

# **Status of COMPASS/BeiDou Development**

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Opportunities Symposium**

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China Technical Application  
Association for GPS

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# Overview

- **China determined to build an independent satellite navigation system in 1980's.**
- **BD-1 (COMPASS/BeiDou Navigation Demonstration System )was completed in 2003.**
- **Since 2005,the COMPASS/BeiDou (Global) Navigation Satellite System (CNSS, also called BD-2) is under construction.**
- **Basic principles:**
  - ❖ Openness
  - ❖ Independency
  - ❖ Compatibility
  - ❖ Gradualness

# Basic Principles (1)

## ◆ Openness

- **COMPASS/BeiDou will provide high quality open services free of charge from direct users, and its worldwide use is encouraged.**
- **China will widely and thoroughly communicate with other countries on satellite navigation issues to facilitate the development of GNSS technologies and the industry.**

## ◆ Independency

- **China will develop and operate COMPASS/BeiDou system independently.**
- **COMPASS/BeiDou can independently provide services for global users and particularly provide high quality services in Asia-Pacific region .**

# Basic Principles (2)

## ◆ Compatibility

**COMPASS/BeiDou will pursue solutions to realize compatibility and interoperability with other Global Navigation Satellite Systems.**

## ◆ Gradualness

- **The construction of COMPASS/BeiDou system follows a step-by-step pattern based on technical and economic evolution in China.**
- **COMPASS/BeiDou will provide long-term continuous services for users, improve system performance and ensure smooth transition during all life cycle.**

# **System Description**

- **System Structure**
- **Signal Characteristics**
- **Time System**
- **Coordinate System**
- **Services and Performances**

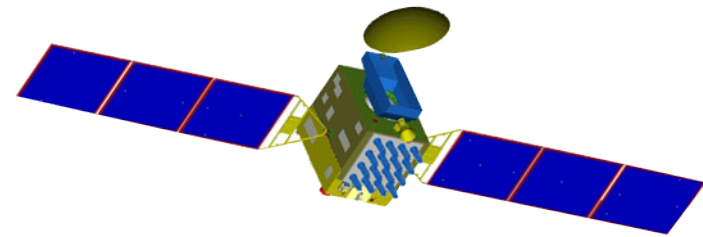
# System Structure-1

## ◆ *Space Segment*

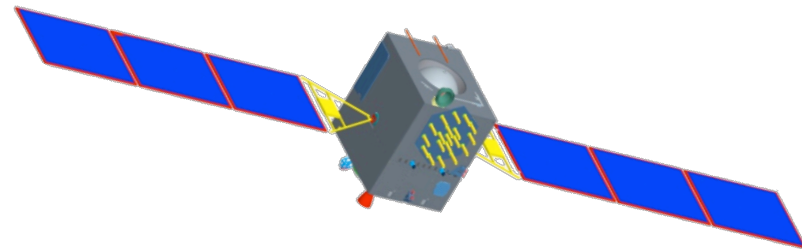
**5 GEO satellites and 30 Non-GEO satellites**



**Constellation**



**GEO Satellite**



**MEO Satellite**

# System Structure-2

## ◆ *Ground Segment*

**The ground segment consists of one Master Control Station, two Upload Stations and 30 Monitor Stations.**

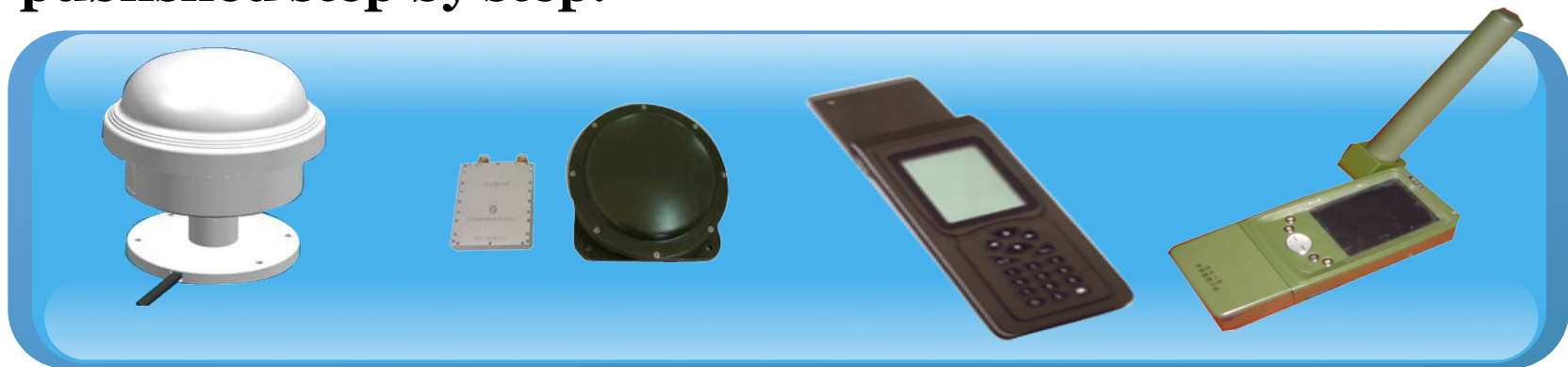




# System Structure-3

## ◆ *User Segment*

- The user segment consists of COMPASS user terminals and interoperable terminals with other GNSS.
- The development of user terminals is making progress steadily. And policymakers are studying associated issues to shape the domestic application environment.
- COMPASS ICD has already been compiled and is about to be published step by step.



