Why is it 20:00:00, Wednesday 2\textsuperscript{nd} November 2011?

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2011-11-02 20:00:00 GMT
2011: The Year

Seasons: Weather cycles, days lengthen and shorten.

Aim of our calendar: Keep Equinoxes and Solstices at the right time of year, especially the vernal equinox.
Tricky: year isn’t whole number of days (365.24219).

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 5^{th} January 2012.
Counting Years

Count years from the (supposed) year of Christ’s birth.

Dionysius Exiguus (AD 523) produced table of Easter Dates.

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

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

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

Need bigger division of years than just days. Moon’s phases is next most obvious thing in the sky.

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

We’ve ended up with funny months.

Story says Romulus gave 10 months, a successor added 2 more.
## Julian Reform

<table>
<thead>
<tr>
<th>Month</th>
<th>Days</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ianuarius</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>Februarius</td>
<td>28</td>
<td>28/9</td>
</tr>
<tr>
<td>Martius</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Aprilis</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Maius</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Iunius</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Quinctilis</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Sextis</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>September</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>October</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>November</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>December</td>
<td>29</td>
<td>31</td>
</tr>
</tbody>
</table>

Old leap: Cut Feb at 23/24, intercal of 27 days, irregular.
Took a 445 day year, and some fumbling to get there.
Aiming for 365.24219 day year.

<table>
<thead>
<tr>
<th>When</th>
<th>Calendar</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>45BC</td>
<td>Julian</td>
<td>365.25</td>
</tr>
<tr>
<td>1582AD</td>
<td>Gregorian</td>
<td>365.2425</td>
</tr>
<tr>
<td>355 ± £££</td>
<td>old roman</td>
<td></td>
</tr>
</tbody>
</table>

**Wednesday: Day of Week**

7 day week is very old. Ptolemaic week by Romans and biblical week by Jews.

<table>
<thead>
<tr>
<th>Portuguese</th>
<th>English</th>
<th>French</th>
<th>Planet</th>
</tr>
</thead>
<tbody>
<tr>
<td>domingo</td>
<td>Monday</td>
<td>lundi</td>
<td>Moon</td>
</tr>
<tr>
<td>segunda-feira</td>
<td>Tuesday</td>
<td>mardi</td>
<td>Mars</td>
</tr>
<tr>
<td>terça-feira</td>
<td>Wednesday</td>
<td>mercredi</td>
<td>Mercury</td>
</tr>
<tr>
<td>quarta-feira</td>
<td>Thursday</td>
<td>jeudi</td>
<td>Jupiter</td>
</tr>
<tr>
<td>quinta-feira</td>
<td>Friday</td>
<td>vendredi</td>
<td>Venus</td>
</tr>
<tr>
<td>sexta-feira</td>
<td>Saturday</td>
<td>samedi</td>
<td>Saturn</td>
</tr>
<tr>
<td>sábado</td>
<td>Sunday</td>
<td>dimanche</td>
<td>(Sun)</td>
</tr>
</tbody>
</table>

Obviously, it gets dark and bright once per day!

Different cultures start days at: sunset, sunrise, midnight, midday, ...

Must be something to do with Earth going around.

Solar vs. sidereal days.
Hours

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

Were very uneven. Gradually fixed (14C).

Came to us via monastery and Roman army.

In 7C, lots of subdivisions, by middle ages we have *minutae primae* and *minutae secondae*. 
Irish Legal time

Problem with midnight — it depends where you live.

In 1792, move from apparent time to mean time.

In 1858, case law chooses local time.

In 1880, legislation fixes GMT in England, DMT in Ireland.
Dunsink Observatory made measurements.
Usher: 25m7–48s (1787).
Brinkley: 25m22s (1832).
Romny-Robinson: 25m21s (1838).
Legal Time Since

1916 Move to GMT with GB
1916 Daylight saving
1923 Western-European Time
1968 Standard Time (GMT+1)
1971 Changed mind?
1986 Order giving effect to EEC directive
2001 2000/84/EU directive currently in force

In this Act the expression ‘West-European time’ means Greenwich mean time.
Seconds: Universal Time

All in terms of GMT. There’s a problem...  
... GMT is dead!

*Universal Time* is calculated from sidereal time (now ERA) using a formula like this:

\[ 86636.55536790872 + 0.000005098097 T + 0.0000000000509 T^2 \]

(A day is usually 86400 long).
Atomic Seconds

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

**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.
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 UTC is adjusted.
UTC UT1 offset, Feb 73 to Oct 11

Offset (s) vs. MJD
Pros and Cons

- Keeps UTC in sync with mean day.
- Preserves legal status-quo.
- Needed by astronomers and navigators.

- Subtracting dates is hard or impossible.
- Makes software more complex.
- Misapplication could be dangerous.
Final Story

Can you copyright a timezone?