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**

  i) fix the timing system

  ii) evaluate/verify/certify
    - the timing system
    - the timestamps

[watch this space]

achievable by a service?

What Could Possibly Go Wrong?

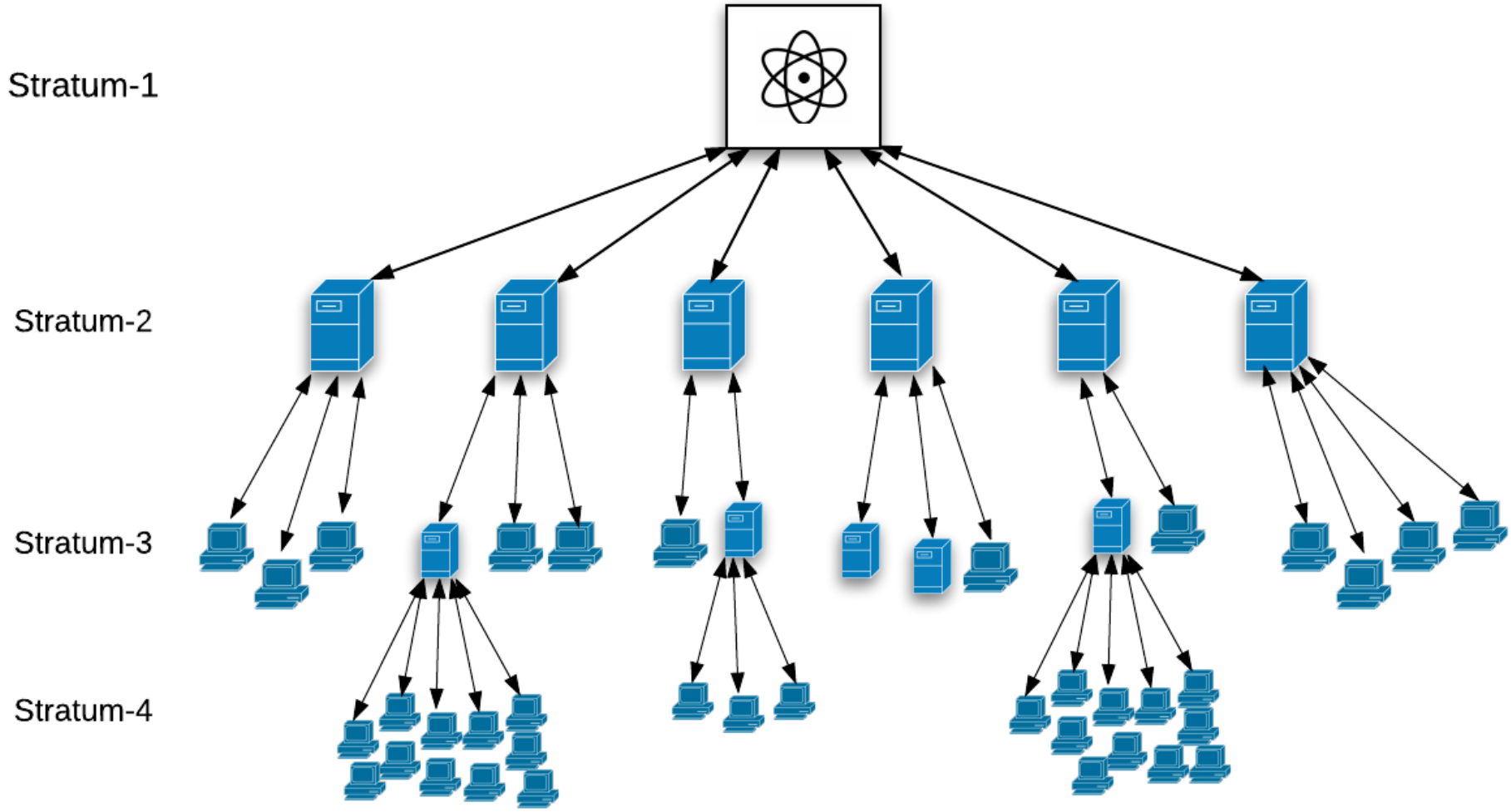
Timing Purposes ➙ Timing `Data Types'