User terminals of COMPASS/BeiDou system

# Signal Frequencies

## ◆ Frequencies

**B1: 1559.052~1591.788MHz**

**B2: 1166.22~1217.37MHz**

**B3: 1250.618~1286.423MHz**

# Signal Characteristics (1)

◆ *Already transmitted: B1, B1-2, B2, and B3*

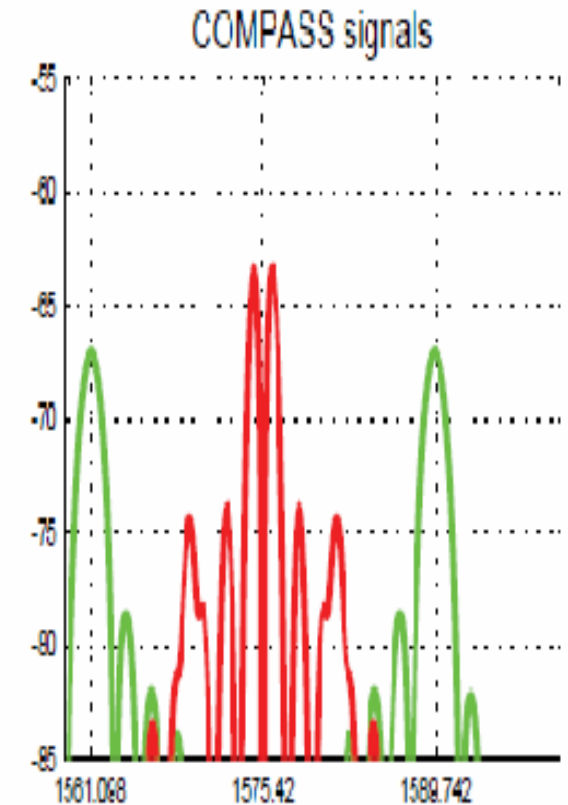
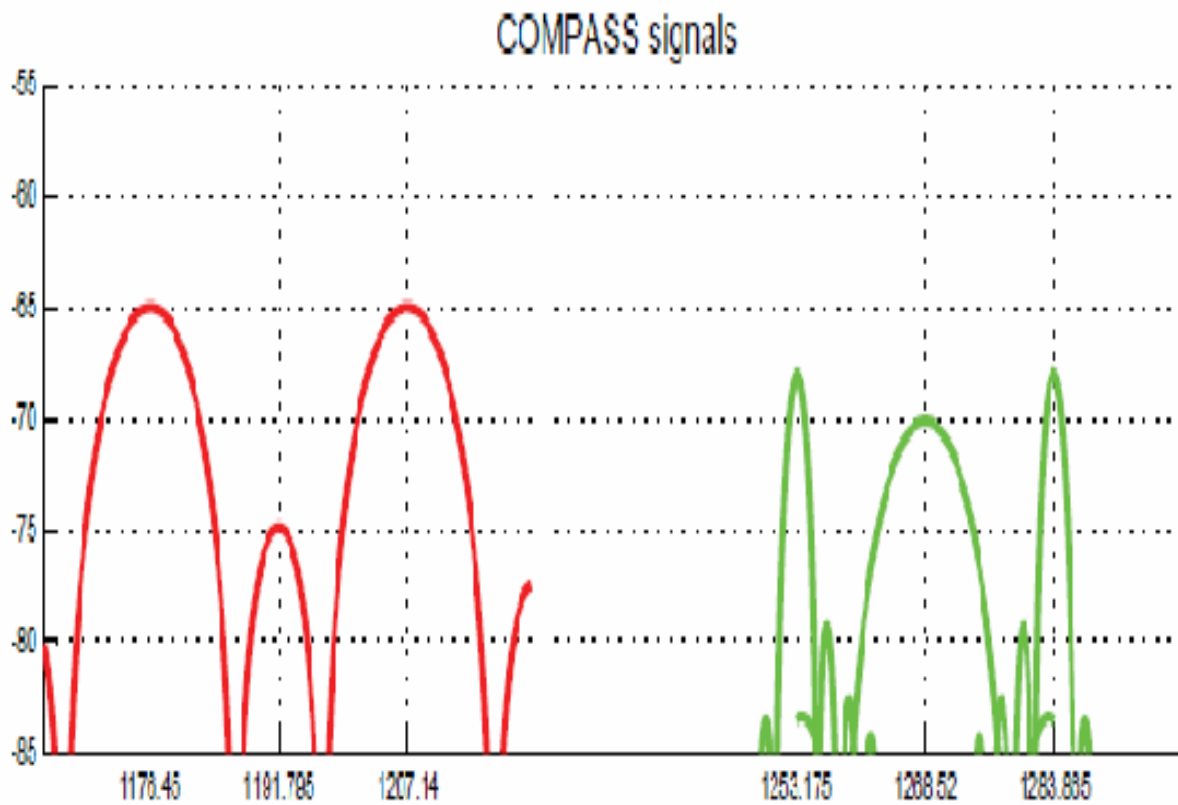
Component	Carrier Frequency (MHz)	Chip Rate (cps)	Bandwidth (MHz)	Modulation Type	Service Type
B1(I)	1561.098	2.046	4.092	QPSK	Open
B1(Q)		2.046			Authorized
B1-2(I)	1589.742	2.046	4.092	QPSK	Open
B1-2(Q)		2.046			Authorized
B2(I)	1207.14	2.046	24	QPSK	Open
B2(Q)		10.23			Authorized
B3	1268.52	10.23	24	QPSK	Authorized

