GNSS Timescale Description

IGS Time v1.0

Definition of System

1. **System timescales:** IGST (Final products) & IGRT (Rapid products)

2. **Generation of system timescale:**
   Dynamically weighted clock ensemble of IGS tracking station frequency standards and GPS satellite clocks as observed via GPS pseudorange and carrier phase data. The inputs to this timescale are the combined clock estimates of the IGS Analysis Centers tabulated and distributed nominally at 5-min intervals. Parallel product streams are issued daily about 17 hr after the end of the previous day (Rapid) and weekly about 10 d after the end of each GPS week (Final). A denser 30-s clock time series is also available for the GPS satellite clocks as part of the IGS Final products.

3. **Is system timescale steered to a reference UTC timescale?**
   No, it is steered to broadcast GPS Time, which can be related to UTC indirectly using offsets published by the BIPM in Circular T at daily intervals.

   a. **To which reference timescale:** broadcast GPS time

   b. **Whole second offset from reference timescale?**
      Yes, the IGS timescales are offset from UTC by the same integer second count as GPS time, which equals (UTC + 15 s) since 01 January 2009.

   c. **Maximum offset (modulo 1s) from reference timescale?**
      Typically, the IGS timescales are steered to stay within +-50 ns of GPS time and UTC (modulo 1 s), though no offset maximum is formally established.

4. **Corrections to convert from satellite to system timescale?**
   Yes. **If yes:**

   a. **Type of corrections given; include statement on relativistic corrections**
      The recorded GPS observational data are corrected in the individual reductions by the IGS Analysis Centers

to account for the 2nd order relativistic offsets due to non-zero orbit ellipticities (-2*R*V/c), as prescribed in the system interface document IS-GPS-200. This, combined with the hardware oscillator frequency offsets applied aboard the GPS satellites to account for 1st order relativistic time dilation and gravitational potential shifts, ensures that the observed GPS satellite clocks are consistent with Terrestrial Time (TT) timescales in mean frequency. In addition, the broadcast GPS satellite linear corrections to GPS time are applied in forming the IGS timescales in order to approximately align the IGS clocks to mean GPS time in 1 d batches.

   b. **Specified accuracy of corrections to system timescale**
   The GPS relativitistic correction is essentially conventional, as additional higher-order corrections (e.g., due to the oblateness of the Earth's geopotential field) are not applied in order to ensure consistency of IGS clocks with GPS time.

   c. **Location of corrections in broadcast messages**
   The GPS satellite corrections to GPS time are the standard clock components in the broadcast message. The relativistic corrections applied do not rely on the broadcast message.

   d. **Equations to correct satellite timescale to system timescale**
   see above

5. **Corrections to convert from system to reference UTC timescale?** No such corrections are applied. However, the empirical offsets of the IGS timescales compared to UTC are tracked using published Circular T offsets of GPS time relative to UTC. **If yes:**

   a. **Type of corrections given**

   b. **Specified accuracy of corrections to reference timescale**

    c. Location of corrections in broadcast messages

    d. Equations to correct system timescale to reference timescale

6. **Specified stability of system timescale**
   The stability of IGS timescales is not specified formally, but their empirical stability is about 1×10^{-15} over 1-d intervals.

7. **Specified stability of reference timescale**
   The stability of the reference (GPS Time) is about 2×10^{-14} at 1-d intervals.

8. **Specified stability of satellite clocks**
   The IGS observes and publishes the actual epoch offsets of each satellite clock relative to the IGS timescales, at 5-min (Rapid and Final products) and 30-s intervals (Final products only).

9. **Availability of System to GNSS Time Offset (GGTO)**
   The IGS timescale offsets are inherent in the published values for clocks of each GNSS.

   a. Systems for which corrections are given?
   The IGS publishes observed clocks for GPS only at the present time, though it is expected that observed clock offsets will be published for additional GNSSs in the future.

   b. Type of GGTO corrections given
   N/A

   c. Stated accuracy of GGTO correction, if available
   N/A

   d. Location of corrections in broadcast messages
   N/A

   e. Equations used for GGTO message
   N/A

Describe the details of the system, i.e. locations of system and

reference timescale clocks, generation of timescales, and other details.
The IGS clock products and their inherent timescales are based on a global network of multiband GNSS tracking stations, data centers, analysis centers, and product combination centers.

Describe how the timescale transfers from the reference timescale to the system timescale and finally to the satellites. Include the nominal rate of SV updates.
N/A

If any other pertinent details exist concerning the generation and realization of system and/or reference time, include them as well.