



International Committee on
Global Navigation Satellite Systems

The 7th Meeting of International Committee on GNSS

Development of BeiDou Navigation Satellite System

China Satellite Navigation Office

November 5, 2012

Beijing, China

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Part I Development Plan

Part II System Progress

Part III Contribution to GNSS

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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**

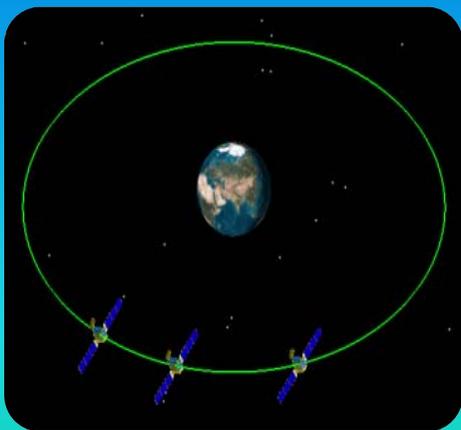
Objective:

- **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.**



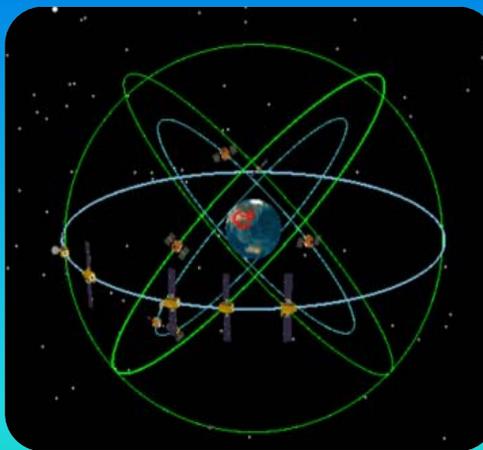
2. Development Plan

1st Step



BeiDou Demonstration System

2nd Step



BeiDou Navigation Satellite System

3rd Step



BeiDou Navigation Satellite System

1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020



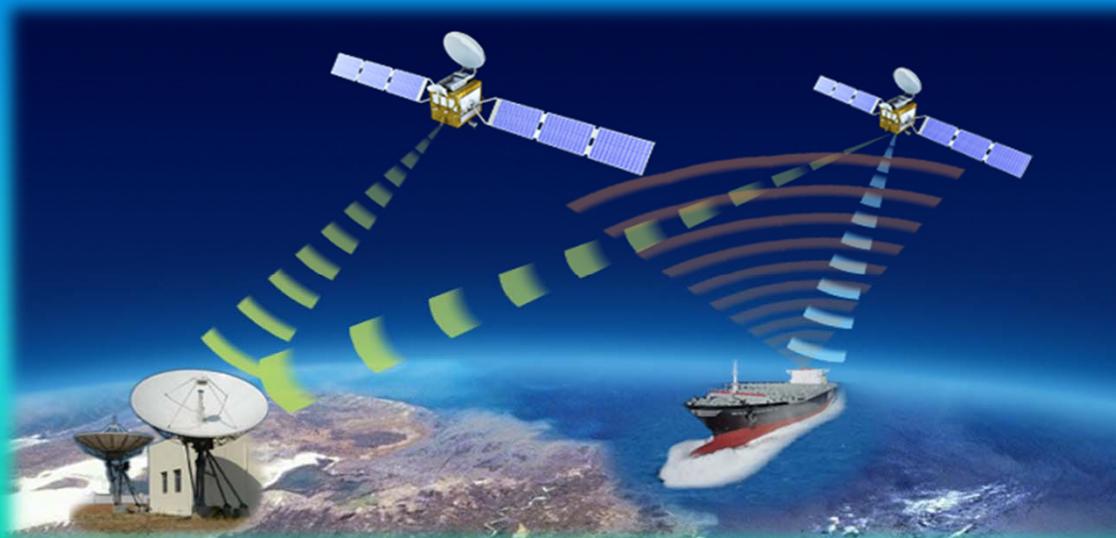
2. Development Plan

1st step

2nd step

3rd step

First initiated in 1994, BeiDou demonstration system was able to provide regional active services in 2000.





