The Study of GNSS System Time Differences Monitoring
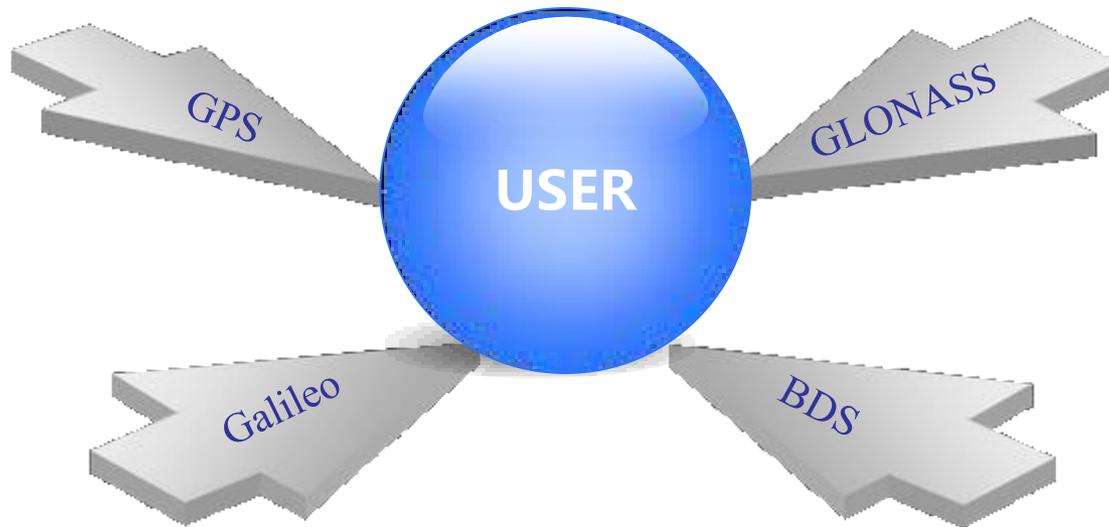
Jihai ZHANG, Haibo YUAN, Wei GUANG

National Time Service Center of CAS, PR China

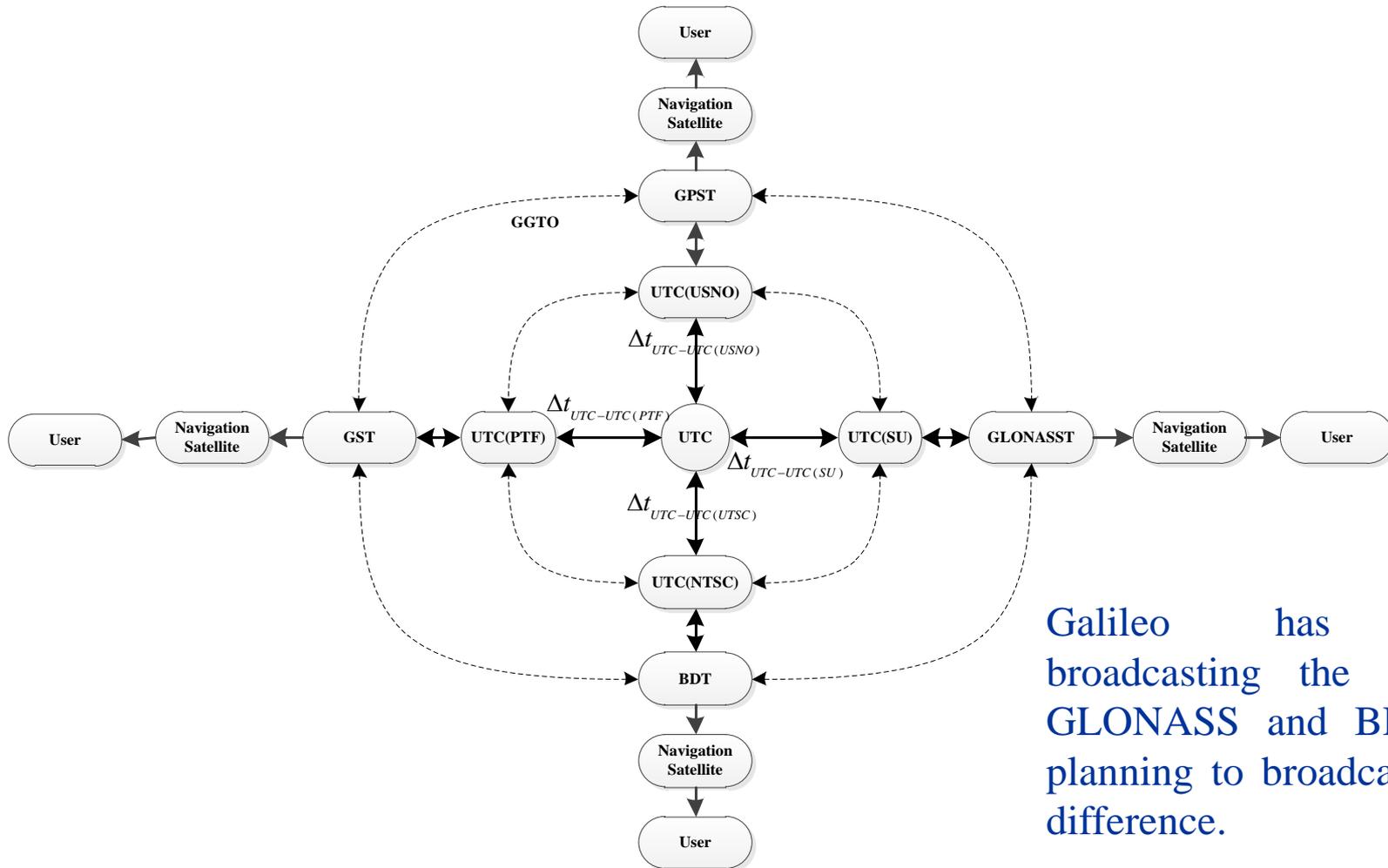**JULY 2017 .Paris**

The Content of Report

- ✓ **Background**

- ✓ **Principle of GNSS time difference Monitoring**

- ✓ **Results and Analysis**

- ✓ **Summary**

1. Background

- **(1) Necessary for GNSS compatibility and interoperability.**

- **(2) Will improve the consistency of time service by GNSS.**

- **(3) Improve the responsibility of GNSS provider .**

1. Background

Relationship of GNSS time and UTC

Galileo has been broadcasting the GGTO. GLONASS and BDS are planning to broadcast time difference.

