IEEE 802.1/802.15 Joint Meeting: Time Reference Points in IEEE 802.1/TSN

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Overview

Purpose

This slide set is intended to encourage discussion between IEEE 802.1 and IEEE 802 MAC/PHY groups on *time measurement reference points* used in IEEE 802.1 protocols and protocol mechanisms (see also https://1.ieee802.org/tsn/) and discussed in IEEE 802.1 Maintenance Item #314.

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- IEEE 802.1 Maintenance Item #314 in a Nutshell

- Some uses in IEEE 802.1 Standards

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IEEE 802.1 Maintenance Item #314 in a Nutshell

IEEE 802.1 Maintenance Item #314: Requested on 2021-03-04

- **Rationale**
  The text "boundary between the network media and PHY" is problematic due to terminology/abbreviation usage in the context of 802.1Q. This text is found at various locations throughout the standard (16 matches in D0.2 of the next Q-Rev). …

- **Proposed Text**
  Options for discussion:
  1) Avoid using "PHY" - one set of replacement phrases to start discussion could be the following: "boundary between the physical medium and the station [Port]", …
  2) Add a definition of PHY such as …
  3) Add two definitions such as "PHY" and "PHY device"/"PHY entity", …
  …

Source: https://www.802-1.org/items/427/requests/317/pre

IEEE 802.1 Maintenance Item #314: Subsequent Meetings (1)

- **Maintenance TG Meeting 2021-06-22**
  … It was agreed that the best solution would involve defining a reference point in 802.1AC and have each MAC then specify how to identify it. Then 802.1Q would use the 802.1AC reference point where appropriate. …

- **Maintenance TG Meeting on 2022-03-29**
  In reviewing 802.3cx, it was agreed that the bottom dashed line of Figure 90-5 (below the MDI) is the desired reference point to describe in 802.1Q when discussing a reference point for timing.

  …
  In 802.1AS and IEEE1588, the term "reference plane" is used to describe basically the same point, but for the purposes of the PTP protocol. We could use the same term, but we would need to make sure the definition is the same in 802.1Q to avoid confusion. It was agreed that defining such a reference point in 802.1AC is still the appropriate course of action, …

Source: https://www.802-1.org/items/427

Note: Subsequent slides refer to two reference points (i.e., plural): One for ingress and one for egress.

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IEEE 802.1 Maintenance Item #314: Subsequent Meetings (2)

- **Maintenance TG Meeting 2022-07-12**
Agreed that communication with 802.11 and 802.15 is needed. …

- **Maintenance TG Meeting on 2023-09-12**
The joint 802.1/802.15 meeting in November 2023 can be used as a venue to discuss this with 802.15. P802.1ACea, if its PAR is approved, may potentially serve as a vehicle. …

- **Maintenance TG Meeting on 2024-03-05**
This was not discussed in November 2023 in the joint 802.1/802.15 meeting. We will bring up in the March 2024 Plenary.
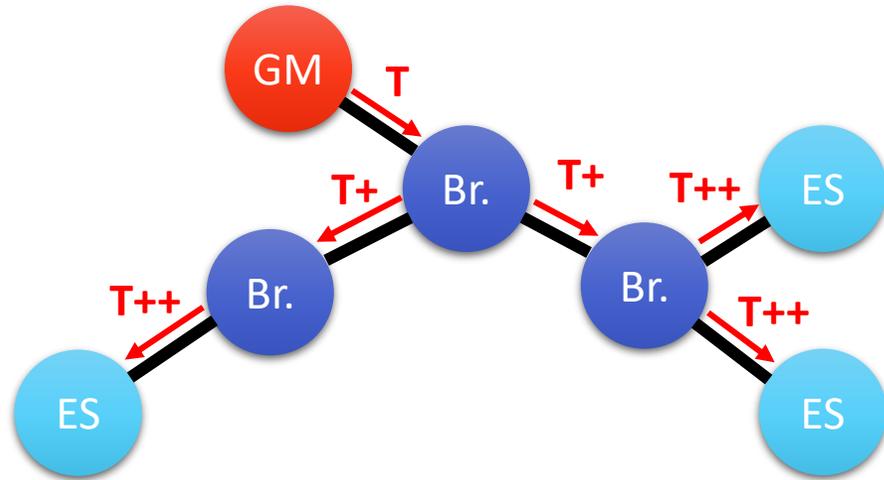
- **Maintenance TG Meeting on 2024-03-13**
This item was discussed in the joint 802.1/802.15 meeting at the March 2024 plenary. It was proposed that a joint presentation be put together to socialize this with the other groups of 802.

