IEEE 802.3 Study Group

SPE point-to-point Enhancement Long Term – Process Industry

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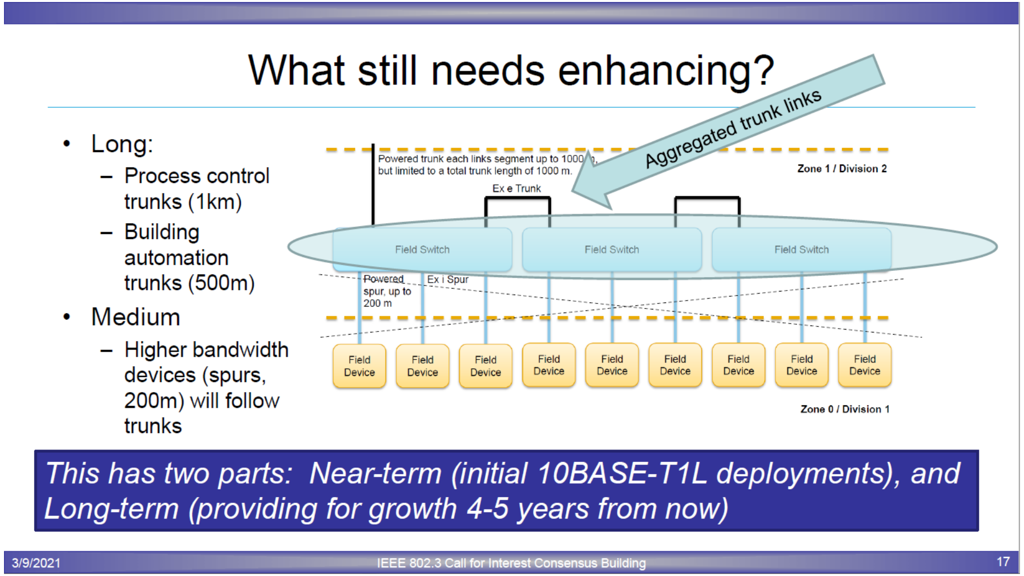
IEEE 802.3 ”Enhancements to Single Pair Long Term

Bandwidth is always a limitation for future use-cases !



Source: CFI George Zimmermann March 2021

Why is there a great market potential for bandwidth extension !!!

- Building Automation
- Factory Automation
- Renewable energy industry
- Process Automation
- and more …

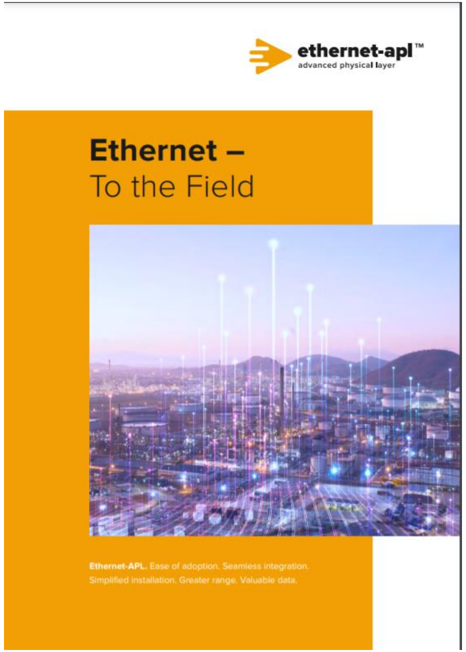



Ethernet-apl Group activities

Organization of the Cooperation

The agreement to develop the Ethernet-APL technology under "The APL Project" was established in 2018 and is backed by the leading industry standard development organizations (SDOs) FieldComm Group, ODVA, OPC Foundation, and PROFIBUS & PROFINET International, as well as by major industry suppliers of process automation, including ABB, Emerson, Endress+Hauser, Krohne, Pepperl+Fuchs, Phoenix Contact, R. Stahl, Rockwell Automation, Samson, Siemens, Vega, and Yokogawa.