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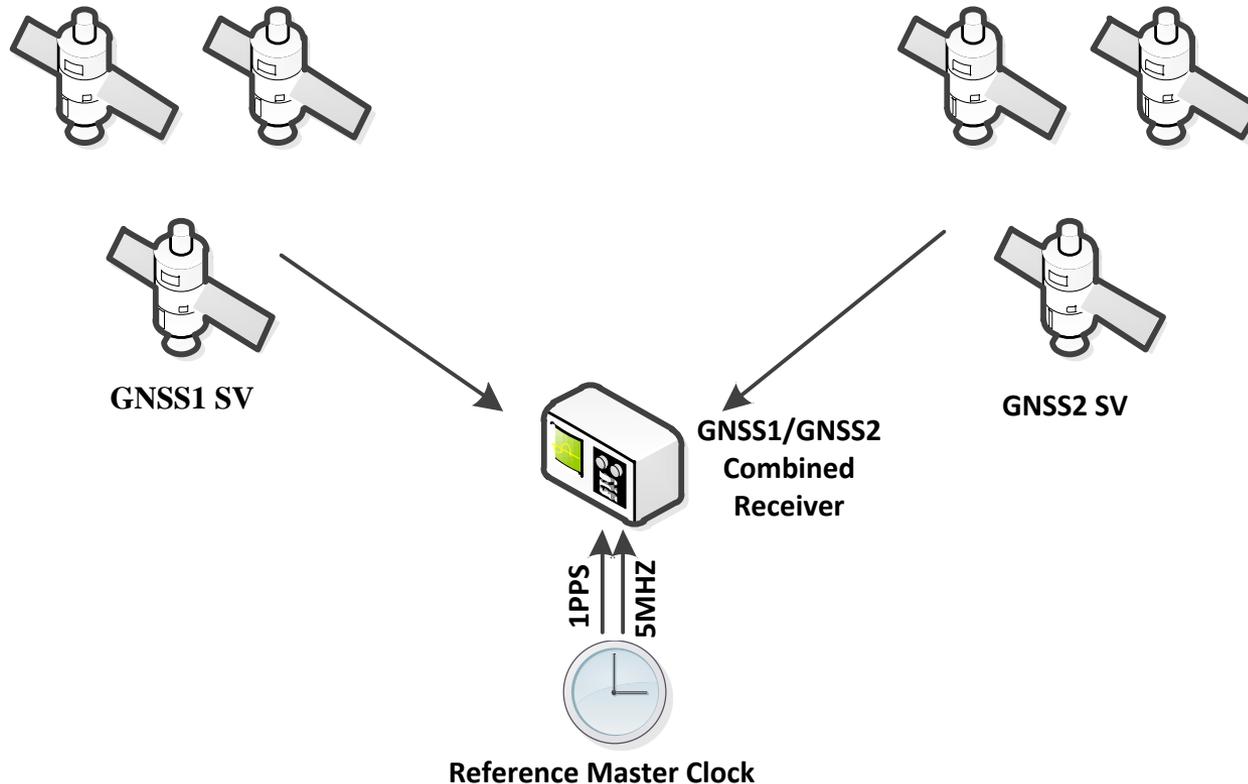
2.Methods for GNSS time difference monitoring

