BeiDou Navigation Satellite System
Open Service Performance Standard
(Version 3.0)

China Satellite Navigation Office

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Revision Record

Index	Document Title	Version Number	Release Time	Note
1	BeiDou Navigation Satellite System Open Service Performance Standard	Version 1.0	December 2013	
2	BeiDou Navigation Satellite System Open Service Performance Standard	Version 2.0	December 2018	
3	BeiDou Navigation Satellite System Open Service Performance Standard	Version 3.0	May 2021	

Foreword

The BeiDou Navigation Satellite System (BDS) has been built and developed in accordance with a "three-step" strategy. BDS-1 construction was started from 1994 and put into use in 2000. It adopted an active positioning scheme to provide Chinese users with positioning, timing, wide-area differential and short message communication services. BDS-2 construction was started from 2004 and put into use in 2012. Besides inheriting the technically compatible with BDS-1, BDS-2 also added a passive positioning scheme to provide users in the Asia-Pacific regions with positioning, velocity measurement, timing and short message communication services. BDS-3 construction was started from 2009 and fully completed in 2020. On the basis of BDS-2, BDS-3 further improves services performance and expands services functions.

BDS-3 provides various services, including positioning, navigation, timing, global short message communication, and international search and rescue services for global users, as well as the satellite-based augmentation, ground augmentation, precise point positioning and regional short message communication services for users in China and surrounding areas.

This document defines and stipulates the BDS open service performance standard, and will be updated as BDS evolves.

BDS-OS-PS-3.0
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1 Scope

This document presents the performance standard of the BDS services, including the positioning, navigation, timing, the GEO satellite-based precise point positioning, the regional short message communication, ground augmentation, and the international search and rescue. The performance standard of other services will be provided in subsequent versions.

2 Reference Documents

The references for this document are listed in Appendix A.

3 Abbreviations

The abbreviations used in this document are listed in Appendix B.

4 BDS Overview

4.1 Space Segment

The BDS-3 nominal constellation consists of 3 GEO satellites, 3 IGSO satellites, and 24 MEO satellites. The GEO satellites operate in the orbits at an altitude of 35,786 kilometers and are located at 80° E, 110.5° E, and 140° E respectively. The IGSO satellites operate in the orbits at an altitude of 35,786 kilometers and an inclination of the orbital planes of 55° with reference to the equatorial plane. The MEO satellites operate in the orbits at an altitude of 21,528 kilometers and an inclination of the orbital planes of 55° with reference to the equatorial plane, and are distributed in a Walker24/3/1 constellation. On-orbit backup satellites will be deployed as needed.

4.2 Ground Control Segment

The ground control segment is responsible for the BDS operation and control, which mainly consists of the master control station (MCS), the time synchronization/upload stations (TS/US) and the monitoring stations (MS).

The MCS is the BDS operation and control center, whose main tasks include:

a) to collect observation data of the NAV signals from each TS/US and MS, to process the data, and to generate and upload the satellite NAV messages;

b) to perform mission planning and scheduling, to conduct system operation management and control;

c) to observe and calculate the satellite clock biases;

d) to monitor the satellite payloads and analyze anomalies, etc.

The main tasks of the TS/US are to measure satellite clock biases, and to upload the satellite NAV messages.

The main tasks of the MS are to continuously monitor the satellite NAV signals, and to provide real-time data to the MCS.

4.3 User Segment

The user segment consists of various types of BDS user terminals.

4.4 Coordinate System

BDS adopts the BeiDou Coordinate System (BDCS). BDCS uses the reference ellipsoid parameters defined by the China Geodetic Coordinate System 2000 (CGCS2000), which is in accordance with the International Earth Rotation and Reference Systems Service (IERS), consistent with the latest International Earth Reference Framework (ITRF), and is updated annually.

For more details, please refer to BeiDou Satellite Navigation System Signal in Space Interface Control Documents.

4.5 Time System

BDS adopts the BeiDou Navigation Satellite System Time (BDT) as the time reference. BDT uses the international system of units (SI) second without leap seconds. The initial epoch of BDT is 00:00:00 on January 1,2006 of the Coordinated Universal Time (UTC). BDT connects with UTC via UTC (NTSC), and the deviation of BDT to UTC is maintained within 50 nanoseconds (modulo 1 second). The leap second information is broadcast in the NAV message.

4.6 BDS Information Dissemination Channel

The latest BDS information is disseminated through the BDS official website (www.beidou.gov.cn). Users can inquire and obtain information about the satellite launch log, the constellation ephemeris, the SIS status, as well as the monitoring and assessment results, etc., and download the latest version of the relevant BDS documents, though the website.

5 Positioning, Navigation and Timing Service

5.1 Service Overview

The service refers to the radio navigation satellite service (RNSS) which uses open signals B1C, B2a, B2b, B1I and B3I broadcast by BDS to determine the user's location, velocity, and time. The main service standards include the SIS accuracy, integrity, continuity and availability, the PNT accuracy and service availability, etc.

Currently, the RNSS services are jointly provided by BDS-2 and BDS-3 constellation.

5.2 Service Volume

BDS can provide positioning, navigation, timing services to users on the global surface of the Earth and its near-earth areas extending 1,000 kilometers above the Earth surface.

