IGNSS 2009 December 1-3 Gold Coast Australia

Development and Applications of Compass/Beidou Satellite Navigation System

China National Administration of GNSS and Applications (CNAGA)

1. Basic principles

- China decided to build its own independent satellite navigation system in 1980s'.
- The COMPASS navigation demonstration system went into operation in 2003, since then it has been used in many areas.
- Now the COMPASS navigation satellite system is under construction.
- The basic polices of the system are:

  Openness, Independency,

  Compatibility and Gradualness.

1. Basic principles (continue)

Openness

- COMPASS will provide open services free of charge for direct users. Worldwide use of COMPASS is encouraged.
- China will be engaged in promoting the development of GNSS technologies and the satellite navigation industry through extensive communication and cooperation with other countries.

1. Basic principles (continue)

Independency

- China will develop and operate COMPASS system independently, which can provide services for global users and particularly provide better services in Asia-Pacific region.

Compatibility

- COMPASS will join with other satellite navigation systems in the effort of realizing compatibility and interoperability.

1. Basic principles (continue)

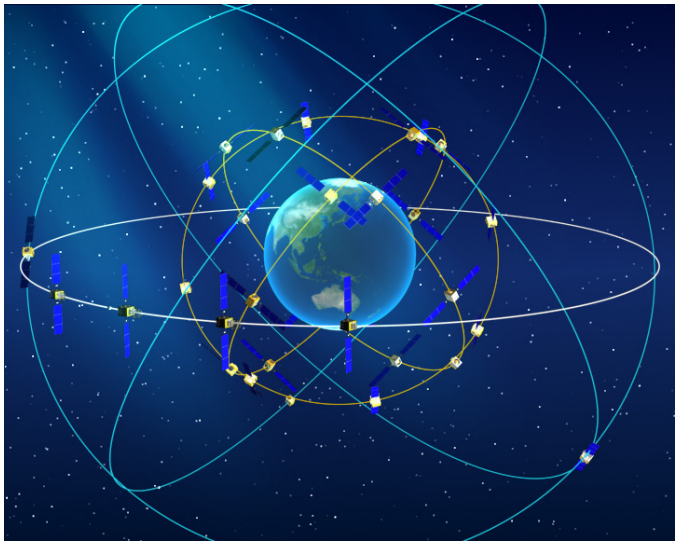
Gradualness

- COMPASS system will be constructed and improved step by step.
  - ✓ Regional navigation---RDSS;
  - ✓ Extended regional continuous navigation services—RDSS+RNSS;
  - ✓ Global navigation services.
- It will be devoted to provide continuous services, and ensure smooth transition before the system provides global services.

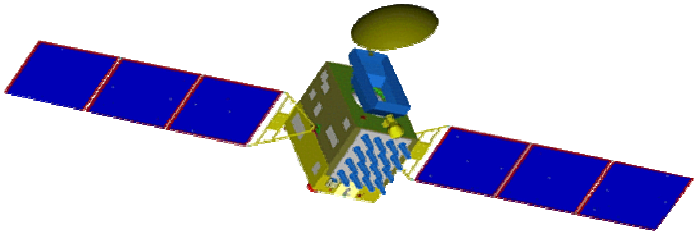
2.1 System Structure

■ Space Segment:

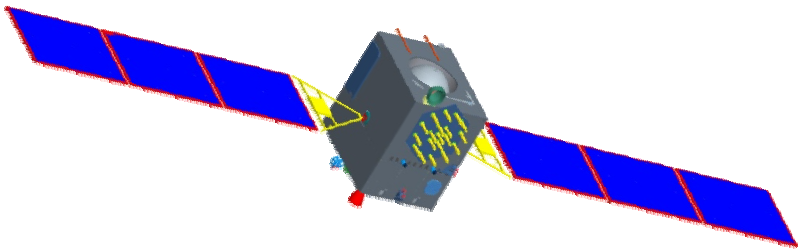
✓ 5 GEO and 30 Non-GEO satellites



Constellation



GEO Satellite



MEO/IGSO Satellite

2.1 System Structure (continue)

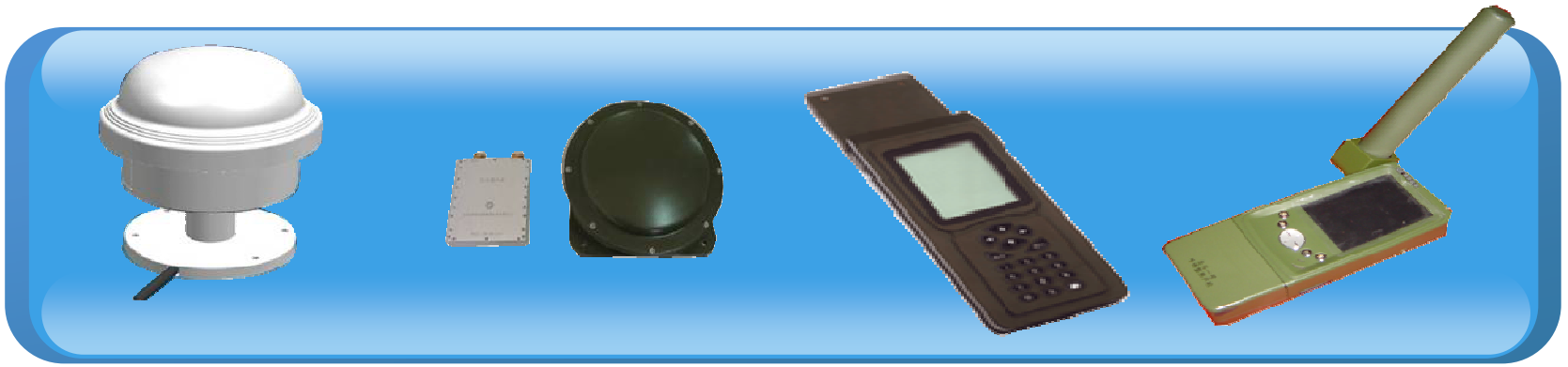
■ Ground Segment

- ✓ Master Control Station
- ✓ Upload Stations
- ✓ Monitoring Stations.

2.1 System Structure (continue)

■ User Segment

✓ The user segment consists of COMPASS user terminals and multi-GNSS terminals.



User terminals of COMPASS system

2.1 System Structure (continue)

User Segment

- ✓ Related standards and regulations for various receivers have been started.
- ✓ COMPASS ICD for open services has already been compiled and is about to be published step by step.

2.3 Time System

- COMPASS time is named as BDT. It can be traced to UTC, and synchronized with UTC within 100ns. The epoch time of BDT is UTC 00d 2006.
- Interoperability of BDT with GPS/Galileo time was considered in the design of COMPASS time system.
- The offset between BDT and GPST/ GST will be measured and broadcasted.

2.4 Coordinate System

- COMPASS/BeiDou uses China Geodetic Coordinate System 2000 (CGCS2000) with its coordinate frame as CTRF 2000 consists of more than 2600 stations.
- The CTRF2000 coincides with ITRF at a few cm level, and for most applications the difference between CGCS2000 and ITRF can be ignored.
- The velocities of the CTRF will be provided next year---based on the continuous GNSS operational stations.

2.5 Services and Performances

- Two kinds of global services
  - Open Service： free and open to users
    - ✓ Positioning Accuracy: 10 m
    - ✓ Velocity Accuracy: 0.2 m/s
    - ✓ Timing Accuracy: 20 ns
  - Authorized Service: ensure highly reliable use even in complicated situation.

2.5 Services and Performances (continue)

- Two kinds of regional services
  - Wide area differential service
    - ✓ Positioning accuracy: 1 m
  - Short message service

