Beidou/Compass and its Unique Contributions to GNSS

- New Applications in China

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GNSS Evolution

	1st Gen GNSS	2.5G GNSS			
	Transit Doppler				
Space	• Polar orb: 10 sv • Height: 1100km/106min • Freq.: 150/400MHz • Nav: Orb&clk	• 30 SVs • 20000km/12hrs • Freq.: L1/L2/L5 • Modulation: BPSK/QPSK • Nav: Orb/clk	• 24 SVs • 19130km/11.25hrs • Freq.: L1/L2/L3 • Modulation: BPSK/QPSK • Nav: Orb/clk	• 35 SVs • 24000km/14hrs **36000km/24hr** • Freq.: B1/B2/B3 • Modulation: QPSK • Nav: Orb/clk	• 30 SVs • 24000km/14.7hrs • Freq.: E1/E5/E6 • Modulation: QPSK/BOC • Nav: Orb/clk
Control	• Ground tracking, injection, master stations. • Mnaged by USA	• Ground tracking, injection, master stations. • Managed by USA	• Ground tracking, injection, master stations. • Managed by RU	• Ground tracking, injection, master stations. • Managed by China	• Ground tracking, injection, master stations. • Managed by EU
User	• Measurements: Doppler • Position fix every few hours • geodetic and timing	• Measurements: Doppler, Range, Phase • Continuous nav & timing • Geodetic	• Measurements: Doppler, Range, Phase • Continuous nav &timing • Geodetic	• Measurements: Doppler, Range, Phase, **2-way range** • Continuous nav & timing • Geodetic • **Short message service**	• Measurements: Doppler, Range, Phase • Continuous nav & timing • Geodetic

What Do We Need from 3rd Gen?

There are more applications, a greater dependency on GNSS and more concern about GNSS vulnerability

- **More satellites are needed**
  - Assured availability, especially in urban canyons, mountainous areas, under foliage, etc.
  - Positioning accuracy (geometry improvement)
  - RAIM/Robustness
- **More frequency diversity and more modulation modes**
  - Resistance to interference
  - Reduce multipath
  - Reduce TTFF and improve sensitivity by having different signal components, e.g. pilot and data
  - Improve performance of high accuracy applications
- **Communication capability**
  - Two-way communication capability and/or one-way receiving capability
  - Receive signals from each other among satellites in different constellations
- **Managed by different authorities**
  - Avoid intentional denial or accuracy degradation
  - Bounded inaccuracy due to accidental system failure
- **Minimum extra cost for user terminals**

Defining the 3rd Gen GNSS

- **The 3rd GNSS System: Meeting requirements in the previous slide. It is actually an open architected GNSS operated by different authorities.**
- **The 3rd GNSS system has 3 segments:**
  - Space segment: all navigation satellites, and receiving signals from each other
  - Ground segment:
    - different operating authorities responsible for satellites
    - different organizations provide satellite orbit and clock information for variety of applications
  - User segment: GNSS receivers with communications capability
- **Extendable by any party under following guidelines:**
  - Compatibility
  - Interoperability
  - Interchangeability
  - Minimum extra cost for the user segment

Beidou Contributions to 3rd Gen GNSS

- **New type of measurements**
  - RDSS two-way ranging capability
- **New services on communications**
  - E.g. Short Message Service
- **More satellites and better frequency diversity**
  - 35 more satellites
  - New frequencies, more signal components and more modulations
  - Mid/high orbit satellites for better ITRF maintenance
  - GEO satellites： improve DOP, availability and TTFF
- **Better accuracy and integrity**
  - Wide area differential corrections and integrity broadcast
  - Broadcast of precise ephemeris and satellite clock
- **Interoperability/Interchangeability improvement**
  - Providing transformation parameters among different coordinate and timing systems of GPS, Glonass and Beidou/Compass, Galileo, etc.
- **Improve the robustness in cases of service disruptions**