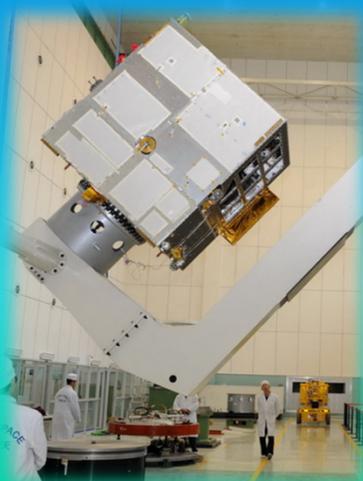
2. Development Plan

1st step

2nd step

3rd step

BeiDou system construction was initiated in 2004 and will provide regional passive services by 2013.





2. Development Plan

1st step

2nd step

3rd step

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

System Structure

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





4. System Description

Service and Performance



Positioning accuracy
 ≤ 10 meters

Timing accuracy
 ≤ 20 ns

Velocity accuracy
 ≤ 0.2 m/s

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Part I Development Plan

Part II System Progress

Part III Contribution to GNSS



1. System Construction

1) Satellite launch record

Launch Time	Satellite Number
2007	1
2009	1
2010	5
2011	3
2012	6

2011. 12. 2



IGSO

2012. 2. 25



GEO

2012. 4. 10



2 MEO

2012. 9. 19



2 MEO

2012. 10. 25



GEO

Since ICG-6



1. System Construction

2) Constellation status

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

Stage	BeiDou Navigation Satellites System															
Num	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Type	MEO	GEO	GEO	GEO	IGSO	GEO	IGSO	IGSO	IGSO	IGSO	GEO	MEO	MEO	MEO	MEO	GEO
Date	2007. 4.14	2009. 4.15	2010. 1.17	2010. 6.2	2010. 8.1	2010. 11.1	2010. 12.18	2011. 4.10	2011. 7.27	2011. 12.2	2012. 2.25	2012. 4.30	2012. 4.30	2012. 9.19	2012. 9.19	2012. 10.25
Status																



Operational



Flight test



In maintenance



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.



MCS



US



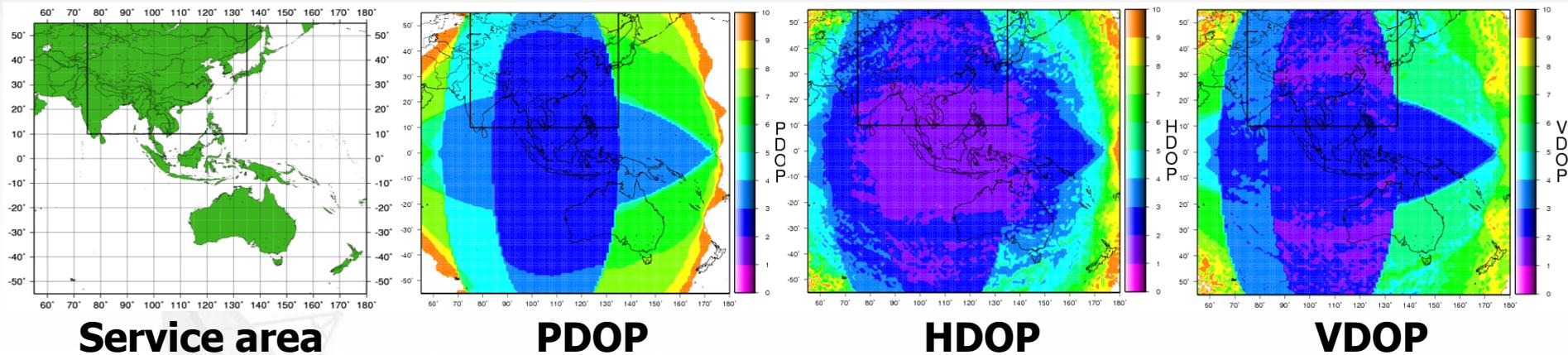
MS



1. System Construction

4) Coverage

Service area: $55^{\circ}\text{S} \sim 55^{\circ}\text{N}$, $55^{\circ}\text{E} \sim 180^{\circ}\text{E}$.

