USING CO-ORDINATED UNIVERSAL TIME

Welcome to a discussion of UTC, Co-ordinated Universal Time. All over the world at a given moment, it is the same time—UTC—instead of different times determined by time zones. UTC refers to standard time in Greenwich England. (The UTC clocks on this site are explained here.)

Currently, with time zones, 22:00 (in the 24-hour system) is intended to mean approximately 2 hours before local midnight in each of them. Under UTC, because there are no time zones, 22:00 may mean any sun position. In London it would be about 2 hours before local midnight. In Reedsburg Wisconsin, longitude 90° west, 22:00 would occur a quarter-day earlier with regard to sun position. In Manikganj Bangladesh, longitude 90° east, it would occur a quarter-day later.

Consequences of using UTC
Here are some results of using UTC only. (Questions that arise are indicated in Italics.)

1. We no longer have to determine which time zone a person is in some hundreds or thousands of kilometres away, or what time it is there, because it's the same as ours. We no longer have to deal with who has daylight saving time and when.

The corresponding disadvantage is that we don't know, for a given place, what (for example) 22:00 means. But, as will be seen, it's easy to find out.

2. Especially for people who travel at high speed (e.g. by plane), frequently, or over long distances, UTC makes sense. Indeed, aviation uses UTC internally, as does meteorology, because to rely on time zones for airplanes in flight, or for moving weather systems, is awkward and likely to produce confusion or error.

Travellers leaving Paris at 11:00 for an 8-hour flight to New York simply plan to arrive at 19:00. There's no guessing how long a flight is by having to find out the time difference first.

3. Computer programmers no longer have problems knowing at what time certain events occur when working on systems running in distant places, which is very common. Messages sent over the Internet are stamped in an unambiguous time, independent of where they are sent from, transmitted, or received.

4. Day cycle and date no longer match. The date changes everywhere at the same time, 00:00 UTC. The day, however, may still last 24 hours from one midnight to the next, or (if we prefer) one noon to the next, both of which are local.

In many places people find their day changing its date during their waking or working hours. In Beijing, local midnight is about 16:15 UTC; in Sydney Australia, it's about 13:55. In the former, urban people might start work at 00:00 or 01:00; in the latter, at 22:00 or 23:00.

Necessarily, a person's day and its events start at a time determined by longitude. That may seem arbitrary. *But how hard is it to start work or something else recurring on one date and stop on the next?*

5. *How might the world's religions adapt to UTC?*

More issues and questions

6. *Do the names of the days of the week change with the date, or do they follow the local sun?* If the latter, in most places a day of the week awkwardly spans two dates, and a date likewise spans two days of the week. The names of the days may therefore not be usable for distant communication unless they are tied to dates.

In most places, that has a particular consequence if we think in phases of the day, specifically *overnight, morning, afternoon,* and *evening*. In Melbourne, Monday's morning phase starts at about 20:20 UTC and becomes Tuesday morning with the date change at 00:00. *How would that be handled, in practice?*

7. *How hard is it to determine holidays, birthdays, and the like?* Their dates remain. Only their 24-hour period shifts, for most people. If the date changes early in the morning phase, as it does in Perth Australia (about 1¾ hours into it), at about the time a person wakes up, she may start enjoying a special date. In Warm Springs Nevada, the date changes about 1¾ hours before evening.

For legal reasons, adoption of UTC might not allow change of a person's birth date or year, although Russians managed it when they adopted the Gregorian calendar in 1918. Some events would have to move to remain on the date they were on with time zones. A person born on January 29 at 19:00 in Ancaster Canada would find that time on that date becoming about 00:20 UTC on January 30. *Is the time relatively unimportant, making the better option to move it but keep the date?* People may have been born under standard time that became DST on their date, or they may now live in a different time zone altogether, or they may not even know what time they were born. *Despite all that, to when should a birth time be moved?*

8. Presumably UTC would be declared at 00:00 UTC on a January 1. For people at a negative longitude, that would shorten December 31; for the others, it would lengthen it. In Honolulu, December 31 would last about 13½ hours, and in Auckland, a little more than 36½ hours. *How might the change be handled?*

9. Currently, China is on only one time zone despite its width implying five. It uses Beijing time everywhere, including in one time zone to the east and four to the west. Apart from political considerations, people in western China on Beijing time may not have trouble experiencing local midnight at about 04:00 current Chinese time. *In principle, is that a problem? If not much of one, may it simply be converted to UTC and extended worldwide?*

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There have been several UTC clocks on the Internet. They indicate UTC and have a switch or second clock for a computer's local time. But that's insufficient for wider understanding and use of UTC, as the following will show.

