

COMPASS Satellite Navigation System Development

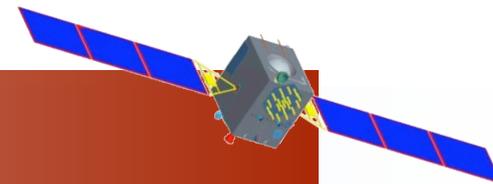
Chong Cao
China Satellite Navigation Engineering Center

Guifei Jing
National Remote Sensing Center of China

Ming Luo
Stanford University

For 'PNT Challenges and Opportunities' Symposium
Nov. 5th-6th, 2008
Stanford University

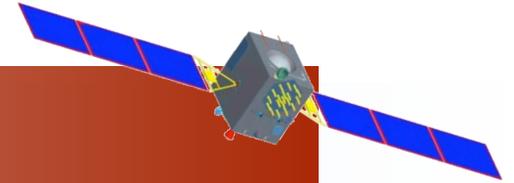
Mr. Chong Cao



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- **Research Fellow of China Research Institute of Radio-wave Propagation**
- **Director of Compass (Bei Dou) Civil Application Market and Industrialization Expert Committee**
- **Director of Editorial Committee of *GNSS world of China* Magazine**
- **Director of Information Consultant Center of China Technical Application Association for Global Positioning System.**

Dr. Guifei Jing



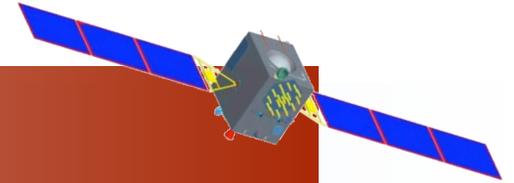
**Head of Navigation Division of National Remote Sensing Center,
Ministry of Science and Technology of China (NRSCC/MOST)**

**Project manager in Division of Information Technology of
Department of High Tech Development and Industrialization of
MOST.**

**Focused on Europe-China cooperation on Galileo project,
Management of key S&T programs related to Positioning
technology.**