Typical Receiver Design

GPS

GPS Signal Processing Unit

+

GLONASS

Glonass Signal Processing Unit

+

Beidou

Beidou Signal Processing Unit

+

GALILEO

Galileo Signal Processing Unit

Tightly Integrated PVT Processing Unit for all Systems

Deeply Integrated Receiver Design

The 3rdG GNSS

The 3rdG Receiver

Signal Receiving — Any 4 (or more) GNSS satellites

Baseband

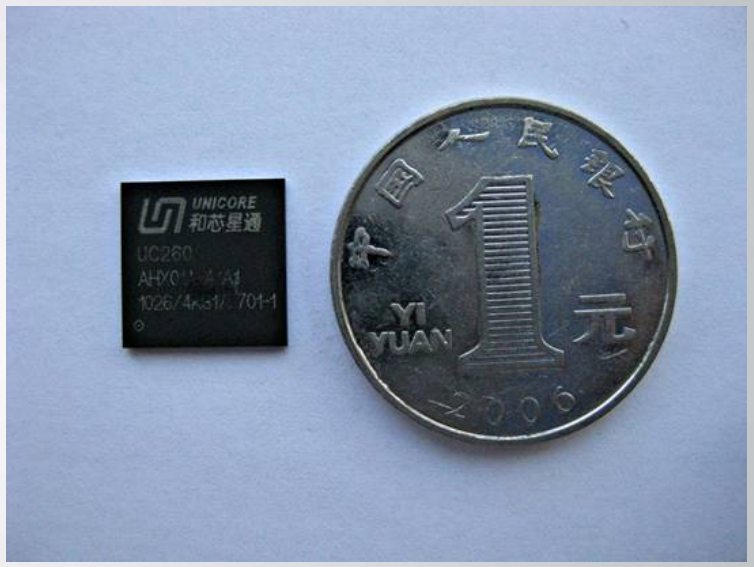
- **Unified and configurable baseband architecture**
- **Code generation unit to support all types of PRN codes**
- **Support BPSK, QPSK, BoC, mBoC, AltBoC, etc.**
- **Correlator, FFT and match filter to support all systems**

PVT

- **Unified GNSS coordinate and time system**
- **PVT with Embedded RAIM for security and integrity**

The 3rd Generation Receiver Design

- **Antenna (multi-band receiving, overlay and separatability)**
- **Radio frequency (multi-channel and configurable)**
- **Baseband processing (re-configurable architecture for different modulation modes, different ranging codes, acquisition and tracking units, etc.)**

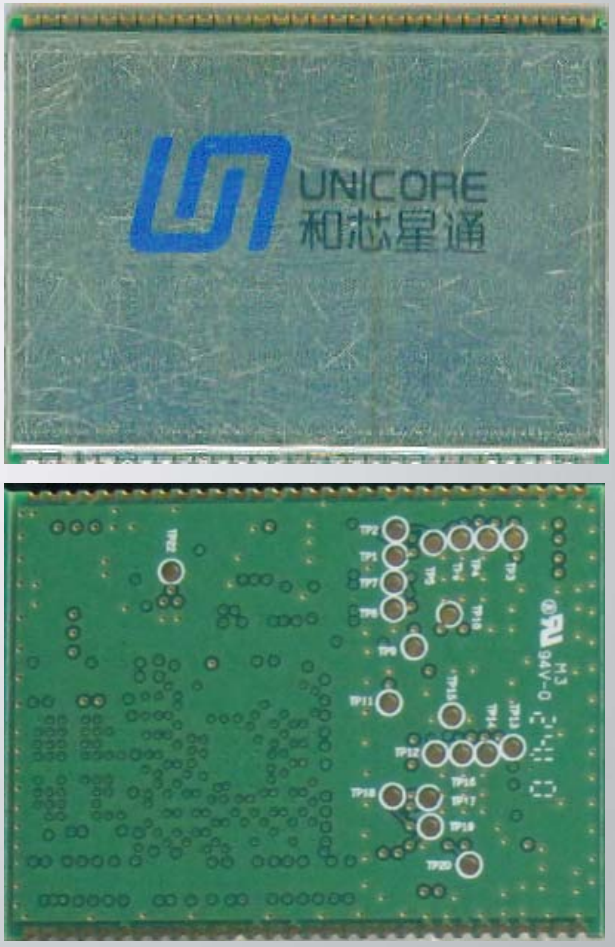


- **Position, Navigation and Timing computation (embedded coordinate and time transformation) to achieve positioning with any 4 (or more) satellites**
- **RAIM with integrity check for both inter-system and intra-system**
- **Both transmitting and receiving capabilities**
- **Low cost message receiving capability**