5.3 SIS Interface Characteristics

5.3.1 SIS RF Characteristics

The followings are the five signals in space that provide the RNSS services:

a) The B1C signal: With the center frequency at 1575.42 MHz and the bandwidth of 32.736 MHz, B1C contains a data component B1C_data, and a pilot component B1C_pilot. The data component adopts binary offset carrier modulation (BOC(1,1)), and the pilot component adopts orthogonal multiplexing binary offset carrier modulation (QMBOC(6,1,4/33)), and polarized by right-hand circular polarization (RHCP). For details, please refer to "BeiDou Satellite Navigation System Signal in Space Interface Control Document Open Service Signal B1C (Version 1.0)" (BDS-SIS-ICD-B1C-1.0).

b) The B2a signal: With the center frequency at 1176.45 MHz and the bandwidth of 20.46 MHz, B2a contains a data component B2a_data, and a pilot component B2a_pilot. Both the data component and the pilot component are modulated by binary phase shift keying (BPSK (10)), and polarized by RHCP. For details, please refer to "BeiDou Satellite Navigation System Signal in Space Interface Control Document Open Service Signal B2a (Version 1.0)" (BDS-SIS-ICD-B2a-1.0).

c) The B2b signal: With the center frequency at 1207.14 MHz and the bandwidth of

20.46 MHz, B2b_I is modulated by BPSK (10), and polarized by RHCP. For details, please refer to "BeiDou Satellite Navigation System Signal in Space Interface Control Document Open Service Signal B2b (Version 1.0)" (BDS-SIS-ICD-B2b-1.0).

d) The B1I signal: With the center frequency at 1561.098 MHz and the bandwidth of 4.092 MHz, B1I is modulated by BPSK, and polarized by RHCP. For details, please refer to "BeiDou Satellite Navigation System Signal in Space Interface Control Document Open Service Signal B1I (Version 3.0)" (BDS-SIS-ICD-B1I-3.0).

e) The B3I signal: With the center frequency at 1268.52 MHz and the bandwidth of 20.46 MHz, B3I is modulated by BPSK, and polarized by RHCP. For details, please refer to "BeiDou Satellite Navigation System Signal in Space Interface Control Document Open Service Signal B3I (Version1.0)" (BDS-SIS-ICD-B3I-1.0).

5.3.2 NAV Message Characteristics

5.3.2.1 NAV Message Types

The NAV messages used by the five RNSS SIS include:

The B1C signal NAV message adopts the B-CNAV1 message format, and the navigation information frame is detailed in BDS-SIS-ICD-B1C-1.0.

The B2a signal NAV message adopts the B-CNAV2 message format, and the navigation information frame is detailed in BDS-SIS-ICD-B2a-1.0.

The B2b signal NAV message adopts the B-CNAV3 message format, and the navigation information frame is detailed in the regulations of BDS-SIS-ICD-B2b-1.0.

NAV messages of the B1I and B3I signals adopt the D1 message format and the D2 message format respectively. The B1I and B3I signals of all MEO/IGSO satellites broadcast NAV messages in the D1 format, while the B1I and B3I signals of all GEO satellites broadcast NAV messages in the D2 format. For details of the navigation information frames, please refer to BDS-SIS-ICD-B1I-3.0 and BDS-SIS-ICD-B3I-1.0.

The corresponding relationship between different types of SIS signals and NAV messages is shown in Table 5-1.

Table 5-1 Correspondences among BDS In-Orbit Satellite Types, Signals and NAV Messages

Signal	NAV Message	Satellite Type
B1C	B-CNAV1	BDS-3I BDS-3M
B2a	B-CNAV2	
B2b	B-CNAV3	
B1I, B3I	D1	BDS-2I BDS-2M BDS-3I BDS-3M
	D2	BDS-2G BDS-3G

5.3.2.2 NAV Message

The NAV message mainly consists of:

a) Satellite ephemeris parameters updated hourly;

b) Satellite clock offset parameters updated hourly;

c) Time group delay correction parameters updated every two hours;

d) Ionospheric delay model parameters updated every two hours;

e) Satellite health status updated in real-time according to the current status of the satellites and SIS;

f) Integrity parameters updated in real-time according to the current status of the satellites and SIS;

g) BDT-UTC time synchronization parameters updated in a period less than 24 hours;

h) Constellation status (almanac) updated in a period less than 7 days.

For more details of the NAV messages, please refer to BDS-SIS-ICD-B1C-1.0, BDS-SIS-ICD-B2a-1.0, BDS-SIS-ICD-B2b-1.0, BDS-SIS-ICD-B1I-3.0 and BDS-SIS-ICD-B3I-1.0.

5.3.3 SIS Status Characteristics

5.3.3.1 SIS Status

A BDS SIS takes one of the following three states:

a) "Healthy": The signal meets the service performance standard specified in this document;

b) "Unhealthy": The signal is not providing services or is being tested;

c) "Marginal": The signal is neither healthy nor unhealthy.

5.3.3.2 SIS Status and Associated Flags

The B-CNAV1, B-CNAV2, and B-CNAV3 messages employ "Satellite Health Status (HS)", "Signal Integrity Flag (SIF)" and "Data Integrity Flag (DIF)" to indicate satellite/SIS status:

a) "HS" indicates the health status of the entire satellite and is represented by 2 bits;

b) "SIF" indicates the health status of the signal, and is represented by 1 bit;

c) "DIF" indicates whether the accuracy of the SIS exceeds the SISA value broadcast by the signal, and is represented by 1 bit.

The relationships among the "healthy", "unhealthy" and "marginal" states of the B1C, B2a, and B2b signals and the relevant flags in NAV messages are shown in Table 5-2.

Table 5-2 Relationships among the B1C, B2a and B2b NAV Signal Status and Relevant Flags

SIS Status	**Health Flags of the SIS and NAV Messages**		
	B1C-(B-CNAV1); B2a-(B-CNAV2); B2b-(B-CNAV3)		
	HS	**SIF**	**DIF**
Healthy	0	0	0
Unhealthy	0/1/2/3	1	0/1
	1	0/1	0/1
Marginal	0	0	1
	2/3	0	0

The SIF (B1C) of the B1C signal is broadcast in the NAV messages B-CNAV1 and B-CNAV2. It is recommended that the B1C/B2a dual-frequency users give the priority to use the integrity status flag SIF broadcast by the B2a NAV messages, because of the higher update frequency of the B2a NAV messages.

The D1 and D2 messages of the B1I and B3I signals use the "Satellite Autonomous Health Flag (SatH1)" to indicate the signal status, and represented by 1 bit. The relationship between the "healthy", "unhealthy" and "marginal" states of the B1I and B3I signals and the relevant flags in each NAV message are shown in Table 5-3.

