Who says it's lunchtime?

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1pm Wed 20 October 2004

Time

What is time all about?

second: In the International System of Units (SI), the time interval equal to 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.

For scientists that's usually as far as it goes, but what do *ordinary* people make of time?

> It's that incredibly useful stuff that we all use to stop every thing happening at once.
> — Jeff Rosson

Mostly time is used for ordering our lives, not measuring how long has passed between events.

I want to look at this while avoiding the profound issues.

If a job application must be in by 5pm, how do you know when that is?

Time In Ireland

1880	GMT in England, DMT in Ireland
1916	assimilated with GB
1925	Western-European Time (minister of justice)
1968	Standard Time (GMT+1)
1971	Changed mind
1986	Order giving effect to EEC directive
2001	2000/84/EU directive currently in force

All in terms of GMT. What is GMT?

GMT

Greenwich Mean Time: Mean solar time at the Greenwich Meridian.

Note the word solar — days are related to the sun!

GMT used to be measured from noon (00:00GMT) to noon. In 1925 they moved to starting the clock at mid-night.

Universal Times

Sidereal Time is measured against a point in the sky, the catalog equinox. You can find out the local sidereal time by measuring where a star is in the sky and then looking it up in a catalog. The sun isn't important here.

Universal Time is calculated from sidereal time using a formula (which is periodically updated).

$$86636.55536790872 + 0.000005098097T + 0.000000000509T^2$$

(A day is usually 86400 long).

