



Discussion on the separation of calendar units and units of time metrology

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Abstract: On the 27th General Conference of Weights and Measures (CGPM) in 2022, the resolution on the use of UTC and its future development was adopted. The current rule inserting leap second by calculating the difference between UT 1 and UTC is no longer a compulsory requirement. With regard to time rules, calendar units and time metrology units are two types of time units. And this conference marks a new beginning with them separated. Time rules are set to achieve time unification and three elements are included: time unit, time epoch and time calendar. The calendar defines different periods of time such as day, week, month and year on the earth ground. It also defines rotation cycles of celestial bodies and its specific intervals. A more universal definition of calendar is the law of cumulative carry of time units, mainly related to the periodic changes of nature events. Calendar unit refers to the periodic interval of events, and stable periodic intervals can be used as the unit of time. We use calendar to differentiate these periods, and to coordinate the scale by inserting leap seconds or leap year, such as day, week, month, year, and century to better serve the life and work of human beings. More than 60 years ago, the unit of the calendar was also used as the unit of time metrology. The unit of time second was defined as $1/86400$ of the mean average of a solar day or $1/31\,556\,925.974\,7$ of the return year of the Earth revolution, tracing the unit of time to the cycle of celestial motion. Since 1967, the 13th CGPM defined SI second, tracing time metrology unit to the frequency of radiation of cesium-133 atom, which is no longer irrelevant with celestial motion. Then, calendar units were no longer used as time metrology units. The two types of units are practically separated. SI seconds, represented on the geoid, is irrelevant with the earth's rotation cycle and its rotation cycle around the sun. The latest discovery shows that the earth's rotation is slowing down irregularly. To solve this problem caused by the separation of the two units, and to further synchronize universal time (UT1) with atomic time (TAI), the Coordinated Universal Time (UTC) was introduced on January 1st 1972. Leap seconds are inserted to coordinate the two types of units. Since the first separation in 1958, and the coordination in 1972, the two types of units will be separated again in 2026 when the CGPM resolution is scheduled. When comes to space metrology, if the calendar units describing the periodic motion of the celestial bodies are separated from the unit of time metrology, calendar rules based on their own motion of celestial bodies will a more favorable choice. And this will be a calendar based on its local time table. A temporal uniform approach on other bodies other than Earth will no longer be subject by the standard time limit of Earth's geoid, or calendar units such as year, month and day. Therefore, the re-separation of the two time units provides favorable environment to develop time rules in outer space as mentioned in theory of space metrology, which will promote the research of new fields, such as the Mars calendar, Mars local time, lunar calendar, lunar local time, and etc.

Key words: spatial measurement, calendar, unit of calendar, time rule, time measurement, unit of measurement, Mars calendar