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ADAPTED UNIVERSAL TIME—STRETCHING THE DAY BY MILLISECONDS USING LETTER TIME FORMAT

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Adapted Universal Time (UTA) is proposed as a new uniform timescale system designed to work in conjunction with Coordinated Universal Time (UTC). Leap seconds create a discontinuity that certain computer systems have had difficulties in handling. UTA eliminates this problem by adding to each day miniscule time durations called a Mean Stretch Adjustment (MSA), which are daily increments. This daily MSA value, calculated to a precision of nanoseconds, completes an assessed Length of Day (LOD). This UTA improvement to UTC was initially inspired by Google's "Leap Smear" adjustment. UTA uses Letter Time Format where hours are indicated with letters instead of numbers which is based on Sanford Fleming's Cosmopolitan Time, UTA's timescale runs uninterrupted in the background for POSIX-like computer systems for NTP (Network Time Protocol) interoperability synchronization. UTA keeps UTC as the official civil time standard with its current 24-hour time format and occasional leap seconds, while computer internet servers follow UT1 running on UTA's stretched time.

INTRODUCTION

Leap seconds are added occasionally in Coordinated Universal Time (UTC) when astronomical observations of the Earth's rotation deem it necessary. Leap seconds are needed because there are slightly more than 86,400 SI seconds in one mean solar day. However, leap seconds have become problematic especially in recent years because they introduce a discontinuity for computer communication systems across the world. Internet servers have problems with processing the time stamp on documents or commands and this incompatibility is what needs to be resolved. A proposed solution that has gained significant popularity in recent years is to eliminate leap seconds entirely, letting UTC effectively be decoupled from UT1 for a period of many years, only to be corrected with a leap minute or even a leap hour. But such a change would break the long tradition of maintaining civil time to within a close tolerance of the mean day, a practice that has been particularly meaningful to the global community of astronomers.

Attributes of an ideal solution would include a time standard that introduces no discontinuities while closely maintaining a stable atomic time reckoning to the Earth's rotation. One standing solution to accomplish this is to redefine the second so that it once again fits exactly to $1/86{,}400^{th}$ of one mean solar day which is a strategy that would require a redefinition of the second based on date. The proposed system of Adapted Universal Time (UTA) compensates for this change to keep alignment of time with our apparent motion about the sun.

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In the name Universal Time, the word "universal" carries the connotation of one version applicable to all. It does not imply that it be used as the universe's time. The style of the name and its acronym "UTA" derive from the naming convention for Coordinated Universal Time, or UTC.

Adapted Universal Time has been created as the uniform time scale system that follows atomic time without discontinuities while maintaining alignment with UT1. UTA increases the length of each day by a set number of milliseconds, introducing the interval known as the Mean Stretch Adjustment (MSA) and adding it to the end of each day. This approach was originally inspired by the Google strategy for smoothing out leap second discontinuities.[1] Leap seconds are never needed because UTA is an official lengthening of the day to a duration that is slightly longer than 24 hours. An example, the UTA's day lasts approximately 86,400.002 SI seconds on average.

LETTER TIME FORMAT

UTA re-introduces the practice of marking hours with letters, akin to the proposal made by Sir Sanford Fleming in the late 1800's in a system he called "Cosmopolitan Time".[2] Under UTA this practice is called Letter Time Format (LTF) where hours are designated with the sequential letters in the arrangement of the ASCII Modern Roman alphabet as an ordinal method to count 25 successive instances. The 24 letter-hours "A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X" each consist of exactly 3600 seconds. These letter-hours are denominated as "lours" with "A" being the first lour of the LTF's day. This use of LTF will serve to make the UTA time format clearly distinct from UTC. Computer terminals and electronic devices that display the time of day can display LTF as a universal time for the entire world. LTF offers the significant advantage of giving no special status to any one particular time zone which is unavoidable when using of number-hours because of it coinciding as a local time.