Figure 2: Industry partners and associations of The APL Project

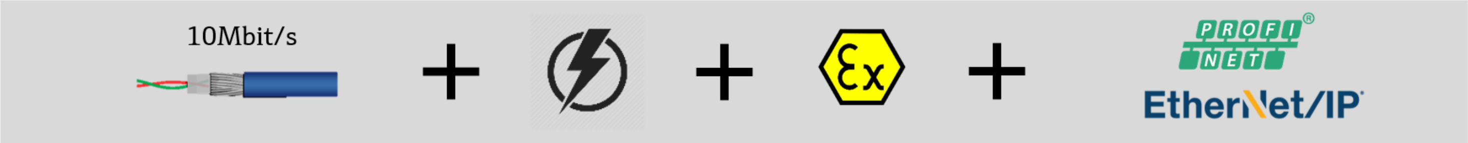


Document Source: LINK

APL Project Phase1: 10 Mbps Project Phase 2: 100 Mbps
Bandwidth Enhancement use Case in Standard and EX-area

E+H APL Phase 1 with 10Base-T1L

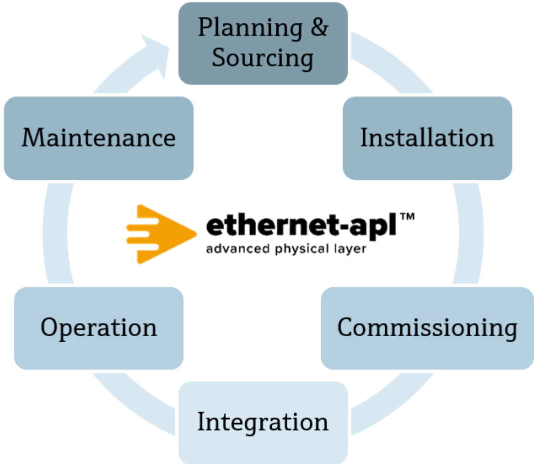
Summary: Ethernet-APL as single physical layer for top performance and IIoT



Central device data consolidation and analyses
→ Plant status insights

Insights into device health status
→ Predictive Maintenance

Remote and fast device configuration without manual scaling of process variables



Homogenous network for seamless data access
→ less hardware without protocol conversion

Increased quality and quantity from the process
→ more process variables with increased measurement accuracy

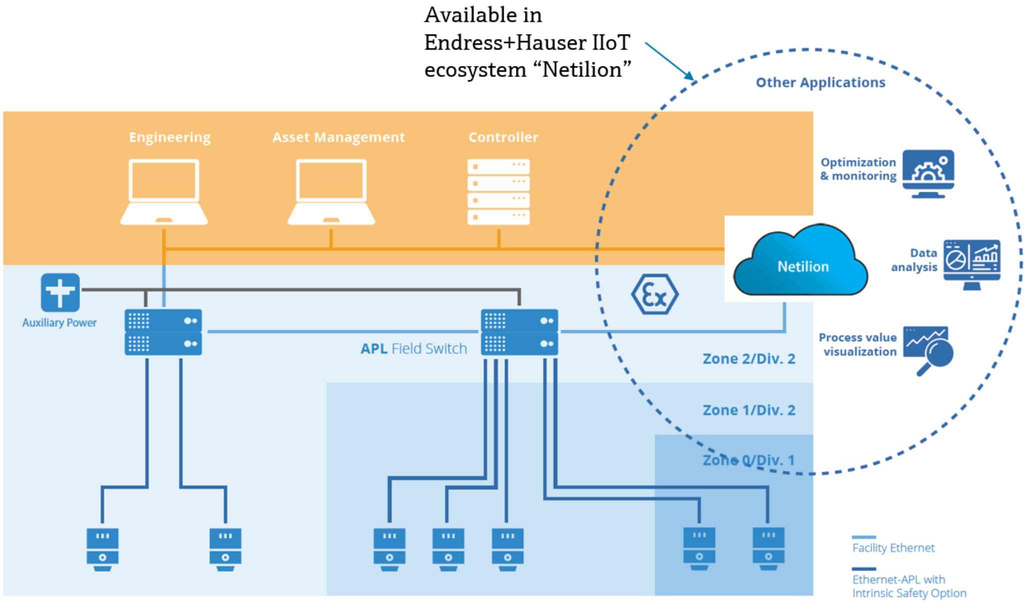
Automatic network discovery and automatic device name assignment
→ Simplified DCS integration

