GNSS Time Scales Referencing based on Broadcast Data

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GNSS Time Interoperability Methods Suggested by ESA

Methods:

- based on broadcast ***XGTO corrections;***
- based on ***Multi-GNSS Ensemble Time*** **(MGET)**.

The key advantage of the methods:

- the need to broadcast only one correction for GNSS Time interoperability

Drawbacks/Bottlenecks of XGTO/MGET Methods

- **Implementation - much efforts to implement**

  - producing and maintaining the new time scale (MGET)

  - development of hardware/software techniques of measurements (agreed measurement and calibration techniques)

  - processing, calculating, uploading, broadcasting

  - changes in navigation message structure - to provide backward compatibility at the receiver level XGTO/MGET corrections are to be broadcast in addition to currently broadcast corrections

  - if corrections are produced by an authorized international service - Providers are to broadcast data that they can't be responsible for

- **Accuracy – the increase in accuracy is not provided as compared with the methods based on currently broadcast information**

  - disturbances and failures in one GNSS Time scale can influence interoperability of all GNSS

  - MGET disturbances influence interoperability of all GNSS

  - if corrections are produced by Providers with using some measurements - different configurations of SV's in view cause additional error

GNSS Time Interoperability Methods based on Currently Broadcast Information

I - based on broadcast ***UTC(k)-GNSS Time offset*** parameters;

II - based on broadcast direct ***GNSS-GNSS Time offset*** parameters;

III - based on broadcast ***GNSS-GNSS Time offset parameters relative to one GNSS.***

Pros and Cons of the Methods based on Currently Broadcast Information

I Based on broadcast ***UTC(k)-GNSS Time offset*** parameters

- is implemented in all GNSS
- accuracy depends on UTC-UTC(k) offset

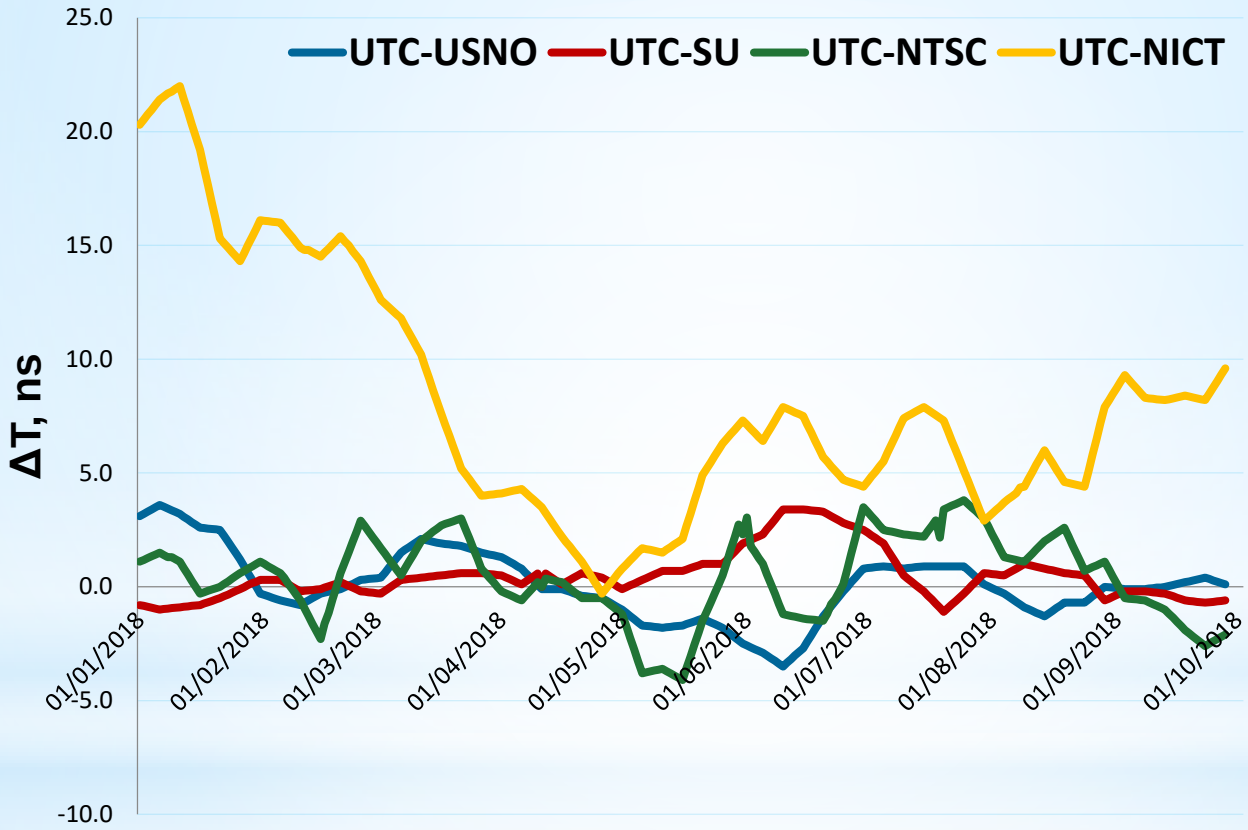
II Based on broadcast ***GNSS-GNSS Time Offset*** parameters

- is implemented in GLONASS and Galileo (broadcast GLONASS-GPS and Galileo-GPS Time Offset corrections)
- can provide the highest accuracy
- requires additional efforts to be completely implemented