Table 5-3 Relationships among the B1I and B3I NAV Signal Status and Relevant Flags

SIS Status	**Health Flags of the SIS and NAV Messages**
	B1I-(D1/D2); B3I-(D1/D2)
	SatH1
Healthy	0
Unhealthy	1
Marginal	N/A

5.4 SIS Performance Characteristics

5.4.1 SIS Coverage

The SIS coverage is represented as the per-satellite coverage, which comprises the portion of the near-Earth region which extends from the Earth surface up to an altitude of 1,000 kilometers above the Earth surface which is visible from the satellite's orbital position.

5.4.2 SIS Accuracy

The SIS accuracy is represented by the error statistics of the "Healthy" SIS. The SIS accuracy mainly includes four parameters:

a) The SIS Ranging Error (SISRE);

b) The SIS Ranging Rate Error (SISRRE);

c) The SIS Ranging Acceleration Error (SISRAE);

d) The Coordinated Universal Time Offset Error (UTCOE).

5.4.2.1 SISRE

The SISRE is represented by the statistical value of the instantaneous SISRE. An instantaneous SISRE is refers to the difference between the pseudorange measured at a given location assuming a receiver clock that is perfectly calibrated to BDT and the expected pseudorange as derived from the NAV message data for the given location and the assumed receiver clock. The instantaneous SISRE only considers the errors associated with the space segment and the ground control segment (excluding tropospheric delay error, multipath, receiver noise, the user receiver clock offset or measurement errors, etc.).

5.4.2.2 SISRRE

The SISRRE refers to the first derivative of SISRE versus time.

5.4.2.3 SISRAE

The SISRAE refers to the second derivative of SISRE versus time.

5.4.2.4 UTCOE

The SIS UTCOE refers to the error of the offset between BDT and UTC (NTSC).

5.4.3 SIS Continuity

The SIS continuity refers to the probability that a healthy SIS can continuously work without any unscheduled outages within a specified time period.

A signal outage refers to an event when the BDS satellites cannot broadcast SIS with a "healthy" status, including the cases when signals cannot be broadcast, the broadcast signals are of non-standard formats, or the signal status is marked as "unhealthy" or "marginal".

The signal outages include scheduled and unscheduled outages. A scheduled outage refers to an SIS outage that is notified in advance, when the satellite signal is not expected to meet the performance specified in this document. An unscheduled outage refers to a satellite signal outage caused by a system failure or other unscheduled outages.

The outage information release time refers to the time interval during which BDS satellite signal outage information is released before a scheduled outage or after an unscheduled outage. Scheduled outages with advance notices will not affect the continuity, while the unscheduled outages information should be notified as soon as possible after the outage occurs.

5.4.4 SIS Availability

The SIS availability refers to the probability that satellites in specified orbital slots in the BDS constellation provide healthy SIS, which includes the per-satellite availability and the constellation availability.

The per-satellite availability refers to the probability that a satellite in a specified orbit in the BDS constellation provides "healthy" SIS.

The constellation availability refers to the probability that the satellites of a specified number in specified orbits in the BDS-3 nominal constellation provide "healthy" SIS.

Each SIS possesses its individual per-satellite availability and constellation availability.

5.5 Service Performance Characteristics

5.5.1 Usage Constraints

The RNSS service performance standards in this specification are based on the following usage constraints:

a) The user receivers are consistent with the relevant technical requirements of BDS-SIS-ICDs, and track and correctly process SIS for PVT calculations;

b) The service is based on BDT and BDCS;

c) The service performance is only associated with the errors of the space and ground control segments, including satellite orbit errors, satellite clock offsets and T_{GD} errors;

d) Dual-frequency users can mitigate the effects of ionospheric delay by using an ionosphere-free combination of carrier phase or pseudo-range measurements;

e) The latest healthy SIS and NAV messages shall be used.

5.5.2 Service Accuracy

The service accuracies include the positioning, velocity measurement and timing accuracies.

The positioning accuracy refers to the statistical value of differences between the positions determined by the BDS signals and the corresponding reference positions, including the horizontal positioning accuracy and the vertical positioning accuracy.

The velocity measurement accuracy refers to the statistical value of the differences between the velocity determined by using SIS and the user's reference velocity.

The timing accuracy refers to the statistical value of the differences between the time determined by the BDS signals and BDT.

5.5.3 Service Availability

The service availability refers to the ratio of the available service time in a specified service time interval. The available service time is the time interval when service accuracy meets specified performance criteria in the given volume. The service availability includes the position dilution of precision (PDOP) availability and the positioning service availability.

The PDOP availability refers to the percentage of time that the PDOP value meets its limit requirements, within the specified time, and under the specified conditions.

The positioning service availability refers to the percentage of time when the horizontal and vertical positioning errors meet the accuracy limitation criteria, within the specified time, and under the specified conditions.

5.5.4 Compatibility and Interoperability

BDS could be compatible and interoperable with other global navigation satellite systems (GNSS).

a) The radio frequencies used by BDS are in accordance with and protected by the International Telecommunication Union Convention, and do not cause any harmful interferences for other GNSS. The radio frequency compatibility can be achieved between BDS and other GNSS;

b) Users can enjoy better service performance by jointly using BDS and other GNSS open service signals without significantly increasing complexity and user cost. The interoperability can be achieved between BDS and other GNSS;

c) The BDT traces back to the Coordinated Universal Time. The time offsets between BDS and other GNSS are broadcast in the navigation messages;

d) The BDS coordinate system is consistent with the International Earth Reference Frame (ITRF).

5.6 SIS Performance Standard

5.6.1 SIS Coverage Standard

The SIS coverage standard is shown in Table 5-4.

Table 5-4 The SIS (Per-Satellite) Coverage Standard

Satellite Type	Coverage Standard
B1C, B2a, B2b, B1I, B3I	100% of the coverage volume (within a height of 1000 kilometers) of any single in-orbit BDS satellite (GEO, IGSO, MEO); The minimum user-received signal power is detailed in BDS-SIS-ICD-B1C-1.0, BDS-SIS-ICD-B2a-1.0, BDS-SIS-ICD-B2b-1.0, BDS-SIS-ICD-B1I-3.0 and BDS-SIS-ICD-B3I-1.0.

