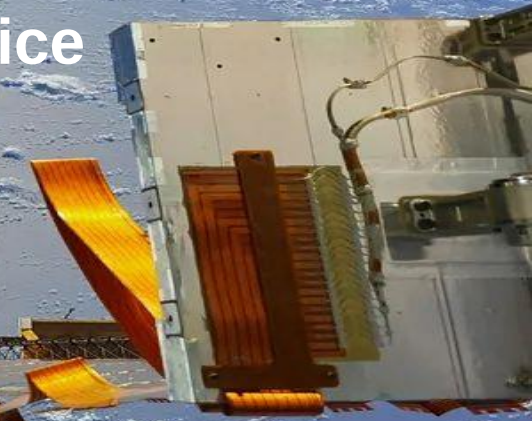
Introduction of BDS Precise Point Positioning Service



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2021-09-29

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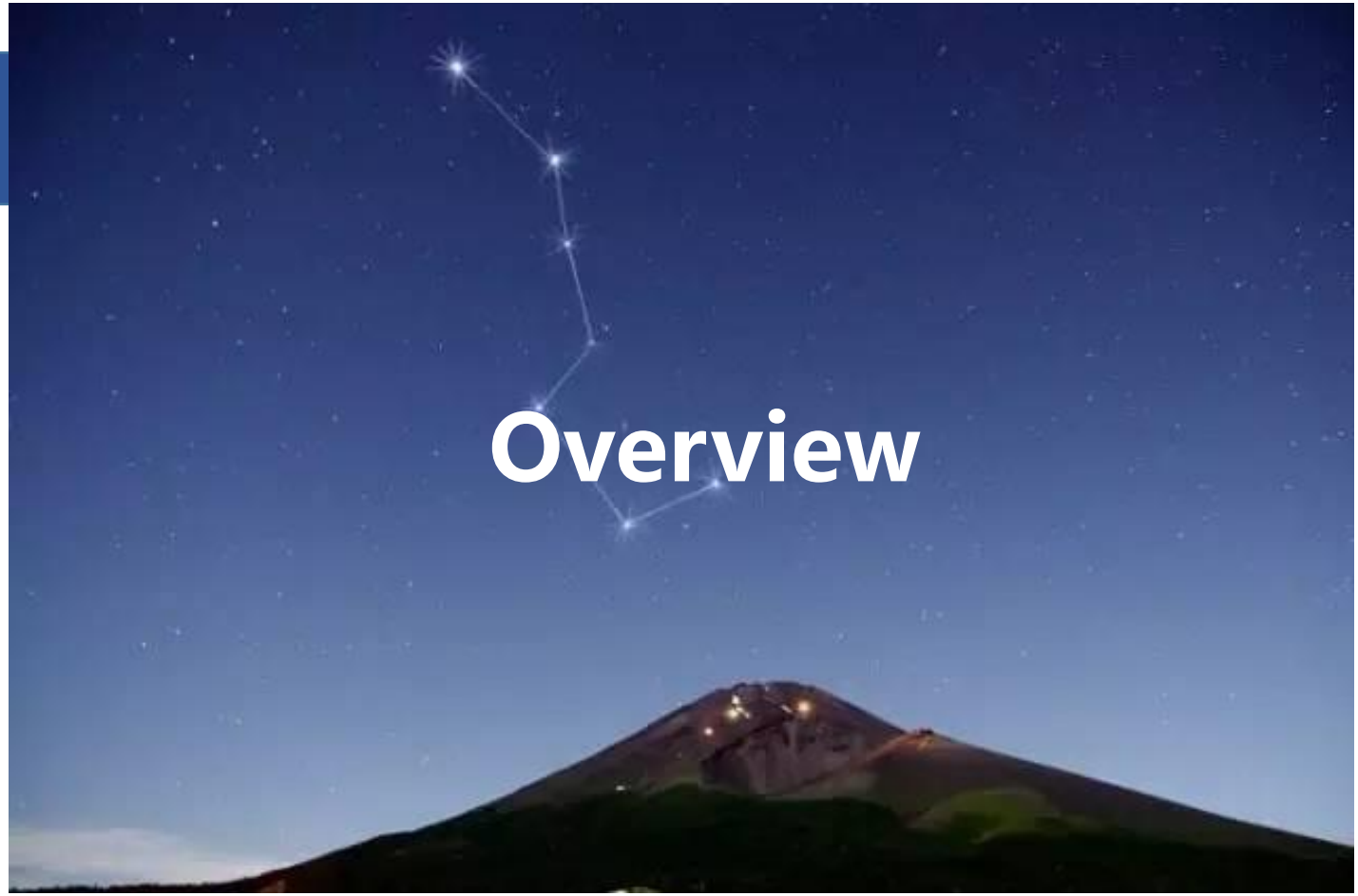