Beidou/GPS module with SMS

Unicore Beidou/GPS module with SMS for applications:

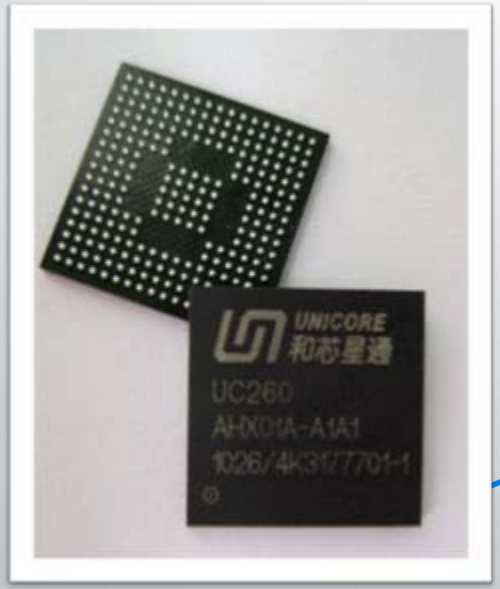
- Offshore fishing service
- Timing for China 3G standard – TD-SCDMA
- Disaster mitigation
- Fleet management rural areas

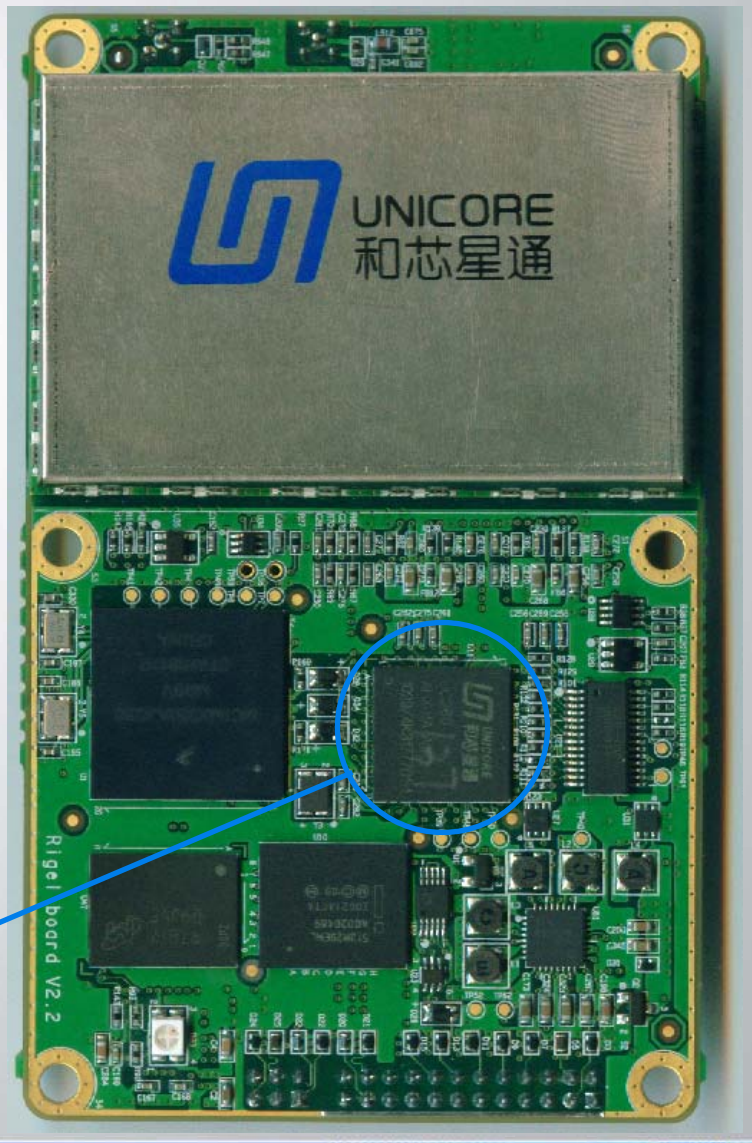