# Signal Characteristics (2)

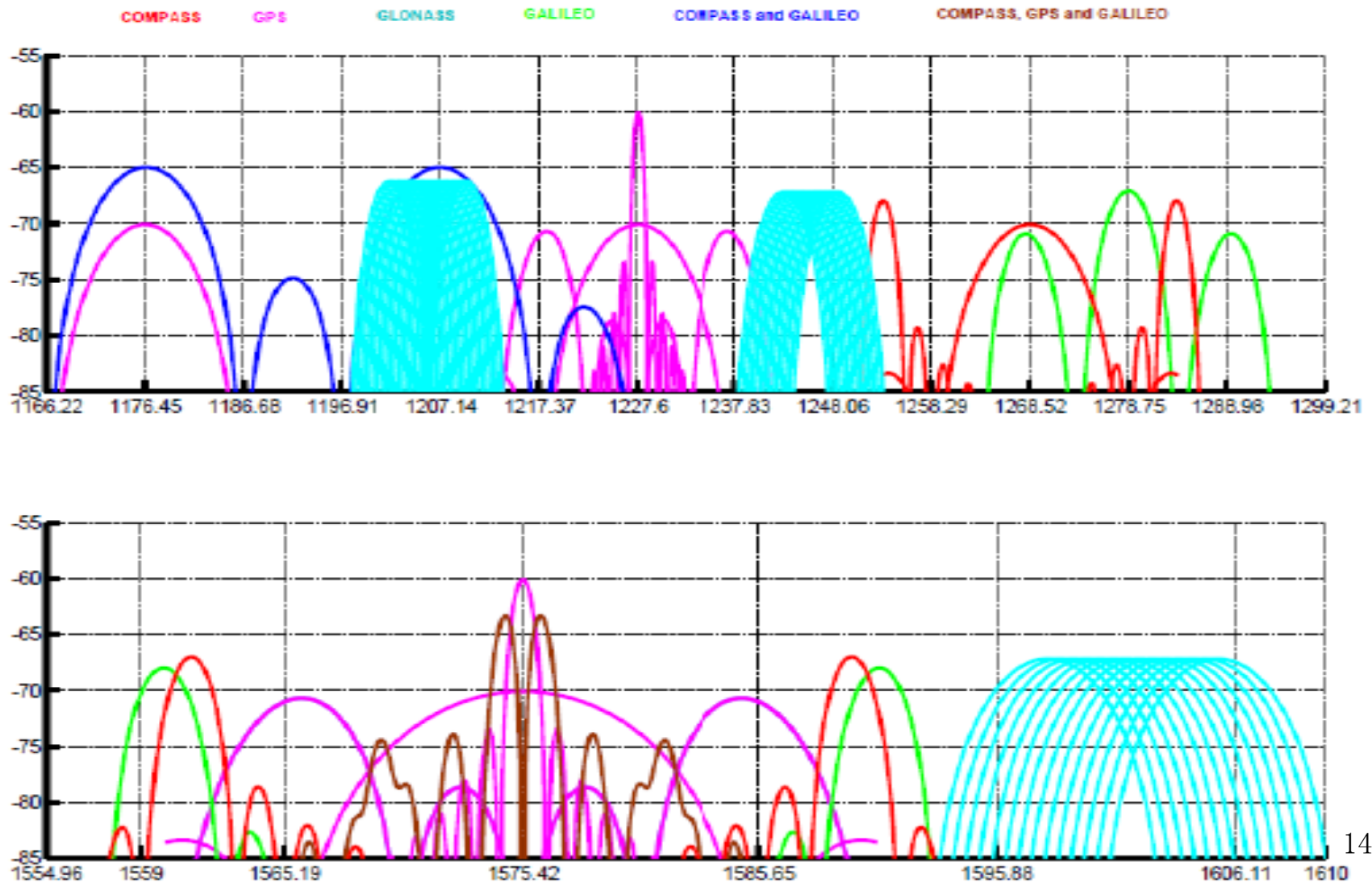
◆ *To be transmitted: B1, B2 and B3*

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

# Compass Frequencies



# Spectrum of Compass and Other GNSS Systems



# Time System

- ◆ **COMPASS/BeiDou time is named as BDT, traced to UTC, and synchronized with UTC within 100ns. The epoch time of BDT is UTC 0000 2006.**
- ◆ **Interoperability of BDT with GPS/Galileo time was considered in the design of COMPASS/BeiDou time system. The offset between BDT and GPST/ GST will be measured and broadcasted.**

# Coordinate System

- ◆ **COMPASS/BeiDou uses China Geodetic System 2000 (CGS2000)**
- ◆ **Coinciding with ITRF at a few cm level.**



# Services and Performances

## ◆ Two kinds of global services

- **Open Service:** free and open to users
  - ❖ Positioning Accuracy: 10 m
  - ❖ Timing Accuracy: 20 ns
  - ❖ Velocity Accuracy: 0.2 m/s
- **Authorized Service:** ensure high reliable use even in complex situation.