E+H APL Phase 1 with 10Base-T1L

2-wire Ethernet to the field

Digital Services for Increased Efficiency in Operation

ethernet-apl™
advanced physical layer



→ Ethernet-APL as enabler for real-time access to data in the field level

→ Access in parallel to process control

→ Hardly any limits for processing of the data within IIoT applications

→ fulfillment of second channel approaches, e.g. NAMUR Open Architecture (NOA)

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E+H APL Phase 1 with 10Base-T1L

2-wire Ethernet to the field

General Timeline

ethernet-apl™
advanced physical layer

IEEE 802.3cg task force:
Enhancements to IEEE completed

IEC:
New work item proposals for TS

Foundations:
Industrial Ethernet specification updated

Field device vendors:
Infrastructure and devices expected

2019 — 2020 — 2021

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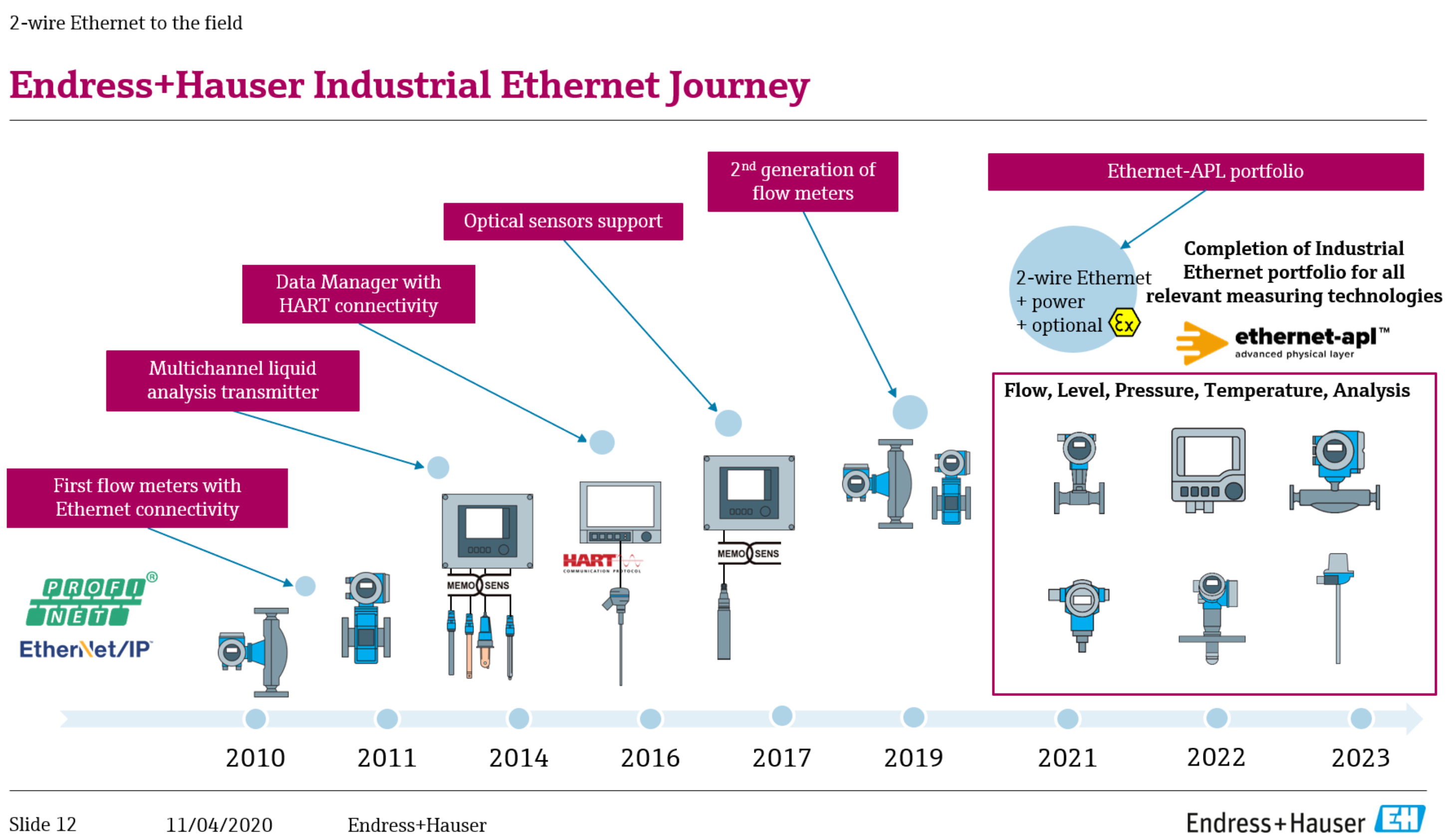
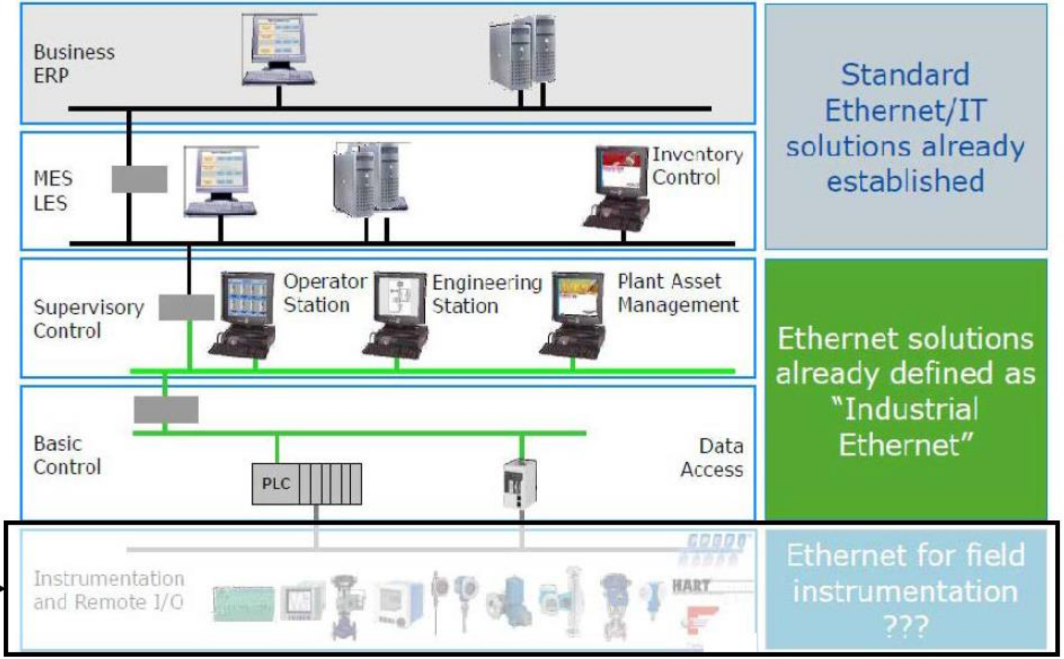
E+H APL Phase 1 with 10Base-T1L



IEEE SPE long term Bandwidth Enhancement

Non-Ethernet fieldbuses still required to complete communications to the edge

- Cable lengths > 1km
- 1200 baud to hundreds of kb/sec
- Challenges: Combined reach & rate, special environments, cost of operation



