Peer-calibration architecture: The “pitch”

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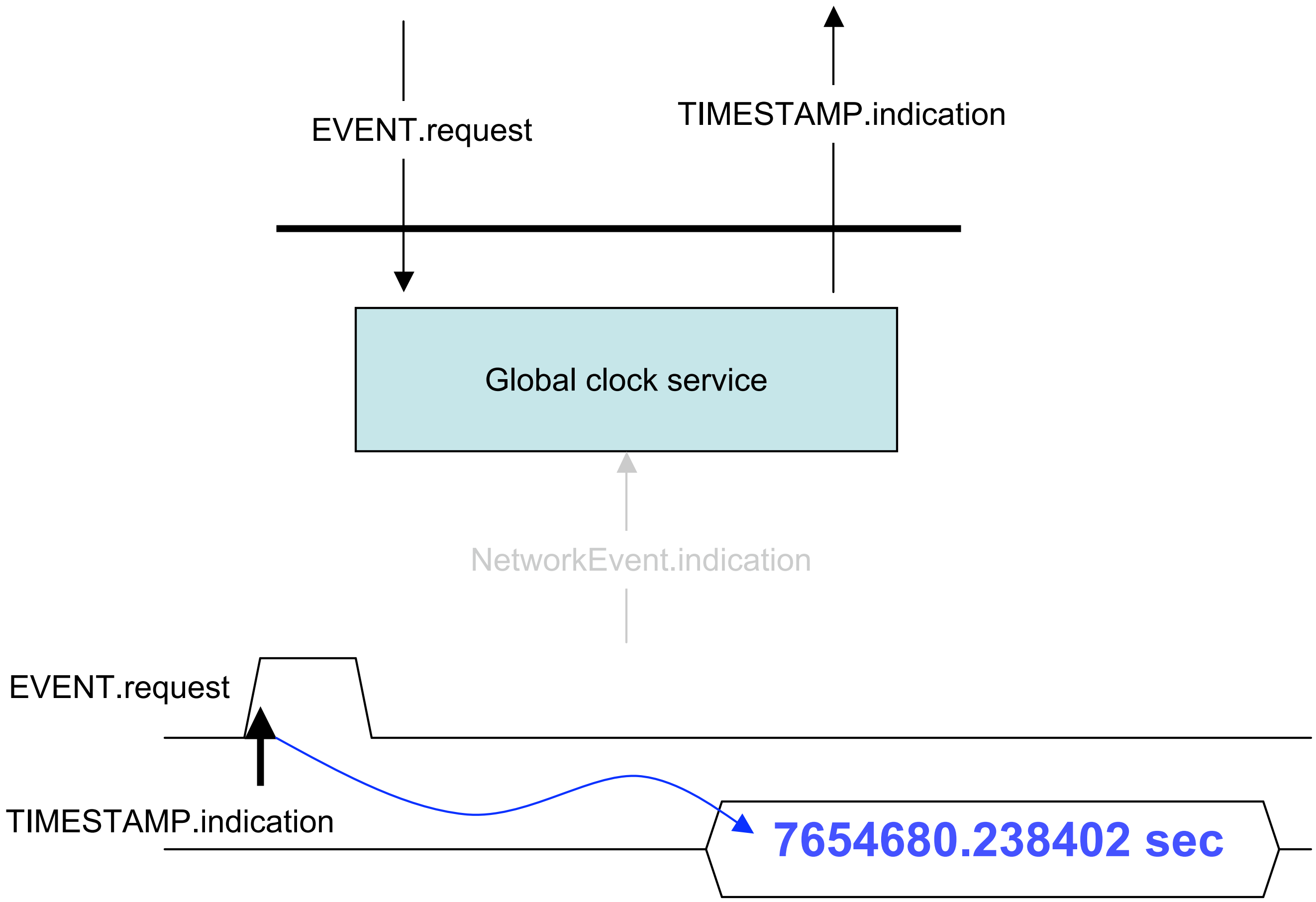
Peer calibration: characteristics

- Independent local clocks
  - All time relationships modeled algorithmically
  - No “controlled clock” phase-locking or frequency-locking in reference model
- Two messages:
  - *LocalSync*: 64 bytes, correlates adjacent clocks, media dependent, gets ingress/egress timestamp, uses local non-forwarding MAC address
  - *Network Event*: 66 bytes, transfers time, media independent, no ingress/egress timestamps, typically uses multicast

