Status of Accumulated latency in industrial applications
Call for Interest

July 11, 2018

Jordon Woods, Analog Devices

CFI Status

- Primary work has occurred in the NEA Ad Hoc Committee:
  - Jan, 2018 Interim, Geneva, CH: Accumulated switch latency in industrial applications (http://www.ieee802.org/3/ad_hoc/ngrates/public/18_01/woods_nea_01a_0118.pdf)
  - Mar, 2018 Plenary, Chicago, IL: Industrial Networking Requirements (http://www.ieee802.org/3/ad_hoc/ngrates/public/18_03/woods_nea_01_0318.pdf)
  - Feb 22, 2018 Teleconference Call: Accumulated switch latency in industrial applications Call for Interest-DRAFT (http://www.ieee802.org/3/ad_hoc/ngrates/public/calls/18_0412/woods_nea_01a_180412.pdf)

CFI Status

- The NEA Ad Hoc Committee has proven an excellent forum for:
  - Introduction of the topic
  - Discussions of CFI content
  - Discussions of use cases and requirements
- I have not been successful, thus far, at building consensus.
- Plan of action:
  - Approach individuals to build a list of supporters and general alignment.
  - Present the resulting CFI to the Ad Hoc Committee for additional consensus building.
  - Ask an IEEE802.3 WG Sponsor to submit the CFI to working group.

IEEE 802.1 WG Involvement

- It is conceivable that the solution to the problem will impact layer 2
- The 802 MAC service interface (IEEE 802.3 section 2.3.2.3) is a packet interface.
  - MAC client receives and sends whole frames, not bytes or words.
- The same is true of the Internal Sublayer Service (ISS) in IEEE 802.1AC, section 11.

IEEE 802.1 WG Involvement

- So, what's my purpose today?
- First and foremost, to keep the 802.1 TG in the loop.
- Second to ask again for supporters. If you agree:
  a) That this problem exists and
  b) That the problem is worth studying then,
- Please let me know that you're willing to be listed as a supporter of the CFI

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CFI Panel Members

Supporters - Page 1

- Brandt, David, Rockwell Automation
- Brychta, Michal, Analog Devices
- Carlson, Steve, High Speed Design, Inc.
- Cummins, Rodney, National Instruments
- Elbakoury, Hesham, Huawei
- Franchuk, Brian, Emerson
- Gunther, Craig, Craig Gunther Consulting, LLC.
- Hantel, Mark, Rockwell Automation
- Kehrer, Stephan, Beldan/Hirschmann
- Lo, William, Axonne
- Mangin, Christophe, Mitsubishi Electric
- McCarthy, Mick, Analog Devices
- Pannell, Don, NXP
- Potts, Mike, GM
- Regev, Alon, Keysight
- Steindl, Günter, Siemens
- Woods, Jordon, Analog Devices
- Xu, Dayin, Rockwell Automation
- Xu, Li (Shirley), Huawei
- Zuponcic, Steve, Rockwell Automation

CFI Objective

- To gauge the interest in starting a Study Group for:

  Accumulated latency in industrial applications

- This meeting will NOT:
  - Fully explore the problem
  - Debate strengths and weaknesses of solutions
  - Choose a solution
  - Create a PAR, CSD or Objectives
  - Create a standard or specification

Agenda

- Overview
- The problem
- Use cases
- Market Potential
- CFI
- Q&A – Please hold until this time
- Straw Polls

802.3 and 802.1

- 802.3 does physical layer interfaces at Layer 1
- 802.1 does bridging at Layer 2
- 802.1 and 802.3 actually share Layer 2---that's why we're here tonight
- We have a long history of working on "shared" projects:
  - 802.3as-2006 Frame Expansion
  - 802.3bf-2011 Time Sync
  - 802.3br-2016 Interspersed Express Traffic
- We'll be discussing another possible "shared" project tonight