Overview

01 Overview

Precise point positioning (PPP) is an important technology for achieving wide area high-precision positioning. On December 27, 2019, the BDS-3 held a press conference to mark the first anniversary of its global services and announced seven kinds of services, including PPP (China Satellite Navigation Office).

01 Overview

The PPP service is provided through the PPP-B2b signal broadcasted by GEO satellites in the BDS-3 nominal constellation. And according to "the Application Service Architecture of BeiDou Navigation Satellite System (V 1.0)", 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≤0.3m Vertical≤0.6m	
Convergency Time	≤30min	

02

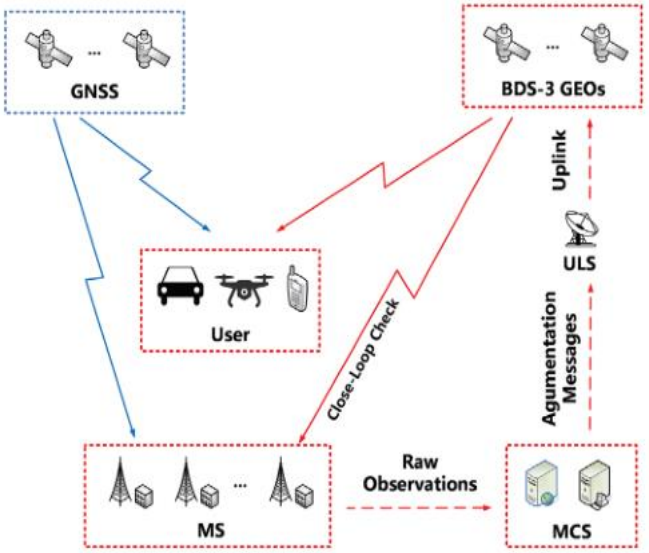
Design of BDS PPP Service

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.

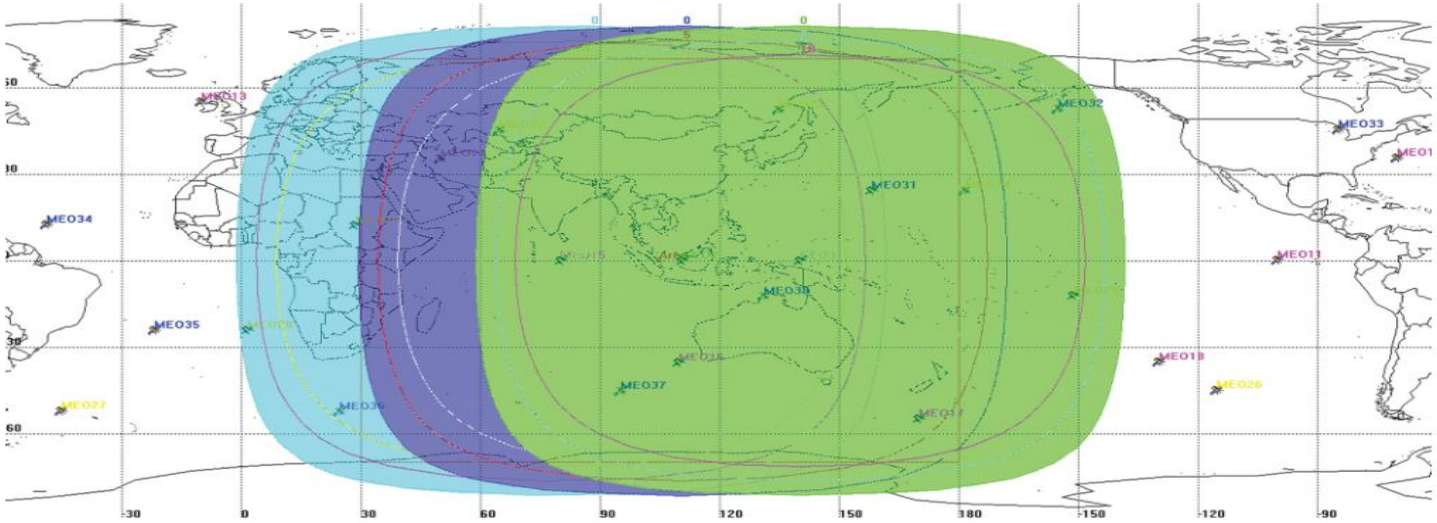
- ✓ Space segment: three BDS-3 GEO located at 80°E , 110.5°E , and 140°E.
- ✓ Ground segment: consists of the master control station (MCS), uplink stations (ULS), and monitoring stations (MS), which are well distributed in mainland China.
- ✓ User segment: includes various receivers with PPP-B2b signal 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 °N~55 °N, 75 °E~135 °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

