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Healthcare and Public Health Sector: Time and Timekeeping - NTP, Khronos, and the General Timestamp API

What I'm gonna say

- NTF: Why, Who, What.
- About Time and Timestamps.
- Timescales.
- NTF’s General Timestamp API Project.
- NTP.
- Khronos.

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Why NTF?

- The NTP Project needed the support and backing of a legal entity.
- I felt an “NTP Foundation” would have insufficient scope.
- Network Time Foundation seemed “right”.
- NTF is a registered 501(c)(3) US Charity.

Who/What is NTF?

- NTF currently supports the NTP, Ntimed, Khronos, LinuxPTP, SyncE, and General Timestamp API projects.
- Implementing NTS and SNT.
- Developing enterprise applications.
- Time Source Consortium.
- Developing Certification and Compliance programs.

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Time: When?

- “Knowing the time” is important because we can note when something happened and we can plan when to do something.
- This requires dissemination and synchronization of “time”, and timestamps that contain “enough” information to be generally useful.
- “Time” means different things to different people.

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Using Time

- How long is a day? “Time” was easier to use when the wobbles were in the noise.
- Timescales solve different problems for different groups.
- If there are disagreements around “signal” and “noise”, there are problems.
- Larry McVoy likes: In theory, theory and practice are the same. But in practice they are not.

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Presumptions

If we're on a computer and we need to know what time it is, we ask for a timestamp.

We simply assume the answer we get is correct. What other choice do we have?

Do we even consider any other conditions?

And later, when we use the timestamp?

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Current Timestamps

Current timestamps are mostly OK for “local use”. Mostly.

- seconds since some epoch
- <days since epoch>,<seconds since midnight>
- YYYYMMDD-HHMMSS - Long-standing hospital database does not bill millions of dollars each Fall’s daylight-savings correction

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Timestamp Issues

- Monotonic time and databases.
- System time may be known to be undergoing a correction.
- Error bounds?
- **What timescale is being used?**
- When comparing T_0 and T_1 did anything happen between those events that would affect the comparison? Did the clock change? Different timescales?

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Timestamp Metadata

- A “clock discontinuity counter” is needed to show if “time steps” have occurred.
- A “host ID” is useful when comparing timestamps between multiple systems.
- A “clock ID” is useful if we need to know what a host is using to track the time.

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About that Clock ID…

- With what degree of specificity should we know the source of time?

Multiple choice question:

- Is 13 microseconds very much time?

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26 Jan 2016 and GPS

SVN 23 was the oldest GPS satellite still in operation on 26 Jan 2016, at the time it was being decommissioned. During that process, the legacy L-band signal was off by 13 microseconds from 00:49 MST until 06:10 MST.

13 microseconds corresponds to a position error of just under 4km / 2.5 miles.

Time on VMs and Laptops

Virtual Machines generally aren't “smooth” with time.

- What about “teleporting” a VM and its IP to another physical host somewhere else on the network? This also affects NTP...

Laptops (at least) sometimes go to sleep.

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GTSAPI Timestamp Structure

- System time (or Elapsed time)
- Amount of any pending correction
- Leapsecond correction (optional)
- Expected/Maximum error
- Timescale (and its revision #)
- Clock discontinuity counter
- Host and Clock ID
- Provable Signature
- Structure/API Version number, Flags

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Using the GTSAPI

A new timestamp structure is only useful if it can be widely and generally portable:

- Kernel support
- Library support
- Application support (NTP, SQL, and a GTSAPI Library)

Using timestamps

The timestamp library API must handle:

- Adding/subtracting timestamps
  - Must accumulate error budgets
- Canonicalization of timestamps
- Comparing timestamps
- Converting timestamps (timescales)

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Timestamp Arithmetic

T_A – Absolute Timestamp
T_D – Difference Timestamp

$T_A - T_A = T_D$

$T_A +/- T_D = T_A$

$T_D +/- T_D = T_D$

Of course, proper “accounting” of error budgets must be maintained.

Timestamp Error Budgets

NTP assumes that clocks accumulate error at the rate of 15ppm.

The initial error budget for a Difference timestamp is 0.

Otherwise, we generally care more about the magnitude of error as opposed to the error value.

Timescale Database

I’m operating on the belief that a timescale database won’t be that much harder to implement and maintain than Arthur David Olson’s Timezone Database.

There are groups actively working on tzdata dissemination.

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Initial Timescales

Rare changes

- TAI/Satellite time (GPS/BeiDou/GLONASS)
- Martian Standard Time
- UTC (leapseconds, and possible smearing)
- Local Timezones (tzdata)
- IERS-A

Frequent changes

Leapsecond smearing is no problem for the GTSAPI.

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How does this help?

Poor timekeeping and timestamps can be incredibly costly and terribly inefficient.

- Power Grid Failure
- Hospital E/R and healthcare data
- Vehicle Fleet Tracking

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Certification and Compliance

- Being able to use a timestamp in a “provable” setting is very helpful.
- For a timestamp to be “provable” it needs to contain enough information to sufficiently understand its provenance, and know its boundaries and limits. GTSAPI.
- The entire “time chain” for the timestamp must be traceable and provable.

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Free vs. Paid Time

Free timestamps must always be available.

Timestamps that cost money (even US$0.01 each) would be provable, traceable, and include liability insurance. The revenue from these would also help support Network Time and the time infrastructure.

NTP

NTP:

- communicates and synchronizes time.
- always gets its time from Somewhere.
- may provide time to other NTP instances.

“Somewhere” can be reference clocks, other NTP servers, or PTP sources.

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NTP

If NTP has enough sources of good quality time, it can keep and be a source of good time.

NTP can easily synchronize time across a LAN to the millisecond level.

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NTP

If NTP has enough sources of good quality time, it can keep and be a source of good time.

What is “enough”?

The Byzantine Generals Problem: To ensure loyal generals will reach agreement in the face of N disloyal generals, one needs at least 2N+1 generals.

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Khronos

Khronos is an NTP watchdog service designed to provide improved security against time shifting attacks on NTP.

Once stabilized, khronos offers a “bounds check” on time, usually in the tens to hundreds of milliseconds (with a maximum of 2 seconds), even during an attack.

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Summary

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Help NTF help you!

https://youtu.be/I-BYzaDwNoE