- **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 (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)

- **System components**
  - Internet timing system
  - remote server side
  - client side {hardware, clock, timestamping, final timestamps}
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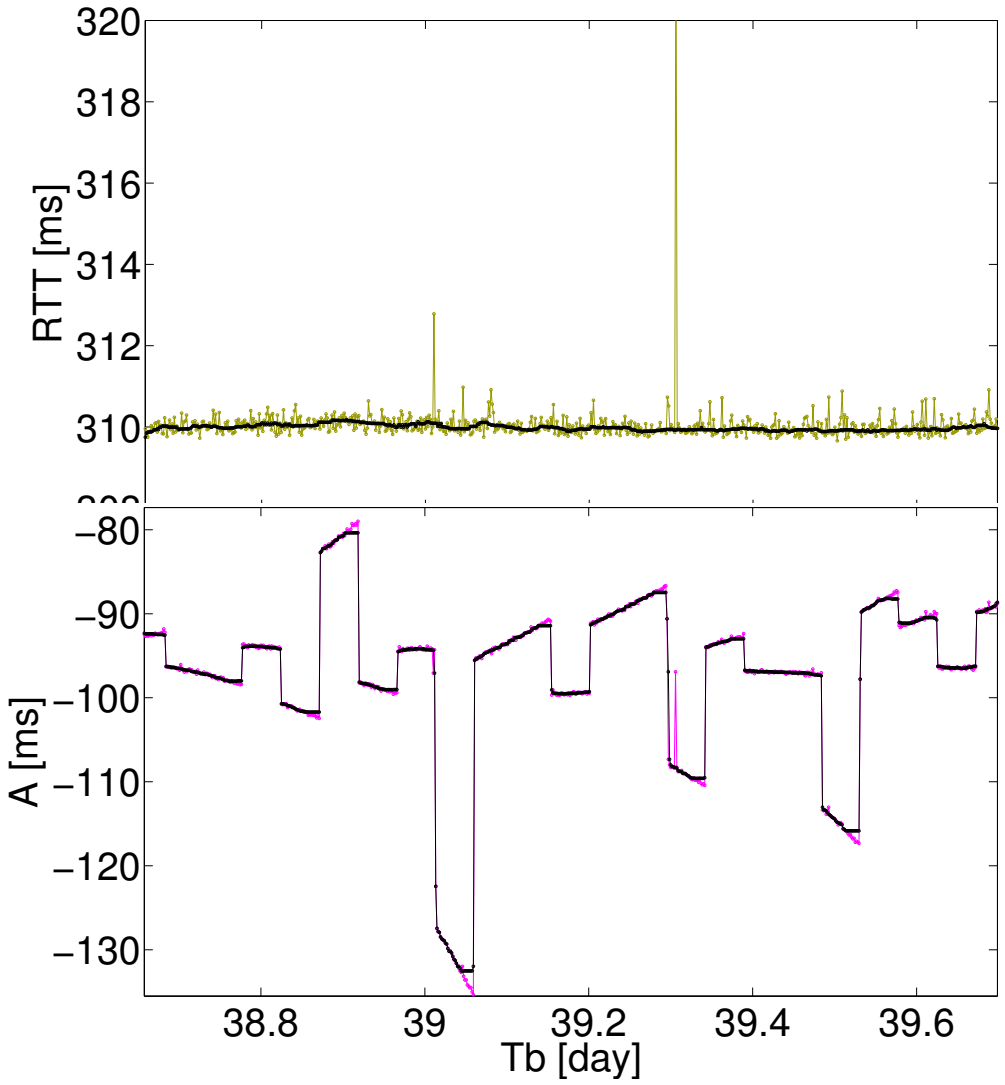
Don’t Use that Server !

