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Part I Development Plan

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Part III Contribution to GNSS
CONTENTS

Part I Development Plan

Part II System Progress

Part III Contribution to GNSS
1. Development Objective

- Stable, reliable and high quality service
- Serve the world, benefit the mankind

Objective:

- Meet the requirements of national security and social economic development.
- Accelerate informationization drive as well as economy development mode transformation.
- Realize social and economic benefits.
- Make contribution to international GNSS community.
2. Development Plan

1st Step
BeiDou Demonstration System

2nd Step
BeiDou Navigation Satellite System

3rd Step
BeiDou Navigation Satellite System

First initiated in 1994, BeiDou demonstration system was able to provide regional active services in 2000.
BeiDou system construction was initiated in 2004 and will provide regional passive services by 2013.
2. Development Plan

BeiDou system will be developed continuously to provide global passive services by 2020.
3. Basic Policy

- Provide continuous space-based PVT services for global users free of charge, continue maintenance and complement in order to enhance service performance.

- Formulate application industry plan and standard to push forward development of GNSS industry and promote BeiDou worldwide use.

- Strengthen international cooperation, including advocating for international GNSS Monitoring and Assessment, achieving compatibility and interoperability between BeiDou and other GNSS, ensuring BeiDou diversified applications.
4. System Description

Space segment
- 5 GEO Satellites
- 30 Non-GEO Satellites

Ground Control Segment
- Master Control Station (MCS)
- Uplink Stations (US)
- Monitoring Stations (MS)

User Segment
- BeiDou user terminals
- Terminals compatible with other GNSS

China Satellite Navigation Office
4. System Description

Service and Performance

- Authorized service
- Wide area differential service
- Open service
- Position report service

Positioning accuracy ≤ 10 meters
Timing accuracy ≤ 20 ns
Velocity accuracy ≤ 0.2 m/s
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1. System Construction

1) Satellite launch record

<table>
<thead>
<tr>
<th>Launch Time</th>
<th>Satellite Number</th>
<th>Satellite Type</th>
<th>Launch Date</th>
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<tbody>
<tr>
<td>2007</td>
<td>1</td>
<td>IGSO</td>
<td>2011.12.2</td>
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<tr>
<td>2009</td>
<td>1</td>
<td>GEO</td>
<td>2012.2.25</td>
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<tr>
<td>2010</td>
<td>5</td>
<td>2 MEO</td>
<td>2012.4.10</td>
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<tr>
<td>2011</td>
<td>3</td>
<td>2 MEO</td>
<td>2012.9.19</td>
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<tr>
<td>2012</td>
<td>6</td>
<td>GEO</td>
<td>2012.10.25</td>
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</table>

Since ICG-6
2) Constellation status

- 14 BeiDou operational satellites in orbit.
- Constellation of 5GEOs, 5IGSOs and 4MEOs.

<table>
<thead>
<tr>
<th>Stage</th>
<th>01</th>
<th>02</th>
<th>03</th>
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<th>06</th>
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<tr>
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<td>Status</td>
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<td>In maintenance</td>
<td>Operational</td>
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<td>Operational</td>
</tr>
</tbody>
</table>
1. System Construction

3) Ground control segment

- Construction of Master Control Station, Uplink Stations and Monitoring Stations have been accomplished.
- Employ BeiDou Time (BDT) and CGCS2000 Coordinate.
1. System Construction

4) Coverage

Service area: \(55^\circ S \sim 55^\circ N, 55^\circ E \sim 180^\circ E\).
5) Initial Operational Capability

- On December 27, 2011, started to provide IOC.
- ICD of BeiDou System (test version) and Development of BeiDou Navigation Satellite System (V2.0) was released.
1. System Construction

6) Practical Operational Capability

Positioning and velocity accuracy

- Horizontal \( \leq 10\text{m (95\%)} \).
- Vertical \( \leq 15\text{m (95\%)} \).
- Velocity \( \leq 0.2\text{m/s} \).

**Diagram:**

- Distribution of error in E and N directions
- Chart showing PDOP and DOY(2012) with annotations for different DOYs and PDOP values.

