Timing Update

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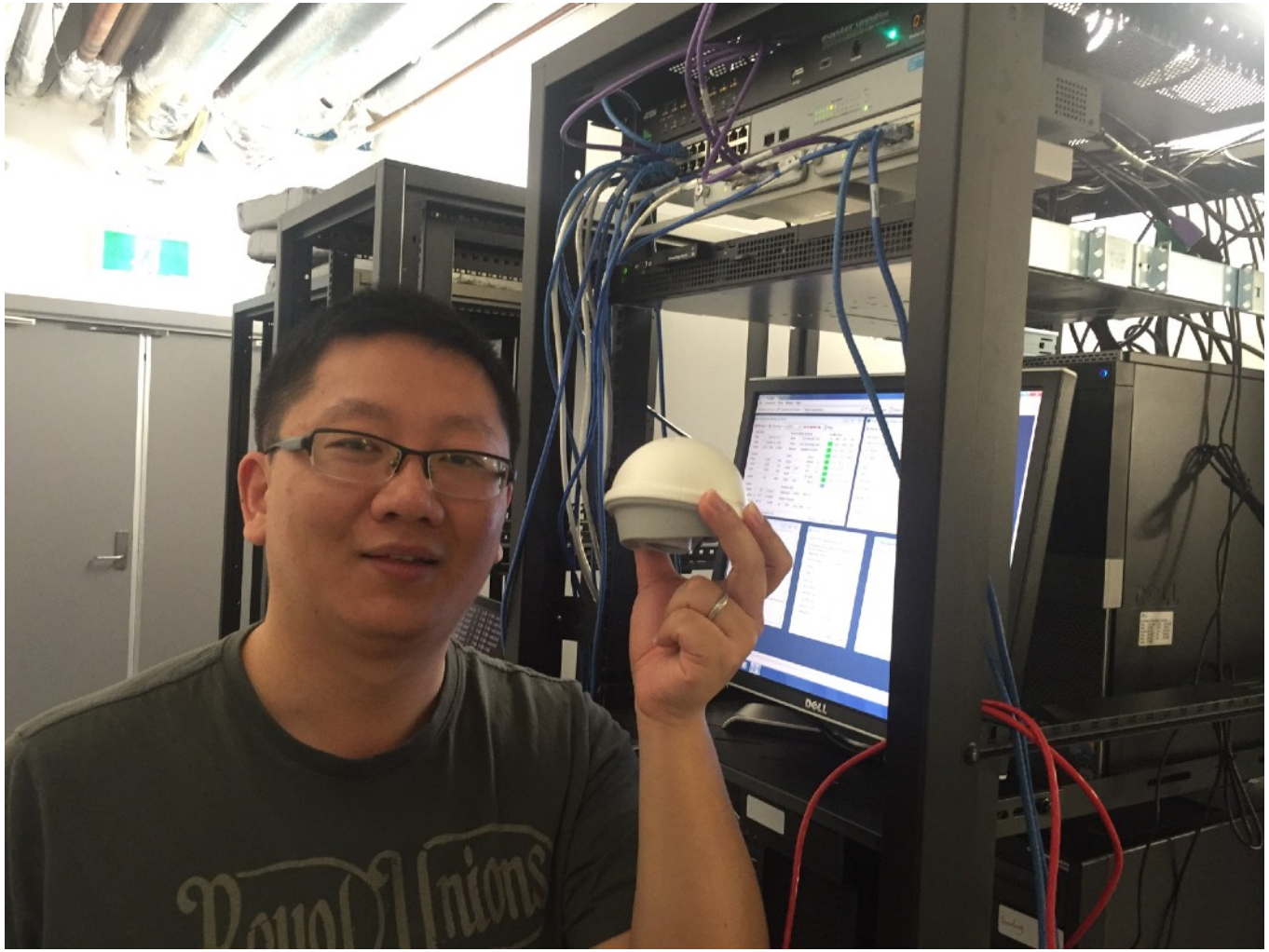
UTS Timing Project

- **Continues SyncLab Project formally at Uni of Melbourne**
  - New testbed with
    - Two 7.5G4 DAG cards
    - low latency taps
    - rubidium atomic clock (SRS FS725)
    - several roof mounted GPSes (Trimble and Symmetricom)
    - time distribution hardware
    - /26 public IPv4 addresses
  - Companion testbed at PolyU (Rocky Chang, Peter Membrey)

