The Problems of GNSS Time Monitoring

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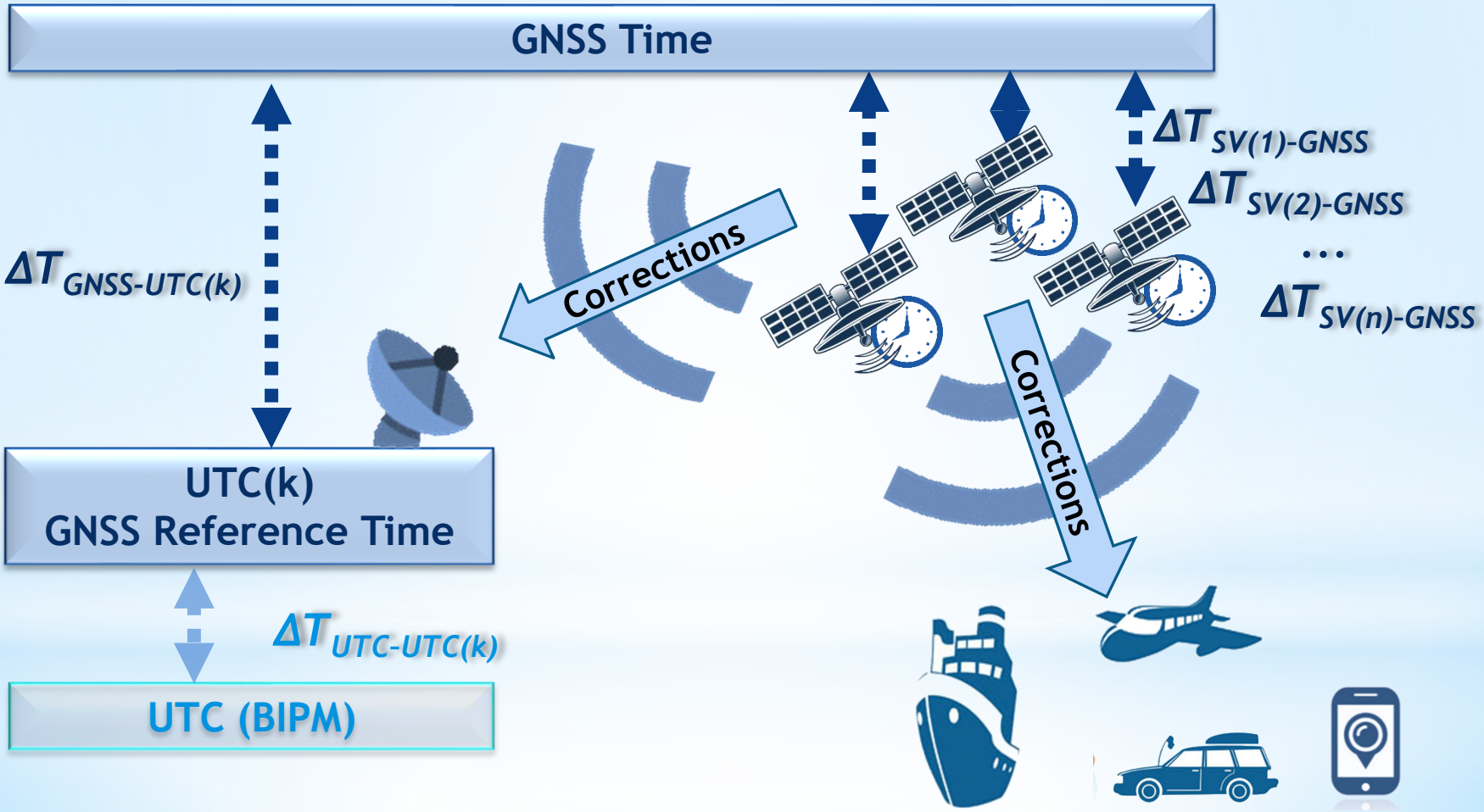
GNSS Time Referencing



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.