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Outline



 **Architecture of the System**

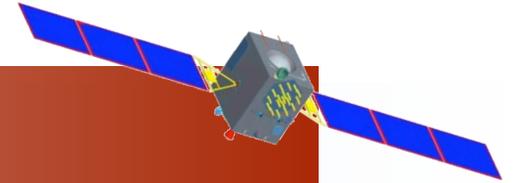
 **Steps of the Deployment**

 **Applications of Compass in China nowadays**

 **Principles of the System**

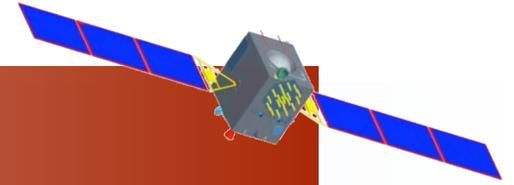
 **Summary**

Overview

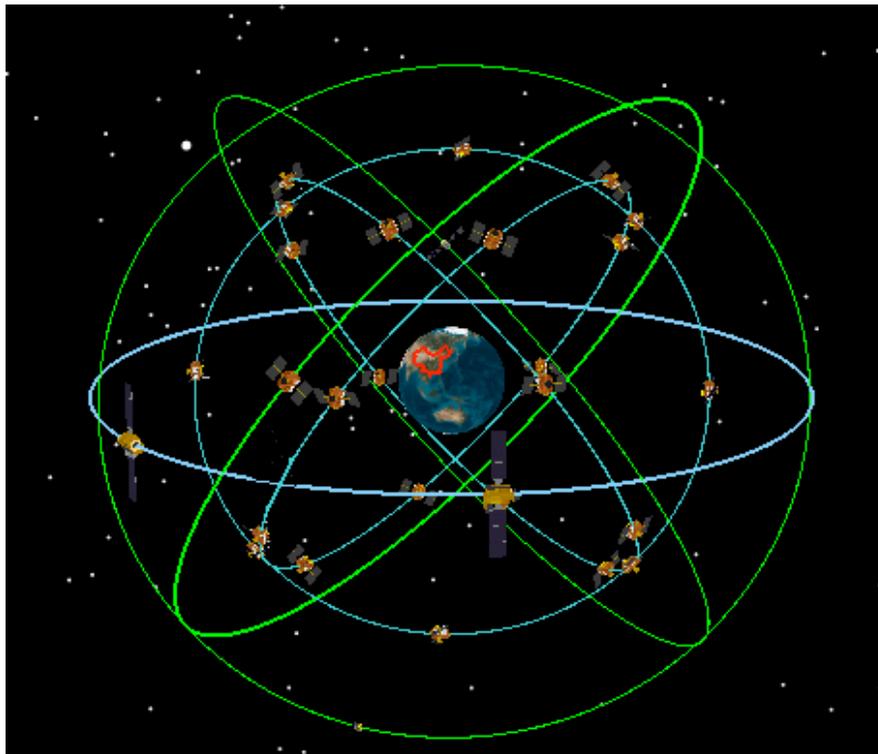


- ✓ China decided to build an independent satellite navigation system in 1980's.
- ✓ In 2003, the Compass Demonstration Navigation System was built and the system has been used in many areas nowadays in China.
- ✓ Now the COMPASS global navigation system is under construction.
- ✓ China Satellite Navigation Project Center is in charge of the construction.

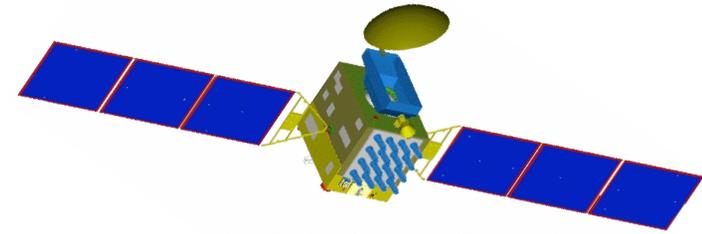
Space Segment



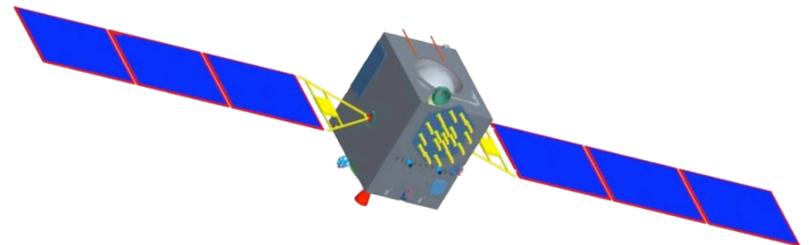
- ◆ 5 GSO satellites and not more than 30 MEO satellites



Constellation

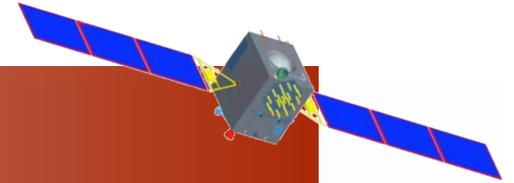


GSO Satellite



MEO Satellite

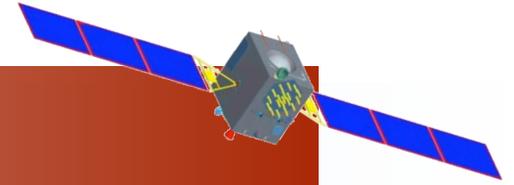
Ground Segment



- ◆ The ground segment consists of Master Control Station, Upload Stations and Monitor Stations.



User Segment

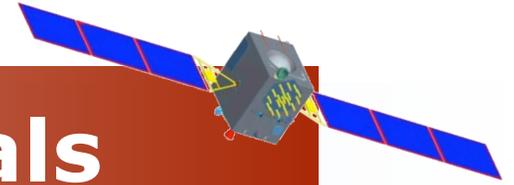


- ◆ The user segment consists of COMPASS user terminals and interoperable terminals.



