Update on BeiDou Navigation Satellite System (BDS)

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By the end of 2018, the construction of BDS-3 preliminary system has been completed to provide global services.

The BDS basic navigation service performance standards are as follows:

- **System service coverage:** global
- **Positioning Accuracy:** 10 meters horizontally
  10 meters vertically (95%)
- **Velocity measurement accuracy:** 0.2 m/s (95%)
- **Timing accuracy:** 20 nanoseconds (95%)
- **System service availability:** better than 95%
**System Construction**

2. BDS will completes the constellation deployment soon.

26 BDS-3 navigation satellites have been launched successfully, and the global constellation deployment will be accomplished soon.

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Launch Time</th>
<th>Orbit</th>
</tr>
</thead>
<tbody>
<tr>
<td>42th,43th</td>
<td>2018.11.19</td>
<td>MEO</td>
</tr>
<tr>
<td>44th</td>
<td>2019.04.20</td>
<td>IGSO</td>
</tr>
<tr>
<td>45th</td>
<td>2019.05.17</td>
<td>GEO</td>
</tr>
<tr>
<td>46th</td>
<td>2019.06.25</td>
<td>IGSO</td>
</tr>
<tr>
<td>47th,48th</td>
<td>2019.09.23</td>
<td>MEO</td>
</tr>
<tr>
<td>49th</td>
<td>2019.11.05</td>
<td>IGSO</td>
</tr>
<tr>
<td>50,51th</td>
<td>2019.11.23</td>
<td>MEO</td>
</tr>
</tbody>
</table>

10 navigation satellites have been successfully launched since ICG-13, and there are 44 operational BDS satellites in orbit currently.
System Construction

3. BDS operates continuously and stably

① SIS quality

Figure 1  Power Spectral Density of the BDS Satellites

② SIS Accuracy

Figure 2  URE of the BDS Satellites

Meet the requirements of the public and international users
01 System Construction  Reference frame accuracy, time stability

3. BDS operates continuously and stably

### Table 1 Transformation parameter conversion between BDCS to ITRF

<table>
<thead>
<tr>
<th></th>
<th>Trans_x mm</th>
<th>Trans_y mm</th>
<th>Trans_z mm</th>
<th>Rotate_x mas</th>
<th>Rotate_x mas</th>
<th>Rotate_x mas</th>
<th>Scal ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation</td>
<td>-0.37</td>
<td>1.12</td>
<td>-0.55</td>
<td>0.01</td>
<td>-0.02</td>
<td>0.05</td>
<td>0.011</td>
</tr>
<tr>
<td>Sigma</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
<td>0.03</td>
<td>0.03</td>
<td>0.04</td>
<td>0.012</td>
</tr>
<tr>
<td>3*Sigma</td>
<td>2.22</td>
<td>2.22</td>
<td>2.22</td>
<td>0.09</td>
<td>0.09</td>
<td>0.11</td>
<td>0.037</td>
</tr>
</tbody>
</table>

Figure 3 The stations adopted to evaluate the alignment accuracy between BDCS and ITRF

Figure 4 Difference between BDT and UTC(NTSC)

Reference frame accuracy

Time Stability

BDS operates continuously and stably
### 4. Five types of the BDS-3 services

<table>
<thead>
<tr>
<th>Type of service</th>
<th>Signal frequency</th>
<th>Satellite</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic navigation services</strong></td>
<td>B1I, B3I, B1C, B2a</td>
<td>3IGSO+24MEO</td>
</tr>
<tr>
<td><strong>B1I, B3I</strong></td>
<td></td>
<td>3GEO</td>
</tr>
<tr>
<td><strong>Regional short-message communication services</strong></td>
<td>L ( uplink )</td>
<td>3GEO</td>
</tr>
<tr>
<td><strong>Global short-message communication services</strong></td>
<td>S ( downlink )</td>
<td>14MEO</td>
</tr>
<tr>
<td><strong>International search and rescue services</strong></td>
<td>B2b ( downlink )</td>
<td>3IGSO+24MEO</td>
</tr>
<tr>
<td><strong>Precise Point Positioning service</strong></td>
<td>B2b</td>
<td>3GEO</td>
</tr>
</tbody>
</table>

**System Construction**

**Navigation, Positioning and Timing / SMCS(Global) / SAR**

**Five types of services**

**SBAS / PPP / SMCS(Regional)**

**Three kinds of services areas**

**Asia-Pacific**
4.1 The BDS performance

- **System Service Availability**: > 99%
- **Positioning Accuracy**: 3.6 meters horizontally, 6.6 meters vertically (95%)
- **Velocity Measurement Accuracy**: 0.05 m/s
- **Timing Accuracy**: 9.8 ns (95%)
- **In the Asia-Pacific region**, the positioning accuracies increased about 30% and availability increased 5%.

