The use of one-step clocks in 60802 Networks

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Background

- The 60802 Joint Project has done substantial work to establish that the 1 us goal for dynamic time error relative to the GM across 64 hops is achievable using IEEE 802.1AS-2020.
  - https://www.ieee802.org/1/files/public/docs2021/60802-garner-new-simulation-results-new-freq-stab-model-0421-v02.pdf
- Amongst other requirements, a need for extremely low residence times (<= 1 ms) has been identified.
- This low residence time implies very rapid calculation of the correctionField which implies a dependency upon the follow-up message in the case of 2-step processing

One-Step vs. Two Step

- PTP 1-step is when the time stamp, correction field and other timing information from the master clock is included in the sync message.
- PTP 2-step, however, sends the time stamp, correction field and other timing information in a separate, follow_up message after the sync message has been sent.
- From IEEE 1588-2018:
  - NOTEA one-step PTP Port modifies PTP message fields, for example, the correctionField, on-the-fly as the PTP message is being transmitted. Therefore, although a one-step PTP Port could implement two-step PTP Port semantics or be reconfigured to be a two-step PTP Port, the converse is not necessarily true and depends on the underlying hardware support.
- This implies that interoperability issues could occur if one-step and two-step implementations exist in the same network.
- The 60802 Joint Project needs to choose an approach.

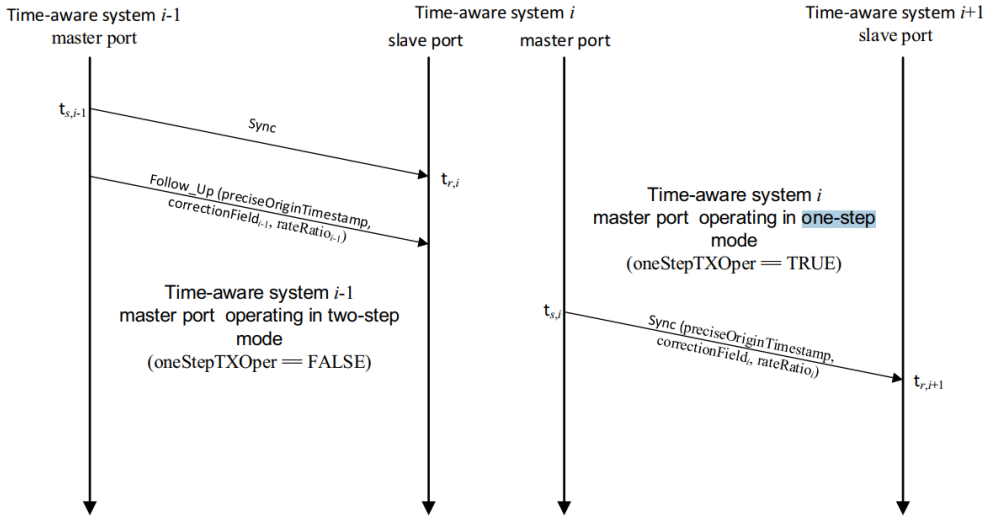

Figure 11-2—Transport of time-synchronization information

Transparent Clocks

- Simulations have shown that |dTE| is highly dependent upon residence time.
- Essentially, it becomes comes a question of how old the synchronization information is by the time it reaches the last device in the line.
- This phenomenon is well known in Industrial Automation and has historically been solved using transparent clocks (other non-1588 solutions are used in some networks).
  - Transparent Clock: A PTP Instance that measures the time for a PTP event message to transit the PTP Instance and provides this information to PTP Instances receiving this PTP event message.
- This calculation is usually done in HW thus reducing residence time.
- IEEE Std 802.1AS-2020 does not support transparent clocks so an equivalent mechanism is needed for 60802.

