IEEE 802.3 Greater than 10 Mb/s long-reach point-to-point Single-Pair Ethernet PHY Call for Interest Consensus Building Meeting

George Zimmerman / CME Consulting
affil: ADI, APL Group, Cisco, CommScope, Marvell, SenTekSe

7/21/21

Supporters & Contributors

Tim Baggett – Microchip
David Brandt – Rockwell Automation
Theo Brillhart – Fluke
Rory Buchanan – ON Semi
Steve Carlson – High Speed Design
John D'Ambrosia - Futurewei
Chris DiMinico – MC Communications
Peter Fischer – BKS Kabel-Service AG
Matthias Fritsche – HARTING
Steffen Graber – Pepperl+Fuchs
Gergely Huszak - Kone
Peter Jones – Cisco Systems
Jon Lewis – Dell EMC

CONFIRMED LIST (page 1 of 2) AS OF 7/22/2021 7:44AM PT. Please email chair if you wish to be added (or deleted)

Supporters & Contributors

Valerie Maguire – Siemon Company
Mick McCarthy – ADI
Brett McClellan – Marvell
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Harald Mueller – Endress+Hauser
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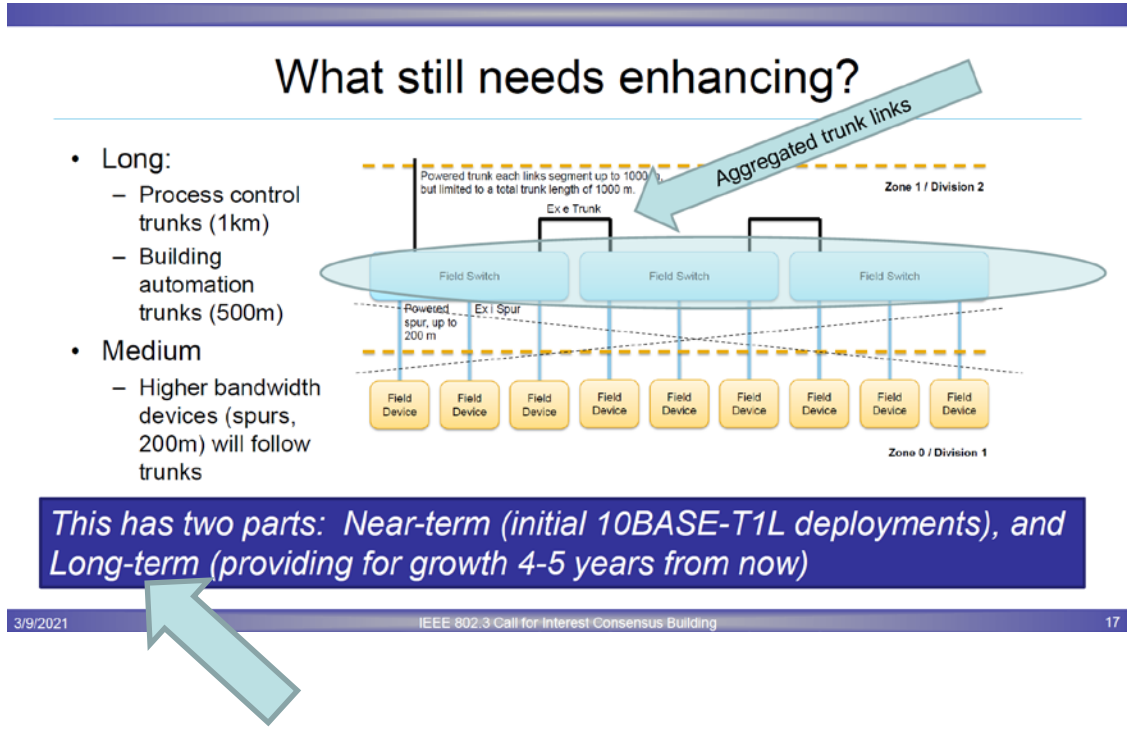
Agenda

- Use Cases for Higher Speed Long Reach pt-to-pt SPE
- Issues to work still from First Phase
- Why now?
- Wrap-up and Q&A

Why are we here?