Example not using UTC

Suppose we live in New York and want to set up a teleconference for February 22, 2018 for four people, one each in London, New York, Buenos Aires, and Rio de Janeiro. What time do we schedule it for?

We need to know a few things: which time zones the cities are in, whether they use daylight saving time (DST), and if they do, whether they've started or gone off it by February 22. Serious checking is needed to find out this set of disparate data:

London	Greenwich Mean Time (UTC), not on DST (UTC+1 hr) yet
New York	Eastern Standard Time, UTC-5 hrs, not on DST (UTC-4 hrs) yet
Santiago	Chile Summer Time (DST), UTC-3 hrs, probably not off it yet
Rio de Janeiro	Brasilia Time, UTC-3 hrs, has just gone off DST (UTC-2 hrs)

Suppose we then have to reschedule the teleconference for one month later. We must check everything again, because this is the period when clocks change in some of these places. As of March 22, London is about to go on DST, New York is on it already, Santiago is probably still on DST, and Rio de Janeiro is still off it.

The South American cities are two time zones apart geographically but for about five months of the year operate on the same time (UTC-3 hrs, as above), because Santiago's daylight time is the same as Rio's standard time, and that's how much their use typically overlaps.

Preliminaries to UTC

The foregoing illustrates why we can't often guess a place's local time. Even though time zones are theoretically an hour wide, many are larger or smaller, many don't have borders where they should be by longitude, and some diverge from what we'd expect by 15 minutes, 30 minutes, or an hour or more. Some areas change their time zone or DST rule suddenly or frequently, causing uncertainty about what their local time is or will be.

In addition, because the date currently changes at each zone's midnight, some places are on a different date simultaneously. On the two sides of the International Date Line, the time is the same but the dates differ by 1. For 2 hours every day, Earth has 3 simultaneous dates, because of irregularities created by some areas in the Pacific Ocean.

Clearly time zones the way they are applied now are often inconsistent and difficult to deal with, likely to be inefficient or to induce error. The figuring for our teleconference would be much easier if time zones were applied rigidly according to longitude and with no DST, but that's not possible. The only way to solve the problems of time zones is to get rid of them and use UTC.

Time zones put distant people on different times simultaneously, with a given sun position being approximately the same time when it occurs in different zones. UTC bands (more about them below) do the opposite: distant people are on the same time simultaneously, with a given sun position being a different time when it occurs in different bands. *Is UTC better?* Probably, although that's still uncertain.

To see how it works, we need offsets from UTC in 24-hour format. The offsets are the UTCs that indicate the nominal local midnight and noon, the two offsets necessarily being 12 hours apart. They may also be said to begin the local day's overnight phase (O) and its afternoon phase (A). (As indicated earlier, the other two phases are morning and evening.)

Because time zones of an hour are rather wide in most of the inhabited areas of the planet and an hour is a big change, we'll use time bands of 15 minutes. They're not zones, because everyone is on the same time. They merely indicate when local midnight or noon is in UTC for each location, with a difference of only 15 minutes on crossing a border of a band. We'll convert minutes to fractions of an hour in calculations, because the hours/minutes division into 60 just gets in the way.

Example using UTC

We start by putting the longitude of each location into the clock and noting the results for the beginning of the afternoon (phase A):

	Longitude in degrees	Phase A (start)
London	-0.1278	12:00
New York	-74.0059	17:00
Santiago	-70.6693	16:45
Rio de Janeiro	-43.1729	15:00

We'll assume that the teleconference will not start earlier than noon minus 3 hours or later than noon plus 9 hours. We may then take the highest offset, subtract 3:00, and see how that time fits. In this example, that gives 14:00, from New York. Therefore, 14:00 may be the UTC for the call. The following shows how far that time is from the local noons:

London	+2 hours from local noon
New York	-3
Santiago	-2.75
Rio de Janeiro	-1

We may also take the lowest offset, add 9:00, and see how that time fits. In this example, that gives 21:00, from London. Therefore, 21:00 may also be the UTC for the call:

London	+9 hours from local noon
New York	+4
Santiago	+4.25
Rio de Janeiro	+6

Any time between 14:00 and 21:00 is within the desired range locally. The time with the least offset for all is the average of the phase A numbers, viz. 15.25 (15:15), to the nearest quarter-hour:

London	+3.25 hours from local noon
New York	-1.75
Santiago	-1.5
Rio de Janeiro	+0.25

Generalities and questions

With UTC, this has taken very little effort. Presumably, everyone makes her/his phase A offset known (on websites, in correspondence, etc.), so that there's no need to look up longitudes and enter those values into the clock. That reduces the steps for finding a common time to a few easy calculations.