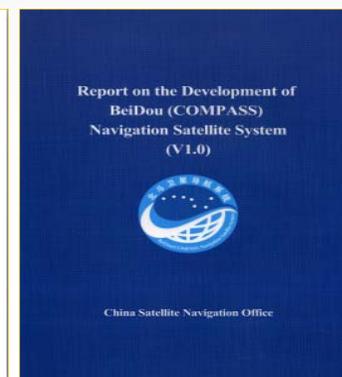
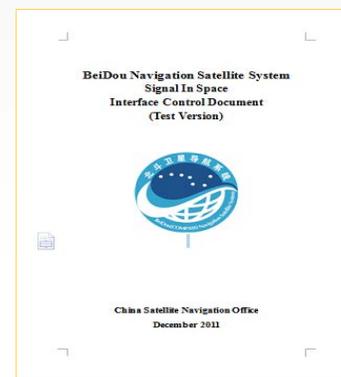




1. System Construction

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.



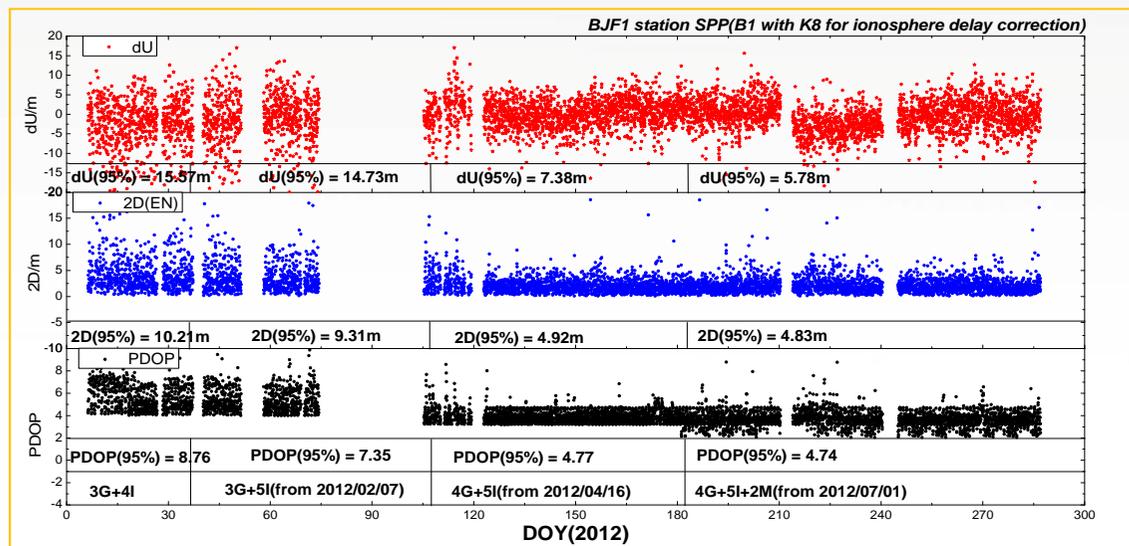
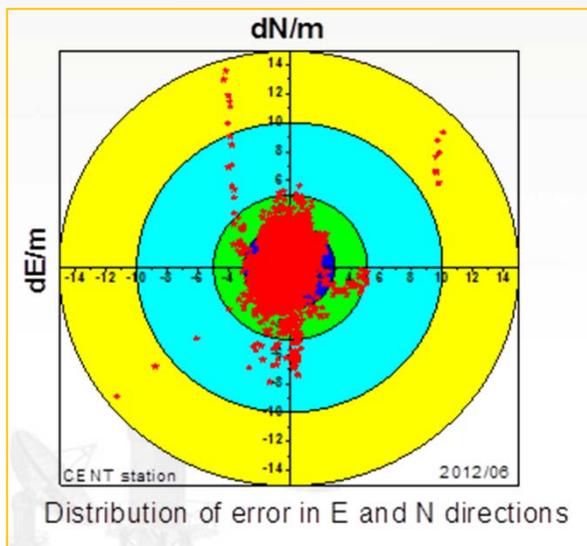