- To:
  - ~~Initiate~~ Continue discussion on the uses of Single-Pair Ethernet in Operational Technology Networks
  - ~~Enhance anything left out of point-to-point Single Pair Ethernet necessary for deployments in Operational Technology~~
  - Continue discussions on the next steps and future roadmap of point-to-point Single-Pair Ethernet for Operational Technology
  - Resolve the rates, reaches, and essential features of the next step in pt-to-pt SPE



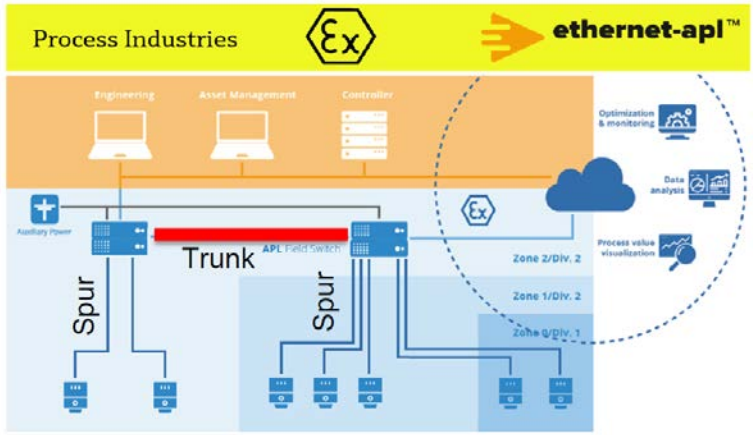
Source: Markup from: https://www.ieee802.org/3/cfi/0321_1/CFI_01_0321.pdf

USE CASES FOR NEXT-GEN PT-TO-PT SPE

Next-Gen Use Case:

Bandwidth Growth in Process Control

- Next step in speed for networks using 10BASE-T1L APL
- 300 to 500m reach
- Does not preclude intrinsic safety
- Remote powering required
- Likely an installation upgrade
  - Potential reuse of existing cabling
    - e.g., fieldbus type A (IEC 61158-2)



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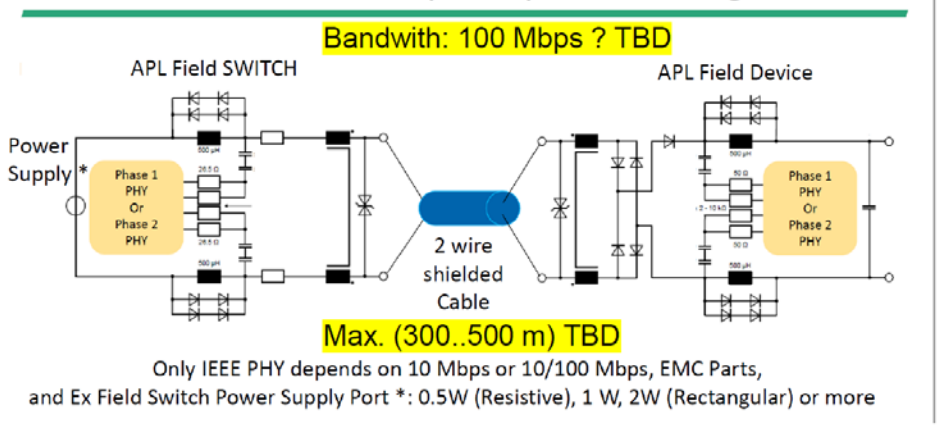
IEEE SPE Bandwidth Enhancement

APL Phase 1: 10 Mbps
APL Phase 2: 100 Mbps Example HW- Blockdiagram



Only IEEE PHY depends on 10 Mbps or 10/100 Mbps, EMC Parts,
and Ex Field Switch Power Supply Port *: 0.5W (Resistive), 1 W, 2W (Rectangular) or more

Bandwidth Enhancement use Case in Standard and EX-area !
=> External termination resistor, limited voltage transmit level,
DC free modulation, Auto negotiation (similar to IEEE802.2cg: 10BASE-T1L PHY)

Harad Mueller, Endress + Hauser 11

Next-Gen Use Case:

Servo Motor Control

- Up to at least 100m reach, 100 Mbps or greater
- Industrial noise environment
  - 3-phase AC w/motor switching
- 10usec feedback data acquisition requirement
- Power over SPE pair
- Volumes of > 10M units per year

General Motion Control Market Size

- By Volume
  - General motion control servo drive: 2021 forecast unit shipment: 11,128,000
  - General motion control servo motor: 2021 forecast unit shipment: 14,054,000