Source: https://www.802-1.org/items/427

Use in IEEE 802.1 Standards, Direction, Projects

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Reference points in 802.1AS: Time Sync., Link Delays

(e.g., a Bridge)   **(e.g., another Bridge)**

802.1AS initiator   802.1AS responder

tx: t1

request

rx: t2

tx: t3

response (t2)

followup (t3)

rx: t4

know t1,t2,t3,t4
calculate:
$$d=((t2-t1)+(t4-t3))/2$$

Figure 7-7—Conceptual medium delay measurement

Source: IEEE Std 802.1AS-2020

- Actually time continuously transferred from Grandmasters to clients
- Compensates delays - Device-/Buffer- and Links-Delays
- Lower delay <u>variation</u> (non-compensable):
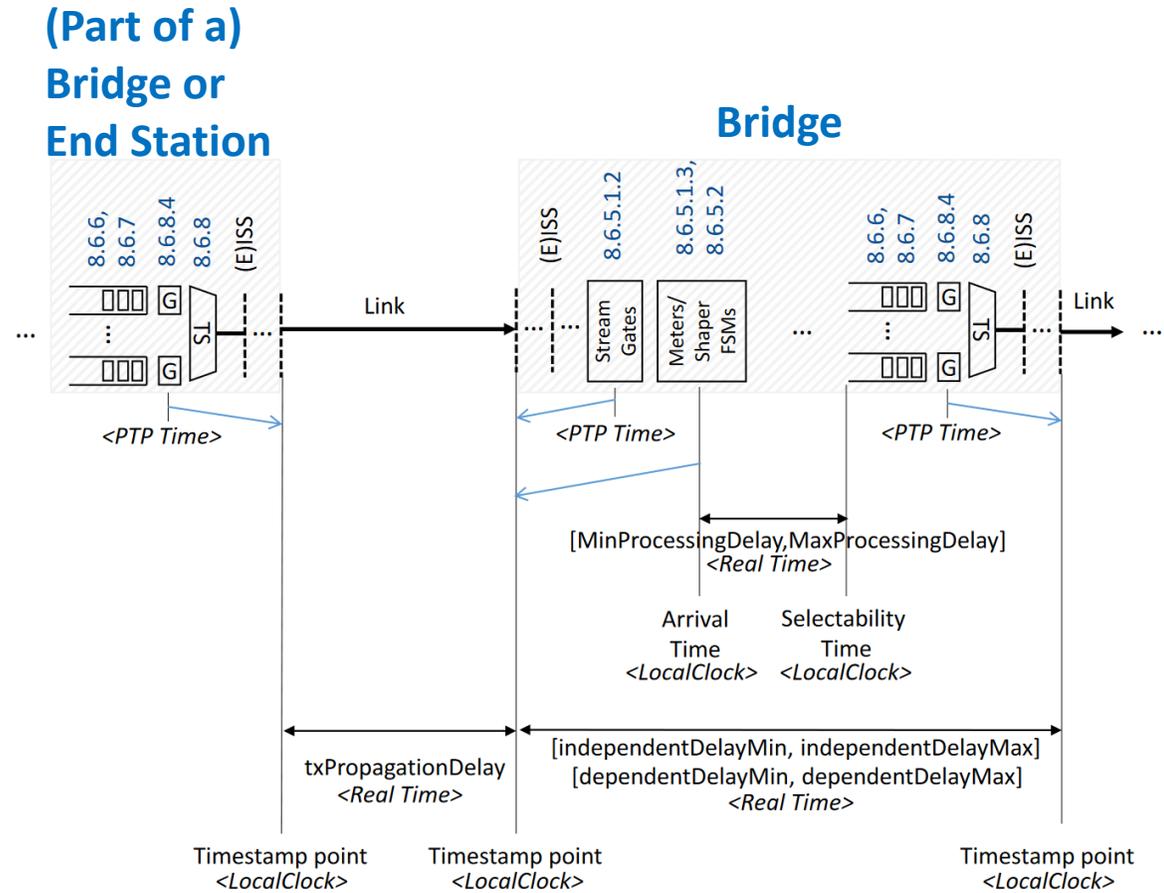 → higher precision/less time deviation between clients
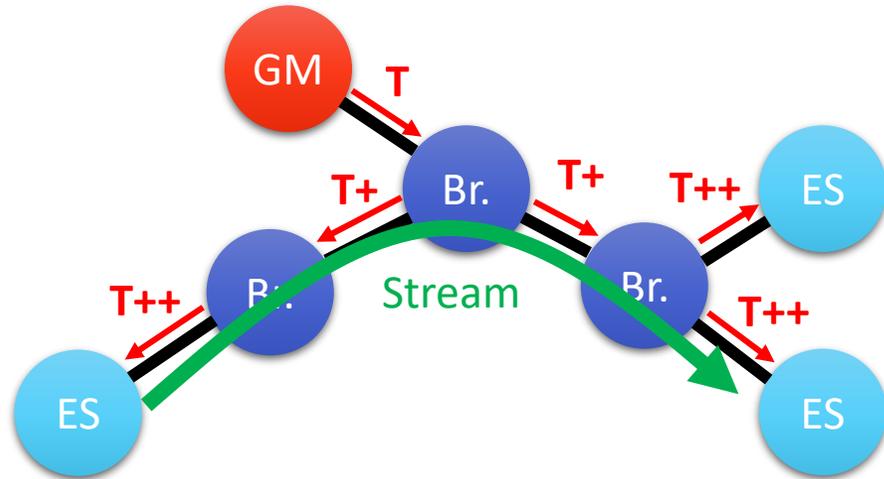
Reference points in 802.1Q: Delay Calculation
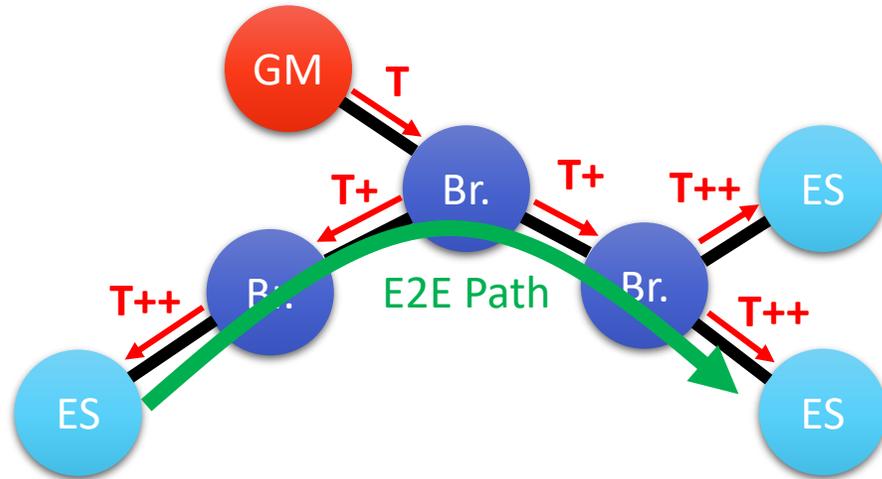
- Environment
  - Typically Static/non-Plug&Play
  - SDN/YANG

