



16th Meeting of the International Committee on Global Navigation Satellite Systems



BDS Precise Point Positioning Service Status

Xin Nie, China Academy of Space Technology

2022-10-11



01

Overview

02

Design of BDS PPP Service

03

Test Result

04

Summary

01

Overview



01 Overview

The PPP service is provided through the PPP-B2b signal broadcasted by GEO satellites in the BDS-3 nominal constellation. According to “The Application Service Architecture of BeiDou Navigation Satellite System(V1.0) ” , the construction includes two phases:

- First phase (until 2020): use the PPP-B2b I-components of the first three GEOs to provide a free and high-precision service for users in China and surrounding areas.
- Second phase (after 2020): with the launch of subsequent satellites, expand the coverage, further improve the accuracy, reduce the convergence time, and better serve high-precision application fields.

Performance Characteristics	Performance Indicators	
	Phase I (Year 2020)	Phase II (After 2020)
Broadcast Data Rate	500bps	It will be extended to enhance multiple global navigation systems, to improve broadcast data rate, to expand satellite service area according to the situation, and to improve positioning accuracy and shorten convergence time.
Positioning Accuracy (95%)	Horizontal $\leq 0.3\text{m}$ Vertical $\leq 0.6\text{m}$	
Convergency Time	$\leq 30\text{min}$	

02

Design of BDS PPP Service

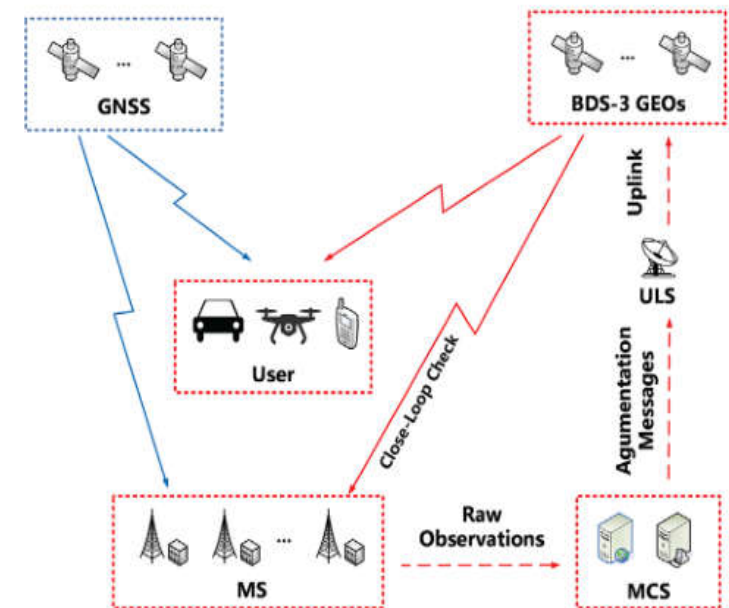


02 Design of BDS PPP Service

1. System Architecture

As part of BDS-3, the BDS PPP service works by using the space and ground segment facilities of BDS-3.