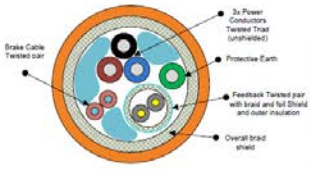
- By Revenue
  - General motion control servo drive: 2021 forecast $4.1B
  - General motion control servo motor: 2021 forecast $4.5B

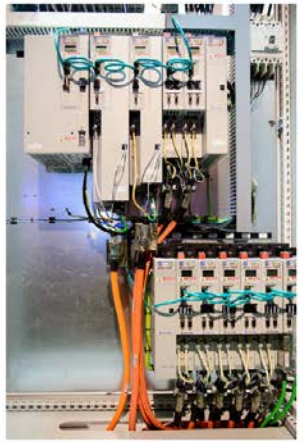
Src: IHS Markit, Motion Control Report - 2019

Source: [xu_3SPEP2P_01a_04282021.pdf]

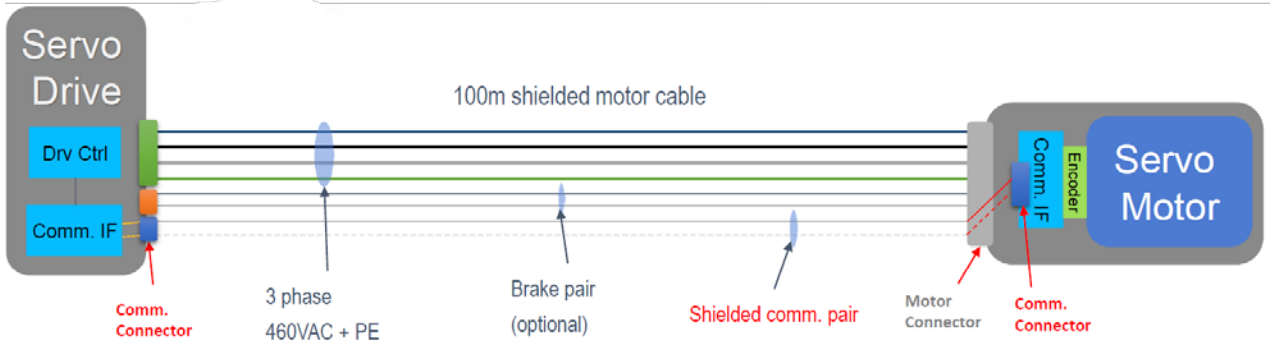
Servo Drive Motor Communication Requirement

- Hybrid motor cable
  - Single shielded twisted pair for SPE communication
  - 460VAC power wires
  - Outer shield
- Minimum cycle time: 31.25us
- Minimum speed: 100Mb/s
- Maximum length: 100m
- Full duplex
- Power delivery over SPE pair
- 12VDC desirable, 24VDC acceptable
- Minimum 500mA
- Use the PHY chip that is used for other industries (e.g. automotive, building)
- Operate under very noisy servo drive-motor operation environment





April 28, 2021 - D. XU IEEE 802.3 Pt-to-Pt SPE Enhancements Study Group 4



Next-Gen Use Case:

Renewable Energy Farms

- 100-500m reach, trunk & spur similar to process control, 100Mb/s or greater
- May have existing cabling, likely greenfield installations
- Volumes of 100k (trunks) + 2-3 million spur ports per year

Wind mills and wind parks

- Big wind turbines have towers higher than 100m and because of this fact Ethernet based on 4-pair copper is not possible.
- With 100BASE-T1L up to 500m link segment length a market potential about 100.000 ports for connections from ground to the top of the tower and between wind mills (wind parks) per year is possible.
- In addition for shorter link segments up to 50m SPE can be used inside the wind mills to and a potential of approx. 2-3 million p.a. ports is possible

→ **Advantage for this use case:** More robust and cost effective connections (just one cable for data and power)

IEEE 802.3 SPEP2P SG: 2021-05-12 – SPE use cases – Matthias Fritsche / HARTING Technology Group 5

Solar energy plants

- **Solar plants are installed at huge areas and between the solar converters the distances usually are bigger than 100m and 100BASE-T1L will be a very good solution with a big market potential.**

IEEE 802.3 SPEP2P SG: 2021-05-12 – SPE use cases – Matthias Fritsche / HARTING Technology Group 6