WAAS and High Precision Services

Unicore Beidou/GPS dual frequency OEM board with:

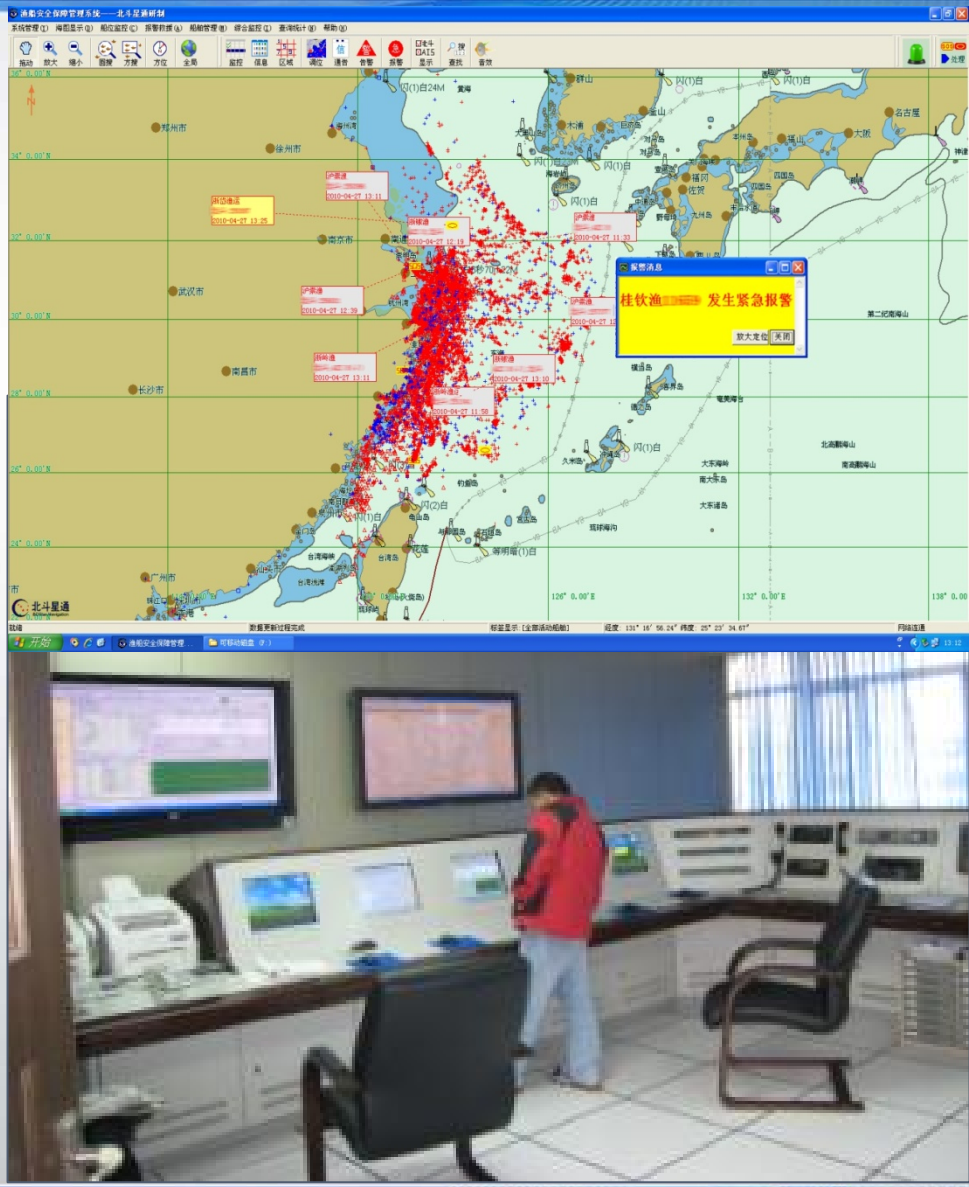
- WAAS information provided by Beidou (Compass)
- Potentially high accuracy orbit and satellite clock information provided by Beidou (Compass)

