ITSF2009

Packet Synchronization – a Comparison of Adaptive Techniques

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Agenda

- Packet clocks
- Frequency
  - Circuit Emulation Services Versus IEEE1588
  - Actual test results
  - PDV Bottle necks
  - Tips and tricks
  - Service clock versus network clock
- Phase and Time of Day
  - Different options
- Conclusions

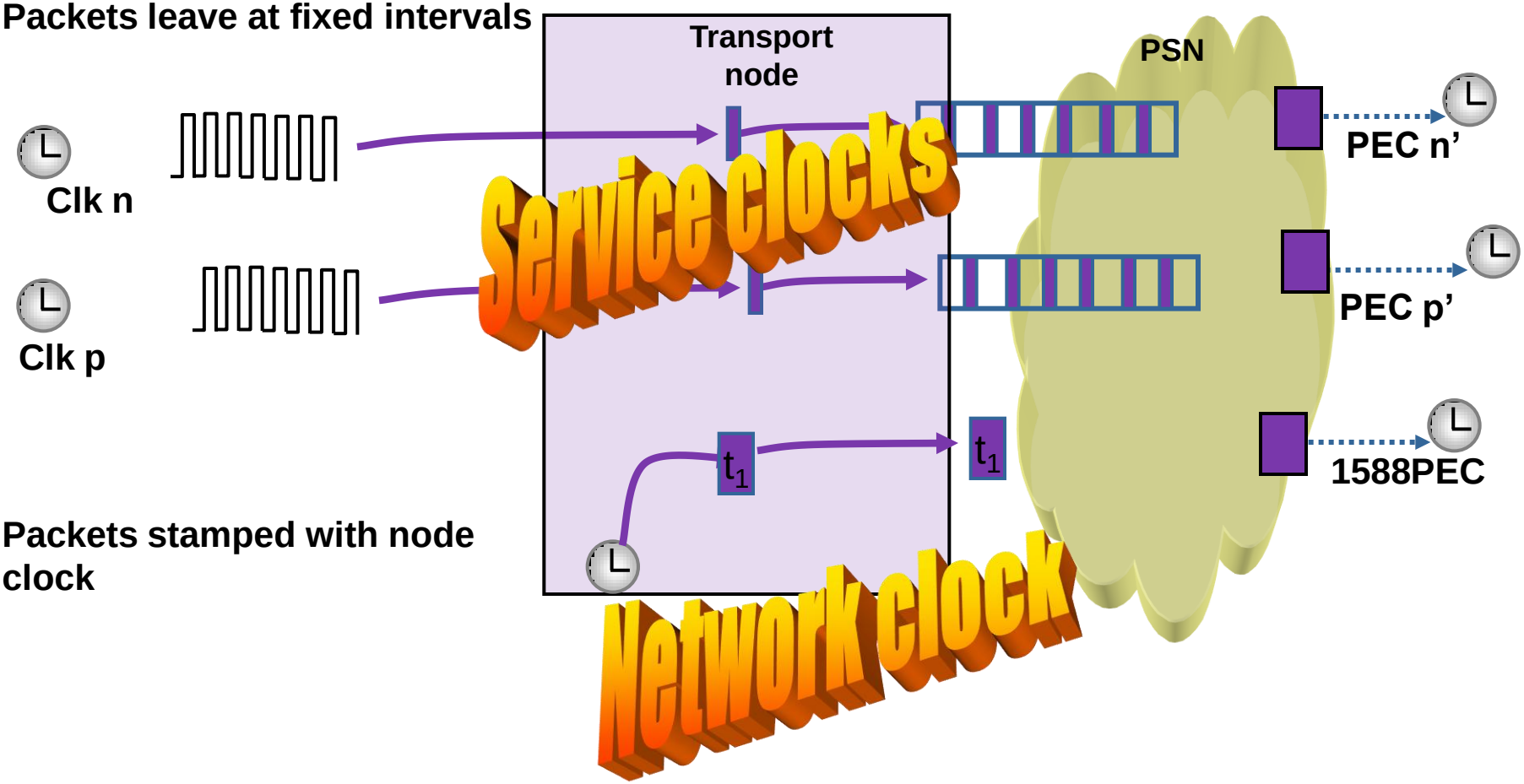
There are different types of Packet Equipment Clocks.

- Frequency or Time
- Master or Slave
- Service clock or network clock
- Topology management via SSM or BMCA
- Synchronous Ethernet assisted or pure PEC

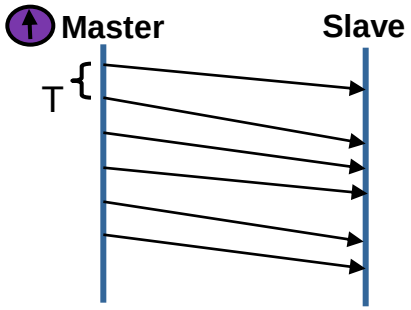
1.Frequency only Packet Clocks

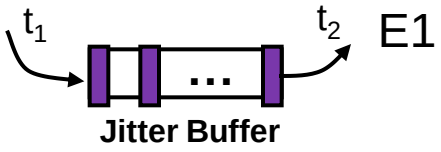
Service and network Packet Equipment Clocks

