



Time Transfer by GNSS

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Calculation of GNSS Time/UTC by Users

Users calculate GNSS Time as:

$$T_{GNSS} = t + \Delta T_{GNSS - SV}$$

t - *SV time*

$\Delta T_{GNSS - SV}$ - *calculated with using corrections to SV time*

Broadcast corrections to SV time:

- *GPS, Galileo, BeiDou and QZSS – 3 parameters*
- *GLONASS: FDMA – 2 parameters*
CDMA – 3 parameters

Calculation of GNSS Time/UTC by Users

Users calculate UTC as:

$$T_{UTC(k)} = T_{GNSS} + \Delta T_{UTC(k) - GNSS}$$

T_{GNSS} - GNSS Time

$\Delta T_{UTC(k) - GNSS}$ - calculated with using corrections to GNSS Time

Broadcast corrections to GNSS Time:

- *GPS, Galileo, BeiDou and QZSS – 2 parameters
and the whole second offset of UTC*
- *GLONASS: FDMA – 1 parameter
CDMA – 2 parameters*



Parameters of Time Transfer by GNSS

	GPS	GLONASS	Galileo	BeiDou	QZSS
<i>Error of SV Time - GNSS Time offset corrections</i>	6 m *	5,6 ns (RMS)	65 sm* (RMS)	2 ns	1,6 m (95%)
<i>Error of GNSS Time - Reference Time offset corrections</i>	40 ns (95%)	40 ns (95%)	28 ns (95%)	5 ns (95%)	-