RoofLab

Yi Cao



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- Overarching Goal `Perfection of Networked Timekeeping'
  - Continues to develop and support RADclock (see AIMS 2015)
  - New foci in Trusted Timing and the Internet of Things
    - New ARC funding 2017–2012 (Barford, Paxson, Wouters)
    - Major Activities
      - Server Health Monitoring (SHM)
      - Network Timing Core (NTC)

Australia's UTC Clock at the NMI

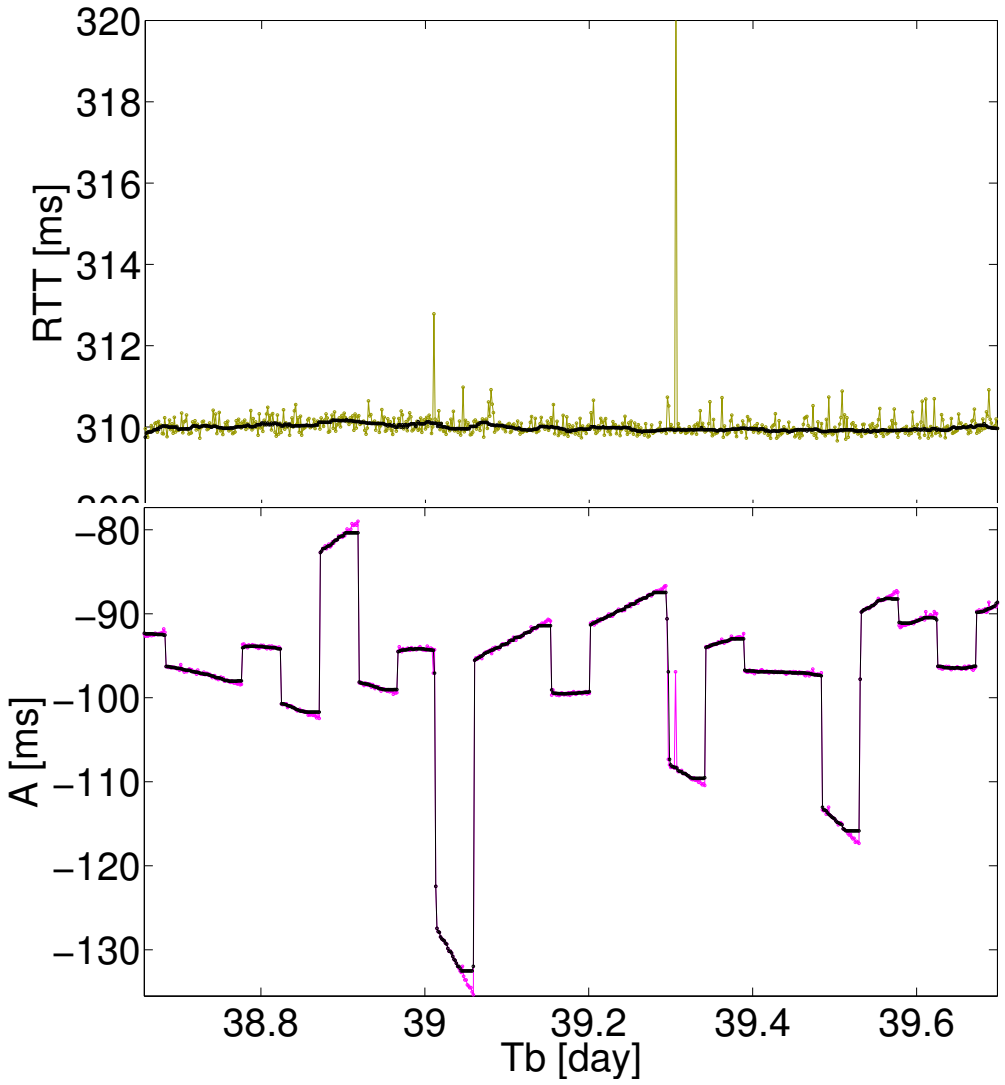
Recent Work

- **Rot at the Roots? Examining Public Timing Infrastructure**
  - INFOCOM 2016
  - Looks at anomalies in ~100 public Stratum-1 servers
- **Network Timing and the 2015 Leap Second**
  - PAM 2016
  - Leap Second behaviour of ~170 public Stratum-1 servers
- **2016 Leap Second and Anomaly experiment (Dec 2016– Jan 2017)**
  - ~500 public Stratum-1 servers (includes all NTPpool servers)
  - Polling up to 1 per second (previously 64s)
  - Still only 1 vantage point.. Ark !
- **Time to Measure the Pi**
  - IMC 2016
  - Potential of Raspberry Pi-1,2,3 and Pi+PPS as a timing platform