User terminals of COMPASS system

Frequencies & Signals



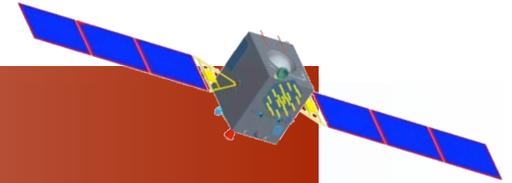
◆ Frequencies

B1, B1-2, B2, B3, B1-BOC, L5

◆ Signals:

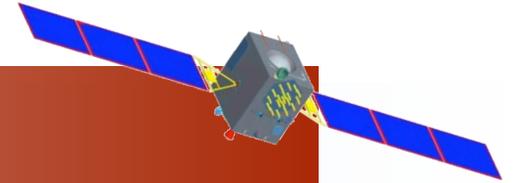
B1(QPSK), B1-MBOC(6,1,1/11) , B1-2 (QPSK),
B2(QPSK), B2-BOC(10,5) ,
B3(QPSK), B3BOC(15,2.5),
L5 (QPSK).

Services



- ◆ 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 highly reliable use even in complex situation.
- ◆ Two kinds of regional services
 - Wide area differential service :
 - Positioning accuracy: 1 m
 - short message service.

Outline



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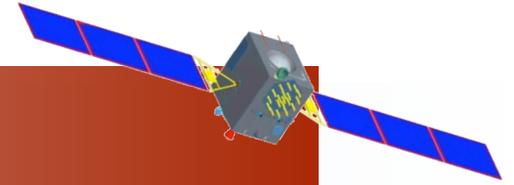
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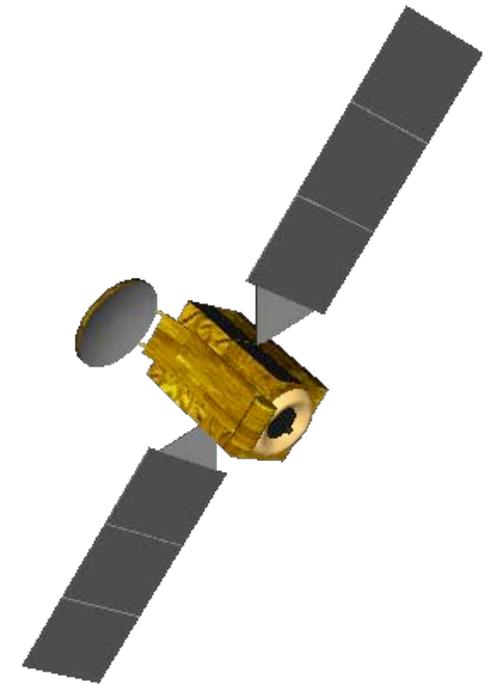
 **Summary**

The 1st Step

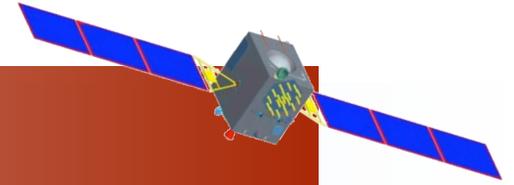


◆ COMPASS Navigation Demonstration System.

Three GEO satellites have been launched since 2000, the demonstration system can provide some basic services including positioning, timing, and short-message communication.

