

Update on BeiDou Navigation Satellite System

13th Meeting of the International Committee on
Global Navigation Satellite Systems

Jiaqing MA
China Satellite Navigation Office

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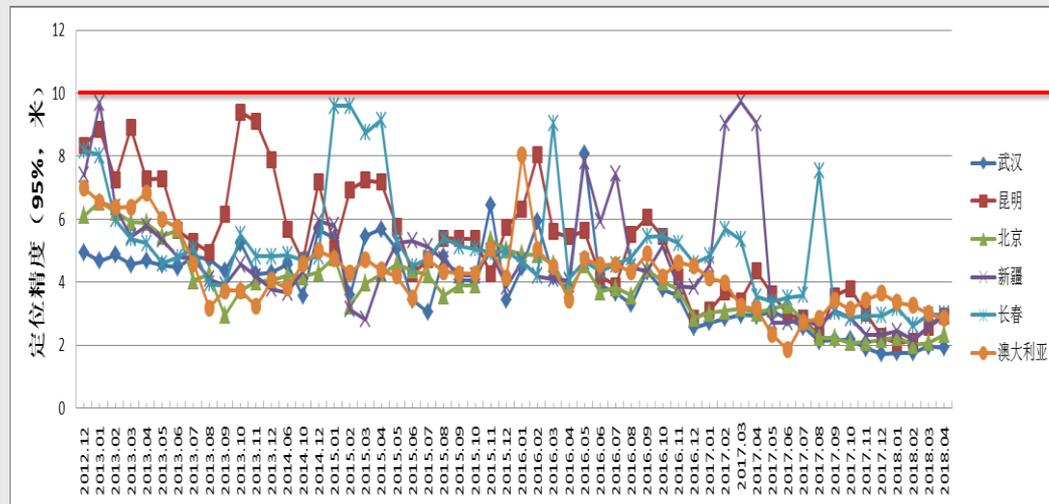


01

System Construction

I. Performance of BDS-2

- **BDS-2 has been providing normal services with 14 satellites since December, 2012**
- **Positioning accuracy is better than 5m**
- **One BDS-2 backup satellites will be launched in 2019 to ensure stable service performance**

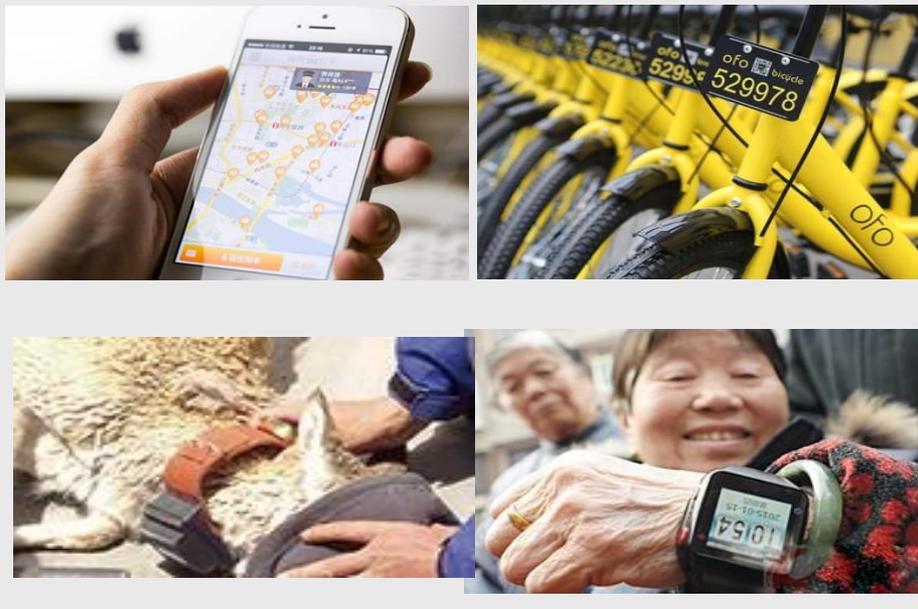


I. BDS-2 applications

- By September, 2018, the sales volume of the BDS navigation chips and modules exceeded 70 million pieces
- High-precision surveying boards and navigation antennas sales account for 30% and 90% of the domestic market
- More than 500 million user equipment including smartphones use the BDS compatible chips