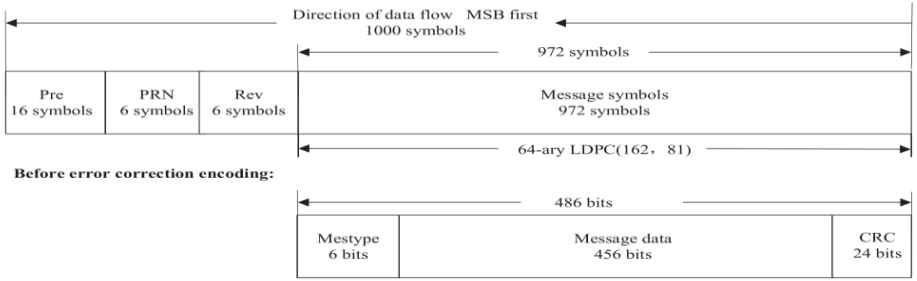
Refer to the "BeiDou Navigation Satellite System Signal-in-Space Interface Control Document: Precise Point Positioning Service Signal PPP-B2b (Version 1.0)" (BDS-SIS-ICD-PPP-B2b-1.0). 2020.8

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	–

PPP-B2b_I can augment all visible satellites of the four core GNSSs above China.

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). 2020.8

02 Design of BDS PPP Service

4. Service Performance Characteristics

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

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

03

Preliminary Test Result

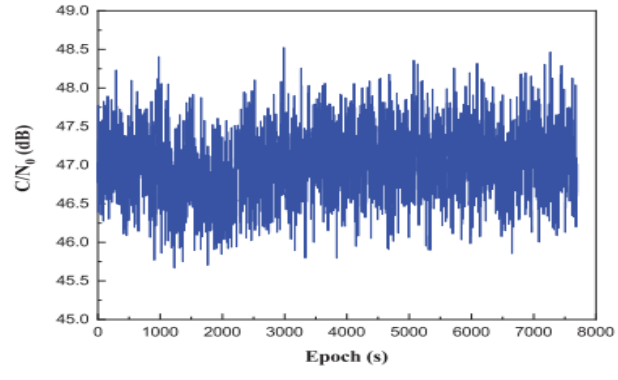
03 Preliminary Test Result

1. Signal quality

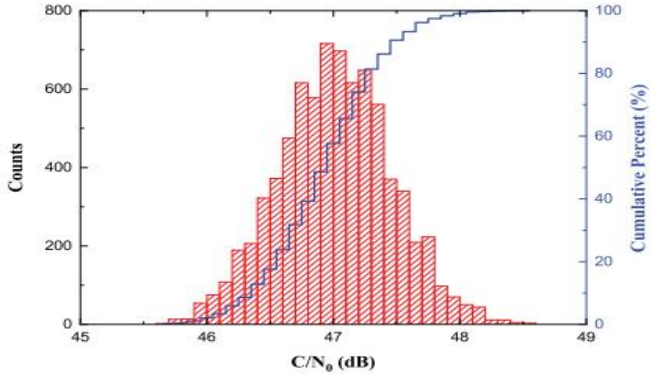
Test at: Beijing ,Open environment
Antenna: External GNSS measurement antenna
Average C/N0:47dB

