WHAT IS TIME?

Time is a difficult topic to define from a philosophical viewpoint. Kant says it is neither an event nor a thing and Heidegger equates it to the concept of Dasein(being and existing at present). What is clear from their studies is that there can be no absolute time, but that one can nevertheless define, from a technical point of view, a relative time as the ratio between two events and a fixed and known event interval such as the time it takes the earth to rotate once about its axis(day), the moon orbits once around the earth(month), or the earth moves in its orbit once around the sun(year). In technology(with origin in rheology) one refer to such a relative time measure as the Deborah Number-

$$DeborahNumber = D = \frac{Elapsed\ Time\ Between\ an\ Event}{Time\ Between\ Known\ Measurable\ Event}$$

For example, my grandson has a D=1/8 while mine is D=7/8, where the ratios indicate ones age relative to an expected lifetime of 80 years. The concept of relative time probably developed as follows. Early man noticed that it took approximately 365+1/4 days for one earth year and thus its measure gave him a marker of when to plant and harvest. The Babylonian concept of 360 degrees in a circle clearly was related to days in a year. The concept of month is obviously related to the period of the moon as is still reflected in the similarity of the German words for month(Monat) and moon(Mond). The 24 hours in a day was probably chosen for convenience and by the fact that it evenly divisible into 360 at 15deg per hour. Further divisions by 60 produces the concept of minutes and seconds which again divide into 360 and fits into the base sixty Babylonian number system. The upshot of these early choices is that we measure relative time as the interval between two events relative to the time it takes for the earth to orbit the sun. The difficulty with this concept is that the number of days in a year is not an integer number and this can lead to calendar discrepancies. The Gregorian Calendar of 1582, having replaced the earlier Julian Calendar and presently used throughout the world, defines the year as-

$$YEAR = 365 + \frac{1}{4} - \frac{1}{100} + \frac{1}{400} = 365.2425 \quad DAYS$$

and includes not only the concept of leap years but also leap centuries. This calendar is still off by about 1 day in 3300 years. The correct number of days in a year is 365.24219… so that there are about-

$$365.24219x24x60x60 = 31{,}556{,}925.22\ Seconds / Year$$

Fortunately about sixty years ago it was realized that atomic transitions can yield a much more accurate measure of relative time compared to astronomical measurements. The earliest atomic clocks were masers (microwave amplificiation by stimulated emission) tuned to microwave transitions of the ceasium-133 atom. This led to a new definition of the second as –

$$1\ Second = 9{,}192{,}631{,}770\ periods\ of\ \ ceasium\ atom\ transitions$$

This new second corresponds exactly to 31,556,925.22 seconds in a solar year. More recently atomic beam and quantum clocks have been introduced bringing the accuracy of these atomic clocks to about (One Angstrom)/(Speed of Light). For future nuclear based clocks the accuracy will become even better. One notices in all of these relative measures that the basic time interval remains the solar year. Here are a few Deborah numbers using the year as the basic time comparison-

EVENT	DEBORAH NUMBER
High Energy Neutron Crossing Nucleus	10^-31
Light Penetrating Length of Nanotube	10^-24
Back and Forth EM Signal to Moon	7x10^-8
Earth Orbit Period about Sun	1
Average Lifetime of Human	7.7x10^1
Time since Big Bang	1.4x10^9

Napoleon never succeeded in introducing a metric time because he had no accurate event measure to compare things to . He was successful with metric length (one quadrant of the earth=10 million meters) and metric mass(1kg=mass of 10^-3 m^3 of water).

Several years ago I played around with coming up with a metric time measure in which dates and times would be combined into a single number(not unlike what they use on StarTrek). So for example, one would write the present time and date of March 1st 2011 at 3:10 pm as-

$$2011 + \frac{60}{365} + \frac{15}{365x24} + \frac{10}{365x24x60} = 2011.166115$$

This shows we are sixty days into the new year of 2011 and are at ten minutes after the fifteenth hour of the day. One could go on and express this number evermore precisely by adding seconds , tenth of seconds etc. Carrying all these numbers in ones head would make this way of measuring time not as practical as the present method of splitting dates and time. From a practical viewpoint the English notation

of the above date as month/day/year= 2/1/2011 is not as clear as the European designation of the same date as day/month/year=1/2/2011.