## ◆ Two kinds of regional services

- **Wide area differential service**
  - ❖ Positioning accuracy: 1 m
- **Short message service**

# System Deployment

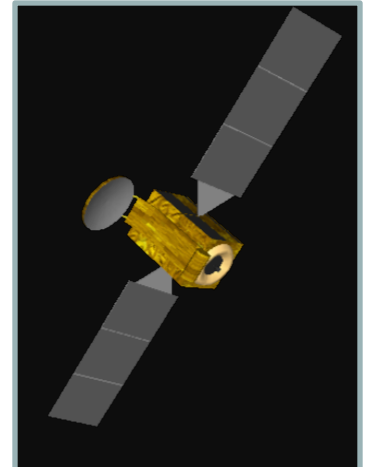
➤ **Deployment Steps**

➤ **Launch Schedule**

# Deployment Steps (1)

## ◆ *1st Step—Testing System*

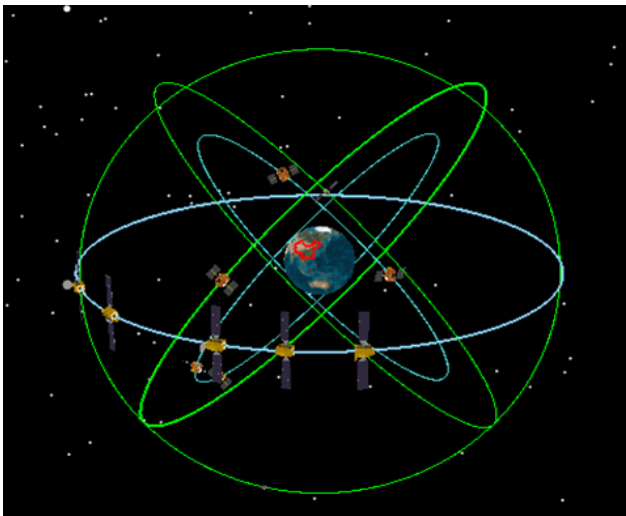
**After 3 GEO satellites being launched since 2000, the demonstration system is able to provide basic services including positioning, timing and short-message communication in regional area.**



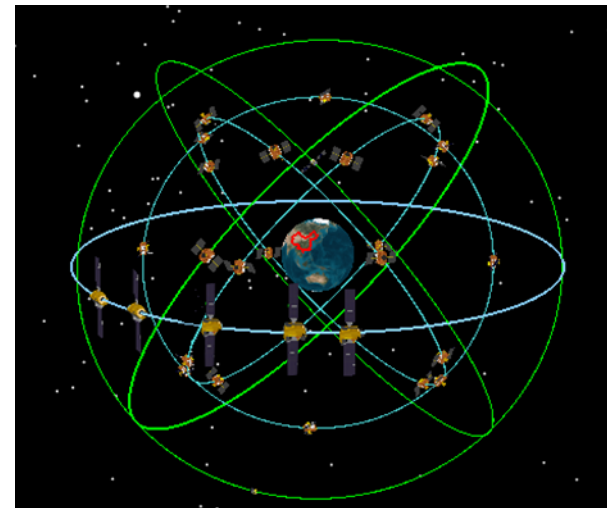
# Deployment Steps (2)