5.6.2 SIS Accuracy Standard

5.6.2.1 SISRE Accuracy Standard

The SISRE accuracy standard is shown in Table 5-5.

Table 5-5 SISRE Accuracy Standard

<table>
<tr><th>Signal Type</th><th colspan="2">SISRE Accuracy Standard</th><th>Constraints</th></tr>
<tr><td>B1C, B2a, B2b, B1I, B3I</td><td>SISRE (95%，statistical value of all satellites)</td><td>≤2m</td><td>The statistics of a specific healthy SIS of all BDS satellites in-orbit by calculating the average value of total ages of data (AOD) of the constellation, with a period of any 7 days.
Include satellite clock offsets, ephemeris and T_{GD} errors;
Exclude single frequency ionospheric delay errors, transmission errors or user segment errors.</td></tr>
<tr><td>B1C, B2a, B2b, B1I, B3I</td><td>SISRE (95%，statistical value of any single satellite)</td><td>≤4.6m</td><td>The statistics of a specific healthy SIS of any single satellite in-orbit by calculating the average value of total AOD of the satellite, with a period of any 7 days.
Include satellite clock offsets, ephemeris and T_{GD} errors;
Exclude single frequency ionospheric delay errors, transmission errors or user segment errors.</td></tr>
<tr><td>B1C, B2a, B2b, B1I, B3I</td><td>SISRE (99.94%，average value over all the points on the global)</td><td>≤15m</td><td rowspan="2">The statistics of a specific healthy SIS of any single satellite in-orbit of BDS-3 nominal constellation (BDS-3I, BDS-3M) by calculating based on AOD of all satellites, over a period of time more than 1 year;
The full constellation service failures do not exceed 3 times per year, and the duration of the failure does not exceed 6 hours;
Include satellite clock offsets, ephemeris and T_{GD} errors;
Exclude single frequency ionospheric delay errors, transmission errors or user segment errors.</td></tr>
<tr><td>B1C, B2a, B2b, B1I, B3I</td><td>SISRE (99.79%，the worst case globally)</td><td>≤15m</td></tr>
</table>

5.6.2.2 SISRRE Accuracy Standard

The SISRRE accuracy is shown in Table 5-6.

Table 5-6 The SISRRE Accuracy Standard

<table>
<tr><th>Signal Type</th><th colspan="2">The SISRRE Accuracy Standard (95%)</th><th>Constraints</th></tr>
<tr><td>B1C, B2a, B2b, B1I, B3I</td><td>SISRRE</td><td>≤0.02m/s</td><td>The statistics of a specific healthy SIS of any single BDS satellite in-orbit;
Exclude single frequency ionospheric delay errors, the effect of pseudo range step changes on SISRRE caused by navigation data switching.</td></tr>
<tr><td colspan="4">Note: This standard is mainly based on the assumption that the stability/3s of the BDS clock is better than 1×10^{-11}.</td></tr>
</table>

5.6.2.3 SISRAE Accuracy Standard

The SISRAE accuracy is shown in Table 5-7.

Table 5-7 The SISRAE accuracy standard

Signal Type	The SISRAE Accuracy Standard (95%)		Constraints
B1C, B2a, B2b, B1I, B3I	SISRAE	≤0.008m/s^2	The statistics over a specific healthy SIS from any single BDS satellite in-orbit (GEO, IGSO, MEO); Exclude single frequency ionospheric delay errors, the effect of pseudo range step changes on SISRAE caused by navigation data switching.
Note: This standard is mainly based on the assumption that the stability/3s of the BDS clock is better than 1×10^{-11}.			

5.6.2.4 UTCOE Accuracy Standard

The SIS UTCOE accuracy standard is shown in Table 5-8.

Table 5-8 The SIS UTCOE Accuracy Standard

Signal Type	SIS UTCOE Accuracy Standard (95%)		Constraints
B1C, B2a, B2b, B1I, B3I	UTCOE	≤20ns	The statistical value over a specific healthy SIS from any single BDS satellite in-orbit (GEO, IGSO, MEO); Exclude transmission errors or user segment errors.

5.6.3 SIS Continuity Standard

The SIS continuity standard is shown in Table 5-9.

Table 5-9 The SIS Continuity Standard

Signal Type	SIS Continuity Standard		Constraints
B1C, B2a, B2b, B1I, B3I	SIS Continuity	≥0.998/h	Assume that the SIS is available at the beginning of every hour; The annual statistical value of all BDS satellites in-orbit of the BDS-3 nominal constellation.

Refer to Table 5-10 for the BDS outage information dissemination time standard.

Table 5-10 The Outage Information Dissemination Time

Timeliness of the information release	Standard	Conditions and Constraints
A scheduled outage before the service is affected	≥48hours	A notice of the scheduled outage or a general announcement.
An unscheduled outage after the service is affected	≤72hours	A notice of an unscheduled outage.

5.6.4 SIS Availability Standard

The per-satellite SIS availability standard is shown in Table 5-11.

Table 5-11 The Per-satellite SIS Availability Standard

Signal Type	SIS Continuity Standard		Constraints
B1C, B2a, B2b, B1I, B3I	SIS Availability	≥0.98	The annual statistical value of any satellite in the BDS-3 nominal constellation.

The constellation SIS availability standard is shown in Table 5-12.

Table 5-12 The Constellation SIS Availability Standard

Signal Type	Constellation SIS Availability Standard		Constraints
B1C, B2a, B2b, B1I, B3I	$P_{21/27}$	≥0.99999	The annual statistical value of the specified probability that at least 21 of the 27 (3 BDS-3I + 24 BDS-3M) in-orbit satellites provide "healthy" SIS.
B1C, B2a, B2b, B1I, B3I	$P_{24/27}$	≥0.998	The annual statistical value of the specified probability that at least 24 of the 27 (3 BDS-3I + 24 BDS-3M) in-orbit satellites provide "healthy" SIS.

