Differential BDS in China and the Research of DBDS standard in the Framework of RTCM

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- Performance of DBDS
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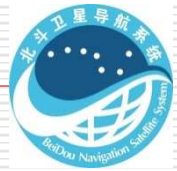
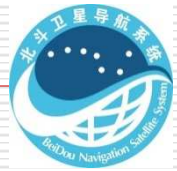
About DBDS



About Differential BDS

- Differential GNSS techniques to improve the accuracy of real time positioning
- Differential GNSS classified by the data sources
  - Code differential(CDBDS), 0.3m~2m
  - Phase differential(RTK),0.02m~0.10m
  - State Space Representation (SSR),0.1m~1.0m
- CORS, GBAS, RBN-DGNSS, etc. are used
- RTCM SC104 protocols are to support the DGNSS applications

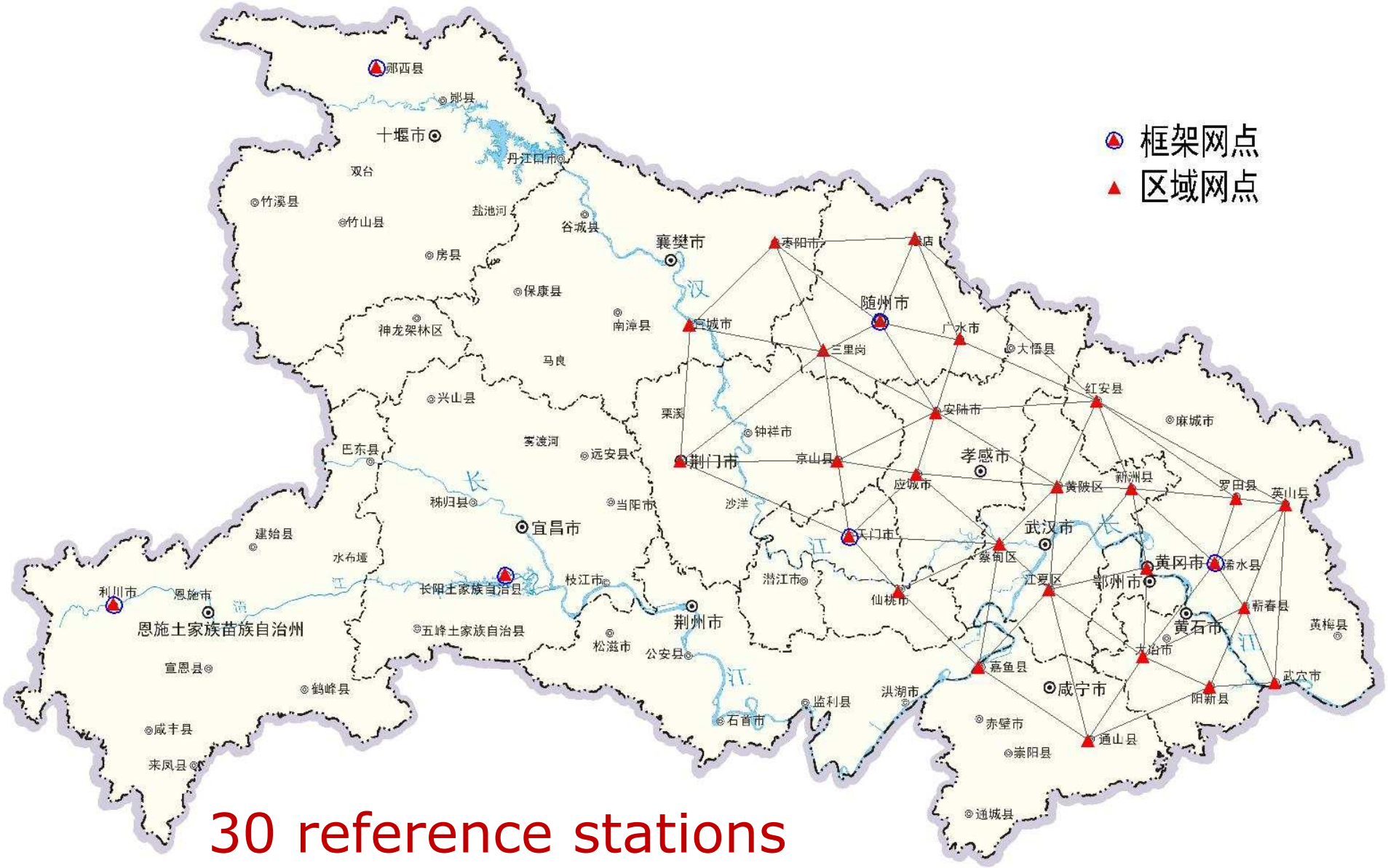
Performance of DBDS



DBDS Test network

- 30+ reference stations
- Hubei Province BDS Network RTK System
- BDS/GPS/GLONASS

