Timing Verification as a Service

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Timing Data is Different

- **Ubiquitous**
  - timestamps a part of almost all measurement

- **Universal**
  - only a small number of key `types`
  - each with the same generic concerns:
    - are my timestamps reliable?
    - how accurate are they?

- **Suggests potential for broad solutions**
  1) fix the timing system [ watch this space ]
  2) evaluate/verify/certify
     - the timing system achievable by a service?
     - the timestamps
What Could Possibly Go Wrong?
Timing Purposes ➔ Timing `Data Types`

- **Event ordering**
  - monotonicity wrt true time (TAI)
  - uniqueness

- **Time interval duration**
  - same clock: running at stable, correct rate
  - different clocks: absolute time up to a constant

- **Absolute time**
  - globally comparable metric and label
  - synchronization to universal standard (TAI, UTC)
Different Clocks for Each Time Type

- **Causal Clock**  (Event ordering)
  - hardware counter, or message passing logic
  - Expect: perfection

- **Difference Clock**  (Time interval duration)
  - local hardware counter
  - timestamp exchange to remote reference
  - smart calibration
  - Expect: very robust, very accurate

- **Absolute Clock**  (Absolute time)
  - stable local hardware counter
  - frequent exchange with remote reference
  - very smart calibration
  - Expect: vulnerability, much less accurate
Timing Hierarchy (in an ideal current world)
Verification Dimensions

- **System components**
  - Internet timing system
  - remote server side
  - client side \{hardware, clock, timestamping, final timestamps\}

- **Timeliness**
  - general certification
  - on-demand auditing
  - ongoing monitoring
  - detailed audit during experiment

- **Auditing body**
  - independent 3rd party \(\text{free or not}\)
  - available software
  - built into timing system

- **Verification approach**
  - remote
  - with server and/or client cooperation

- **Clock Type**
  - Causal / Difference / Absolute
Eg 1: Server Health Monitoring (SHM)

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Don’t Use that Server!

No RTT ‘events’:
- no routing changes
- no major congestion
- $R(i)$ should bound $A(i)$

Large Asym events:
- can’t be routing
- can’t be congestion
- must be server

Longitudinal study (2011, 2015)
Out of 102 servers, 37 bad over entire period!
Eg 2: Client clock vetting for RTT/IAT

- **System components**
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Eg 3: Clock Outsourcing

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  - Internet timing system
  - remote server side
  - *client side* {hardware, clock, timestamping, final timestamps}

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  - ongoing monitoring
  - detailed audit during experiment

- **Auditing body**
  - independent 3rd party (free or not)
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Eg 4: Network Timing Core

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  - Internet timing system
  - remote server side
  - client side {hardware, clock, timestamping, final timestamps}

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  - on-demand auditing
  - ongoing monitoring
  - detailed audit during experiment

- **Auditing body**
  - independent 3rd party (free or not)
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  - remote
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- **Clock Type**
  - Causal / Difference / Absolute
NTP Forest, with Tree-rot

How would we know our tree is rotten? No tools!
Meshed Stratum-1 + Privileged Stratum-2

NMI and AARNet have agreed to support public trails.
Summary

- Timing isn’t going away
- Timing underpins other measurement
- Timing has problems, but they are finite
- Many can be fixed via expertise wrapped in a service
- Let’s just do it