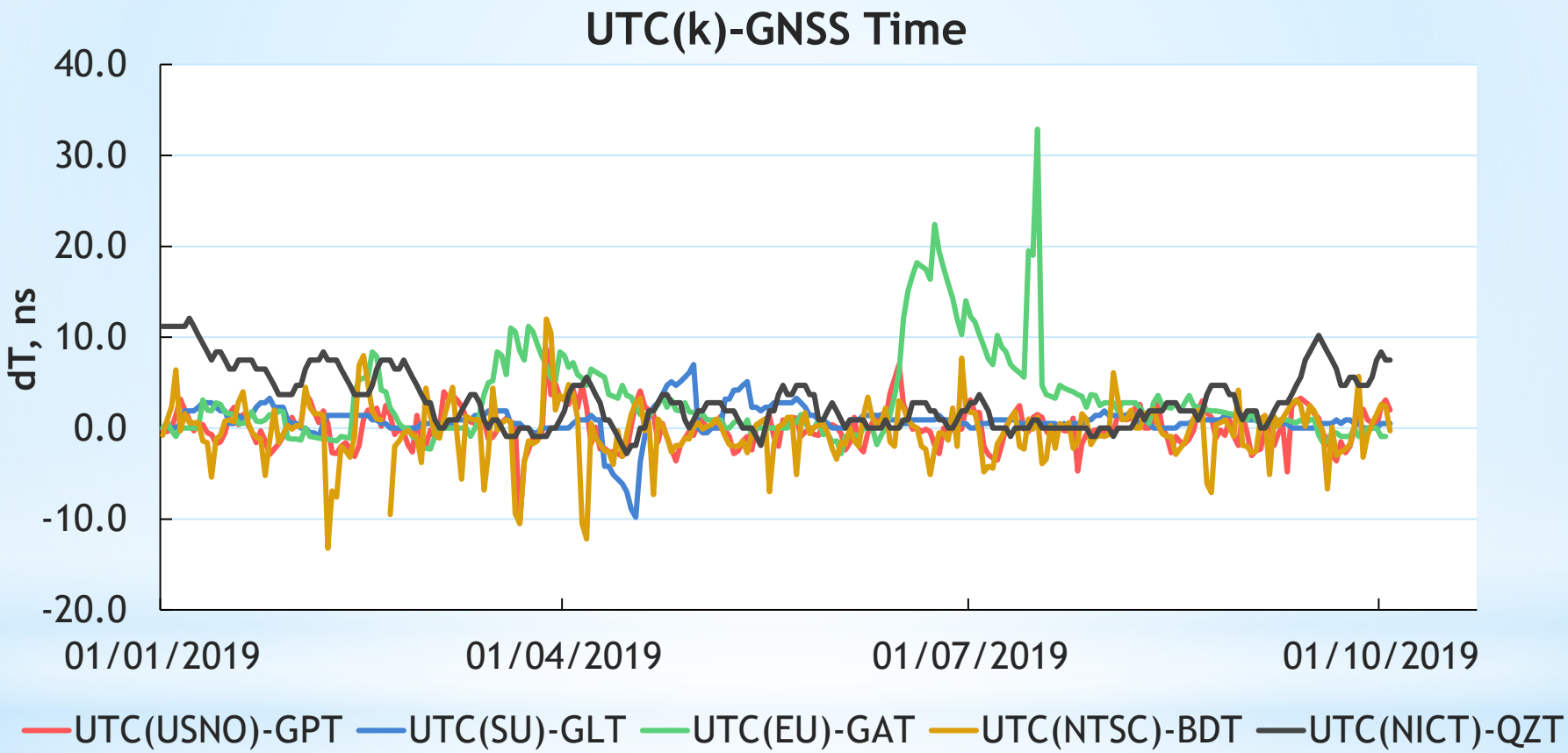
- ***GNSS Time parameters – are not included.***