HuBei BDS Network RTK system



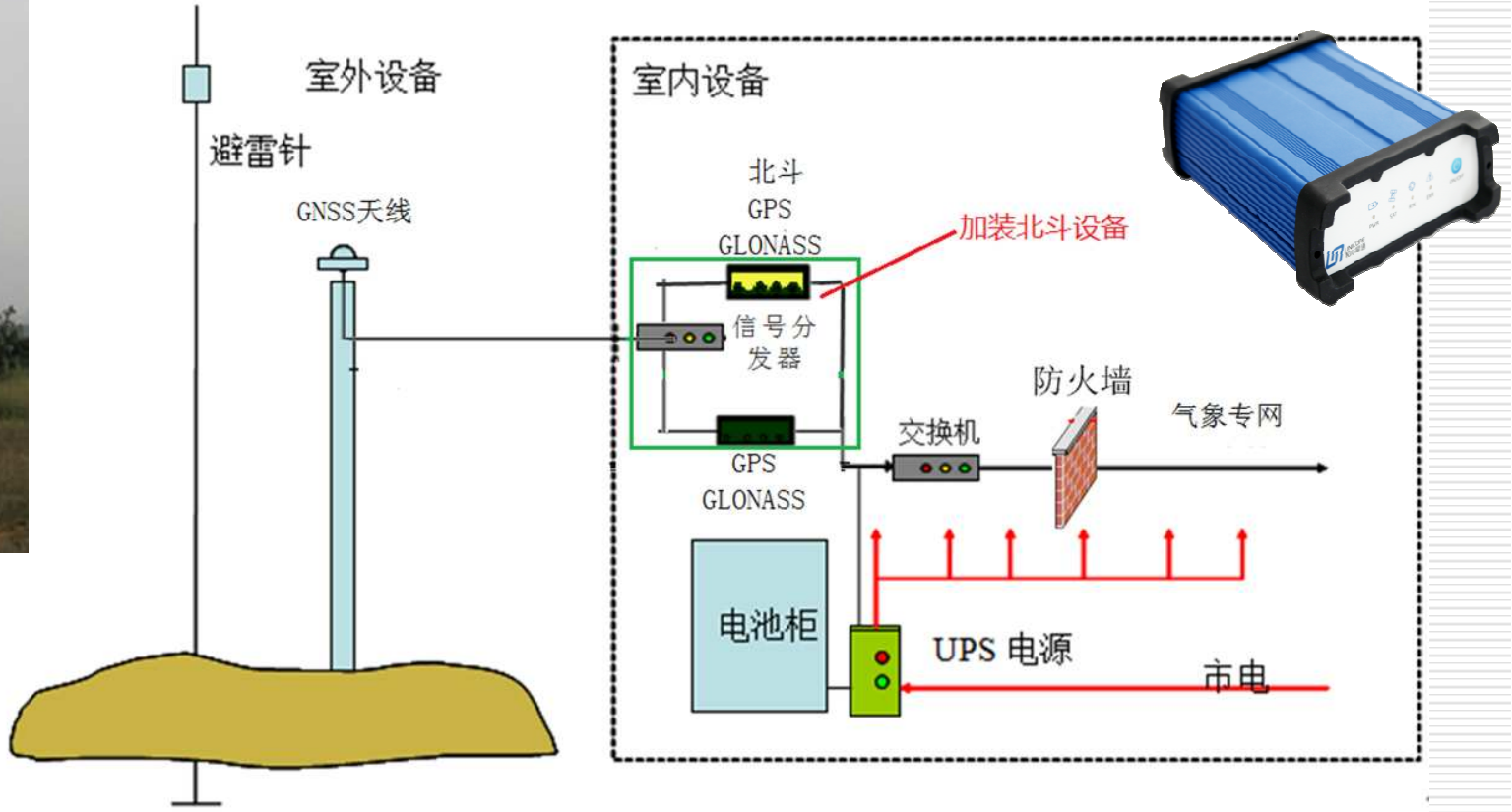
30 reference stations

Reference stations

- BDS/GPS Receiver, UPS, Route, Switch etc.

