Considerations on GNSS Timescale Offsets

Michael J. Coleman, Allison Craddock / IGS
Patrizia Tavella, Gérard Petit / BIPM

Timing Workshop
ICG Joint Meetings
14 June 2019
Overview

- Recommendation has been formed among several members of the IGS’s Clock Products Group and BIPM.
- Main argument is that UTC should be utilized as the common time reference between GNSS as it is the international reference timescale standard.
- Present operation and architecture of GNSS systems should be sufficient to support this approach.
- Statements are supported by the BIPM Time Department.
- Discussion will continue within the IGS (and also the working group) which consists of members from several different organizations.
Current Timescales

• Many reference times are now in existence:
  • TAI  UTC  UT1  GPST  GALT  BDST  GLOT  IGRT  IGST  …
• For timing product users, there are two “times” that are important:
  • The reference time for a particular datum; and,
  • The time of epoch at which the datum occurred.
• The ambiguity of these two points grows when more timescales are critical components of systems that disseminate timing products.
Timescale Steering Architecture

$a_i$ are differences between GNSS($k$)T and UTC($k$). These are estimated by the system and broadcast.

$b_i$ are differences between UTC($k$) and UTC and are published latent to real time—when CircularT is published.

Systems broadcast their best predictions of UTC($k$) and thus unknown offsets between any pair of system(s) is of order $\max |b_i|$. Calibration and prediction errors also affect $a_i$.

Stability and accuracy of UTC($k$) vs. the UTC timescale will help each system time drive toward the international reference time standard.
Offset of UTC($k$) laboratories over the past 250 days as published by the BIPM’s CircularT.

Graph presents UTC($k$) that are the steering targets for various GNSS system times:

GPS    USNO
QZSS   NICT
GAL    PTB, IT, OP, NPL, ROA
GLO    SU
BDS    NIM

Spread of these UTC($k$) reference times falls largely within the range of [-5,+5] ns.
Summary of recommends:

• GNSS providers not consider addition of another system time-scale as a means of promoting interoperability between systems;

• GNSS providers continue to generate the most stable possible internal system reference time and maintain a minimal time offset with respect to UTC (through one or more UTC\((k)\) reference centers);

• GNSS providers continue to transmit the most accurate possible prediction of the time offset of the GNSS internal system time versus UTC or UTC\((k)\);

• UTC\((k)\) timing centers serving as reference stations (in any capacity) for a GNSS or RNSS make efforts to realize UTC\((k)\) with the most stable and minimal possible offset from UTC as published by the BIPM’s Circular T.