



# **GNSS Time Scales Analysis**

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# Introduction

Monitoring GNSS Time scales and GNSS timing parameters is essential for GNSS Time interoperability.

The following issues are presented:

- specified GNSS timing parameters;
- monitoring results produced independently at RIRT based on available “from outside” information.



## Specified GNSS Timing Parameters

	GPS	GLONASS	Galileo	Beidou	QZSS
<b>Reference Time</b>	<b>UTC(USNO)</b>	<b>UTC(SU)</b>	<b>UTC</b>	<b>UTC(NTSC)</b>	<b>UTC(NICT)</b>
<b>GNSS Time - Reference Time offset, modulo 1 s</b>	<b>1 <math>\mu</math>s</b>	<b>1 ms</b>	<b>50 ns (95%)</b>	<b>100 ns</b>	<b>1 <math>\mu</math>s</b>
<b>GNSS Time - Reference Time offset, whole number of seconds</b>	<b>18 s since 01.2017</b>	<b>0 s *</b>	<b>18 s since 01.2017</b>	<b>4 s since 01.2017</b>	<b>18 s since 01.2017</b>
<b>Correction of GNSS Time with UTC leap second corrections</b>	<b>-</b>	<b>+</b>	<b>-</b>	<b>-</b>	<b>-</b>

\*- there is a constant 3-hour GLONASS Time - UTC(SU) offset due to GLONASS Ground Control Complex operational principles



## Specified GNSS Timing Parameters

	GPS	GLONASS	Galileo	Beidou	QZSS
<b>Error of SV Time - GNSS Time offset corrections</b>	6 m *	5,6 ns (RMS)	65 sm* (RMS)	2 ns	1,6 m (95%)
<b>Error of GNSS Time - Reference Time offset corrections</b>	40 ns (95%)	1 μs	28 ns (95%)	5 ns (95%)	-
<b>Error of GGTO corrections</b>	-	GL-GPS 30 ns (RMS)	Ga-GPS 5 ns (95%)	-	QZSS- GPS 6,67 ns

\*- User range error that includes the error of SV Time-GNSS Time offset corrections



# Monitoring GNSS Timing Parameters

GNSS time scales are generated at GNSS Control Centers or Master Stations and, as a result, their parameters can't be directly estimated "from outside".

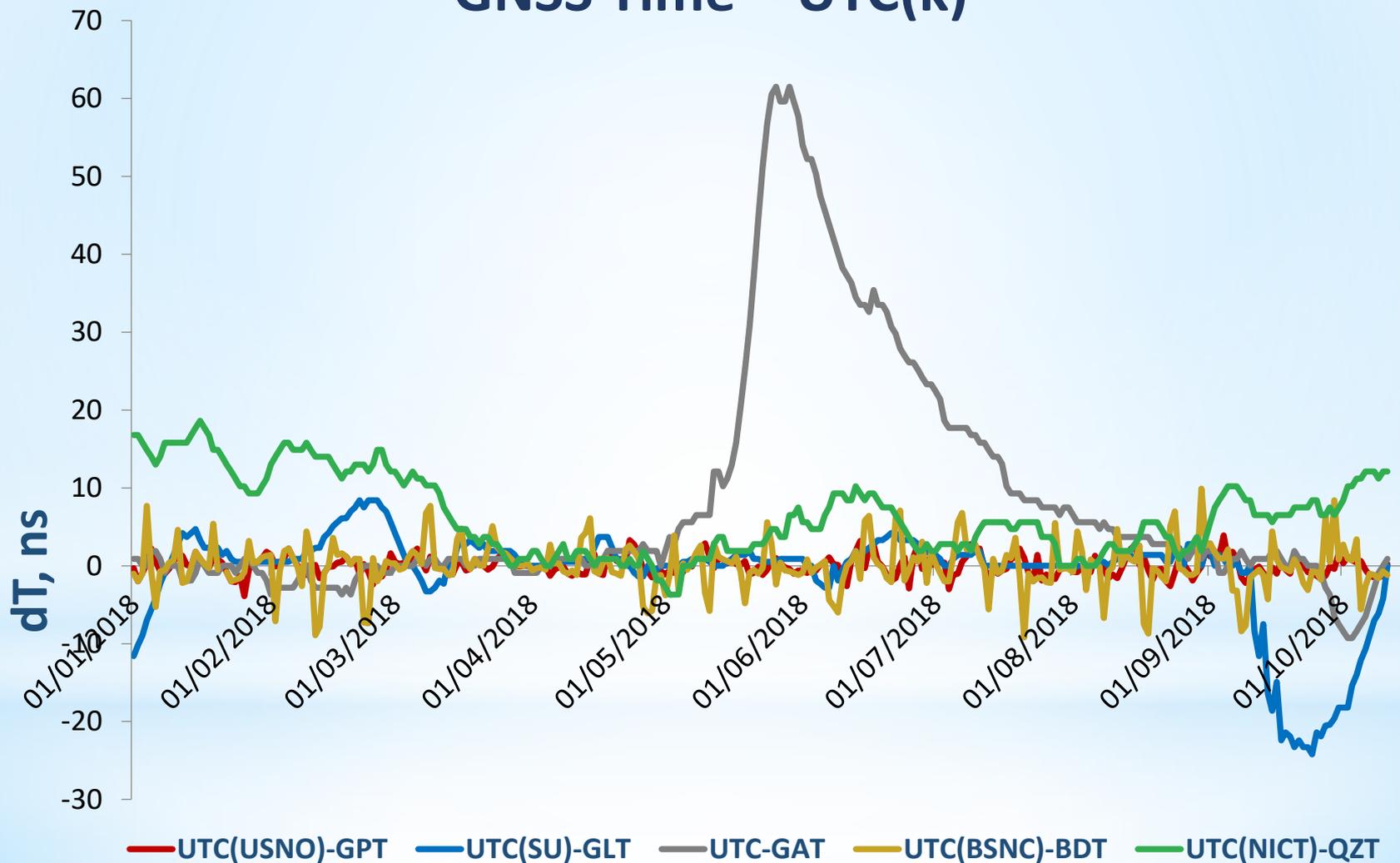
The trustworthy estimates "from outside" can be provided only for GNSS Time – Reference Time Offsets based on available information:

- broadcast corrections to convert from GNSS Time to Reference Time;
- the values of GNSS Time – Reference Time offsets obtained on the basis of the measurement processing at Reference Time Generating Facility.



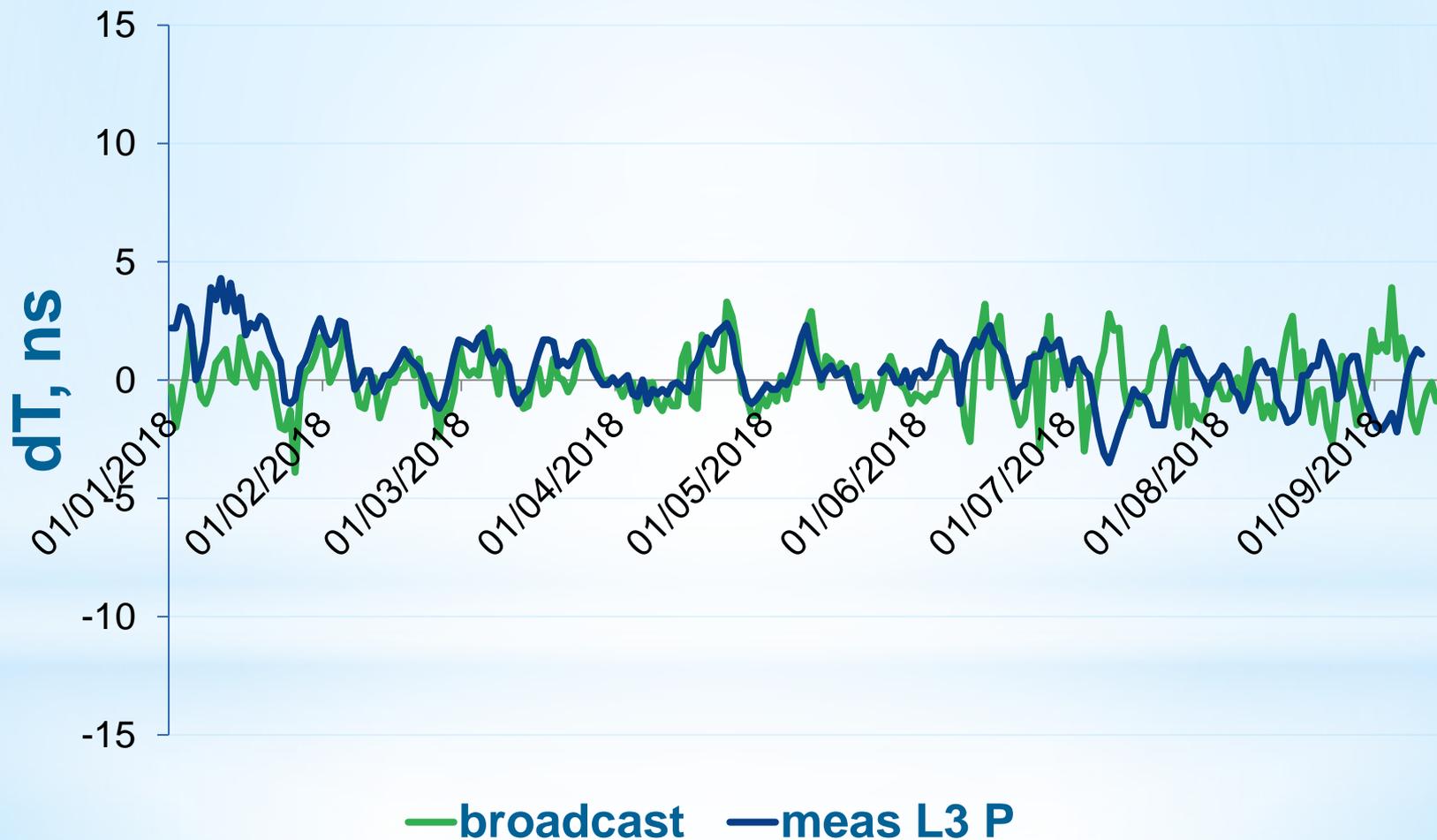
# GNSS Time Scales Analysis

## GNSS Time – UTC(k)





## GPS Time - UTC(USNO)



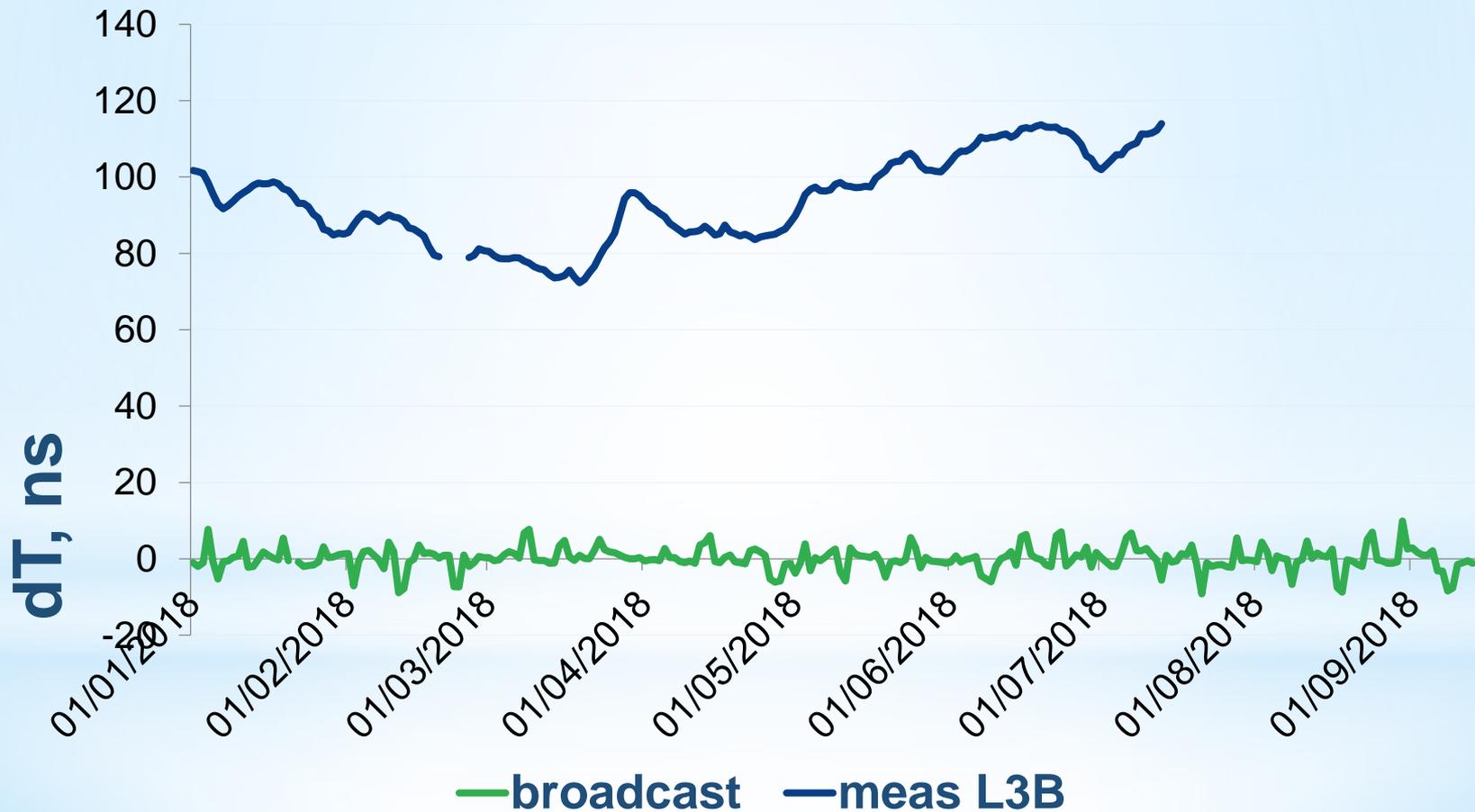


## GLONASS Time - UTC(SU)





## BDT – UTC(NTSC)





### Conclusion

*As GNSS Times are generated independently at Control Centers or Master Stations - their parameters can't be directly estimated "from outside".*

**Monitoring results based on broadcast corrections and based on measurement results by GNSS signals produced at UTC(k) Generation Facilities available «from outside»:**

- **GPS Time - UTC(USNO)** - within  $\pm 5$  ns;
- **GLONASS Time - UTC(SU)** - within  $\pm 10$  ns; up to 24 ns in 09-10/2018.  
The systematic error component of GLONASS Time broadcast by GLONASS is (15-20) ns;
- **Galileo Time - UTC** - within  $\pm 10$  ns, up to 60ns in May - August 2018;
- **Beidou Time - UTC(BSNC)** - within  $\pm 10$  ns;  
Beidou Time - UTC(NTSC) - within 120 ns;
- **QZSS Time - UTC(NICT)** - within  $\pm 20$  ns.



**Thank you for your  
attention!**