

Update of COMPASS (Beidou) And its Applications

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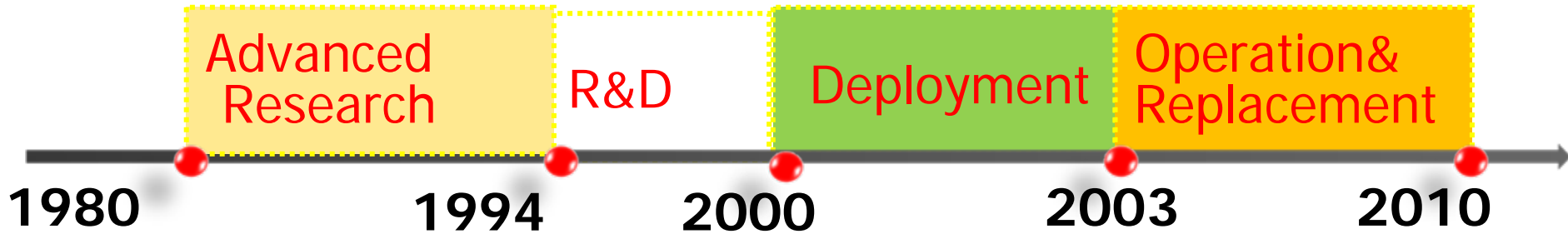
Outline

- 1. Introduction**
- 2. System Status update**
-
- 4. Applications**
- 5. Important Events**
- 6. Conclusion and CSNC 2011**

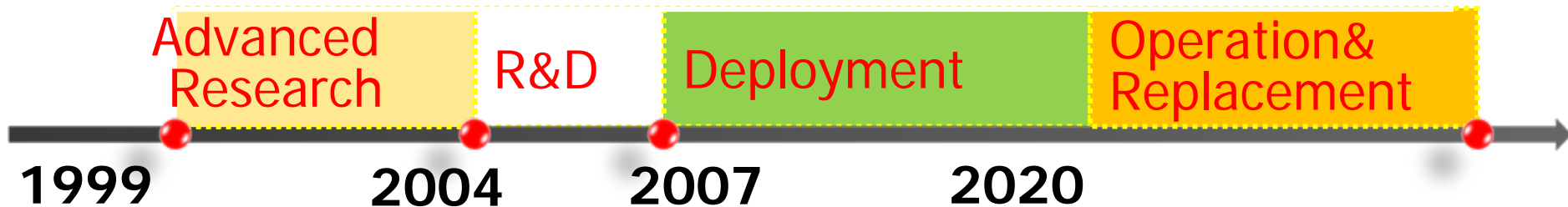


1 Introduction

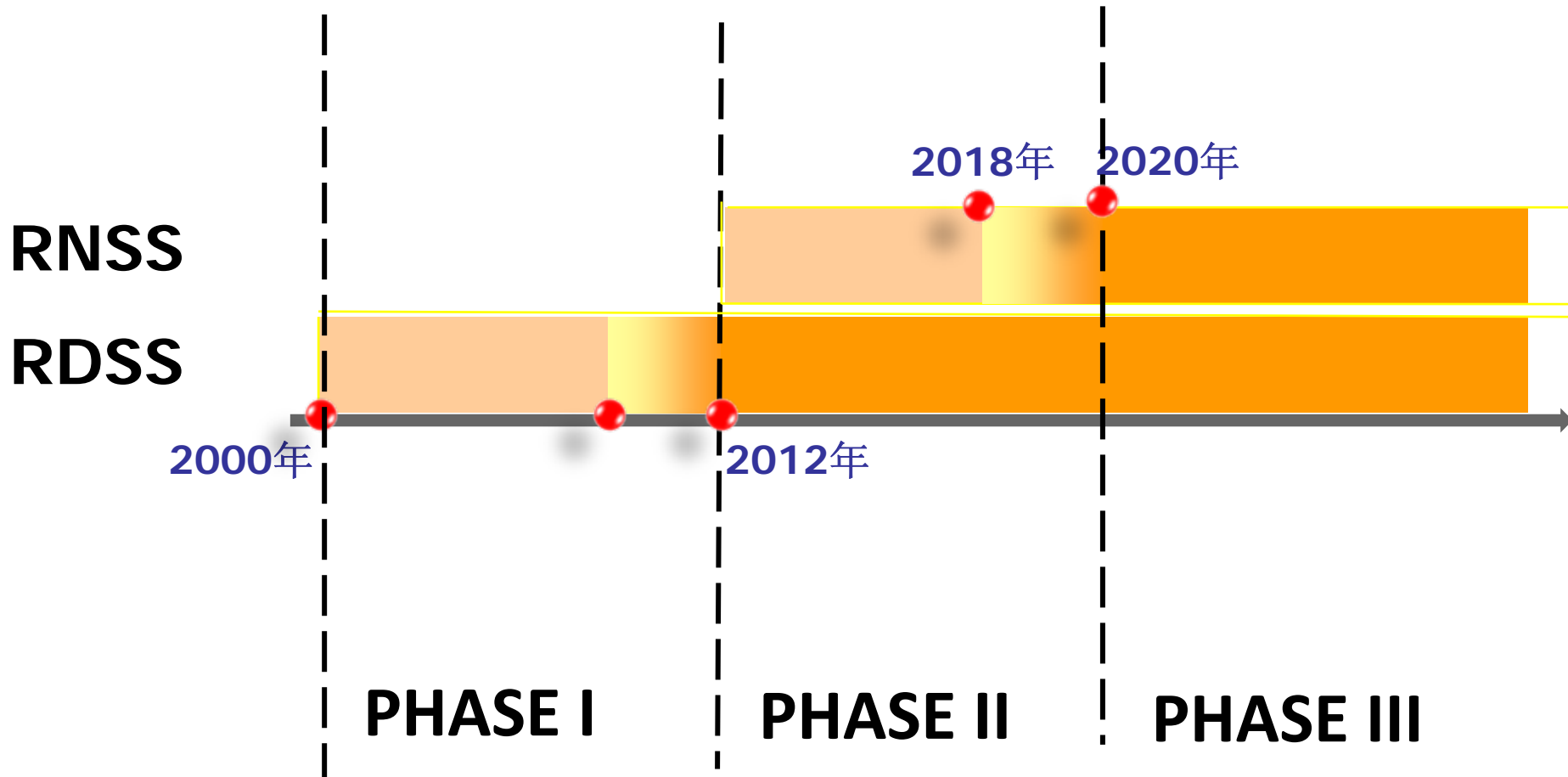
◆ BeiDou Navigation Demonstration System