1. Bits arrive on a clock
2. Encapsulate into fixed size packets
3. Packets leave at fixed intervals
4. Packets stamped with node clock



Frequency only packet clocks (Have been around for some time)

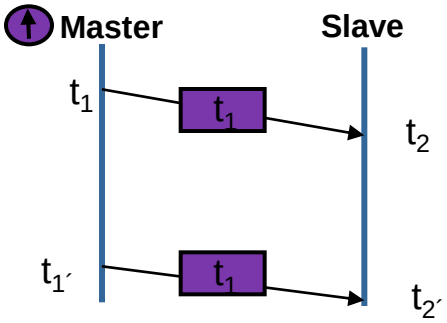




CES

- Constant sending interval
- Local Timestamps (t1, t2)
- Typically needs a physical E1 TDM port

Propriatory

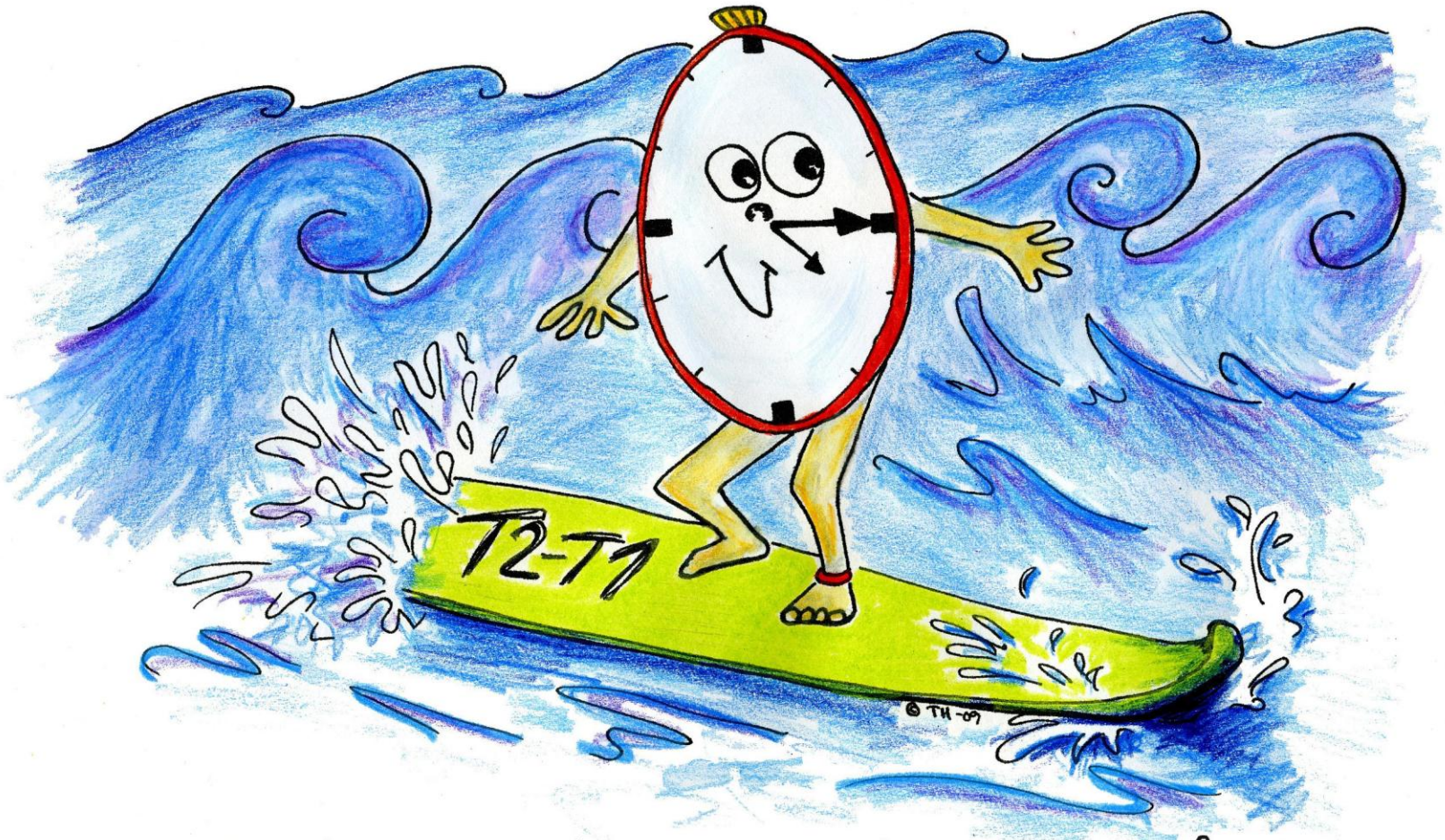


IEEE1588 (or NTP, or…)

- Messages time-stamped (t_1)
- Lower packet rate

Packet selection; min(t2-t1) or mean(t2-t1) or…

Packet clock Surfing championships CES V IEEE1588



Selecting the right wave improves packet clock performance

Factors impacting Packet clock performance:

- Quality of the local oscillator (Temp stability)
- Accuracy of the timestamps (or inter-packet timing)
- Synchronization packets per seconds
- PDV characteristics of the network
- Packet selection algorithm
- Adaptive clock recovery algorithm

Following slides compare

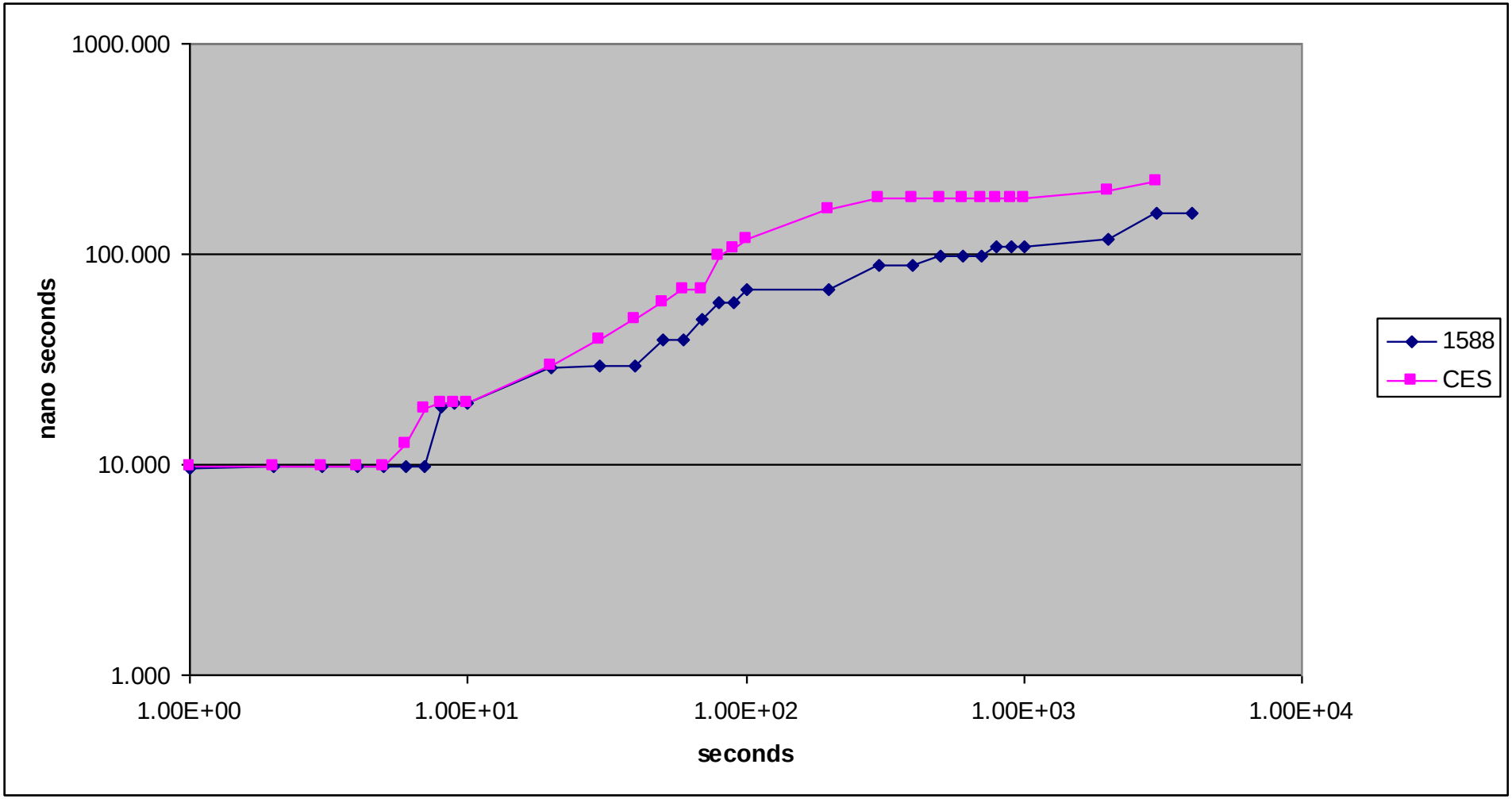
CES (interpacket timing) with IEEE1588 (timestamps)