a) Time-link method

— Time links(TW,PPP,etc.) between GNSS time center

b) Single Station method

— High performance GNSS receiver

c) Multi-Station method

— Many stations with GNSS high performance receiver

2.1 The Principle of Time-link GNSS Time Difference Monitoring
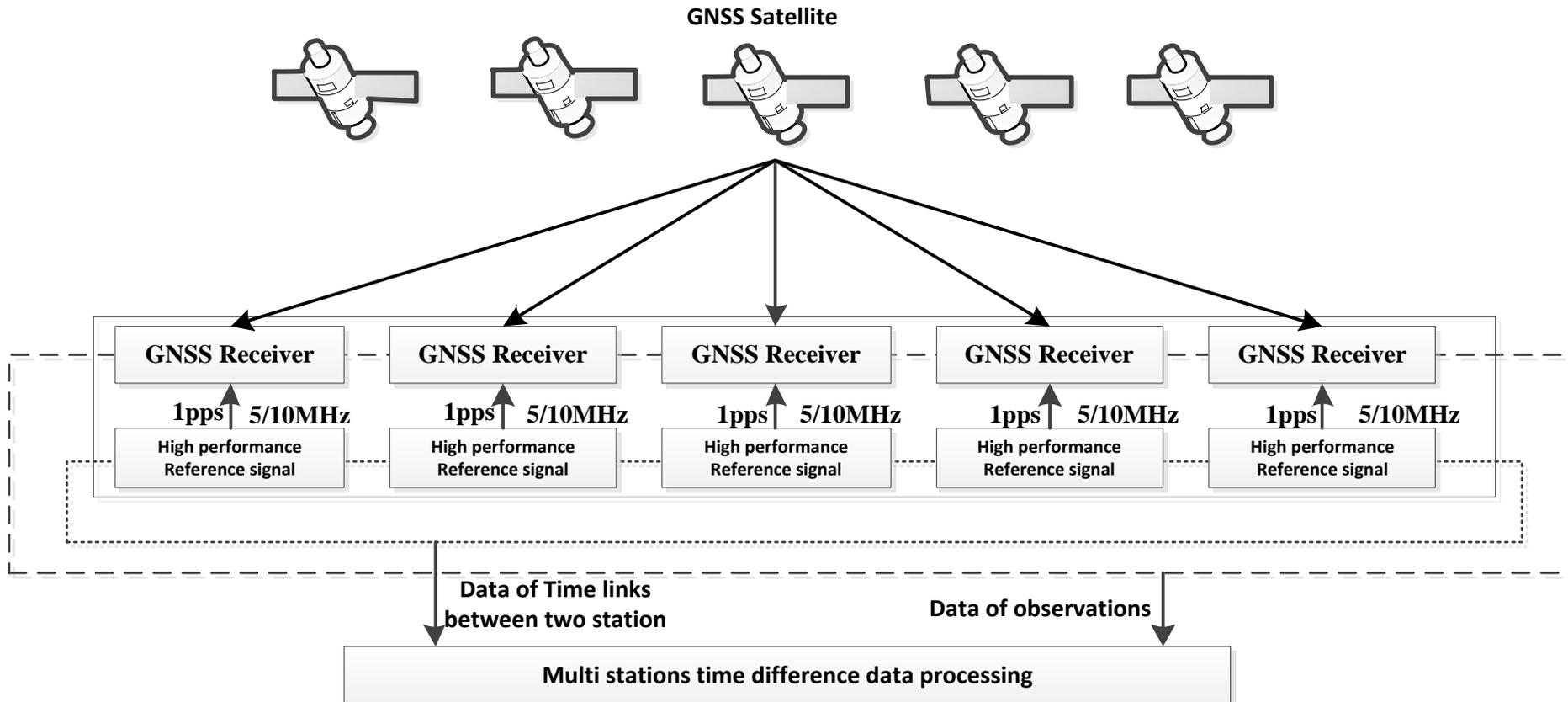
Time links between GNSS time center
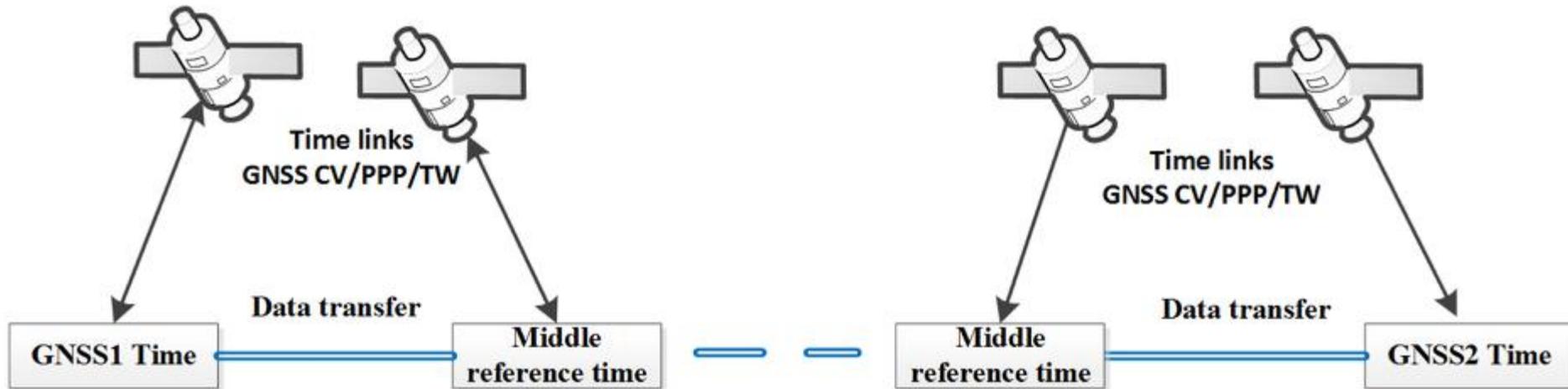
2.2 The Principle of Single Station GNSS Time Difference Monitoring

High performance GNSS receiver Real time data of RefT-GPST , RefT-GLONASST, RefT-BDT, RerT-GST

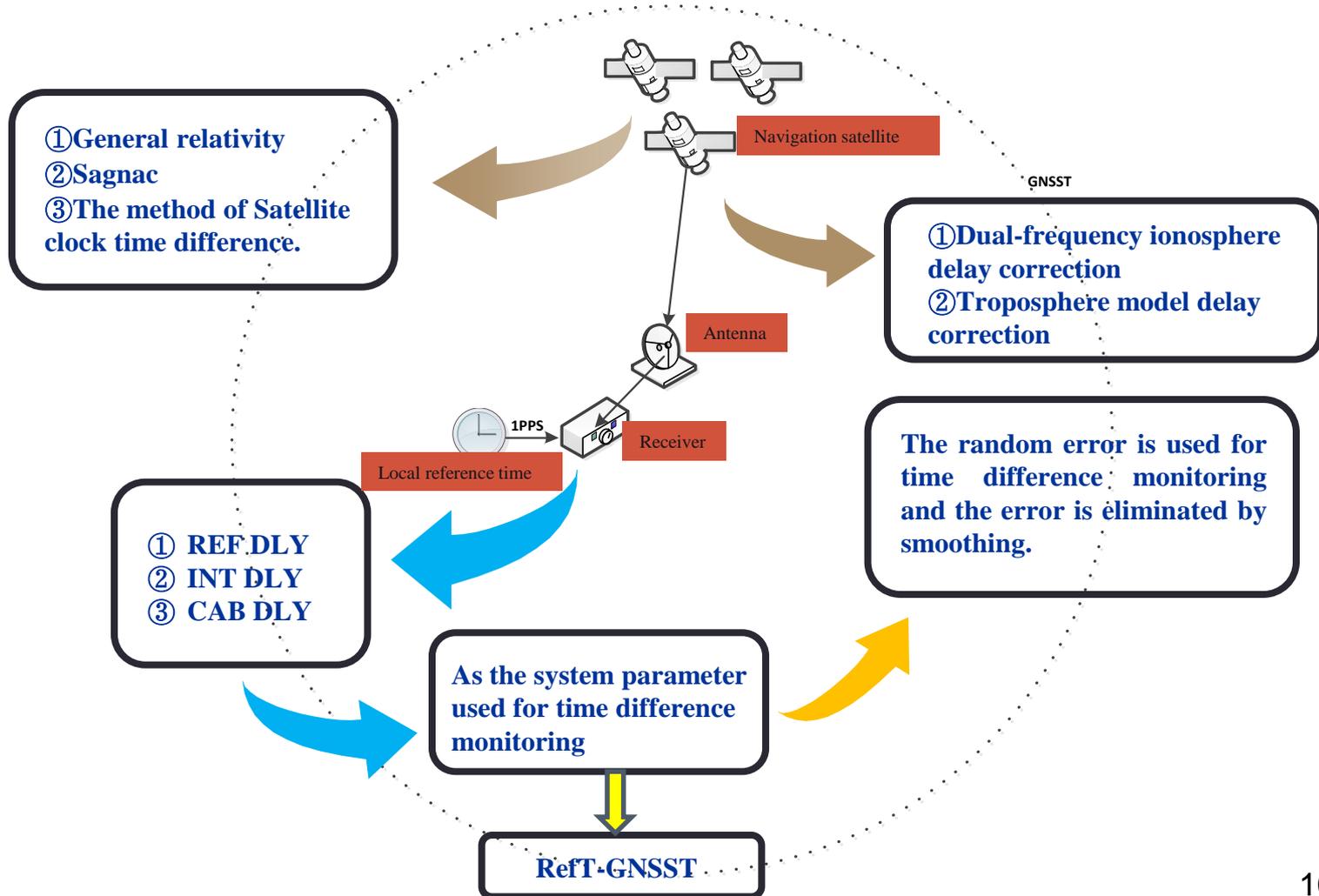# 2.3 The Principle of Multi Stations GNSS Time Difference Monitoring