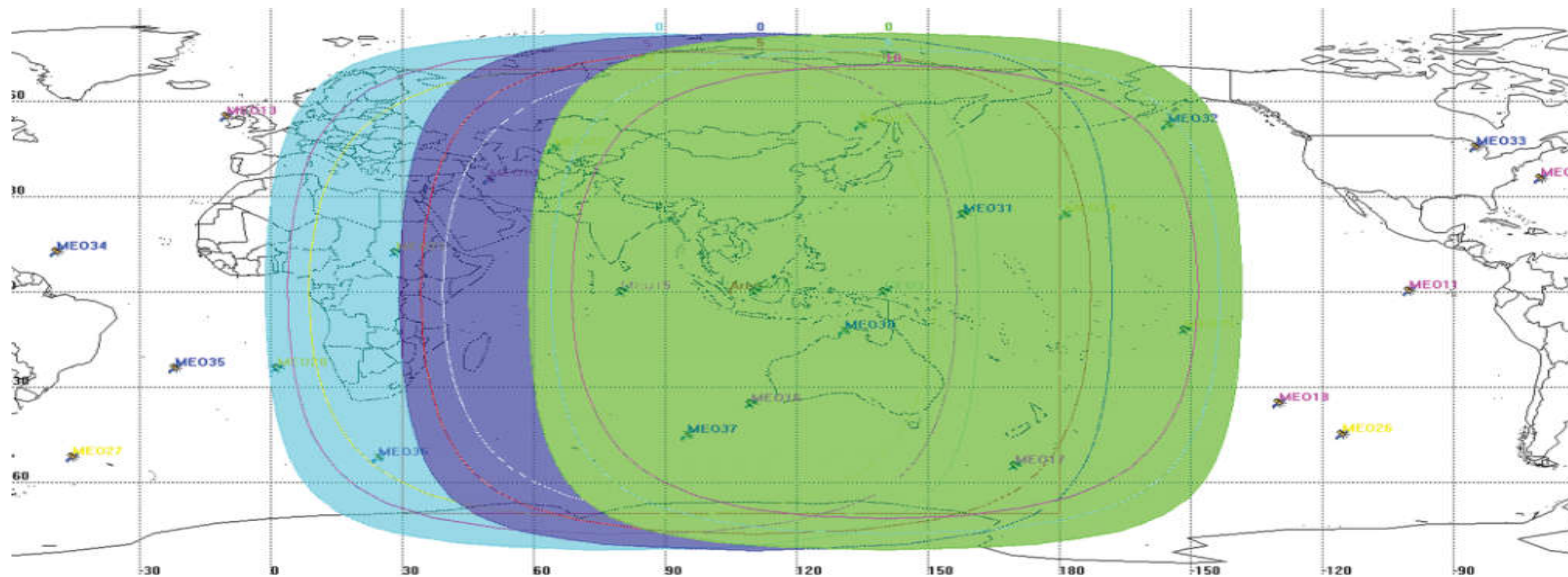
- Space segment: three BDS-3 GEO satellites located at 80°E , 110.5°E , and 140°E .
- Ground segment: consists of the master control station (MCS), uplink stations (ULS), and monitoring stations (MS), which are well distributed in China.
- User segment: includes various receivers with PPP-B2b signal reception, augmentation navigation message demodulation, and PPP solution functions.



02 Design of BDS PPP Service

2. Service Volume

BDS can provide the PPP service to users in China and its surrounding areas in the scope of $10^{\circ}\text{N}\sim 55^{\circ}\text{N}$, $75^{\circ}\text{E}\sim 135^{\circ}\text{E}$, on the surface of the Earth and its near-earth areas extending within 1,000 kilometers above the Earth surface.



02 Design of BDS PPP Service

3. SIS Characteristics

➤ SIS RF Characteristics

The PPP-B2b signal broadcasts the I-component and the Q-component, and the first three BDS-3 GEO satellites only broadcast the I-component.

Signal	Component	Carrier frequency (MHz)	Modulation	Symbol rate (sps)	The first three GEOs	Subsequent GEOs
PPP-B2b	I	1207.14	BPSK(10)	1000	available	available
	Q	1207.14	TBD	TBD	N/A	available

Refer to the "BeiDou Navigation Satellite System Signal-in-Space Interface Control Document: Precise Point Positioning Service Signal PPP-B2b (Version 1.0)" (BDS-SIS-ICD-PPP-B2b-1.0). 2020.7

02 Design of BDS PPP Service

3. SIS Characteristics

BDS PPP service has the same or similar center frequency as other PPP services.