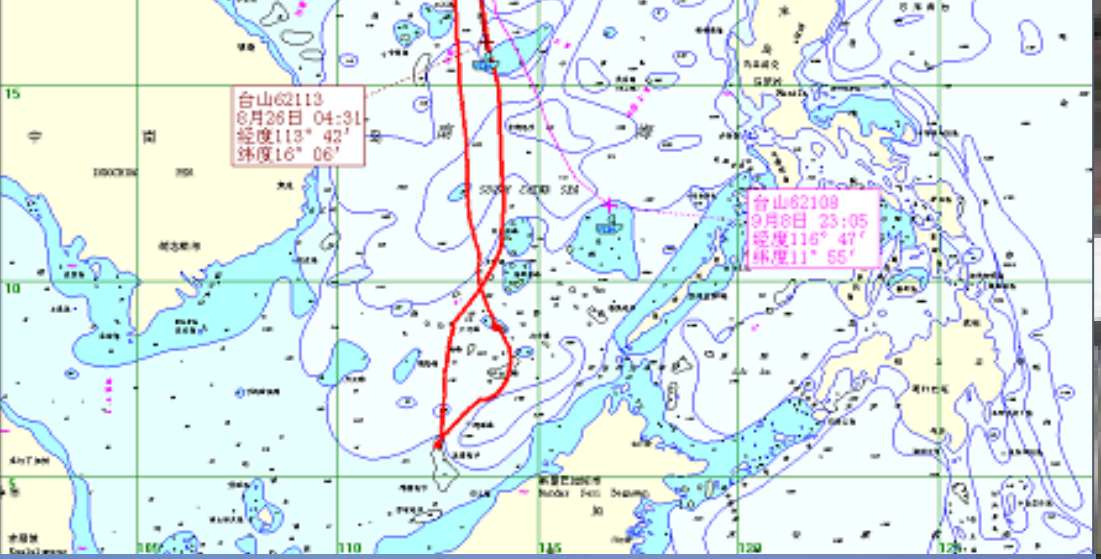




Offshore Fishing Mngt System

- System: Beidou with SMS + China Mobile + GIS + Internet Business
- Functions:
  - Offshore fishing, monitoring, safety, emergency aid
  - Fishing and on-line business services