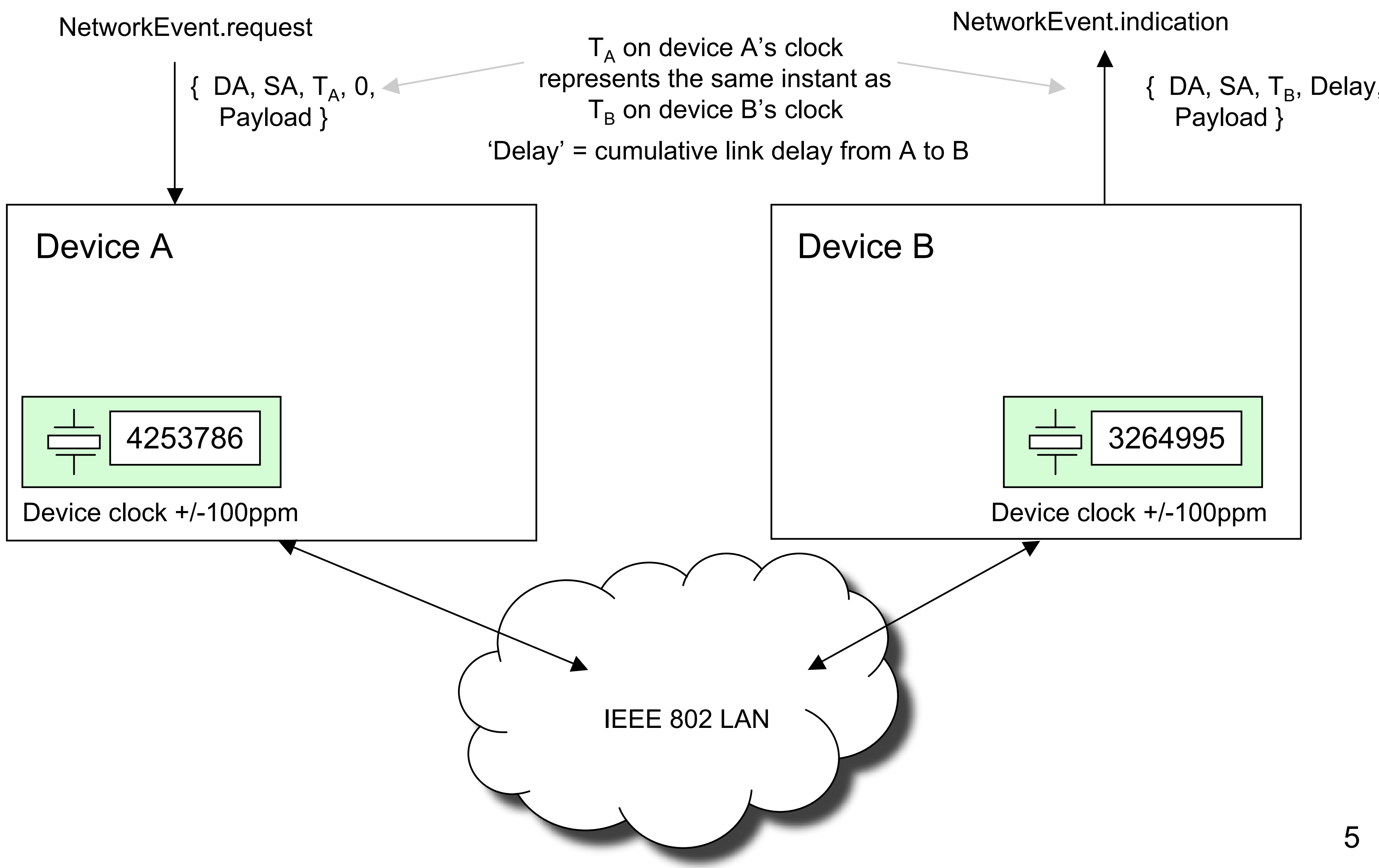
Peer calibration: application features

- Provides Global clock, as event/timestamp
  - No gain peaking (“system engineering” not req’d)
  - Can settle quickly after topology and GM changes
- Provides NE (Network Event), a unique feature
  - NE.indication = { event-time, delay, payload }
  - Addressed and delivered per 802:
    - unicast, multicast, or broadcast for DA (Destination Address)
  - Applications of NE service:
    - Directly supports AVB grandmaster time distribution
    - End-to-end link-delay (distance) report – any two stations
    - Sensor/actuator events without global clock