Notably, no DST and no irregularities in time zones are getting in the way. In our example, another advantage of using UTC is that all cities are on the same date, because the date changes at 0:00 UTC everywhere.

Fundamental questions arise. *How would time bands, and hence offsets, be determined? Within limits, would individual places be able to declare their own? As with time zones now, would bands in principle be an hour wide, or would there be more bands with smaller time differences, as in the examples above? Even more with even smaller? Would time bands be less important than zones, because everyone is on UTC?*

Those uncertainties aside, comparing the current way to schedule a teleconference across time zones with the method using UTC, we find:

Time zones	UTC, no time zones
Look up time difference from Greenwich	Note phase A offset
Determine whether DST will apply; adjust	---
Convert to times of day	---
Calculate a good time	Calculate a good time
Watch for different dates	---

UTC in dozenal time

Here's the same example using dozenal counting and a dozen trices for the time band (both explained elsewhere on this site). This process is even easier.

	Longitude in degrees	Phase A (start)
London	-0.1278$_d$	600$_z$
New York	-74.0059$_d$	860$_z$
Santiago	-70.6693$_d$	840$_z$
Rio de Janeiro	-43.1729$_d$	750$_z$

Range of desired UTCs: from 460$_z$ to ↊60$_z$. Earliest time: 860$_z$ – 160$_z$ = 700$_z$. Latest time: 600$_z$ + 460$_z$ = ↊60$_z$. Average time: 769$_z$ (15:08 to the nearest decimal/sexagesimal minute):

London	+169$_z$ trices from local noon
New York	-↋3$_z$
Santiago	-93$_z$
Rio de Janeiro	+19$_z$

Another example:

	Longitude in degrees	Phase A (start)
San Francisco	-122.4194$_d$	↊10$_z$
Toronto	-79.3832$_d$	880$_z$
Berlin	+13.4050$_d$	570$_z$
Bengaluru	+77.5946$_d$	350$_z$

Range of desired UTCs: from 460$_z$ to ↊60$_z$. Earliest time: ↊10$_z$ – 160$_z$ = 870$_z$. Latest time: 350$_z$ + 460$_z$ = 7↋0$_z$. In this case, no time works, because the earliest time is 80 trices later than the latest. The desired range is 600$_z$ trices, but the range of phase A offsets is 80$_z$ more.

We may fix that by choosing a time between the two calculation results, i.e. between 7↋0$_z$ and 870$_z$. If we choose half way, the teleconference will be at 830$_z$, implying that the desired range goes from 420$_z$ to ↊↊0$_z$ UTC, with these deviations from local noon:

San Francisco	-1↊0$_z$ trices from local noon
Toronto	-50$_z$
Berlin	+280$_z$
Bengaluru	+4↊0$_z$

Deducting another 20$_z$ trices may also work. A conference time of 810$_z$ will bring San Francisco to -200$_z$ from local noon, and Bengaluru to +480$_z$.

The detailed procedures in these examples are based in simple arithmetic and are easy to work with, especially in dozenals. *Are time zones a bigger problem?* They may not be for those who stay almost always within one or two zones, which means a great many people. *But for those who travel more or communicate beyond their own time zones, may UTC prove better?*

International Date Line

Another question arises from the overhaul that UTC and time bands provide: *should UTC be determined from Greenwich?* Currently the International Date Line (IDL) has many deviations from 180° longitude because it would otherwise split a country or a close group of islands. If we move 0° longitude 11.56470 degrees to the east, that is minimized. By going through Munich, the new 0° provides an IDL that goes only through water from the North Pole to Antarctica except for a small part of one almost uninhabited island.

The IDL might still be considered to determine date changes. If we keep those occurring at midnight in Greenwich or Munich, that would of course be noon 180° away.

In conclusion

UTC remains mostly an idea, used currently for only a few specific purposes. It needs wider use without time zones, and experiments to show or not show its effectiveness.

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