TABLE 12 Antenna specifications

Items	Specification
Working frequency	1190 MHz~1270 MHz
	1521 MHz~1615 MHz
Support positioning signal	GPS L1/L2
	GLONASS G1/G2/G3
	BDS B1/B2/B3
	Galileo E1/E5b
Phase center deviation	≤2.0 mm
Phase center repeatability	≤1.0 mm
Polarization	Right-handed circular polarization (RHCP)
Low noise amplification (LNA)	43 ± 2 dB (Typical value)



(a) C/N_0 value sequence



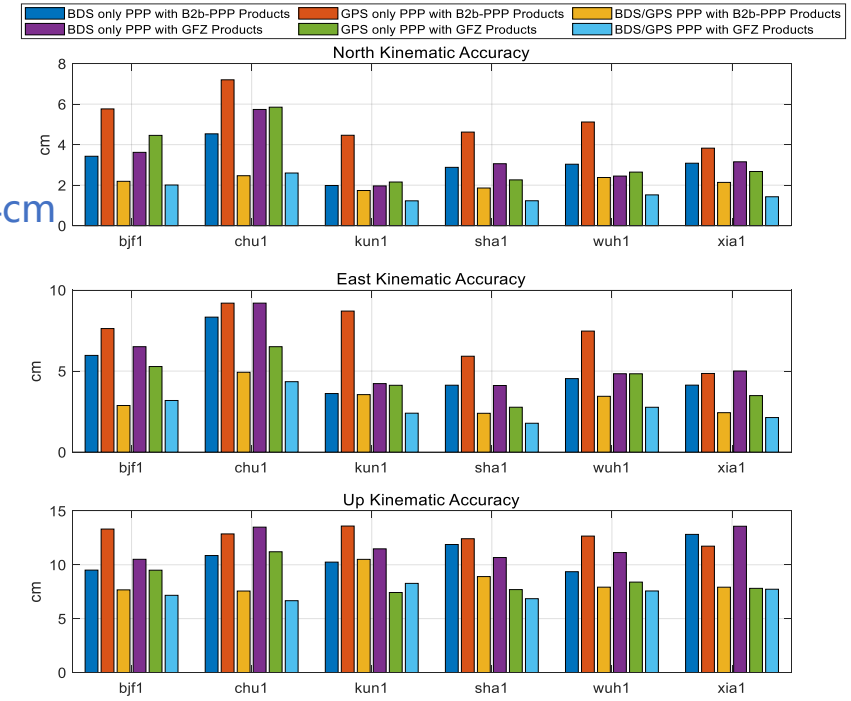
(b) Probability statistics

03 Preliminary Test Result

2. Positioning Accuracy

Test Data: 2020.8.1 ~ 2020.8.7, iGMAS
BDS Horizontal & Vertical (95%) : 6cm、10.8cm
GPS+BDS Horizontal & Vertical (95%) : 3.9cm、8.4cm

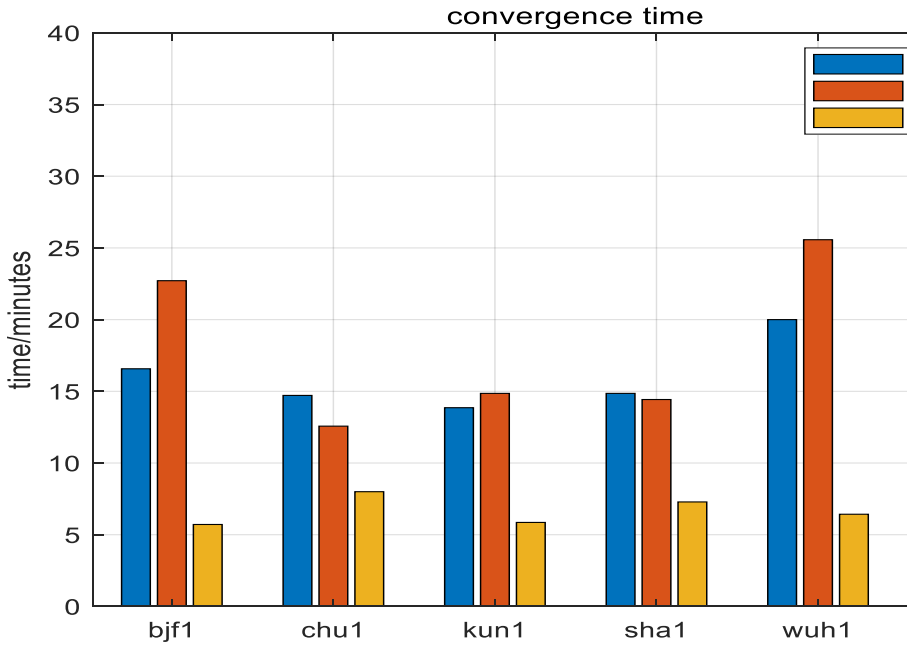
System	Product	N(cm)	E(cm)	H(cm)	V(cm)
BDS	B2b-PPP	3.157	5.118	6.01	10.78
	GFZ	3.33	5.646	6.55	11.81
BDS/GPS	B2b-PPP	2.128	3.271	3.90	8.414
	GFZ	1.669	2.769	3.23	7.376