Following an alphanumeric descending order, LTF uses the letter-hour followed by the two digits for minutes, and then the two digits for seconds* immediately followed by a decimal period with up to three places for a millionth of a second representation (Figure 1).

A34 56.789

Figure 1. LTF sample time expressing lour A, with 34 minutes, and 56.789 seconds.

An additional twenty fifth lour "Y" consists of a brief interval that includes the Mean Stretch Adjustment (MSA) which is calculated with nanosecond precision with a typical value serving to stretch the day on a represented order of milliseconds to fit closely with the day of UT1.† The optimal value of the MSA will be generated by an algorithm that will be agreed upon by an authorized body of experts. The same MSA value may be used for a long period of time until a newer agreed upon value replaces it. Optimally the MSA value should be evaluated on a daily basis. Because the MSA is the mean of a large pool of historical UT1 data values it is rather stable. If the planet were to continuously accelerate for several decades then the MSA would tend towards zero. This would make the LOD of UT1 equal to UTC and there would be no need for an MSA or

* ISO 8601 hour defined as 3600 seconds and minute defined as 60 seconds.

† The latency and accuracy of MSA corrections will be a direct function of the latency and accuracy in the obtaining and processing of UT1 data.

a leap second. The MSA would never be a negative value. An alternative representation of LTF adds the local time zone hour (Figure 2).

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Figure 2. Alternative LTF sample local time representation. The first two digits are the local hour 12, followed by lour A, with 34 minutes, and 56.789 seconds.

UTA sets the length of day to 86,400 seconds plus the MSA value, for example 86400.002 SI seconds. Or more generally, by equation (1):

$$LOD_{UTA} = 86{,}400 \text{ seconds} + MSA \quad (1)$$

For civilian timekeeping UTC can continue the practice of inserting leap seconds. UTA adoption will require a significant period for software and hardware verification and validation in order to build confidence in a smooth transition to a new timescale system. To properly administer the full rigor of UTA timekeeping, computer software must include an algorithm that is able to process a record of the latest MSA daily values and have a value relayed from UT1 to calculate the new MSA of the day and appended this time stamp to digital documents. UTA's magnitude of accuracy will be dependent on the obtaining of a UT1 daily value from the IERS but it may be envisioned to have the calculation down to a second.

CONCLUSION

Changing the way humans reckon time is challenging. We have become familiar with the telling of time in a standardized set way that is known throughout the world. Sir Sanford Fleming proposed telling time with letters instead of hours, a method that would be uniform for everyone around the world. While he may have been more than a century ahead of his time in an era that was needing to fix a problem of timing in railroad technology, his solution is needed in the current era that is working to fix a problem with the more modern application of computer network communication technology.

UTA is proposed as the solution for providing a time standard to be used by computer servers across the world in a manner that eliminates discontinuities while keeping atomic time closely aligned to earth rotation time. The advantages of UTA may prove to be superior to UTC for civil timekeeping as well.

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ABBREVIATIONS, ACRONYMS AND TERMS

ASCII – American Standard Code for Information Interchange

ISO – International Organization for Standardization

IERS – International Earth Rotation and Reference System

LOD – Length of Day

lour – Letter-hour

LTF – Letter Time Format (sequential letter-hours/lours are used instead of numbers)

MSA – Mean Stretch Adjustment

NTP – Network Time Protocol

POSIX – Portable Operating System Interface for uniX (POSIX time is known as Unix time)

SI – International System of Units (from the French: *Le Système international d'unités*)

TAI – International Atomic Time (a very stable weighted average of many atomic clocks)

UT1 – Universal Time, primary (mean solar time calculated from astronomical observations)

UTA – Adapted Universal Time

UTC – Coordinated Universal Time (atomic time periodically aligned to mean solar time)

REFERENCES

[1] http://googleblog.blogspot.in/2011/09/time-technology-and-leaping-seconds.html

[2] Papers on Time-Reckoning and the Selection of a Prime Meridian, Fleming, Sanford, Sir