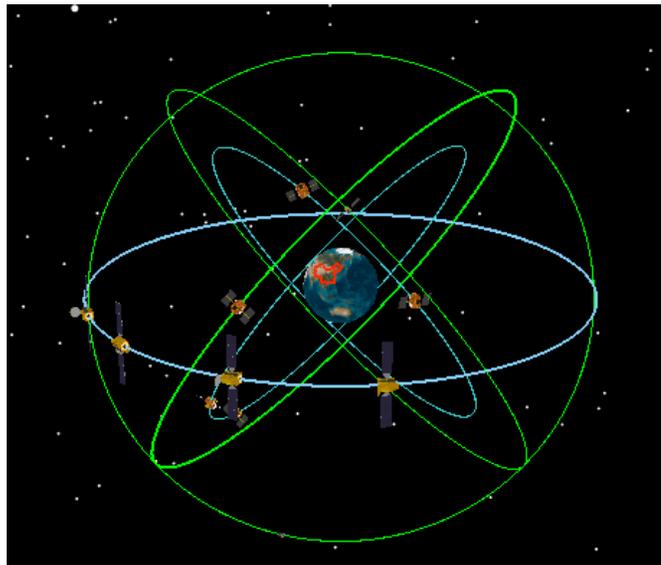


The 2nd Step

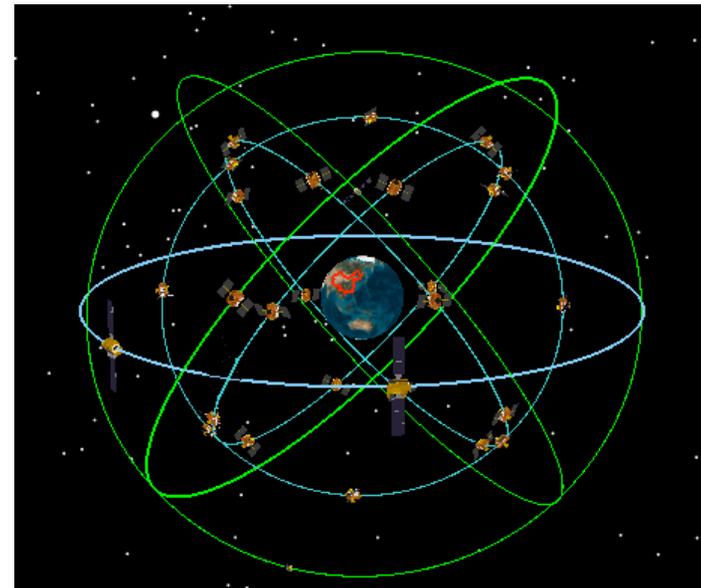
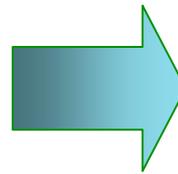


◆ **COMPASS Navigation Satellite System.**

As a global system COMPASS will cover Asia-Pacific area firstly in about 2010.



2010

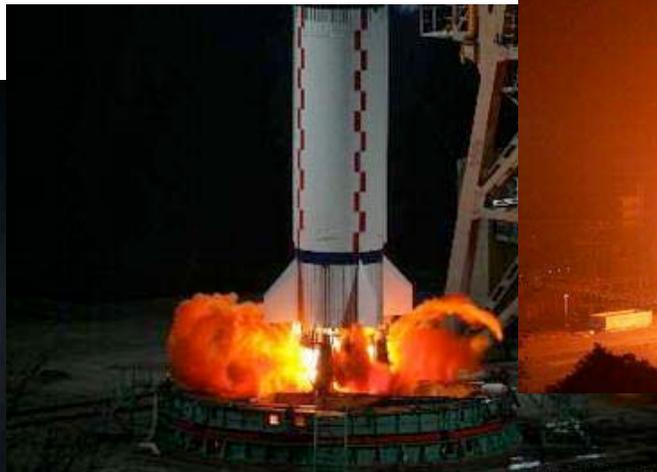


The near future

Compass-M1 Experimentation



- ◆ After the technical configuration of COMPASS has been determined, the first MEO satellite of Compass was launched in Apr. 2007. The main tasks of M1 were to test satellite technology (IOV) and to secure the frequency filings. The ground segment is ready, and constellation deployment is in schedule.



Compass-M1 Experimentation



◆ Some Experiment Results

Overlap orbit errors: 4.3 meter (Position).

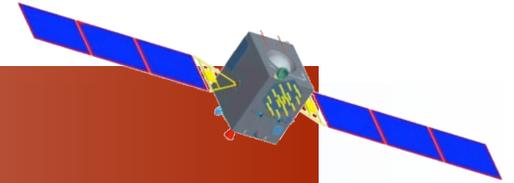
SLR Comparison errors: 0.058 meter.

Compatible Positioning errors (with GPS) : 10 meter (95%).