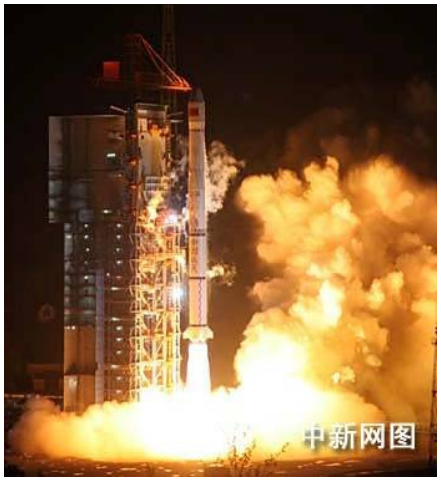
3.System Deployment

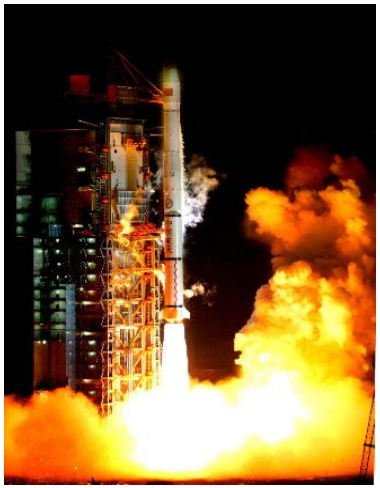
- **Deployment Steps**
  - ✓ 1st Step—Demonstration System
  - ✓ 2nd Step—Extended regional navigation system
  - ✓ 3rd Step–Global System
- **Launch Schedule**
  - ✓ Launched satellites
  - ✓ Launch plan

3.1 Deployment Steps

■ 1st Step—Demonstration System

- Since 2000, 3 GEO satellites had been launched, which consists of COMPASS Demonstration System.
- It is able to provide services including positioning, timing and short-message communication mostly within China.

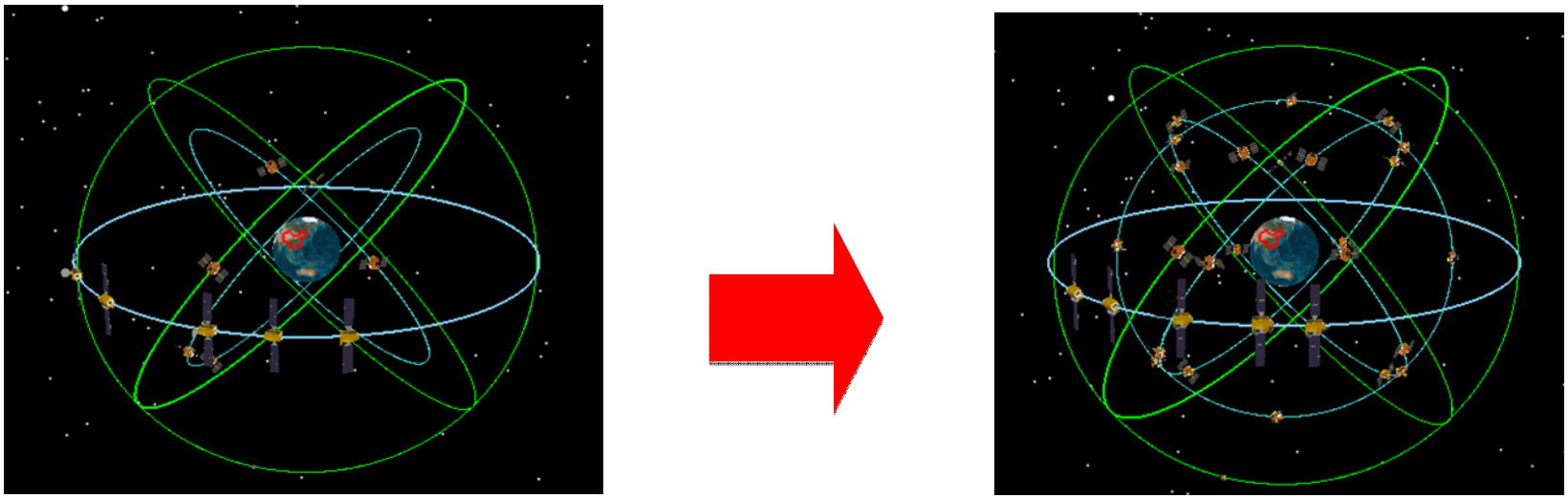






3.1 Deployment Steps (continue)

2nd Step—Global System

- COMPASS will cover Asia-Pacific region around 2011,
- It 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 April 2007

■ COMPASS-G2 Launch

On April 15 2009, the first GEO satellite named Compass G2 was launched at Xichang Satellite Launch Center of China.

