



The Problems of GNSS Time Monitoring

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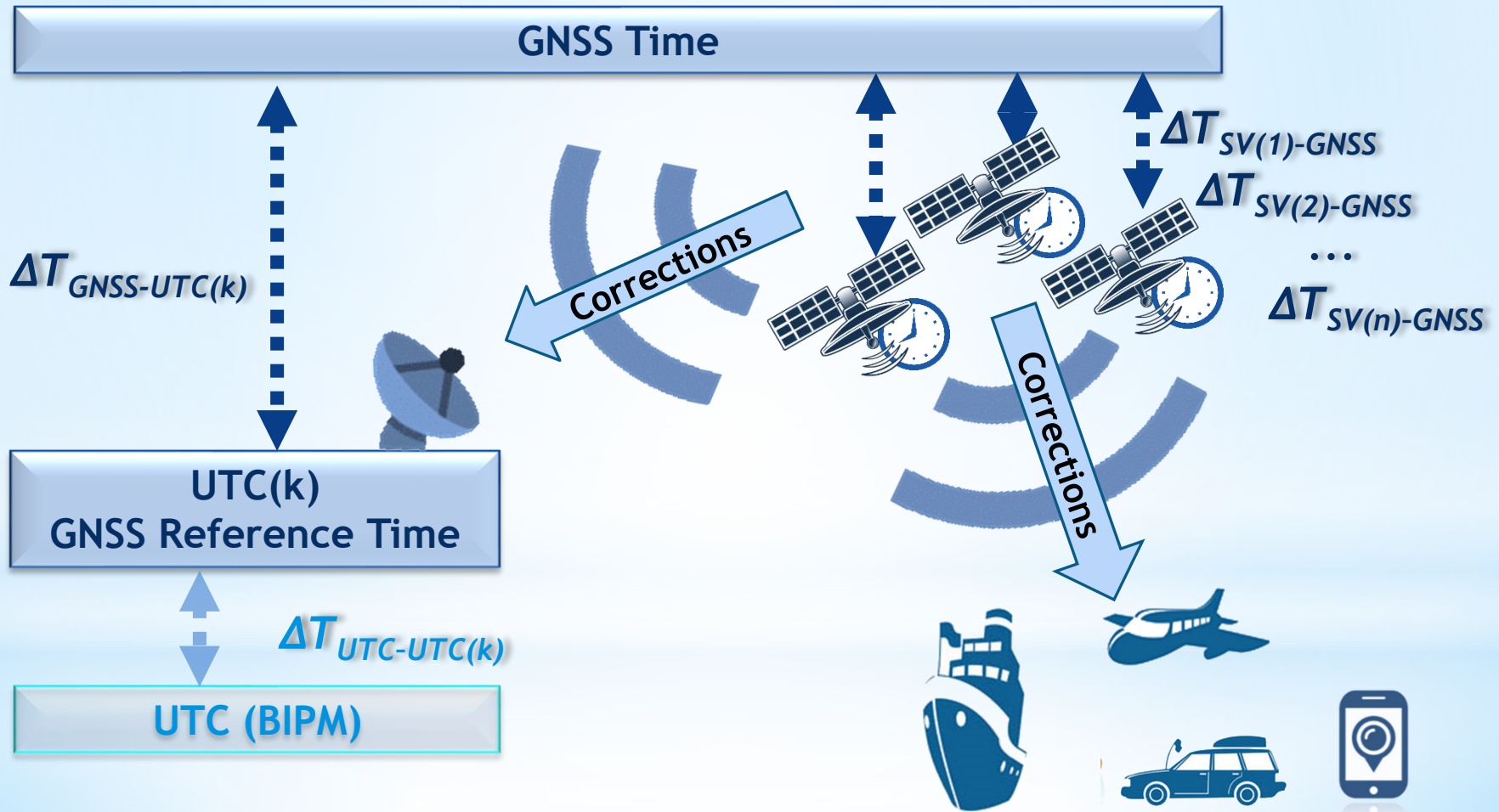
*14th Meeting of International Committee on Global Navigation Satellite Systems
8-13 December 2019, Bangalore, India*



