Time Scales: UT1 vs. UTC
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Time Scales: UT1 vs. UTC

While UTC is derived from the coordinated atomic times provided by the atomic clocks operated by a number of metrology institutes in different countries all over the world, UT1 is the time associated with the real motion of the Earth.

The motion of the Earth is continuously monitored by the Earth Orientation Center located at the SYRTE observatory at Paris, France, which is an organizational unit of the International Earth Rotation And Reference Systems Service (IERS).

The Earth's motion is less constant than the atomic time scales, and also the exact location of the North Pole and South Pole is slowly moving around (polar motion), so the real length of a day (LOD) varies a little bit each day.

The accumulated variations in the length of day cause a slowly varying time difference between UT1 and UTC, which is also called DUT1. Whenever the absolute value of DUT1 gets close to 1 second, a leap second is inserted into the UTC time scale to make sure DUT1 stays less than 1 second, so the atomic time scale UTC stays roughly synchronized to the earth rotation represented by UT1.

A summary including current leap second information as well as a graphs of the development of the length of day and the polar motion over time can be found at the EOP's web page:


The long-term development of UT1 and UTC compared to the common atomic time scale TAI are shown as graph here:

http://hpiers.obspm.fr/eop-pc/earthor/utc/leapsecond.html

Since the Earth spins by 360° per day, UT1 is often also interpreted as a rotation angle, and is used in many scientific fields like geodesy, astronomy, and geophysics. For example, astronomers use UT1 to be able to point their telescopes to specific regions of the sky and space.

EOP And DUT1 Information Sources

Measurements results and evaluations from the IERS' EOP division are made available as bulletins. An overview can be found here:

https://www.iers.org/IERS/EN/Publications/Bulletins/bulletins.html

Specifically, Bulletin A, Bulletin B, and Bulletin D provide information on the Earth orientation and DUT1, while. Bulletin C is used to publish leap second announcements.

A list of available versions of Bulletin A can be found here:

https://datacenter.iers.org/availableVersions.php?id=6

It's possible to plot the development of a bunch of measured EOP parameters online:

https://www.iers.org/IERS/EN/DataProducts/EarthOrientationData/eop.html

Here's a plot of the development of DUT1 over time:
DUT1 Dissemination

Services by NIST

Several time dissemination services operated by NIST (the U.S. metrology institute) also include information on DUT1, usually with 0.1 s resolution. Those services include the radio stations WWV, WWVH, and WWVB as well as the telephone modem service ACTS. See: [https://www.nist.gov/pml/time-and-frequency-division/atomic-standards/leap-second-and-ut1-utc-information](https://www.nist.gov/pml/time-and-frequency-division/atomic-standards/leap-second-and-ut1-utc-information)

NIST also operates NTP servers that deliver **UT1 instead of UTC**: [ut1-time.colorado.edu](http://ut1-time.colorado.edu) and [ut1-www.nist.gov](http://ut1-www.nist.gov).

These servers seems to have quite strict access restriction. If too many requests are received from the same IP address then requests may simply be dropped, and no reply is sent to the client. Care must be taken if several clients poll the NIST UT1 NTP server from behind a NAT firewall: for the server this looks as if all requests are sent from the same (public) IP address, and thus some client services may not see any replies at all.


In June 2016 this service has been announced officially by the IERS: [https://datacenter.iers.org/data/2/message_303.txt](https://datacenter.iers.org/data/2/message_303.txt)

Service by MSF

Also the longwave transmitter MSF operated by the UK's National Physical Laboratory (NPL) provides DUT1 data. Details can be found in this PDF: [http://www.npl.co.uk/upload/pdf/MSF_Time_Date_Code.pdf](http://www.npl.co.uk/upload/pdf/MSF_Time_Date_Code.pdf)

Related Details

IERS Bulletin A is also encoded in a different format used by some astronomer software: [http://maia.usno.navy.mil/ser7/mark3.out](http://maia.usno.navy.mil/ser7/mark3.out)

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