The new results of GNSS Time Offsets Monitoring and the Opinion about MGET and xGTO

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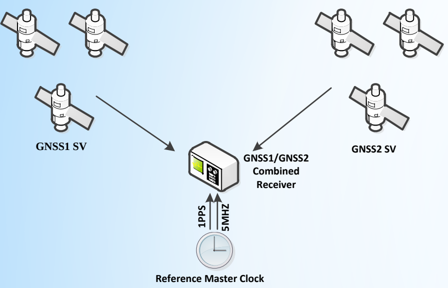
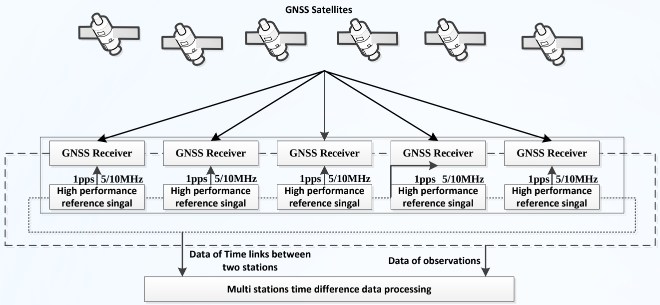
CONTENT

1. BDS Time Offsets Monitoring

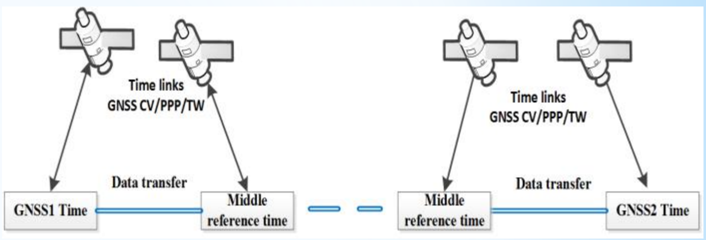
Three methods For GNSS Time Offsets Monitoring



Single Station



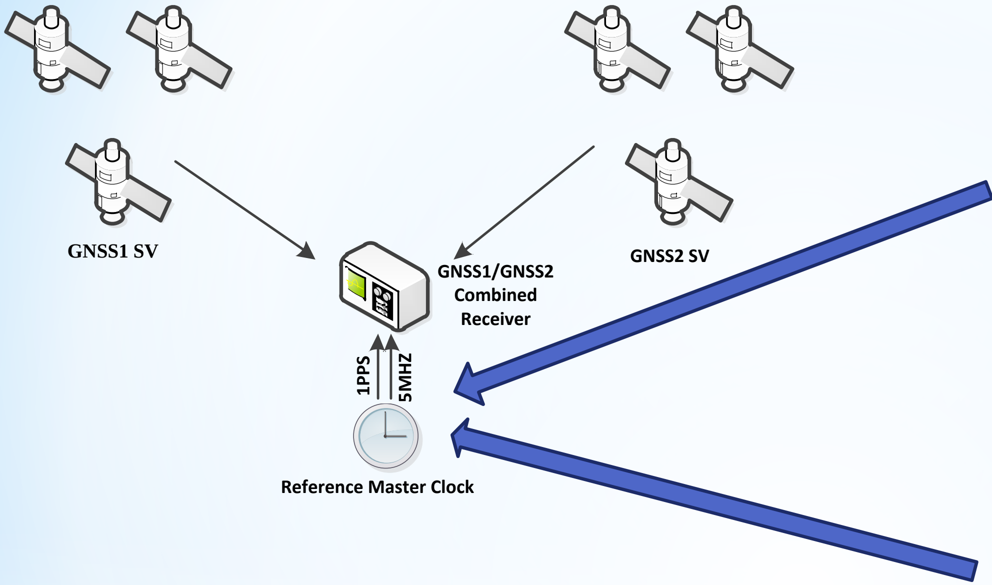
Multi Stations



Time Comparison Links

Items	Single station	Multi Stations	Time links
Equipment	Multi mode GNSS Receiver In Time Lab.& GNSS MCS	Multi mode GNSS Receiver In different time laboratory	Time comparison between each GNSS MCS
Data processing	Real time calculation	Data selection, fusion, Post processing	Data interchange, Post processing
Time limit	Real time	Latency 1day or more	Due to time comparison links
Accuracy	~10ns	5~10ns	~5ns