1. System Construction

6) Practical Operational Capability

Positioning and velocity accuracy

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



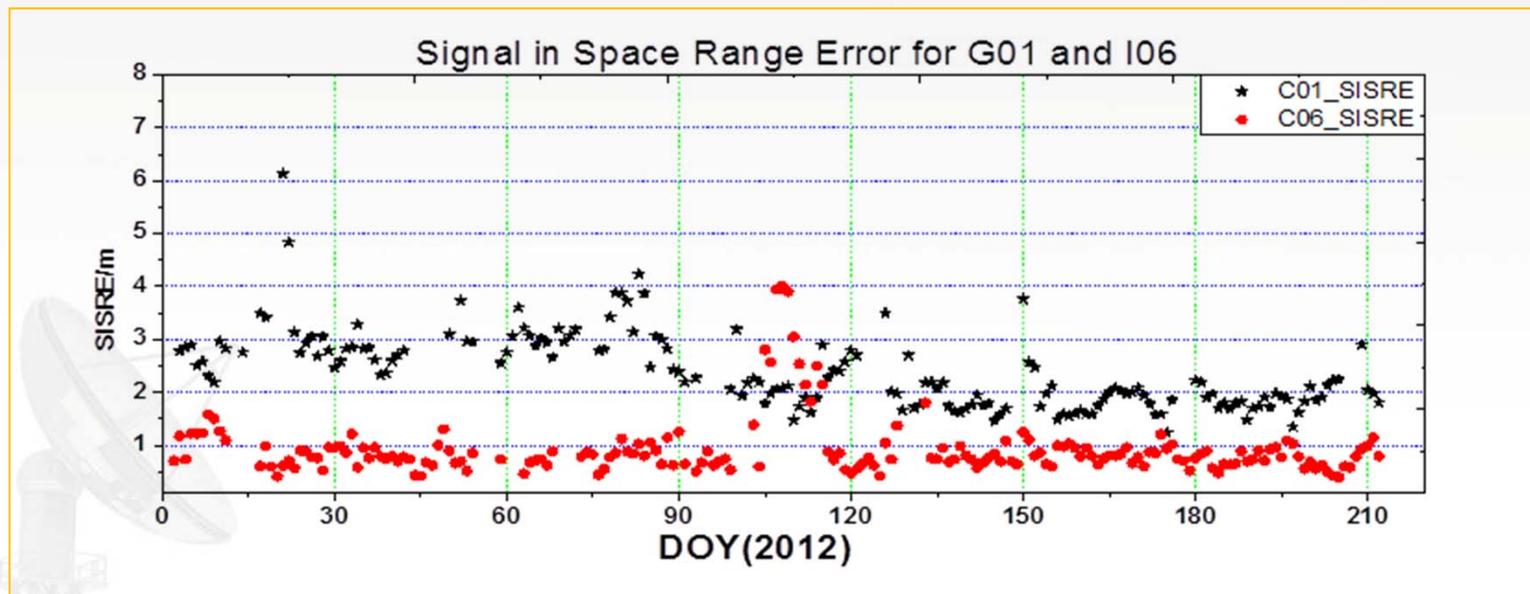


1. System Construction

6) Practical Operational Capability

Broadcast ephemeris precision

- **URE $\leq 1.5\text{m}$.**
- **Clock bias $\leq 5\text{ns}$.**