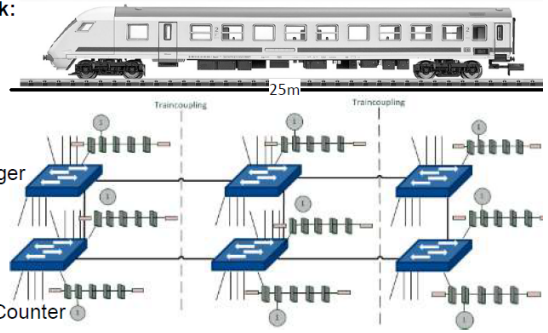
Source: Fritsche_3SPEP2P_01_05122021.pdf

Next-Gen Use Case:
Large Mobile Machinery

- 40m+ reach (longer than automotive)
- Applications include video for control
  - (100 Mb/s, 1 Gb/s, and higher rate)
- Low latency
- Specialized cabling may be used
- Potential volumes in millions of ports/yr

Railway transportation

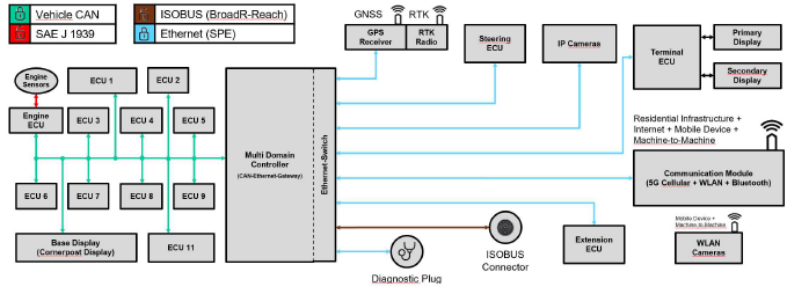
- **Global yearly produced volume of rolling stock:**
  - HighSpeed trains: 250 sets/a
  - Trams / Metro: 6.500 sets/a
  - DMU / EMU: 1.800 sets/a
  - Loco: 5.000 sets/a
- **Technical requirements:**
  - Link length: minimum 40m (one wagon) and longer
  - 100Mbs and 1Gbps; future also up to 5/10Gbs
  - low latency ≤ 1ms
- **Typical applications:**
  - PtP 1000Base-T1/100Base-T1 w/o PoDL up to 50W for IP Cameras, Displays, Passenger Counter
  -
- **Market estimation**
  Depending on the train type different speed and number of ports are needed and also today Ethernet is used in trains. An estimation see a potential of new 1.5 – 0,9 million SPE ports per year.



source: HIRSCHMANN/Belden

SPE for Mobile working machines

- **Global yearly produced volume of Off-Highway Machinery approx. 3,5 million vehicles**
  - Agriculture: 1,36 million tractors, harvester, various implements and so on..
  - construction machinery: 840.000 vehicles
  - material transport mining etc.: 1,3 million
- **Technical requirements:**
  - The new SPE based High Speed Iso BUS based on 1000BASE-T1
  - Link length: minimum 40m and longer
  - 100Mbs and 1Gbps; future also up to 5Gbs
  - low latency ≤ 1ms



source: HARTING

- **Market estimation**
  - A typical network for mobile working machine show a lot of CAN bus for the basis driving functions and new SPE based communication additional application like vision sensors, terminals, communication
  - Across this various vehicles we expect in average 5-10 additional SPE based applications.
  - If we calculate as average with 7 SPE applications we need 14 ports per vehicle (switch and device side)
- In this way the world market is could be in 2030: 40 -50 million ports
- More info at AEF page: [High Speed ISOBUS - AEF Online (aef-online.org)]

Source: [Fritsche_3SPEP2P_01_05122021.pdf]

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ISSUES TO WORK STILL FROM FIRST PHASE