## ◆ *2nd Step—Global System*

**COMPASS/BeiDou will cover Asia-Pacific area around 2011, and will cover all over the world before 2020.**



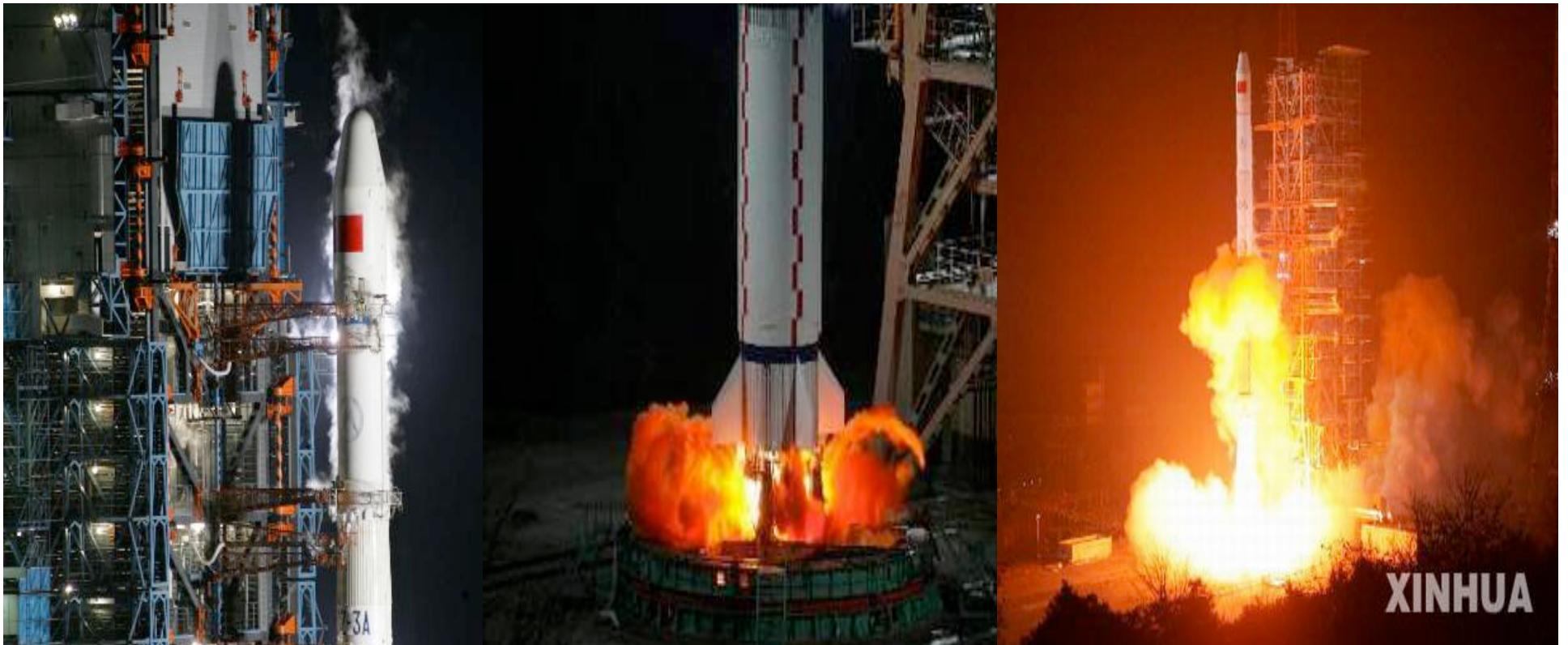
**Around 2011**



**2015-2020**

# COMPASS-M1 Launch

**The first MEO satellite named COMPASS-M1 was launched in Apr. 2007.**



# **COMPASS-G2 Launch**



**The first GEO  
satellite named  
COMPASS-G2 was  
launched by a Long  
March-3C carrier  
rocket at the Xichang  
Satellite Launch Center  
on Apr.15 2009.**

# Launch Schedule

◆ *Planned launches in recent 2-3 years*

**More than 10 satellites will be put into orbit in recent 2-3 years by Long-March launchers.**

# **CNSS Regional and Global Capacity**

## **◆ Regional Capacity(2011-2012)**

**Will cover China and adjacent areas with 12 satellites:**

- **5 in geostationary orbits (GEOs)**
- **3 inclined geosynchronous orbits (IGSO)**
- **4 in middle earth orbits (MEO)**