- **Global Coverage**, **System Service Availability**: > 87%
- **Positioning Accuracy**: 2.4 meters horizontally, 4.3 meters vertically
- **Velocity Measurement Accuracy**: 0.06 m/s
- **Timing Accuracy**: 19.1 ns (95%)
4.2 Short-message communication services (regional)

Service Planning:
- 3 GEO satellites
- Serve China and the surrounding regions
- System capacity increased by 10 times compared to BDS-2
- 1000 Chinese characters per message
- User power reduced to the previous 1/10 (1-3w)

Construction Progress:
- Launched: 1 GEO
- Underway: in-orbit tests
System Construction

4.2 Short-message communication services (global)

Service Planning:
- 14 MEO satellites
- Global access
- 40 Chinese characters per message

Construction Progress:
- Launched: 12 GEO
- Underway: in-orbit tests
4.3 Satellite-based augmentation services

**Service Planning:**
- 3 GEO satellites
- Follow ICAO standards
- Serve China and the surrounding regions

**Construction Progress:**
- Launched: 1 GEO
- Underway: in-orbit tests
01 System Construction

4.4 International search and rescue services

Service Planning:
- Follow international standards
- 6 MEO satellites
- Return-links

Construction Progress:
- Launched: 6 MEO
- Underway: in-orbit tests
System Construction

4.5 Precise Point Positioning Service

Service Planning:
- 3 GEO satellites
- Serve China and the surrounding regions
- Positioning precision: dynamic decimeter-level, static centimeter-level

Construction Progress:
- Launched: 1 GEO
- Underway: in-orbit technical tests
## 5. Information Dissemination

- The latest released documents of Open Service Performance Standard, Signal In Space Interface Control Document, System Time, and Reference Frame Template are shown as followings.
- More information is available at: [en.beidou.gov.cn](http://en.beidou.gov.cn)

<table>
<thead>
<tr>
<th>Document</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>BeiDou Coordination System Temple</td>
<td>2019.12</td>
</tr>
<tr>
<td>Space Weather Payloads Observation Data Onboard BDS Satellites</td>
<td>2019.12</td>
</tr>
<tr>
<td>Definitions and Descriptions of BDS/GNSS Satellite Parameters for High Precision Application</td>
<td>2019.11</td>
</tr>
<tr>
<td>BDS SIS ICD Open Service Signal B1I (V 3.0)</td>
<td>2019.02</td>
</tr>
<tr>
<td>BDS Open Service Performance Standard(V 2.0)</td>
<td>2018.12</td>
</tr>
<tr>
<td>BDS SIS ICD Open Service Signal B3i(V 1.0)</td>
<td>2018.02</td>
</tr>
<tr>
<td>BDS SIS ICD Open Service Signal B2a(V 1.0)</td>
<td>2017.12</td>
</tr>
<tr>
<td>BDS SIS ICD Open Service Signal B1C (V 1.0)</td>
<td>2017.12</td>
</tr>
<tr>
<td>BDS Timescale Description Reference Document</td>
<td>2016.11</td>
</tr>
</tbody>
</table>
System Construction

6. Future Plan

- **2019**: 2 BDS-3 satellites
- **2020**: 2 BDS-3 satellites
- **Before the end of 2020**: Possess Full Operational Capability
PART TWO

Applications Promotion
Applications Promotion

1. Fundamental Products

- The mass-production of the 22nm SoC chips integrated with the BDS RF and baseband has been initialized
- High-precision OEM boards and antenna have been sold to over 100 countries and regions
BDS has been widely used in traffic & transportation, agriculture, forestry & fishery, and many other fields.
The world's largest dynamic monitoring system operational vehicles has been built:
- operational vehicles: 7 million
- Postal and delivery vehicles: 30,000
- Buses: 80,000
- Inland waterway navigation facilities: over 3,200
- Marine navigation facilities: over 2,900
- Major accidents: decreased by 50%
- Deaths and disappearances: decreased by 50%
Serve agricultural equipment: **120,000+**

Labor cost for precision farming: **reduced by around 50%**

Income growth of Per Mu per peasant household: **RMB 60-90**

Networked boats: **70,000+**

Rescued people: **10,000+**
Applications Promotion

2.3 Disaster Response and Relief

- BDS/GNSS terminals promotion: 45,000+
- Relevant disaster response information has been enhanced
- Disaster relief materials management has been improved
3. Emerging Applications

- Integration of BDS and 5G mobile communication networks.
- Integration of BDS positioning technology and NB-IoT low-power WAN technology.
- Integration of BDS and artificial intelligence technology.
Applications Promotion

4. International Applications

• BDS has been adopted in many international applications, such as land rights confirmation, precision agriculture, warehouse logistics in ASEAN countries, building construction in West Asian countries, time service in airports, marine piling in South Asian countries, electricity patrolling and checking in Eastern European countries and homeland testing in African countries.
PART THREE

International Cooperation
International Cooperation

1. Bilateral Cooperation

- China-Russia cooperation has achieved many breakthroughs. The intergovernmental cooperation agreement has been signed and entered into force.
- China and the United States have been discussing B2/L5 signal interoperability after reaching consensus on the B1/L1 signal.
- China and the EU have actively promoted cooperation between BDS and Galileo systems and conduct frequency coordination.
International Cooperation

2. Multilateral Cooperation

- Hosted the ICG-13, the 10th China Satellite Navigation Conference, and many GNSS international training courses.
- Actively participated in international academic exchanges, such as Munich Satellite Navigation Summit, International Navigation Forum, etc.
- Held China Ancient Navigation Exhibition during 61th COPUOS meeting in UNOOSA
International Cooperation

2. Multilateral Cooperation

Jointly held the 2nd China-Arab States BeiDou Cooperation Forum.

Held the first China-Central Asia Cooperation Forum.

Established the China-ASEAN BDS /GNSS (Nanning) Center.
Positive efforts have been devoted to advance the BDS ratification in various international organizations and standards.
PART FOUR

Future Prospects
A more ubiquitous, integrated and intelligent PNT system will be established.

- In 2020, BDS will be fully completed. Besides RNSS, it will provide more high-quality services.
- In 2035, with BDS/GNSS as a core, a positioning, navigation, and timing system (PNT) with the supplement, backup, augmentation, and other multiple methods will be built.
Thank you
For your attention and support to BDS.

http://en.beidou.gov.cn