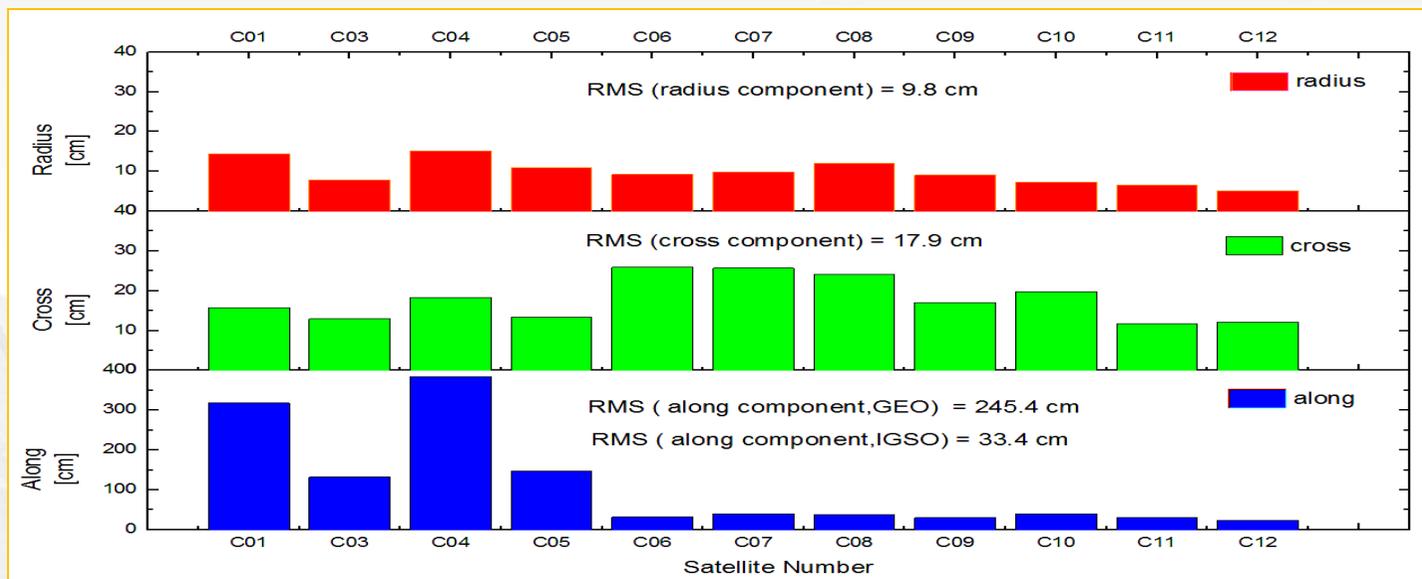


1. System Construction

6) Practical Operational Capability

Orbit determination and time synchronization

- Orbit determination < 10 m.
- Time synchronization < 2ns.



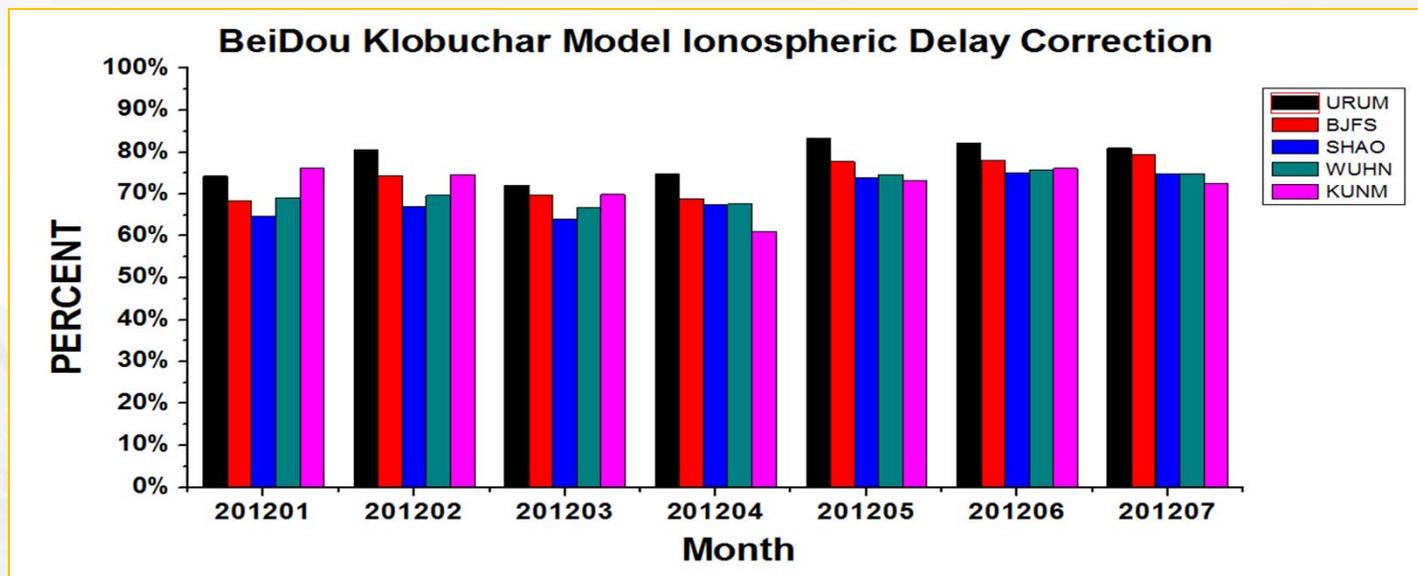


1. System Construction

6) Practical Operational Capability

Ionospheric Model

➤ Ionospheric correction of Klobuchar 8 model is about 80%.