Methods of GNSS Time Monitoring

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

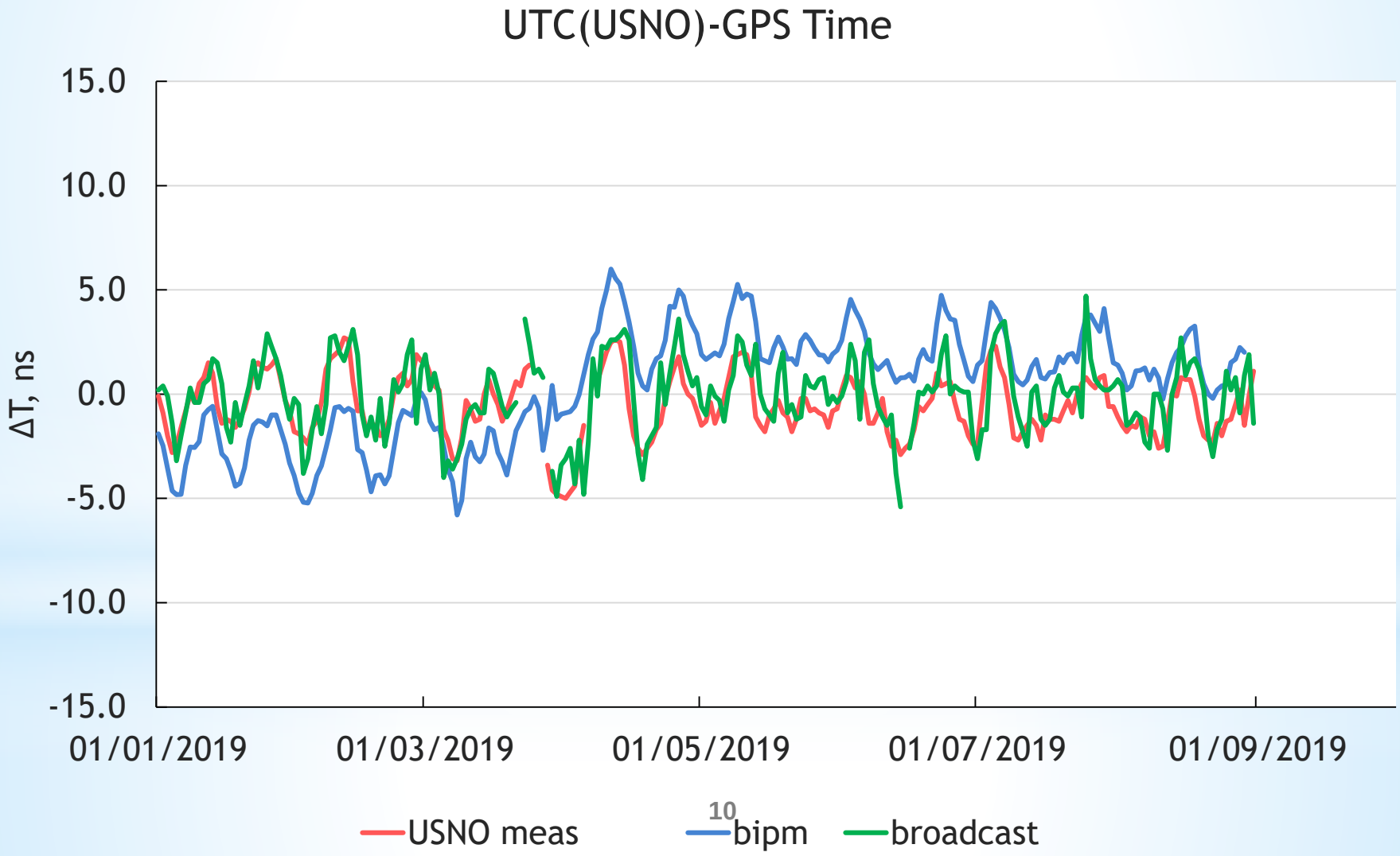
- ***broadcast corrections to convert from GNSS Time to Reference Time which is, as a rule, national realization of UTC(k)***
- ***measurements at UTC(k) Generating Facilities***
- ***BIPM data on [UTC-GNSS Time] that were transformed to the values of [UTC(k)-GNSS Time]. The data are provided for GPS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