Server Health Anomalies are Real

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

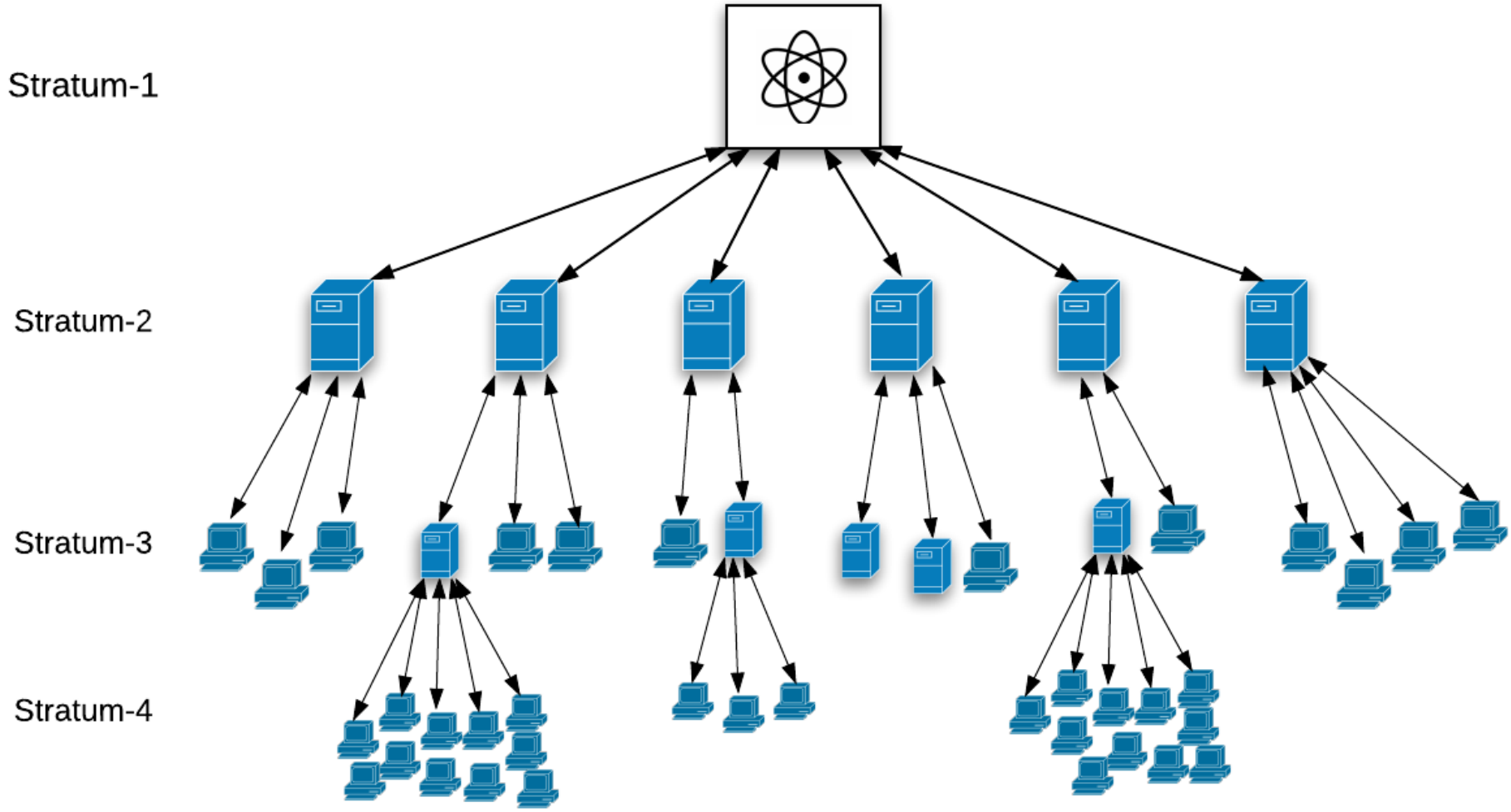


Longitudinal study (2011,2015)
Out of 102 servers, 37
bad over entire period !

