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On Implementing Time

draft-aanchal-time-implementation-guidance-01

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Motivation.

- functionality and security of apps hinges on some notion of time.
- choose from multiple clocks on systems.
- applications oblivious to implications of choosing one or the other clock for implementation

Scope of the Document.

- Expressing Time: methods to express time by applications
- Different clocks: properties of clocks maintained by digital systems
- trade-offs of using one clock over the other
- provides guidance to help implementers make an informed choice

Non-Scope of the Document.

- Not specific to architecture of a PC or other devices
- Not specific to any OS.
- Does not deal with how different clocks are available on different PCs or other devices
- No set-in-stone final recommendation.

The final decision would vary depending on the availability of clocks and the security requirements of the specific application under implementation.

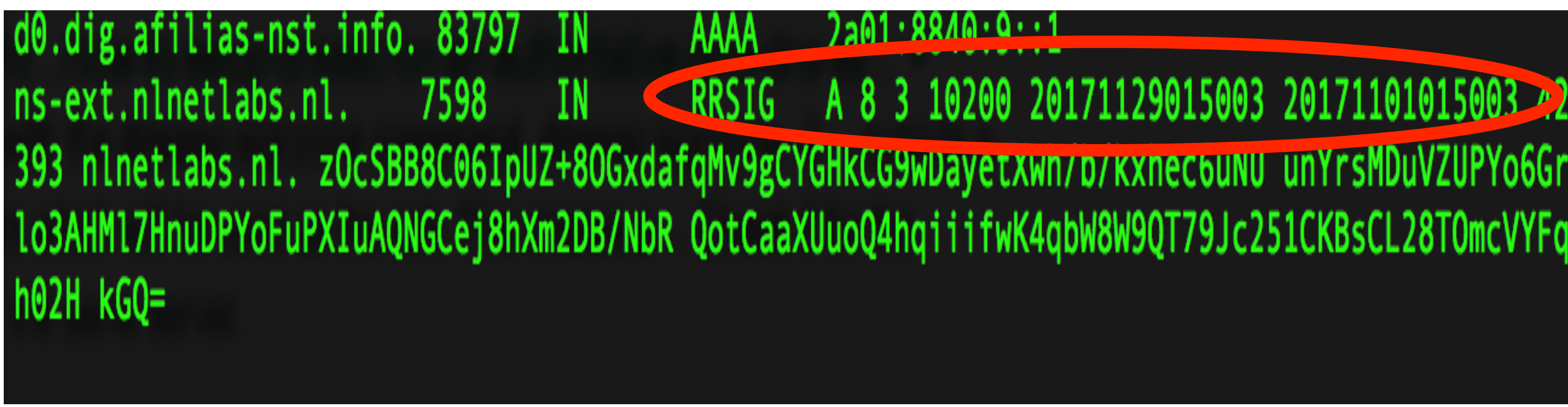
Outline.

- Expressing Time: Absolute vs Relative Time
- Keeping Time: Native Time vs World Time
- Trade-offs of using Native vs World Time
- Current implementation approaches
- POSIX & Windows Example.

Expressing time: Absolute vs Relative time

- **Absolute Time:** expresses an absolute point in time. Nov 6, 2018 12.10pm

- E.g. validity of objects with a limited lifetime that are shared over the network.



Expressing time: Absolute vs Relative time

- **Relative Time:** measures the time interval that has passed from a reference point.

- e.g. Time-to-Live values that determine the length of time for which an object is valid or usable.

```
d0.dig.afilias-nst.info. 83797  IN      AAAA    2a01:8840:9::1
ns-ext.nlnetlabs.nl.     7598   IN      RRSIG   A 8 3 10200 20171129015003 20171101015003 42
393 nlnetlabs.nl. zOcSBB8C06IpUZ+8OGxdafqMv9gCYGHkCG9wDayetXwh/b/kxhec6uNU unYrsMDuVZUPYo6Gr
lo3AHMl7HnuDPYoFuPXIuAQNGCej8hXm2DB/NbR QotCaaXUuoQ4hqiiifwK4qbW8W9QT79Jc251CKBsCL28TOmcVYFq
h02H kGQ=
```

Different Clocks – Native Clock

- **Native Clock:** system's own perception of time
  - obtained by:
    - counting cycles of an oscillator
    - using process CPU times or thread CPU timers
  - returns difference in time between two points

Different Clocks – Native Clock (Properties)

- Properties
  - monotonic
  - immune to vulnerabilities from external time sources
  - quality depends on stability of oscillator or CPU timer
  - Clock drift: clock rate may vary from other systems

Different Clocks – World Clock

- **World Clock :** in synch with other systems.
  - Obtained by:
    - manual settings.
    - accessing hardware clock provided by the system which itself is set/updated obtained from an external time source.
    - via external sources of time such as Network Time Protocol (NTP), Chrony, SNTP, OpenNTP and others.

Different Clocks – World Clock (Properties)

- Properties
  - can be adjusted for clock drift
  - may stay in sync with other systems
  - manual setting -> misconfiguration errors
  - H/W clock access
    - is resource intensive
    - quality of the hardware clock may not be very high leading to a large clock drift if solely relying on it.
  - otherwise, external sources opens up to network attacks

How do software implementations deal with relative time?

COMMON APPROACH

relative time ---> absolute time

Absolute time =? current system time

Updated by external time sources

Other possible implementation approaches & their trade-offs.

To implement absolute time, no other option but the world clock.

To implement relative time, one MAY use native clock.

POSIX & Microsoft Windows API.

- POSIX: clock_gettime() may provide native time
- Microsoft Windows:
  - GetTickCount returns 32 bit count
  - GetTickCount64 returns 64-bit count

Way forward for the draft?