5.7 Service Performance Standard

5.7.1 Service Accuracy Standard

The positioning accuracy standard is shown in Table 5-13.

Table 5-13 The Positioning Accuracy Standard

Service Scheme	Positioning Accuracy Standard (95%)		Constraints
Single-frequency or dual-frequency	Average globally, horizontal	≤9m	The elevation mask is 5 degree; Usage constraints are met, and healthy SISs are used for calculation;

Service Scheme	Positioning Accuracy Standard (95%)		Constraints
	Average globally, vertical	≤10m	The statistical value of any 7-day positioning errors of all points in the global region; Excludes transmission errors and user segment errors.
single-frequency or dual-frequency	Horizontal error at the worst point.	≤15m	The elevation mask is 5 degree; Usage constraints are met, and healthy satellite signals are used for calculation; The statistical value of any 7-day positioning errors of the world's worst position; Excludes transmission errors and user segment errors.
	Vertical error at the worst point.	≤22m	

The velocity measurement accuracy standard is shown in Table 5-14.

Table 5-14 The Velocity Measurement Accuracy Standard

Service Scheme	Velocity Measurement Accuracy Standard (95%)		Constraints
single-frequency or dual-frequency	Average globally	≤0.2m/s	The elevation mask is 5 degree; Usage constraints are met, and healthy SISs are used for calculation; The statistical value of any 7-day velocity measurement errors of all points in the global region; Excludes transmission errors and user segment errors.

The timing accuracy standard is shown in Table 5-15.

Table 5-15 The Time Accuracy Standard

Service Scheme	Timing Accuracy Standard (95%)		Constraints
Single-frequency or dual-frequency	Average globally	≤20ns	The elevation mask is 5 degree. Usage constraints are met, and healthy SISs are used for calculation; The statistical value of any 7-day timing errors of all points in the global region; Excludes transmission errors and user segment errors.

5.7.2 Service Availability Standard

5.7.2.1 PDOP Availability Standard

The PDOP availability standard is shown in Table 5-16.

Table 5-16 The PDOP Availability Standard

Service Scheme	PDOP Availability Standard		Constraints
Single-frequency or dual-frequency	Average globally	⩾98%	The elevation mask is 5 degree; PDOP⩽6; The statistical value over any 7-day period at all points in the global region.
	At the worst point	⩾88%	The elevation mask is 5 degree; PDOP⩽6; The statistical value over any 7-day period at the worst point in the global region.

5.7.2.2 Positioning Service Availability Standard

The positioning service availability standard is shown in Table 5-17.

Table 5-17 The Positioning Service Availability Standard

Service Scheme	Positioning Service Availability Standard		Constraints
Single-frequency or dual-frequency	Average globally	⩾99%	The elevation mask is 5 degree. 95% confidence level, the horizontal positioning accuracy is better than 15m; 95% confidence level, the vertical positioning accuracy is better than 22m; The position calculation is conducted under the specified user constraints; The average of all points in the global region over any 7 days.
Single-frequency or dual-frequency	At the worst location	⩾90%	The elevation mask is 5 degree. 95% confidence level, the horizontal positioning accuracy is better than 15m; 95% confidence level, the vertical positioning accuracy is better than 22m; The position calculation is conducted under the specified user constraints; The statistical value at the worst location in the global region over any 7 days.

6 Precise Point Positioning Service

6.1 Service Overview

The Precise Point Positioning (PPP) service is provided through the PPP-B2b signal broadcast by the three GEO satellites in the BDS-3 nominal constellation. Users can achieve high-precision positioning through this service. The main performance standards include the positioning accuracy and the convergence time, etc.

6.2 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.

6.3 SIS Interface Characteristics

6.3.1 SIS RF Characteristics

The center frequency of the PPP-B2b signal is 1207.14 MHz, and the bandwidth is 20.46 MHz. The I component of PPP-B2b signal is modulated in BPSK (10), and polarized by RHCP, while the right-hand circularly polarized antenna is 0 dBi gain (or the linearly polarized antenna is 3 dBi gain), the minimum power level that reaches the output of a receiver antenna is -160 dBW.

For details, please 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).

6.3.2 Characteristics of Navigation Messages

The types of messages broadcast by PPP-B2b are shown in Table 6-1.

Table 6-1 The PPP-B2b Message Types

Message types (in decimal)	Message Content
1	Satellite mask
2	Satellite orbit correction and user range accuracy index
3	Differential code bias
4	Satellite clock correction

Message types (in decimal)	Message Content
5	User range accuracy index
6	Clock and orbit corrections - combination 1
7	Clock and orbit corrections - combination 2
8-62	Reserved
63	Null message

The NAV message data frame of the I component of PPP-B2b signal employs the reserved flags to indicate the status of the PPP service. The "1" in the highest bit of the reserved flags means the PPP service of this satellite is unavailable and the "0" in the highest bit of the reserved flags means the PPP service of this satellite is available.

For details of the navigation messages, please refer to BDS-SIS-ICD-PPP-B2b-1.0.

6.4 Service Performance Characteristics

6.4.1 Usage Constraints

The PPP service performance standard in this specification are based on the following user constraints:

a) The user receiver meets the relevant technical requirements specified in BDS-SIS-ICD-PPP-B2b-1.0, can track and correctly process the dual-frequency RNSS signals and the PPP-B2b signal, and use the augmentation information to complete the positioning calculation;

b) The service is based on BDT and BDCS;

c) Exclude errors of the signal transmission and the receiving terminal;

d) When the highest bit of the reserved flags is "1", the PPP information broadcast by the satellite should not be used.

6.4.2 Positioning Accuracy

The positioning accuracy refers to the statistical value of the difference between the user’s reference position and the position determined by using the PPP service. The positioning accuracy includes the horizontal and vertical component respectively.

6.4.3 Convergence Time

The convergence time is the time to meet the positioning accuracy requirements for the first time, under the condition that the receiver starts meeting the positioning accuracy and continues for 5 minutes.

6.5 Service Performance Standard

The augmentation service performance for using BDS only or the dual-system (BDS+GPS) is presented in Table 6-2.

