GNSS time interoperability
Estimation of GGTO via GNSS UTC brdc info

The views expressed in this presentation are those of the author and do not necessarily reflect the official position of the GSA/EC

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Context

Each GNSS has its own time scale.

Combining measurements from different GNSS require the determination of their relative time offsets.

These relative time offsets can be :

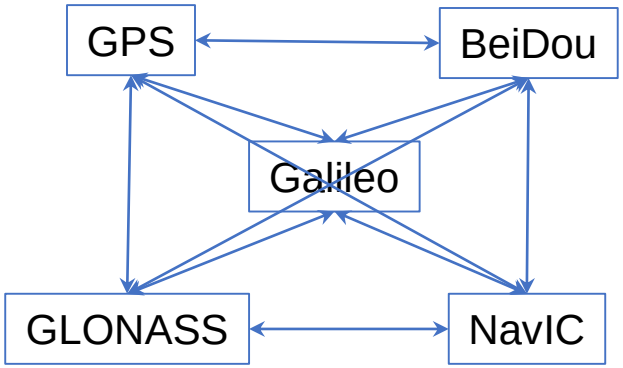
- determined at user level if sufficient measurements are available

  >> this method shall always be preferred when possible because it is deemed to be more accurate

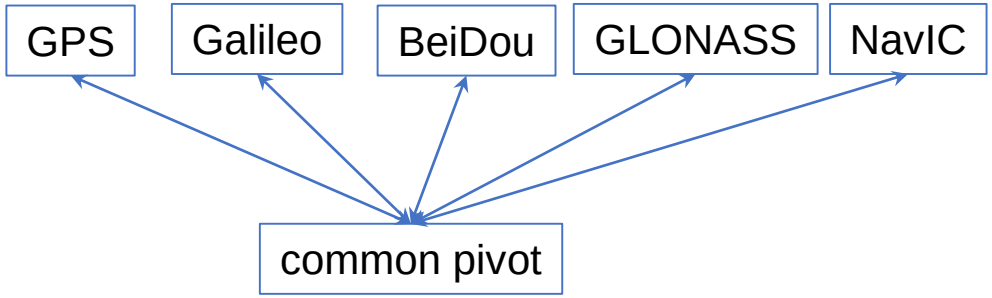
- determined using a broadcast information

Possible approaches

The inclusion of the GNSS-to-GNSS time offset (GGTO) in the broadcast information can be envisaged with 2 approaches:



Each GNSS broadcasts its time offset wrt all the other GNSS



Each GNSS broadcasts its time offset wrt a common pivot

Common pivot

For the common pivot, several options might be considered :

- a given GNSS time or a given UTC(k)
  >> single point of failure : probably unacceptable
- a new time scale created externally (MGET proposal)
  >> at least 3 drawbacks : complex, who would compute it ?, another time scale
- a new time scale created internally (xGTO proposal)
  >> no external 3rd party, tests needed to assess perfo (see J. Hahn's presentation)
- UTCr
  >> 10-d latency imposes extrapolation, tests needed to assess perfo
- UTC as broadcast by each GNSS
  >> nothing additional to implement, tests needed to assess perfo

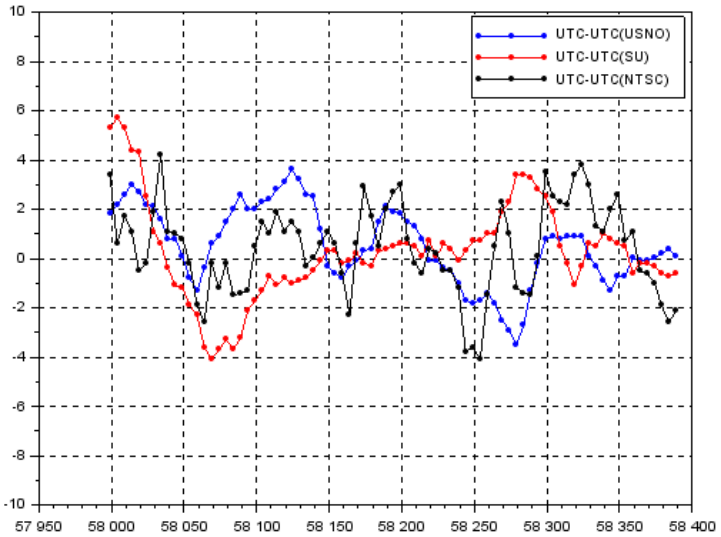
Estimation of GGTO via GNSS UTC brdc info

Each GNSS broadcasts an estimation of GNSST – UTC(k)

>> UTC(USNO) for GPS, UTC(SU) for GLONASS, UTCp for Galileo, UTC(NTSC) for BeiDou

Therefore this approach requires consistency of

- these estimations
- UTC(j) vs UTC(k)



UTC(k) reference time scales of GNSS are consistent with one another at ~2 ns (1-σ)