◆ BeiDou Navigation Satellite System



Roadmap



1. Introduction - System Brief

1.1 System Infrastructure

1.2 Signal Characteristics

1.3 Service

1.4 Time & Coordinate System

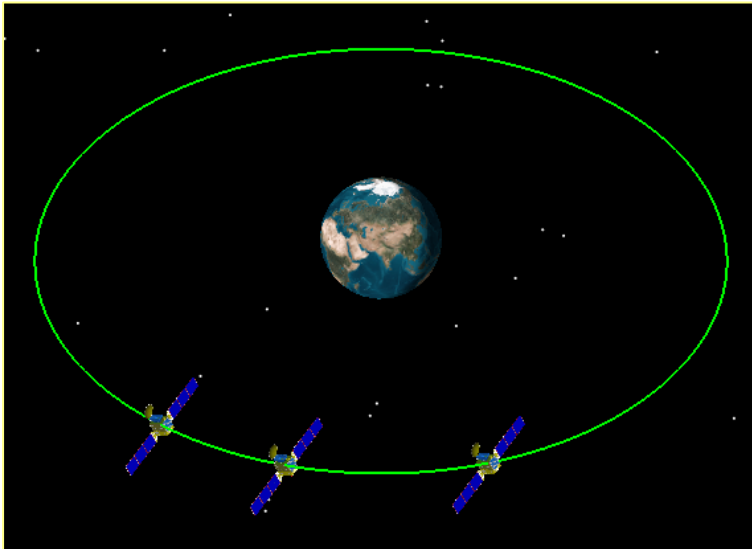


1.1 System Infrastructure

- ◆ Space segment
- ◆ Ground segment
- ◆ User segment



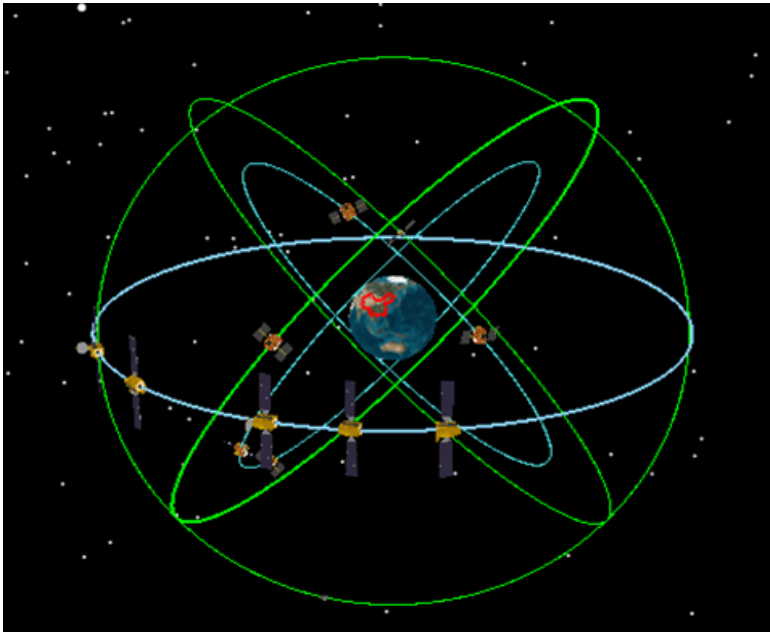
Space Segment Phase I:



Orbit	GEO
Semi-major Axis (km)	42164
Eccentricity	0
Inclination (deg)	0
RAAN (deg)	180E, 210.5E, 240E
Argument Perigee (deg)	0
Mean Anomaly (deg)	0
Satellite Number	2 operational 1 spare



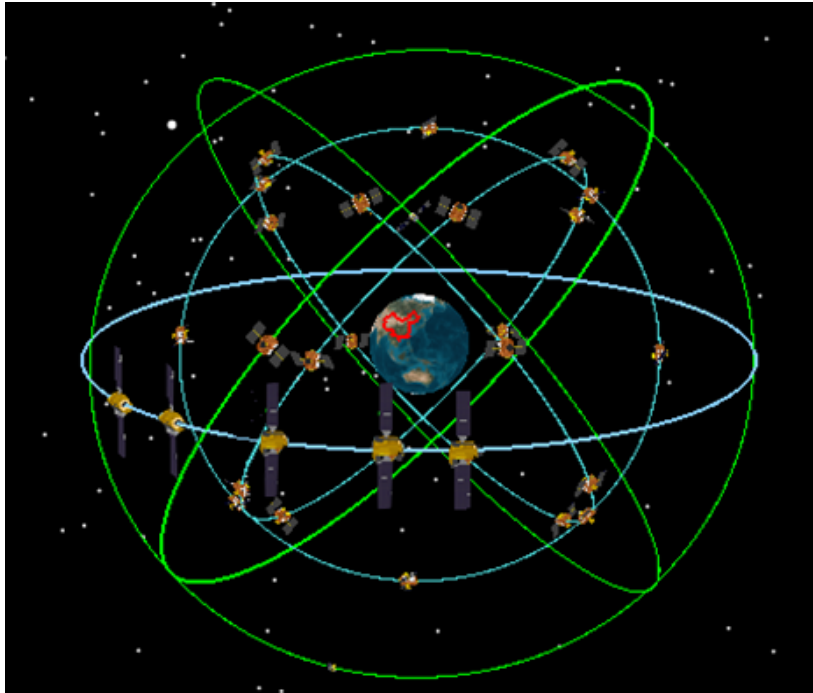
Space Segment Phase II:



Orbit	GEO	IGSO	MEO
Semi-major Axis (km)	42164	42164	27878
Eccentricity	0	0	0
Inclination (deg)	0	55	55
RAAN (deg)	158.75E, 180E, 210.5E, 240E, 260E	218E, 98E, 338E, 218E, 98E	0E, 120E
Argument Perigee (deg)	0	0	0
Mean Anomaly (deg)	0	218E:0, 98E:120, 338E:240, 218E:337, 98E:97	105, 150, 270, 315
Satellite Number	5	5	4
Plane Number	1	3	2



Space Segment Phase III:

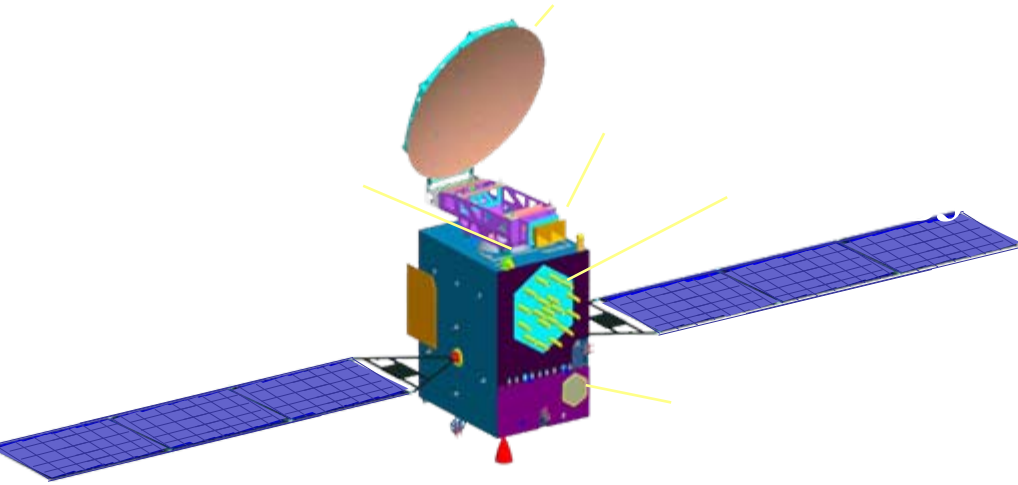


**MEO constellation:
Walker 24/3/1 plus 3 spares**

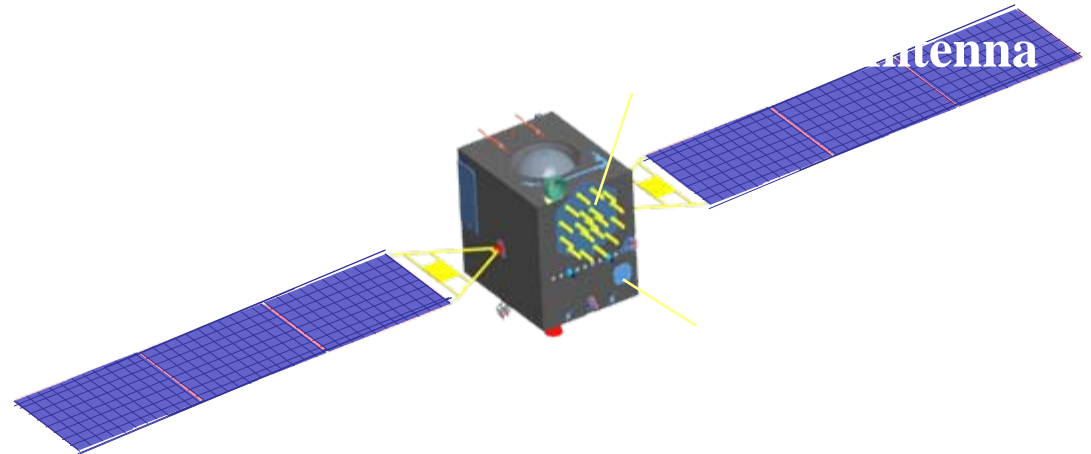
Orbit	GEO	IGSO	MEO
Semi-major Axis (km)	42164	42164	27878
Eccentricity	0	0	0
Inclination (deg)	0	55	55
RAAN (deg)	158.75E, 180E, 210.5E, 240E, 260E	218E, 98E, 338E	
Argument Perigee (deg)	0	0	---
Mean Anomaly (deg)	0	218E:0, 98E:120, 338E:240	
Satellite Number	5	3	27
Plane Number	1	3	3



◆ GEO Satellite



◆ MEO/IGSO Satellite



1.1 System Structure

◆ Ground Segment

- Master Control Station
- Uplink Station
- Monitor Station



1.1 System Structure

◆ User Segment

- **BeiDou user terminals**
- **Interoperable terminals with other GNSS**



1.2 Signal Characteristics

◆ Signals of PHASE II

Component	Carrier Frequency (MHz)	Chip Rate (cps)	Bandwidth (MHz)	Modulation Type	Service Type
B1(I)	1561.098	2.046	4.092	QPSK	Open
B1(Q)		2.046			Authorized
B2(I)	1207.14	2.046	24	QPSK	Open
B2(Q)		10.23			Authorized
B3	1268.52	10.23	24	QPSK	Authorized



1.2 Signal Characteristics

◆ Signals of Phase III

Component	Carrier frequency (MHz)	Chip rate (cps)	Data/Symbol rate (bps/sps)	Modulation Type	Service type
B1-C _D	1575.42	1.023	50/100	MBOC(6,1,1/11)	Open
B1-C _P			No		
B1	1575.42	2.046	50/100	BOC (14, 2)	Authorized
			No		
B2a _D	1191.795	10.23	25/50	AltBOC(15,10)	Open
B2a _P			No		
B2b _D			50/100		
B2b _P			No		
B3	1268.52	10.23	500bps	QPSK(10)	Authorized
B3-A _D		2.5575	50/100	BOC(15,2.5)	Authorized
B3-A _P			No		

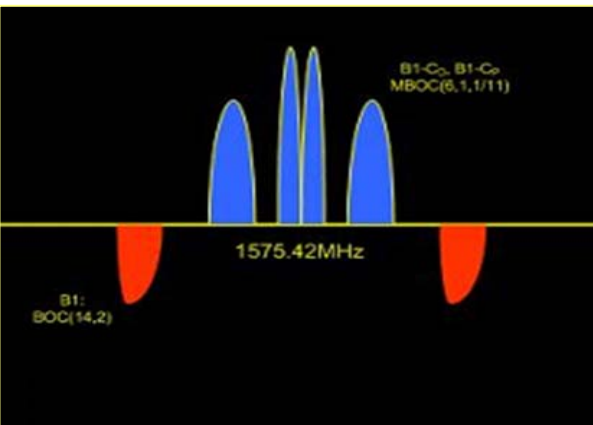




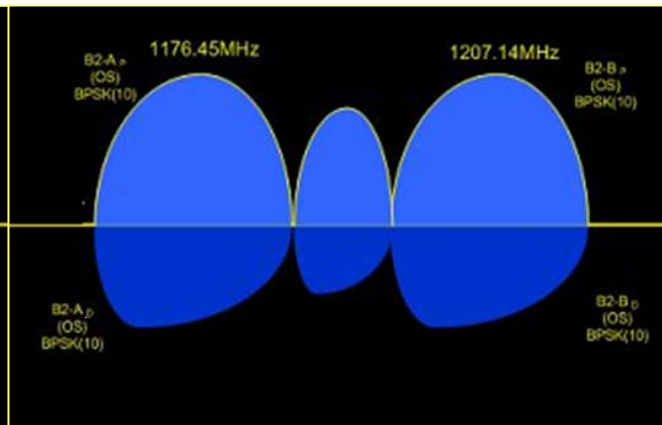
Open Services



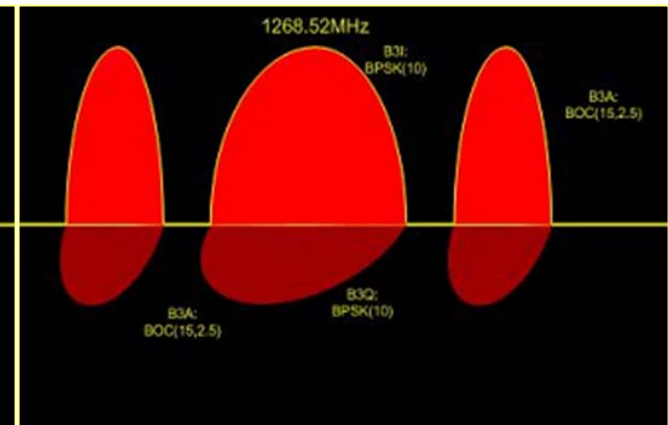
Authorized Services



B1 Signals



B2 Signals



B3 Signals



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1.3 Services and Performances

Two kinds of global services

Open Service open and free to users	Positioning Accuracy: 10 m
	Timing Accuracy: 20ns
	Velocity Accuracy: 0.2 m/s
Authorized Service	Ensure highly reliable use even in complex situations

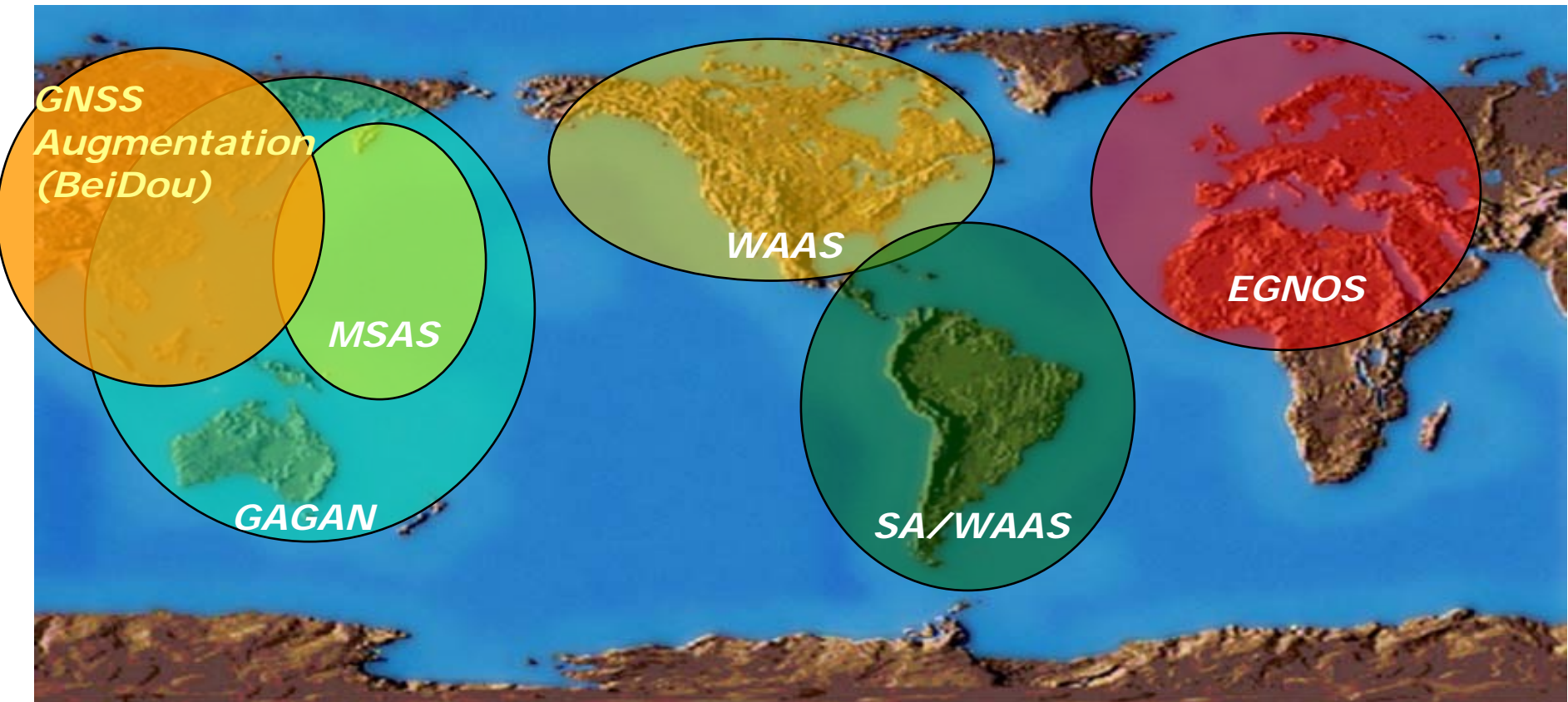


Two regional services from BeiDou

Wide range differential service:

Positioning accuracy: 1 m

Short message service



Augmentation Systems in the world



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1.4 Time and Coordinate System

BeiDou time (BDT) is aligned to UTC

China Geodetic Coordinate System 2000 (CGCS2000)

is consistent with ITRS

Both BDT and CGCS2000 is improving



2. System Status update

2.1 System Deployment

2.2 Satellite Launch event in 2010

2.3 In-orbit Verification



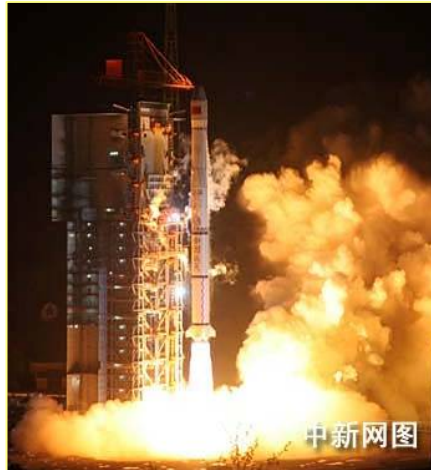
2.1 System Deployment

◆ Phase I—Demonstration System

- From 2000 to 2003, 3 GEOs were launched



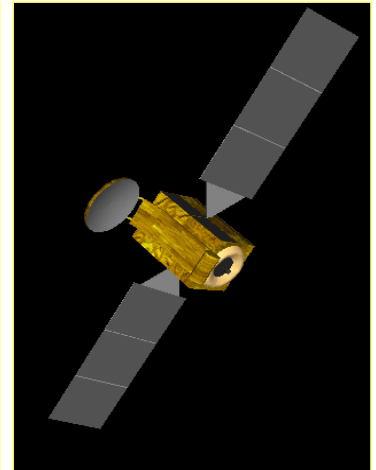
Oct 31, 2000
140E



Dec 21, 2000
80E



May 25, 2003
110.5E



2.1 System Deployment

At present, system construction has come into the phase II.

<i>Date</i>	<i>Type</i>	<i>Launch Center</i>	<i>Launch Carrier</i>	<i>Launch Cabin</i>	<i>Orbit</i>
2007.04.14	MEO	Xichang	CZ-3A	DFH-3	~21,500km
2009.04.15	GEO	Xichang	CZ-3C	DFH-3	In-orbit maintenance
2010.01.17	GEO	Xichang	CZ-3C	DFH-3	144.5° E
2010.06.02	GEO	Xichang	CZ-3C	DFH-3	84° E
2010.08.01	IGSO	Xichang	CZ-3A	DFH-3	Intersecton node:118° E



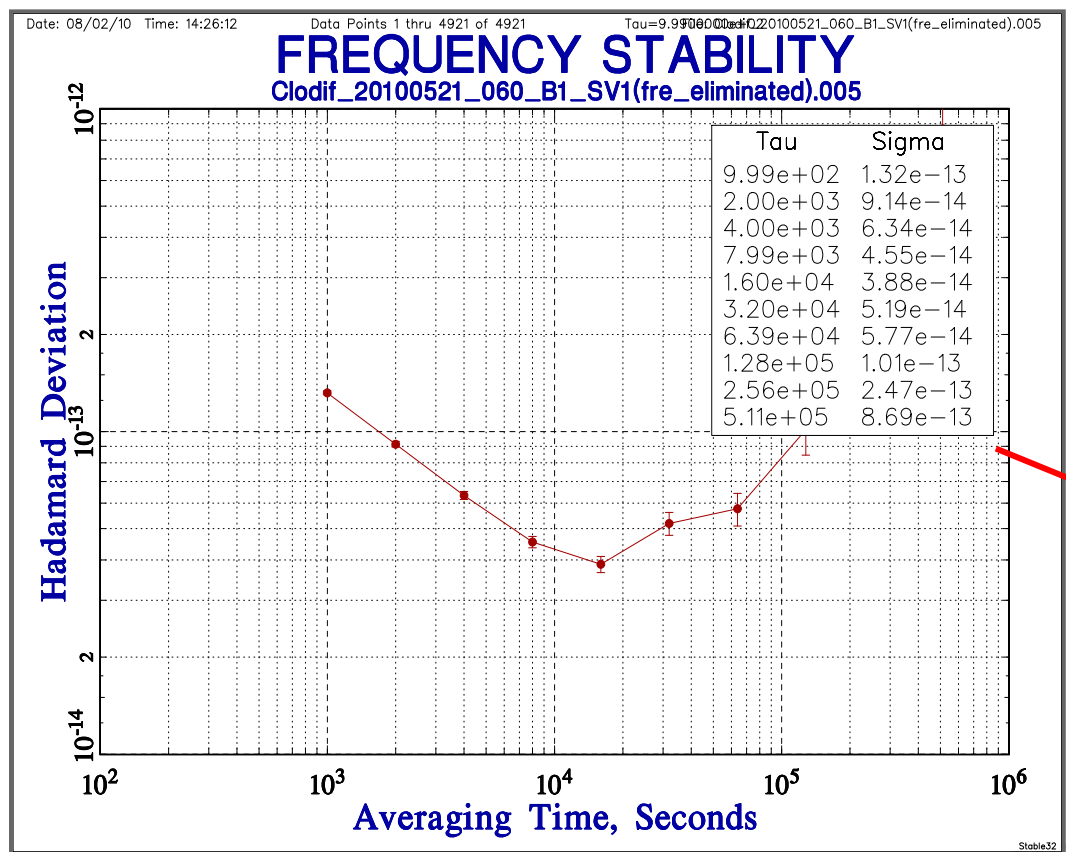
2.2 Satellite Launch Event in 2010

- **In November , 6th satellite — 4th GEO**
- **After the ICG5, In December 18,
7th satellite — 2nd IGSO**



2.3 In-orbit Verification

◆ Rubidium Atom Frequency Standard Stability:

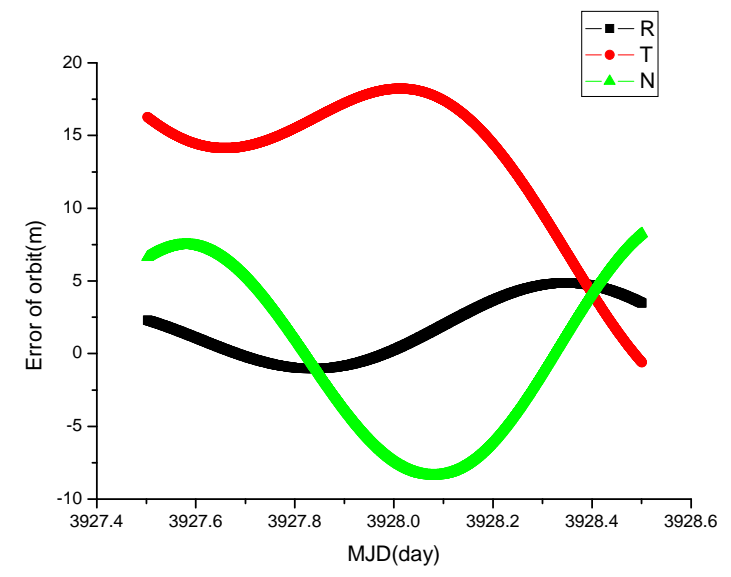
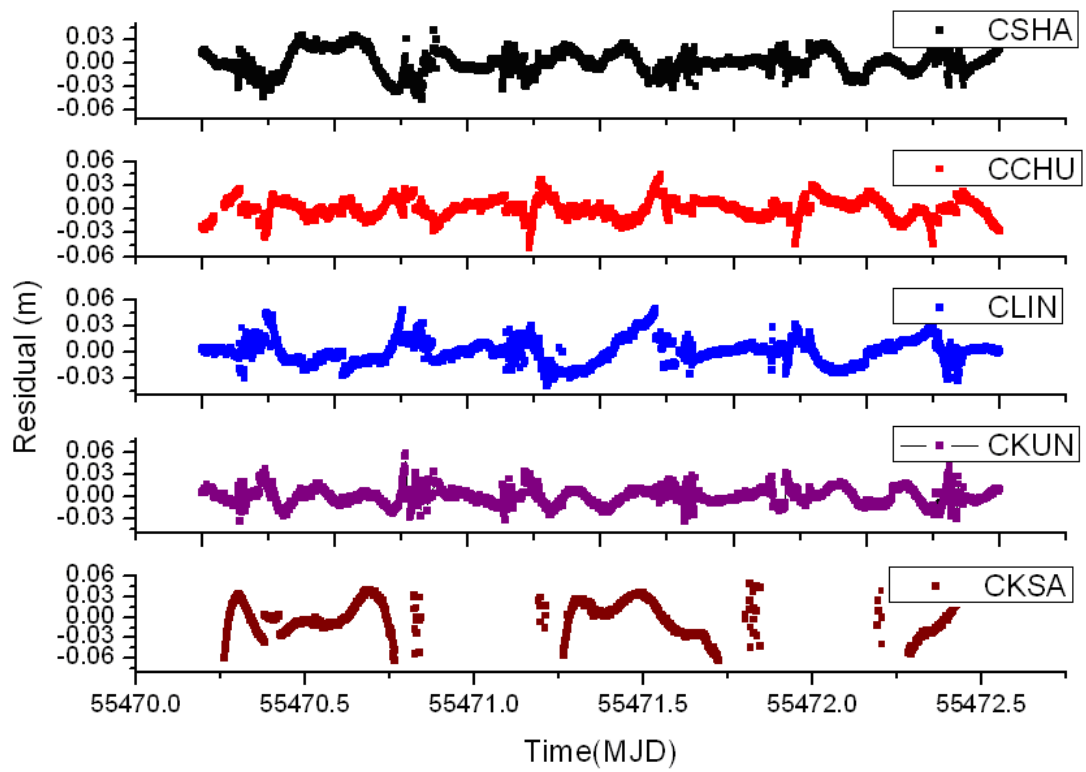


**Stability:
5e-14/day**



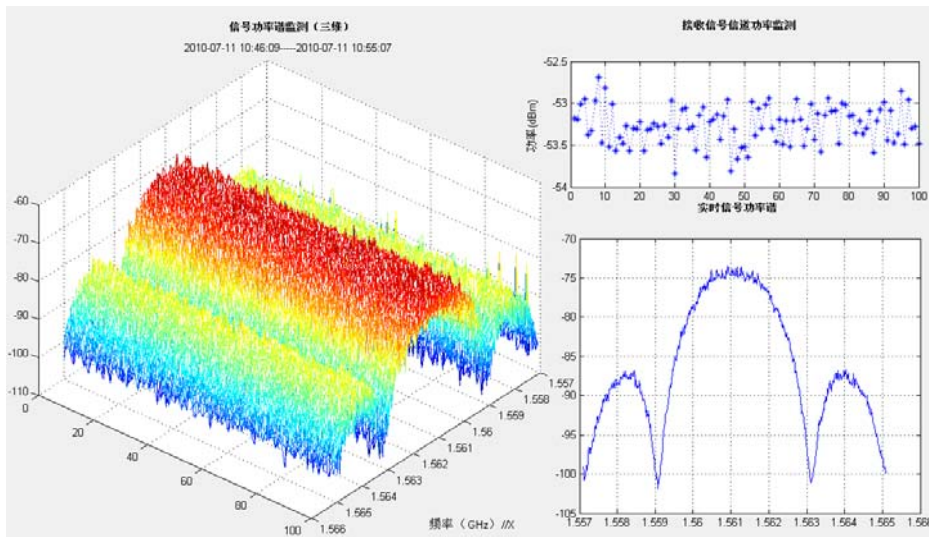
2.3 In-orbit Verification

- **Orbit determination precision: < 10 m**
- **Time synchronization precision: < 2ns**

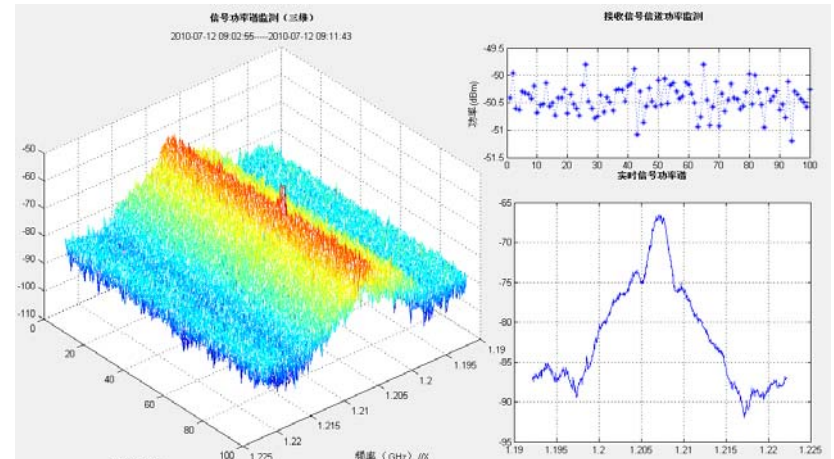


2.3 In-orbit Verification

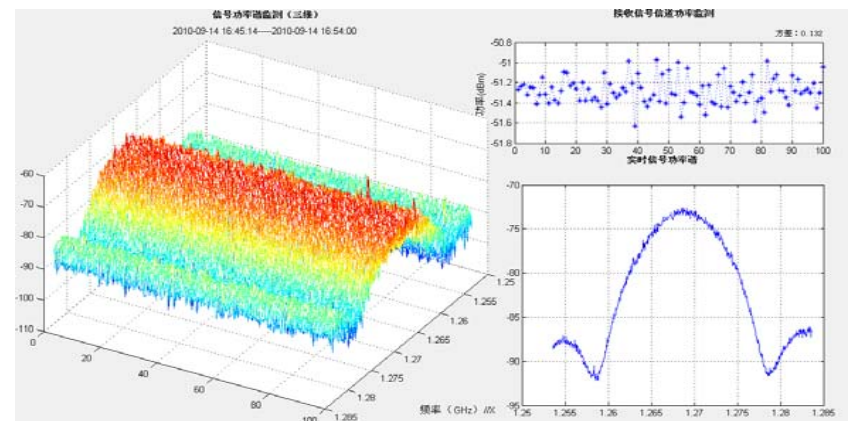
◆ Signal Spectrum



B1 Signal



B2 Signal



B3 Signal



3 Applications

- ◆ **Fishery**
- ◆ **Transportation**
- ◆ **Water conservancy**
- ◆ **Meteorology**
- ◆ **Forest Fire Prevention**
- ◆ **Timing**
- ◆ **Disaster Prevention and Mitigation**
- ◆ **Soil Monitoring**



Fishery



Distribution of marine fishery applications



BeiDou-based integrated information service network

- **Fishery management services**
- **Fishing boat services**
- **SMS services**



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Fishery

- ◆ 14,000 fishing users, more than 40,000 mobile phone users
- ◆ Since 2007, more than 500 fishing boat emergency alarms and hundreds of vessel cross-border warnings



Transportation

- ◆ Ship monitoring system
- ◆ Road infrastructure safety monitoring system



Water conservancy

BeiDou based hydrologic monitoring system:

- **more than 4,000 users**
- **Southern regions of Shaanxi**
- **Changjiang valley**
- **Yellow river basin**
- **Especially in Barrier lake during Wenchuan earthquake**