tower:

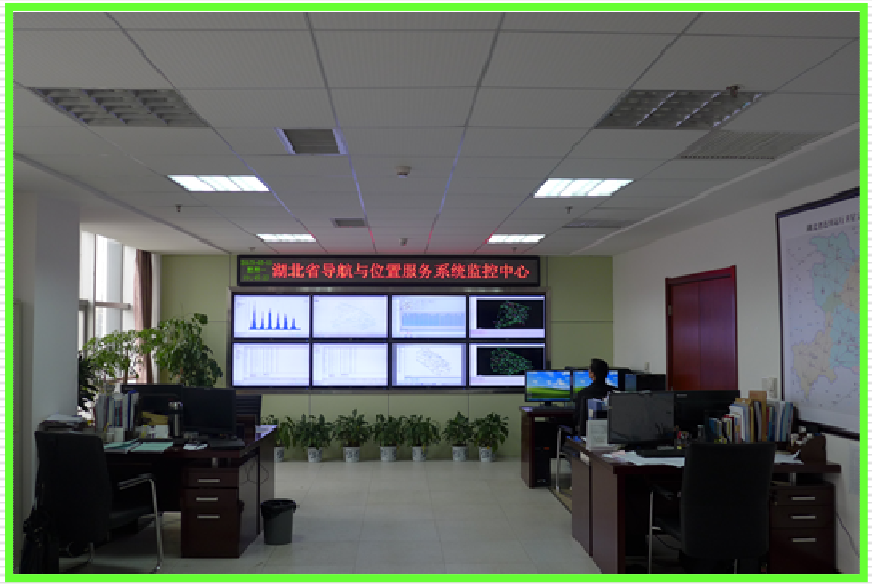
high 3.5m



Data center

- Located at Hubei Surveying &Mapping Bureau

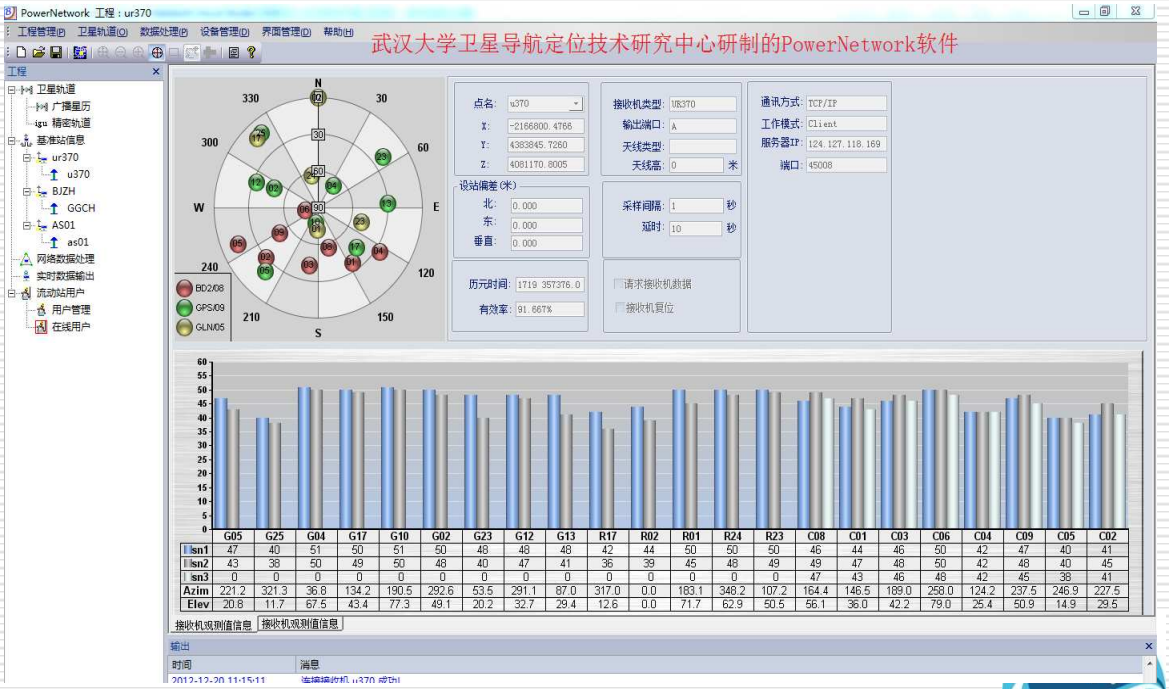
Building of Hubei SMB



Control Center

Software

- Functions
  - RS management
  - Data process
  - User management
- Systems
  - BDS B1, B2, B3
  - GPS L1, L2
  - GLONASS L1, L2