## **◆ Global Capacity(2015-2020)**

**CNSS will comprise the full operational capability (FOC) system:**

- **27 MEOs**
- **5 GEOs**
- **3 IGSOs**

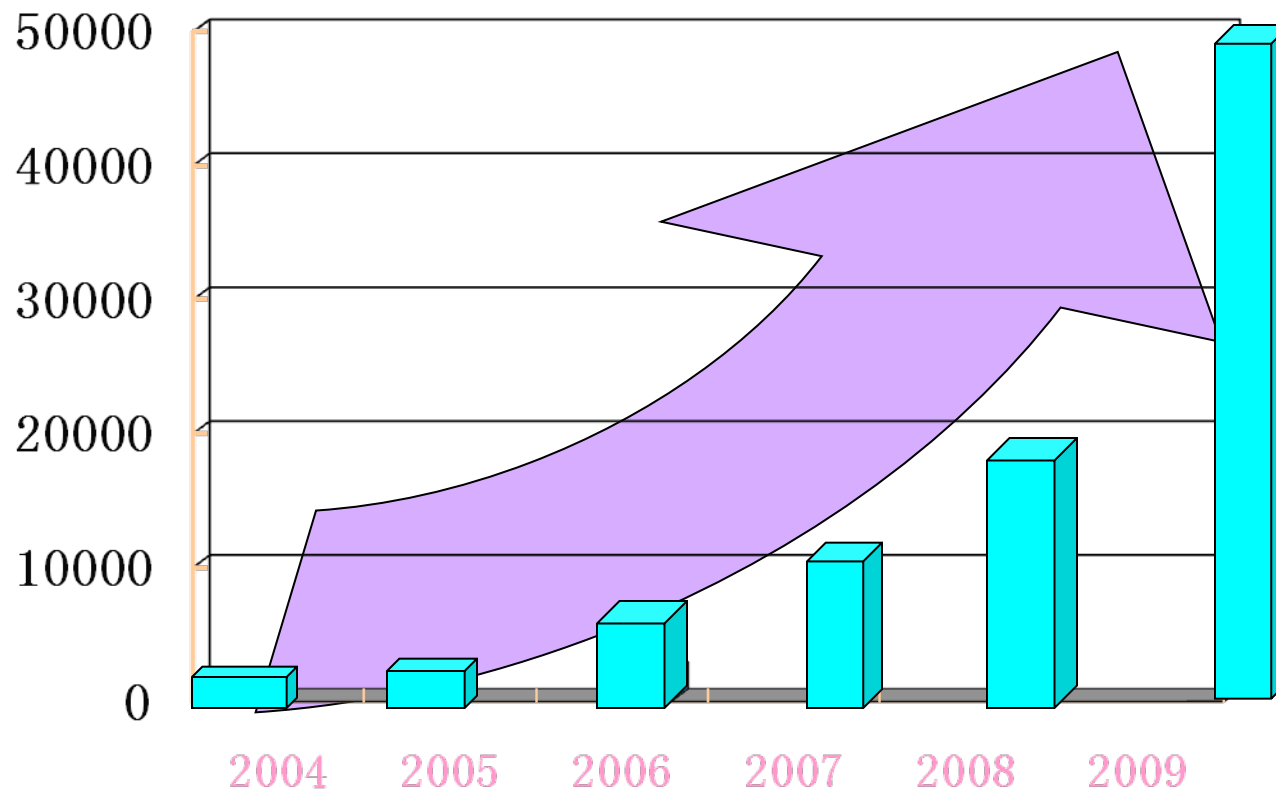


# Applications and Markets

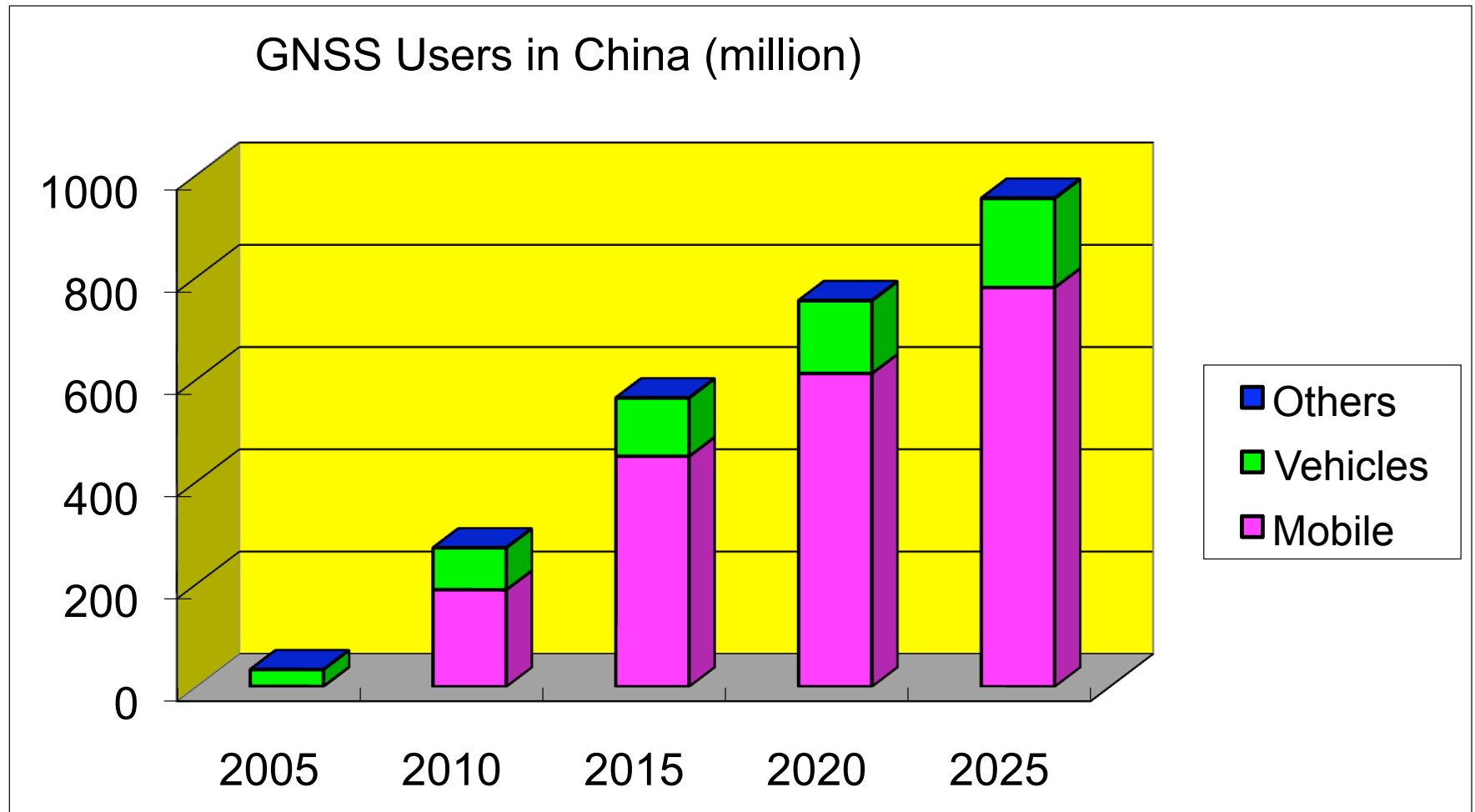
◆ **COMPASS Navigation Demonstration System has played important roles in different areas.**

- **Survey and mapping**
- **Communication**
- **Water conservancy**
- **Disaster mitigation**
- **Marine**
- **Transportation**
- **Mining**
- **Forest fire rescue**
- **etc.**

