Development and update strategy of Beidou reference frame

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Reference frame is the realization of coordinate system

Satellite navigation system: the reference frame can be reflected in broadcasted ephemeris through orbiting
Development of BeiDou reference frame

BDS-1 established in 2003

BDS-2 established in 2012

BDS-3 will provide global service in 2020
BDS-1—XI'AN 80 coordinate system

First realization: About 20 monitoring stations were established to support the operation, and approximately 10 stations were used for orbit determination of GEO satellite.

Update and maintain: Position of monitoring station is determined by adjusting with frame points of XI’AN 80, the coordinates were updated according to requirement.
First realization: About 30 monitoring stations were established for BDS-2, the coordinates of these stations were calculated by adjusting with high accuracy domestic stations and IGS stations.

Update and maintain: The coordinates of monitoring stations were updated once every 2-3 years, and will be updated yearly.
BDS-3 —— BDCS

Station selection: About 60 stations were selected, including about 10 monitoring stations, 3 IGS stations in China and approximately 50 IGS stations around the world.
Realization and maintenance of reference frame

**BDS-3 —— BDCS**

- **Observation technology:** GNSS is mainly used at present, other observation technologies such as VLBI, SLR may also be used.
- **Maintain:** The frame points are monitored continuously, and their coordinates are adjusted together with IGS stations. The coordinates and velocities of frame points will be determined regularly.
Test results

In order to verify the performance of BDCS, BDS/GPS data of 52 IGS core stations, 3 IGS stations in China and 11 MGEX stations were used. The time span is 2018.4-2018.5.
Test results - Coordinate repeatability

Repeatability in N, E and U directions are 0.77cm, 0.80cm and 1.17cm respectively.
Test results - Coordinate accuracy

Coordinate accuracy in N, E and U are 1.43cm, 1.32cm and 2.00cm respectively.
Test results - Transformation parameters

- 7-parameter transformation between BDCS and ITRF
- The common stations: 35 ITRF stations

<table>
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<th></th>
<th>X/cm</th>
<th>Y/cm</th>
<th>Z/cm</th>
<th>R1/mas</th>
<th>R2/mas</th>
<th>R3/mas</th>
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<td>-0.2</td>
<td>0.4</td>
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<td>σ</td>
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<td>0.025</td>
<td>0.030</td>
<td>0.031</td>
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- linear displacements: x, y smaller 0.5cm, about 1cm in z
- scale factor is -1.79 ppb (~ -1.1 cm)
- rotate elements are close to zero
To satisfy the requirement of reference frame interoperation, terrestrial reference frame of BDS will be updated yearly.

- **Update strategy**: Update information will be released on 30 June of each year based on yearly solution of coordinate and velocity of frame point

- **Improvement of current frame point**: In order not to influence the orbiting and positioning accuracy, the position of current frame point will be corrected step by step
Conclusions

- With development of BDS, its reference frame will also be improved gradually.

- In order to realize the interoperation between BDS and other GNSS, the reference frame of BDS will be updated every year.

- BeiDou terrestrial reference frame will keep close relation with ITRF.
THANK YOU!

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