P802.1DG and 10SPM CFI

by: Craig Gunther

Craig Gunther Consulting, Bosch

Why create this presentation?

- CFI for 802.3 10SPM will be held July 16, 2019 from 20:30-21:30
  See http://www.ieee802.org/3/interims/july_0719_sched.html
- Last day to add proposed content (via PowerPoint slide(s)) is **July 5** AOE.
- Interest in the following TSN standards has already been discussed on the 10SPM CFI Consensus Building calls and are included in the CFI:
  - 802.1AS-Rev: *Timing and Synchronization for Time-Sensitive Applications*
  - 802.1Qbv-2016: *Scheduled Traffic* (802.1Q-2018 clause 8.6.8.4, Annex Q)
  - 802.1Qch-2017: *Cyclic Queuing and Forwarding* (802.1Q-2018 clauses 5.4.1.9, 5.13.1.2, 5.28, Annex T)
  - 802.1Qci-2017: *Per-Stream Filtering and Policing* (802.1Q-2018 clauses 5.4.1.8, 5.13.1.1, 5.27)
- What else is there to do?
  - Packet delivery latency variation (jitter)? We'll talk about this in a few slides.
  - Other shapers (e.g. 802.1Qcr: *Asynchronous Traffic Shaping*)?

10SPE (802.3cg) background

What is 10SPE (802.3cg)?

See *IEEE P802.3cg 10Mb/s Single Pair Ethernet: A guide*
(www.ieee802.org/3/cg/public/Jan2019/Tutorial_cg_0119_final.pdf)

- Single pair, 10Mb/s PtP (15m, 1000m) and multidrop (25m) Ethernet
- Multidrop supports segments of 25m and 8-nodes
- Multidrop runs half-duplex CSMA/CD (shared-medium)
  - PLCA (optional) removes collisions from CSMA/CD
  - PLCA Burst mode (aPLCAMaxBurstCount, aPLCABurstTimer) allows more packets per transmit opportunity (TO) for preconfigured nodes

10SPM (802.3cg++) background

What is 10SPM and how does it relate to 802.3cg (10SPE)?

- 10SPM is currently defined as *10SPE Multidrop Enhancements*
  - Enhancement: mixing segment longer than 25m. 75m?
  - Enhancement: mixing segment with more than 8 nodes. 32 nodes?
  - Enhancement: mixing segment PoDL (Power over Data Lines)
  - Potential enhancement: use TPMR (Two-Port MAC Relay) to extend reach even further
- Target markets
  - Industrial (e.g.: in-cabinet)
  - Building Automation (e.g.: lighting automation)
  - Other markets: elevators, alarms, etc.
  - Question from P802.1DG: Is there any interest from Automotive? Need a use case.

10SPM considerations: Latency variation - 1

More nodes = more packet delivery jitter. Is that okay?

What is the delivery latency variation (jitter)?

- Minimum latency/node = idle node = 24 bit-times (to_timer in 30.16.1.5, 148.4.5.4) = ~1.9µs
- Maximum latency/node = 1524 byte packet = ~1msec
  You can obviously make this better by limiting maximum packet size
- **10SPE: Maximum latency variation with 8 nodes = ~1ms to ~8ms**
  Assume 1 node transmitting 1524 bytes, 7 nodes idle = (1 * ~1ms) + (7 * ~1.9µs) = ~1013.5µs
  Assume all 8 nodes transmitting 1524 bytes = (8 * ~1ms) = ~8msec
- **10SPM: Maximum latency variation with 32 nodes = ~1ms to ~32ms**

Do we care about latency variation? As long as 1ms to 32ms latency variation on delivery is okay does it really matter? (1722 puts *Presentation Time* in its packets so delivery latency variation is not that important as long as max latency is acceptable).

10SPM considerations: Latency variation - 2

PLCA has also introduced Burst Mode which allows a node to transmit more than one packet per Transmit Opportunity (TO).

- See 30.16.1.6 aPLCAMaxBurstCount (0-255): Maximum number of packets to burst.
- See 30.16.1.7 aPLCABurstTime (0-255, 128 is default): Minimum time other nodes wait to see if another packet is included in the burst. 128 bit-times = ~10.24µs

More packets/node/TO = more packet delivery jitter. Is that okay?