# Estimated BD-1 Users



# Projection of GNSS Users in China for 2005-2025

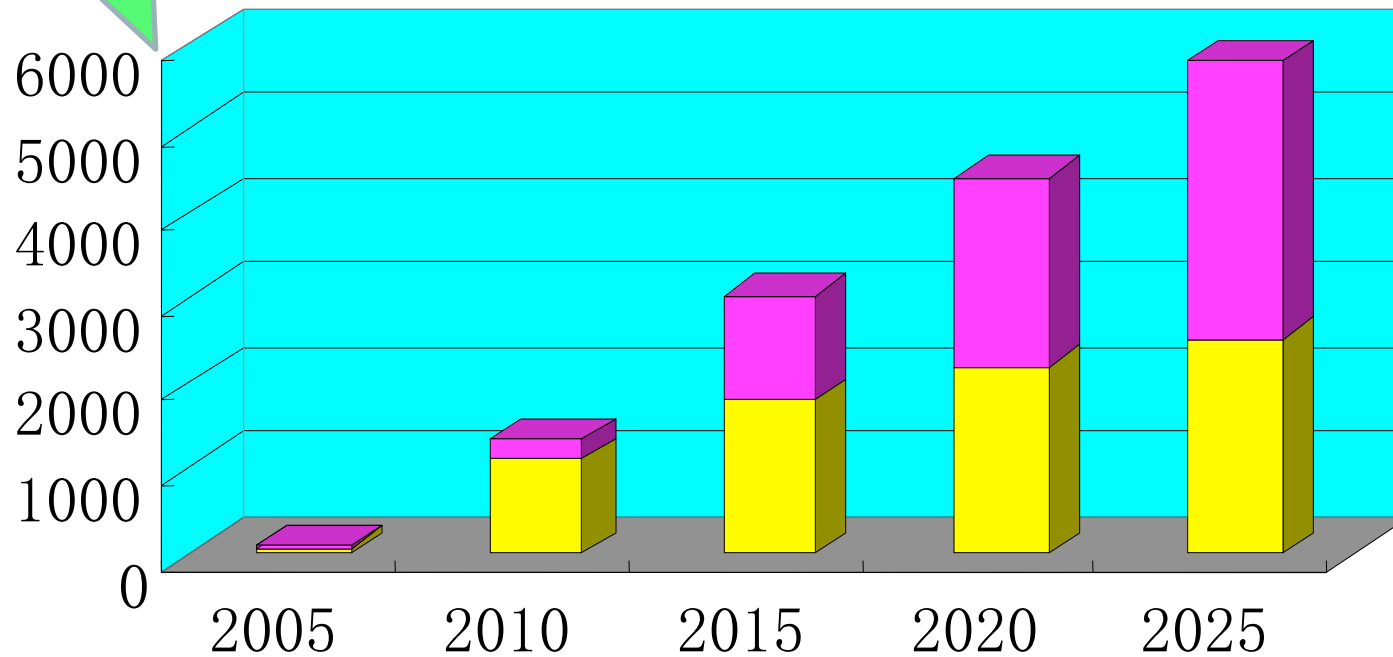


# Projected GNSS Sales in China

Projected GNSS Sales in China (100 mil RMB)

US\$ 86 Bil

Applications Services



# **Compatibility and Interoperability**

- **Considerations of Compatibility and Interoperability**
- **Related Bilateral Activities**

# Compatibility Consideration (1)

- ◆ **Compatibility means the ability of multiple satellite navigation systems to be used separately or together, without generating interference to affect the navigation performance of each other.**
- ◆ **International Telecommunication Union provides a framework for discussion on radiofrequency compatibility.**

# Compatibility Consideration (2)

## **Spectrum overlap:**

- ◆ **There actually exist some cases of frequency overlap between signals of different systems**
- ◆ **It is feasible for navigation systems to share the same frequency spectrum.**
- ◆ **The frequency spectrum overlap of open signals is beneficial for the realization of interoperability for many applications.**

# Compatibility Consideration (3)

## Spectrum Separation of AS:

- ◆ **The Authorized Service (AS) signal spectrum separation with open service signals is beneficial.**
- ◆ **Due to the very limited frequency resources, authorized signal spectrum separation is very difficult at present.**
- ◆ **It's very difficult to satisfy the frequency resource requirements of modernization signals of existing systems and the signals of new systems to be built.**



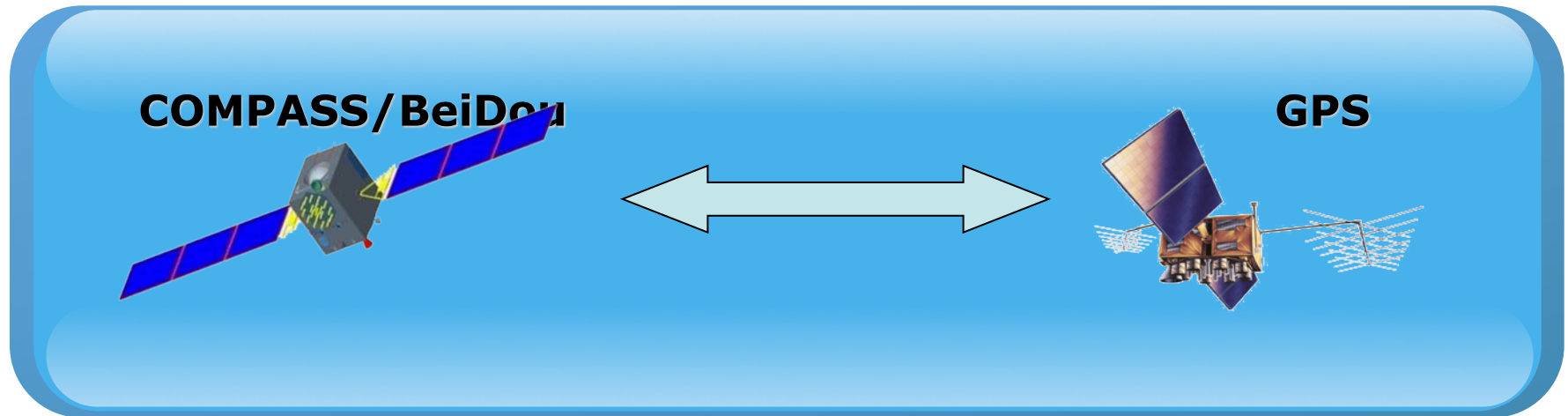
# Interoperability Consideration (1)