AVB Global Clock Service



Network Event Service (generic)

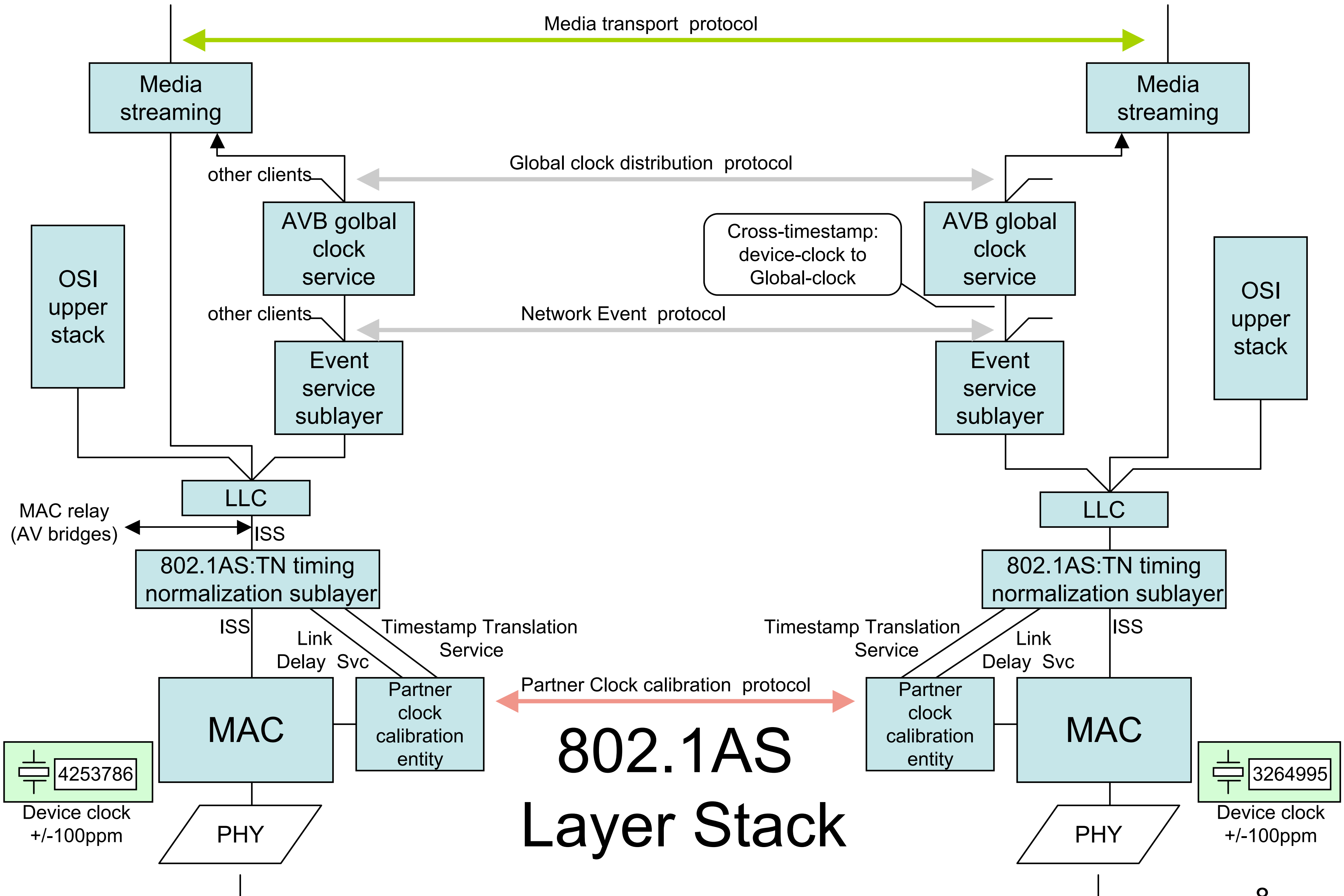


Peer calibration: structural features

- Layered, 802-friendly design
  - Modularity 1: peer calibration layer
    - Peer calibration protocol (LocalSync message in 802.3) may be “swapped out” for different physical media, e.g. 802.3, 802.11, PON, 802.17, etc.
    - Fully specified internal abstract interface (Timestamp Translation Service, Link Delay Service)
  - Modularity 2: timed event layer
    - Behavior readily specified using existing 802.1 architectural elements: MAC, ISS, LLC, MAC Relay
    - AV Bridge behavior has no dependence on global timescale
    - Media-independent event message uses *no* HW timestamp