III Based on broadcast ***GNSS-GNSS Time offset*** parameters relative to one GNSS

- is implemented in GLONASS and Galileo and specified in BeiDou and QZSS
- provides generally two times lower accuracy than direct broadcasting GGTO

UTC-UTC(k)



UTC-UTC(USNO), UTC-UTC(SU), UTC-UTC(NTSC) – within ±4 ns
UTC-NIST – within ±20 ns

Minimizing UTC-UTC(k) Offset

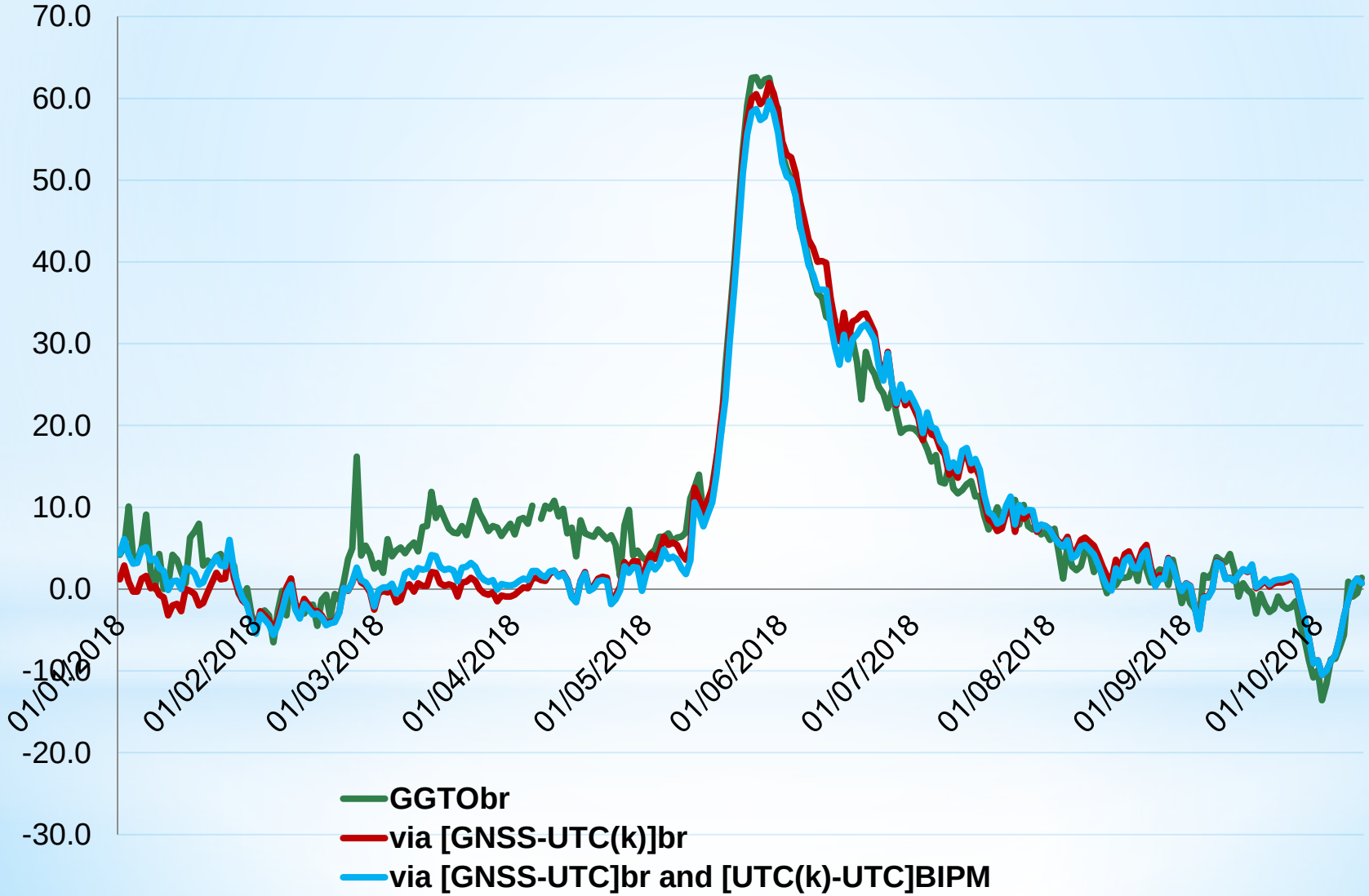
According to the results of the 1st Timing Workshop in 2017 in Paris, France:

- all system providers should continue to improve the alignment of their individual system times with UTCk to benefit users

According to the results of the 2nd Timing Workshop in Vienne and WG-S meeting 17 July 2018 in Noordwijk, Netherlands:

- WG-S is to propose to interested members of BIPM Consulting Committee for Time and Frequency to prepare a recommendation for national time laboratories to improve the accuracy of synchronization of UTC-UTC(k) and to reduce the publication delay of UTC-UTC(k) data.

Galileo Time - GPS Time



Conclusion

1. **As implementation of MGET/XGTO methods requires changes at the system level, they are to be considered by System Providers with assessment of implementation feasibility, taking into account: the necessary accuracy of providing GNSS-GNSS Time offsets to multi-GNSS users and backward compatibility with the existing user equipment.**
2. **Methods XGTO and MGET do not provide the increase of accuracy as compared with the methods based on currently broadcast information and need much efforts to be implemented.**

Thank you for your attention!