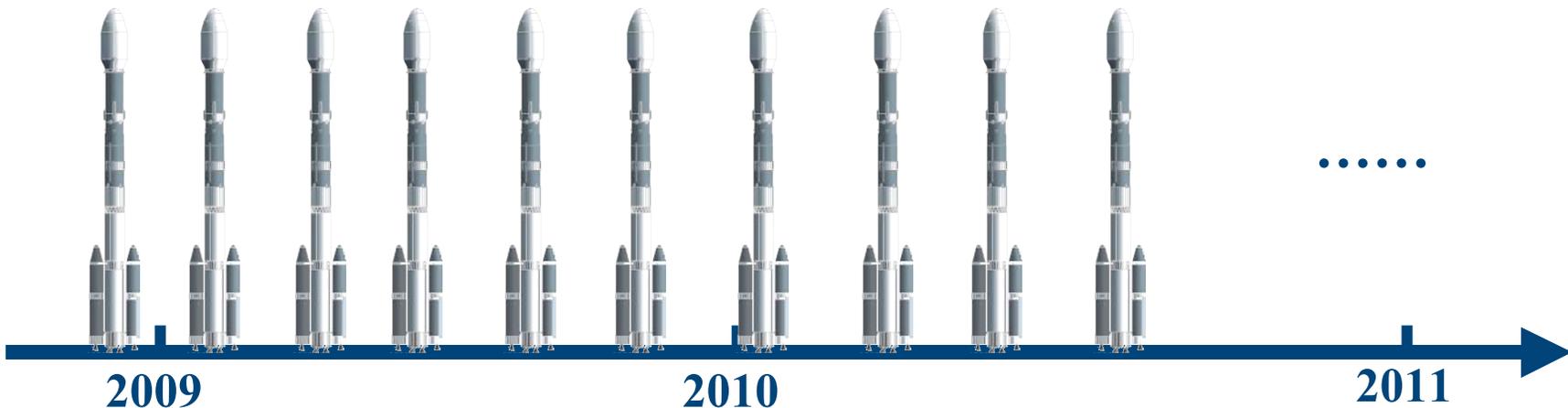
Orbit prediction maximum errors: 25 meter (24 hours).

Clock prediction maximum errors: 11 ns (24 hours).

Launches

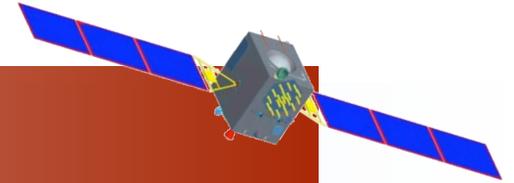


- ◆ 10 rockets of Long-March 3 will be launched in recent two years, more than 10 satellites will be put into use, after that the system can offer services regionally.



Planned launches in recent two years

Outline



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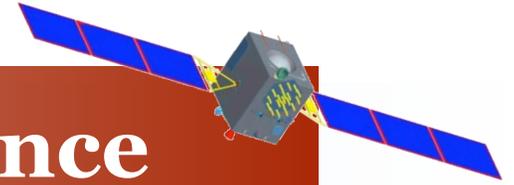
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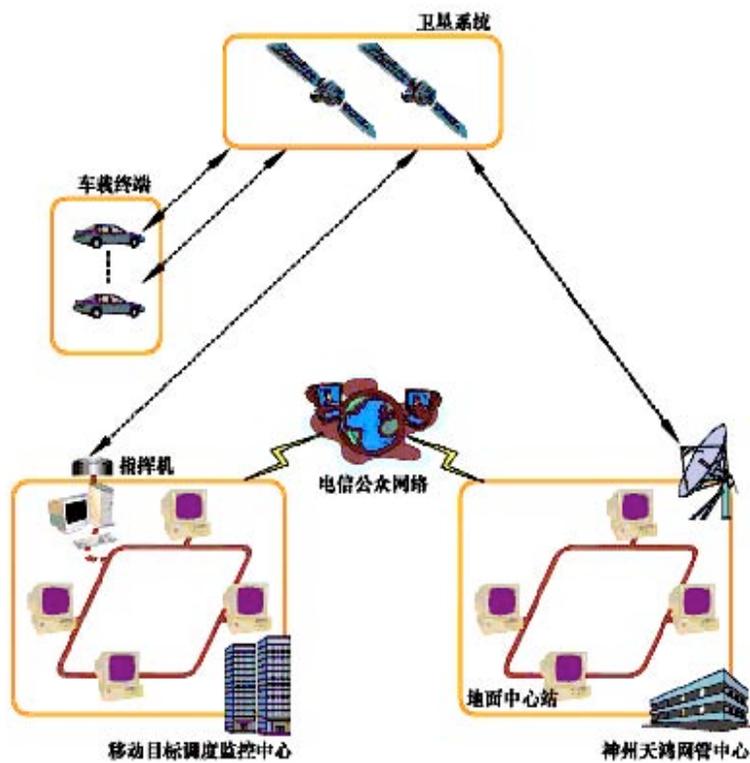
Applications at One Glance



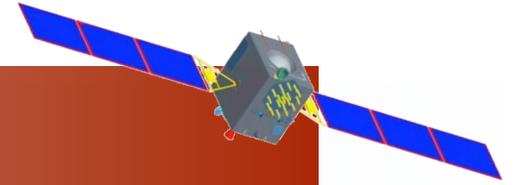
- ◆ The COMPASS Navigation Demonstration System has played an important role in many areas.
 - telecommunications,
 - transportation,
 - meteorology,
 - forest fire prevention,
 - disaster forecast,
 - Marine.