- End-2-End Delay =
  ... + Bridge delay + Link delay +
  + Bridge delay + Link delay + ...

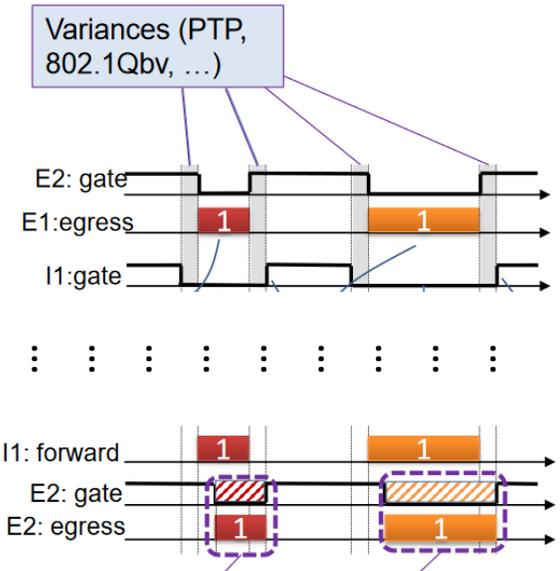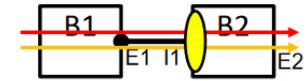- Link delay is between two subsequent reference points