GNSS Satellite

GNSS Receiver	GNSS Receiver	GNSS Receiver	GNSS Receiver	GNSS Receiver
1pps 5/10MHz	1pps 5/10MHz	1pps 5/10MHz	1pps 5/10MHz	1pps 5/10MHz
High performance Reference signal	High performance Reference signal	High performance Reference signal	High performance Reference signal	High performance Reference signal

Data of Time links between two station

Data of observations

Multi stations time difference data processing

Ref1T-GNSS1T Ref1T-GNSS2T…

Ref2T-GNSS1T Ref2T-GNSS2T…

Ref1T-Ref2T(time links), average the results, GNSS1T-GNSS2T

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2.4 The Principle of Monitoring

①General relativity
②Sagnac
③The method of Satellite clock time difference.

①Dual-frequency ionosphere delay correction
②Troposphere model delay correction

GNSST

Navigation satellite

Antenna

1PPS

Local reference time

Receiver

① REF DLY
② INT DLY
③ CAB DLY

The random error is used for time difference monitoring and the error is eliminated by smoothing.

As the system parameter used for time difference monitoring

RefT-GNSST
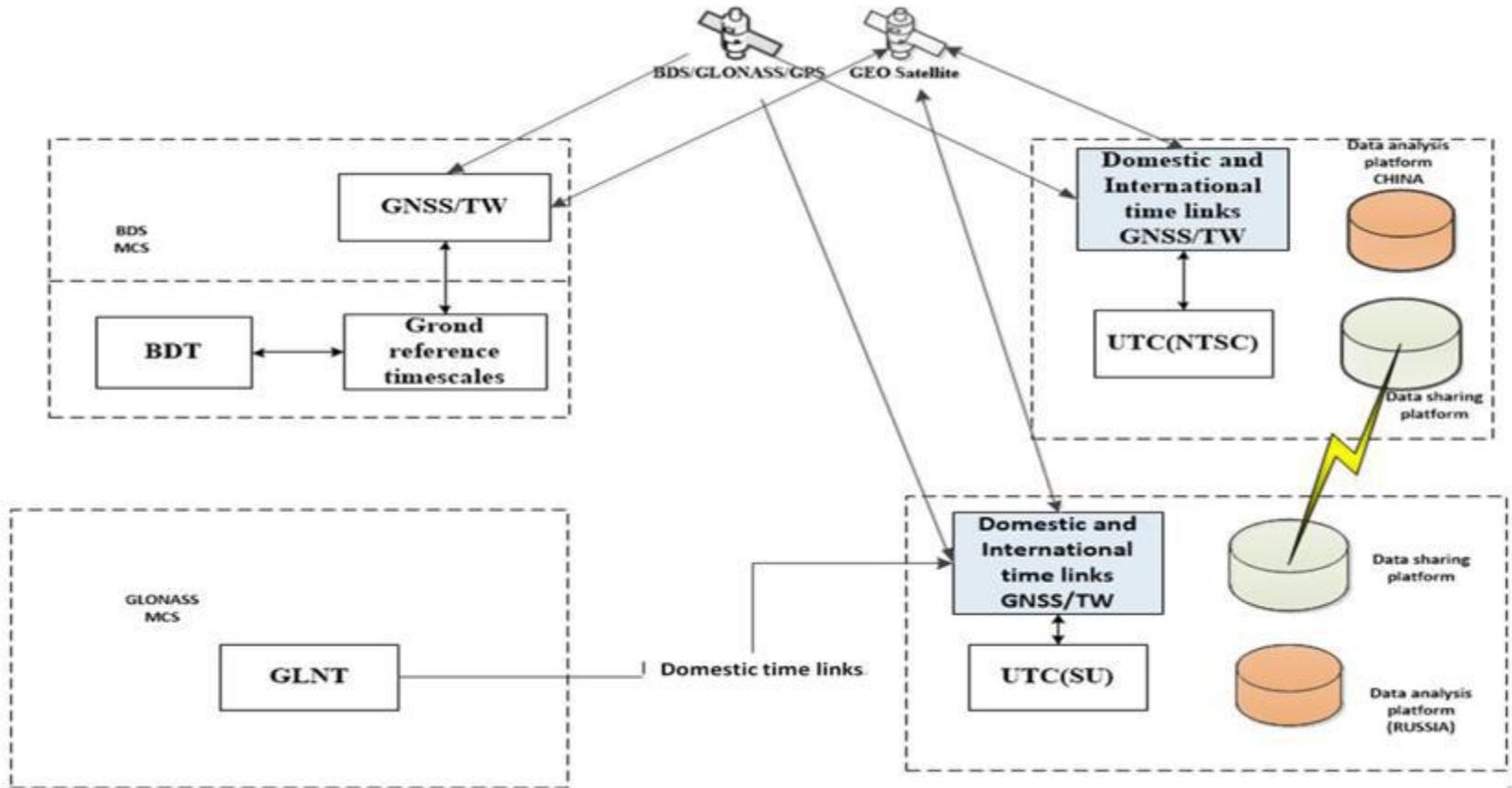
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2.5 GLONT and BDT monitoring