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**
  - Internet timing system
  - remote server side
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  - ongoing monitoring
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Eg 3: Clock Outsourcing

- **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 (free or not)
  - available software
  - built into timing system
- **Verification approach**
  - remote
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- **Clock Type**
  - Causal / Difference / Absolute

Eg 4: Network Timing Core

- **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 (free or not)
  - available software
  - built into timing system
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  - remote
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- **Clock Type**
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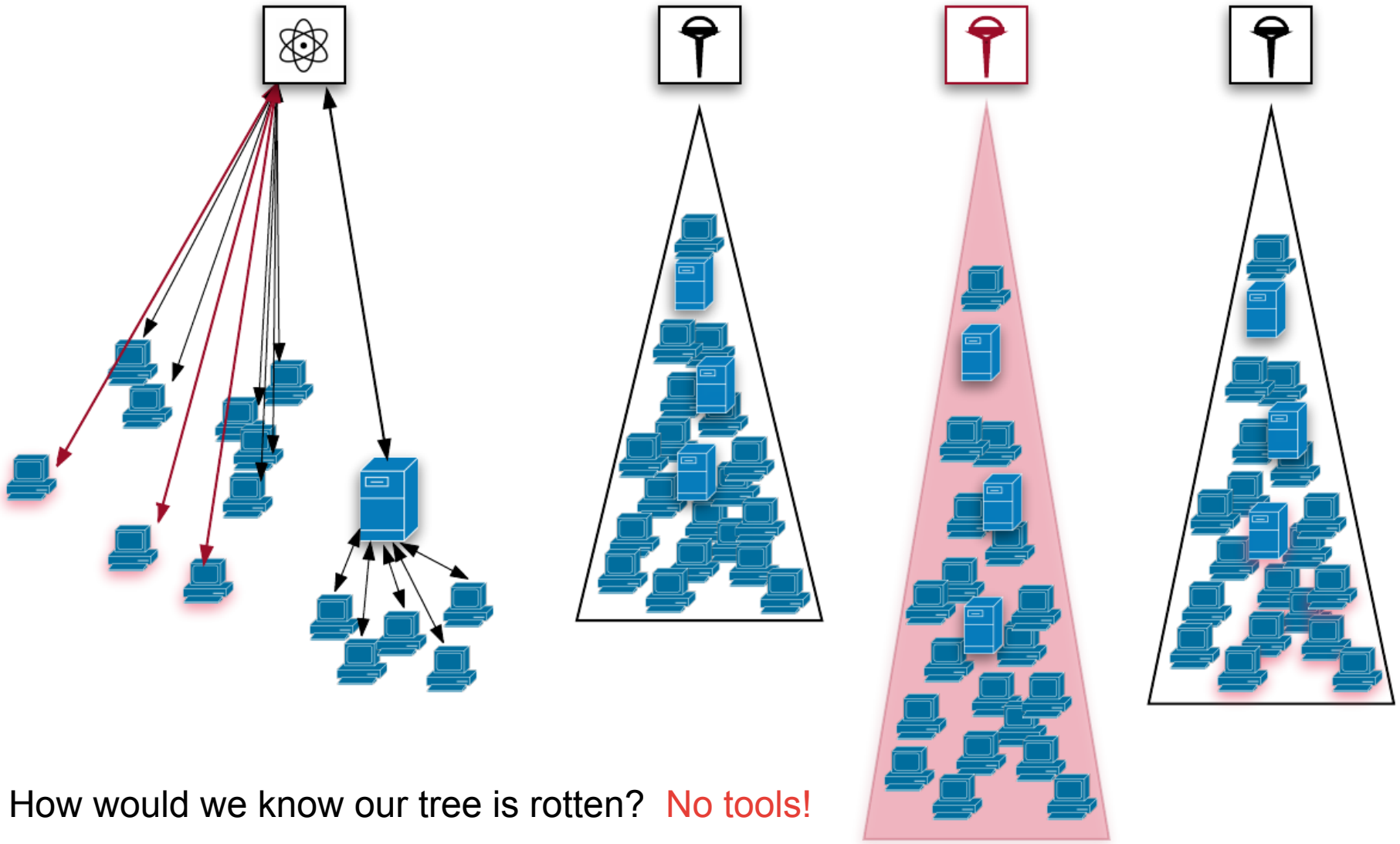
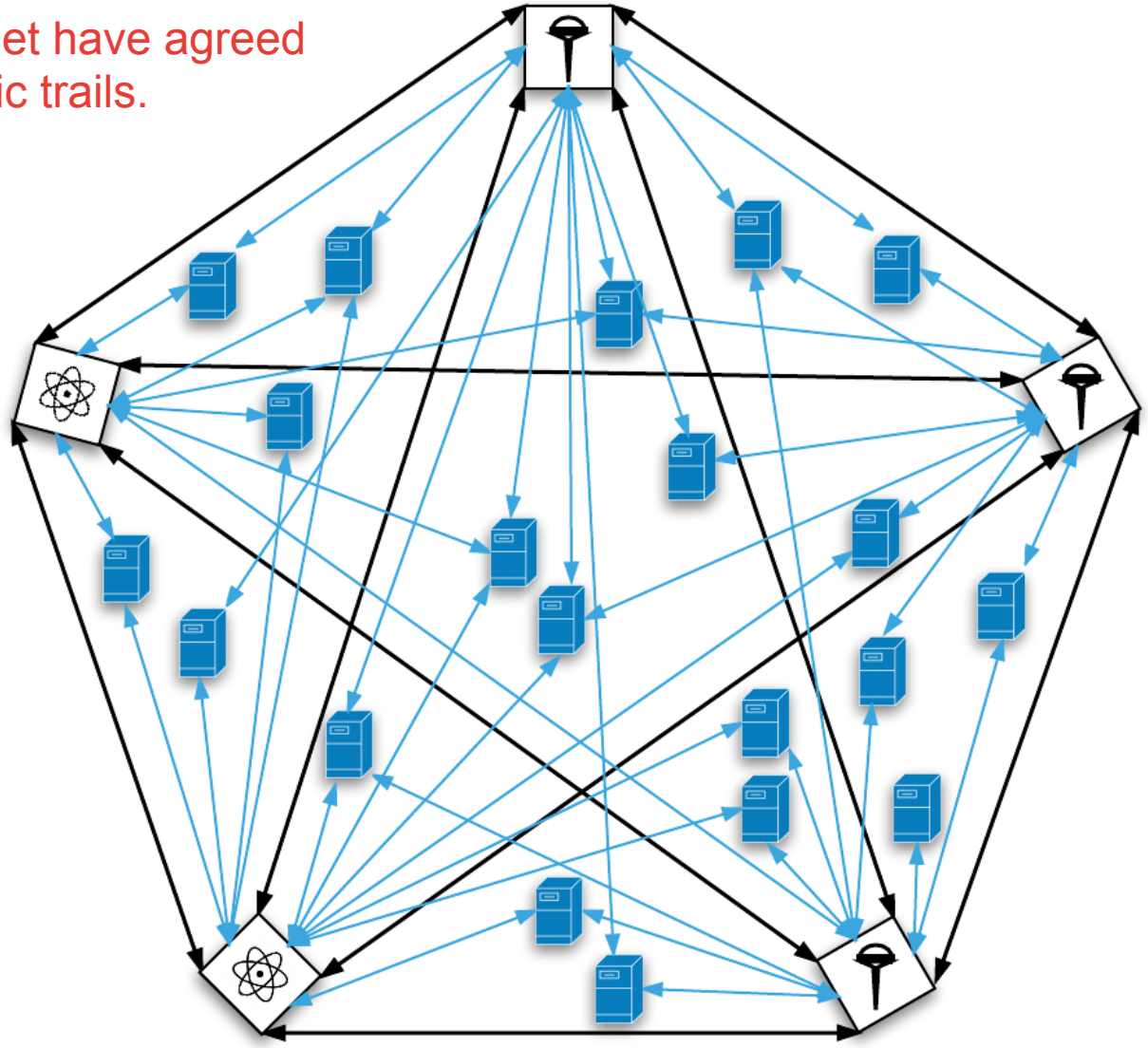
NTP Forest, with Tree-rot



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**