WATCH
WYOSCAN
0.5 Hz

The time right now is 2012 Jul 26 11:33 AM. Look at your new watch, what does it say? Certainly it's different. These two times could never be precisely alike—each is a specific POINT, and no two are ever exactly the same.

My time, according to my computer now, comes courtesy a networked time server maintained by Apple Computer and named, simply, time.apple.com. This external beacon commands not only the official time here on my MacBook, but also synchronizes its local clock with those of Apple users worldwide (laptops, desktops, phones, pods, pads, who-knows-whats-nexts). It's easy enough to think of time.apple.com as a master clock, but actually it is itself only a network of time machines, a collection of counters comprised of a circuit of servers—computers named time1.apple.com, time2.apple.com, time3, time4, time5, time6 and time7. (The server my laptop is using right now (time4) is located at 20400 Stevens Creek Blvd. in Cupertino, California, just a few blocks away from Apple's appropriate corporate address, 1 Infinite Loop.)

All of these servers communicate and agree what time it is at time.apple.com. But this covers only North and South America, and also must synchronize itself with time.asia.apple.com and time.europe.apple.com to provide a unified answer. All this close coordination, communicated over distance and time, is governed by Network Time Protocol (NTP), a set of time-sharing conventions developed in advance of the World Wide Web in 1985, by University of Delaware professor Dr. David Mills. It is one of the oldest, and essential, Internet protocols.

NTP runs as a Ponzi-scheme. Each layer in the scheme organizes a set of time servers, who both receive the correct time from the layer above (each layer is properly called a "stratum" in the protocol) and also are responsible for dispersing the correct time to computers in the next layer down. At each level, more and more computers are connected.

The protocol works by sending a message between two points on a network containing two bits of information: 1. what time it is now at the source, and 2. how long it took to transmit this message to its receiver. Simple addition tells you what time it is on the receiving computer (according to the sender). So, what time is it, precisely? Multiply this transaction through the layer-cake of millions of computers redundantly organized around the Network Time Protocol, and you'll begin to see a collective consensus emerge that passes for accuracy.

Turns out that in order to send a MESSAGE between two POINTS, it's essential that the two points agree on what time it is, otherwise the communication is jumbled. A quick thought gymnastic confirms. You live in Los Angeles and I live in New York. Agreeing on EST, your clock tells you it is 2:34 PM, and mine tells me it is 2:32 PM, and you tell me, "Hey! In one minute the eclipse is going to start, you'd better run outside right now to see it (don't forget your sunglasses)!" and I drop what I'm doing to rush right outside. I see nothing. I'm bummed. I write back — "Nothing doing out there, I must've missed it." You reply, "But the eclipse is scheduled for 2:33 pm! You probably came in too early!" And I respond, "I'd already missed it then. It's 2:34 now." "No you haven't, it's in one minute still!" In the midst of this tedious exchange, surely the moon has passed in front of the sun and everyone in question has missed the party. What a misunderstanding!

These kinds of missteps multiply exponentially over a network, and it should be blindingly clear how critical agreement on the correct time is now, in our intimately connected present. For communication, then, perhaps time is more of a medium than a measure. If we are going to be able to say anything to each other, we'd better first set your watch to the "correct" time. Here's how:

Watch Wyoscan 0.5 Hz has three buttons labeled counter-clockwise from top-left, A, B & C:

Press B and C at the same time to begin. Use C to cycle through hours, minutes, seconds and A (+) and B (–) to adjust each value. When you have finished and your watch displays correctly, press C to exit. Time will continue as usual.

OK, now we're in sync and our clocks agree, so let's back out and look again at the time I reported in the first sentence. This time was handed down through the cascade of networked time servers described before, but where did the original "time" come from and how was it set?

In the top tier of the Network Time Protocol, one computer is hooked directly to one extraordinarily accurate clock. Currently, this is the Cesium Fountain Atomic Clock running at the National Institutes of Standards and

Technology laboratory in Boulder, Colorado, named NIST-F1. Atomic clocks rely on the fuzzed logics of quantum mechanics. As electrons orbit the nucleus of an atom, rather than winding down gradually in energy like a pendulum, they lose energy in discrete chunks, at which point the circling electron jumps down to the next closest orbit producing something like a very very very faint "click." These steps are consistent for any one atom, and this quantity is its RESONANT FREQUENCY. The resonant frequency of the cesium atom, for example, is 9,192,631,770 Hertz (or cycles per second). And in a twist of recursive identity, the NIST has set the official standard for 1 second to be equal to 9,192,631,770 vibrations of the cesium atom. The United States' primary time and frequency standard is set then by NIST-F1 and is accurate to within one second every 60 million years.

So you can now more or less assume that the time stamped in the first line of this text does rather accurately reflect when the first sentence was written.

We'd all agree that 2012 Jul 26 11:33 AM identifies one specific POINT in time, a forever unrepeatable instant that disappears as quickly as we can stamp it. 18th-century empirical philosopher David Hume would certainly concur.