Source: https://www.ieee802.org/1/files/public/docs2017/cr-specht-bridge-timing-0917-v01.pdf

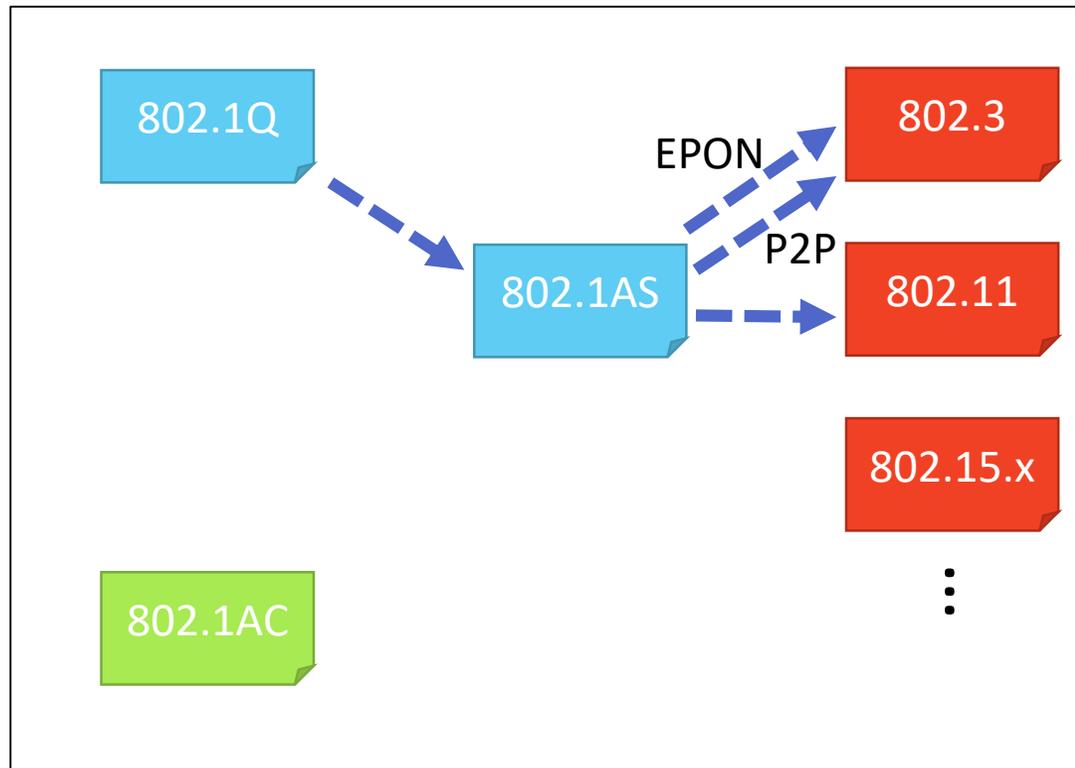# Reference points in 802.1Q: Gate Configuration