Meteorology

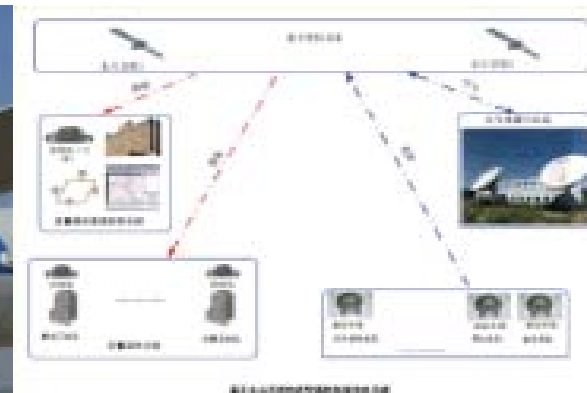
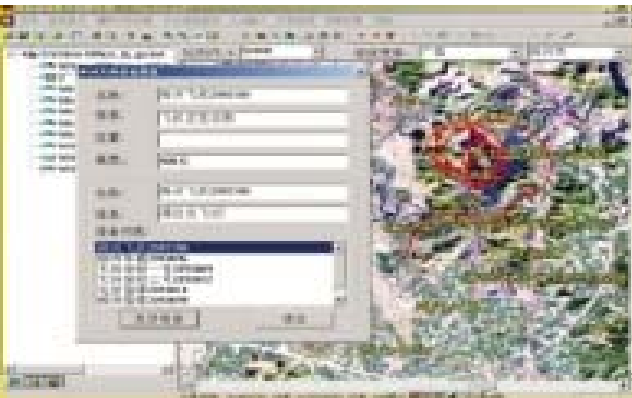
Series of weather forecasting terminals and system application solutions:

- **Automatic digital information transmission and collection among national administration, regional centers and various weather stations**
- **Visualization of weather station distribution map**
- **hundreds of Beidou terminals**



Forest Fire Prevention

- Fire positioning and detection, guided fire fighting, logistic support and damage assessment
- In 2001, study of Beidou application in forest fire prevention
- In 2002, application demonstration completed
- In 2003, practical use in forest fire prevention
- More than 200 terminals equipped in forest fire prevention systems, more than 500 terminals equipped in forest headquarter and affiliated forces



Timing

- Beidou/GPS dual-mode time synchronization devices
- Embedded Beidou/GPS timing module



- Timing test of CDMA network in 7 provinces of southeast coast
- Successful trials in 200 sets of base station equipments
- applied more than 4 years
- Synchronization accuracy : $< 100\text{ns}$



Disaster Prevention and Mitigation

Improving rescue response and decision making capability

- **Rapid and timely disaster forecast warning report**
- **Rescue command scheduling**
- **Rapid emergency communication**



After earthquake happened in Wenchuan Sichuan Province and Yushu Qinghai Province, Beidou terminals sent the disaster and rescue information to command center at the first time.



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Soil Monitoring

- Remote data collection
- BeiDou system
- GIS technology
- Satellite remote sensing



- Real-time monitoring of the soil moisture, temperature, humidity and location
- Comprehensive drought condition analysis
- Land area and distance measurement



◆ Frequency coordination

	Sequence	Time	Location
BeiDou & GPS	1	Jun 2007	Geneva, Switzerland
	2	May 2008	Xi'an, China
	3	Oct 2008	Geneva, Switzerland
	4	Dec 2009	Sanya, China
	5	Sep 2010	Chengdu, China
BeiDou & Galileo	1	May 2007	Beijing, China
	2	Jan 2010	Beijing, China
BeiDou & GLONASS	1	Jan 2007	Moscow, Russia



◆ Technical Working Group on Compatibility and Interoperability

	Sequence	Time	Location
BeiDou & Galileo	1	Sep 2008	Beijing, China
	2	Dec 2008	Beijing, China
	3	Jun 2009	Brussels, Begium
	4	Jan 2010	Beijing, China
	5	Oct 2010	Brussels, Begium



4 Important events

Nation level

In Sep 8th, 2010, the documents of “The decision on striving to cultivate and develop strategic emerging industries” adopted by State Department

A new generation of information technology established as one of seven strategic emerging industries



Satellite navigation technology: one important member of the new generation of information technologies.

Included in the "12th Five-Year" plan of many Ministries, Commissions and Administrations of the government

- **Development and Reform**
- **Transportation**
- **Meteorology**
- **Agriculture, etc.**



Academic Events in China

CSNC (China Satellite Navigation Conference)
**Shanghai Intelligent Traffic and Navigation
Industry Technology Development Forum**
CPGPS (Chinese Professionals in Global
Positioning Systems) Forum



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CSNC 2010

1st China Satellite Navigation Conference(CSNC2010)

May 19 to 21, 2010, China National Conference Center

Large number of participants: More than 1000 experts, scholars and other representatives, more than 400 proposed paper, dozens of enterprises entrance into satellite navigation exhibitions

Exchange platform on system construction, navigation technology, application and industrialization



Intelligent Traffic and Navigation Industry Technology Development Forum

Sep. 1st to 2nd, 2010, Shanghai

Focus New generation satellite navigation system and
innovation navigation technology application

More 800 officers, experts, scholars and enterprise
representatives



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CPGPS Forum

**Chinese Professionals in Global Positioning Systems (CPGPS)
& Satellite Navigation and Positioning Technology Forum**

August 18 to 19, 2010, Shanghai

**Focus on Navigation and Location Service - Emerging Industry
and International Communication**

**More than 400 experts, scholars and representatives from home
and abroad**



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Activities in Education and Training

Since 1992, Chinese government promote the multi-lateral cooperation in Asia-pacific area.

The Asia-Pacific Space Cooperation Organization (APSCO) formally started operation in Beijing in 2009, 16 years after the idea was put forward.

The APSCO, headquartered in Beijing, now has seven member states, China, Bangladesh, Iran, Mongolia, Pakistan, Peru and Thailand. Indonesia and Turkey also signed the APSCO convention.



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Activities in Education and Training

In September 2001, China proposed “establishing Asia-pacific space science & technology education center in China” and get the approve by the 6th Asia-pacific Space cooperation general assembly.



Mr. Sergio Camacho, Director of Office for Outer Space Affairs visited Beihang University in September, 2006 and met with the former President Prof. Shen shituan



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Activities in Education and Training



Ms. Alice Lee, Vice Director of Office for Outer Space Affairs was invited to attend the opening ceremony the MASTA2006 in July, 2007



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Activities in Education and Training



Summer session program, International Space University held in Beijing, China, 2007

In November 2001, Chinese government endorsed that the center could be established in BUAA.

In December 2001, the state of council approve the abovementioned suggestion.

From 2001 to now, BUAA has been making efforts to organize activities including training class, postgraduate education, discipline configuration and facilities construction.



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Activities in Education and Training