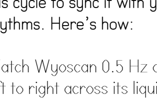
Working from the center of the Scottish Enlightenment, Hume described his particular, uncompromised version of empiricism. He asserted that everything we know or can know about the world arrives to us ONLY through direct sensory experience. Nothing exists outside of our own practical encounter with it as we move through the world. Further, he suggests that any sensible experience is composed of a single indivisible sensory building block which is marked by the limits of our perception. If you can't experience it, it does not exist. Hume was clearly an essentialist.

While American empirical philosopher William James built many of his ideas on Hume's scaffolds, he also rejected Hume's reductive essentialism. In James's second-wave or "Radical" Empiricism, although knowledge about the world still arrived through direct experience, he dismissed what he called Hume's "atomism" or the idea that this experience was ever-assembled from smaller elementary blocks. James was, instead, a "Gestaltist"—a totalist who, although insisting on the incrementalism of building the world piece by piece, also understood that any one experience was whole and complete in and of itself, neither equivalent to nor reducible into any constituent bits.

So if we could query Hume on our time stamp, he would identify it as one irreducible moment. However, ask William James and he says that this POINT is really more of a DURATION. Time is like that— both point AND duration. This is how it can bend and warp. A week, a second, a season: all are specific and discrete, but none are the same. The present can be cut to any number of lengths, from a single vibration of a cesium atom to the display cycle of a digital watch.

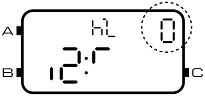
You will have already noticed that your new watch has a particular display. In fact, reading the time requires more attention than usual as the 7-segment liquid crystals are lit one at a time across the watch face. It is now time to adjust this cycle to sync it with your personal perceptual rhythms. Here's how:

Watch Wyoscan 0.5 Hz draws the time from left to right across its liquid crystal display, completing 1 cycle every 2 seconds. Recalling that Hertz = cycles/second, then the standard setting of 2 seconds is 0.5 Hz.



This duration may be adjusted slightly (tuned) over a range from 1 cycle every 1.5 seconds (.67 Hz) to 1 cycle every 3 seconds (.33 Hz).

To adjust the display cycle, press **A** and **C** together. You are now in HERTZ TUNING (hZ) mode and your display should look like this:

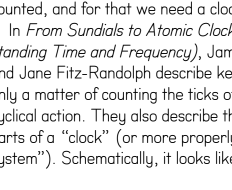


Use **A** (+) and **B** (–) to adjust the tuning up or down within its range of –9 to +9 (shown below)

until the display's speed reaches THE LIMITS OF YOUR PERCEPTION. You should *just* be able to read the time if it is set correctly. Be patient until you get this just right.

Now that you and your watch are synchronized, let's return once more to the time stamped in the first sentence: 2012 Jul 26 11:33 AM. And also, to the time as it stands right *now*: 2012 Sep 11 5:49 PM. We'll agree that the difference between these two points describes a length, but how can we measure it? Our meter-stick won't do. Time is nothing until it is counted, and for that we need a clock.

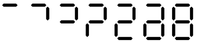
In *From Sundials to Atomic Clocks (Understanding Time and Frequency)*, James Jepsersen and Jane Fitz-Randolph describe keeping time as only a matter of counting the ticks of any regular, cyclical action. They also describe the constituent parts of a "clock" (or more properly a "clock system"). Schematically, it looks like this:



First, you need a device that can produce a periodic phenomenon (for example, a pendulum). This is the RESONATOR. Next you'll have to sustain the periodic motion by feeding it POWER (for example, a small DC battery). Finally you need a means for counting, accumulating and rendering the ticks of the resonator. This is the DISPLAY (for example, a watch face and arms). Together, these three pieces define a clock. But of course to be useful—to measure a length—our clock must be RUNNING. With all of these conditions met, we can now simply determine the duration between writing the first sentence of this text and editing this one: 27 days, 3 hours, 14 minutes. And this delivers one final paradox: Time can ONLY be measured by MOVING.

This "clock system" Jespersen and Randolph describe can be easily applied to the digital watch you now hold in your hands. POWER comes from a Lithium battery housed inside the plastic case. The battery then produces an electric current passed through a tiny quartz crystal soldered to the circuit board, and like the cesium atom described earlier, the quartz oscillates, swinging the signal back and forth at a highly predictable frequency. This is the regular tick-tick-tick of the RESONATOR. The DISPLAY is handled by a liquid crystal readout composed of a sequence of modular digits, controlled by the watch's integrated circuitry. Still, there is a trick: the electric pulses needed to light up each of the seven-segments that define any one number from Watch Wyoscan's electronic circuit can *not* be sent precisely simultaneous. They must, by definition, arrive one at a time.

In order to efficiently COMMUNICATE the time measured by the resonator to the display that renders it, the segments are multiplexed, sent one at a time. The signal that communicates these instructions is a WAVE, a sequenced set of messages that light up each segment in series, Wyoscanning across the liquid crystal to reveal the current time. It looks like this:



And, like time itself, this form of communication *only works when it is moving.*

Press A and B at any moment to display a time stamp that identifies the precise Network Time when your Watch Wyoscan's software was compiled and it began ticking.

Dexter Sinister, Watch Wyoscan 0.5 Hz is produced by Halmos with additional support from Objectif Exhibitions and Yale Union.

http://www.halmos.us.com