I. BDS-2 applications

- BDS has been applied in new areas such as railway subgrade settlement monitoring, vehicle automated driving and pet monitoring
- Wearable BDS devices are developing rapidly

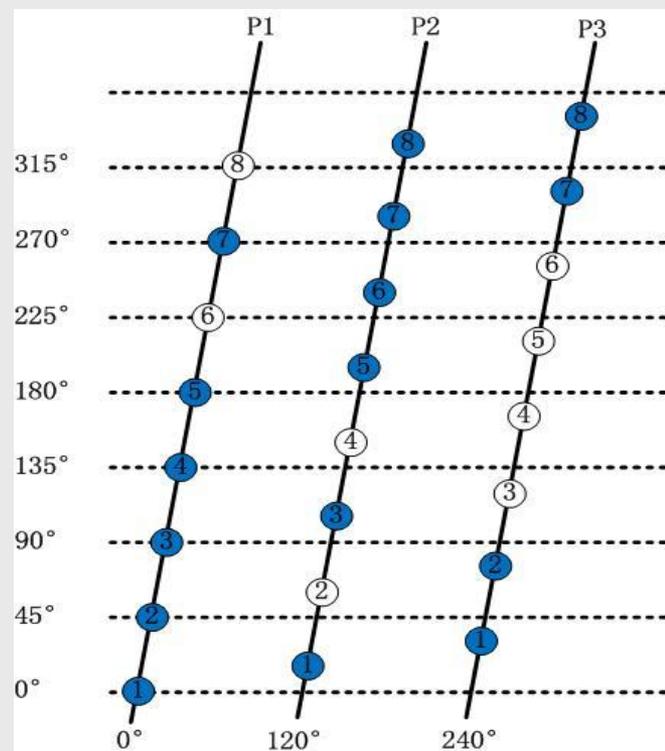


01 System Construction

II. BDS-3 Constellation

Since November 5, 2017, 8 pairs of BDS-3 MEO satellites and 1 BDS-3 GEO satellite have been successfully launched

Satellite	Launch Time
First pair	2017.11.05
Second pair	2018.01.12
Third pair	2018.02.11
Fourth pair	2018.03.30
Fifth pair	2018.07.29
Sixth pair	2018.08.25
Seventh pair	2018.09.19
Eighth pair	2018.10.15
First GEO	2018.11.01



CCTV 13
新闻

北斗三号卫星发射画面
CCTV.com

2017年11月5日



“一箭双星”发射成功
中国北斗开启全球组网新时代

II. BDS-3 services

Service type	Satellite
RNSS	3GEO+3IGSO +24MEO
SBAS	3GEO
Regional short message communication service	3GEO
Global short message communication service	14MEO
International SAR service	6MEO
Precise point positioning	3GEO

II. BDS-3 RNSS Service

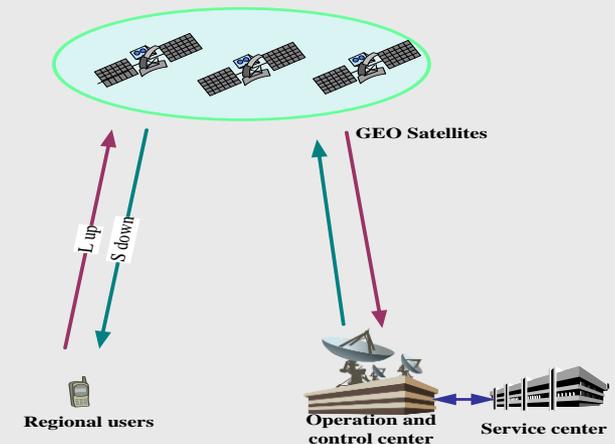
- **3 signals inherited from BDS-2: B1I, B3I, B3Q**
- **5 new signals: B1C, B1A, B2a, B2b and B3A**
- **Performance improvement**
 - Add new open, authorized navigation signals
 - Advanced modulation method
 - Advanced channel coding and multiplexing
 - Reduce the message rate
 - Optimize navigation message structure
 - Accuracy and anti-interference ability are greatly improved