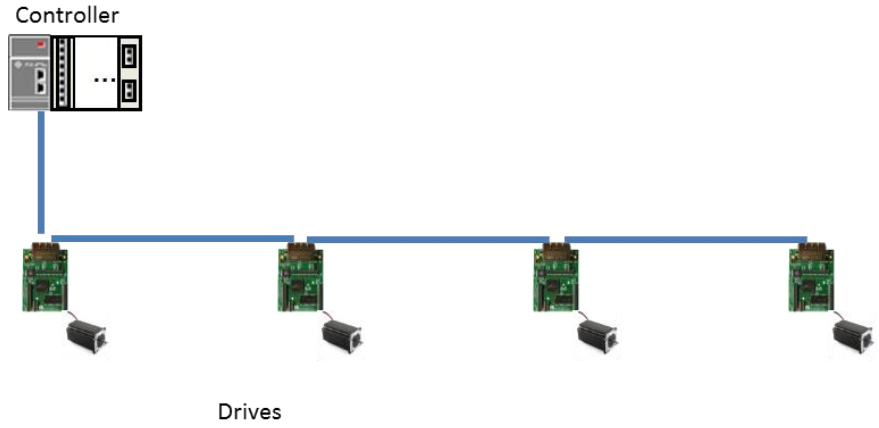
Industrial and Commercial Networking Toolkit

- **Scalability** – Well addressed by IEEE802.3 and IEEE802.1.
- **Physical Layer** – Wide variety of copper and optical PHYS, including emerging single-pair from 802.3
- **Convergence** – Well addressed by IEEE802.3 and IEEE802.1.
- **Security** – On-going work in IEEE802.1, IETF, IEC and other organizations shows promise for these applications.
- **Time-Sensitive Performance** – Addressed by emerging IEEE802.1 TSN work.
- **Flexible Topologies** – Well addressed by IEEE802.1
- **Low-Bridging Latency** – Accumulated Latency remains a challenge in industrial applications.

Use Cases - Industrial Automation

Control Applications (line topologies)

- Control Applications (line topologies)
  - Utilization of line topologies is prevalent in industrial applications utilizing embedded bridge technology
  - There can be many hops along the line (64 hops or greater)
  - Latency along these hops accumulates, eating into the time available for updates. (see http://www.ieee802.org/3/ad_hoc/ngrates/public/18_01/woods_nea_01a_0118.pdf)
  - However, the effects of these delays are cumulative. Each delay per hop consumes part of the time available during the cycle.
  - This is really a question of the accumulated latency per hop.



Why Line Topologies?

- Physical constraints make cabling for star topologies impractical
- The construction of the application naturally lends itself to point-to-point connectivity
- They are, after all, assembly “lines”

Current Approach

- Today, industrial applications employ proprietary techniques known collectively as “cut-through”
  - The exact techniques vary and are not always interoperable
  - These features are typically not supported by management
- For example assuming an 8 byte preamble and 1500 byte packet:
  - At 100Mbps: Bridge Delay (s&f)= 121.12 usec/hop; (c-t) = 2.56 usec/hop
  - At 1Gbps: Bridge Delay (s&f)= 12.54 usec/hop; (c-t) = 688 nsec/hop
    - See http://www.ieee802.org/1/files/public/docs2017/new-woods-cutthroughconsiderations-0518-v01.pdf for calculations
- There are known risks to the uses of cut-through (security, incorrect forwarding, runt frames, etc.)
  - Industrial applications have employed various techniques for mitigation of these risks
  - These techniques have been successfully deployed in industry for over a decade.

Market Potential

Industrial Network Growth

- Entire market is growing
  - Fieldbus (58%), 7% growth
  - Ethernet (38%), 20% growth
  - Limited wireless adoption
- With the advent of a common layer 2 (TSN), Industrie 4.0, China 2025, etc., strong growth is expected.
  - Global industrial Ethernet market valued at USD $24B in 2016
  - Expected to grow to $58.98 billion by 2022
  - CAGR of slightly above 16.20% (2017 and 2022)
    - Source: Zion Market Research, 2017 - https://www.zionmarketresearch.com/news/global-industrial-ethernet-market

Call for Interest

Why Now and Why in IEEE 802.3?

- The industrial/commercial networking industry is requesting it—it's a missing piece in the 802.1/802.3 industrial toolkit
- Proprietary solutions have existed for over a decade
- An interoperable solution standardized in 802.3 and 802.1 is desired
- 802.3 shares Layer 2 with 802.1
  - Both WGs need to be involved
- With the rapid growth of Ethernet in the industrial and commercial automation spaces, now is the time to start this work

Q&A

Straw Polls

Straw Polls and Counts

- **Room count:**
  - **Would you support the formation of a Study Group for** Accumulated Latency in Industrial Applications?
  Y: N: A:
  - **Would you attend and contribute to a Study Group for** Accumulated Latency in Industrial Applications?
  – Tally:
  - **Would your company support participation in a Study Group for** Accumulated Latency in Industrial Applications?
  – Tally: