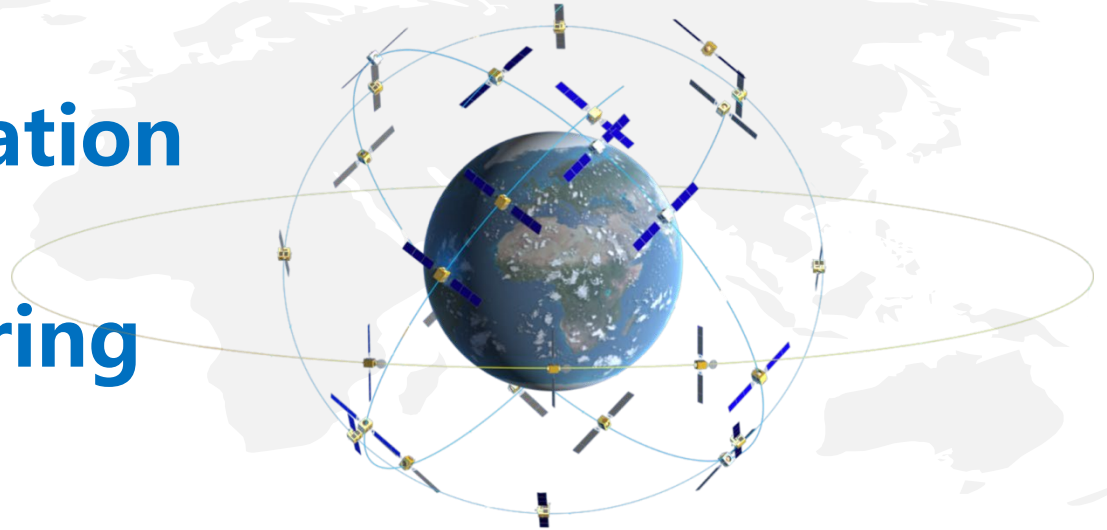
**International Cooperation**



# International Cooperation

**Open Cooperation**

**Resource Sharing**





# International Cooperation

The UN International Committee on Global Navigation Satellite Systems (ICG)

## 13<sup>th</sup> Meeting of the International Committee on Global Navigation Satellite Systems



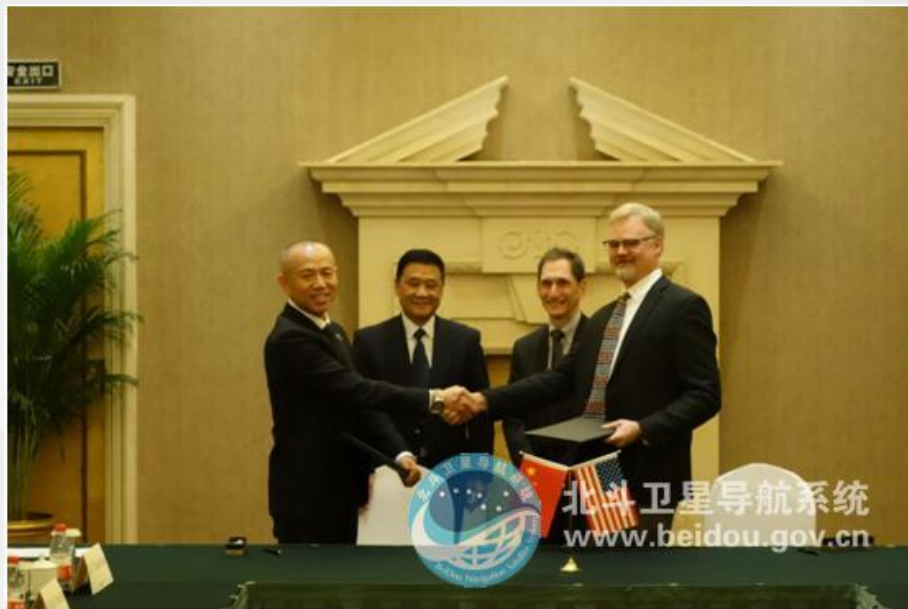




# International Cooperation

## The China-US Cooperation

- Three plenary meetings of the China-US Cooperation have been held. Working groups have been set up to discuss related topics.
- “The Joint Statement on Civil Signal Compatibility and Interoperability between GPS and BDS” was signed in November 2017





# International Cooperation

## The China-Russia Cooperation







# International Cooperation

## The China-Arab States BDS Cooperation





# International Cooperation

## International standards



A GLOBAL INITIATIVE



国际民航组织

COSPAS-SARSAT.INT  
INTERNATIONAL SATELLITE SYSTEM FOR SEARCH AND RESCUE  
406<sup>TM</sup> DISTRESS ALERTING SERVICE



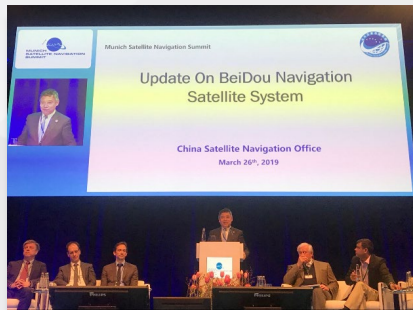
International  
Electrotechnical  
Commission





# International Cooperation

## International Conferences







China Satellite Navigation Office

# International Cooperation

The China Satellite Navigation Conference (CSNC) – CSNC2020 ( "GNSS, New Global Era" ) : November 23-25, 2020, Chengdu, China





# Conclusion

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## Looking back on the past decade and looking into the new journey,

- During the past decade, BDS has gone global successfully, being developed from struggling to keep up with its peers, to matching its peers.
- The BDS/GNSS based technologies have played important roles in fighting against COVID-19.
- In the next decade, BDS will play a more active role in serving mankind and the world and keep contributing wisdom and strength to the world with its stronger abilities and better-quality services.



# Thank you.

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