IEEE1588, PRECISION TIME PROTOCOL: WHERE IT CAME FROM AND WHERE IT'S GOING

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Agenda

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- IEEE 1588 (PTP) Basics
- History and evolution of the standard and technology
- Thoughts on the past and future of IEEE 1588

IEEE 1588 Basics

Like all time distribution systems IEEE 1588 provides:

- A mechanism for establishing the time distribution topology,
- A mechanism for distributing the time.
- Definition of all attributes, message formats and other information to enable the distribution of precise time

In addition IEEE 1588 provides a mechanism (profiles) for specializing IEEE 1588 for particular applications or industries.

IEEE 1588 Basics

The mechanism for establishing the time distribution topology

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IEEE 1588:

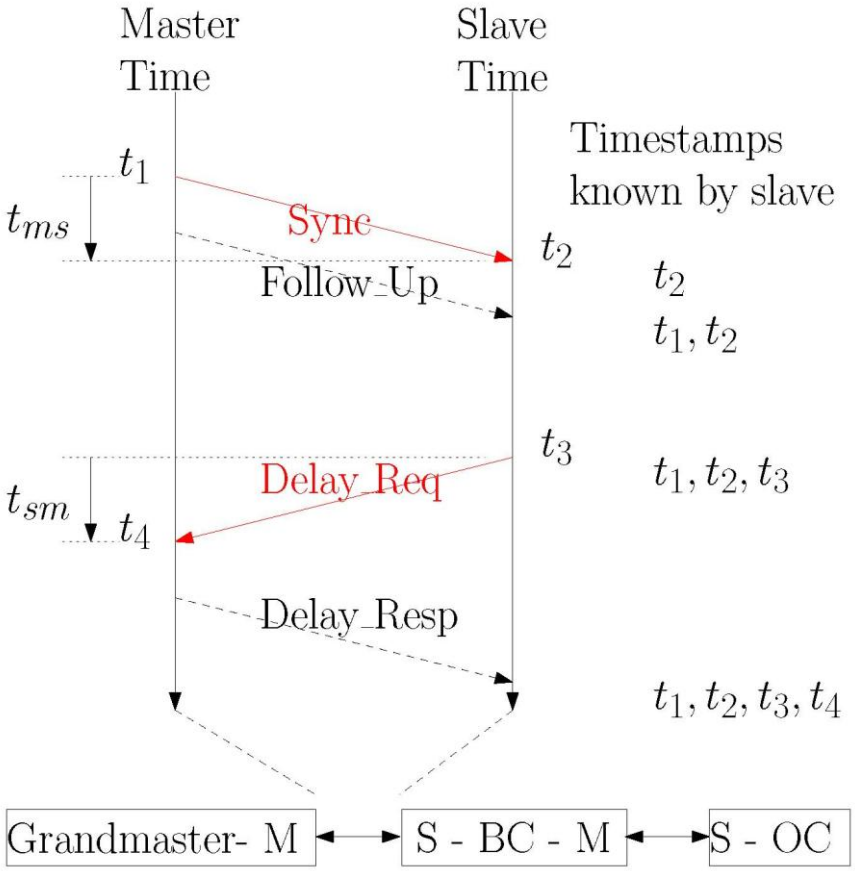
- Uses a master-slave hierarchy for time distribution
- The root of this hierarchy is a clock termed the grandmaster
- The grandmaster is the source of time distributed by the protocol
- The determination of the hierarchy is done via a distributed algorithm called the best master clock algorithm, or BMCA
- The BMCA uses attributes defining clock characteristics and topological information.

By contrast NTP defines a collection of servers that jointly determine the time to be distributed to clients.

IEEE 1588 Basics

The mechanism for distributing the time

IEEE 1588 is a two-way time transfer protocol where time information is exchanged between a master and slave .



If link is symmetric:

$$Offset = t_{slave} - t_{master} = [(t_2 - t_1) - (t_4 - t_3)]/2 = [t_{ms} - t_{sm}]/2$$

$$Propagation\ time = [(t_2 - t_1) + (t_4 - t_3)]/2 = [t_{ms} + t_{sm}]/2$$

IEEE 1588 Basics

The mechanism for distributing time-(more details)

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The major impairments to precise time transfer are: jitter in measuring timestamps, jitter in path latency and in path asymmetry.