Example: BGTO (Time offset of the BDT and GLONT)
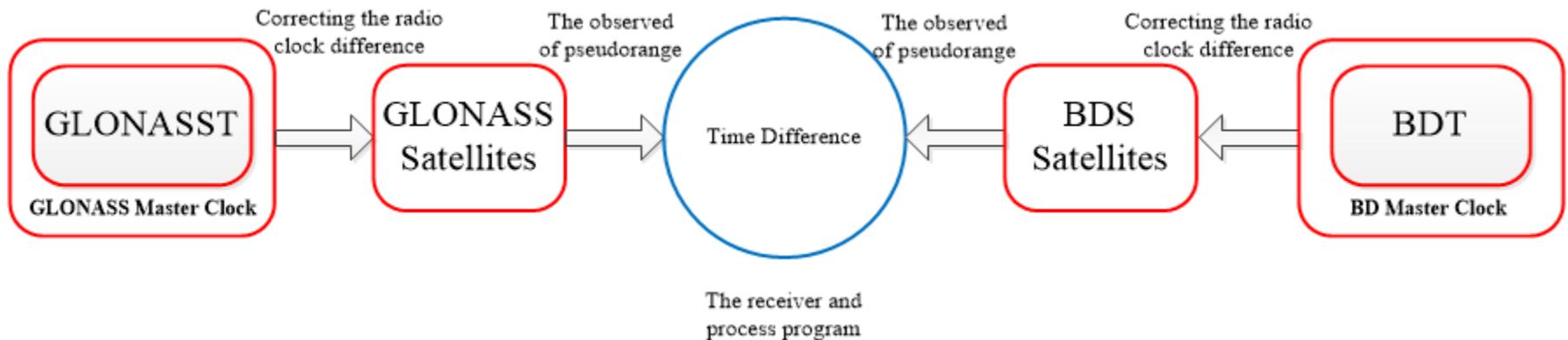
The RefGLONASS、RefBDS are the time difference between local time and the navigation satellite system, then the time difference between two navigation satellite system can be calculated by:

$$GLONT-BDT=RefT-BDT-(RefT-GLONT)=GLONT-BDT$$

2.6 GLONT and BDT monitoring (Time-link method)

Time difference monitoring and checking system between GLONASS and BDS
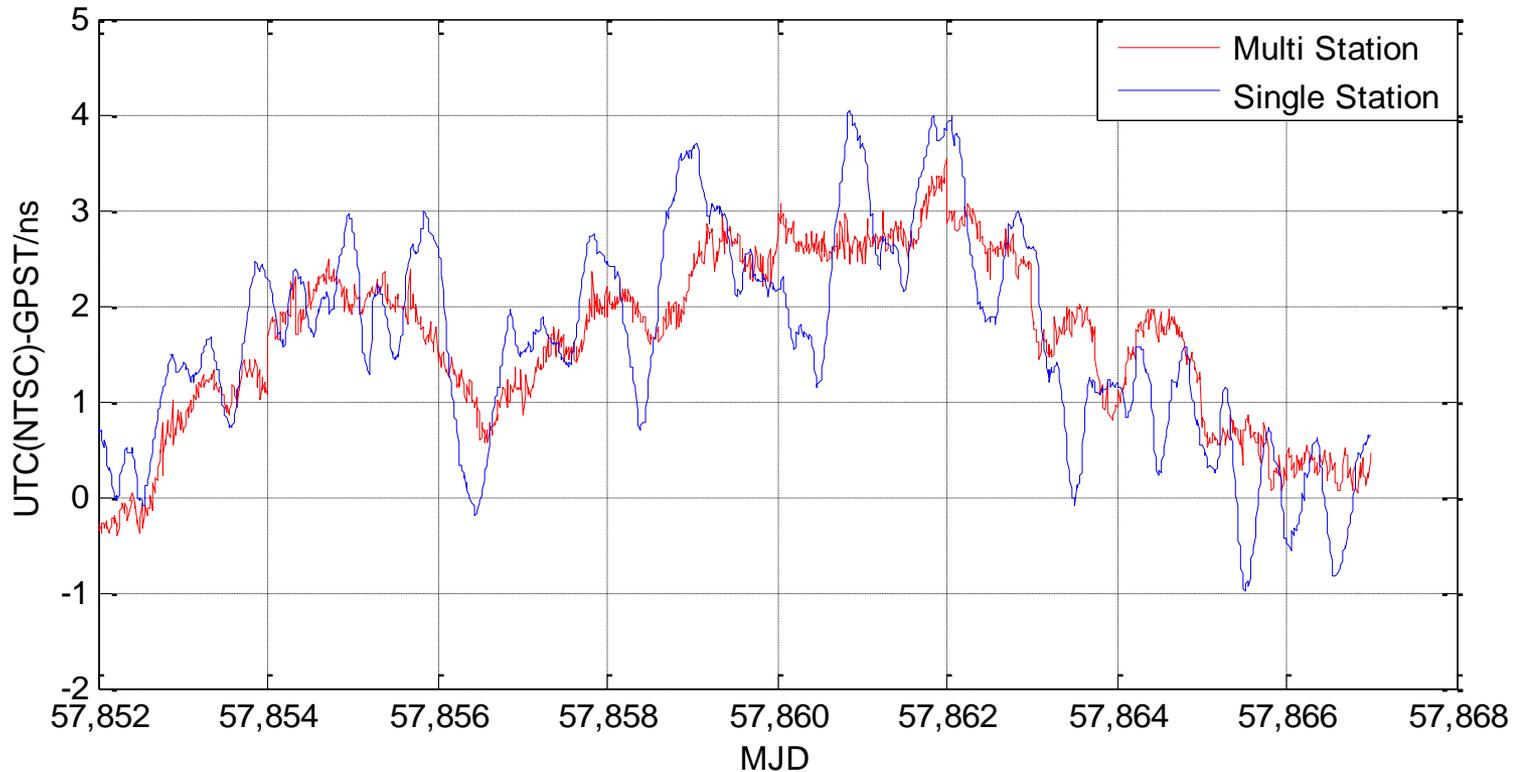
Example: GLONT and BDT, UTC(SU)-UTC (International links), UTC(SU)-GLONT (Domestic links), UTC(NTSC)-BDT(Domestic links), GLONT-BDT (Lagged) for checking /confirm