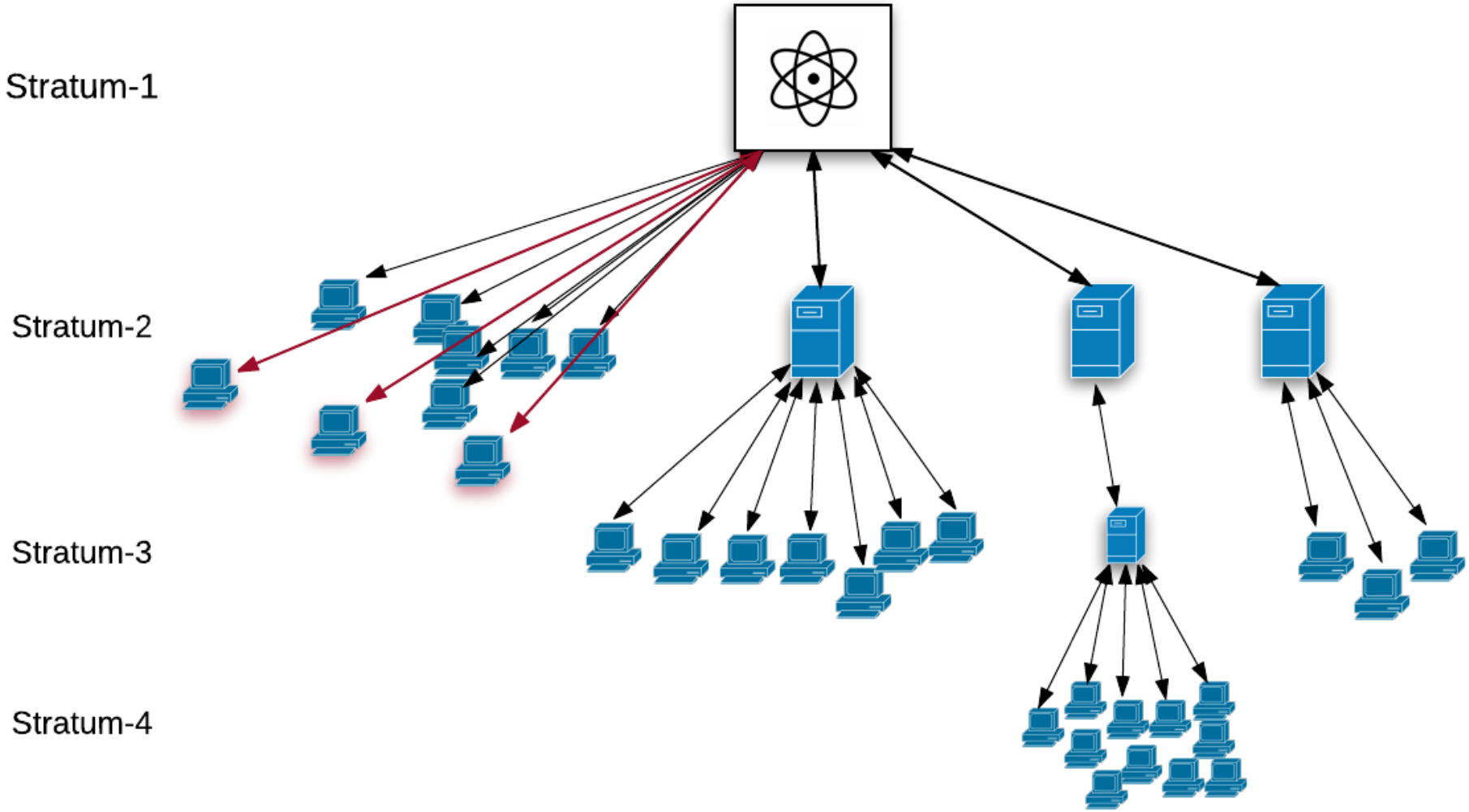
Server Health Monitoring

- **Health and Vulnerability of Today's Internet Timing**
  - Stratum-1
  - Generally
  - Main expansion dimensions:
    - assess all IPv4 Stratum-1
    - assess entire IPv4 forest
    - move from single to multiple vantage point
- **Statistically sound server anomaly detection**
  - Principles; algorithms; code; rigorously evaluated
  - Developing its use:
    - vetting tools [use by experts, anyone]
    - incorporated into timing algorithms and protocols
    - as a service [CAIDA? later taken over by ntp.org?]

