TIMEBEAT
CLOCK QUORUM – CREATING PNT RESILIENCE THROUGH CONSENSUS

TIMING
SOLUTIONS
FOR THE
MODERN
WORLD

MAY 2024

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AGENDA

20 years - of POPs 'n' Clocks

Spirit of IEE1588
- "form a time distribution network from a bunch on interconnected clocks"
- "… installed and operated without requiring the management attention of users."

A PTP framework…
- Arranging connectivity between clocks (gets harder as the bunch grows)
- Provisioning connectivity – Rules V Static
- Master selection – Measured V Assumed
- Slave accuracy – Single (BMCA) V concurrent masters
- …

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20 YEARS TICK BY….

Network
- **Speed** increase ~1000x
- Latency/Technologies
- **Topologies**

Oscillator
- Stability per $ ~100x

PTP Hardware
- Switches
- **Servers**
- **Open** Timecard

- **GNSS**
  - Accuracy (L1,L2,L5) ~10x
  - Resiliency?

- **PTP**

  - PTP V2
  - PTP2.1 – (HA)

- **ITU-T (network models/limits)**
  - Full timing support ~ done
  - Partial Timing support?

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Time NETWORK Requirements 2025

- Resilient to local GNSS outages
- Security and Privacy (~~TC~~)
- Manageability
- Wide Area
- Hi-speed; Low latency connectivity
- Independent (Timescale)

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TIME CLOCKS OF 2025

Small GMCs / BCs widely deployed

- Servers + Cards + Modules

Standard Servers challenging proprietary boxes

Multi-frequency GNSS (L1, L2, L5)

Improved Holdover (OCXOs)

- Lots of quality sources of UTC
- Lots of places that provide good holdover
- Lots of possible paths
- Lots of opportunities to compare different time sources, filter and verify...
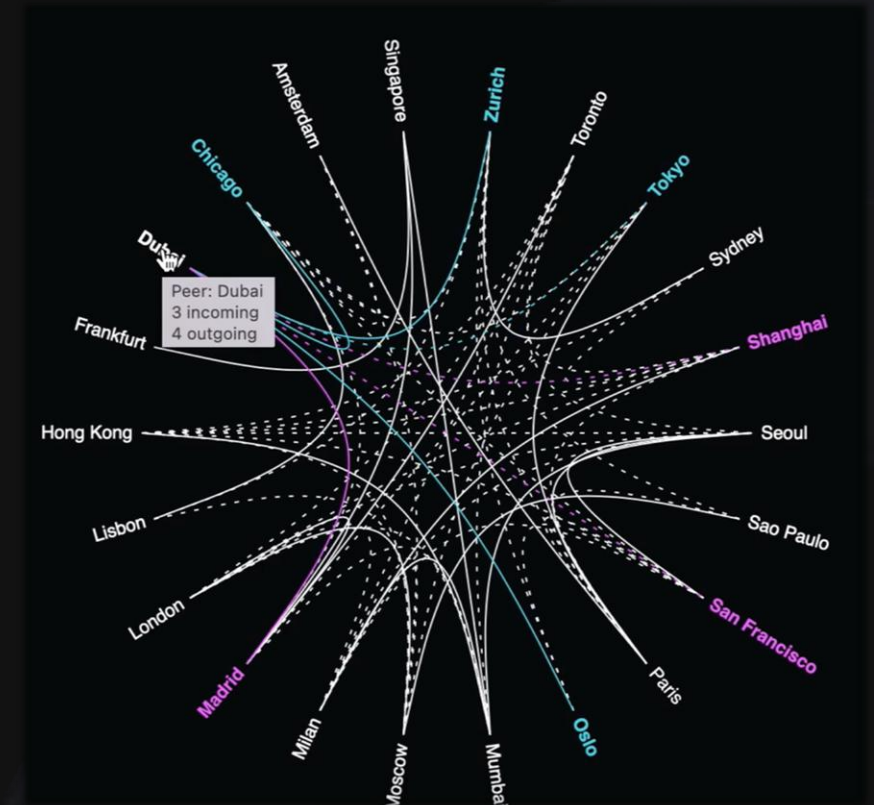
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CONNECT THE CLOCKS (POPs)
Compare with Telecom Hierarchy…

Interconnected POPs (Data center /exchange)

3rd party Operators (Fiber/Dark Fiber)

High speed links

TC available?, used?…

PTP in POPs ; High speed low-latency links

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PROVISIONING OF PTP OVER IP NETWORK

Requires

- A peer-to-peer connectivity so PTP entities can communicate
- Set up PTP transmission between nodes
- Check available capacity
- Maintain "domain" boundaries

Optionally (usually proprietary...)

- Adjusts hierarchy for time source quality dissemination
- Allows reservations in the form of "preference" scores
- Allows for comparison / verification of different time sources
- Includes the concept of "reputation" scores

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CONFIGURATION OF PTP NETWORK IS CHALLENGING

RULES, TOOLS & SELF MONITORING (PTP²)

Define rules:

1. How clocks discover each other

2. Utilize all non-circular paths

3. Allow for n-of-m combination

4. Define clock selection/combination criteria
   to include monitored clock quality

Continuously optimize based on rules and
measurements

OVERLAY TO STANDARD PTP

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HOW DO THE NODES DISCOVER EACH OTHER

Paths created dynamically using either:

mDNS (rfc6762)
- Quick and easy: zero conf
- Not particularly scalable

DHT
- Requires a few nodes whose IP and public key are known
- Highly scalable

Framework - PTP+SQUARED

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CONCURRENT SOURCES

- PTP^2 framework supports synchronizing concurrently to an arbitrary number of sources

- PTP^2 node monitors all available sources (m)

- higher "cost" sources can be brought to an "active" state if lower cost sources fail

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REAL NETWORK EXAMPLE

- TO BE ADDED

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SUMMARY

- Evolution of Networks – the world is not all "Telecom"

- Clock is "just another server"

- Framework of rules and tools for discovery and self optimizing

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Thank you !

Check out our Poster!

ken@timebeat.app

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