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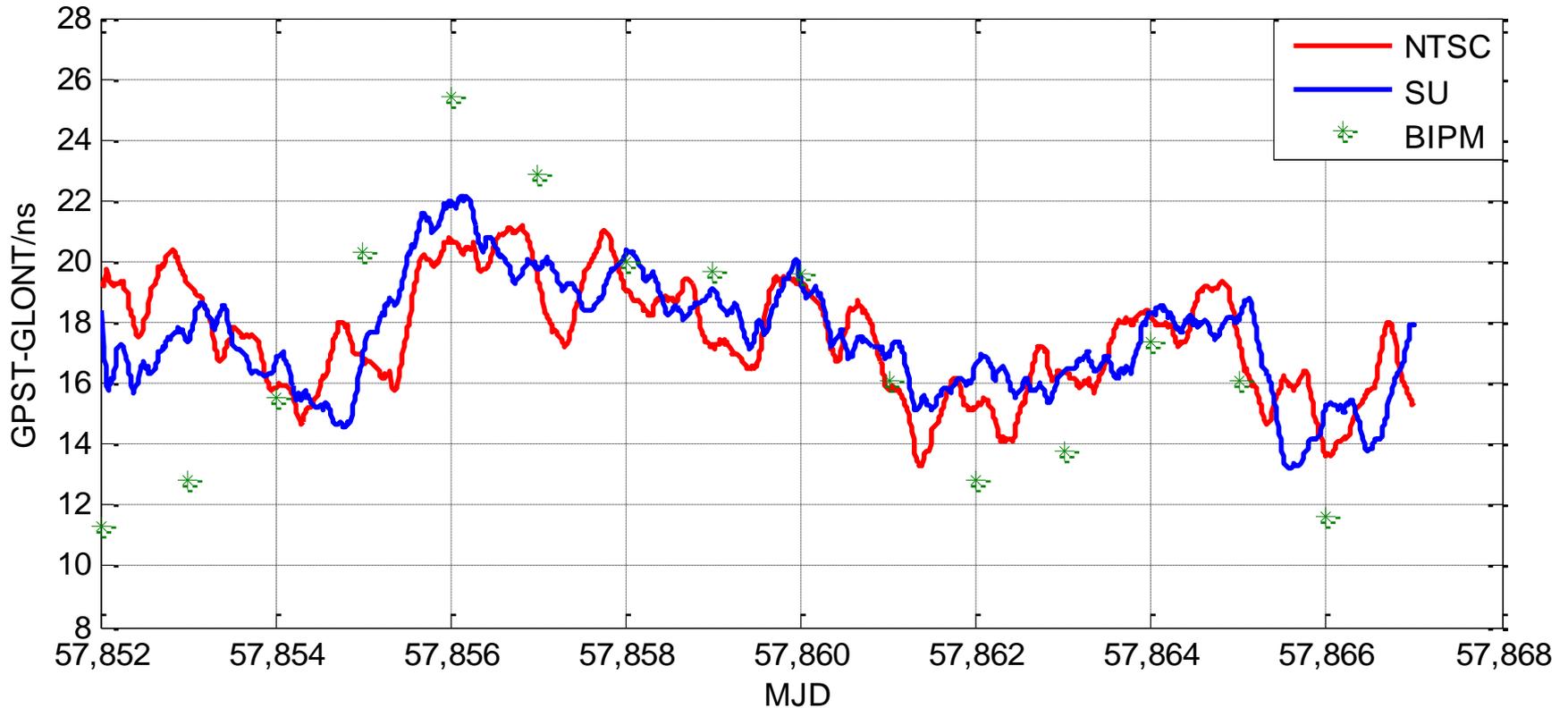# 3. Results and analysis (Date:2017.04.09—2017.04.23)

The result of UTC(NTSC)-GPST by different ways (Multi Station& Single Station).