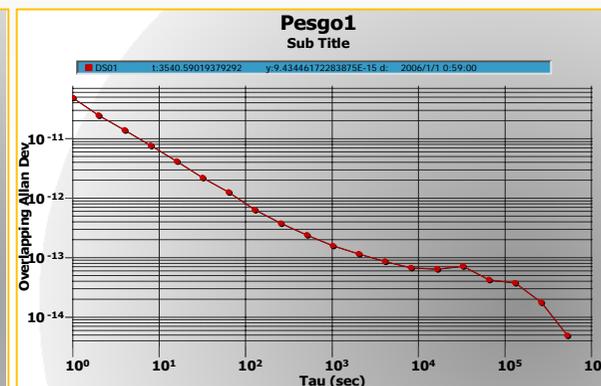
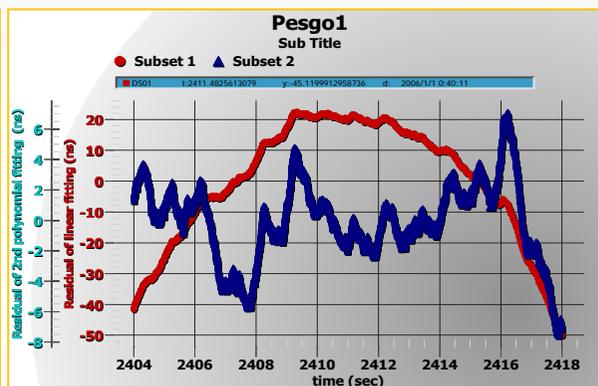
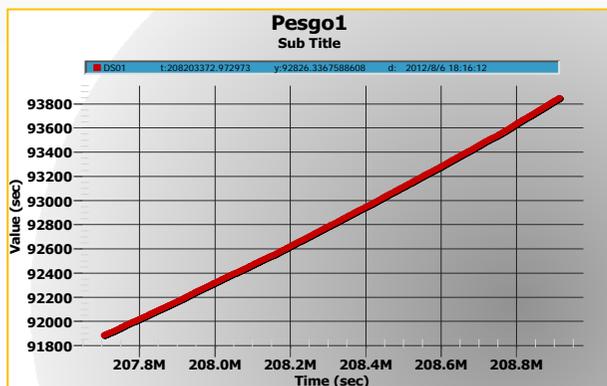


1. System Construction

6) Practical Operational Capability

Satellite clock performance

- frequency accuracy of the master clock is $1.62E-12$.
- drift is $3.05E-14$.
- ten thousand seconds stability is $6.59E-14$.





2. System Application

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.