■ Planned launches

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

4. Applications

- Since 2003, COMPASS Satellite Navigation Demonstration System has been in good operation.
- The system features:

  - ✓ Quick positioning
  - ✓ Timing with high accuracy
  - ✓ Position monitoring
  - ✓ Combination of positioning and short message communication

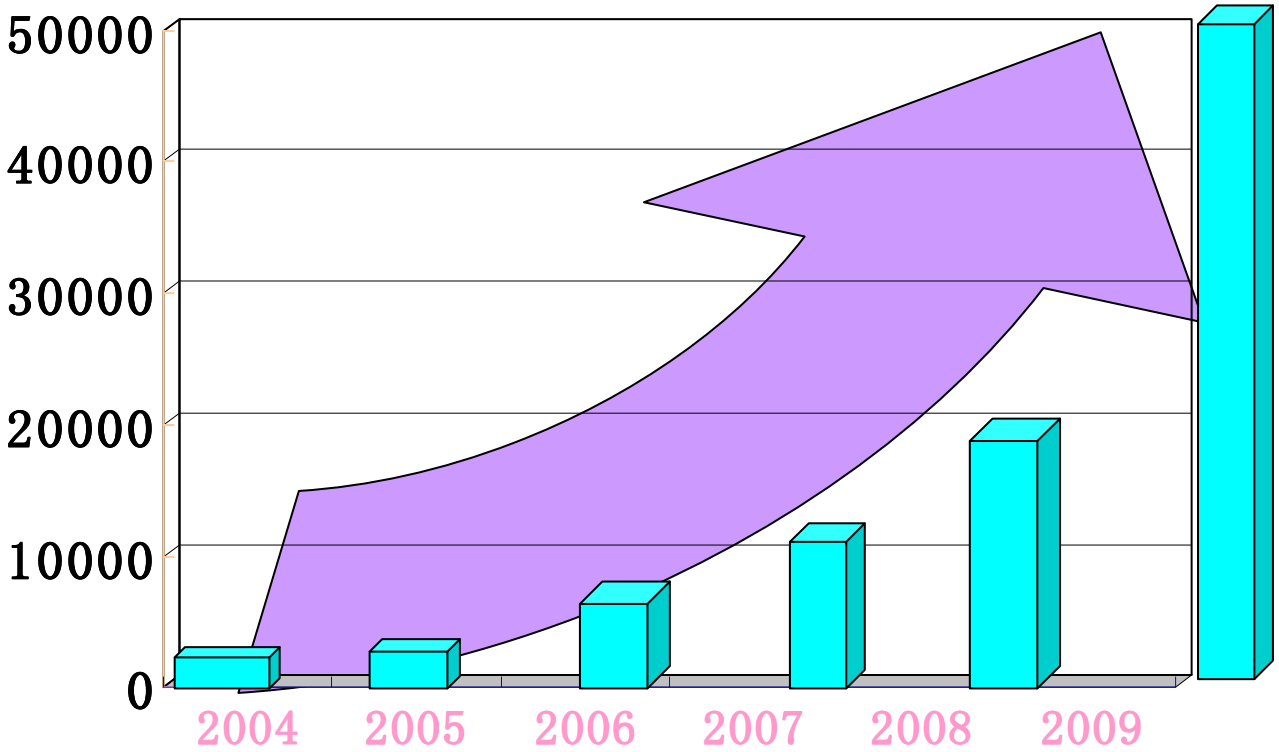
4. Applications (continue)

- **The successful application area includes**
  - **Transportation**
  - **Marine**
  - **Fishery**
  - **Disaster forecast and management**
  - **……**

It plays an important role in the national economic and social development. It is an important tool in navigation, timing and communication especially when terrestrial communication systems are not available.

4. Applications (continue)

Registered users



4. Applications (continue)

- **Two cases of COMPASS application**
  - **Disaster relief**
  - **Forest fire prevention**

Example 1---Earthquake Relief

- In Sichuan earthquake on May 12, 2008, the local roads and telecommunication infrastructure were severely destroyed;
- What about the situation in the disaster area?
- How to organize the rescue activities?