With same packet clock

CES V IEEE1588

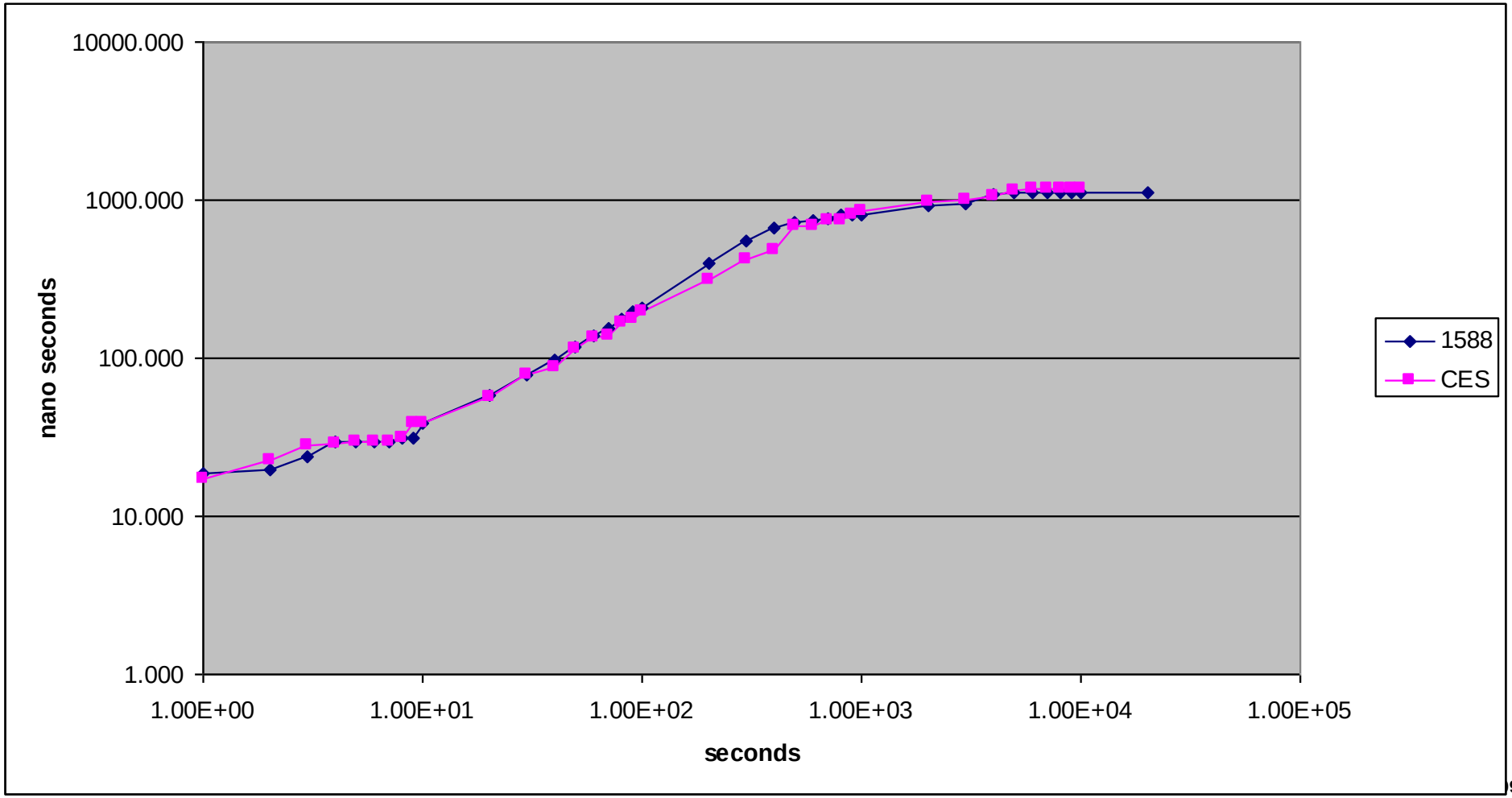
G.8261 Test case 1 Traffic model 2

CES @ 1000pps Versus IEEE1588 @128pps

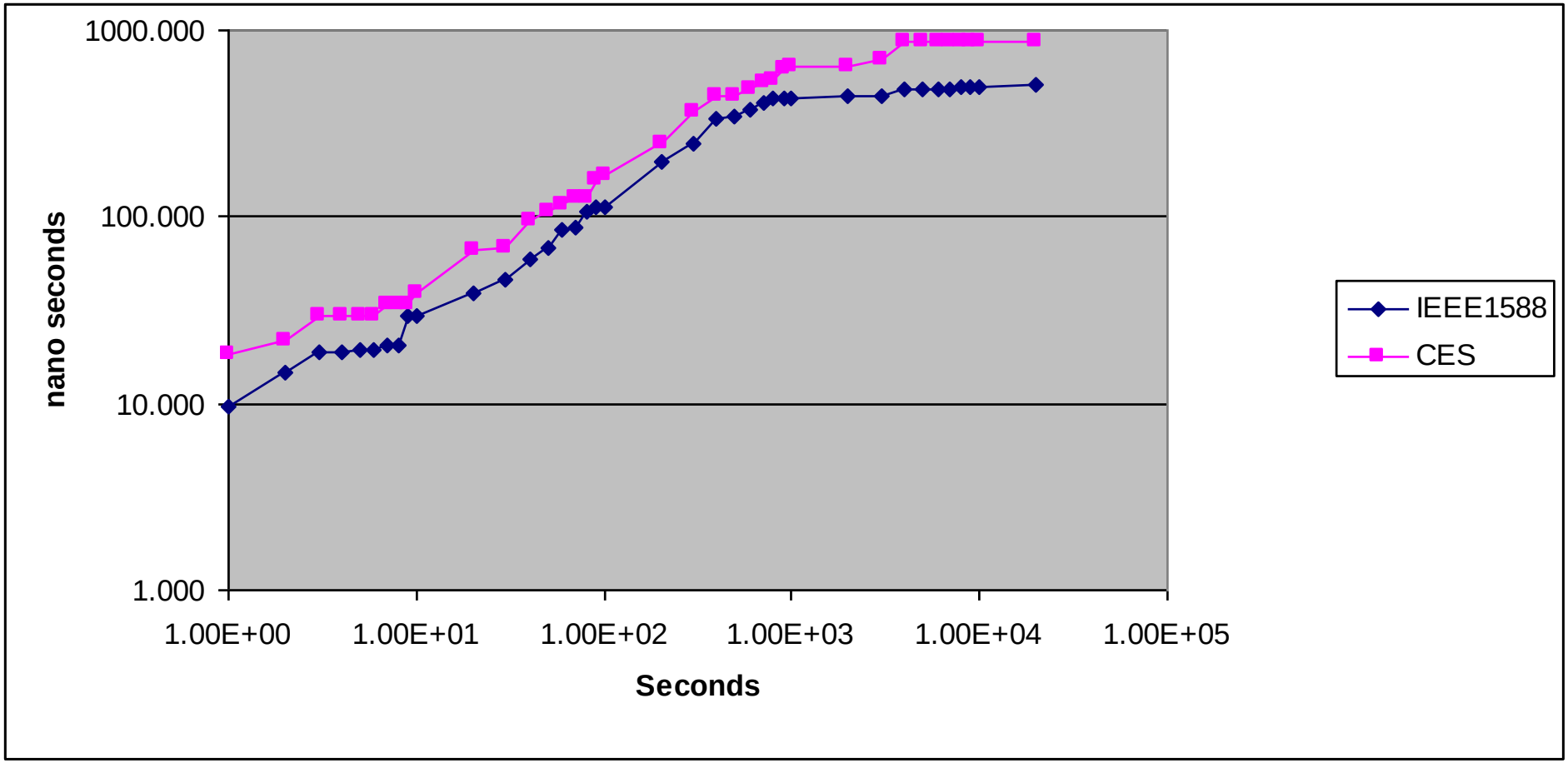


