

A Zone of Your Own:

Local Solar Time on a smartphone

John McHugh

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Introduction

This project will produce a smartphone based clock app that can display local solar time (LSoT) as well as one or more standard times including local standard time, local zone standard time (with DST (Daylight Savings Time) as appropriate) and UTC (Universal Coordinated Time). Optionally, the display might include graphically, the position and altitude of the sun relative to its noon / midnight positions.

As can be seen in the essay at the end of this document, standard time is a creature of the 19th century railroads and daylight savings time is a creature of the government. In previous eras, accurate local solar time required careful observations of the noon sun. The Global Positioning System (GPS) provides accurate Universal Co-ordinated Time (UTC) and location information. In combination these can produce accurate local standard time (a longitude based offset from UTC) as well as local solar time where noon always occurs when the sun is highest in the sky. The later requires a seasonal correction to local standard time to compensate for the tilt of the earth's axis.

It is worth noting that the LSoT is exactly the time that would be displayed by a properly designed and installed sun dial. Sun dial time is often called Local Apparent Time (LAT) and the computations to get from UTC to LSoT are the inverse of those needed to get from LAT to the proper local standard time and UTC. See <https://sundialsoc.org.uk/making-sundials/>, <https://equation-of-time.info/>, and similar sources for calculations and explanations.

Project Requirements

The proposed project will develop a clock application for an Android cell phone that displays the local solar (Sun) time based on the location of the phone as determined by the internal GPS and the current time and (possibly) time zone as determined by the cellular network to which it is attached if one is available or from the GPS.

In its simplest form (the minimum for the project to be successful), the app will display a text box containing:

1. A label line saying “LSoT” or “Local Solar Time”
2. A line with the time in 24 hour notation “14:32:15” where the seconds portion is desirable, but not necessary.
3. A line giving the current position of the phone in degrees and fractions of latitude and longitude, “31.35135, -82.44439”

A more complete form might use the full screen of the phone displaying up to 5 time boxes, one in the center and up to four more in the corners. Each box would have a label line and a time line and might contain an additional information line. Possibilities include:

Local Zone Standard Time containing the time and time zone obtained from the phone. This should include the time zone name or abbreviation which should indicate whether DST is in effect, e.g. “EST” or “EDT”

Home Zone Standard Time which is the Local Zone Standard at the location that the owner of the phone considers to be home. The primary difficulty with this case is determining whether DST is in effect at the home location.

Universal Coordinated Time which is the base reference for all zoned times.

Local Solar Standard Time which is a longitude based offset from UTC that does not include the equation of time offsets that account for the tilt of the earth’s axis. This might display both a time and a signed offset in hours, minutes, and (possibly) seconds from UTC.

Zone standard times for specific zones / places which could be useful for users who need to call specific locations and need an easy to keep track of, e.g., the time in Timbuktu. Again, determining whether DST is in effect may be problematic.

Although useful, screens full of text are not very pleasing and adding a graphical background would make the application more attractive and simplify the information transfer. The sun rises in the east, rises to its maximul height in the sky at local noon then sinks in the west. On the days of the equinoxes, the rise is due east at 06:00 LSoT and the set at due west at 18:00 LSoT. We can visualize the sun’s path across the sky as an oval on the rectangular screen of the cell phone with thn noon position an the top, the midnight position on the bottom and the 6 o’clock positions to the right (PM) and left (AM). Hourly markers could appear as “tick marks” along the oval. Rather than adjust the oval’s position to track the seasons, we can adjust the “horizon” splitting the screen into upper day and lower night portions of, say, light and dark blues. In the tropics, the sun may go above the zenith and be in the north at noon in the northern hemisphere (and in the south in the southern). In these cases, we may want a zenith line through the daytime sky. Similarly, in the polar regions, the sun never rises at some times of year and never sets at others, so we may want to make provision for all day or all night screens at some times of year. If we use this kind of graphic as a background, we should be able to put one textual time block in the center of the oval