II. BDS-3 RNSS Services

3GEO + 3IGSO + 24MEO		Asia Pacific		Global	
		SF	DF	SF	DF
Position accuracy	H	6m	2.5m	7m	3m
	V	8m	4m	9m	5m
Velocity measurement accuracy		0.1m/s		0.2m/s	
Timing accuracy		10ns		20ns	
Integrity	Alert time	300 s		300 s	
	threshold	H:556m		H:556m	
	probability	$1 \times 10^{-7}/h$		$1 \times 10^{-7}/h$	
continuity		$10^{-4}-10^{-8}/h$		$10^{-4}-10^{-8}/h$	
Availability		99%		99%	

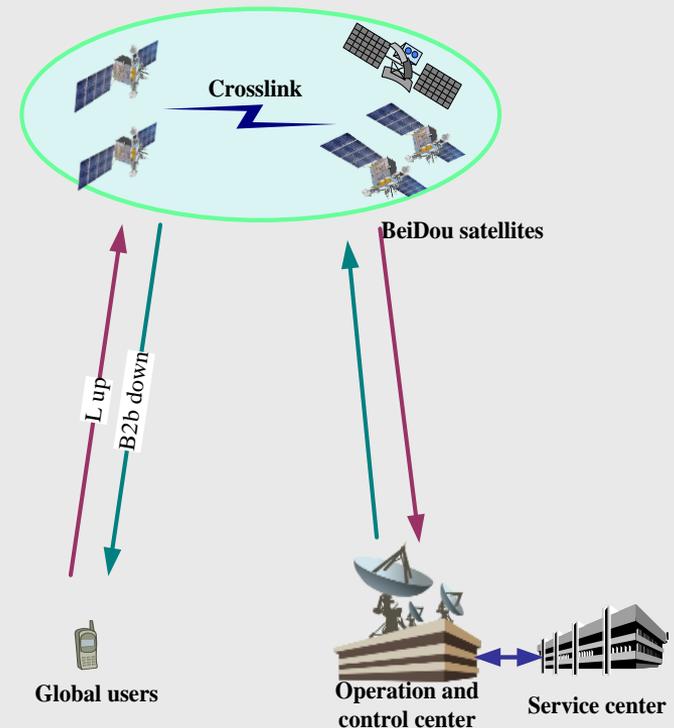
II. BDS-3 Short message communication service— Regional

- Characteristics: use two-way links to solve the problem of position and status
- Satellite : 3 GEO
- Service region : China and the surrounding areas
- System capacity : more than 10 million times/hour



II. BDS-3 Short message communication service—Global

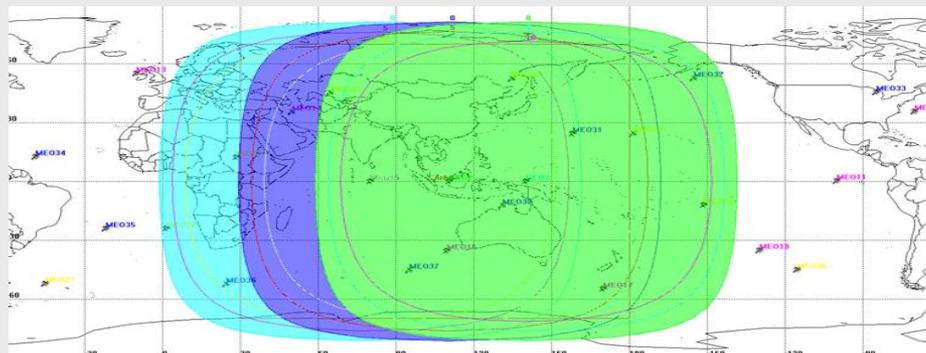
- Characteristics: Through innovation design, promote short message communication service to the global users
- Satellite : 14 MEO
- Service area : Global
- System capacity : 200,000 times/hour