- Ingress and egress gates, configured by periodic open (pass) and close (block) events
- Can synthesize TDMA schemes
- Gates located "somewhere" in the stacks, but …
- … <u>the open/close timing is configured relative to the reference points</u>
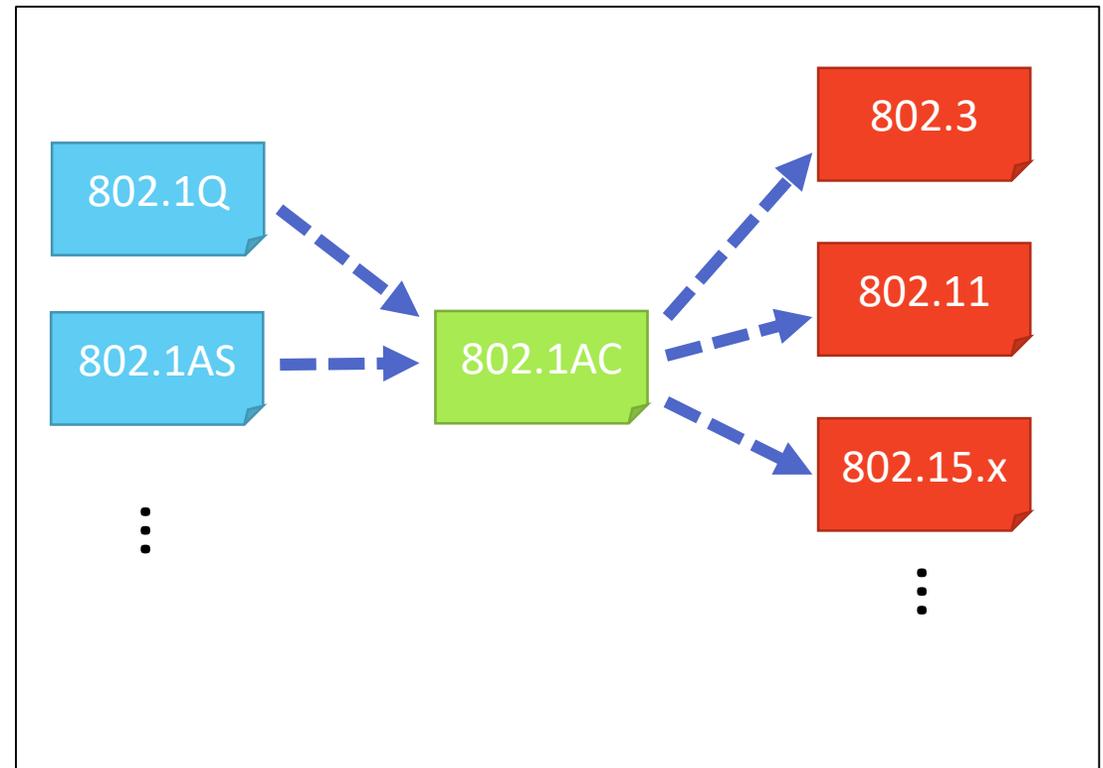

Source: https://www.ieee802.org/1/files/public/docs2014/new-tsn-specht-samii-tas-protection-1114-v02.pdf

Pointers to Reference Points

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IEEE 802.1 Standards and some Projects

- Changes in IEEE 802.1 Standards:
  - IEEE Std 802.1AC
    - Generic element (e.g., clause, table) to point to from IEEE Stds 802.1Q and 802.1AS
    - Pointers from there into IEEE 802 MAC Standards
  - IEEE Std 802.1AS
    - Replace current pointers into 802 MAC Standards with pointers into IEEE Std 802.1AC
    - Potentially shift selected contents into IEEE Std 802.1AC
  - IEEE Std 802.1Q
    - Replace several descriptions with pointers into IEEE 802.1AC
    - Potentially shift selected contents into IEEE Std 802.1AC

- IEEE 802.1 Projects:
  - Either ongoing amendment projects,
  - revisions, or
  - new amendment projects

Project	Title	Next Action	PAR ends
802.1ACea	802.15.16 convergence	Editor's draft	
802.1ASds	Half-duplex support	TG Ballot	Dec'26
802.1ASeb	Announce	NesCom	
802.1AS-2020 rev	Timing and Synchronization	TG Ballot	Dec'27
802.1Qdt	PFC MACsec	TG Ballot	Dec'26
802.1Qdv	Cyclic Queueing and Forwarding	TG Ballot	Dec'26
802.1Qdw	Source Flow Control	Editor's draft	Dec'26
802.1Q-2022 rev	Bridges and Bridged Networks	Editor's draft	Dec'27

Source: https://www.ieee802.org/1/files/public/minutes/2024-03-closing-plenary-slides.pdf

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Summary

- **Desire per IEEE 802.1 Maintenance Item #314**
  - Reference points, ingress and egress, needed for IEEE Stds 802.1AS and 802.1Q.
  - <u>Desire:</u> Pointers into IEEE 802 MAC/PHY Standards from IEEE Std 802.1AC, allowing a single pointer into IEEE Std 802.1AC from other IEEE 802.1 Stds

- **Reference points details**
  - Low delay variation from egress to ingress reference points enhances precision
  - The exact reference point positioning in IEEE 802 MAC/PHY stacks may be flexible to a certain extent (i.e., not necessarily limited to "the boundary between PHY entity and physical medium"), as long as it is defined and delay variation is "sufficiently" low

- **Across multiple IEEE 802 WGs**
  1. 802.1 Stds: Additions and re-arrangements across 802.1 Standards
  2. 802 MAC/PHY Stds: Elements to point to from IEEE Std 802.1AC; potential contents for 802.1AC.

Thank You for Your Attention!

Questions, Comments, Ideas?

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