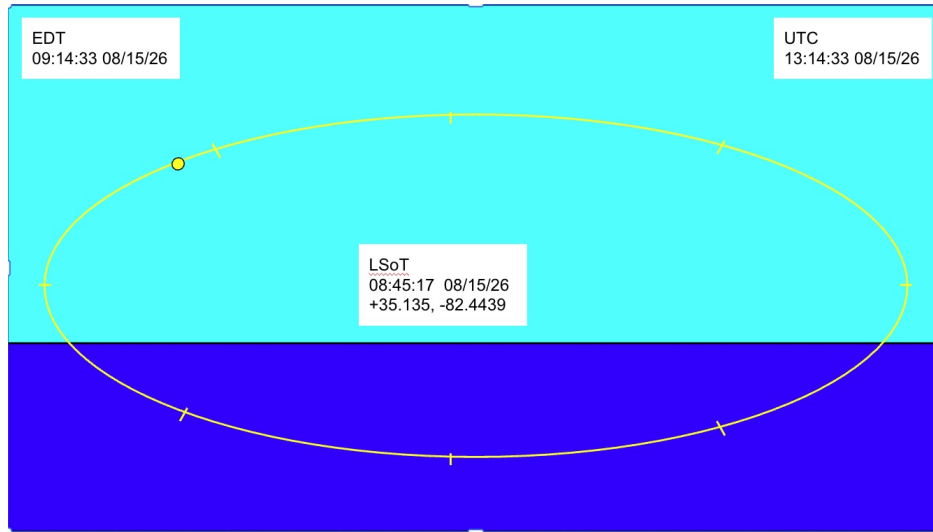


Figure 1: Mockup of a full screen output from the app

and possibly others in the corners. This kind of graphic would make a useful and attractive “Lock” screen for the phone. Figure 1 shows an example with tickmarks at the 0, 3, 6, 9, 12, 15, 18, and 21 hour marks along with time boxes showing LSoT, EDT, and UTC times.

Efficiency and practical issues

For purposes of the app, it is not necessary to perform the full calculation every second, even if seconds are being used. At 60 MPH, a vehicle going north or south will move about 0.015 degrees in a minute. Even at fast commercial aircraft speeds, the difference will be small. Only in the polar regions will the change in longitude be significant at realistic speeds and the meaning of “local” is suspect when the location is changing rapidly. This means that it is probably safe to use a single observed position for as much as a minute or more in computations and use the phone’s internal time (adjusted back to UTC if necessary) for the time input for updates at one second intervals for clock updates. Note that the computationally intensive portion of the LSoT calculation is the equation of time correction which is primarily a slowly varying function of the date.

Showing the time for specific locations or zones is complicated. Sites such as <https://www.timeanddate.com/> have complete lists of time zones defined in terms of their UTC offsets. In addition to the 24 basic zones with hourly offsets, there are a number of zones with offsets that are multiples of 30 or 15 minutes, e.g. Australian Central Western Standard Time (ACWST) is 8:45 hours ahead of Coordinated Universal Time (UTC). The site lists the current rules for DST for zones that use it. It is probably reasonable to assume that the current information will be available to the app when it is in such a zone. If the user wants to track the time in such a zone, it is probably not unreasonable to include a configuration option where the user provides information such as the zone name / abbreviation, the location

to be displayed and the start and end dates for DST. The later might be in the form of things like “First Sunday of October at 02:00” in a suitable encoding.

Logistics

I have a Motorola, Moto G 2022 smart phone running Android that can be used for the project. It has a data only Sim associated with my Google Fi account and can also connect via wi-fi on either band. The team can modify this phone in any way they see fit. I am sending the phone to Professor Stotts so that it will be available to the team at the beginning of the project.

I will be traveling (road trip) from August 26 through September 10. I can be reached via email (mchugh@cs.unc.edu), text or phone (410 858 7048) but I should have internet connections for an initial zoom call during that period. Once I return, I should be available most days. I live in Hendersonville, NC just south of Asheville, but have friends in the triangle area and could come over to meet with the team at some point during the project.

In all cases, the best way to set up an appointment to talk is to send me both a text and an email indicating potential dates and times.

Extensions and future projects

The project could be enhanced and extended in a number of ways. It is unlikely that the current team will have the time and resources to address these, but they might form the basis for one or more future projects.

Other Platforms

The app could be adapted as a home screen or screen saver app for other platforms, notably GPS equipped tabular or laptop computers. The additional screen area of these platforms would allow more detail in the graphical portion of the application and might simplify issues such as determining dates for DST, etc.