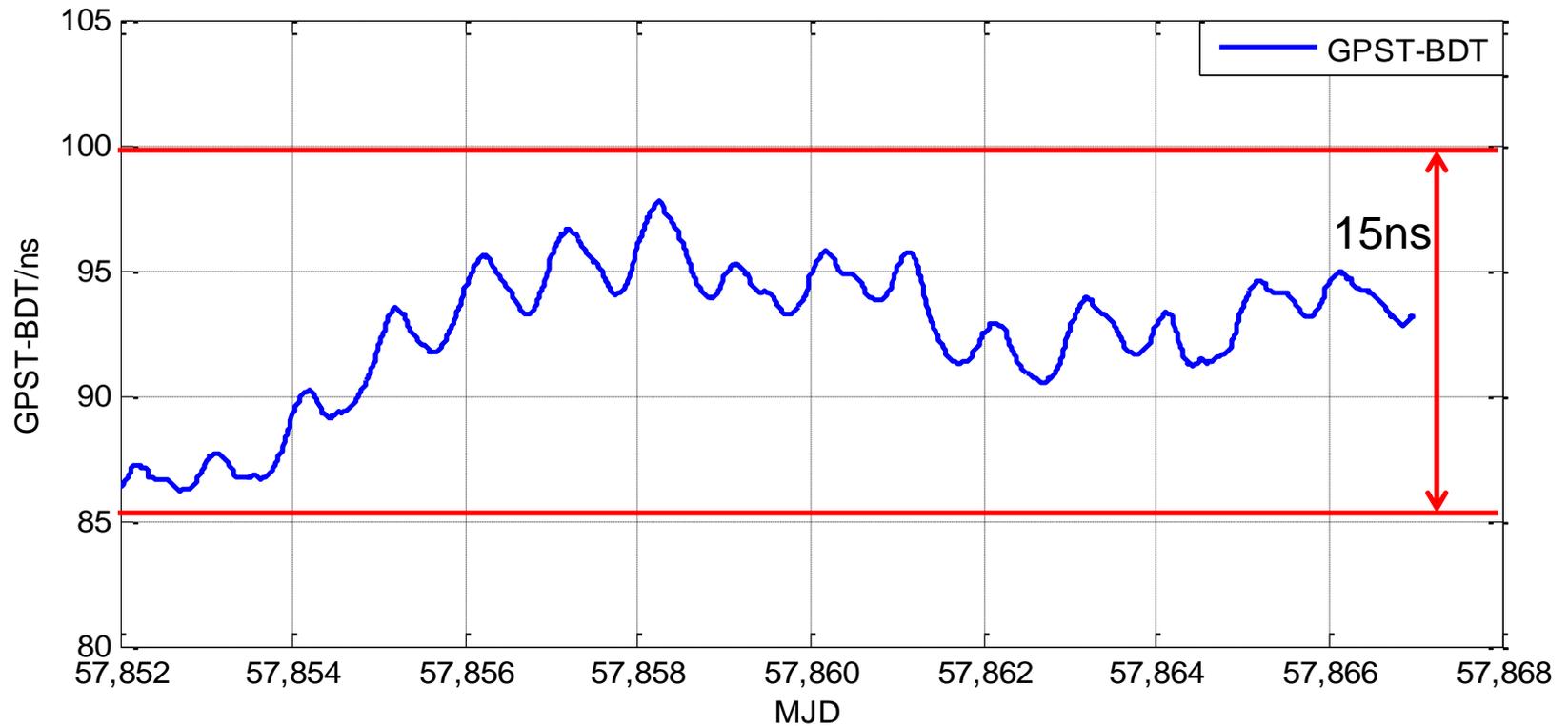|	Single Station	Multi Stations
STDEV (ns)	1.1055	0.8822