Chips



OEM



Antenna



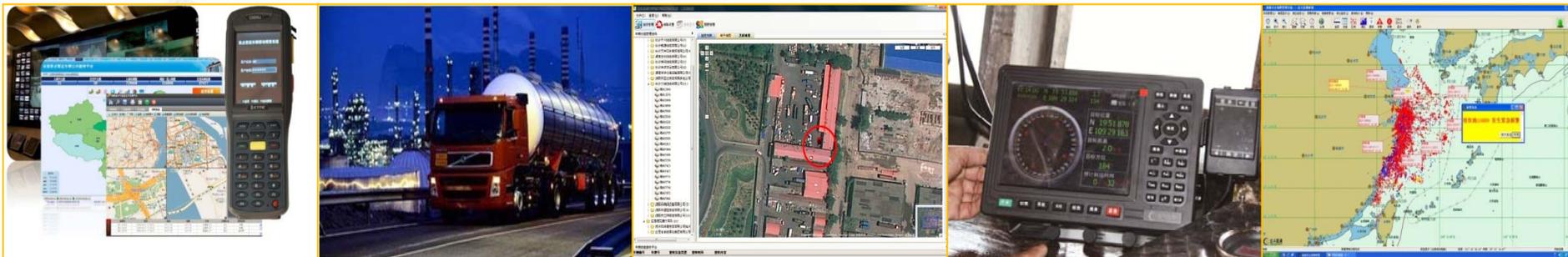
2. System Application

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

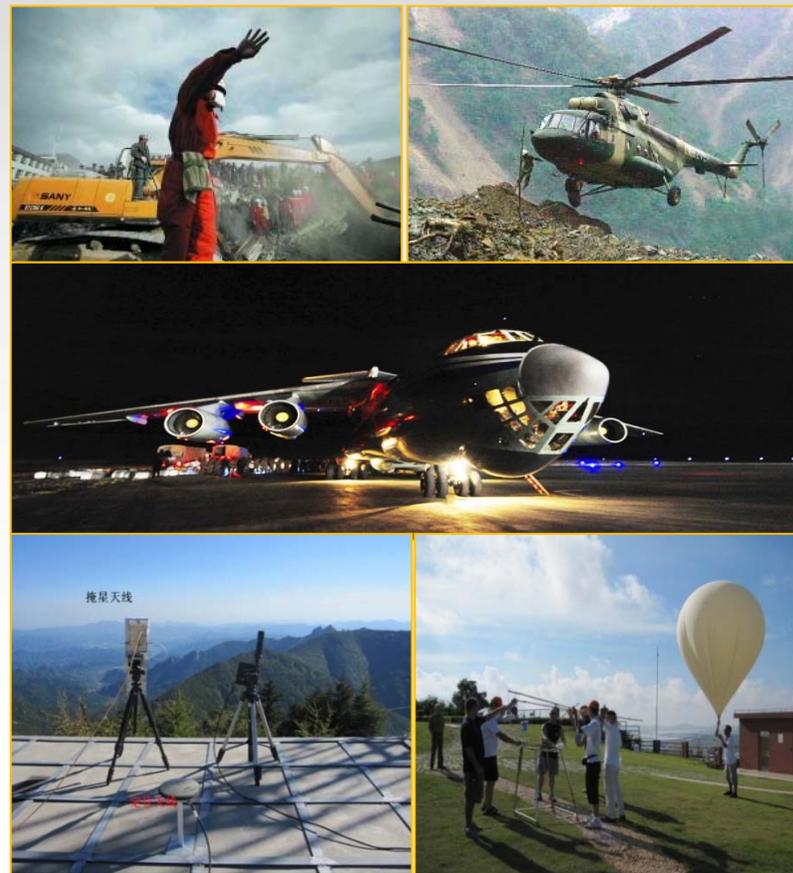
2) Industry Popularization

Rescue

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

Meteorology

- Meteorological sounding.
- Meteorological monitoring.
- Meteorological information gathering and release.





2. System Application

3) Popular Application

BeiDou chips embedded mobile phones and vehicle terminals have been in practical use.





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

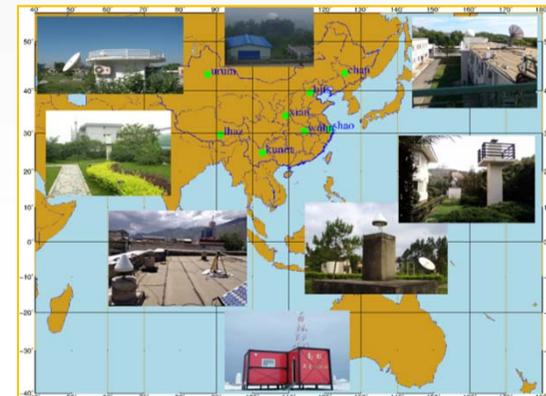
- Deeply participate in activities of ICG as one of core system providers.
- Host the 7th meeting of ICG.
- Speed up iGMAS construction, strengthen cooperation with IGS, related organizations and other GNSS.



8th meeting of ICG Providers' forum



55th meeting of COPUOUS



iGMAS tracking stations



3. International Activity

2) Bilateral Coordination

- Comply with radio regulations of ITU.
- carry out more than 10 rounds of bilateral and multilateral coordination to jointly share frequency and orbit resources.



2011 orbit safety consultation meeting for 140E



Technical Working Group meeting on C&I between China and Europe



5th Frequency coordination of China and US



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.



2nd China-Russia Aerospace cooperation working group meeting



The 2nd China-Pakistan Satellite Navigation Cooperation Meeting



3. International Activity

3) International Exchange

- Host world-oriented China Satellite Navigation Conference, more than 2000 persons presented in CSNC 2012.
- Take part in academic exchange activities sponsored by GNSS, international and regional organizations more than 10 times.