CES V IEEE1588
G.8261 Test case 2 Traffic model 1

CES @ 1000pps Versus IEEE1588 @128pps



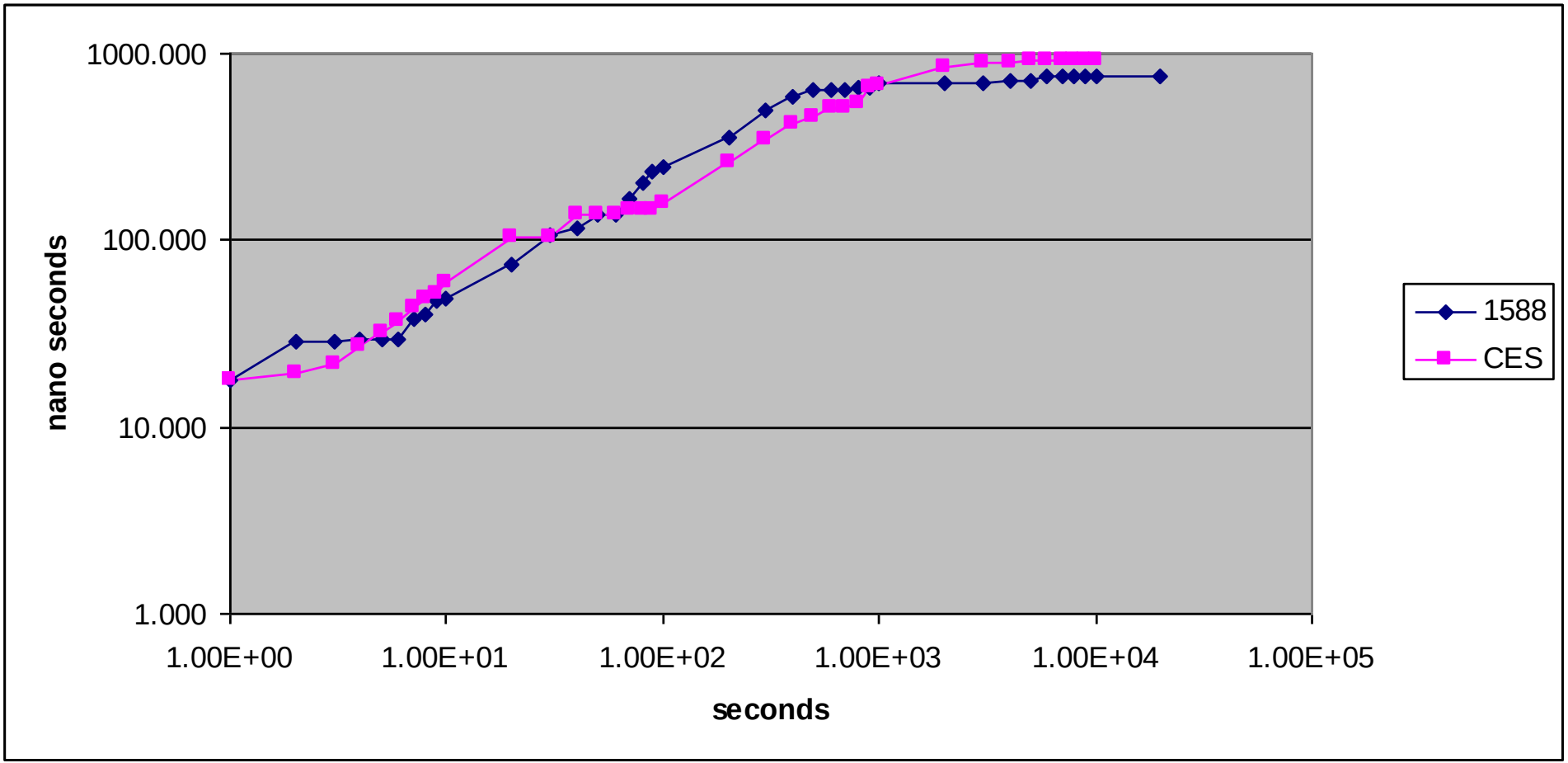
CES V IEEE1588
G.8261 Test case 2 Traffic model 2