Table 6-2 The PPP Service Performance Standard

Constellation	Performance Characteristics	Performance Standard	Constraints
BDS	HorizontalPositioning Accuracy (95%)	≤0.3m	The correction targets: PPP-B2b information is used to correct the CNAV1 NAV message of the BDS B1C signal and the LNAV NAV message of the GPS L1C/A signal; Requirements for the correction targets: the BDS RNSS service performance meets the requirements of this specification; GPS service performance meets the requirements of "GPS Standard Positioning Service Performance Standard (Version 5.0)". Elevation mask is 10 degrees; Dual-frequency positioning; The statistical time interval is 7 days, and all points in the service area are averaged.
	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	

7 Regional Short Message Communication Service

7.1 Service Overview

The Regional Short Message Communication (RSMC) Service is provided through the L-band and S-band signals of the three GEO satellites in the BDS-3 nominal constellation. Having completed the application and registration, the authorized users can use the short message communication service in the modes of point-to-point, multicast, and broadcast. The main performance standards include the service success rate, the service delay, the service frequency, and the maximum length of a single message, etc.

7.2 Service Volume

BDS can provide the RSMC 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.

7.3 SIS Interface Characteristics

7.3.1 User Transmitted Signal

The user transmitted signal is within a L frequency band 1610.0 MHz - 1626.5 MHz, using the direct sequence spread spectrum (DSSS) and the BPSK modulation.

7.3.2 User Received Signal

The signal received by the users is within a S frequency band of 2483.5 MHz - 2500 MHz, including a pilot component S2C_p and a data component S2C_d, all using the DSSS and BPSK modulation.

7.4 Service Performance Characteristics

7.4.1 Usage Constraints

The RSMC service performance standards in this specification are based on the following usage constraints:

a) The user terminal meets the relevant technical requirements of the "BeiDou Navigation Satellite System Regional Short Message Communication Service Signal in Space Interface Control Document (Version 1.0)", registration is needed for the service;

b) Possess the ability to transmit L frequency band signal;

c) If the user's radial velocity relative to satellite is greater than 1000 km/h, the user terminal needs to perform the adaptive Doppler compensation;

d) It can correctly receive the S2C signal broadcast by GEO satellites of the BDS, and the minimum power received by user is -157.6 dBW;

e) The user terminal should be working in an outdoor open area, the user's line of sight to the GEO satellite is unobstructed, and the elevation mask of 10 degrees.

7.4.2 Service Success Rate

The service success rate refers to the probability that the system correctly provides services. It defined as the ratio of the number of the correctly received results to the number of service requests issued by the sender.

7.4.3 Service Delay

The service delay refers to the delay of information transmission, which is defined as the time interval between the user sending the request information (the last bit of the information) and the successful reception of the correct service information (the last bit of the information) in the service area.

7.4.4 Service Frequency

The service frequency refers to the minimum time interval between two consecutive service requests sent by users.

7.4.5 Maximum Length of A Single Message

The maximum length of a single message refers to the maximum volume of a single message.

7.5 Service Performance Standard

The RSMC service performance standard is presented in Table 7-1.

Table 7-1 The RSMC Service Performance Standard

<table>
<tr><th>Performance Characteristics</th><th colspan="2">Performance Standard</th><th>Constraints</th></tr>
<tr><td>Success Rate</td><td colspan="2">≥95%</td><td rowspan="5">The user has the ability to transmit L frequency band signal;
The user's line of sight to the GEO satellite is unobstructed, and the elevation mask is 10 degrees;
The S2C signal minimum power received by user is -157.6 dBW;
The user's actual service frequency and the maximum length of a single message are bounded to the registration parameters;
The service delay is a standard under the condition of non-congested outbound link;
If the user's radial velocity relative to satellite is greater than 1000 km/h, adaptive Doppler compensation is required.</td></tr>
<tr><td>Service Delay</td><td colspan="2">Better than 2 seconds on average</td></tr>
<tr><td rowspan="2">Service Frequency</td><td>Average</td><td>1 time/30s</td></tr>
<tr><td>Maximum</td><td>1 time/s</td></tr>
<tr><td>Maximum Length of A Single Message</td><td colspan="2">≤14000 bits</td></tr>
</table>

8 International Search and Rescue Service

8.1 Service Overview

The BDS provides international search and rescue (SAR) services with return link, by a 406 MHz signal which conforms to the COSPAS-SARSAT standard and the BDS B2b signal. BDS and other medium-orbit satellite search and rescue systems form a global medium-orbit satellite search and rescue system to provide users worldwide with distress warning services, and distress alerts acknowledgement services based on the return link function. The main performance standards include the detection probability, the positioning accuracy, the availability, as well as return link delay and success rate, etc.

The SAR service is provided by six MEO satellites carrying search and rescue payloads in the BDS-3 nominal constellation, averagely distributed in three orbital planes. The satellites are located respectively in slots 6 and 8 of the first orbital plane, slots 1 and 3 of the second orbital plane, and slots 3 and 5 of the third orbital plane of the MEO satellite's Walker 24/3/1 constellation. The return link is available from the 24 MEO satellites and the 3 IGSO satellites, supported by the inter-satellite links.

Based on the BDS ground control segment, the BDS SAR service ground segment also includes the Medium-altitude Earth Orbit Local User Terminal (MEOLUT), the mission control center (MCC) and the BDS return link service provider (RLSP). The MEOSAR service adopts the WGS-84 coordinate system in accordance with the related COSPAS-SARSAT standards. The offset of the WGS-84 coordinate system and BDCS is far smaller than the error allowed by the SAR service.

8.2 Service Volume

BDS can provide the SAR service to all users on the surface of the Earth and its near-earth areas extending 50 kilometers above the Earth surface, while the beacon moving speed is less than 1 Mach.

8.3 SIS Interface Characteristics

8.3.1 User Uplink Distress Beacon Signal

User uplink distress signals are classified into the first-generation beacon signals and the second-generation beacon signals according to the types of 406 MHz beacons. The first-generation beacons are modulated by BPSK; the second-generation beacons are modulated by DSSS-OQPSK.