01 System Construction

II. BDSBAS

- Follow the ICAO standards
- 3 GEO (80°E , 110.5°E , 140°E)
- Provide CAT-I service



Service accuracy(95%)	Positioning accuracy	Single frequency H < 2.5m, V < 4.0m	Double frequency H < 1.5m, V < 2.0m
	Timing accuracy	10ns	
	Velocity accuracy	0.1m/s	
Service reliability	Availability	>99%	
	Integrity	Alarm time: 6s Risk probability: 10^{-7} /approach (threshold: H 40m, V 10-15m)	
	Continuity	Risk probability: 10^{-6} /15s	

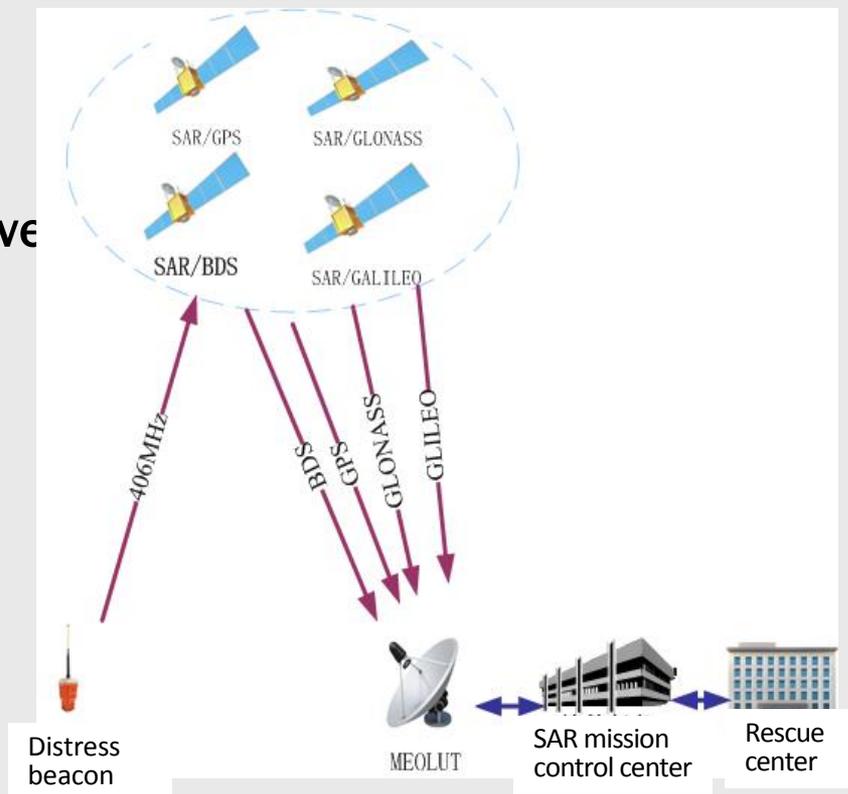
II. BDS-3 International SAR service

➤ Characteristics

- Meet international SAR standards
- Return link so that user do not have to make repeat call