CES V IEEE1588

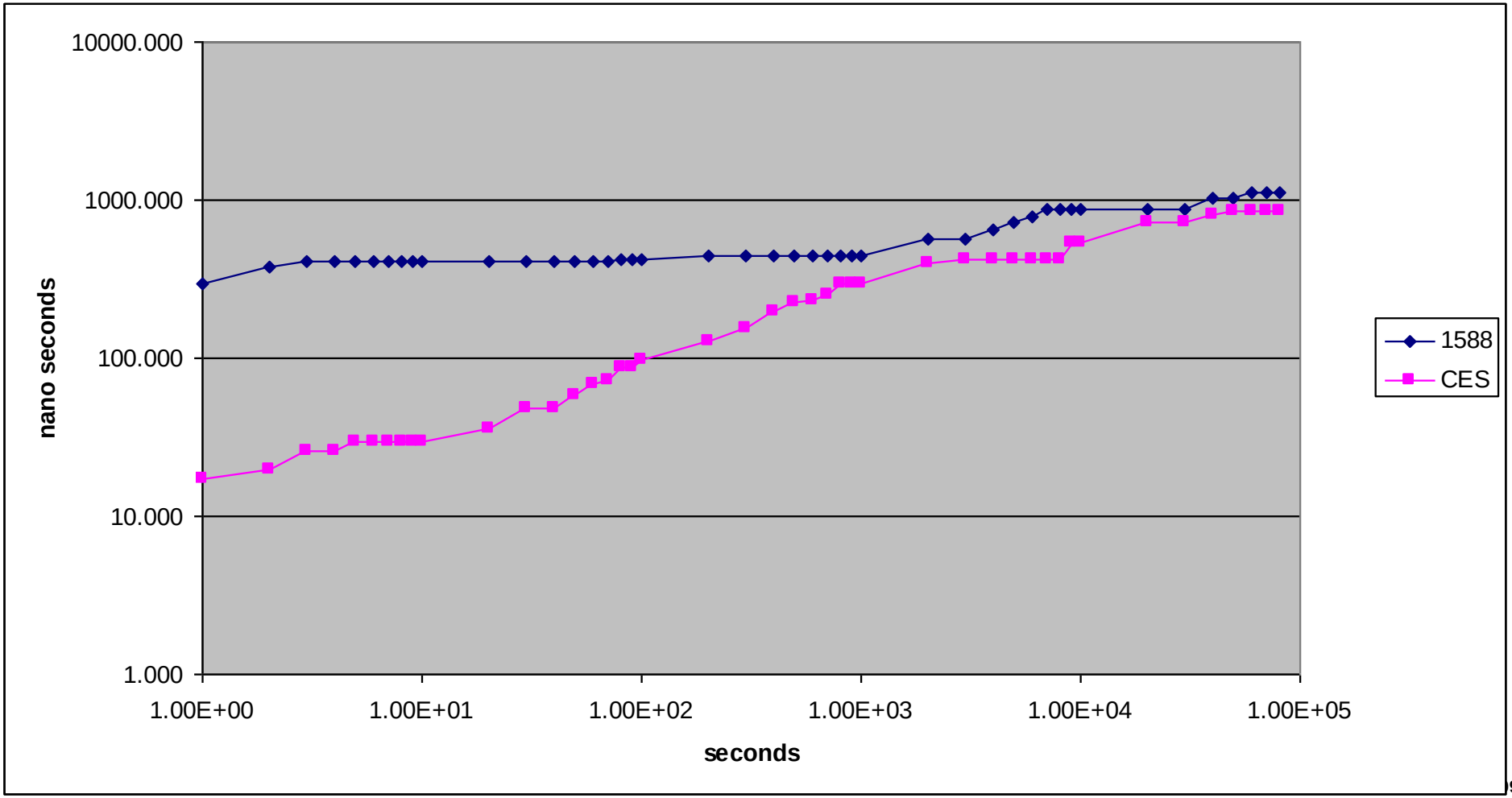
G.8261 Test case 2 Traffic model 2 Peak 90%