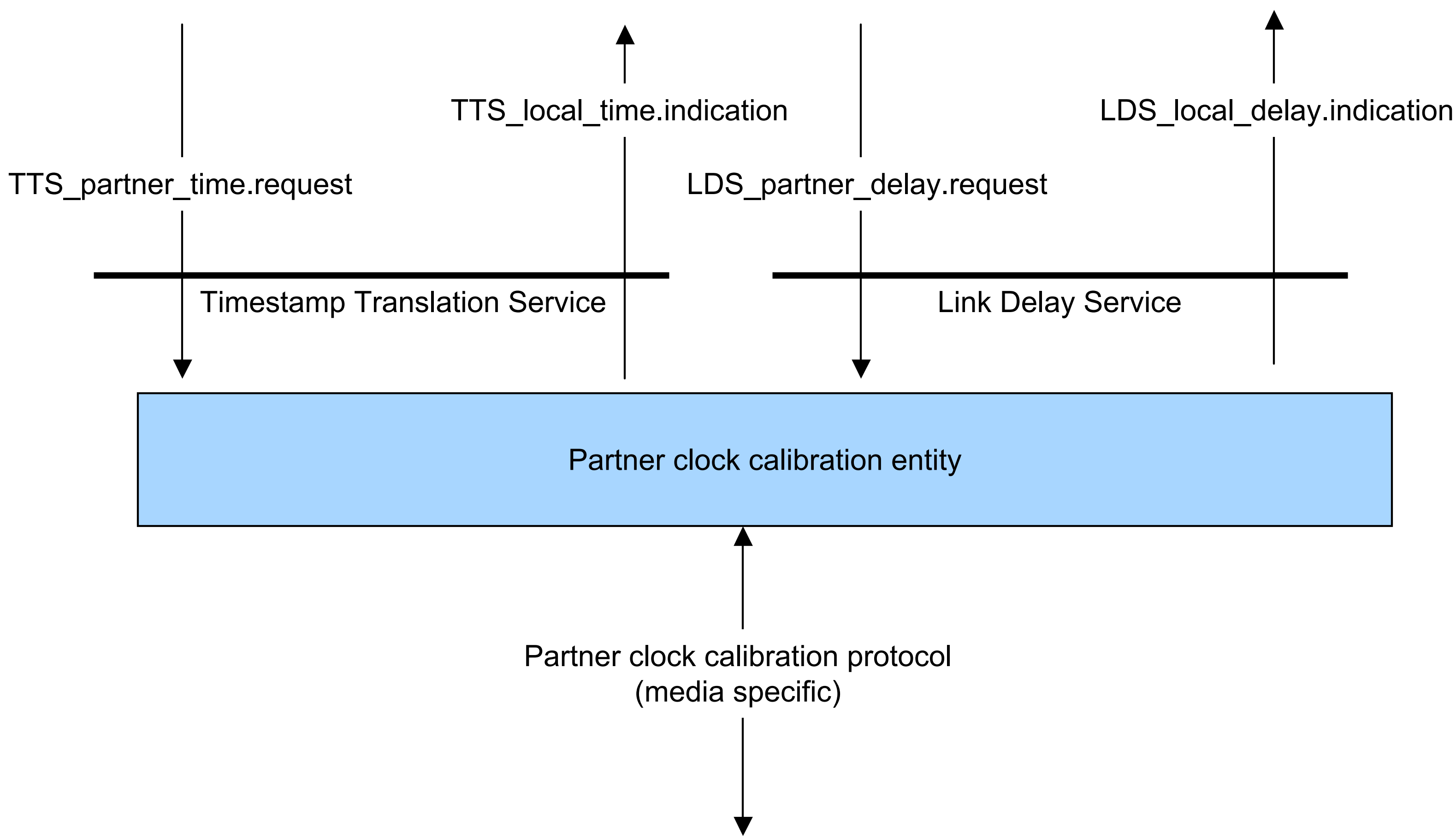
Peer calibration: structural features (cont'd)