IEEE 1588's contribution to solving these issues:

- Recommends that timestamps be generated as close as possible to network interface (e.g. within the PHY)
- Two-step clocks (use follow up messages) for easier implementation
- On-path support (boundary and transparent clocks) to eliminate latency and jitter in bridges
- Specification of how to handle asymmetry if known
- Unlike NTP, PTP does not specify synchronization servo algorithms (which allows telecom vendors to create algorithms for filtering PDV)

IEEE 1588 Basics

Definition and profiles

IEEE 1588-2008:

- Defines all attributes, message formats and other information to enable the distribution of precise time
- Allows organizations (e.g. ITU-T) to define profiles which specialize IEEE 1588 for their particular applications.
- Current profiles are:
  - Default profiles for use in general application work
  - ITU-T profiles for telecom (these will be discussed in more detail in later talks)
  - Power industry profile
  - 802.1AS (audio applications, also being extended to automotive and industrial)
  - WIP: enterprise, financial, motion picture industry

Thoughts on the past and future of IEEE 1588
(wherein all is revealed about telecom's growing influence on IEEE 1588- and the consequences thereof)

- PTP is based on work started in the late '80s at Hewlett Packard and continued at Agilent Technologies.
- IEEE 1588-2002 committee consisted of 13 members: Test and Measurement (T&M) 46%, Industrial Automation (IA) 31%, Timing Community (Time) 23%, (sorry no telecom)
- In 2003 the first IEEE 1588 workshop held at NIST : 16 papers (12 IA, 2 T&M, 1 power, and 1 telecom)

"Implementation of IEEE Std.-1588 in a Networked I/O Node", Mark Shepard, GE Drives & Controls

"IEEE 1588 Proposal for Metro Ethernet Enterprise Solutions", Glenn Algie, Nortel Networks


Courtesy of General Electric


Courtesy of Huawei

Thoughts on the past and future of IEEE 1588

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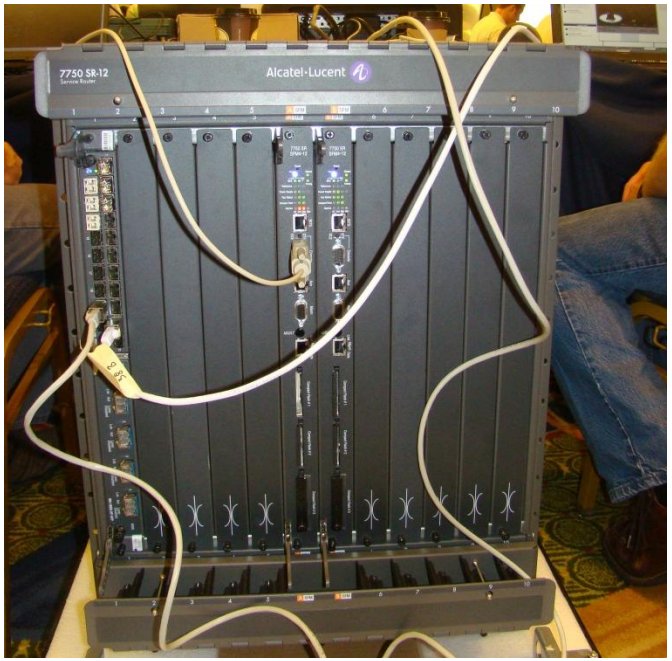
- IEEE 1588-2008 committee consisted of 50 members: T&M 45%, Telecom 42%, IA 8%, Power 6%, Military 4%, Time 2%
- ISPCS 2012 San Francisco: Plugfest with heavy telecom presence



Thoughts on the past and future of IEEE 1588

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- 2013 IEEE ICAP certification process for telecom profile
- IEEE 1588-201? committee consists of 187 members of which 59 are voting members: Of voting members: General (includes chip, GM clock vendors) 39%, Telecom 31%, IA 12%, Academic 8%, T&M 7%, Power 2%, Military 2%
- 2013 operating PTP application device count in order (an educated guess)
  - Telecom: ~500K to 1M nodes (China Mobile alone reported 440K at ITU)
  - Power generation: ~100K (based on conversations with GE)
  - T&M, financial, industrial, audio and consumer, scientific, others: <10K each.

Thoughts on the past and future of IEEE 1588

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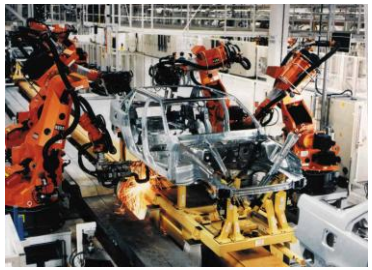
All applications are important in making PTP widely adopted and in advancing the technology

Brüel & Kjaer

Alan D. Monyelle, USN, 5/23/02

CERN

Agilent Technologies



Kuka

Brüel & Kjaer

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Thoughts on the past and future of IEEE 1588
A guess (maybe even a certainty)