Results of GNSS Time Monitoring

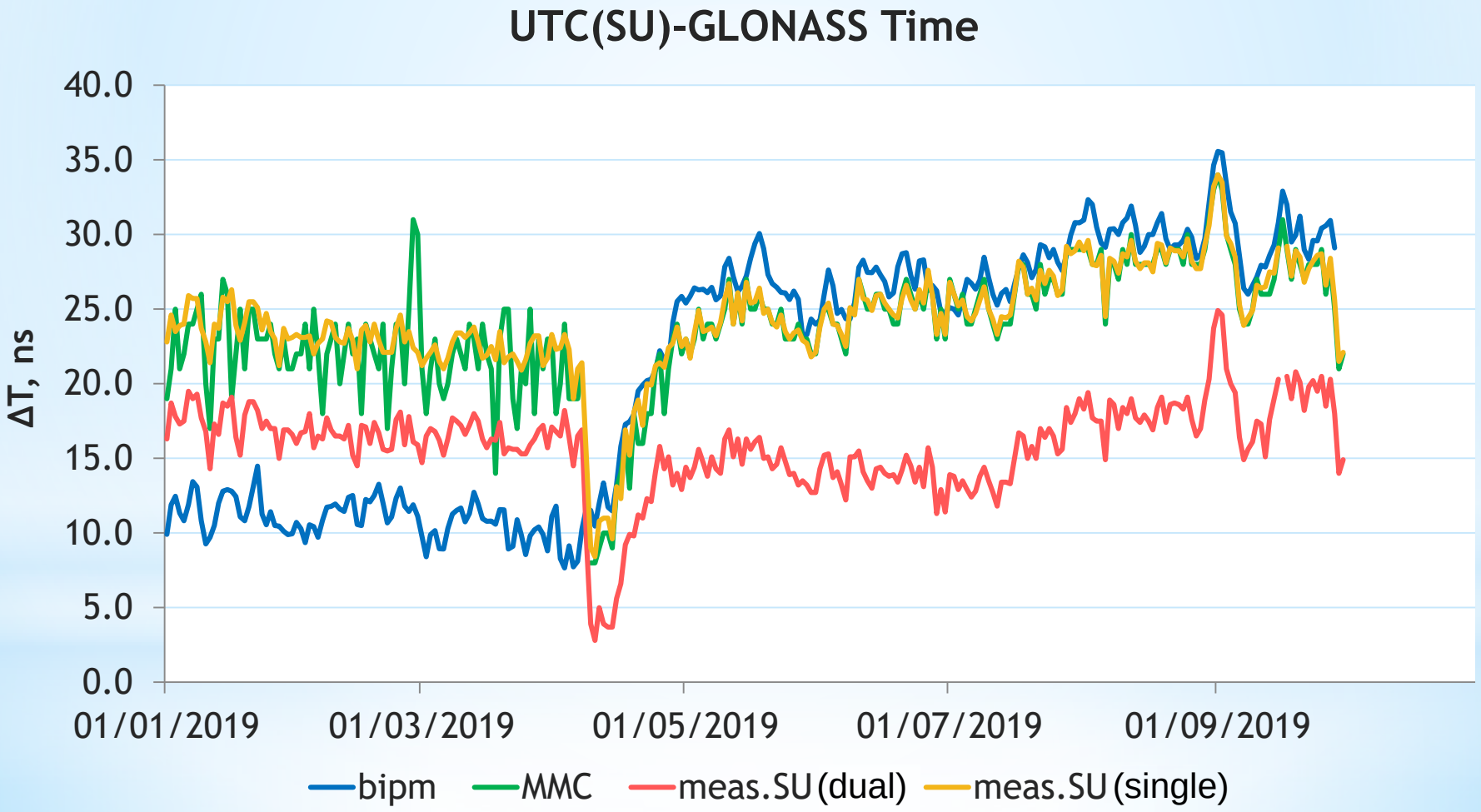


[USNO-GPS]	± 5 ns	[< 1 μs]
[SU-GLONASS]	mainly ± 5 ns	[< 1 ms]
[UTC-Galileo]	mainly ± 10 ns	[< 50 ns]
[NTSC-BeiDou]	± 10 ns	[< 100 ns]
[NICT-QZSS]	± 10 ns	[< 1 μs]