1.1. Single Station method and GNSS time offsets differential station



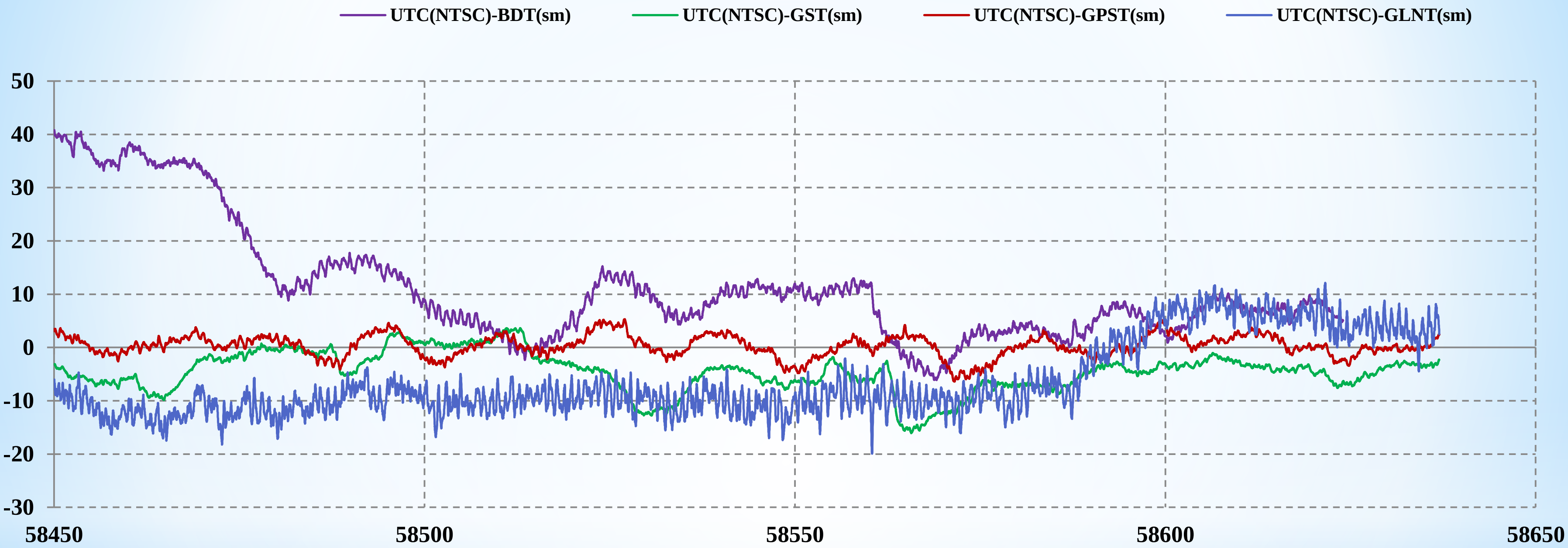
The reference signal: a clock
Factors: Receiver, Signal quality, Environment, the reference clock, prediction algorithm,…

The reference signal:UTC(k)
Factors: Receiver, Signal quality, Environment, UTC(k), prediction algorithm,…

Relative time offsets between two GNSS time

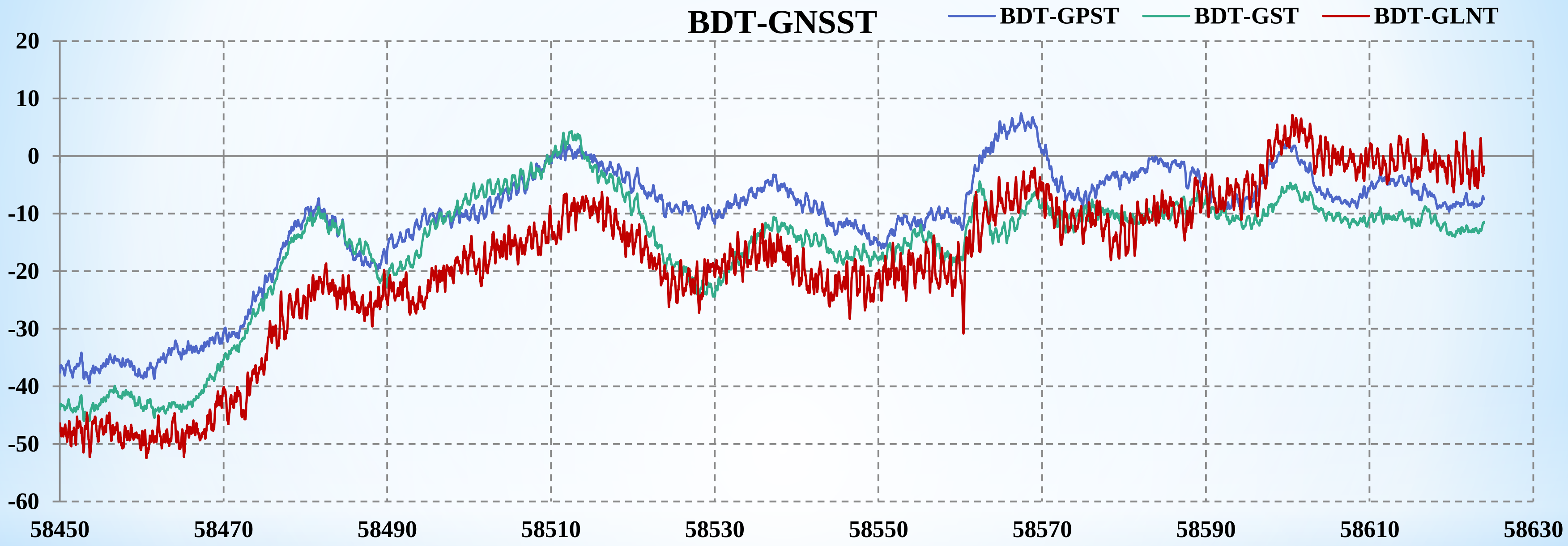
Absolute time offsets between GNSS Time and UTC(k), UTC(k) is used as a dirrerential station.