The first-generation beacon signal structure is detailed in COSPAS-SARSAT document T.001 "Specification for COSPAS-SARSAT 406 MHz Distress Beacons" (C/S T.001)[1], and the second-generation beacon signal structure is detailed in COSPAS-SARSAT document T.018 "Specification for Second-Generation COSPAS-SARSAT 406-MHz Distress Beacons" (C/S T.018)[1]。

8.3.2 SAR Payload Downlink Signals

The downlink signals of the SAR payload are mainly provided to the LUT stations. The BDS SAR payloads are designed to comply with COSPAS-SARSAT relevant standards and are compatible with other MEO SAR systems. The main opreating parameters are detailed in COSPAS-SARSAT document R.012 "COSPAS-SARSAT 406 MHz MEOSAR Implementation Plan" (C/S R.012)[1] and T.016 "Description of the 406 MHz Payloads Used in the COSPAS-SARSAT MEOSAR System" (C/S T.016)[1].

8.3.3 Return Link Signal RF Characteristics

The return link message (RLM) is broadcast by the B2b signal of the BDS-3 IGSO and MEO satellites.

RLM is carried by navigation messages formatting in the B-CNAV3 format, as defined by the B2b ICD. It includes data segments such as the user terminal ID, the message type, and the message content. The ID is the unique COSPAS-SARSAT identification code. The terminal in distress determines whether the message is sent to itself based on the ID.

For details, please refer to "BeiDou Navigation Satellite System Signal in Space Interface Control Document Public Service Signal B2b (Version 1.0)" (BDS-SIS-ICD-B2b-1.0).

8.4 Service Performance Characteristics

8.4.1 Usage Constraints

The MEOSAR service performance standards in this specification are based on the

1 The documents can be downloaded at http://www.cospas-sarsat.int/en/documents-pro/system-documents .

following Usage Constraints:

a) The signal transmitted by the user terminal complies with the C/S T.001 "Specification for COSPAS-SARSAT 406 MHz Distress Beacons", or C/S T.018" Specification for Second-Generation COSPAS-SARSAT 406-MHz Distress Beacons";

b) The user terminal needs to be registered according to the requirements of the COSPAS-SARSAT.

8.4.2 Detection Possibility

The detection probability refers to the probability that MEOLUT detects the transmission signal and recovers the valid beacon message within 10 minutes after the user terminal sends the first distress message.

8.4.3 Positioning Accuracy

The positioning accuracy refers to the statistical value of the difference between the user's position calculated by the ground MEOLUT station and the user's reference position.

8.4.4 Availability

The availability refers to the ratio of the serviceable time to the expected service time. The serviceable time refers to the time that system provided to meet the specified service performance.

8.4.5 Return Link Delay

The return link delay refers to the time interval from the time when the BDS return link service provider (RLSP) receives a user return link request to the time when the user terminal receives the corresponding RLM.

8.4.6 Return Link Success Rate

The return link success rate refers to the probability that the user terminal receives the corresponding RLM after the BDS RLSP receives the user's return link request.

8.5 Service Performance Standard

The SAR service performance standard is presented in Table 8-1.

Table 8-1 The SAR Service Performance Standard

Performance Characteristics	Performance Standard	Constraints
Positioning Accuracy	≤5km	Can be jointly used in with other MEOSAR systems; The user terminal complies with C/S T.001 standard or C/S T.018 standard; The MEOLUT complies with C/S T.019 "COSPAS-SARSAT MEOLUT PERFORMANCE SPECIFICATION AND DESIGN GUIDELINES"; The statistical period is not less than 3 months.
Detection Probability	≥99%	
Availability	≥99%	
Return link delay	≤2min	The user terminal complies with the C/S T.001 standard or the C/S T.018 standard, and supports the BDS return link.
Return link success rate	≥95%	

9 Ground Augmentation System Service

9.1 Service Overview

The Ground Augmentation System (GAS) Service is provided through mobile communications. Through the GAS Service, users can obtain real-time high-precision positioning services at the meter, decimeter and centimeter levels, as well as post-processing service at millimeter level. The main performance standards include positioning accuracy and convergence time, etc.

9.2 Service Volume

BDS can provide GAS service to areas covered by mobile communications in China and surrounding areas.

9.3 Service Interface Characteristics

The interface characteristics of GAS service are detailed in the BeiDou Navigation Satellite System Ground-based Augmentation Service Interface Control Document (Version 1.0) (BDS-SIS-ICD-GAS-1.0) .

9.4 Service Performance Characteristics

9.4.1 Usage Constraints

The GAS service performance standard in this specification are based on the following usage constraints:

a) The user terminals are consistent with the relevant technical requirements of BDS-SIS-ICD-GAS-1.0, and can track and process ground augmentation information for position calculations;

b) The service is based on BDT and BDCS;

c) Registration is needed for acquiring real-time centimeter-level network RTK and post-processing millimeter-level services.

9.4.2 Positioning Accuracy

The positioning accuracy refers to the statistical value of the difference between the user's reference position and the position determined by using the GAS service. The positioning accuracy includes the horizontal and vertical component respectively.

9.4.3 Convergence Time

The convergence time is the time to meet the positioning accuracy requirements for the first time, under the condition that the receiver starts meeting the positioning accuracy and continues for 5 minutes.

9.5 Service Performance Standard

The GAS service performance standard is presented in Table 9-1.