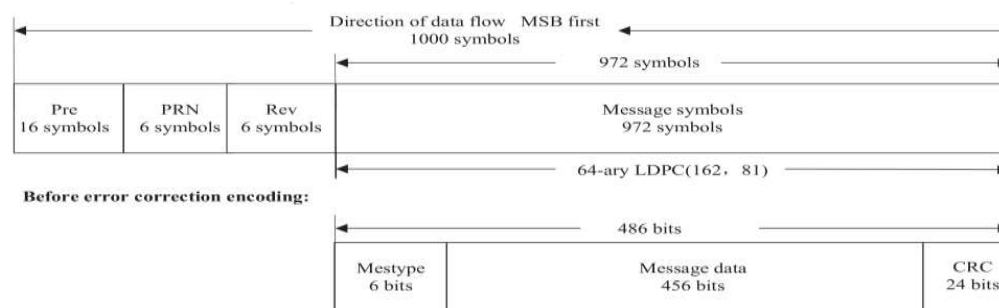
	Parameters	Japan		EU	Australia/ New Zealand	China	Russia
	Satellite Grouping	No	No	Yes	No	No	Yes (Satellite grouping for retranslation to be added in a later phase)
Transport	Framing Design	Preamble+payload+error correction	Preamble+payload+error correction	Preamble+payload+error correction	Preamble+payload+error correction	Preamble+payload+error correction	Preamble+payload+error correction
	Checksum and Error Correction	Reed-Solomon (255,223)	Reed-Solomon (255,223)	CRC and FEC ($r=1/2$) at 1 sec page level. HPVRS at message level.	TBD (16bits per word available)	Each message 486 bits, wherein the lowest 24 bits are CRC. After 64-ary LDPC(162, 81) encoding, the frame length shall be 972 symbols.	CRC-24Q Reed-Solomon (250,218)
	System Alert	Yes	Yes	-	No	TBD	No
	Generator ID ⁵	Yes	Yes	No TBC	No	No	No
Network	Signal	L6D	L6E	E6-B	TBD	B2b	L3SVI
Data-link	Carrier Frequency	1278.75MHz	1278.75MHz	1278.75MHz	1207.14MHz	1207.14MHz	1202.025MHz
	Signal Polarization	RHCP	RHCP	RHCP	RHCP TBC	RHCP	RHCP TBC

02 Design of BDS PPP Service

3. SIS Characteristics

➤ Navigation Message Characteristics

Considering the downlink bandwidth and the performance requirement, the BDS PPP Service carried out a compression design based on the standard SSR and developed its customized message format.



Message type (in decimal)	Information content	Nominal validity time (s)
1	Satellite mask	-
2	Satellite orbit correction and URA	96
3	DCB	86400
4	Satellite clock correction	12
5	URA	96
6	Clock correction and orbit correction - combination 1	96
7	Clock correction and orbit correction - combination 2	96
8-61	Reserved	-
62	Reserved	-
63	Null message	-

Refer to : "BeiDou Navigation Satellite System Signal-in-Space Interface Control Document: Precise Point Positioning Service Signal PPP-B2b (Version 1.0)" (BDS-SIS-ICD-PPP-B2b-1.0). 2020.7

02 Design of BDS PPP Service

3. SIS Characteristics

The navigation contains information such as satellite mask of other systems, ID of signal and tracking modes, which provides the possibility to support compatible and interoperability at the message level.

Definitions of signal and tracking modes

ID of signal and tracking mode	BDS	GPS	GLONASS	Galileo
0	B1I	L1 C/A	G1 C/A	Reserved
1	B1C(D)	L1 P	G1 P	E1 B
2	B1C(P)	Reserved	G2 C/A	E1 C
3	Reserved	Reserved	Reserved	Reserved
4	B2a(D)	L1C(P)	Reserved	E5a Q
5	B2a(P)	L1C(D+P)	Reserved	E5a I
6	Reserved	Reserved	Reserved	Reserved
7	B2b-I	L2C(L)	Reserved	E5b I
8	B2b-Q	L2C(M+L)	Reserved	E5b Q
9	Reserved	Reserved	Reserved	Reserved
10	Reserved	Reserved	Reserved	Reserved
11	Reserved	L5 I	Reserved	E6 C
12	B3 I	L5 Q	Reserved	Reserved
13	Reserved	L5 I+Q	Reserved	Reserved
14	Reserved	Reserved	Reserved	Reserved
15	Reserved	Reserved	Reserved	Reserved