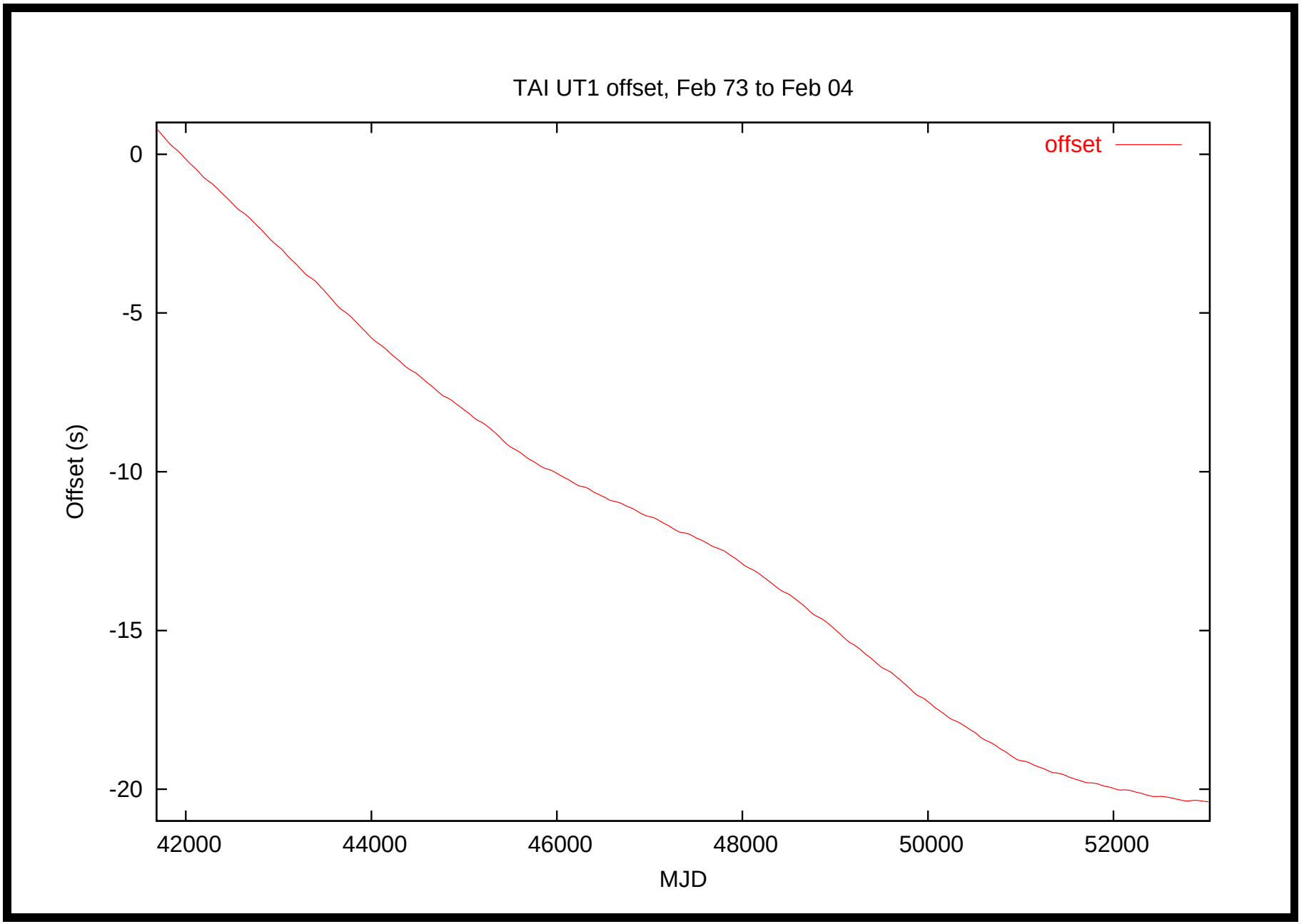
TAI and UTC

International Atomic Time has been available since 1955 (officially since 1972). Uses SI second.

Problem is that UT seconds and SI seconds are different.

Coordinated Universal Time is a compromise. It ticks once per SI second, in sync with TAI.

If UTC is more than one second from UT1 then a leap second is introduced.


TAI UT1 offset, Feb 73 to Feb 04
offset
0
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Offset (s)
42000
44000
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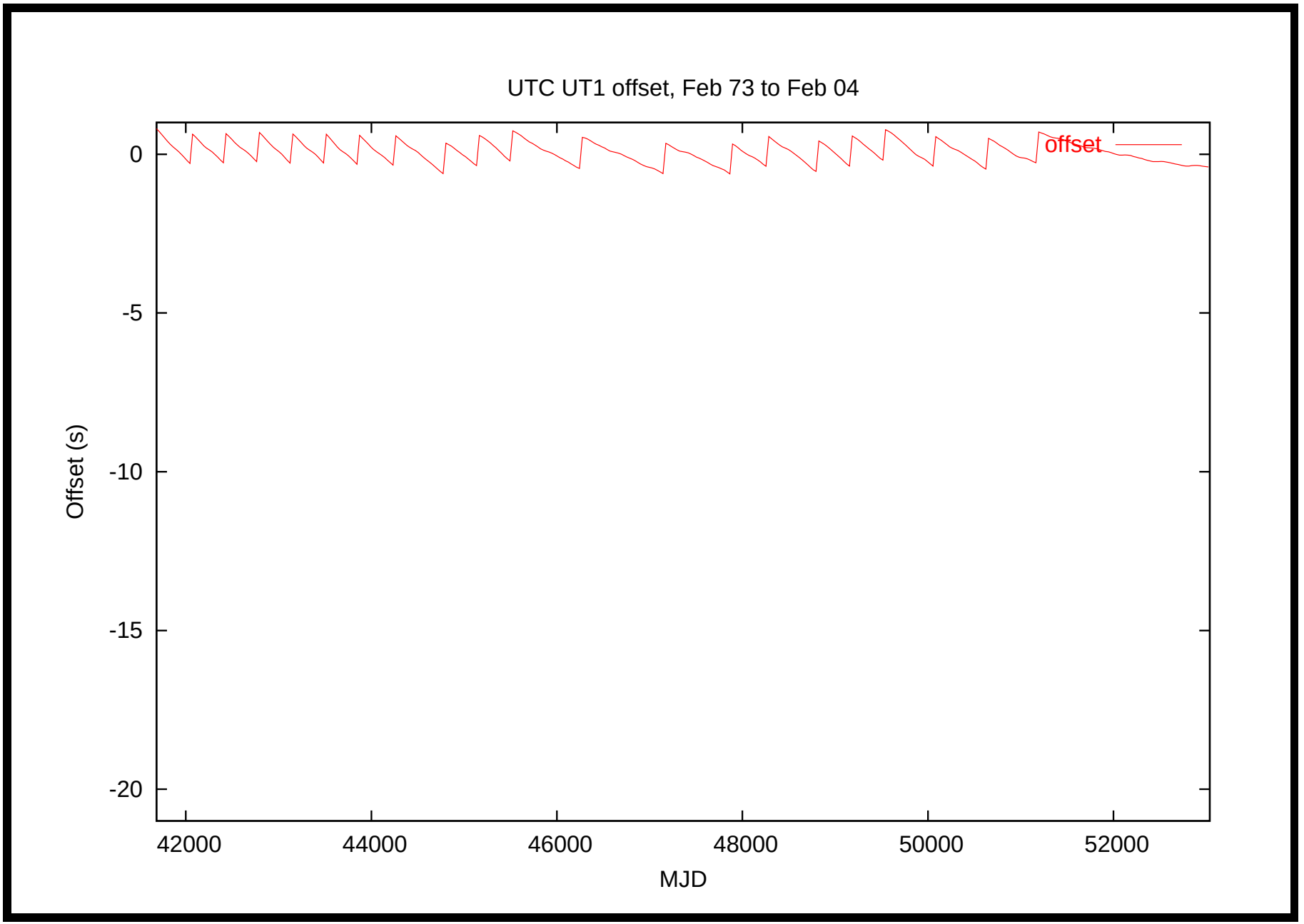
MJD