Table 9-1 The GAS Service Performance Standard

Service Type	Service Class	Performance Characteristics	Performance Standard	Constraints
Single Frequency Pseudo-range Augmentation Service	Real-time; Meter level	Horizontal Positioning Accuracy (95%)	≤1.2m	The constellations of support: BDS; Correction objects: the pseudo-range/ carrier phase measurement value of the BDS B1I signal,and carrier phase measurement value of the BDS B1I & B3I signals; Observation Conditions: Number of available valid satellites≥6; PDOP≤2; The elevation mask is 10°.
		Vertical Positioning Accuracy (95%)	≤2.5m	
Single Carrier Phase Augmentation Service		Horizontal Positioning Accuracy (95%)	≤0.8m	
		Vertical Positioning Accuracy (95%)	≤1.6m	
		Convergence Time	≤15min	
Dual Frequency Carrier Phase Augmentation Service	Real-time; Decimeter level	Horizontal Positioning Accuracy (95%)	≤0.3m	
		Vertical Positioning Accuracy (95%)	≤0.6m	
		Convergence Time	≤30min	
Dual or Multi-Frequency Carrier Phase Augmentation Service	Real-time; Centimeter-level	Horizontal Positioning Accuracy (RMS)	≤4cm	Registration is needed for user service; The constellations of support: BDS/GPS/GLONASS; Correction objects: the carrier phase measurement value of the BDS B1 I& B3I, GPS L1 & L2 & L5, GLONASS L1 & L2 signals; Observation Conditions: Number of available valid satellites≥6; PDOP≤2; The elevation mask is 10°.
		Vertical Positioning Accuracy (RMS)	≤8cm	
		Convergence Time	≤45s	
Relative Baseline measurement by Post-processing service	Post-processing; Millimeter-level	Horizontal Positioning Accuracy (RMS)	4mm	
		Vertical Positioning Accuracy (RMS)	8mm	

Appendix A: References

Index	Title	Released by
[1]	BeiDou Navigation Satellite System Signal in Space Interface Control Document Open Service Signal B1I (Version 3.0), BDS-SIS-ICD-B1I-3.0	China Satellite Navigation Office February 2019
[2]	BeiDou Navigation Satellite System Signal in Space Interface Control Document Open Service Signal B3I (Version 1.0), BDS-SIS-ICD -B3I-1.0	China Satellite Navigation Office February 2018
[3]	BeiDou Navigation Satellite System Signal in Space Interface Control Document Open Service Signal B1C (Version 1.0), BDS-SIS-ICD -B1C-1.0	China Satellite Navigation Office December, 2017
[4]	BeiDou Navigation Satellite System Signal in Space Interface Control Document Open Service Signal B2a (Version 1.0), BDS-SIS-ICD-B2a-1.0	China Satellite Navigation Office December, 2017
[5]	BeiDou Navigation Satellite System Signal in Space Interface Control Document Open Service Signal B2b (Version 1.0), BDS-SIS-ICD-B2b-1.0	China Satellite Navigation Office July, 2020
[6]	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	China Satellite Navigation Office July, 2020
[7]	BeiDou Navigation Satellite System Signal in Space Interface Control Document Search and Rescue Service (Version 1.0), BDS-SIS-ICD-SAR-1.0	China Satellite Navigation Office July, 2020
[8]	BeiDou Navigation Satellite System Ground-based Augmentation Interface Control Document (Version 1.0), BDS-SIS-ICD-GAS-1.0	China Satellite Navigation Office July, 2020
[9]	Specification for COSPAS-SARSAT 406 MHz Distress Beacons, C/S T.001	http://www.cospas-sarsat.int/en/documents-pro/system-documents
[10]	Description of the 406 MHz Payloads Used in the COSPAS-SARSAT MEOSAR System, C/S T.016	
[11]	Specification for Second-Generation COSPAS-SARSAT 406-MHz Distress Beacons, C/S T.018	
[12]	COSPAS-SARSAT MEOLUT Performance Specification and Design Guidelines, C/S T.019	
[13]	COSPAS-SARSAT 406 MHz MEOSAR Implementation Plan, C/S R.012	

Appendix B: Abbreviations

AOD	Age of Data
BDCS	BeiDou Coordinate System
BDS	BeiDou Navigation Satellite System
BDT	BDS Time
BDS-1	BDS Phase I
BDS-2	BDS Phase II
BDS-2G	a BDS-2 GEO satellite
BDS-2I	a BDS-2 IGSO satellite
BDS-2M	a BDS-2 MEO satellite
BDS-3	BDS Phase III
BDS-3G	a BDS-3 GEO satellite
BDS-3I	a BDS-3 IGSO satellite
BDS-3M	a BDS-3 MEO satellite
BOC	Binary Offset Carrier
BPSK	Binary Phase Shift Keying
CGCS2000	China Geodetic Coordinate System 2000
COSPAS-SARSAT	Космическая СистемаПоиска Аварийных Судов-Search And Rescue Satellite-Aided Tracking
DSSS-OQPSK	Direct Sequence Spread Spectrum-Offset Quadrature Phase Shift Keying
EPIRB	Emergency Position Indicating Radio Beacon
GAS	Ground Augmentation System
GEO	Geostationary Earth Orbit
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSMC	Global Short Message Communication
ICD	Interface Control Document
IERS	International Earth Rotation and Reference Systems Service
IGSO	Inclined Geosynchronous Orbit
ITRF	International Terrestrial Reference Frame
LUT	Local User Terminal
MCC	Mission Control Centre

MCS	Master Control Station
MEO	Medium Earth Orbit
MEOLUT	Medium Earth Orbit Local User Terminal
MEOSAR	Medium Earth Orbit Search And Rescue
NAV	Navigation (as in "NAV data" or "NAV message")
NTSC	National Time Service Center
OS	Open Service
PDOP	Position Dilution of Precision
PPP	Precise Point Positioning
PRN	Pseudo Random Noise
PVT	Position, Velocity, and Time
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RHCP	Right-Hand Circular Polarization
RLM	Return Link Message
RLSP	Return Link Service Provider
RNSS	Radio Navigation Satellite Service
RSMC	Regional Short Message Communication
RTK	Real Time Kinematic
SBAS	Satellite-Based Augmentation System
SIS	Signal In Space
SAR	Search And Rescue
SISA	SIS Accuracy
SISRAE	SIS Range Acceleration Error
SISRE	SIS Range Error
SISRRE	SIS Range Rate Error
T_{GD}	Time Correction of Group Delay
UTC	Universal Time Coordinated
UTCOE	UTC Offset Error
WGS-84	World Geodetic System 1984 Coordinate System