Disaster Control



Forest Fire Prevention System



Disaster Control



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“北斗一号”传回各点位最新情况 多数救援队到位

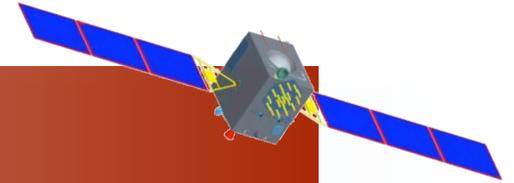
中央政府门户网站 www.gov.cn 2008年05月16日 来源: 新华社

【字体: 大 中 小】 【E-mail推荐 发送】 打印本页 关闭窗口

新华社北京5月16日电(记者黎云)救援部队携带的“北斗一号”终端机15日继续传回汶川地震灾区的最新灾情和救援情况,大部分救援部队已经到达指定救援位置,在灾区各乡镇展开全面搜救。济南军区某红军师15日共发现救出受伤群众79人,妥善安放遇难者遗体17具,转移群众400多人。

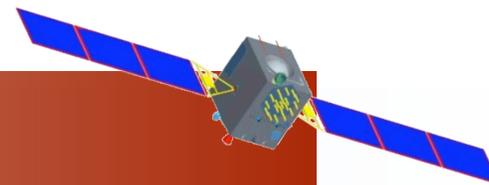
Emergency Position & Information Services in Sichuan Earthquake

Marine Application



Offshore Tide Monitor Data Transmission

Marine Application



The image displays a marine control system interface on the left and a photograph of a fishing vessel on the right. The interface shows a map of the East China Sea with various data points and labels. A red circle on the vessel's superstructure is connected by a red line to a handheld electronic device in the bottom right, which displays a compass and other navigation data.

Map Labels:

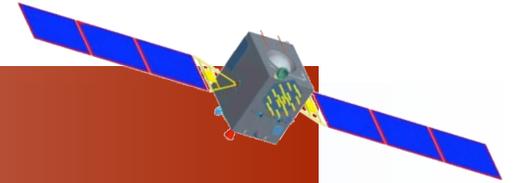
- 台沙2951 黄涂育 3月18日 10:17
- 远渔220 汕头市远洋渔 3月18日 11:01
- 粤湖南11188 汕头市侨丰集团有限公司 3月18日 10:39

Map Coordinates:

- 【T】2008-03-18 11:06:35: 0 【提示】
- 【点位】L=142° 56' 06.47" B=24° 23' 23.51471 【视区】L=86.15 R=145.82 T=49.69 B=14.92 【全区】L=-180.00 R=180.00 T=83.62