- ◆ **Interoperability means the ability of open services of multiple satellite navigation systems to be used together to provide better capabilities at the user level than would be achieved by relying solely on one service, without significantly increasing the complexity of receivers.**

# Interoperability Consideration (2)

- ◆ **Benefit gained is larger than cost paid**
- ◆ **Provide better capabilities at the user level**
- ◆ **Make it easy for receiver developers and manufacturers.**
- ◆ **Max received power should be compatible**
- ◆ **Common carrier frequency and spectrum are important**
- ◆ **Interoperability signals**
  - ❖ **B1-C : 1575.42 MHz**
  - ❖ **B2a: 1176.45 MHz**
  - ❖ **B2b: 1207.14 MHz**

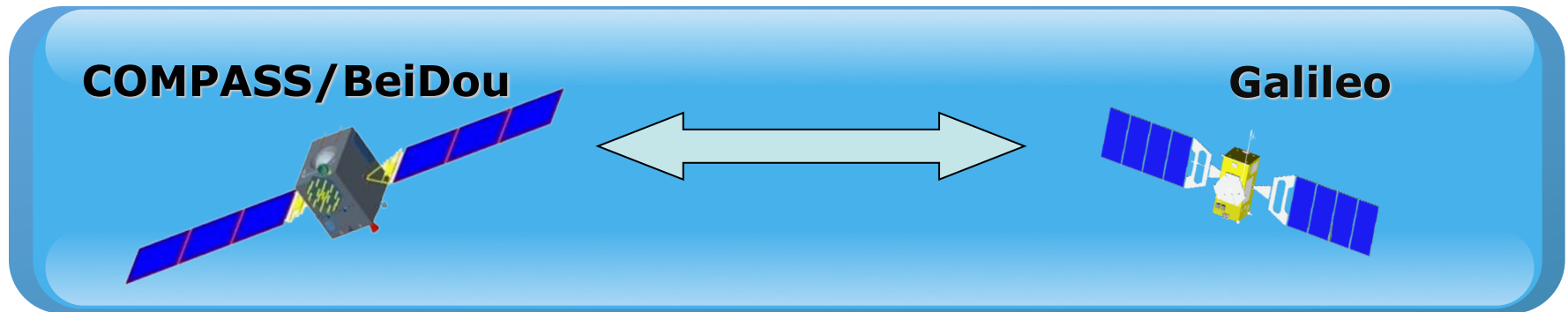
# Related Bilateral Activities (1)



## Three meetings on frequency compatibility coordination

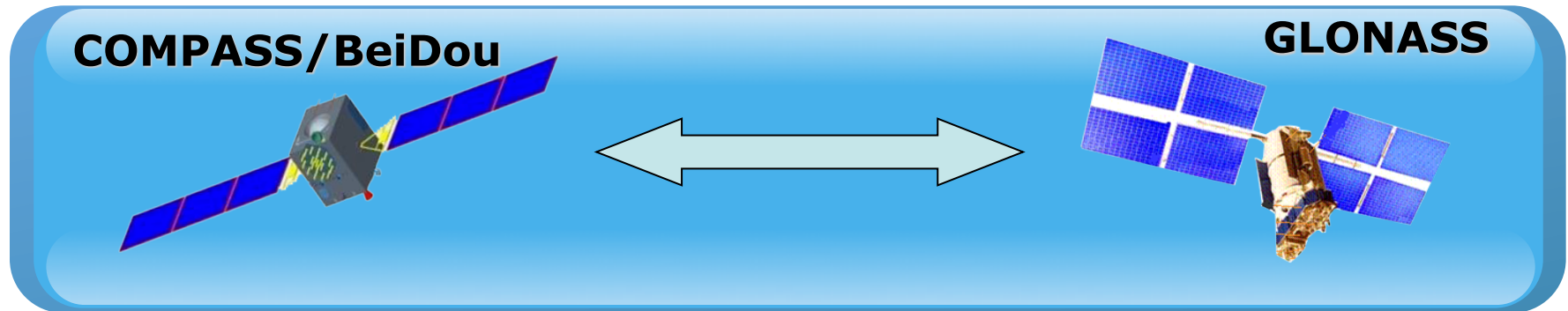
- ◆ The 1st Meeting was held in Geneva in June 2007.
- ◆ The 2nd Meeting was held in Xi'an in May 2008.
- ◆ The 3rd Meeting was held in Geneva in Oct 2008.

# Related Bilateral Activities (2)



- ◆ The 1st frequency compatibility coordination meeting was held in Beijing in May 2007.
- ◆ The 1st Technical Working Group meeting on Compatibility and Interoperability was held in Beijing in Sep 2008.
- ◆ The 2nd TWG meeting was held in Beijing in Dec 2008.
- ◆ The 3rd meeting was held in Brussels in Jun 2009.

# Related Bilateral Activities (3)



- ◆ The frequency compatibility coordination meeting was held in Moscow in Jan 2007.

# Conclusion

- ◆ **The development of COMPASS/BeiDou is one of China's national strategies.**
- ◆ **COMPASS/BeiDou is being constructed smoothly.**
- ◆ **COMPASS/BeiDou is an essential element of the GNSS, and encourages international cooperation with other navigation systems.**

**Thanks  
for your attention!**