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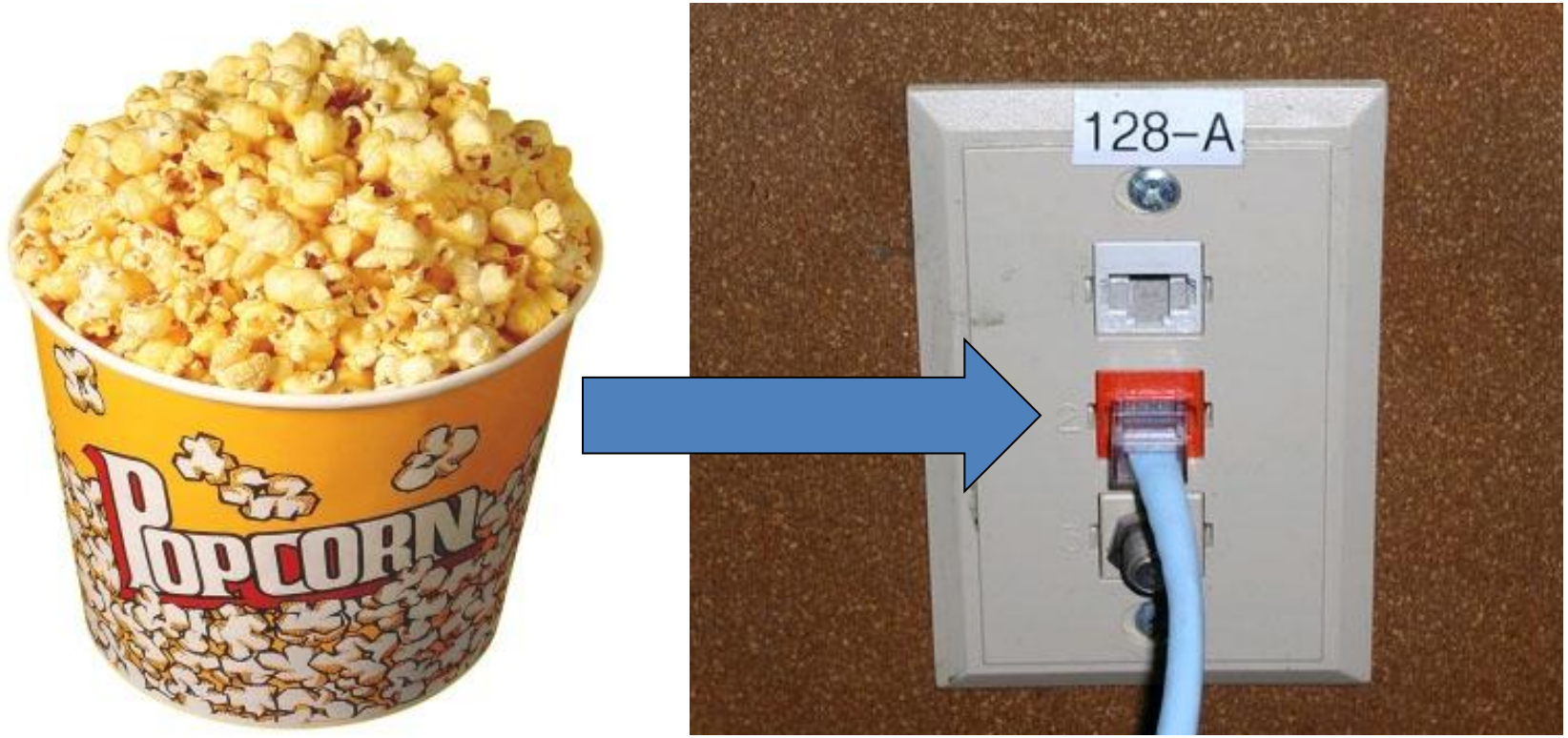
- Users will demand accurate, precise, robust, ubiquitous time
- Users are going to try running their own IEEE 1588 domains over the public internet.
- **It will not be satisfactory** (no on-path support)
- How will this affect telecom sync and operators?
- (so far you have thought about IEEE 1588 primarily for telecom purposes)

What if we brought back popcorn?



"At the next tick of the IEEE 1588 clock the time will be:
2013-11-05 10:35:02.010234 1µs TAI
(or for a few more $,€,£/month 10ns)"

My guess is-

- Result in more deployment of distributed applications
- More robust timing based on redundancy between GPS, wire line (NTP and IEEE 1588), and
- **New innovative ways of using time by customers you have never heard of**

Conclusions

- We have only scratched the surface of time-based applications
- GPS, NTP and IEEE 1588 will jointly and separately play key roles
- We can expect many more innovative uses of time and of high accuracy time
- Ubiquity is key- time must be a service not an application domain function
- **Telecom industry has a KEYSTONE role to play to enable timing capabilities and opportunities for your customers**

Thank you