➤ International standard SAR payload

- Satellite : 6 MEO
- Service area : Global



II. BDS-3 PPP service

➤ Characteristics

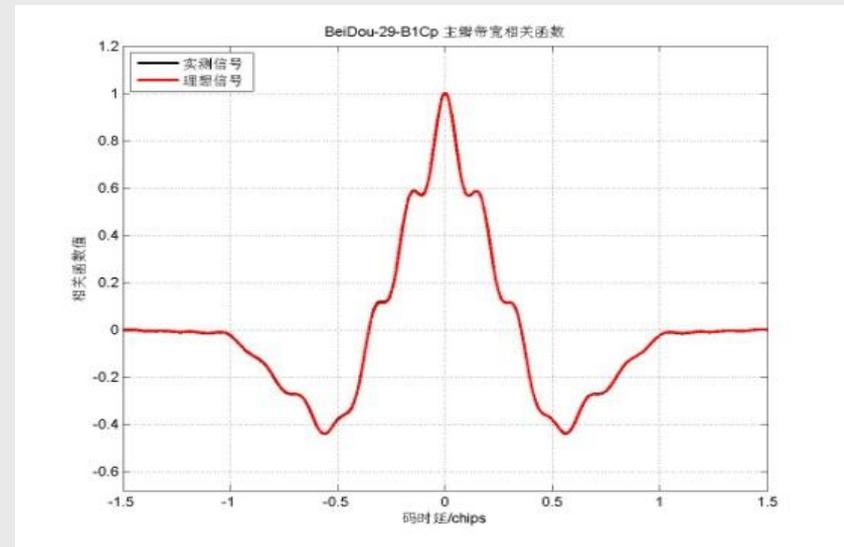
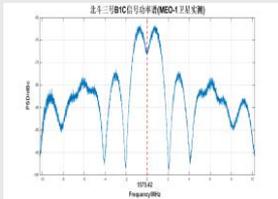
- Broadcast the precise positioning information of multi-GNSS systems
- Accuracy: low dynamic decimeter level, static centimeter level

➤ Satellite : 3 GEO

➤ Service area : China and surrounding areas

II. BDS-3 in-orbit test

1. SIS quality



Test results show that satellites are in good condition and service performance meets the requirements

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II. BDS-3 in-orbit test

2. SIS Accuracy

The average user range error(URE) of BDS-3 satellite is better than 0.5m

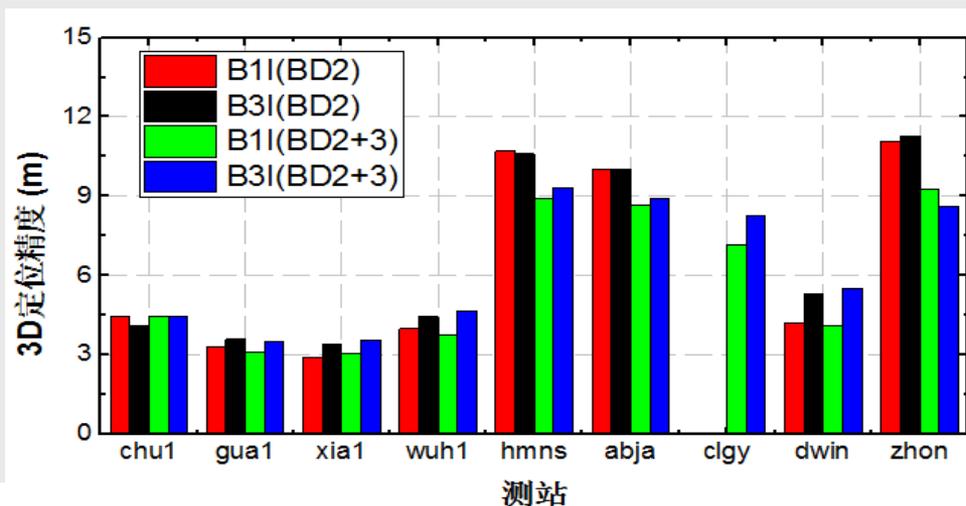
		Radial(m)	Tangential(m)	Normal(m)	Three-dimensional(m)	Clock difference(ns)	URE(orb)
BDS-3 satellite	C19	0.10	0.56	0.58	0.82	1.95	0.65
	C20	0.10	0.53	0.43	0.69	0.99	0.34
	C21	0.16	0.71	0.67	0.98	0.81	0.30
	C22	0.18	0.65	0.73	1.00	1.12	0.42
	C27	0.20	0.58	0.68	0.91	1.08	0.37
	C28	0.22	0.59	0.57	0.84	0.86	0.38
	C29	0.25	0.91	1.50	1.77	0.84	0.37
	C30	0.31	0.97	1.20	1.57	1.32	0.65
Ave		0.19	0.69	0.79	1.07	1.12	0.44