User receiver—BDS/GPS OEM

	Specification
Freq	Beidou B1/B2 + GPS L1/L2
Positioning Mode	Support point positioning using Beidou only, GPS only, and Beidou/GPS
BDS	Support Beidou B1/B2, Support Beidou point positioning, differential Beidou, and high precision relative positioning
Differential Corrections	CMR,CMR+,RTCM2.x,RTCM3.x
RTK Positioning	Support instant RTK and long range RTK
RTK accuracy	Horizontal: 1cm+1ppm Vertical: 2cm+1ppm
Power	1.6W
WAAS	Support WAAS and PPP

User receiver

- RTK Rover
- GIS data collector
- ……

Testing items

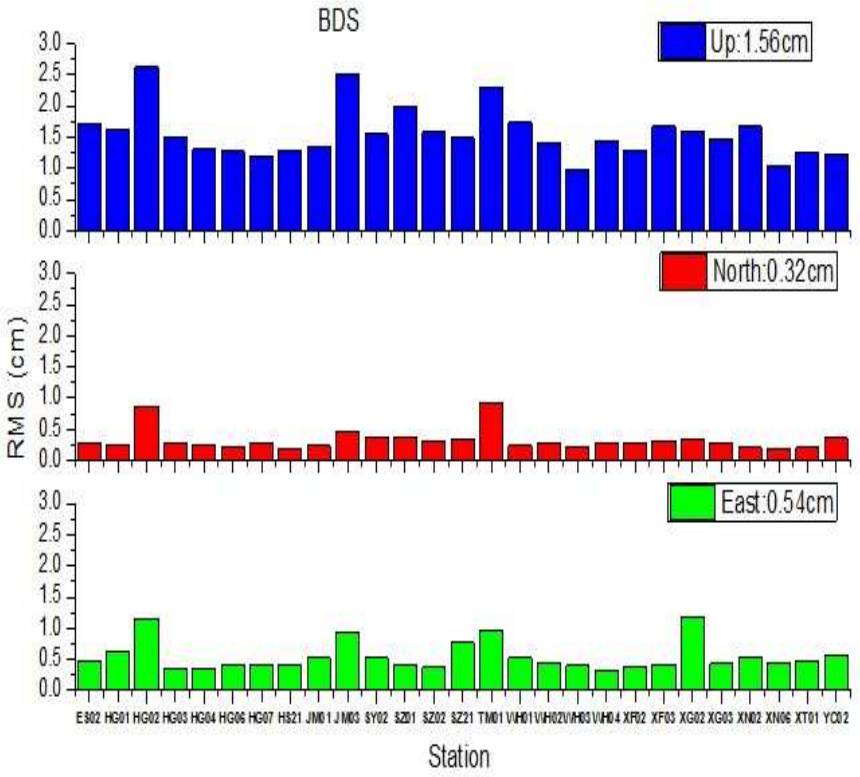
- Reference Station Coordinates
- Static post-processing
- Network RTK
- Code Differential
- Precision Point Positioning