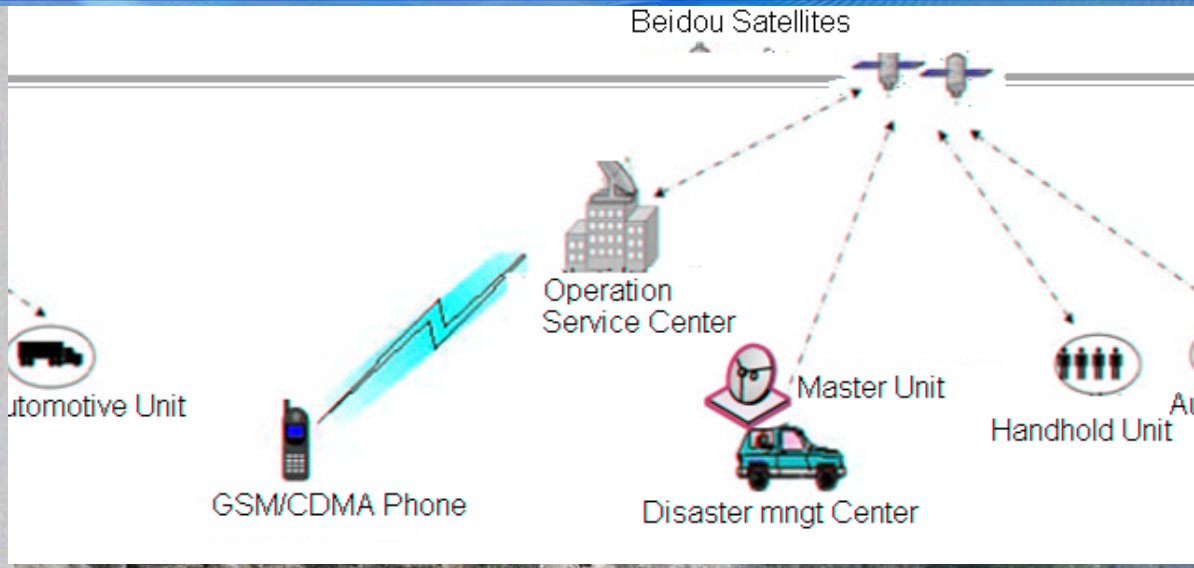

台山62113
8月26日 04:31
经度113° 42'
纬度16° 06'
台山62109
9月8日 23:05
经度116° 47'
纬度11° 55'

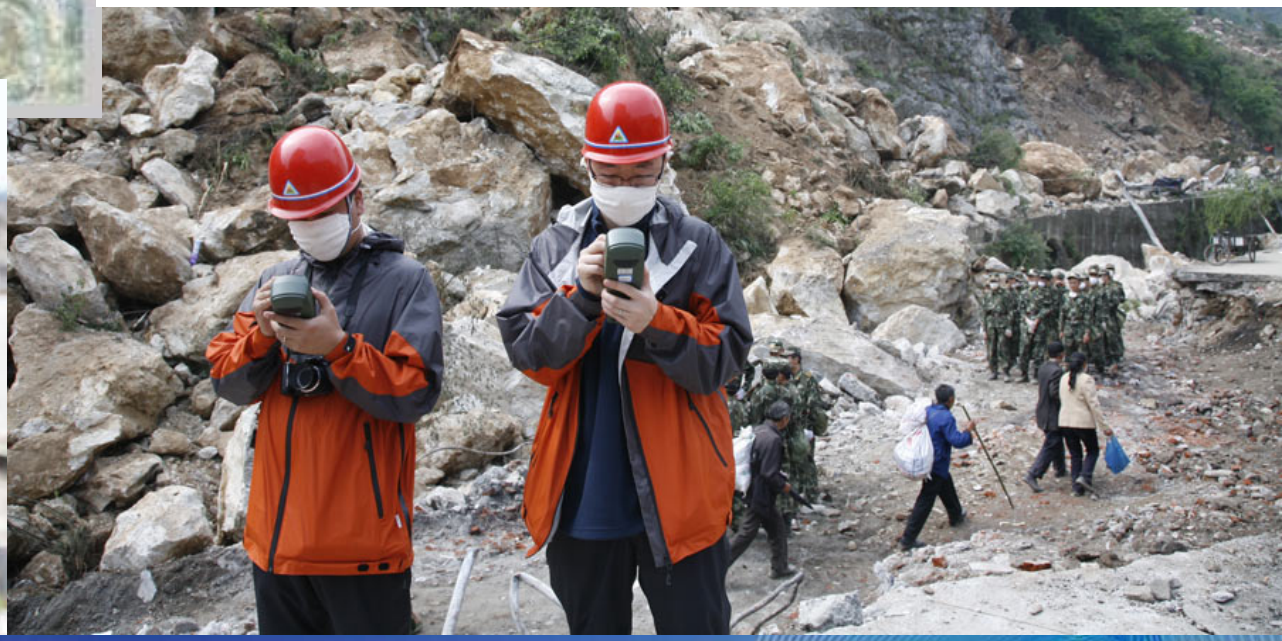

Times
信息时报

Earthquake/Disaster Mitigation

- System: Beidou RDSS/SMS + China Mobile + GIS + Internet Business
- Functions:
  - Monitoring,
  - Communications,
  - and Management

