Tour de l’IGS Stop 4: BDS Constellation Spotlight

BDS Short Message Communication

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1. BDS-1 Short Message
2. BDS-2 Short Message
3. BDS-3 Short Message
4. Application of BDS-3 Short Message
I. Basic design of BDS-1

- Constellation: 3 GEO satellites with 2 work satellites and 1 backup satellite.
II. Coverage area and performance of BDS-1

- **Coverage Area:**
  - Longitude: 70°~140° E
  - Latitude: 5°~55° N
- Positioning and reporting are done in the same channel.

<table>
<thead>
<tr>
<th>Performance Characteristics</th>
<th>Performance Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timing accuracy</td>
<td>20ns</td>
</tr>
<tr>
<td>Response time</td>
<td>several seconds</td>
</tr>
<tr>
<td>Positioning accuracy</td>
<td>20m</td>
</tr>
<tr>
<td>Capability per Message</td>
<td>≤240bits</td>
</tr>
</tbody>
</table>
III. Message communication service (MCS) of BDS-1

- Support a single message of up to 120 Chinese characters
- The transmission delay is 0.5 seconds
- The maximum frequency of communication is 1 time per second

Realize two-way digital message communication between user machine and user machine and ground control center.
The principle of short message communication

**From transmitter to ground central station**

The transmitter of the short message first forwards the communication signal inbound through the satellite.

**From ground central station to receiver**

The ground central station forwards the received communication application to the user via satellite broadcasting. The receiver's user computer receives the outbound signal, demodulates and decrypts the outbound message.
III. Message communication service (MCS) of BDS-1

Based on RDSS and Message communication service, BDS-1 has been widely used in various fields.

Earthquake relief
Provide information on disaster and rescue

Flood control
Advance warning and parallel reporting

Landslide monitoring
Automatic acquisition, transmission and processing of monitoring data

Meteorological data communication
Make up for the traditional way of network blind area
I. BDS-2 Navigation Satellite System

The project was started in 2004, and by the end of 2012 a total of 14 satellites, which contains 5 GEOs, 5 IGSOs and 4 MEOs. BDS-2 inherits the active positioning and short message communication services of BDS-1, and adds passive positioning.
II. BDS-2 RDSS (Radio Determination Satellite System)

- BDS-2 RDSS services include:
  - Rapid positioning
  - Regional Short Message Communication (RSMC)
  - Precise timing

- RSMC—— The most important and valuable service of RDSS
  - Position Report
  - Users Communication (Send short message)

<table>
<thead>
<tr>
<th>Performance Characteristics</th>
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</tr>
</thead>
<tbody>
<tr>
<td>RMSC Service Capability</td>
<td>1680 bits per time (about 120 Chinese characters)</td>
</tr>
<tr>
<td>Service Success Rate</td>
<td>≥95%</td>
</tr>
</tbody>
</table>
III. The applications of BDS-2 RSMC

Applicable Scene:
- Areas that are not covered by communication signals: wild, sea, etc
- Emergency search and rescue
- Command and control
- Safety monitoring
- IoT applications

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III. The applications of BDS-2 RSMC

Representative Application:
I. Basic design of BDS-3

- Started in 2016 and completed in 2020
- Constellation: 30 satellites with 3 GEO, 3 IGSO and 24 MEO are on orbit.

Service: Regional short message communication (RSMC), **Global short message** communication (GSMC), Regional PPP, Global SAR, etc.
II. Signal of BDS-3

<table>
<thead>
<tr>
<th>Service type</th>
<th>Signal frequency</th>
<th>Satellite</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RNSS</strong></td>
<td><strong>Open</strong></td>
<td><strong>B1I, B3I, B1C, B2a, B2b</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Authorized</strong></td>
<td><strong>B1A, B3Q, B3A</strong></td>
</tr>
<tr>
<td><strong>SBAS</strong></td>
<td><strong>Open</strong></td>
<td><strong>B1C, B2a</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Authorized</strong></td>
<td><strong>B1A</strong></td>
</tr>
<tr>
<td><strong>Regional message communication services (RMCS)</strong></td>
<td><strong>Authorized</strong></td>
<td><strong>L(uplink), S(downlink)</strong></td>
</tr>
<tr>
<td><strong>Global short message communication services (GSMCS)</strong></td>
<td><strong>Uplink: 406MHz</strong></td>
<td><strong>14MEO</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>International SAR service</strong></td>
<td></td>
<td><strong>6MEO</strong></td>
</tr>
<tr>
<td><strong>Transmission of precise positioning information</strong></td>
<td><strong>B2b</strong></td>
<td><strong>3GEO</strong></td>
</tr>
</tbody>
</table>