Experiments and Results

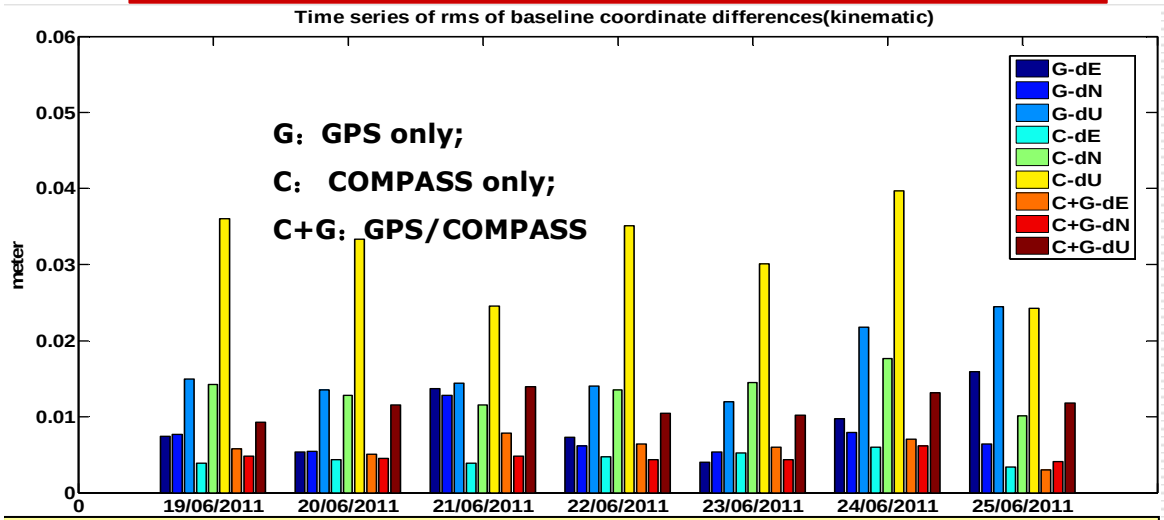
- Reference Station Coordinates—CGCS2000(BDS data only)

RMS H:0.006m、RMS V: 0.015m

ECEF RMS		Baseline Repeative
	RMS	Fixed +Scale
X	0.007m	6.7mm+2.8×10^{-8}
Y	0.010m	10.0 mm +1.6×10^{-8}
Z	0.006m	5.8mm +3.0×10^{-8}

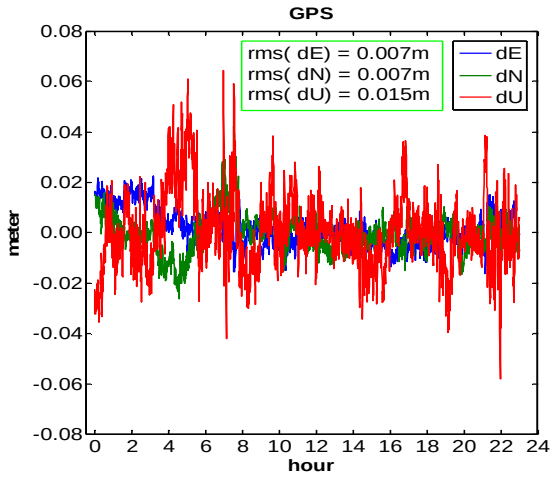


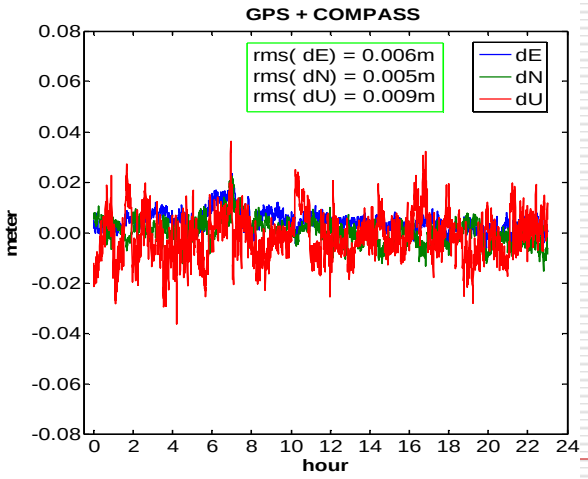
Experiments and Results-Static post-processing



7Days Positioning Result Vs. GPS (Dynamic, epoch by epoch)

	dE (mm)	*dN (mm)*	*dU (mm)*
GPS	***9***	***7***	***17***
Beidou	***5***	***13***	***32***
GPS + Beidou	***6***	***5***	***12***





DOY170 (Dynamic) Vs. GPS

20% precision improved using BDS+GPS than single GPS (Dynamic)