- Layered, 802-friendly design
  - Modularity 3: global clock layer
    - Single global-clock domain (AVB requirement) readily implemented using 802.1 multicast addressing model
    - Alternate application clock domains can transparently coexist through distinct multicast groups or unicast
    - Simple grandmaster election (3-state state machine)
    - "Flat" clock hierarchy, no BCs needed to meet AVB spec
  - Result:
    - Clarity in standards presentation: 4 simple state machines, well decoupled = easy to design to, easy to define compliance tests
    - Extensibility to other media, other event/delay applications, other time distribution applications = long standards life



802.1AS Layer Stack

Partner clock calibration services (abstract internal interface)



Peer calibration architecture: current status

- Most recent published draft
  - as-harrison-protocol-text-0307.pdf (numbered as clause 7)
  - Covers similar scope to clauses 7 & 9 of P802.1AS/D0.6
- Technical work remaining in standard
  - Formal state machines
  - Refinement (e.g. message fields)
  - Managed objects
  - Default parameters (based on simulations)
  - Compliance
- Supporting work remaining
  - Simulation
  - Editorial

Enjoy Orlando!

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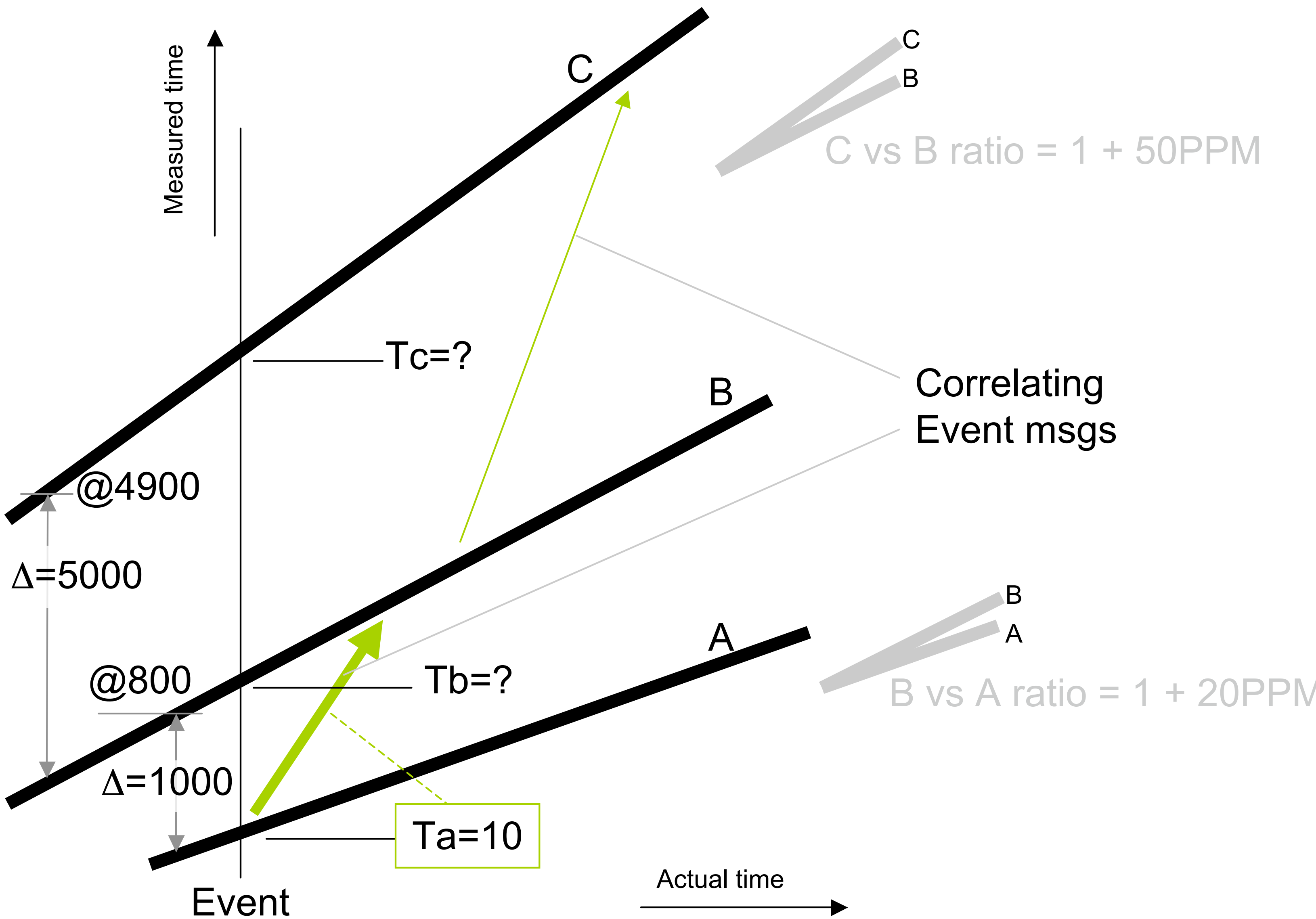
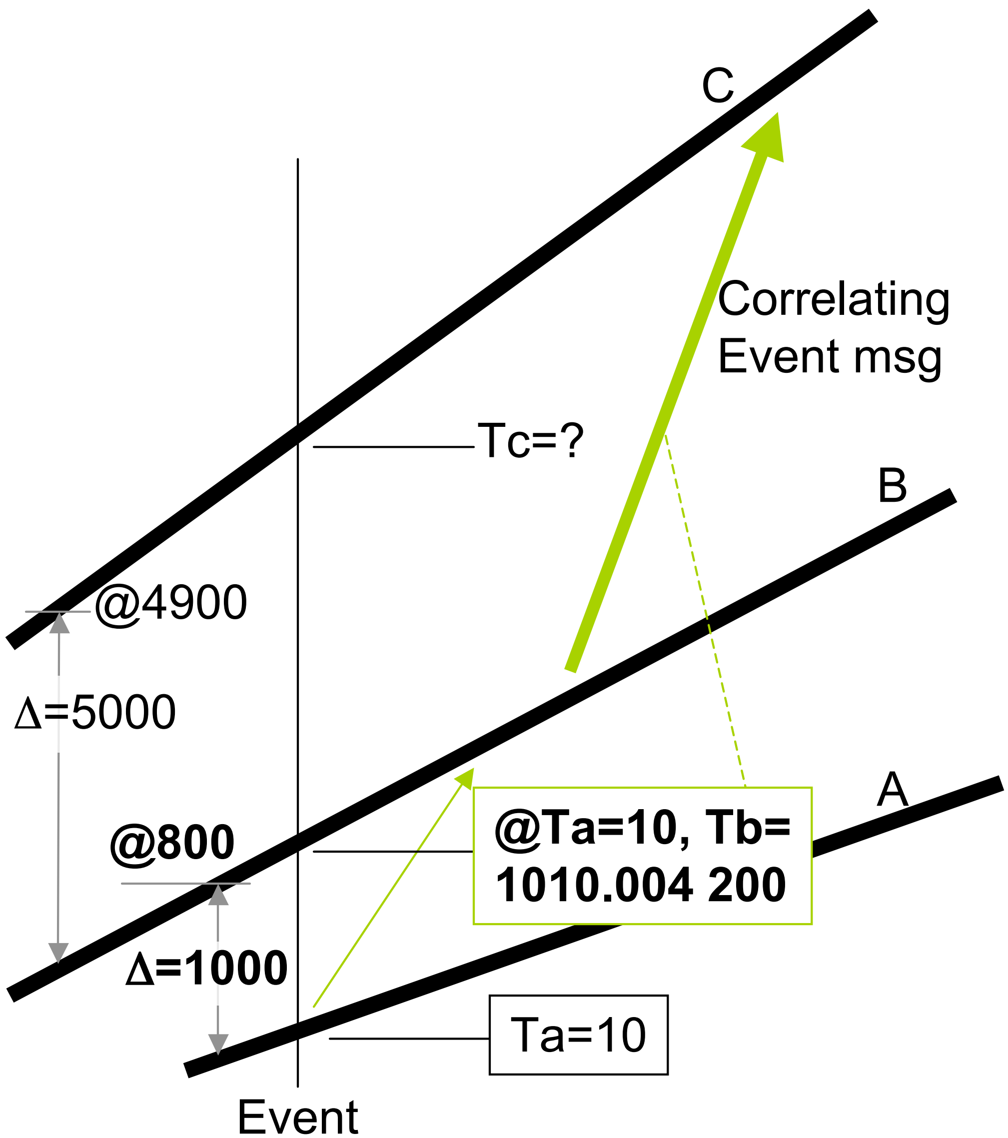
Example scenario

- Three nodes: A, B, and C.
- Event happens in A at Ta=10. Other nodes have clocks that have the time and absolute PPM offsets as follows:
  - Ta=10, 0 PPM (the Grand Master)
  - OFFab=1000, PPMab= +20, last measured at local B time of 800 (B faster than A by 20ppm)
  - OFFbc=5000, PPMbc= +50, last measured at local C time of 4900
- At Tc=7500, an application running at C asks, “What time is it?”