Additional Information Display

Additional astronomical and other data could be incorporated into the daily graphic. For example, a lunar orbit could be superimposed on the daily field so that the moon’s position in the sky and phase could be seen, as well. Similarly, the tracks for the brighter planets, Venus, Jupiter, and Mars might be added. This might be particularly useful on tablets or laptops.

A background essay

The following was submitted to the Hendersonville Lightning, a local weekly newspaper in Hendersonville, NC where I live. The editor found it amusing, but did not publish it. At the time, legislation had been introduced that would have made daylight savings time permanent in North Carolina. Similar legislation has passed the U.S. House of Representatives in the current session, but is unlikely to be taken up by the Senate.

A Modest Proposal: To each their own zone

We have just gone through our twice yearly debacle of changing our clocks at the expense of a week or so of disrupted sleep, getting up before dawn, and other effects just to create a situation where, in a few months, we will go to bed before it gets dark. Daylight savings time is, at best, a misnomer and, at worst, a fraud. If daylight could be saved in the summer when it is abundant and spent in the winter when it is not, “saving” it might be desirable but there are problems. North Carolina is in the western half of the UTC-5 time zone. At the center of the zone, some miles out in the Atlantic east of Rodanthe on the Outer Banks, the sun is at its highest elevation at noon, EST. This means that our daylight hours are always shifted towards later sunsets and later sunrises than those at the center of the zone. At the western edge of the state, this shift exceeds 30 minutes as a small portion of the state should be in the Central Time Zone. Proposals such as the one by N.C. State Rep. Jason Saine, now echoed by U.S. Rep. Madison Cawthorn make the situation worse, leaving much of the state in the dark in the morning during the fall, winter, and spring with the official clock time being as much as an hour and a half off of the natural sun time.

Standard time is largely a creature of the railroads who wanted to simplify timetables and scheduling. It was first introduced in Great Britain in the late 1840s and in the US (by law) in 1918. Many US railroads had their own “standard” times during the 1800s, adopting a single set of standard time zones by agreement in 1883. Prior to Railroad Time, time was a local affair with local noon being established by observation of the sun. The introduction of standard time was opposed on religious grounds as well as by people who did not want the railroads controlling their lives. Much of the opposition came from areas near the time zone borders where the changes were most pronounced. In many areas, the mix of railroad time for train travel and local time for everything else persisted until the 1918 law (which also introduced Daylight Savings Time) took effect.

With the advent of computers, smart phones and the like, reversion to the mixed system of the earlier era becomes easy. With its GPS, a smart phone clock can easily be implemented that shows local time as well as one or more standard times. Ordinary clocks can easily be set to local time using a smart phone clock. The smart phone clock will continuously reset itself as the user moves, always providing the correct local time. Adopting local time for local activities allows our lives to once more be attuned to the sun and, unlike the proposed legislation, actually places the choice of a time reference back in local hands. For most local activities, the time difference between locations is usually insignificant. Henderson county is slightly less than 1/2 of a degree of longitude wide so the maximum local time difference

between the Eastern most and Western most points in the county is less than 2 minutes.

With local and individual choice, hours for schools and jobs that involve outdoor work can be set to take maximum advantage of the available daylight. This could involve shorter hours in the winter and longer ones in the summer providing more free daylight time year round. If a locality is willing start school or work hours before daylight (as effectively mandated by the proposals of Saine and Cawthorn) and end them after dark, the choice of longer work / school days in the winter could result in fewer or shorter work / school days in the spring and summer, a real savings of daylight. The choices would be local and not dictated by state or federal officials. For jobs that involve interaction with people in other locations, time differences will pose a problem, but this is the case today for business relationships that span multiple time zones. The same technology that provides local time can easily compute the time at remote locations. One can even envision a call setup mechanism that queries the current location of the called phone and asks you if you really want to call it at 3AM, recipient's time.

Reverting to sun based local time allows us to take maximum advantage the daylight that we have where and when we have it. As we struggle with the results of the recent change to Daylight Savings Time, we need to realize that there are other ways to avoid its undesirable consequences and that its year round use may create at least as many problems as it solves.