Experiments and Results—NETRTK

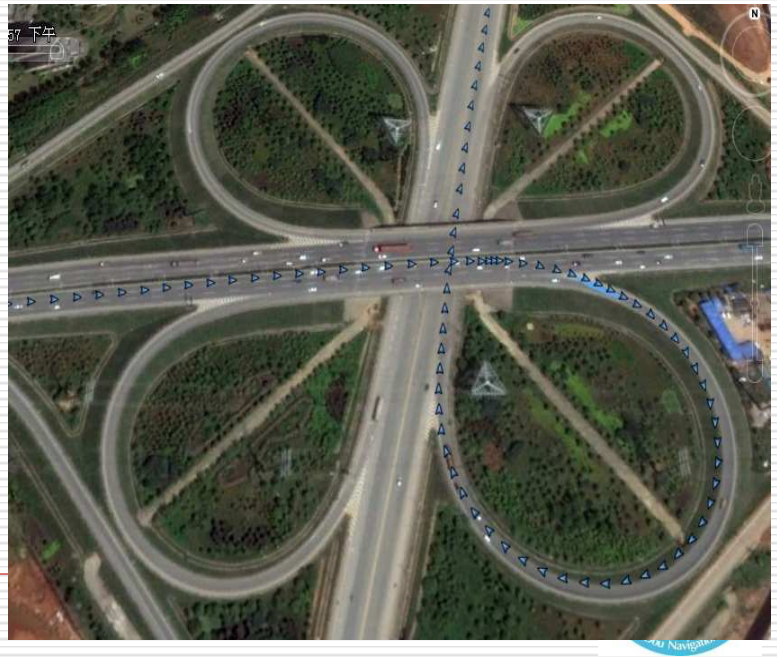
- Network RTK Positioning
  - BDS B1/B2 + GPS L1/L2

Mode	*Fixed*	*Initial Time（s）*	*STD/m（Average）*		*RMS/m（Average）*	
			H	*V*	*H*	*V*
GPS+BDS3	***100%***	***5.76***	***0.004***	***0.018***	**0.010**	**0.036**
GPS+BDS2	***80%***	***27.46***	***0.003***	***0.015***	**0.011**	**0.042**
BDS3	***83%***	***16.40***	***0.007***	***0.020***	**0.013**	**0.052**
BDS2	***40%***	***50.78***	***0.003***	***0.015***	**0.014**	**0.045**
GPS	***44%***	***40.28***	***0.006***	***0.021***	**0.012**	**0.048**

Experiments and Results—CDBDS

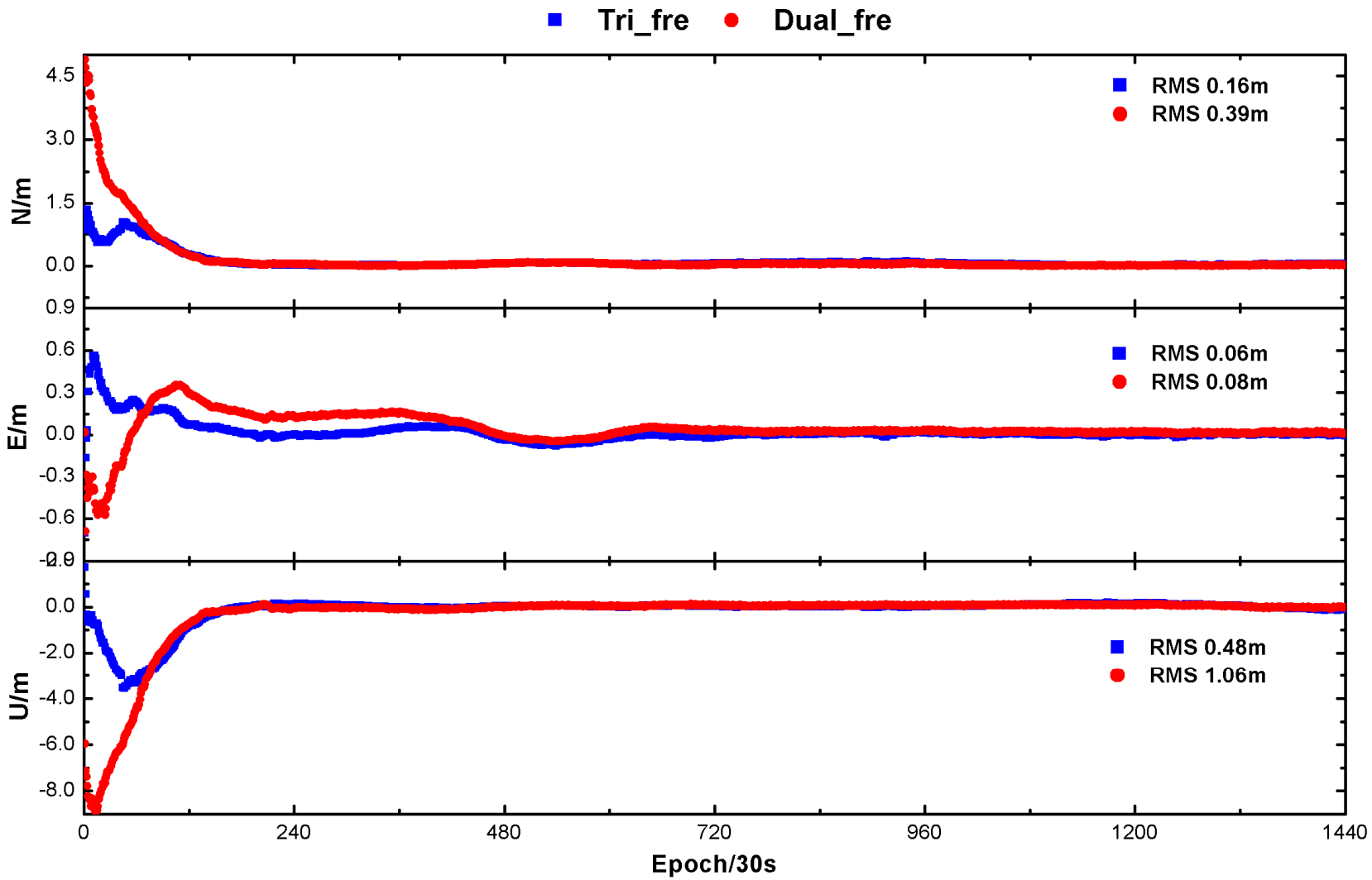
- Dynamic testing
- 1Hz position output
- RMS:0.67m，1.5m(95%)