*- URE that includes the error of SV Time-GNSS Time offset corrections



Parameters of Time Transfer by GNSS

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

- *Time Transfer Accuracy UUTCE*
- *UTC Time Dissemination Accuracy UTCOE*

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

- *orbit and clock error*
- *User range error*
- ***UTC Offset Error***
- *PDOP*

Methods of Time Transfer Monitoring

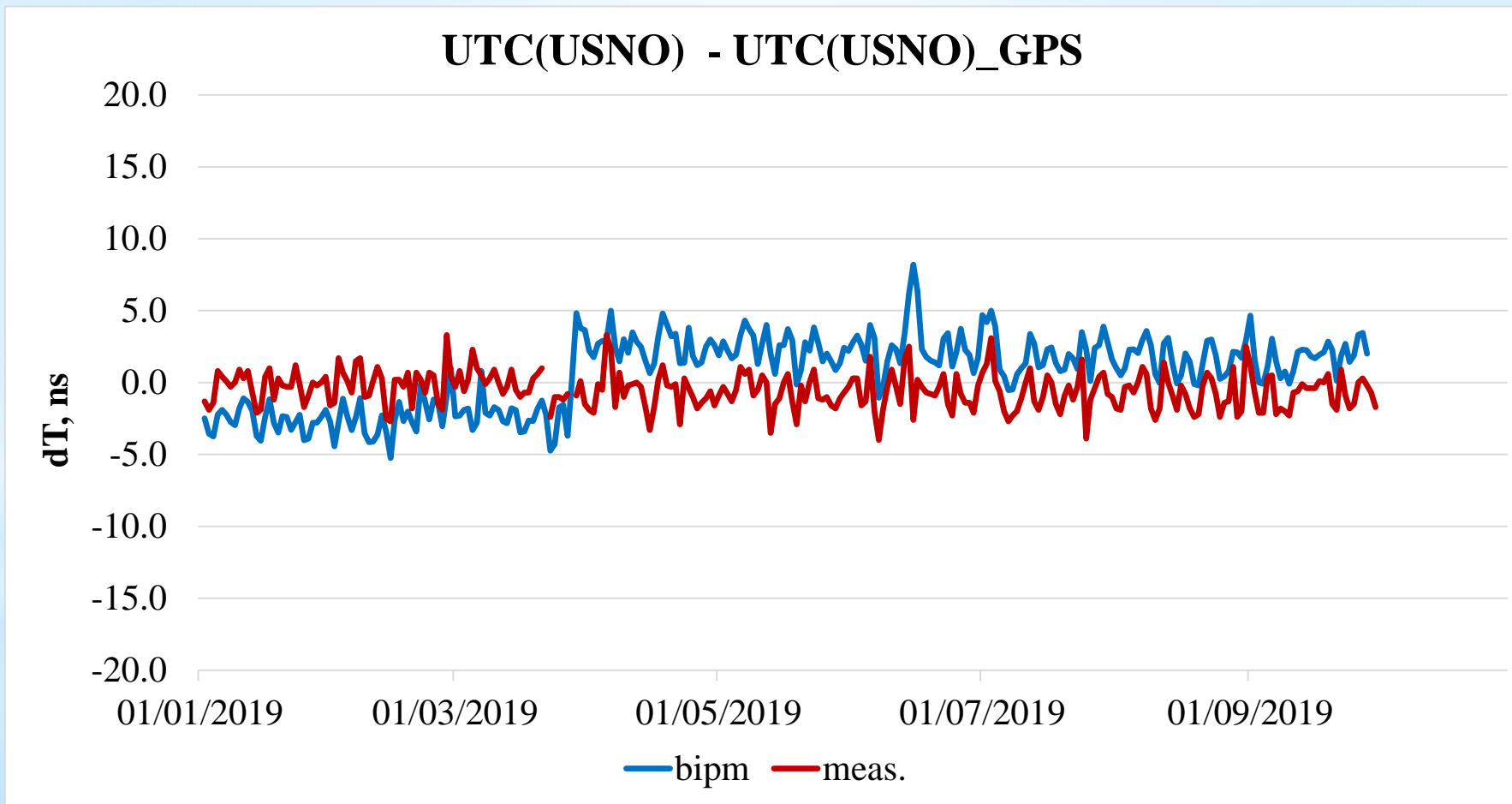
- ***BIPM data:***

*[UTC-GNSS Time] , [UTC-UTC(k)_GNSS] are transformed to
[UTC(k)-GNSS Time] , [UTC(k)-UTC(k)_GNSS]*

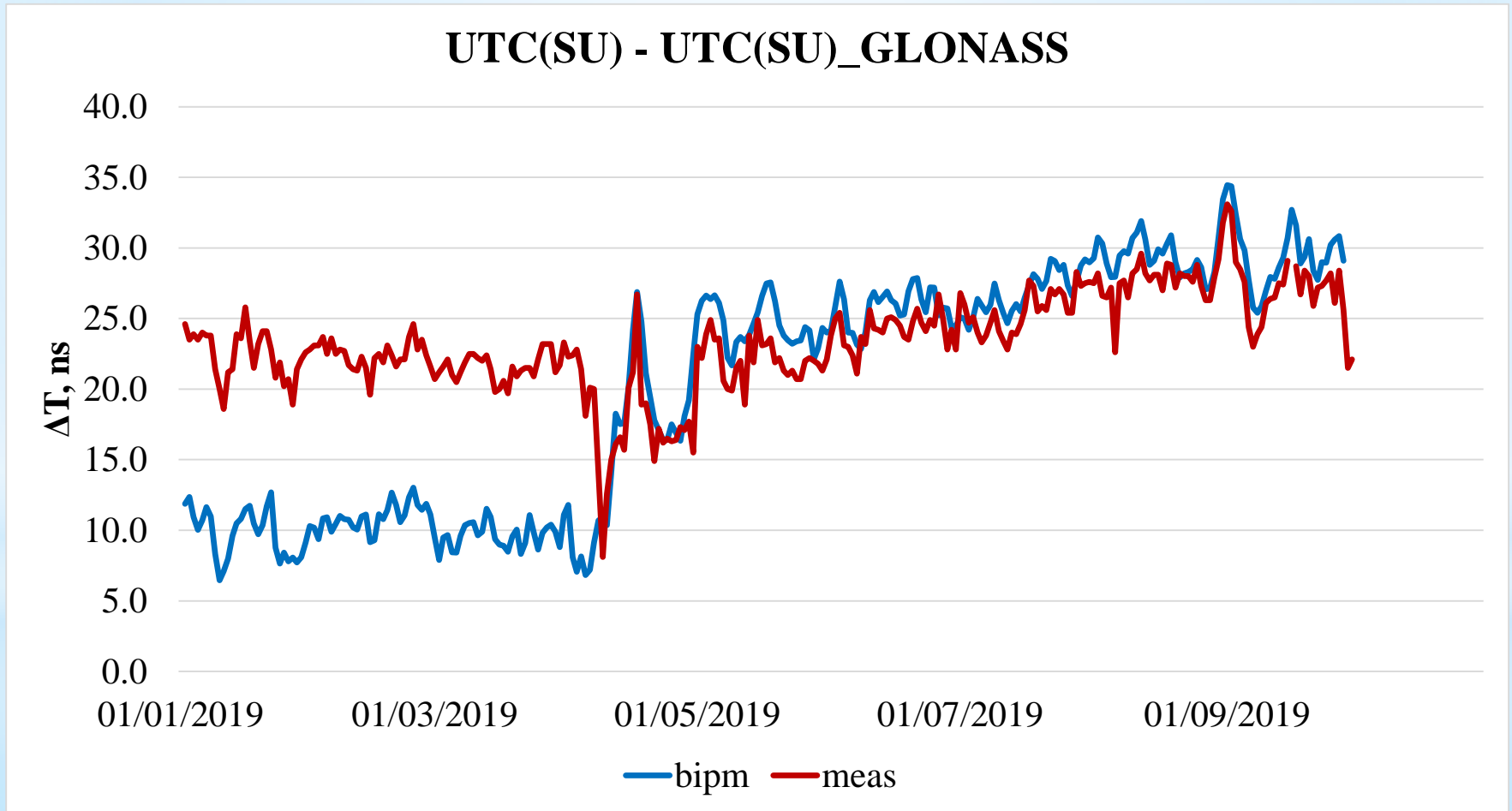
- ***Measurements at UTC(k) Generating Facilities***

[UTC(k)-GNSS Time] => [UTC(k)-UTC(k)_GNSS]

Results of Estimation of Time Transfer by GNSS



Results of Estimation of Time Transfer by GNSS



Conclusion

- *The results of estimation of Time Transfer based on BIPM data and measurements at UTC(k) Generating Facilities show some difference.*
- *The difference can be explained by different techniques of measurement processing and the lack of calibration of measuring facilities.*



**Thank you for your
attention!**