CES @ 1000pps Versus IEEE1588 @128pps

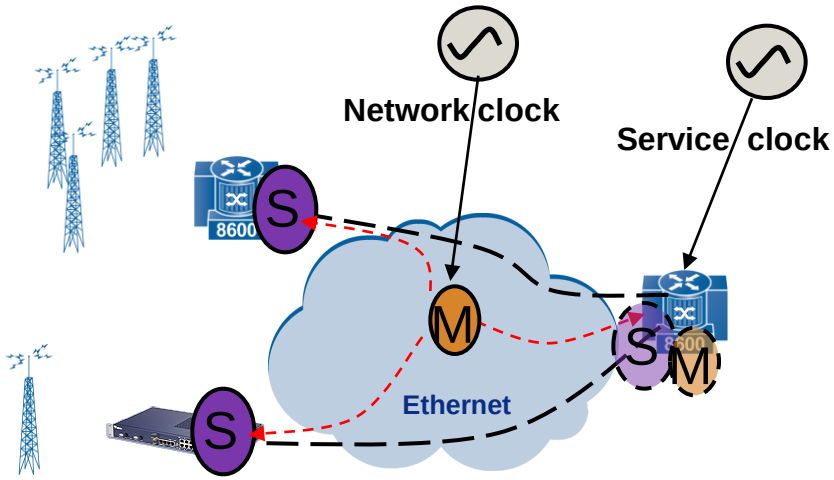


CES V IEEE1588
G.8261 Test case 3 Traffic model 1

CES @ 1000pps Versus IEEE1588 @128pps



Network clock has shorter path, but… most problems are in the access



M 1588 Master

S 1588 Slave

1588 Network Clock

Data Flow

Timing options:

1. **Service clock via CES –** quality implementation dependent

2. **Network clock via 1588**

3. **Service clock via 1588 –** scalability, quality?

4. **Differentially timed via 1588 and CES**

   scalability, demarcation issues?

Medicine for bottle necks
Where congestion introduces excessive PDV

- Bottle necks – e.g:
  - Microwave links
  - Ethernet over SDH
  - SLA policed connections

Shaper – the PDV dragon

- Timing aware shaping can be used when required
  - strict priority
  - Not delayed
  - Fine granularity on queues

- Alternative is link-by-link processing of timestamps (after traditional shaping)

Tips and Tricks
To improve packet clock performance

Uplink PDV

1. Two way syntonization
   - Easier to implement in 1588

   (Harder to implement on CES)

Downlink PDV

2. Multiple master ensembling
   - Possibly part of master protection
   - Not really practical with CES

3. Other – Acme Algorithms Inc.

Standardization effort

- **CES considered non-standard (rightly or wrongly)**
- **IEEE1588-2008 standard leaves many options open**
- **IEEE1588 use in telecoms frequency applications – work on defining a suitable profile is ongoing in ITU-T Q13.**
  - **One goal is specification of metrics for pacet clocks**
  - **Another is Clock selection mechanism (BMCA).**

ITU-T 1588 telecoms profile for Frequency

- Masters are always masters
- Slaves are always slaves

- Network is traffic engineered (carefully)
  - PDV limited (priority, bandwidth, routing, technology...)
- BCs / TCs are not available (no on-path support)
- Clock selection in the spirit of ITU-T G.781
  - Slaves use traceability information and local “priority”

Definition of a BMC for telecoms

Difficult to give “hard quality guarantees”

2. Phase and TOD Packet Clocks

Telecom Phase and TOD solution will be completely different

Timing service – next generation network

- Every nodes contains mechanisms to compensate for:
  - PDV
  - and link delay

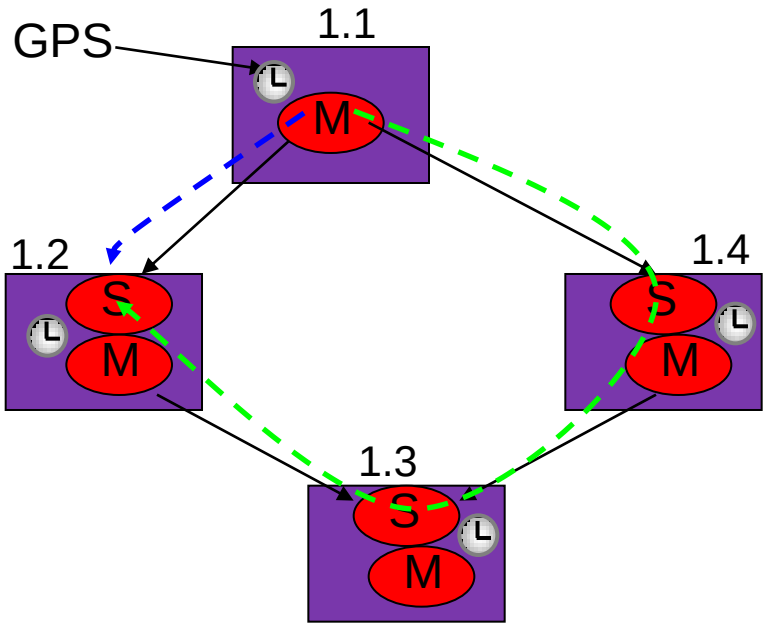
- Fixed provisioning
  - Master roles
  - Slave roles
- Topology management

Versus auto-provisioned

Assymetry is the issue not PDV!