- **3 signals** inherited from BDS-2: 
  - B1I, B3I, B3Q
- **5 new signals**: 
  - B1C, B1A, B2a, B2b and B3A

**Performance Improvement:**

- Advanced modulation method, channel coding and multiplexing
- Optimized navigation message structure
- Improved accuracy and anti-interference ability
III. Message communication service (MCS) of BDS-3

Support a single message of up to 1000 Chinese characters
The terminal transmission power is less than 3W
Inbound capacity is better than 10 million times/hour
III. Message communication service (MCS) of BDS-3

Regional short message communication (RSMC)

- Satellites: 3 GEO satellites
- Coverage Area: China and surrounding areas
- Maximum length of a single message: 14,000 bits (around 1,000 Chinese characters)

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<tr>
<td>Service Success Rate</td>
<td>≥95%</td>
</tr>
<tr>
<td>Service Time Delay</td>
<td>better than 2s on average</td>
</tr>
<tr>
<td>Service Frequency</td>
<td>30s per time</td>
</tr>
<tr>
<td>Capability per Message</td>
<td>≤14000 bits</td>
</tr>
</tbody>
</table>
III. Message communication service (MCS) of BDS-3

Global short message communication (GSMC)

- Satellites: 14 MEO satellites
- Coverage Area: Global
- Method: Global Random Access
- Maximum length of a single message: 560 bits (40 Chinese characters)

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<tr>
<td>Service Capability</td>
<td>Uplink 300,000 times/hour</td>
</tr>
<tr>
<td></td>
<td>Downlink 200,000 times/hour</td>
</tr>
<tr>
<td>Service Success Rate</td>
<td>≥95%</td>
</tr>
</tbody>
</table>
### IV. BDS-3 Search and Rescue (SAR) Service

- Main functions of BDS-3 SAR are nearly the same as the international SAR service.

<table>
<thead>
<tr>
<th>BDS-3 SAR Service</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Satellite: 6 MEO &amp; SAR Payloads</td>
<td>Two differences of BDS SAR</td>
</tr>
<tr>
<td>▪ Standard: COSPAS-SARSAT</td>
<td>▪ Return link</td>
</tr>
<tr>
<td>▪ Service area: Global</td>
<td>▪ Inter-satellite link</td>
</tr>
</tbody>
</table>

**Diagram:**
- **International SAR**
  - Distress beacon
  - Operation Control Center
  - SAR mission control Center
  - Rescue Center
- **BDS SAR**
  - Distress beacon
  - Operation Control Center
  - SAR mission control Center
  - Rescue Center
Compared with BDS-2, BDS-3 short message service capacity has been increased by 10 times, the transmission power of the user machine has been reduced to $1/10$, and the single communication capacity has reached 1000 Chinese characters (14000bit), which guarantees the feasibility of voice and image transmission.
C. Main Innovations

1. Coding and enhancement technology for very low rate speech compression

2. Image compression and transmission technology with error resistance and high compression ratio in narrow bandwidth

3. Efficient and reliable voice and image transmission protocol optimization technology

4. RDSS signal compatible receiving and processing technology

5. LPC analysis based on clear / voiced voice judgment in speech transition

6. Beamforming speech enhancement algorithm based on Ensemble Learning

7. Optimization of image transmission strategy with high compression ratio in narrow bandwidth

8. Speech and image transmission protocol resistant to long delay
Experimental video
Completed at the end of 2021:
Beidou major project - Research on voice and image transmission technology based on Beidou-3 RDSS Service.
Application

- Application product of beidou-3 voice and image transmission technology

- Beidou Bluetooth box: Geological survey, forestry
- Beidou law enforcement instrument: Patrol inspection, border defense
- Beidou vehicle mounted direct terminal: Forest defense, off road
- Beidou handheld terminal: Fire fighting, electricity
- Beidou multimode intercom: Border defense, Outdoor
- Beidou infrared camera: Wildlife Conservation, animals
- Beidou field call Post: National Park, scenic spot
- Beidou field camera: Reservoir, earthquake
- Huawei Mate 50: BDS satellite messager
Beidou is an integrated navigation and communication system. Based on Beidou RDSS satellite short message, it expands “Beidou +” satellite Internet of things applications such as Tiantong / Starlink satellite network.

- Battlefield Command
- Situational awareness
- Strike confirmation
- Remote investigation
- Ocean escort
Thanks for your attention!

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