Content

- ***GNSS Time Referencing***
- ***Limitations of GNSS Time Monitoring***
- ***GNSS Time Monitoring Activities***
- ***Methods of GNSS Time Monitoring***
- ***Results of GNSS Time Monitoring***
- ***Conclusion***

GNSS Time Referencing





Limitations of GNSS Time Monitoring

- *GNSS Time scales are produced at GNSS control centers => the direct access to them is impossible “from outside”;*
- *Galileo Reference Time is not UTC(k) but mathematical average;*
- *BeiDou Reference Time is BSNC time, which is not monitored by BIPM;*
- *Measurements at Reference Time Generating Facilities:*
 - *the lack of availability;*
- *broadcast corrections are predicted values.*



GNSS Time Monitoring Activities

BIPM provides:

[UTC – GNSS times] and [UTC – UTC(k)_GNSS] for:

- **GPS** – based on measurements at OP, France
- **GLONASS** – based on measurements at AOS, Poland

Publication - for the period of 1 month

Publication delay - up to 2 weeks.

The data for **Galileo** and **BeiDou** Time are not provided.



GNSS Time Monitoring Activities

The Main Metrological Center of the Russian State Time and Frequency Service MMC provides:

[UTC(SU) – GLONASS Time]

- ***Publication*** - for the period of 1 month
- ***Publication delay*** - up to 2 weeks.



GNSS Time Monitoring Activities

IGMA/IGS Joint Trial Project - a limited set of 4 monitoring parameters.

- ***GNSS Time Parameters – are not included***

Performance Standard Team (WG-S) – a template for defining GNSS open service performance.

- ***GNSS Time parameters – are not included.***



Methods of GNSS Time Monitoring

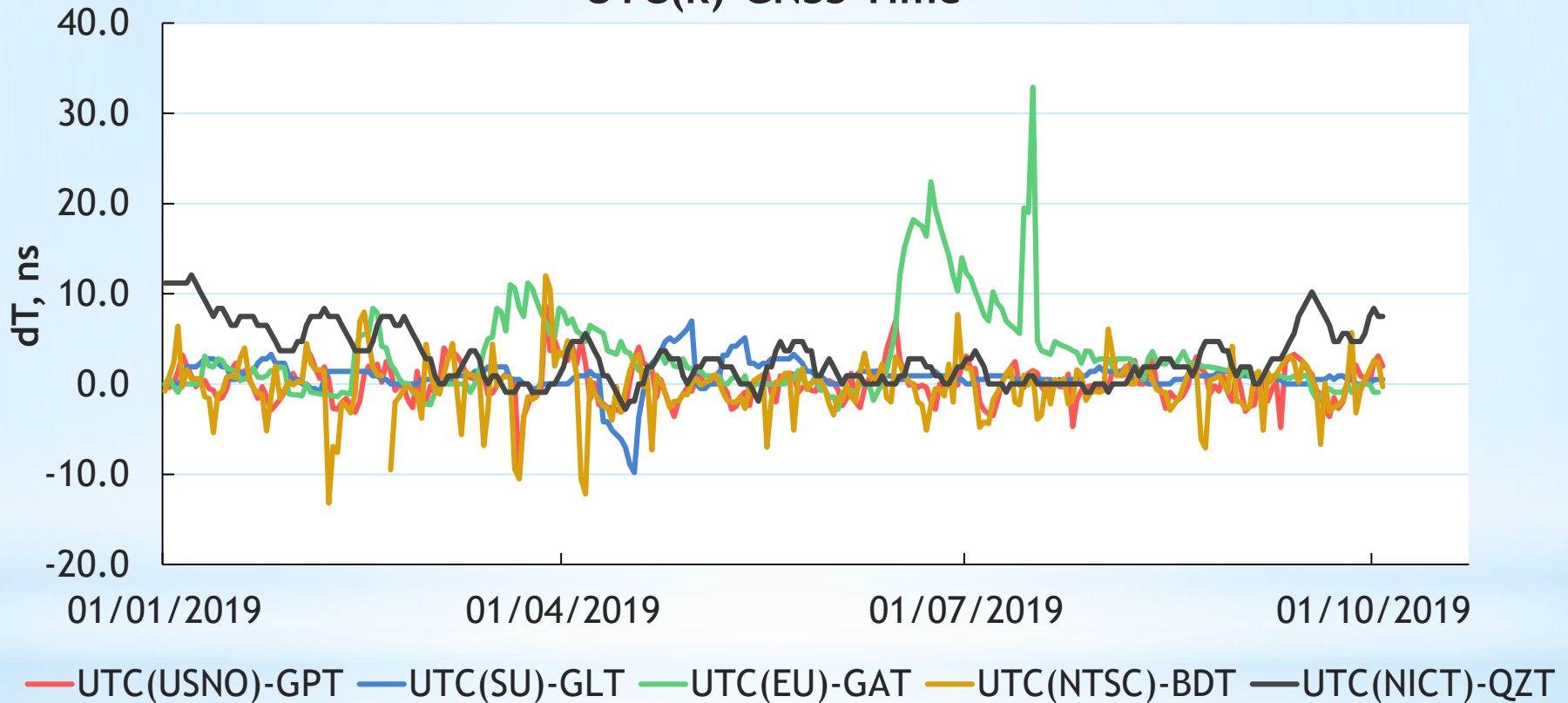
GNSS Time – Reference Time offsets were monitored with using the following available data:

- ***broadcast corrections to convert from GNSS Time to Reference Time which is, as a rule, national realization of UTC(k)***
- ***measurements at UTC(k) Generating Facilities***
- ***BIPM data on [UTC-GNSS Time] that were transformed to the values of [UTC(k)-GNSS Time]. The data are provided for GPS and GLONASS***
- ***MMC data on [UTC(SU) - GLONASS Time] offsets***



Results of GNSS Time Monitoring

UTC(k)-GNSS Time



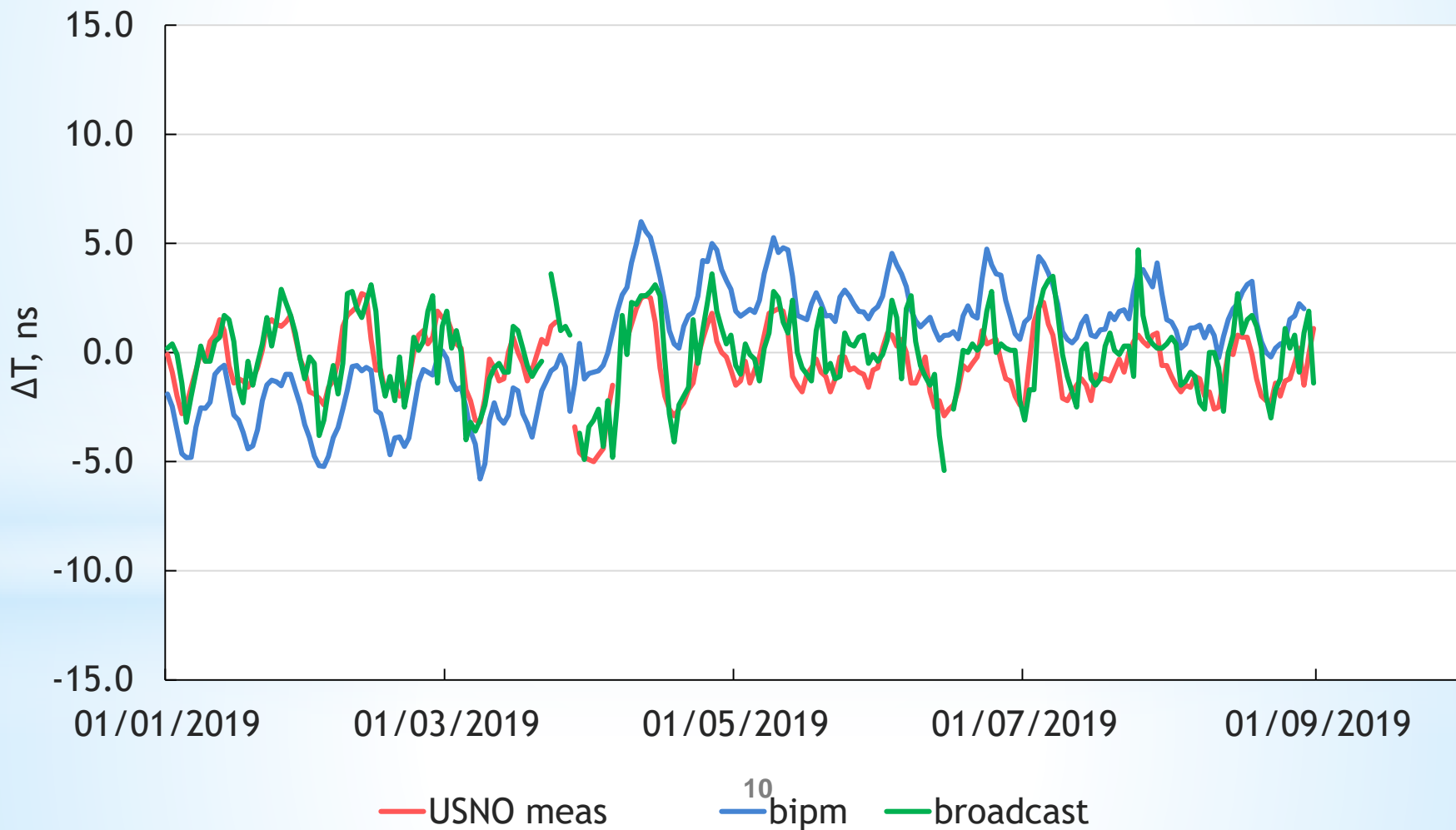
[USNO-GPS] ± 5 ns [< 1 μ s]
 [SU-GLONASS] mainly ± 5 ns [< 1 ms]
 [UTC-Galileo] mainly ± 10 ns [< 50 ns]

[NTSC-BeiDou] ± 10 ns [< 100 ns]
 [NICT-QZSS] ± 10 ns [< 1 μ s]