Mode	BDS L1
Points number	1344
1Sigma	0.67m
95%	1.44m



Experiments and Results—PPP

- PPP B1/B2 and B1/B2/B3



Research of DBDS standard in the framework of RTCM SC104

2013-11-21

RTCM SC104 DGNSS Service

- Radio Technical Commission for Maritime services Special Committee No.104 (RTCM SC104) provides to DGNSS standard
- Using for manufactory, R&D, Service provider etc.
- Versions:
  - RTCM SC10402.3 for DGNSS applications
  - RTCM SC10403.2 for high precision applications

The thoughts of adding BDS Messages

- For RTCM SC10402.X
  - Add: B1 Code differential messages
  - Modified: Some messages
- For RTCM SC10403.X
  - Add: BDS Network RTK Corrections
  - Add: BDS Satellite Ephemeris
  - Add: BDS SSR
  - Comments: MSM messages etc.

The progress in 2013

- Attend the RTCM SC104 conference in Nashville, Sept 2013
- Wuhan Navigation & LBS Inc. suggested to form BDS Working Group to provide BDS support to RTCM committee.
- Dr. Shaowei Han was elected as RTCM SC104 the BDS WG chair. Dr. HuiLiu is the secretary.
- There were 15+ organizations apply to attend the BDS WG
  - Trimble、Novatel、Geo++、Navcomm、etc.

RTCM SC104 WebSite

Upcoming Meetings:

30-31 January 2014
Bahia Hotel
San Diego, CA, USA
Transport and Lodging Information

21-22 May 2014
European Space Operations Centre
Darmstadt, Germany

8-9 September 2014 (to be confirmed)
Tampa, FL, USA

Reference Materials
RTCM Bylaws
RTCM Standards Development Policies
Galileo ICD
BeiDou ICD
RTCM 3.2 Message Sample/Template

Active Working Groups	Chair
RTK Network MSG	Frank Takac
Internet Protocol	Georg Weber
GALILEO	Hans-Jürgen Euler
GLONASS	Alexei Zinoviev
DGNSS Beacon Services	Al Cleveland
Private Services	Ivo Milev
State Space	Gerhard Wübbena
Version 3	Paul Alves
Coordinate Transformation	Martin Schmitz
RINEX	Ken MacLeod
BeiDou	ShaoWei Han

Conclusions

- BDS is in operation. The performance of DBDS in China is satisfied to the most user's requirements
- It is necessary to define the DBDS unified interface between service provider and end users.
- The full BDS messages in RTCM SC-104 standards are needed as quick as possible so that worldwide GNSS manufacturers can participate those campaigns.
- BDS WG will push it to happen faster.

Thanks you very much for the attention!

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