3. International Activity

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



International GNSS exchange and training center



GNSS frontier technology summer school



3. International Activity

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.



ICAO meeting



Multi-GNSS marine application
standardization meeting

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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

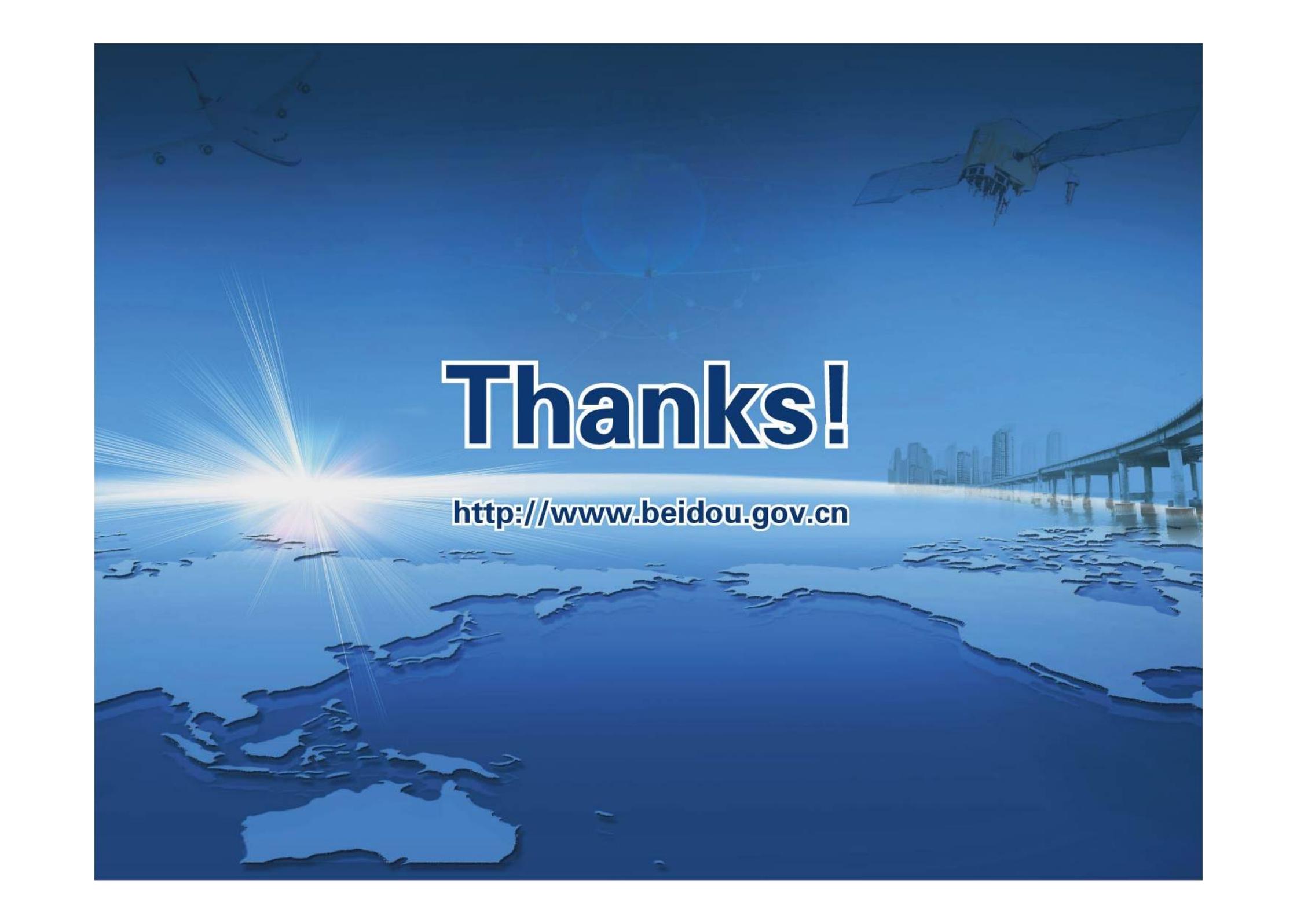
- **BeiDou chips is matured day by day.**
- **Application is promoted in large scale.**
- **ICD (formal version) is to be released to support industry development .**



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>