01 System Construction

II. BDS-3 in-orbit test

3. Positioning Accuracy

- The joint positioning accuracy of BDS-2 and BDS-3 is improved
- After adding 8 satellites, the PDOP value is improved, the joint positioning accuracy improved about 20%



02

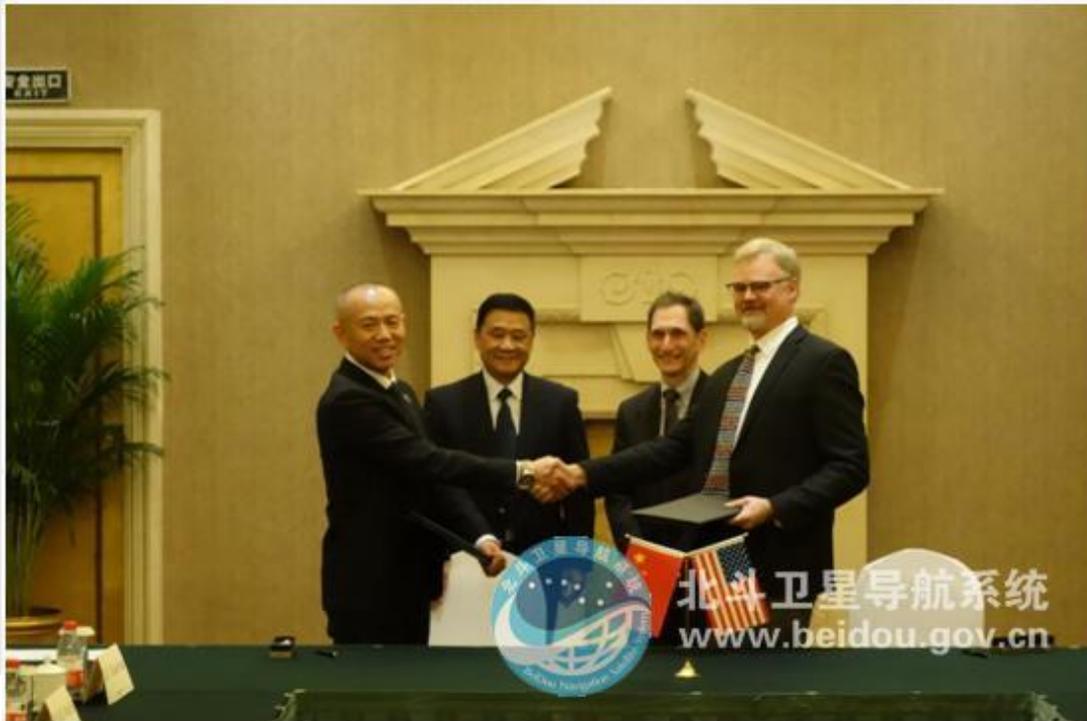
International Cooperation

We will continue to conduct compatibility and interoperability coordination with other satellite navigation system providers, achieve win-win results for multiple systems, and provide global users with more efficient and reliable services .