BJF1 station SPP(B1 with K8 for ionosphere delay correction)

- dU(95%) = 7.38m
- 2D(95%) = 4.92m

PDOP(95%) = 4.77

- PDOP(95%) = 7.35
- PDOP(95%) = 4.77
- PDOP(95%) = 4.74

3G+4I
- 3G+5I(from 2012/02/07)
- 4G+5I(from 2012/04/16)
- 4G+5I+2M(from 2012/07/01)
1. System Construction

6) Practical Operational Capability

Broadcast ephemeris precision

- $\text{URE} \leq 1.5\text{m.}$
- Clock bias $\leq 5\text{ns.}$
1. System Construction

6) Practical Operational Capability

Orbit determination and time synchronization

- Orbit determination < 10 m.
- Time synchronization < 2ns.
1. System Construction

6) Practical Operational Capability

Ionospheric Model

- Ionospheric correction of Klobuchar 8 model is about 80%.
6) Practical Operational Capability

Satellite clock performance

- frequency accuracy of the master clock is $1.62 \times 10^{-12}$.
- drift is $3.05 \times 10^{-14}$.
- ten thousand seconds stability is $6.59 \times 10^{-14}$.
Since IOC provision, the continuous constellation deployment, gradual improvement of service performance has

- promoted R&D of BeiDou chips and terminals.
- Implemented application demonstration in various industries and regions.
- Popularized mass market.
2. System Application

1) Fundamental Products

Chips, antennas, OEM have been launched to market.
2) Industry Popularization

Transportation

- Road transportation management.

Marine Fishery

- Vessel position monitoring.
- Emergency rescue and region alarm.
- Port entry and depart management.
2. System Application

2) Industry Popularization

**Rescue**
- rescue dispatching.
- emergency communication.
- rapid report.

**Meteorology**
- Meteorological sounding.
- Meteorological monitoring.
- Meteorological information gathering and release.
3) Popular Application

BeiDou chips embedded mobile phones and vehicle terminals have been in practically used.
3. International Activity

- Undertake more international responsibilities through ICG related activities.
- Cooperate with major GNSS, and popularize applications with neighbor countries.
- Promote international technical exchange.
- Promote BeiDou to merge into international standards.
3. International Activity

1) Multilateral Coordination

- Deeply participate in activities of ICG as one of core system providers.
- Host the 7th meeting of ICG.
- Speed up iGMAS construction, strengthen cooperation with IGS, related organizations and other GNSS.

8th meeting of ICG Providers’ forum
55th meeting of COPUOUS
iGMAS tracking stations
Comply with radio regulations of ITU.

carry out more than 10 rounds of bilateral and multilateral coordination to jointly share frequency and orbit resources.

2) Bilateral Coordination

- 5th Frequency coordination of China and US
- 2011 orbit safety consultation meeting for 140E
- 12th Satellite Network coordination meeting between China and Japan
3. International Activity

2) Bilateral Coordination

- Meetings between China and Russia Satellite Navigation Cooperation to promote satellite navigation monitoring, interoperability and application.

- Satellite navigation cooperation meetings between China and Pakistan to jointly promote BeiDou/GNSS international popularization.
3. International Activity

3) International Exchange

- Take part in academic exchange activities sponsored by GNSS, international and regional organizations more than 10 times.
3) International Exchange

Education and training

- Set up international GNSS exchange and training center in Beihang University.
- Established GNSS frontier technology summer school.
- Established MASTA programme on GNSS
4) International Standardization

- Take part in 3 significant meetings of International Civil Aviation Organization (ICAO), promote BeiDou to enter into ICAO standard framework.
- Accomplish application procedure, promote BeiDou standardization in marine application.
1. Unique Development Pattern

- Form the development philosophy of Region highlighted, Global service and Distinguished features.
- Explore the roadmap of gradual development.
- Adopt the integration method of passive position and short message communication.
2. Innovative Technology

- Design hybrid asymmetry constellation: consists of GEOs, IGSOs and MEOs, rapidly realize application step by step.
- Provide triple frequency signals.
- Optimize system mechanism by uniting RDSS, RNSS and Wide-area differential services.
3. Numerous Application Occasions

- Having service capability in Asia-Pacific region, provide numerous choices of multi-systems compatible application.

- Having service capability of triple frequency navigation signals, expand innovative chances of high-precision application.

- Having integrated service capability of RNSS and short message communication, support diversified application.
Conclusions

BeiDou Construction

- The second deployment step has been accomplished.
- BeiDou will possess full operational capability early next year.
- BeiDou is expected to enter into comprehensive operational service stage.

BeiDou Application

- BeiDou chips is matured day by day.
- Application is promoted in large scale.
- ICD (formal version) is to be released to support industry development.
Conclusions

BeiDou International Activity

- Carry out international exchange, coordination and cooperation.
- Carry out BADEC, promote multi-GNSS fusion applications.
- Speed up the construction of iGMAS, support international monitoring and assessment to ensure reliable GNSS services for global users.
Thanks!

http://www.beidou.gov.cn