Estimation of GGTO via GNSS UTC brdc info

- **GPS broadcasts GPST – UTC(USNO)**
- **Galileo broadcasts GST – UTCp**

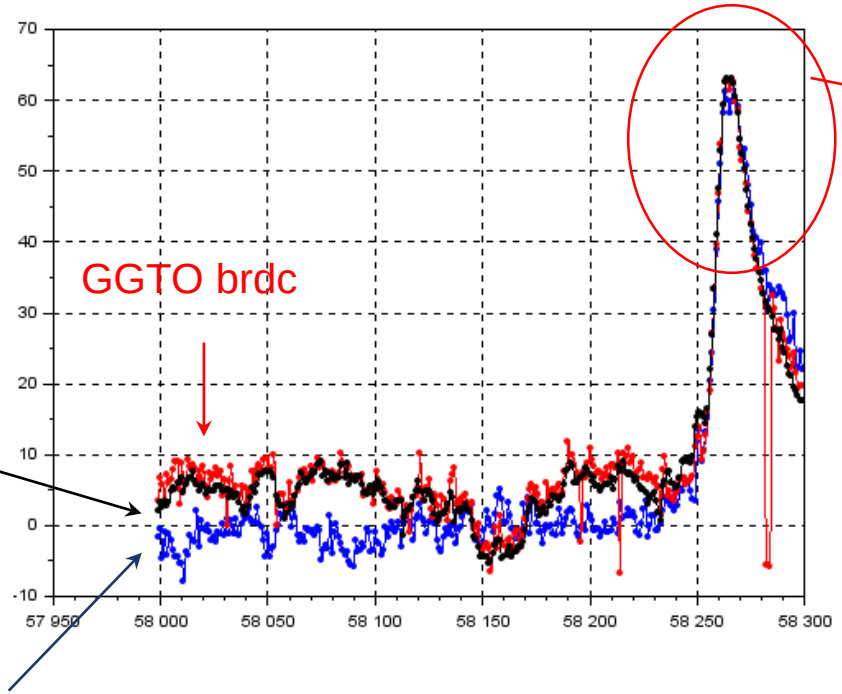
Combining these two already existing messages, one gets GST – GPST but with what level of accuracy ?

Test of this approach :

- GPST – UTC(USNO) : one value per day, using the RINEX nav header of CNES station
- GST – UTCp : one value per day, using the RINEX nav header of CNES station
- computation of [GST – UTCp] – [GPST – UTC(USNO)]

Estimation of GGTO via GNSS UTC brdc info

Comparison from Sept. 2017 to July 2018



Drift of GST accurately reflected in the UTC-GST brdc info

► no impact to users

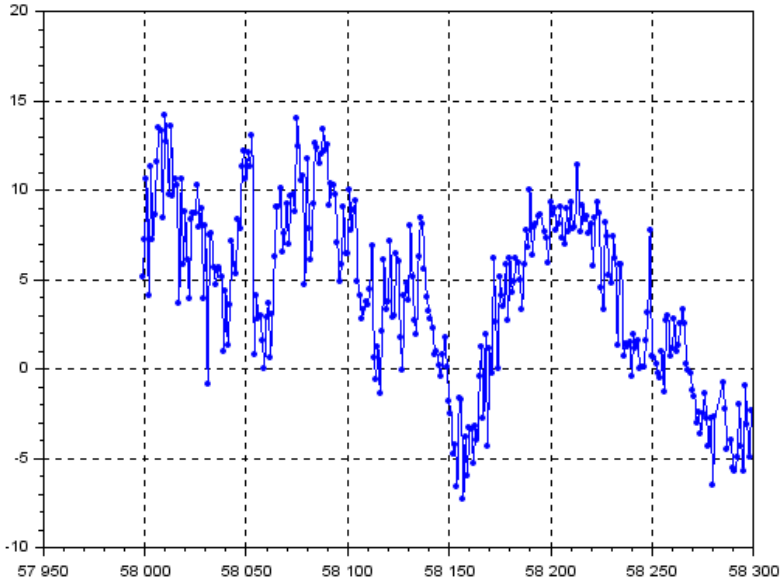
GGTO computed at user level

(GST – UTCp) – (GPST – UTC(USNO))

Estimation of GGTO via GNSS UTC brdc info

GGTO_brdc –
[(GST – UTCp) – (GPST – UTC(USNO))]

Mean = 4.4 ns
Stdev = 4.9 ns



Good performances even over period where GST was a bit far from UTC (because the GST – UTCp correctly reflected this)

TBC whether this performance is sufficient for interoperability

Conclusion

Several possible approaches to allow GNSS users to determine the GGTOs

Simple approach (investigated here) makes use of already-existing broadcast information :

- Good performance for GPS/Galileo
- To be tested with other GNSS

Required uncertainty on GGTO is TBD

Thank you for your attention

Questions ?

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