Peer scenario (graphically)



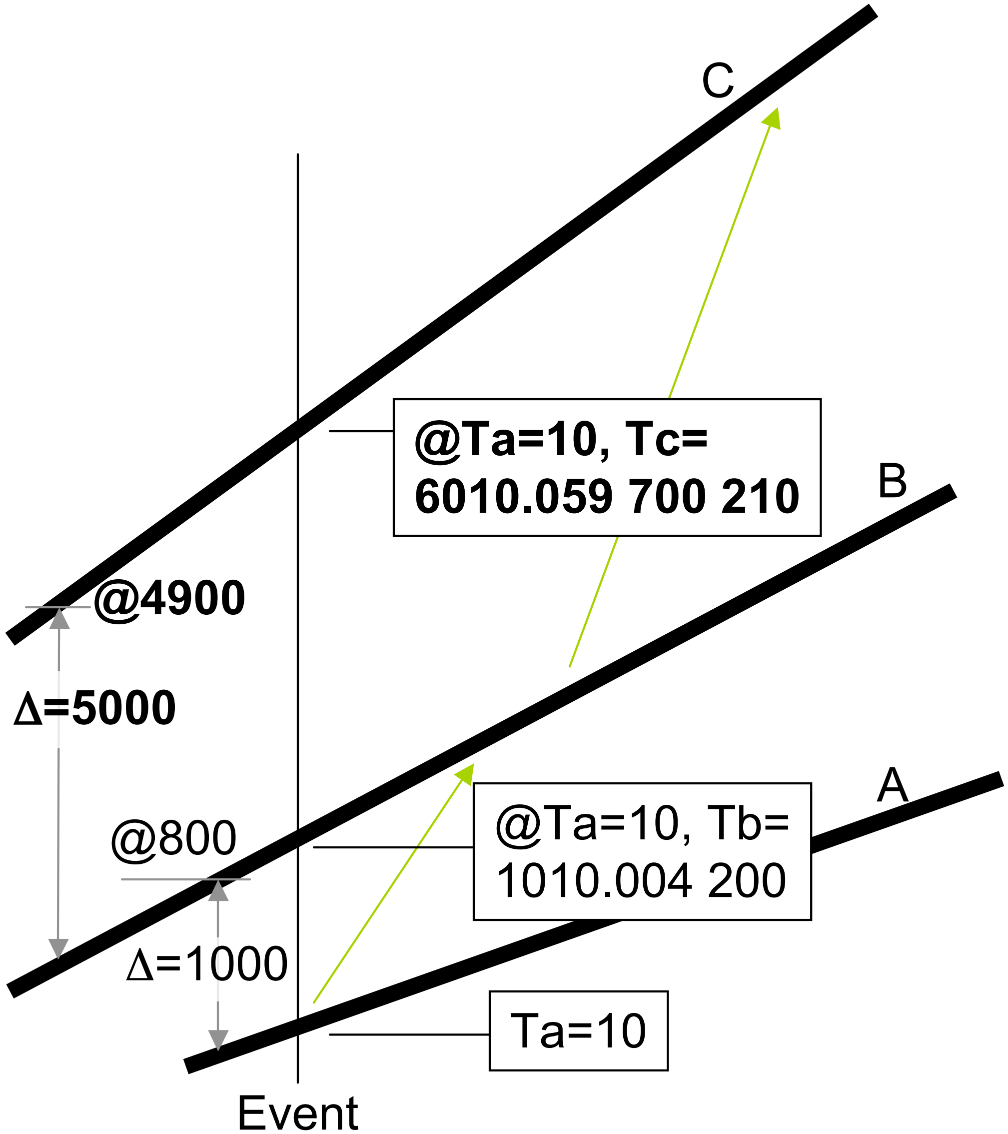
Peer scenario (graphically)



Node B says:
I was 1000 ahead of peer A when local was 800, and running 20PPM fast. So when peer's time=10 happened, my local time was at 1010 + 20PPM * (1010-800)

Tb= 1010+210*20e-6
= 1010.004 200 000

Peer scenario (graphically)