2000
Program



2002 Program

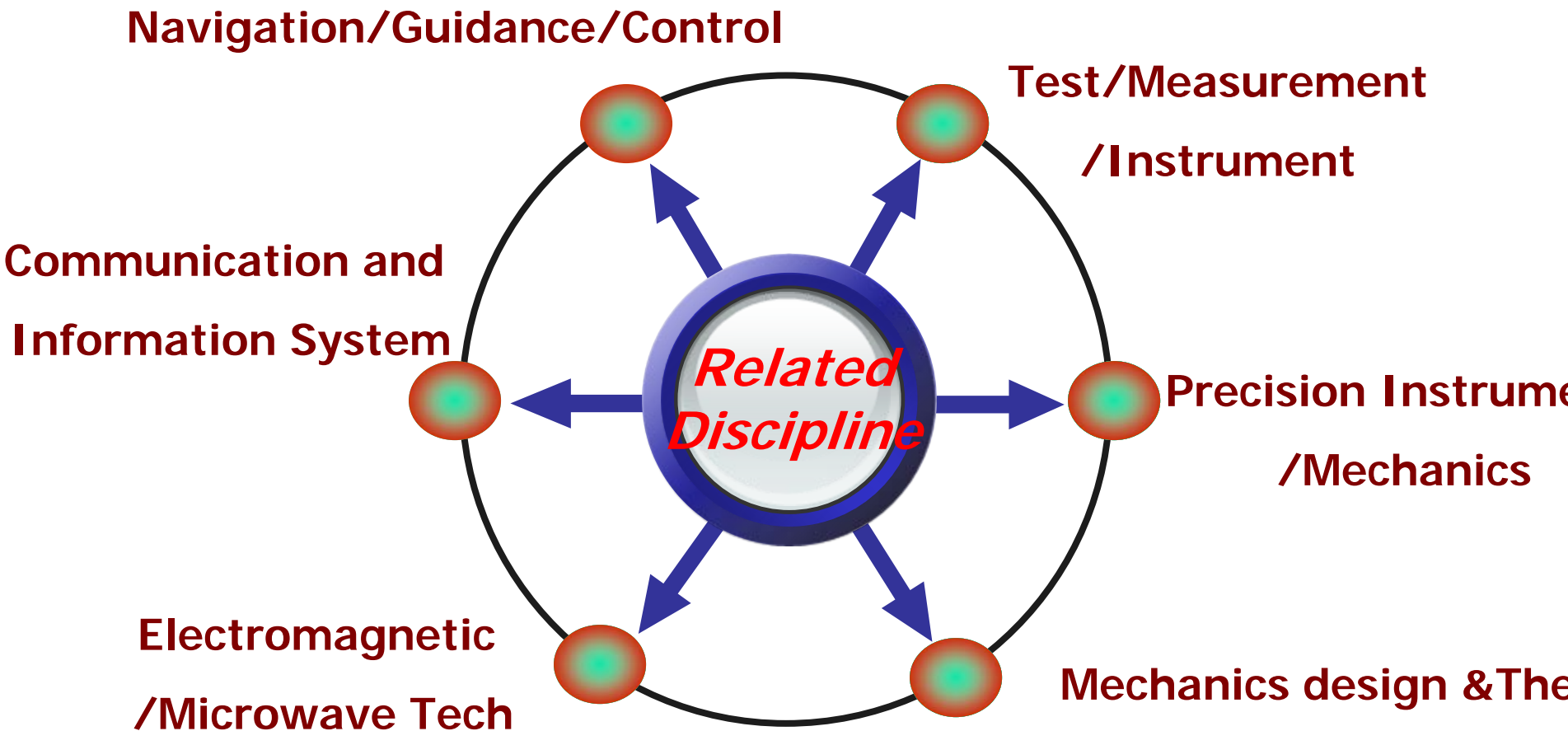


2004 Program

Master Program in Space Application Technology

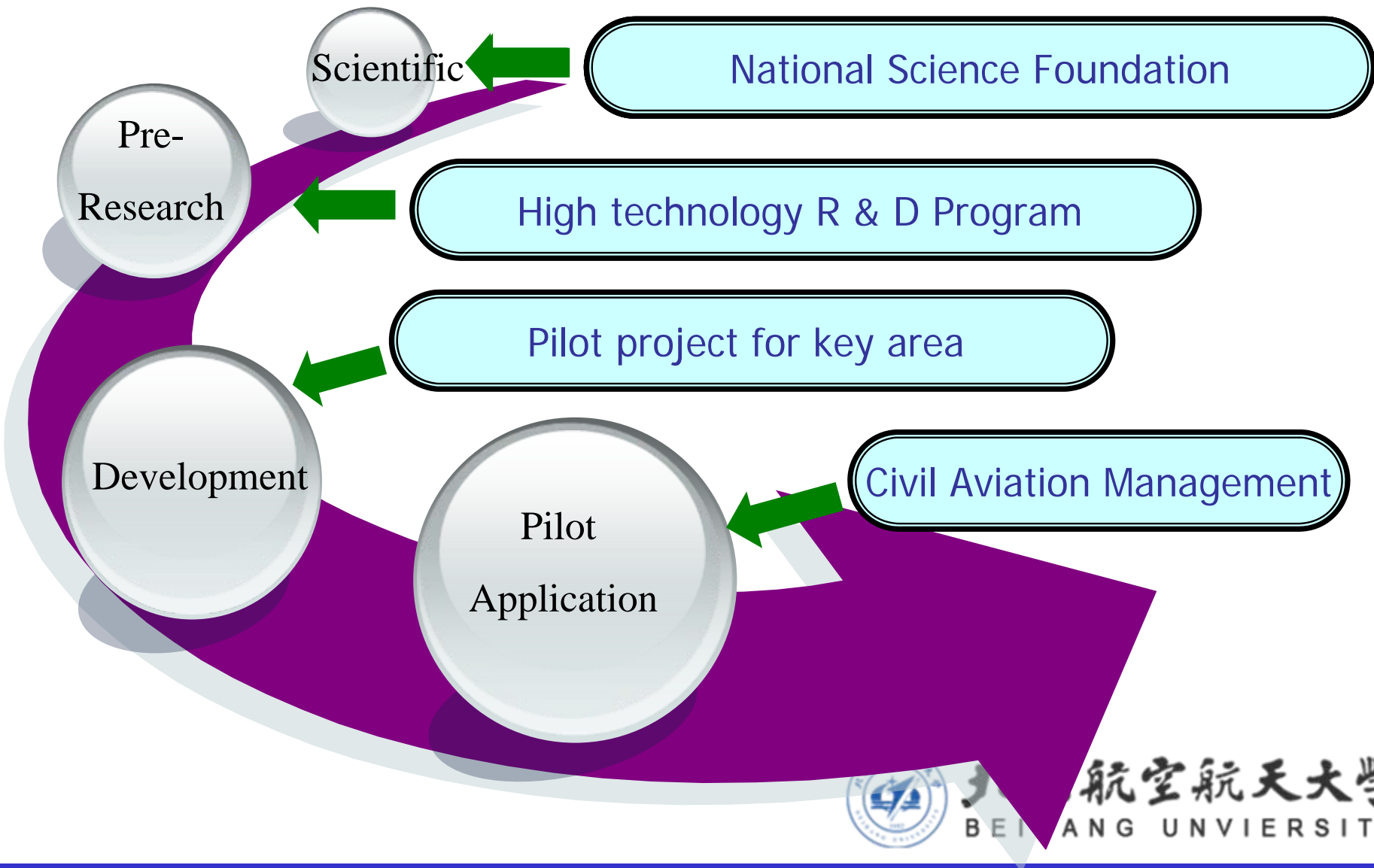


Discipline Configuration on GNSS



All of These are national level key Disciplines

R&D on GNSS



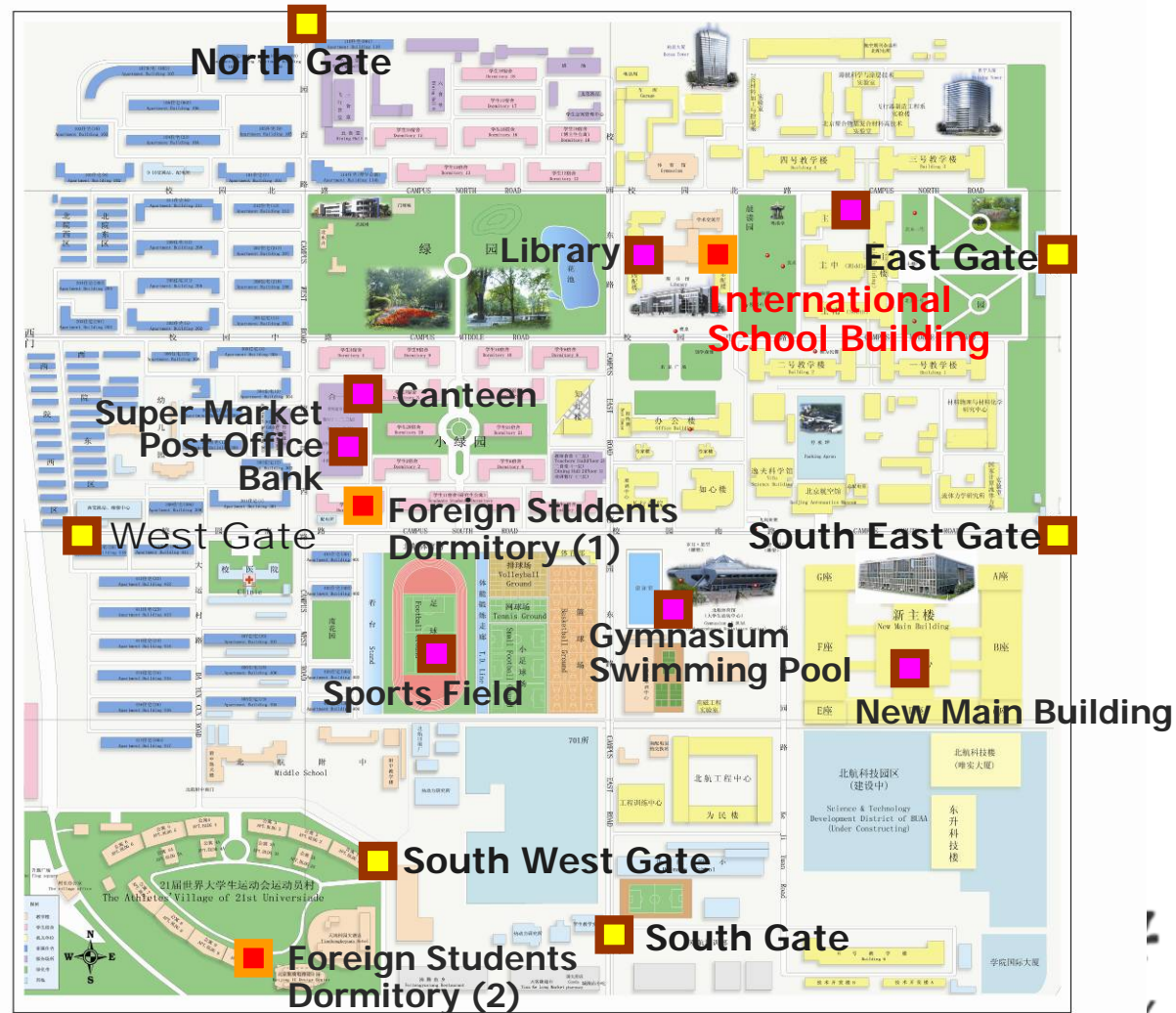
Facilities and accommodation

Excellent Study Environment

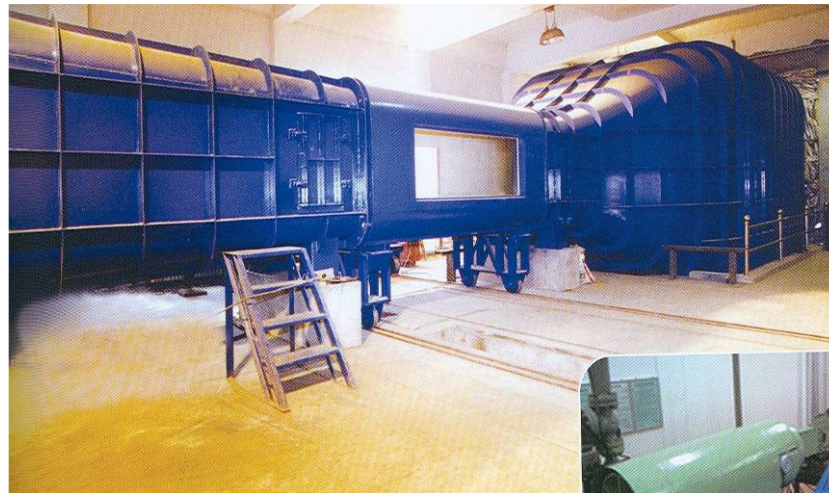
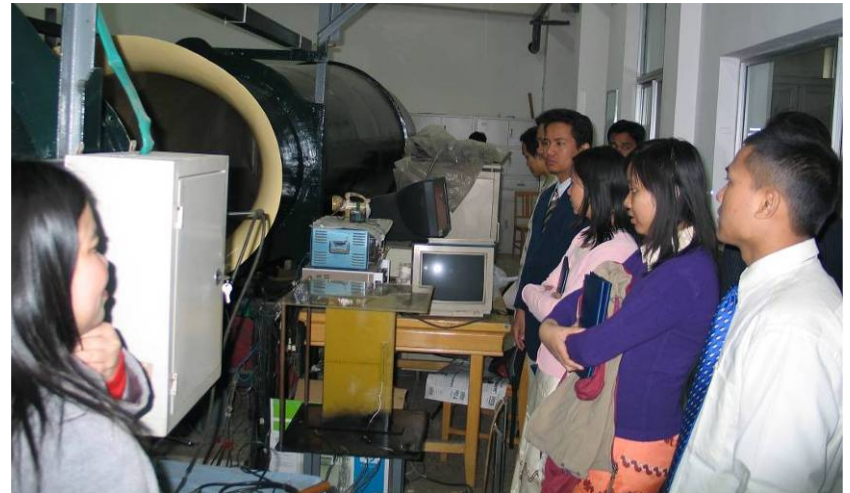


Complete and Convenient Facilities

- Main Building
- New Main Building
- Library
- Gymnasium
- Swimming Pool
- Sports Field
- Supermarket
- Post Office
- Bank



Professional Labs



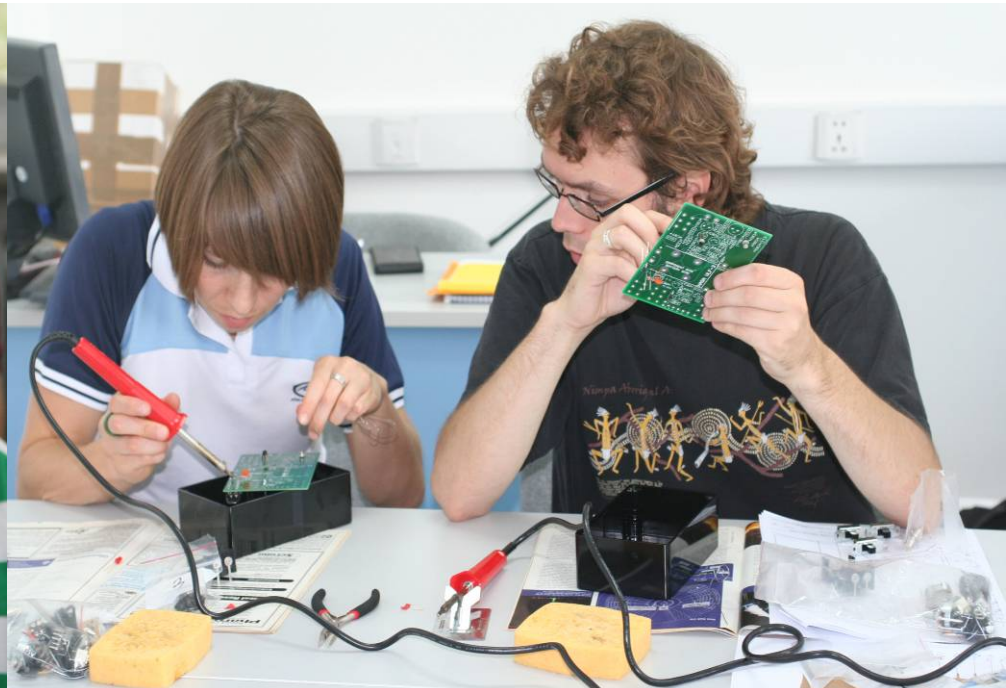
Foreign Student Dormitory



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Colorful living & study

Class Time



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Spare time



Academic Activities



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Social Activities



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5. Conclusions

China highly emphasizes on BeiDou system development and applications, and satellite navigation has great prosperity in China.

7 satellites were launched up to now. System construction is being developed smoothly .

BeiDou is contributing to better services, wider applications through international coordination, extensive academic exchange and domestic activities, especially on compatibility and interoperability.



Latest Announcement

**2rd China Satellite Navigation Conference (CSNC2011)
will be held in May, 2011, Shanghai, China**

**Training Program on Satellite Communication
and Global Navigation Supported by China
Satellite Navigation Office will be held in
July,2011 in Beihang University, Beijing.**

**It is our pleasure to have your coming!
Please contact us at edkyang@buaa.edu.cn**



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Thanks for your attention!



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