Example 1---Earthquake Relief

- To make the rescue plan, the information was necessary!
  - ✓Where the victims of the disaster?
  - ✓What the victims need? ----food, medication…
  - ✓How many victims in some area?
  - ✓How many rescuers and goods are needed?
  - ✓How to arrive the rescue position? …
- Disaster Positioning and Communication are very important!

Example 1---Earthquake Relief

- Stage I: Rescue plan----Information collection
- Stage II: Disaster rescue process
  - ✓Positioning: Victims and rescuer
  - ✓Communication: rescuer team ⟷ command center
    rescuer team ⟷ rescuer team
  - ✓Rescue route plan----based on Compass and GIS
- Stage III: Post-earthquake assessment
  - ✓Damage area surveying
  - ✓Damage analysis

Example 1---Earthquake Relief

Professional detection sensor connected with COMPASS terminal can be quite useful in disaster management and forecast.

■Example 2---Forest Fire Prevention

- There are about 130 million hectares of forest in China.
- Forest fires break out every year
- Huge damage to people, wild animals, natural resources and environment

Example 2---Forest Fire Prevention

- **Forest Fire Prevention Problems**
  - ✓ Defectiveness of current fire detecting devices
  - ✓ Lack of effective communication devices

- **COMPASS-based fire prevention system**
  - ✓ An efficient forest fire prevention（FFP）mechanism by taking full advantage of various technologies, especially of COMPASS System has been established.

Example 2---Forest Fire Prevention

Fire truck equipped with COMPASS Terminal

■Example 2---Forest Fire Prevention

Why choose COMPASS?

✓COMPASS System covers the entire area of Chinese forest with no blind area

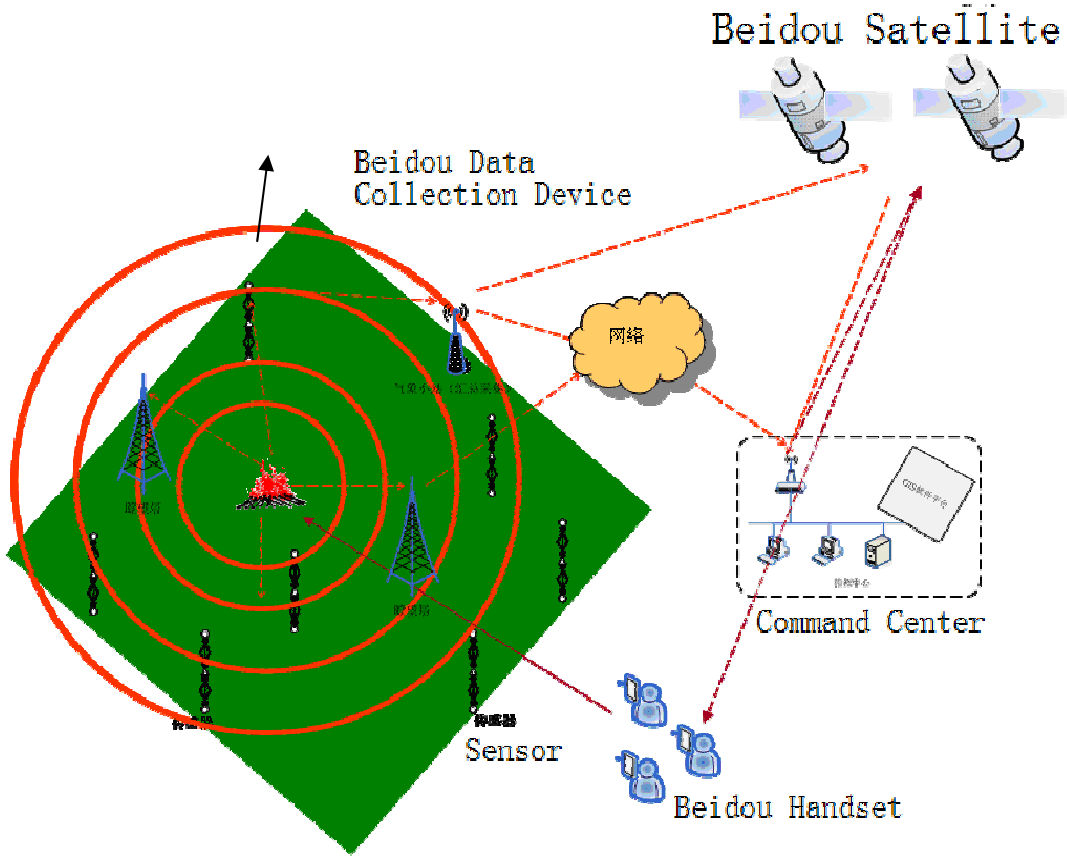
✓Provides positioning and short message service at the same time---efficient commanding