Parameters of message type 1

Field	Name	Length (bit)	Scale factor	Range	Unit	Basic description
MesTypeID	Message type	6	1	0~63	--	See Table 6-1
Epoch	Epoch	17	1	0~86399	s	BDT seconds within a day
Reserved	Reserved	4	1	0~15	--	--
IOD SSR	IOD of SSR	2	1	0~3	--	Change as the system configuration changes.
IODP	IOD of PRN mask	4	1	0~15	--	Issue Of Data of PRN mask
BDS mask	Satellite slot 1	1	1	0~1	--	Broadcasting ID of the first satellite of BDS
	to slot 63	1	1	0~1	--	Broadcasting ID of the 63 rd satellite of BDS
GPS mask	Satellite slot 64	1	1	0~1	--	Broadcasting ID of the first satellite of GPS
	to slot 100	1	1	0~1	--	Broadcasting ID of the 37 th satellite of GPS
Galileo mask	Satellite slot 101	1	1	0~1	--	Broadcasting ID of the first satellite of Galileo
	to slot 137	1	1	0~1	--	Broadcasting ID of the 37 th satellite of Galileo
GLONASS mask	Satellite slot 138	1	1	0~1	--	Broadcasting ID of the first satellite of GLONASS
	to slot 174	1	1	0~1	--	Broadcasting ID of the 37 th satellite of GLONASS
Reserved mask	Satellite slot 175	1	1	0~1	--	Reserved
	to slot 255	1	1	0~1	--	Reserved
Reserved bits	Reserved bits	174	1	--	--	--
CRC	CRC bits	24	--	--	--	--

02 Design of BDS PPP Service

4. Service Performance Characteristics

Characteristics		Performance Standard
	Time System	BDT
	Coordinate System	BDCS
BDS	Horizontal Positioning Accuracy(95%)	$\leq 0.3\text{m}$
	Vertical Positioning Accuracy(95%)	$\leq 0.6\text{m}$
	Convergence Time	$\leq 30\text{min}$
BDS+GPS	Horizontal Positioning Accuracy(95%)	$\leq 0.2\text{m}$
	Vertical Positioning Accuracy(95%)	$\leq 0.4\text{m}$
	Convergence Time	$\leq 20\text{min}$

Refer to : "BeiDou Navigation Satellite System Open Service Performance Standard (Version 3.0) ".2021.5

03

Test Result



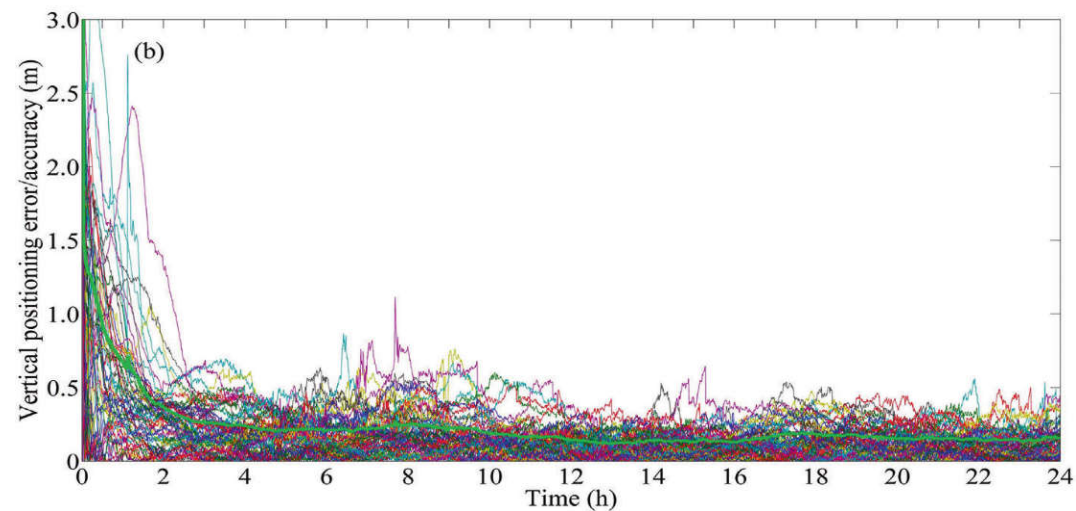
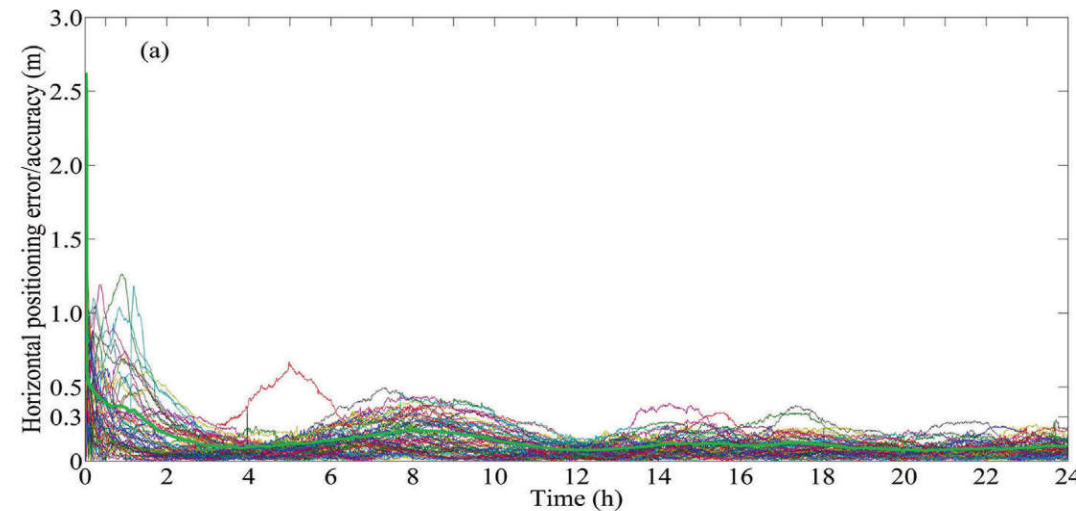
03 Test Result