Wen Chuan Earthquake Example

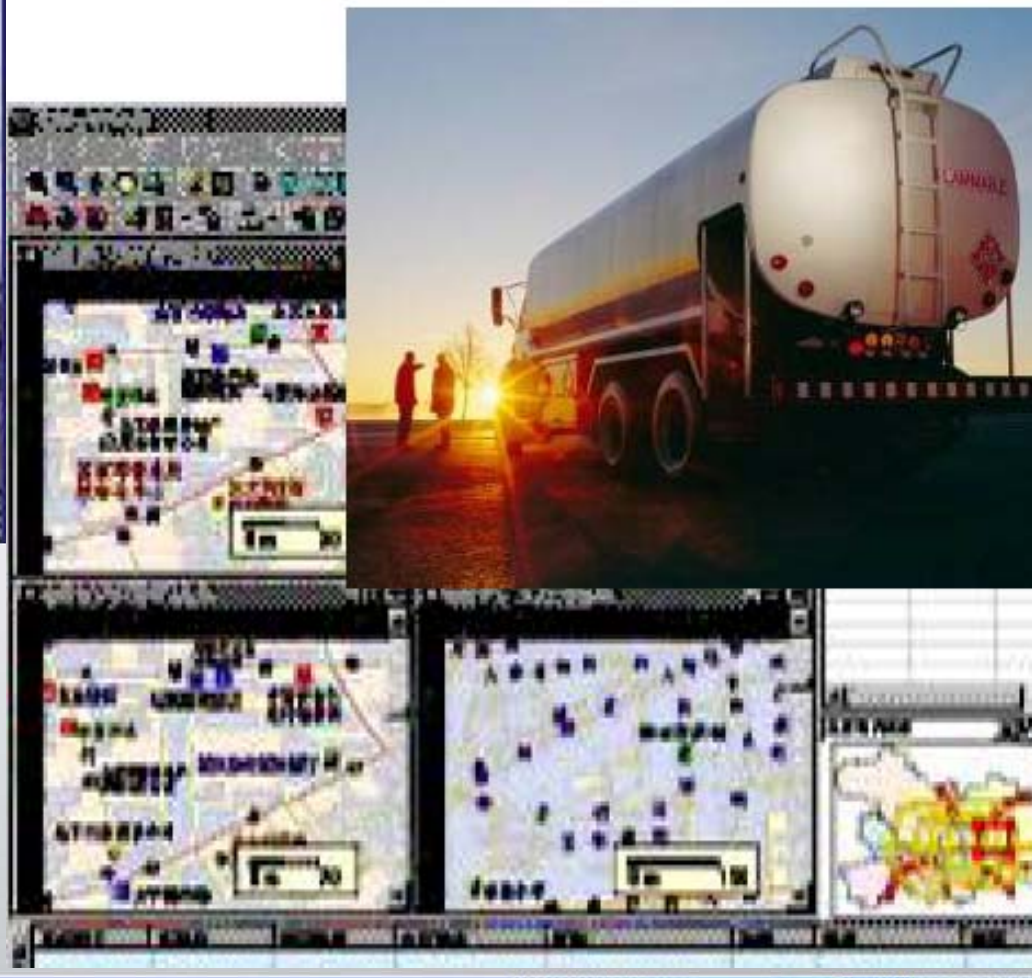




Fleet Management For Rural Areas

Qinghai-Tibet Railway
Monitoring and Control System

Dangerous Truck Tracking and Control System



Concluding Remarks

- **The 3rd Generation GNSS is coming, based on open platform which can be enhanced by any satellite system**
- **Compatible, interoperability and interchangeability should be essential requirements for future systems**
- **China Beidou/Compass provides significant enhancements over the current GNSS**
- **Unicore has designed deeply-integrated receivers for the 3rd Generation GNSS**
- **With such enhancements and receiver technology achievements, wider applications have been, and will be, explored.**

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- New Applications in China

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THANKS