✓Qualified COMPASS terminal devices--- portable, low-energy consuming and high temperature resistant

Example 2---Forest Fire Prevention

What is COMPASS-based Forest Fire Prevention System Composed of?

- COMPASS Satellites
- Command Center
- COMPASS Data Collection Device
- COMPASS Handset
- Temperature and Humidity Sensors



■ Example 2---Forest Fire Prevention

When to use COMPASS?

- Stage I: Fire risk analysis and fire detection
  - ✓ COMPASS-based fire indicator collection
  - ✓ COMPASS-based fire risk analysis
- Stage II: Fire fighting process
  - ✓ Positioning: fire and fire fighter ⟷
  - ✓ Communication: fire fighter ⟷ command center
    fire fighter ⟷ fire fighter
  - ✓ Fire fighting route plan----based on navigation and GIS
- Stage III: Post-fire assessment
  - ✓ Damage area surveying
  - ✓ Data collection automatically

Example 2---Forest Fire Prevention

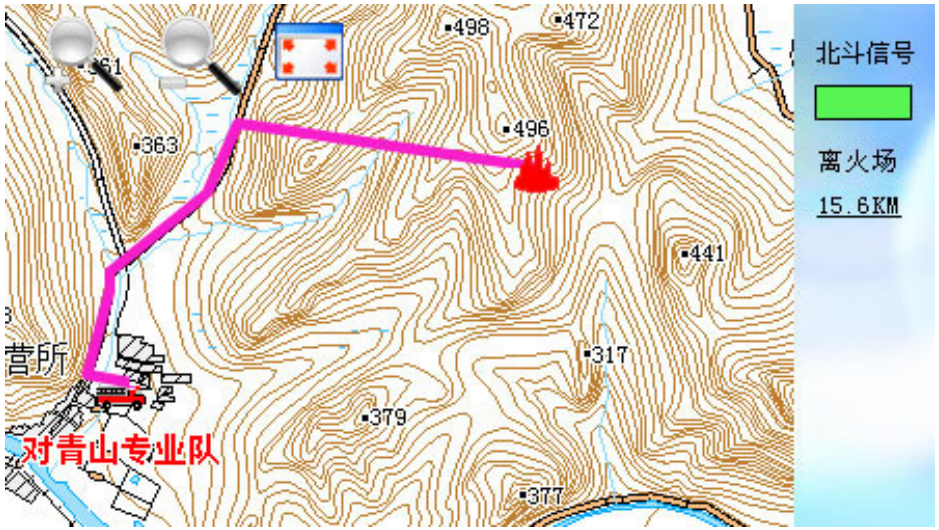
COMPASS-based Forest Fire Prevention System

■Example 2---Forest Fire Prevention

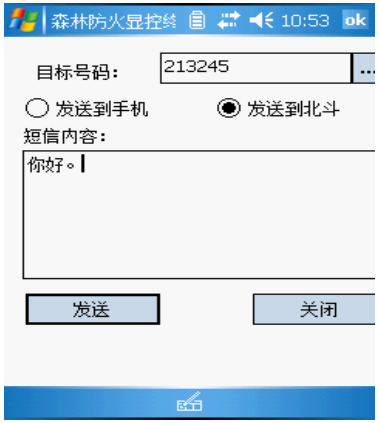
COMPASS Handset

Fire Alarm

Fire Fighting Route Plan



Short Message
--danger alarm
--search for help
--fire damage



Example 3---Water resource monitoring

- There are many water monitoring stations

  —monitoring rainfall, hydrological change, disaster prevention and transmitting collected information.