This is designed to allow *chatty nodes* (this author's term) more messages per TO than other less chatty nodes. The downside is the jitter associated with packet delivery is now even more complex/worse depending on whether *chatty nodes* transmit zero, 1, 2, up to 255 packets (remember to include the ~10.24µs of idle latency vs ~1.9µs without Burst Mode).

Again, limiting packet size can reduce the impact.

10SPM considerations: Latency variation - 3

If the latency variation shown on the previous two slides is acceptable, or can be made acceptable by limiting packet size, then there is no problem.

However, if there is a problem with this latency and variation then we have a chance to make it known to the 10SPM CFI group. A potential solution has been presented: *Priority Support for PLCA* (http://www.ieee802.org/1/files/public/docs2018/new-TSN-pannell-Priority-for-PLCA-for-8023-0918-v07.pdf).

If this Priority Support seems interesting then a single-slide use case needs to be created by July 5. Note that the CFI group is not interested in us telling them a solution, they want to understand the problem. So create a slide that shows the need (less latency, less jitter, or both), not the Priority Support solution.

Note that as currently specified in the CFI, 10SPM only affects the PHY (which is highly desirable). If we ask for Priority Support then 10SPM could become a MAC/PHY project (which is much less appealing to the 10SPM supporters).

10SPM considerations: Latency variation w/ Qbv

What about using 802.1Qbv-2015: *Scheduled Traffic?*

- **Benefit**: Deterministic latency with very low jitter.
- **Benefit**: Configure transmission windows big enough to get multiple packets transmitted in one window; this is good for controllers configuring multiple stations in real time. Comparable to PLCA Burst Mode.
- **Benefit**: Can work with existing CSMA/CD networks (doesn't need PLCA , in fact this author believes PLCA may not be desirable with 802.1Qbv).
- **Drawback**: Unused bandwidth is wasted. Use it or lose it.
- **Drawback**: Requires network designer to engineer network.

You can do this today with 10SPE.

10SPM considerations: Summary

If this presentation has spurred any ideas you need to get a slide or two together that demonstrates a use case that supports your needs. Examples discussed in this presentation include:

- Delivery latency variation
- Additional Shapers

If you have any ideas for the CFI, whether or not related to this presentation, I would STRONGLY encourage you to attend the next 10SPM Consensus Building call (June 26, July 3). For more call details see slide 33 of *802.3 NEAPossible CFI for 10SPE Multidrop Enhancements* (http://grouper.ieee.org/groups//802/3/ad_hoc/ngrates/public/19_05/jones_nea_01a_0519.pdf)

Presentations of interest

- *Proposal for short-reach multi-drop 10M SPE (former PLCA)*
  http://www.ieee802.org/3/cg/public/Sept2017/Beruto_3cg_01a_0917.pdf
- *IEEE P802.3cg 10Mb/s Single Pair Ethernet: A guide*
  http://www.ieee802.org/3/cg/public/Jan2019/Tutorial_cg_0119_final.pdf
- *PLCA FAQ* http://www.ieee802.org/3/cg/public/July2018/PLCA%20FAQ.pdf
- *802.1 Time-Sensitive Networking (TSN) on 802.3cg Multidrop Networks*
  http://www.ieee802.org/1/files/public/docs2017/tsn-cgunther-802-3cg-multidrop-0917-v01.pdf
  - *TSN For 802.3cg An Overview With Some Specific Applications* (Start at slide 20)
    http://www.ieee802.org/1/files/public/docs2017/tsn-cgunther-tsn-for-802-3cg-1117-v02.pdf
  - *Deterministic Latency on 10Mbps 2-wire Ethernet* (Skip forward to the 2:18 time mark)
    https://www.dropbox.com/s/ttag1dmqryplzwh/802.3cg%2010Mbps%203-node%20demonstration.wmv?dl=0
- *PLCA burst mode* http://www.ieee802.org/3/cg/public/Sept2018/beruto_huszak_plca_bursting.pdf
- *Priority Support for PLCA*
  http://www.ieee802.org/1/files/public/docs2018/new-TSN-pannell-Priority-for-PLCA-for-8023-0918-v07.pdf
  - *TSN over 802.3cg Status update (personal observation)*
    http://www.ieee802.org/1/files/public/docs2018/new-TSN-cgunther-Priority-for-PLCA-for-8023-status-1118.pdf

Questions?
Thank you!