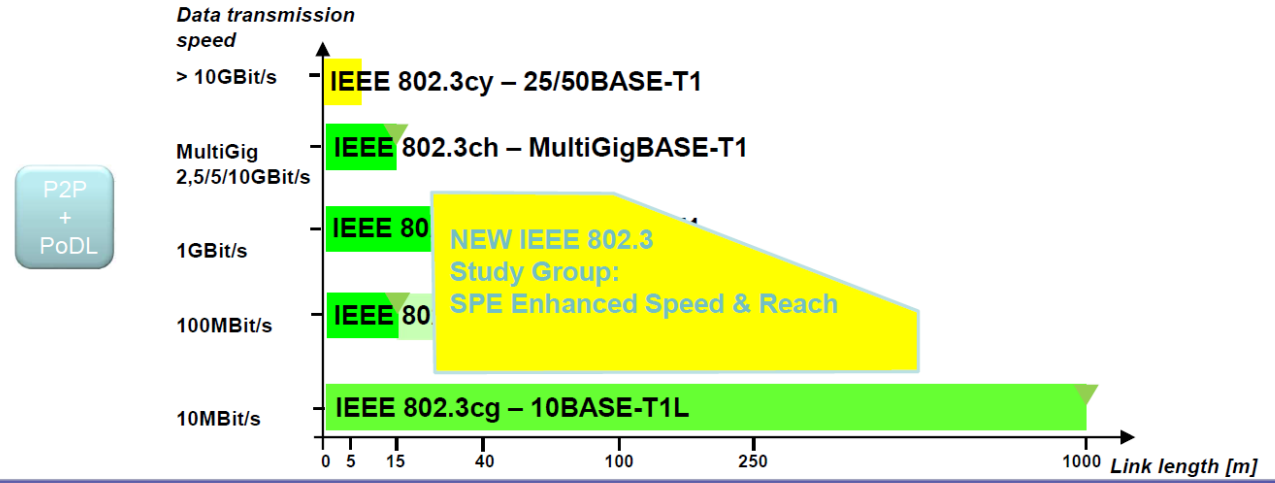
Issues: Scope/Objectives

The next speed, or the next speedS?

- Desire to fill out the SPE ecosystem
  - Traditionally, Ethernet has provided a higher speed
- One speed or multiple speeds at once?
  - 100 Mb/s
  - 1 Gb/s too?
- Auto-negotiation between speeds is important

Long-reach P2P SPE

- Idea behind this proposal: Close the gab for 100MBit/s and 1GBit/s SPE and create a complete SPE ecosystem



Source:
[Fritsche_draft_objectives_longterm_3SPEP2P_06232021.pdf]

Issues: Distinct Identity

Differentiate from BASE-T1 and BASE-T

- Clause 96: 100BASE-T1
  - Defined link segment described as 15m, IL specified for 15m 26 AWG
  - No delay specification, Does it go far enough on less lossy wiring?
- Clause 97: 1000BASE-T1/Option B – 40m…
  - Is this distinct for Gbps at < 100m reach
- Clause 25 (100BASE-TX), Clause 40 (1000BASE-T) both 100m

- Study Group needs to explore these

Reach and Cabling

- Process Control:
  - Very long reach (300m, 500m to 1 km)
  - Reuse of Fieldbus type A desired
- Building / Industrial Automation:
  - ISO/IEC 11801-1 Amd. 1
    - T1A channels (100m, 250m, 400m, 1000m) with frequency extension?
    - T1B channels (100m) possibly with length extension?
  - Any reuse requirements?
- Mobile Machines, Rail, etc.
  - Custom channels? What gauge? Other special requirements?

Need time to finish long term

- Desire not to preclude re-use of existing cable/topologies
  e.g., fieldbus type A (IEC-61158-2), (35 MHz, 16-18 AWG (1.5-0.75mm^2)
  – MUCH less insertion loss/meter than automotive cabling
- Differing views – building consensus
  – Rate: 100 Mbps? 1 Gbps?
  – Reach: 100m, 200m, 500m, 1km
- Varying complexity solutions