03 Preliminary Test Result

3. Convergence Time

Test Data: 2020.8.1 ~ 2020.8.7, iGMAS
Convergence Time:
BDS:<20min
GPS+BDS:<10min

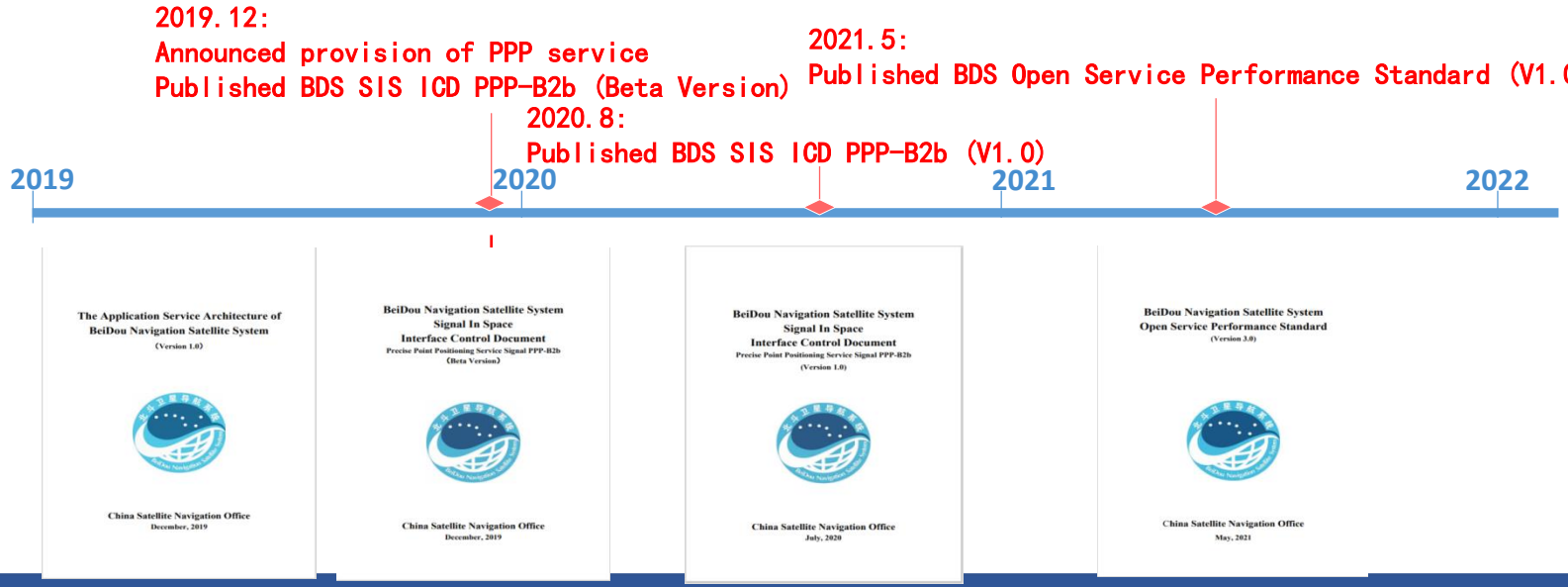


04

Summary

04 Summary

Till now, BDS PPP service has been provided for more than one year. The performance evaluation reveals that the positioning accuracy and the convergence time meets the open service performance standard. And more tests will be carried out in the future.




Thank you
http://en.beidou.gov.cn