Results of GNSS Time Monitoring

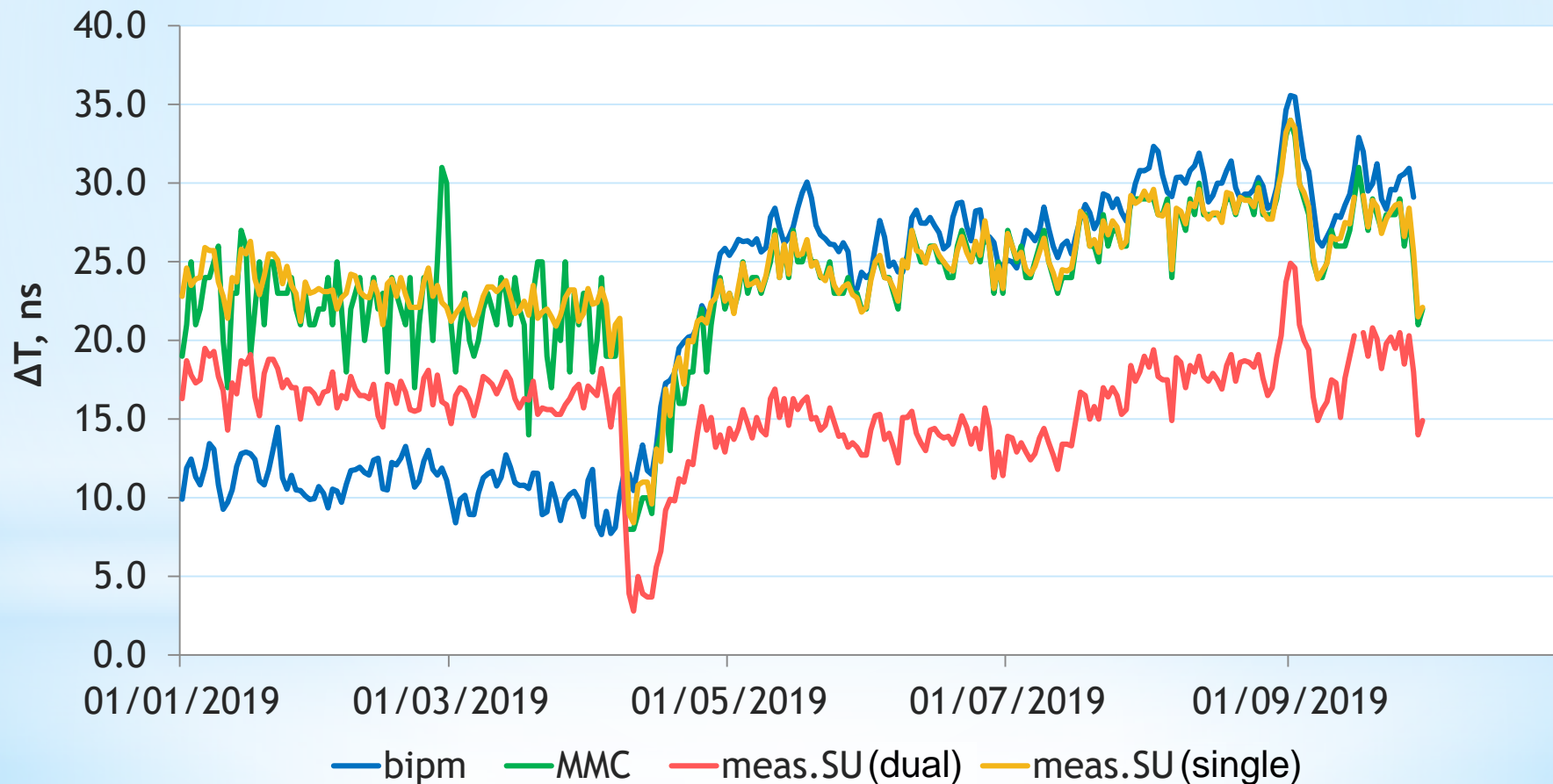
UTC(USNO)-GPS Time





Results of GNSS Time Monitoring

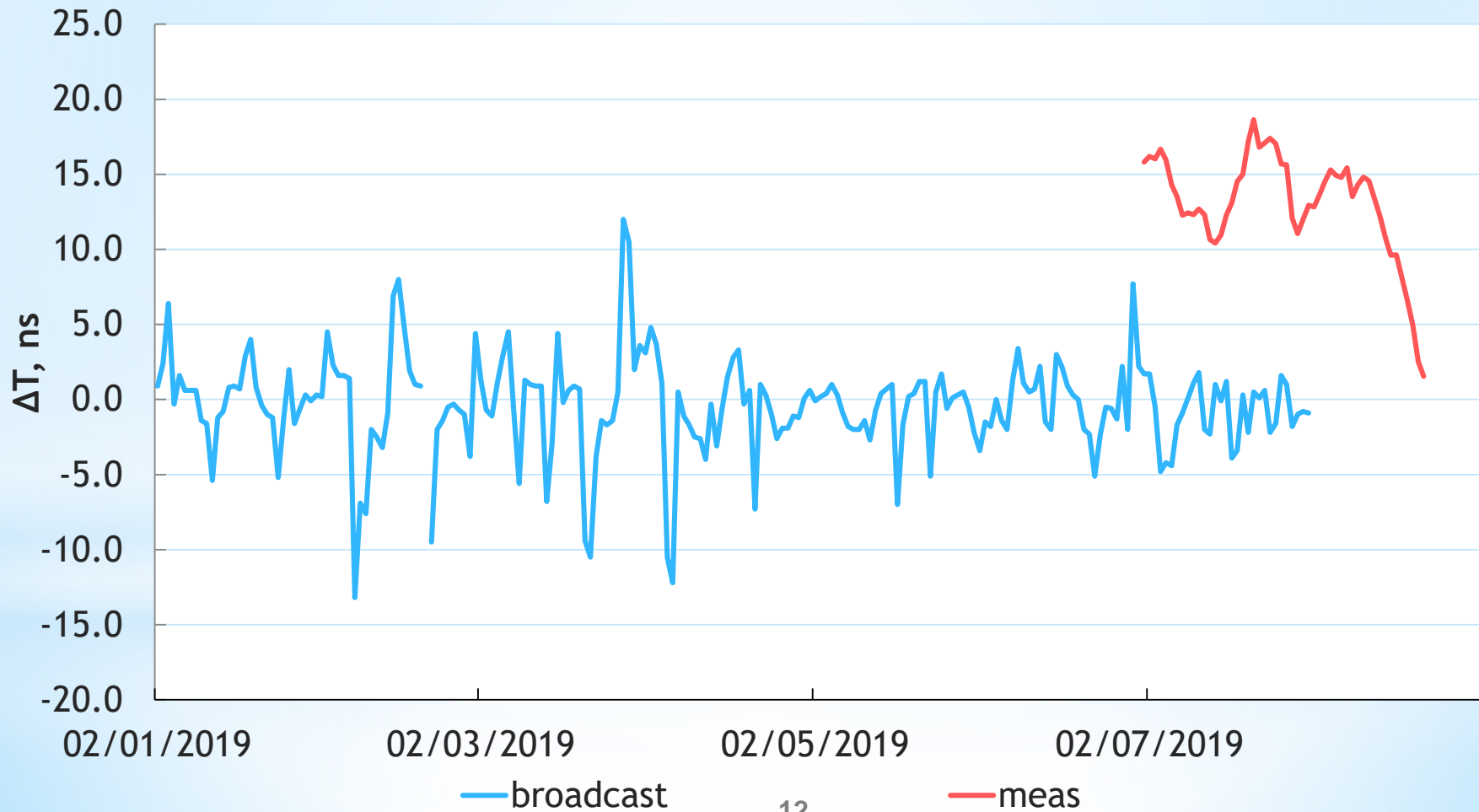
UTC(SU)-GLONASS Time





Results of GNSS Time Monitoring

UTC(NTSC)-BeiDou Time





Conclusion

- ***GNSS Time – Reference Time offsets are maintained within specified values.***
- ***The problems of GNSS Time monitoring are:***
 - ***GNSS Time scales are produced at GNSS control centers and the direct access to them is impossible “from outside”;***
 - ***Galileo Time – cannot be monitored based on measurements at UTC(k) Generating Facilities as Galileo Ref. Time is not UTC(k);***
 - ***The data on Galileo Time, BeiDou Time are not provided by BIPM.***



Conclusion

- ***For international GNSS monitoring it is necessary:***
 - ***to include GNSS-Reference time offset into the set of monitoring parameters;***
 - ***to harmonize monitoring techniques, including the type of used signals and the requirements to calibration accuracy;***
 - ***to arrange monitoring of Galileo Time, BeiDou Time and QZSS Time by international services.***



**Thank you for your
attention!**