I. Bilateral Cooperation

- A bilateral cooperation mechanism between China and the United States has been established and three plenary meetings has been held.
- China and the United States signed a joint statement on the compatibility and interoperability of the BDS and GPS signals in November, 2017



I. Bilateral Cooperation

- The Fifth Meeting of the China-Russia Commission on Important Strategic Cooperation in the Field of Satellite Navigation Convened in September, 2018
- China and Russia will hold satellite navigation collaboration forum together in 2019



II. Multilateral Cooperation

- Presented a BDS-3 model to UNOOSA, which will be permanently displayed in the exhibition district in UN Office Building
- Participate ION, Moscow International Navigation Forum, Munich Navigation Summit, European Navigation Conference and related activities
- Hold CSNC as an international satellite navigation academic exchange and coordination platform



IV. Other activities

- Built the cooperative mechanism with the ASEAN , Arab States , and other countries and organization
- The first overseas BDS/GNSS center is officially opened to promote China-Arab satellite navigation cooperation
- The second China-Arab States BDS Cooperation Forum will be held in Tunis in 2019

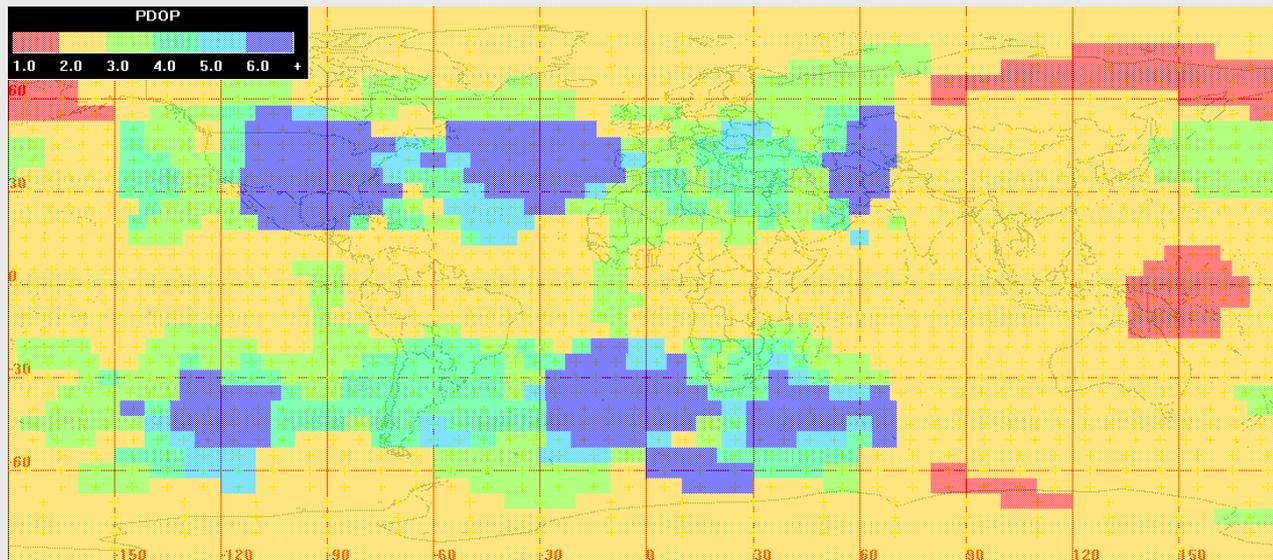


03

Near-term Plans

Deployment of BDS-3

In 2018, another two MEO satellites will be launched. By the end of 2018, BDS-3 will provide initial operational services



Deployment of BDS-3

2018

- 18 MEO satellites
- 1 GEO satellite

2019- 2020

- 6 MEO satellites
- 3 IGSO satellites
- 2 GEO satellites

→ **Dec. 2018**

Initial operational services for Belt and Road alongside countries

→ **Dec. 2020**

Global services

- **Make plans to build a BDS-based PNT system**
- **Continue to promote integrated applications and development of related industries**
- **Keep enhancing cooperation and communication with other navigation satellite systems, and provide better services for users all over the world**

BDS Global User Experience Evaluation Program

- To let users experience BDS-3 service better and earlier
- Global users and equipment providers are welcome to actively participate in the program



Conclusion

- **With the acceleration of the BDS-3 development, China will provide more high-quality services to global users.**
- **BDS, together with other providers, will further promote interoperability and technological innovations in satellite navigation, make full use of satellite navigation, continue cooperation in satellite navigation systems, as well as actively promote the satellite navigation applications.**