1.2 UTC(NTSC)-GNSS Time



November 28, 2018------May 18, 2019

1.3 BDT-GNSS Time



November 28, 2018------May 18, 2019

1.4 BDS Time Service

BeiDou Navigation Satellite System
Signal In Space
Interface Control Document
Open Service Signal B1C (Version 1.0)
China Satellite Naviga...
December, 2...

BDS-3 B1C

BeiDou Navigation Satellite System
Signal In Space
Interface Control Document
Open Service Signal B2a (Version 1.0)
China Satellite Navigation Of...
December, 2017

BDS-3 B2a

3.3 Time System

The BeiDou Navigation Satellite System Time (BDT) is adopted by the BDS as time reference. BDT adopts the international system of units (SI) second as the base unit, and accumulates continuously without leap seconds. The start epoch of BDT is 00:00:00 on January 1, 2006 of Coordinated Universal Time (UTC). BDT connects with UTC via UTC (NTSC), and the deviation of BDT to UTC is maintained within 50 nanoseconds (modulo 1 second). The leap second information is broadcast in the navigation message.

Time Interoperability

Table 7-21 Definitions of the BGTO parameters

No.	Parameter	Definition	No. of bits	Scale factor	Effective range**	Unit
1	GNSS ID	GNSS type identification	3	--	--	dimensionless
2	WN_{0BGTO}	Reference week number	13	1	--	week
3	t_{0BGTO}	Reference time of week	16	2^4	0~604784	s
4	A_{0BGTO}	Bias coefficient of BDT time scale relative to GNSS time scale	16*	2^{-35}	--	s
5	A_{1BGTO}	Drift coefficient of BDT time scale relative to GNSS time scale	13*	2^{-51}	--	s/s
6	A_{2BGTO}	Drift rate coefficient of BDT time scale relative to GNSS time scale	7*	2^{-68}	--	s/s^2

* Parameters so indicated are two's complement, with the sign bit (+ or -)occupying the MSB.
** Unless otherwise indicated in this column, effective range is the maximum range attainable with indicated bit allocation and scale factor.

GNSS ID is used to identify different navigation satellite systems, and its definition is as follows:

000 indicates **not available**;
001 indicates **GPS**;
010 indicates **Galileo**;
011 indicates **GLONASS**;
100 to 111 are **reserved**.

Discussions and analysis on MGET and xGTO

A lot of important questions are not clear:

- who is responsible for the calculation of MGET,
- what data is needed for calculation,
- whether it will increase the operating cost of the system, ...

- About independence of the GNSS

  The time offsets parameter will become the basic parameters of the system. If MGET is adopted, once the parameter acquisition fails, the independence of GNSS system would be affected.

- The advantage of MGET and xGTO
- According to the report of Russian experts at the timing workshop and ICG13 conference in 2018, they did not find the important advantages of MGET and xGTO.
- For the Chinese experts, the similar conclusion.

- Do we really need more time scales?

- Current important time scales: UTC/UTCr, TAI, TT, UTC(k), GNSS System Time, ...
- The navigation system time is indirectly traced to UTC through UTC(k), and if the performance of UTC(k) is good enough, that is, UTC-UTC(k) is small enough, then GNSS Time offsets could be obtained by UTC.
- But, it is not real time!

- Real-time GNSS time offsets monitoring---- single-station
  - If the needs of the system broadcast parameter update period are taken into account, the single-station time offsets monitoring technique can be adopted.
  - The UTC-UTC(k) and GNSS T-UTC(k) data can be used to verify the result of the single station method.

THANK YOU!

13th Meeting of the International Committee on Global Navigation Satellite Systems