3. Results and analysis
(Date:2017.04.09—2017.04.23)

The result of GPST-GLONT by different monitoring station.
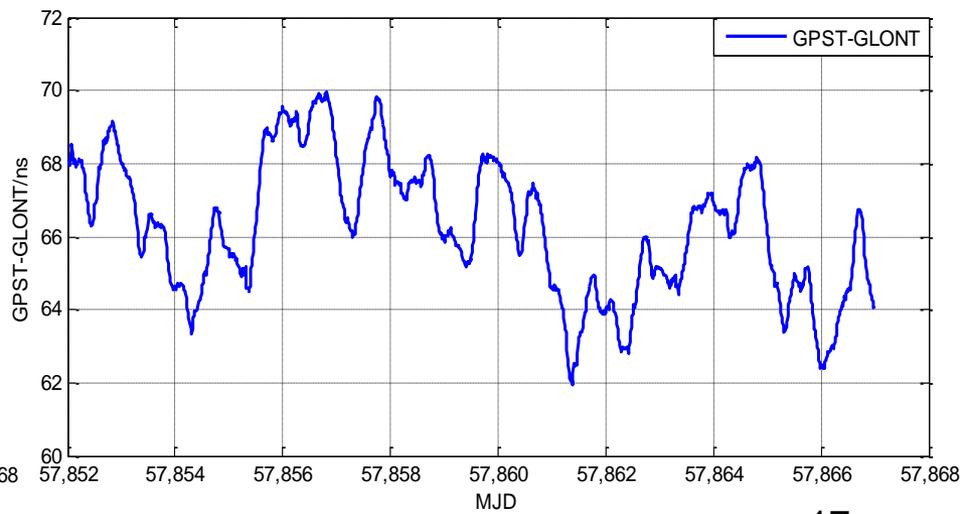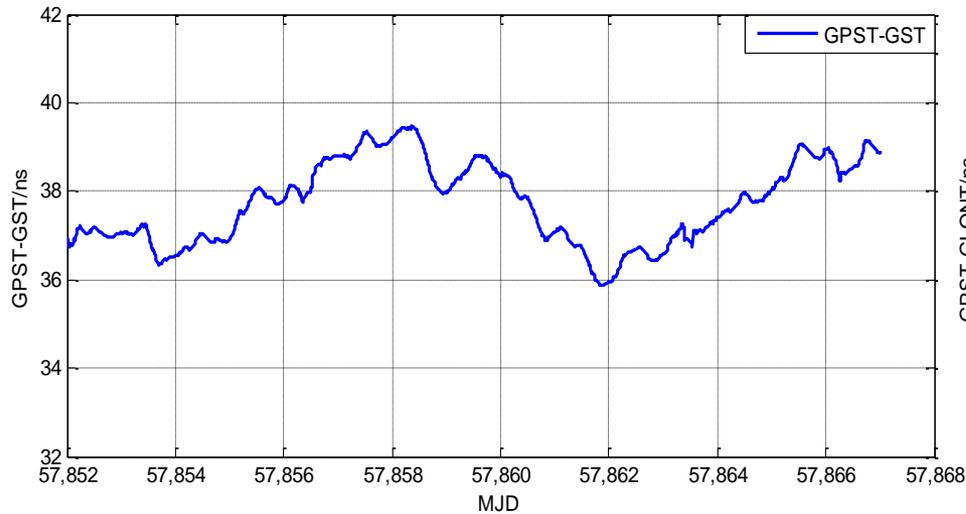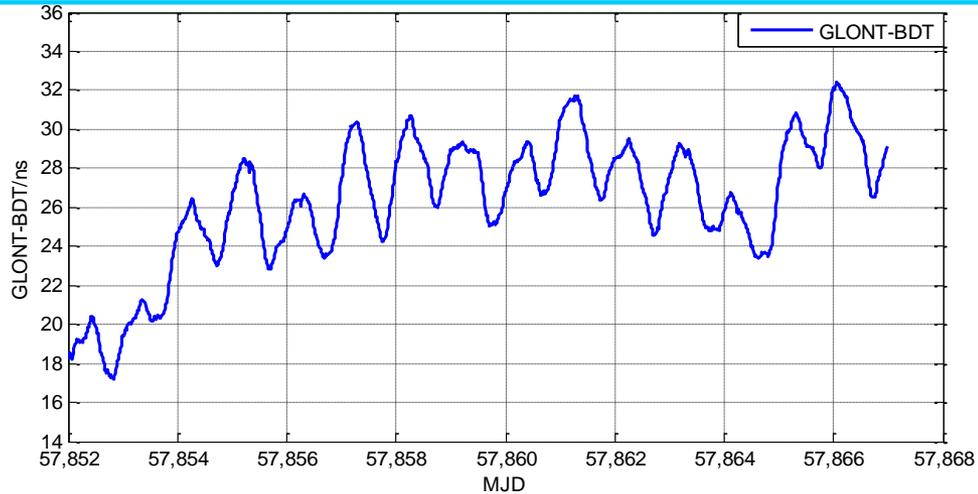
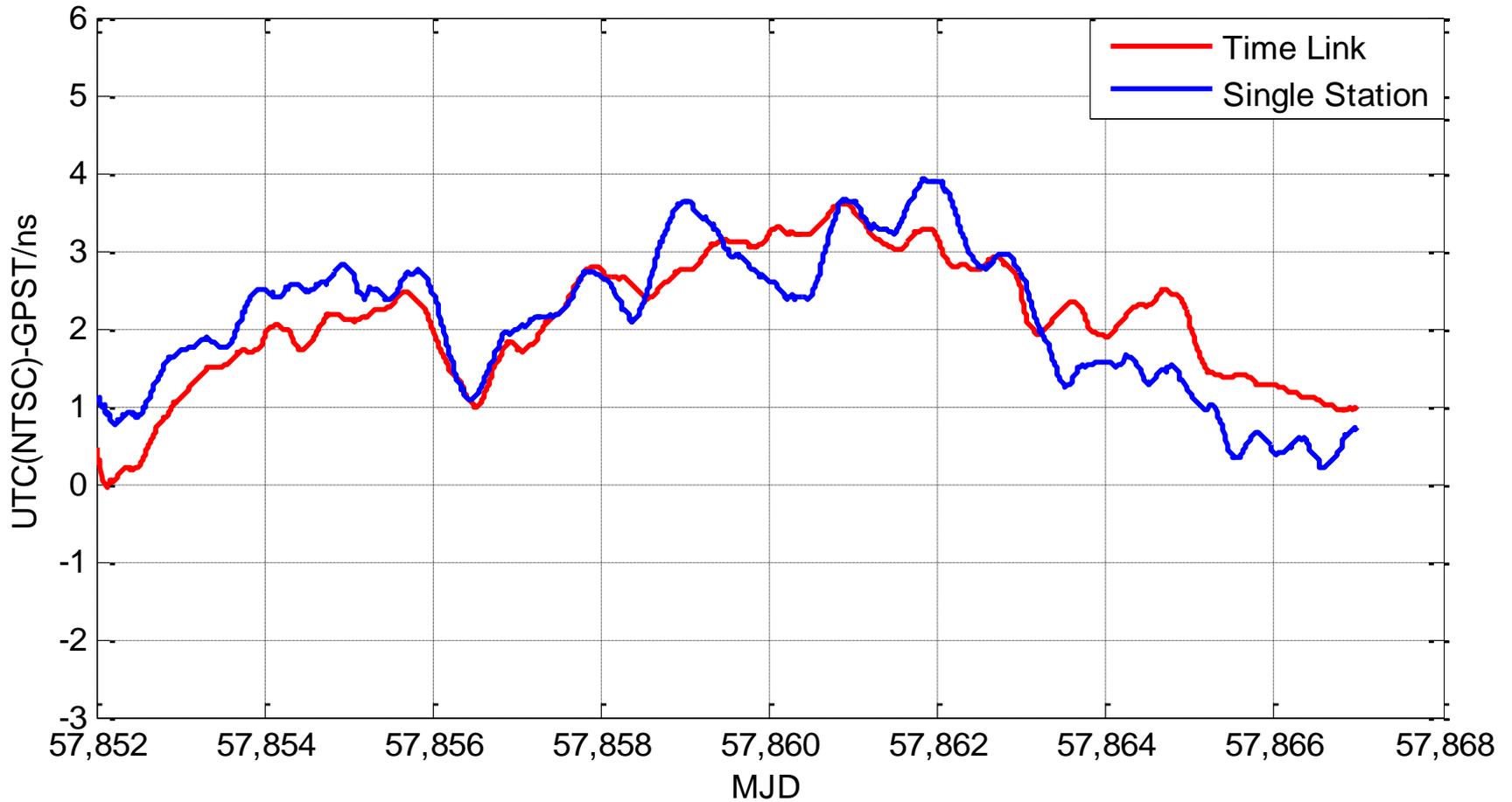# 3. Results and analysis
(Date:2017.04.09—2017.04.23)

The data fluctuates within 15 nanoseconds.

3. Results and analysis
(Date:2017.04.09—2017.04.23)

3. Results and analysis

The result of UTC(NTSC)-GPST by different monitoring methods.

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4. Summary

- BDS has provided the time difference of BDT and GPST, BDT and GLONT in the test satellite, and will provide the formal time difference parameters in the BDS global navigation satellite system.

- The difference methods all can be adopted in the time difference monitoring, but the usage is different.
    - » Single Station GNSS Time Difference Monitoring: real time GNSS time difference monitoring.
    - » Time-link GNSS Time Difference Monitoring: time difference results verifying.
    - » Multi-Station GNSS Time Difference Monitoring: study.

4. Summary

- The GNSS time difference prediction model should be studied. (quadratic model , linear model , the other) How many original data should be used in the construction of the prediction model ? How long can the model parameter be used (the prediction window)? …

- We just did a simple test for the GNSS time difference monitoring, many test will be done to check and verify the validity of the principle.

- We can use the time links between GNSS ground time center, and indirectly calculate the time offset between two GNSS, verify the results from the different methods.

- Time link calibration is also very important, all the time links used in the time difference monitoring must be calibrated accurately.

Thank You for Your Attention!