UTC UT1 offset, Feb 73 to Feb 04
offset
0
-5
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-15
-20
Offset (s)
42000
44000
46000
48000
50000
52000
MJD

Years

Days in sync with mean sunrise.

Years in sync with seasons.

The time of year: angle between earth's axis and the line from the earth to the sun.

NB: seasons nothing to do with distance to sun. Earth is at its closest (Perihelion) about 2^{th} January 2004.

Current aim of our calendar: Keep the vernal equinox near 21^{st} March.

The length of the year isn't a whole number of days (365.24219), which causes complications.

When	Calendar	Length
????	old roman	£££
45BC	Julian	365.25
1582AD	Gregorian	365.2425

It's hard to get the length right when you can't write it down.

Counting Years

We now count years from the (supposed) birth of Christ.

Dionysius Exiguus (AD 523) was asked to produce table of Easter Dates.

Unfortunately, Herod died in 4BC, so Dionysius probably got it wrong.

BC dating came somewhat later, along with the missing year zero.

Before that dates were counted since the founding of Rome. 1AD = 754AUC (ab urbe condita).

Hours, Minutes and Seconds

Pretty arbitrary divisions of a day. They arise by dividing things into 12 and 60.

Weeks and Months

7 day week is very old. Used by Romans and Jews.

English	French	Planet
Monday	lundi	Moon
Tuesday	mardi	Mars
Wednesday	mercredi	Mercury
Thursday	jeudi	Jupiter
Friday	vendredi	Venus
Saturday	samedi	Saturn
Sunday	dimanche	(Sun)

Months supposed to be in sync with the moon (29.5305889 days)? Other calendars are better in this respect.

Easter

Easter Sunday is the first Sunday after the first full moon after vernal equinox. Which full moon and equinox?

$$
\begin{aligned}
G &= Y \mod 19 \quad \text{Golden Number} \\
C &= \frac{Y}{100} \quad \text{Epact} \\
H &= (C - \frac{C}{4} - \frac{8 * C + 13}{25} + 19 * G + 15) \mod 30 \\
I &= H - \frac{H}{28} * (1 - \frac{H}{28} * \frac{29}{H + 1} * \frac{21 - G}{11}) \\
J &= (Y + \frac{Y}{4} + I + 2 - C + \frac{C}{4}) \mod 7 \\
L &= I - J \\
\text{Month} &= 3 + \frac{L + 40}{44} \\
\text{Day} &= L + 28 - 31 * \frac{\text{Month}}{4}
\end{aligned}
$$

Julian Day Number

Another way of counting days avoiding BC/AD problems. Cycle of 7980 years. JD 0 designates the 24 hours starting noon UTC on 1 January 4713 BC.

Today is Julian Day 2453299.5. Last talk was Julian Day 2452018.5. Today's MJD is 53299.

Why start then? Why 7980 years?

A combination of Indiction, Golden Number and Solar Number ($\mathrm{lcm}(15, 19, 28) = 7980$).

Friday the Thirteenth

Solar Number counts what part of the 28 year year/weekday cycle we are in for the Julian Calendar.

$$\text{lcm}(365 * 4 + 1, 7) = 28\text{years}$$

What about the Gregorian Calendar?

$$\text{lcm}(365 * 400 + 97, 7) = 400\text{years}$$

So there is room for bias!

Sunday	687	Monday	685
Tuesday	685	Wednesday	687
Thursday	684	Friday	688
Saturday	684		

Daylight Saving

Introduced in 1916 to save energy during the war. Double summer time was used during the second world war.

Now EC uses last Sunday in March/October. Americans use first Sunday of April and last of October.

EU report covering agriculture, environment, energy, health, leisure, road safety, transport and communications.

Seems to be quite an emotive issue.

Sources of Time

Speaking Clock Ever dialed 1191?, Signal from Rugby and oven oscillator.

ESB Mains at 49.9–50.1Hz, Out by $< 5s$ vs Rugby.

Pips Set against Rugby.

NTP Set against Rugby.