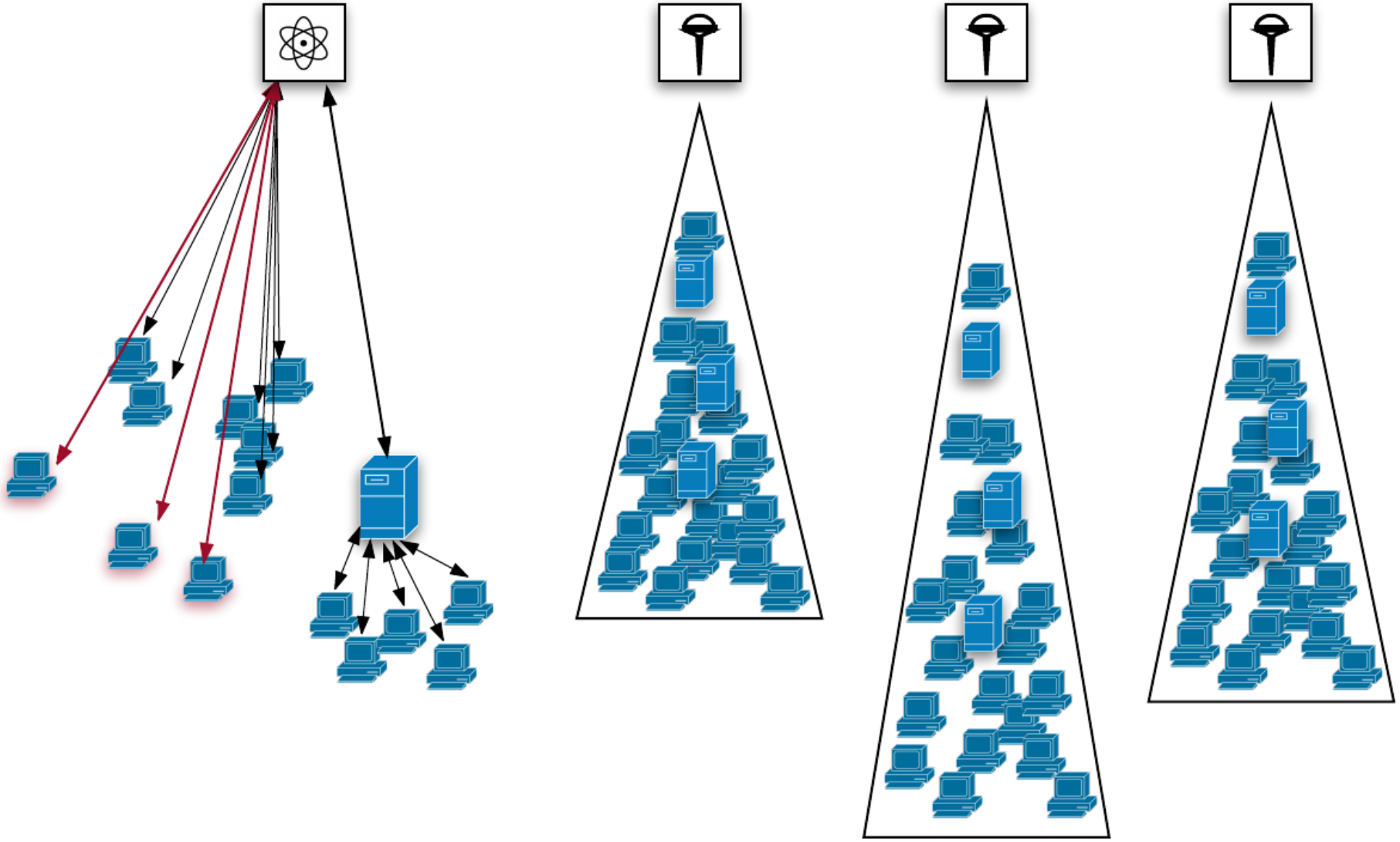
Network Timing Core



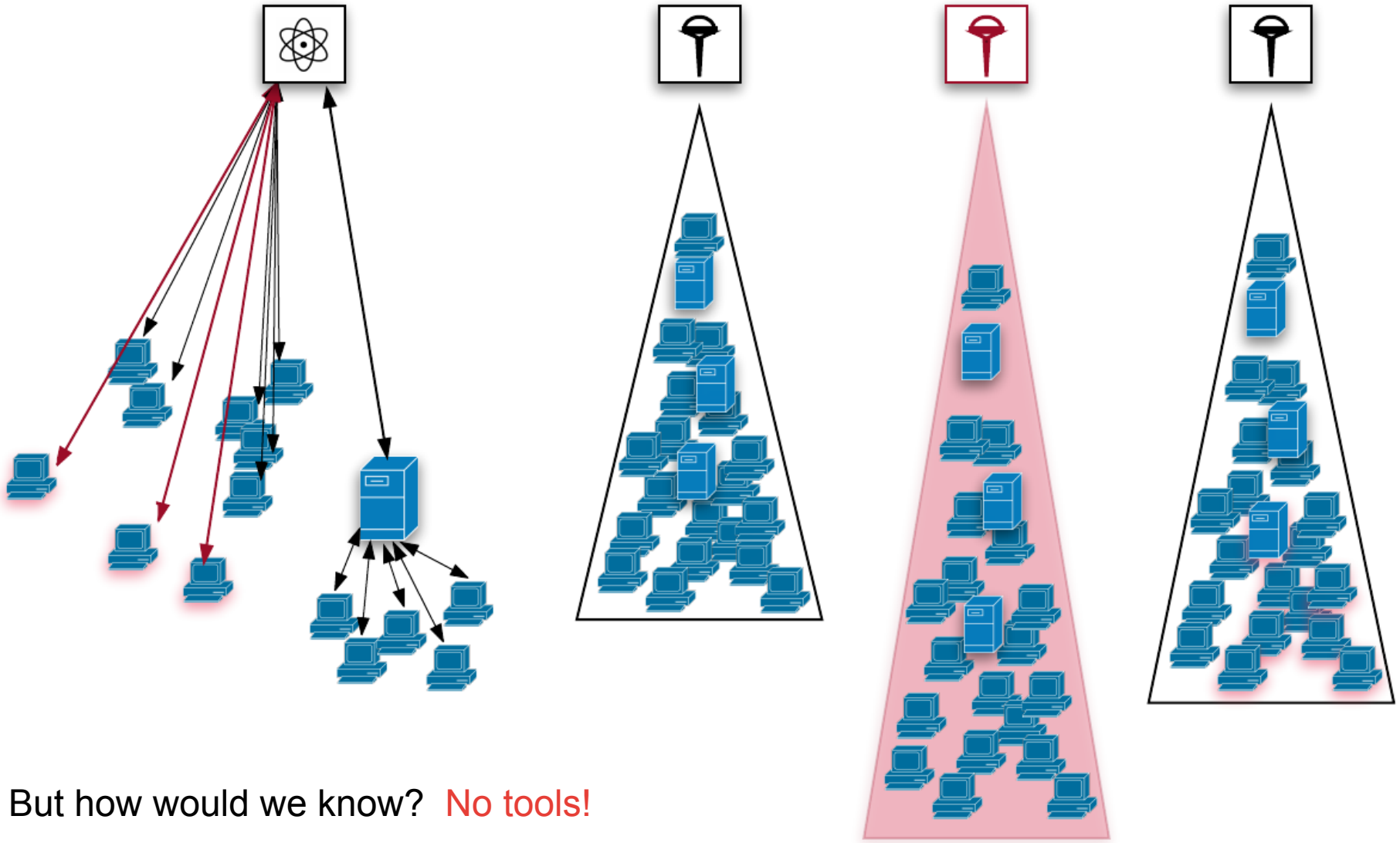
NTP Hierarchy — take II



NTP Forest



NTP Forest, with Tree-rot



But how would we know? No tools!