BC senario – keeping step with network topology

- **Telecom frequency profile:**
  - **Addressing is L3 unicast**
  - **Slaves provisioned with master's address**
- **For accurate phase 1588 must be locked to the link topology.**
- **Synchronous Ethernet could have role.**



Must be link local solution

Clock Address x.y

Node Phase clock L

PTP master M

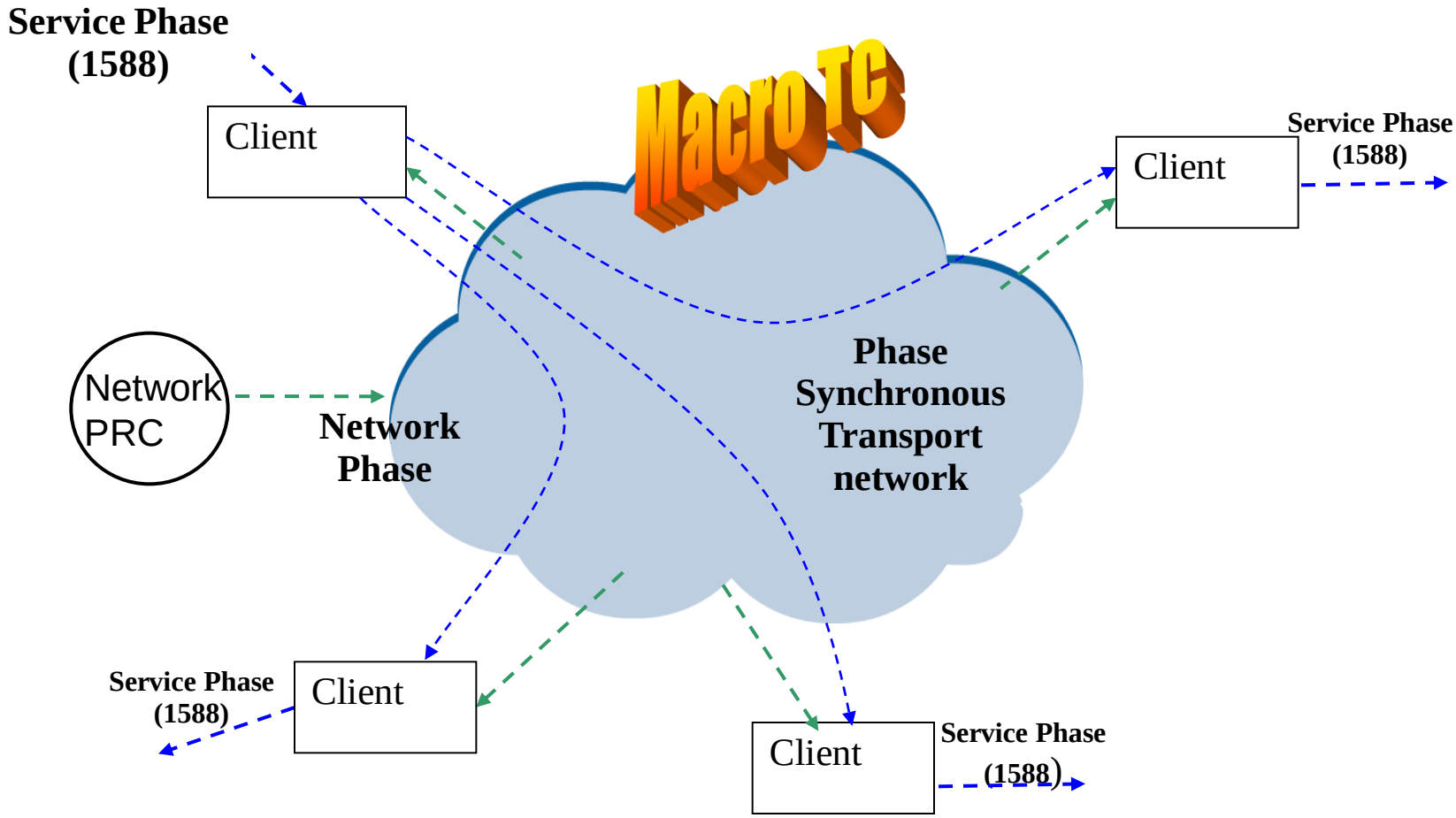
PTP slave S

Speculation on future phase/TOD solutions

- Boundary clock model most appropiate
- Link-by-link is best enforced at layer2
- Multicast has no addressing configuration (link local)
- Topology management via BMCA or SSM (ITU-T is evaluating alternative BMCAs)
- Frequency via Synchronous Ethernet (common with current direction)

Extending Sync-E to support phase would still be the simplest solution

Service phase 1588
Network phase – technology specific



Clients see a perfect network (no PDV) and use IEEE1588 without modification

Conclusions (Take-away)

- Frequency – across legacy network
  - CES and 1588 Packet clocks are essentially the same
  - Network timing via 1588 prefered
  - Service phase delivery via 1588 or differential CES have issues

- Phase and TOD – new network deployment
  - On path support required
  - A mix of Syncronous Ethernet and 1588 looks likely
  - Network must support phase and TOD as a service

- Standardization required
  - 1588 profiles for frequency and phase (will be very different).

Thank you!

Questions?

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