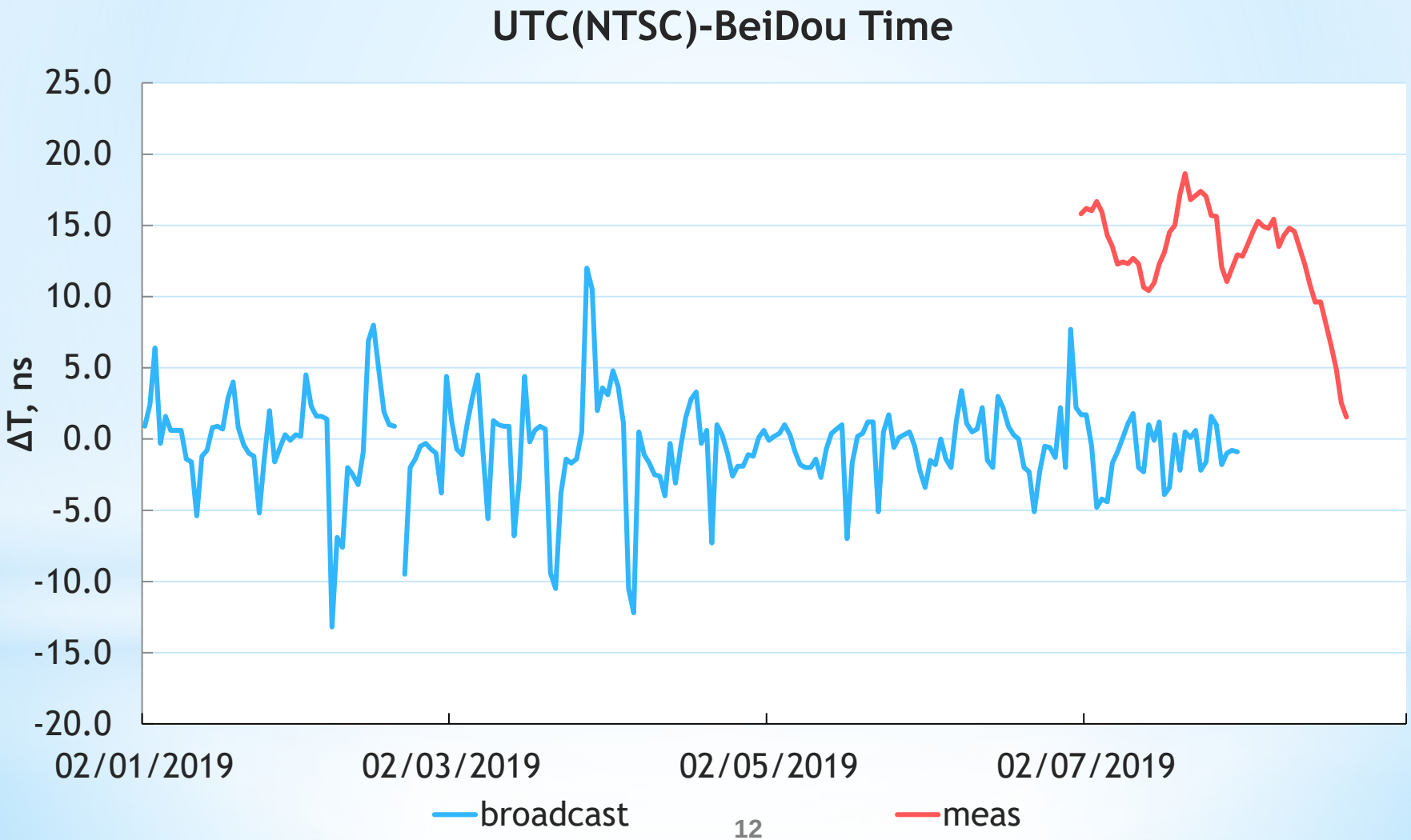
Results of GNSS Time Monitoring



Results of GNSS Time Monitoring



Results of GNSS Time Monitoring



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!