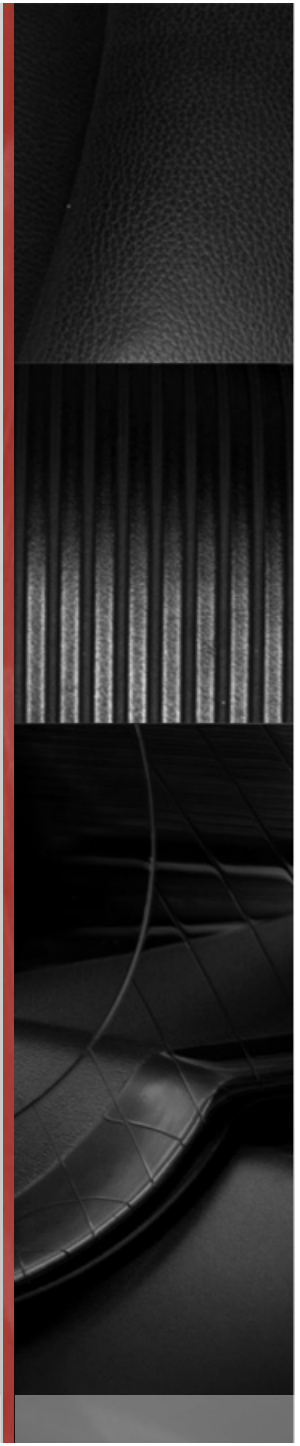
Recommendations on UTC Definition from IAG Working Group 1.1.1

Henno Boomkamp

Former Chair, IAG WG 1.1.1



Core problem

- Key characteristic of UTC
  - Coordinates two conflicting requirements on scale and date

    stable atomic time

    solar time
  - Date stamps within one second of solar time leads to occasional
- Lead to various problems, mainly in the area of correct handling of leap seconds
- Should further application of leap seconds perhaps be discontinued?
  - offset between UTC dates and UT1 dates will grow beyond one second

Relevance of time standards to satellite tracking and orbit determination

- Various time standards include TAI, UT1, UTC, GPS, GLO
- Basic time modelling is usually integer counting
  - progression of seconds or minutes
- Can be interpreted as a representation of TAI
  - Regular
  - Basic to time-dependent computations such as numerical integration

Relevance of time standards to satellite tracking and orbit determination (cont.)

- Modelling of ground station-spacecraft tracking geometry requires Earth rotation angle w/r/t TAI count.
- IERS Technical Notes provide transformation between celestial reference frame & terrestrial reference frame.
  - empirical corrections for daily *dUT1*
  - polar motion offsets dX_p and dY_p
- Key standards are TAI and UT1
  - Other definitions relevant because inputs/outputs use them

Data-analysis issues

- Ambiguous treatment of leap seconds within software.
  - Analyses tend to be iterative
  - Fairly complex housekeeping logic need when UTC tags are involved
- Outdated leap second information in the system.
  - Update not always possible
  - Analysts unaware of need to update

Arguments favoring change?

- No more software issues?
  - Argument only applies to analysis of future data
  - Workarounds with past data lead to new problems
- No more operational issues w/ database updates?
  - Symptom of inadequate design needing attention regardless
- We are forever stuck with past leap seconds
  - datasets back to 1972 will remain relevant for decades to come
- Abandoning future leap seconds one of several possible solutions to operational issues caused by leap seconds

Arguments for maintaining leap seconds

- Continued use of "UTC" confusing / misleading
- Future scale offset from TAI
  - Redundant to TAI, GPS, etc.
- Shifted Atomic Time has no advantages over TAI or GPS time
- Access to solar time requires IERS Bulletins A & B
  - More troublesome than occasional leap seconds

Leap hours, leap days or other intervals

- Insert fewer, larger adjustments to maintain UT1 coordination of UTC
  - leap minutes

    Not likely before 2030
  - leap hours

    Might not occur for the next 1000 years or so

    current time standard s likely meaningless
- These options come *too late*
  - past leap seconds cannot be undone
  - no different than abandoning Universal Time altogether

Summary

- Arguments to abandon leap seconds appear weak.
  - Avoiding future leap seconds does *not* solve software problems with past leap seconds
  - Today's operational problems can already be solved in other ways
- Arguments to continue status-quo UTC are stronger
  - Loss of coordination with UT1
  - Redundant with other "shifted" atomic times (TAI, GPS, etc.)
- World loses something relevant without sufficient return

IAG WG Recommendation

- Continue UTC just like it has been over the period 1972 - 2012, namely, with occasional leap seconds