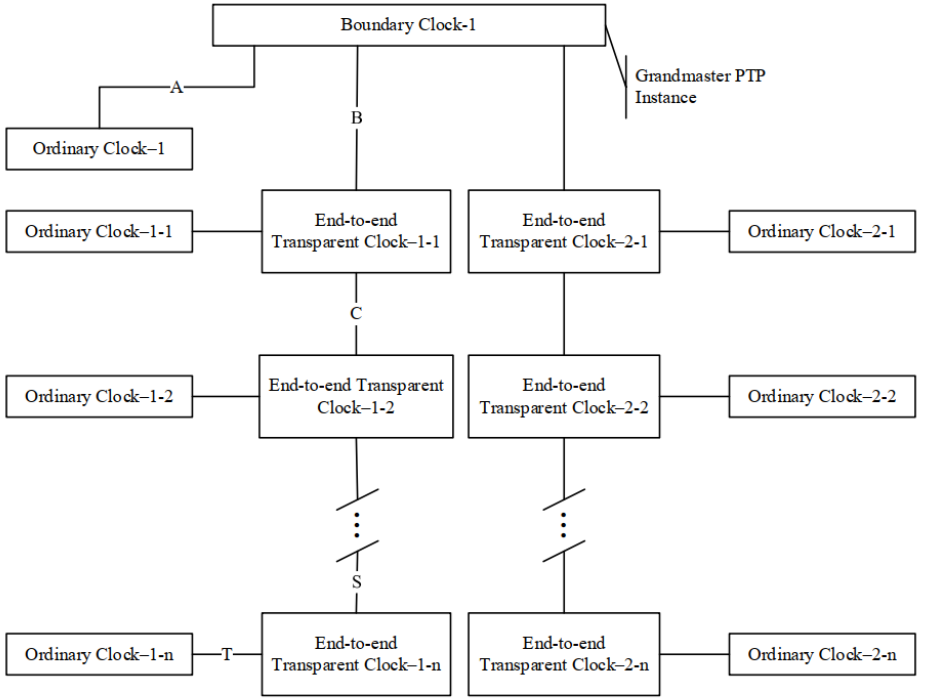

Figure 23—Linear topology

The case for one-step

- Straight-forward to implement in HW when compared to two-step.

- Eliminates timing dependency on the follow-up message.
  - Follow-up messages are typically not express frames, making a guarantee of when the follow-up is transmitted non-deterministic.
  - Sync and Follow-up messages are unscheduled so the risk of getting a sync and having the follow-up delayed is real.

- Reduces SW overhead helping to ensure low residence times.

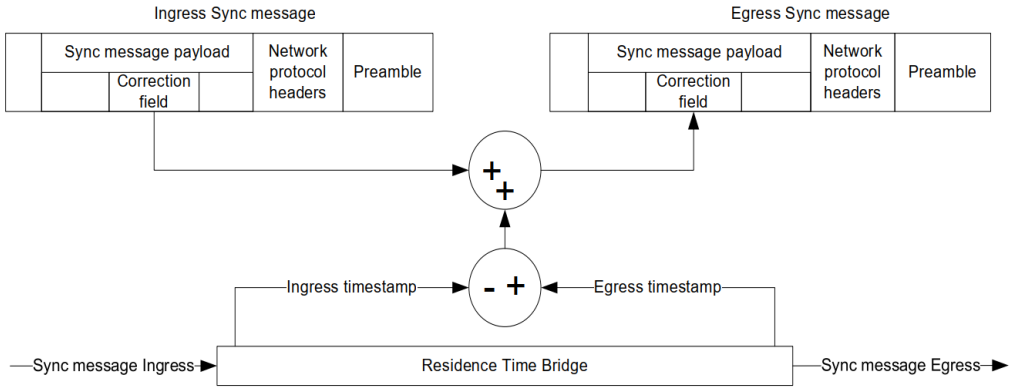

Figure 9—One-step end-to-end residence time correction for Sync message processing

Conclusions

- The use of two-step calculations creates a dependency upon the follow-up message making a guarantee of low-residence time more challenging.
- It is the opinion of this contributor that the 60802-residence time requirement will force at least some constrained applications to implement the correctionField calculation in HW.
- The use of one-step calculations eliminates the dependency upon the follow-up messages and arguably simplifies the implementation of the correctionField calculation in HW or SW.
- One-step and two-step will not easily interoperate, so the Joint Project needs to choose an approach.
- This contributor recommends adopting one-step for the 60802 profile.
- Other options:
  - Adopt a 1588 profile which supports transparent clocks
  - Add support of transparent clocks to 802.1AS
  - Constrain the allowed time between sync and follow-up messages

Thank you