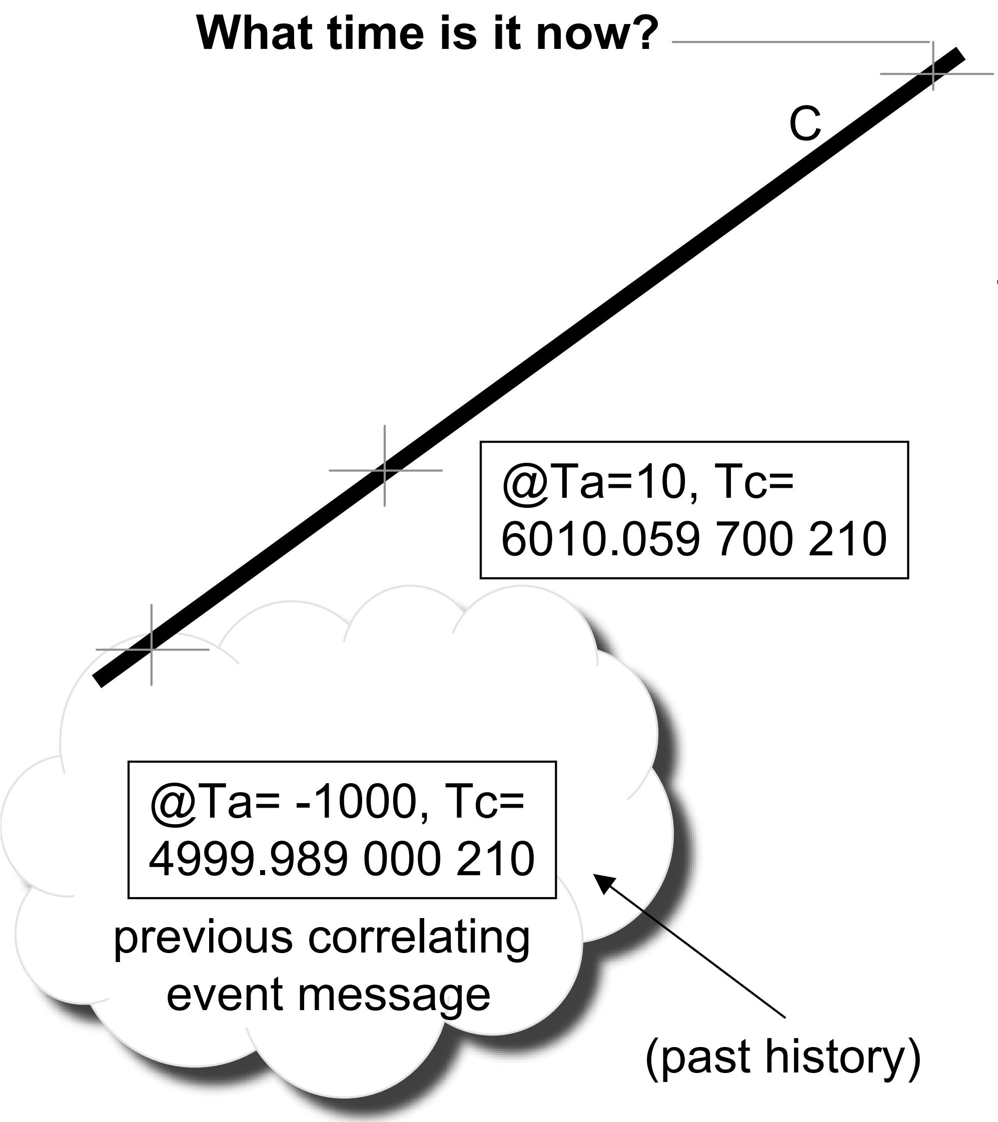


Node C figures:
I was 5000 ahead of peer B when local was 4900, and running 50PPM fast. So when peer's time=1010.004 200 happened, my local time was at 6010.0042 + 50PPM * (6010.0042 - 4900)

Tc= 6010.0042+1110.0042*50e-6

= 6010.059 700 210

Accessing GM time



Node C figures:

The last two GM updates were

Ta = 10, Tc = 6010.059 700 210

Ta = -1000, Tc = 4999.989 000 210

Extrapolating to Tc = 7500,

$$Ta = (7500 – 6010.05970021)^* (10 – (-1000))/ (6010.05970021-4999.98900021) + 10$$

Ta = 1499.836 011 269 211

“now” = 1499.836 011 269 211
Grandmaster Time