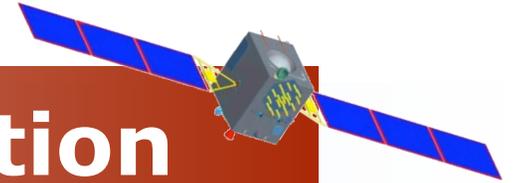
Offshore Fishing Ship Control System

Marine Application



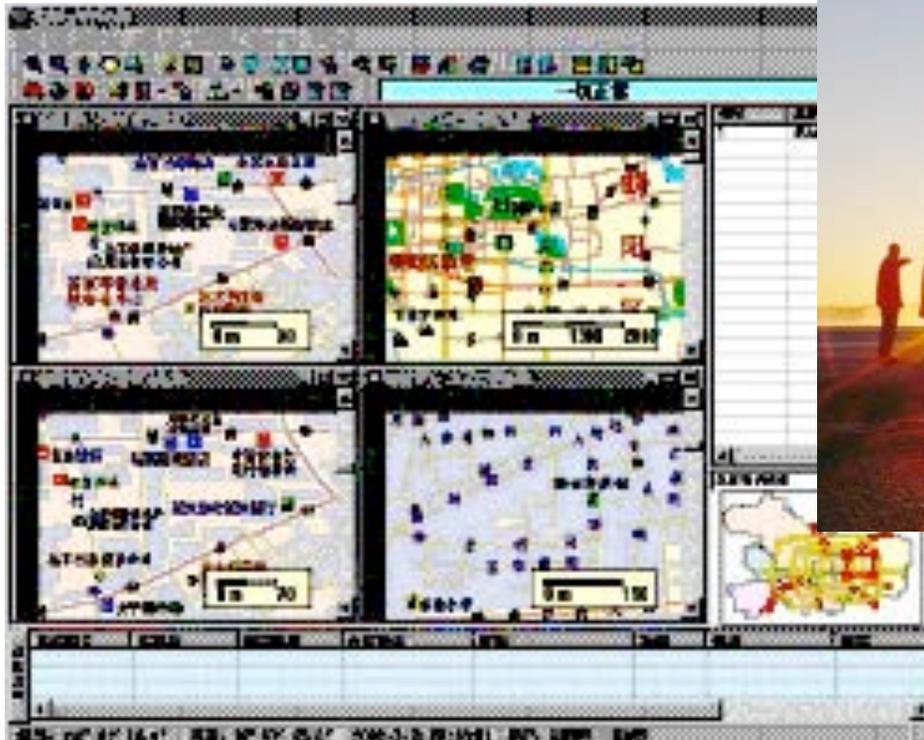
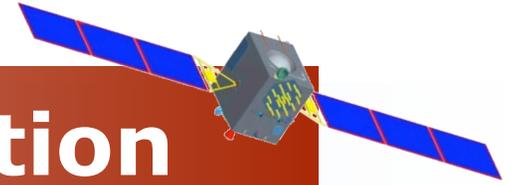
Marine Search and rescue

Transportation Application



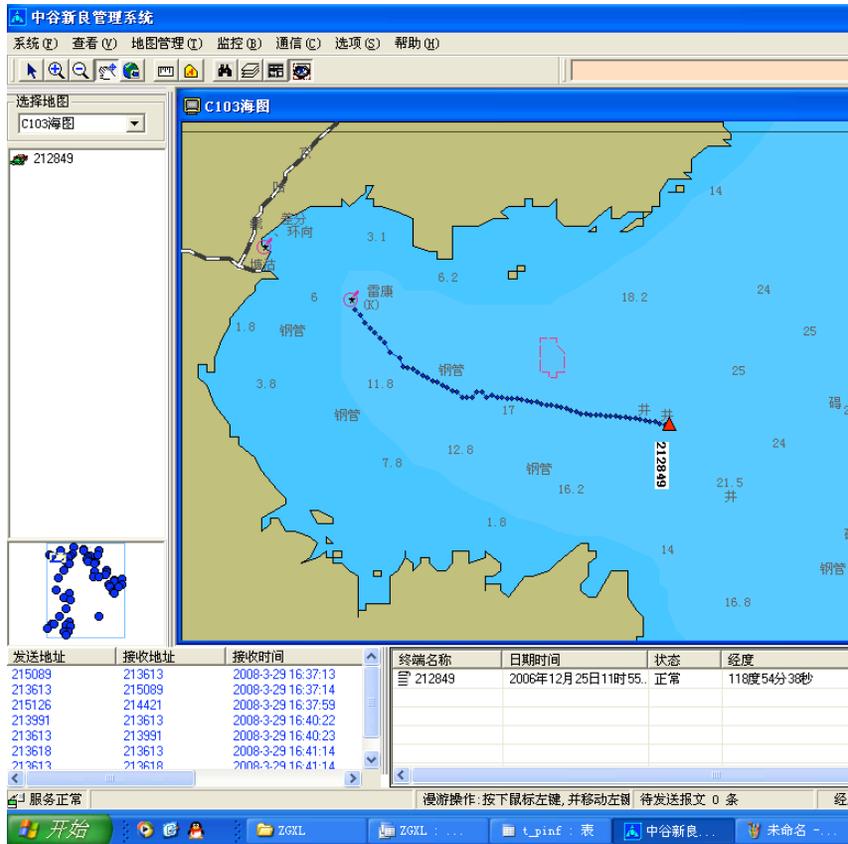
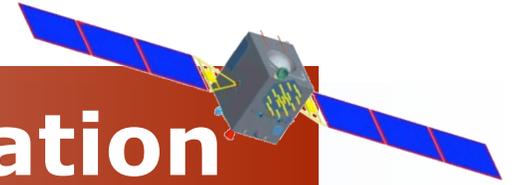
Qinghai-Tibet Plateau Railway Monitor and Control System