GETTING CONSENSUS ON THIS IS WHAT A STUDY GROUP IS ABOUT

Why Now

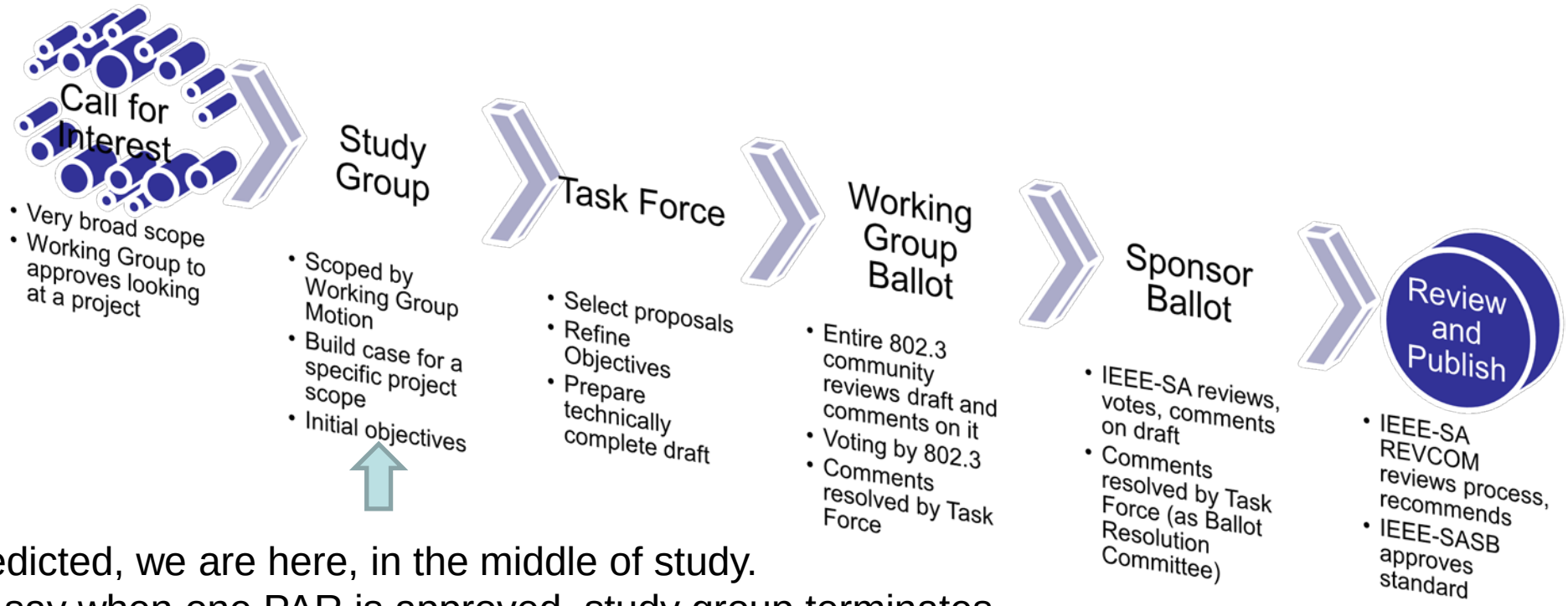
- 10BASE-T1L rolling out
- Standards timeline is longer for next generations
  - More options, learning feedback
    - Next generation needed 2025-2026
- “Near-term” PAR for MACMERGE/TSSI submitted
  - Rules could end SG before long term study is completed

Source: The APL Project

10BASE-T1L / APL demonstration at ACHEMA Pulse 2021
Source: graber_3SPEP2P_01a_06232021.pdf

For Next-Gen products in 2H 2025

				Approved	Products
802.3cg:	Start: July 2016	(Sept 2016)	(Jan 2017)	Nov 6, 2019	2021
Possible next-gen:	Start: March 2021	(May 2021)	(Jan 2022)	Nov 2023?	2025?



As predicted, we are here, in the middle of study.
Rules say when one PAR is approved, study group terminates
"Near-term" PAR is submitted…. Need approval to complete "long-term" work

WRAP UP

What are we planning

- Single PAR
  - Next generation point-to-point SPE (T1L) PHYs and associated powering

Study Group Question…

- Should a study group be formed to study Greater than 10 Mb/s long-reach point-to-point Single-Pair Ethernet PHYs and Associated Powering?
  - Y: 31
  - N: 1
  - A: 2
  - Call Count: 44

Results as of 10:00 AM PT

Straw Polls

- I would participate in the “Greater than 10 Mb/s long-reach point-to-point Single-Pair Ethernet PHYs and Associated Powering” Study Group in IEEE 802.3
  - Tally: 26
- I believe my affiliation would support my participation in the “Greater than 10 Mb/s long-reach point-to-point Single-Pair Ethernet PHYs and Associated Powering” Study Group in IEEE 802.3
  - Tally: 24

Results as of 10:00 AM PT

Future work

- Ask 802.3 WG for approval at July 2021 Closing Meeting
- If approved, request formation of the Study Group by IEEE 802 EC
- Continue to use the SPEP2P SG reflector and web page
- Anticipated SPE P2P Study Group meetings will continue and now be exclusively on the long-term PAR, transitioning to the new SG