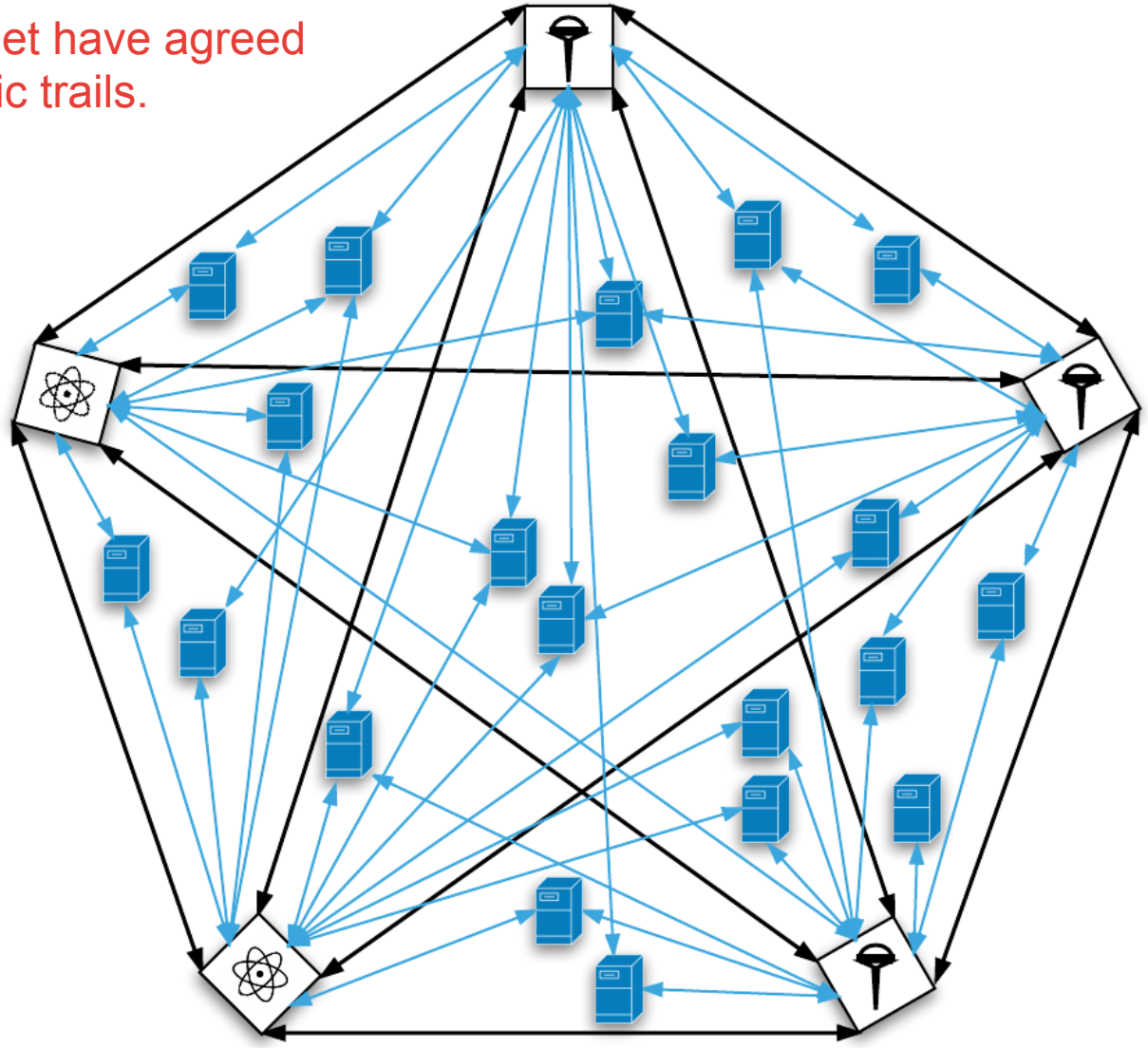
Idea Behind NTC ('DNS for timing')

- **Deal with multiple key problem in one architecture**
  - Failure to address path asymmetry errors
  - Dysfunctional `hierarchy'
  - No effective cross validation across the Stratum-1 roots
  - No sync-friendly server selection or load balancing
  - No trust (malicious or incompetent? who cares)

- **Architecture**
  - NTC Fuses Stratum-1's and privileged Stratum-2's into a unified layer
    - Rare Stratum-1's NOT public
    - Many more Stratum-2's
      - public
      - located within network provider's networks
    - Self vetting using SHM and voting algorithms
  - Asymmetries
    - directly measurable within Stratum-1 mesh
    - achieved throughout the NTC by calibration

Meshed Stratum-1 + Privileged Stratum-2

NMI and AARNet have agreed to support public trails.



What I Want

- **What kind of timeserver vetting/trust do you want/need?**

- **Developers & Collaborators for**
  - NTC
  - RADclock
  - Timing for IoT devices