Transportation Application



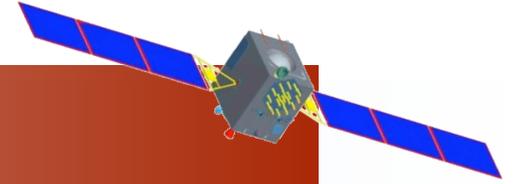
Dangerous Goods Tracking and Control System

Transportation Application



Offshore and Inland Water Transport Control System

Outline



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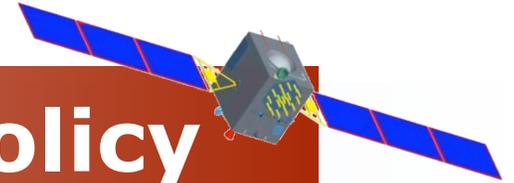
 **Steps of the Deployment**

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 **Summary**

Principles of the State Policy



✓ **Openness**

COMPASS will Provide SIS for civil services, COMPASS applications are encouraged all over the world, open access of all direct users to the civil signals will be free of charge.

✓ **Independency**

COMPASS can provide services for users independently.

The Construction, operation and development of COMPASS will be independent considering national security and user benefit.

Principles of the State Policy



✓ **Compatibility**

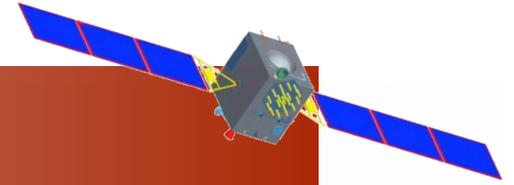
COMPASS is willing to be compatible and interoperable with other satellite navigation systems, and users can get better services with interoperable terminals. The development and manufacture of the interoperable terminals will be encouraged.

✓ **Gradualness**

In order to control risks, COMPASS will be developed step by step based on technology and economy of China.

COMPASS will provide long-term continuous services for users, and improve system performance incessantly.

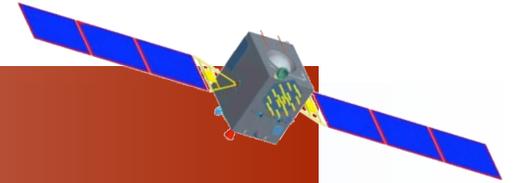
Cooperation



◆ Nowadays Compass is promoting the cooperation with other GNSS, and focusing on:

- Compatibility of frequency
- Interoperability with multi-systems in sense of signals, geodesy reference and time reference
- Development of common standards for GNSS application
- GNSS receiver test and certification
- Future navigation technology development
- Search and rescue service implementation
- Integrity monitoring

Outline



 **Architecture of the System**

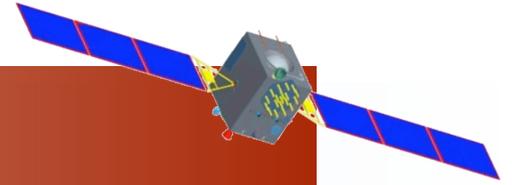
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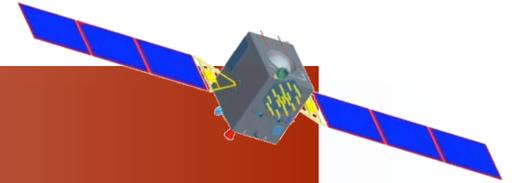
 **Principles of the System**

 **Summary**

Summary



- ◆ The development of COMPASS is a national strategy of China.
- ◆ COMPASS hopes to be an essential element of the international GNSS society.
- ◆ COMPASS is being constructed smoothly.
- ◆ China encourages international cooperation to ensure compatibility and interoperability with other systems.



**Thanks
for your attention!**