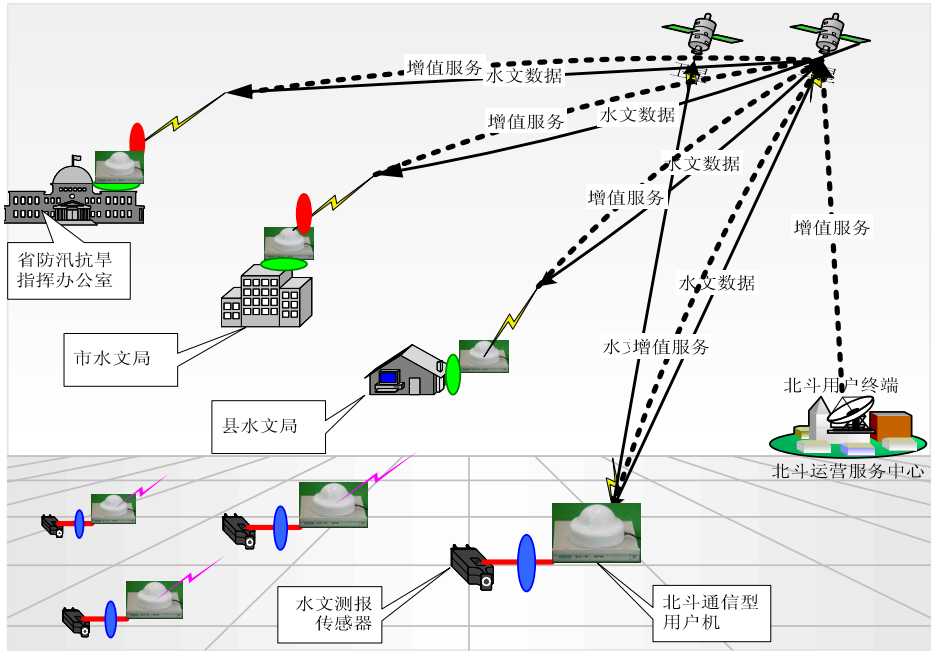
- Short message function

  —The signals of COMPASS system, combined with mobile phone signal, will be rapidly transmitted through short message after receiving rainfall and hydrological information.

- It helps to evacuate downstream people, protect the safety of life and property at the earliest attention, reduce the possible damage of flood disaster.

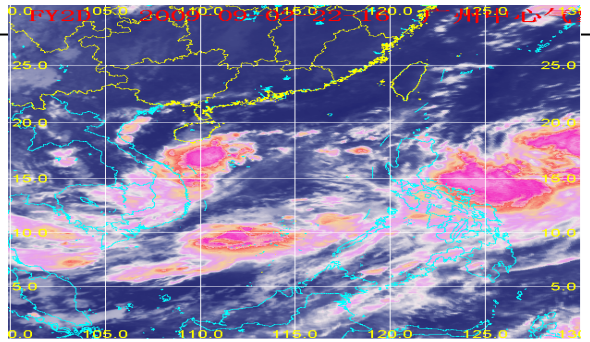
Example 3---Water resource monitoring

What is COMPASS-based Water Resources Monitoring System Composed of?



Example 4--- Application in Meteorology

- **COMPASS-based digital message transmission for meteorology has been developed**
- **The system can mainly**
  - **collect the digital message automatically**
  - **Transmit the message to National Meteorological Department and local weather stations**
  - **Provide visualization of the distribution of weather stations on GIS platform.**



Other Examples----COMPASS-based solutions in other industries

- Fishery industry
- Water hydrology
- Special vehicle safety information
- Container safety and information service
- Travel safety in remote area
- Long-distance safety monitoring
- ……

What are the future applications of COMPASS?

5.Conclusion

- Compass/BeiDou is one important component of national infrastructure.
- Its development is a national strategy in China.
- COMPASS/BeiDou is also an essential element of Global Navigation Satellite Systems.
- It is actively involved in the international cooperation with other navigation systems.
- In the future navigation market, there will be some quotient belongs to Compass.

THANK YOU!