1. Test condition

The ionospheric free combination of B1C and B2a was employed for the B2b-PPP calculation.

2. Test results

The positioning accuracy of the B2b-PPP in the horizontal and vertical components are better than 0.3 and 0.5m, respectively, and the convergence time is usually less than 30 min.



04

Summary



04 Summary

- The performance evaluation of multiple stations in 2022 reveals that the positioning accuracy and the convergence time of BDS PPP meets the open service performance standard.
- BDS PPP service has the possibility of interoperability with other PPP systems at the signal, message and other levels.
- And we will keep monitoring and evaluating the service and promoting the compatibility and interoperability of PPP services.

2019. 12:
Announced provision of PPP service
Published BDS SIS ICD PPP-B2b (Beta Version)

2020. 8:
Published BDS SIS
ICD PPP-B2b (V1.0)

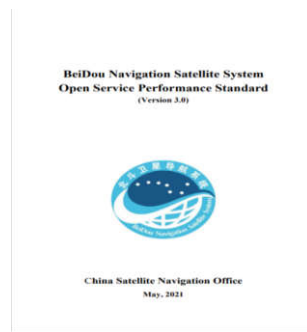
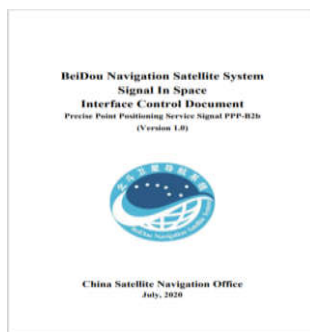
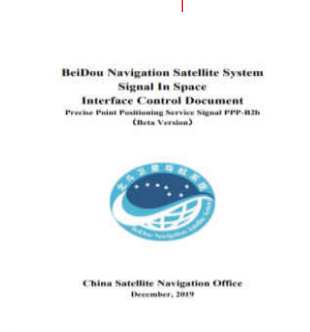
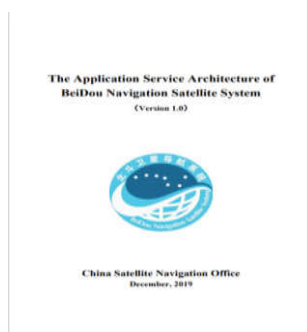
2021. 5:
Published BDS Open Service
Performance Standard (V1.0)

2019

2020

2021

2022





Thank you

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