Recommendation on the definition of time-scales

The Consultative Committee for Time and Frequency (CCTF),

considering that

- Resolution 1 of the 14th CGPM (1971) requested the CIPM to give a definition of International Atomic Time (TAI);
- no complete self-contained definition of TAI has been officially provided by the CIPM; although the Consultative Committee for the Definition of the Second (CCDS) proposed in its Recommendation S2 (1970) a definition which has been extended by a Declaration of the CCDS in 1980;
- the 15th CGPM in 1975 notes that Coordinated Universal Time (UTC), derived from TAI, provides the basis of civil time, and strongly endorses this usage;

recognizing that

- the CGPM is responsible for defining metrological standards, while the International Astronomical Union (IAU) and the International Union of Geodesy and Geophysics (IUGG) with the International Association of Geodesy (IAG) are responsible for defining reference frames for Earth and space applications, and the International Telecommunication Union (ITU) is responsible for coordinating the dissemination of time and frequency signals and making relevant recommendations;

noting that

- Resolution A4 (1991) of the IAU has defined in Recommendations 1 and 2 a system of space-time coordinates for the Earth (Geocentric Reference System) within the framework of General Relativity, and has named its time coordinate Geocentric Coordinate Time (TCG) in Recommendation 3;
- Resolution A4 (1991) of the IAU further defined in Recommendation 4 another time coordinate for the Geocentric System, Terrestrial Time (TT), differing from TCG by a constant rate, the unit of measurement of TT being chosen so that it agrees with the SI second on the geoid;
- Resolution B1.9 (2000) of the IAU re-defined TT to be a time-scale differing from TCG by a constant rate: $dTT/dTCG = 1-L_G$, where $L_G = 6.969290134\times10^{-10}$ is a defining constant chosen to conform to the value $W_0 = 62636856\ m^2s^{-2}$ for the gravity potential on the geoid that was recommended by the Special Commission 3 of the IAG in 1999;

- the re-definition of TT in 2000 introduces an ambiguity between TT and TAI because the CCDS stated in 1980 that TAI has "*the SI second as realized on the rotating geoid as the scale unit*" so that TAI can be considered a realization of TT only as much as the above W_0 value represents the gravity potential on the geoid;

clarifies that

- TAI is a realization of TT as defined by IAU Resolution B1.9 (2000); it is a continuous time-scale produced by the BIPM based on the best realizations of the SI second;
- in the transformation from proper time to TAI, the relativistic rate shift is computed with respect to the equipotential $W_0 = 62636856\ m^2s^{-2}$ of the Earth's gravity potential, which conforms to the constant L_G defining the rate of TT;
- as stated in the IAU Resolution A4 (1991), TT-TAI = 32.184 s exactly at 1977 January 1, 0h TAI in order to ensure continuity of TT with Ephemeris Time;
- UTC is the unique time-scale for international reference and the basis of civil time in most countries; it is produced by the BIPM based on TAI;
- UTC is to be considered as a "modified" version of TAI, from which it differs by an integral number of seconds;
- users can estimate UT1, the time derived from the rotation of the Earth corrected for the effects of polar motion, through the predicted value of the difference UT1-UTC named DUT1; |DUT1| should presently not exceed 0.8 s through a process of insertion of leap seconds to UTC, described in Recommendation ITU-R TF.460-6;
- the International Earth Rotation and Reference Systems Service (IERS) is responsible for determining the value of DUT1 and announcing leap second insertion; users can also retrieve values of UT1-UTC from the IERS;
- UTC is also a means of dissemination of the standard of frequency; however this function is limited to intervals that do not contain leap seconds;
- traceability to UTC is obtained through its local real-time realizations UTC(k); they are maintained by institutes "k" contributing data to the calculation of UTC;

recommends the following definitions of TAI and UTC

- International Atomic Time (TAI) is a realization of Terrestrial Time (TT) as defined by the IAU Resolution B1.9 (2000) with TT-TAI = 32.184 s exactly at 1977 January 1, 0h TAI; TAI is a continuous time-scale produced by the BIPM based on the best realizations of the SI second;
- Coordinated Universal Time (UTC) is a time-scale produced by the BIPM, based on TAI. UTC has the same rate as TAI, but differs from TAI by an integral number of seconds. The procedure for UTC adjustment is described in an ITU Recommendation. The difference TAI-UTC is published by the BIPM.

and further recommends that

- all relevant unions and organizations consider these definitions and work together to develop a common understanding on reference time-scales, their realization and dissemination with a view to waive the present limitation on the maximum magnitude of DUT1 so as to meet the needs of the current and future user communities.
- that all relevant unions and organizations work together to further improve the accuracy of the prediction of DUT1 and the method for disseminating UT1 and DUT1 to satisfy the future requirements of the users.