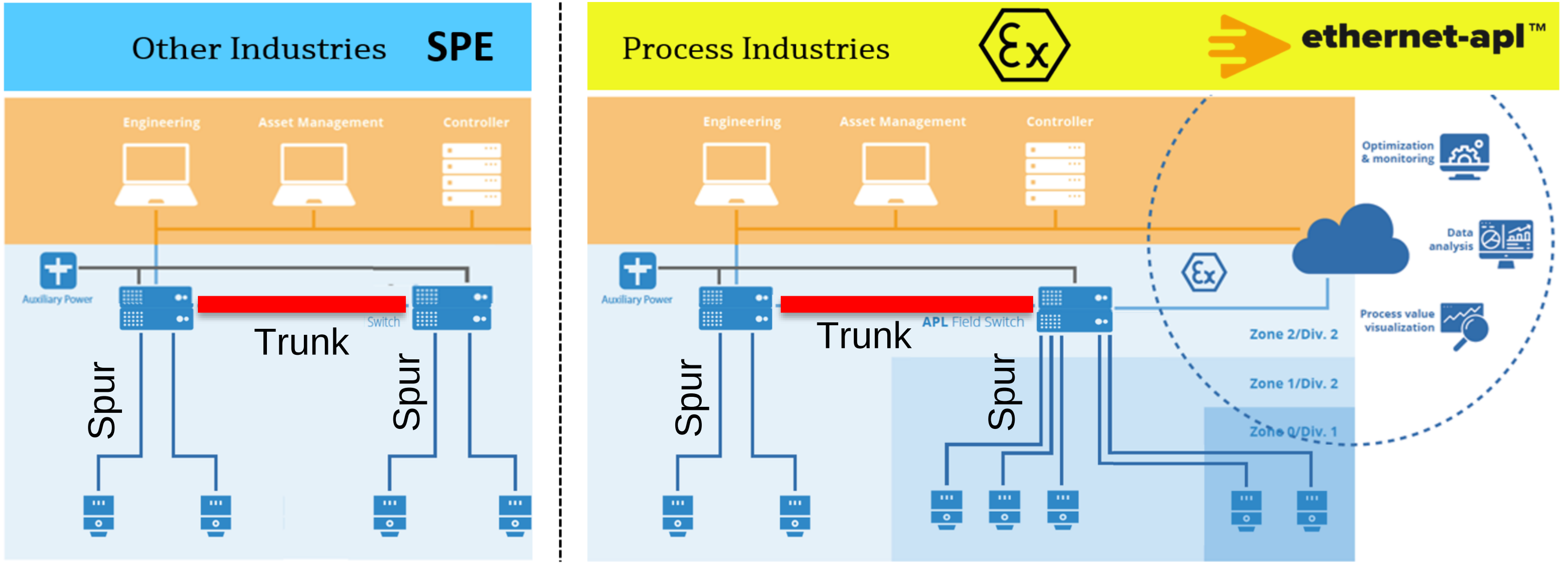
- **Bandwidth limitation**

Ethernet Gap at the 'Edge'

Credit: Dr.Raimund Sommer, Endress+ Hauser, ODVA Industry Conference, Oct. 2014.

From https://www.ieee802.org/3/cfi/0716_1/CFI_01_0716.pdf

IEEE SPE Bandwidth Enhancement



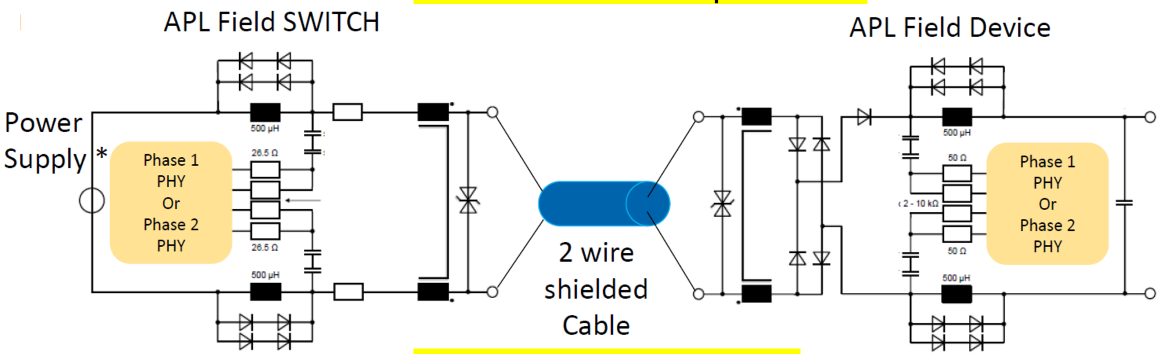
IEEE SPE point-to-point Bandwidth Enhancement

Bandwidth Enhancement use Case in Standard and EX-area !
Trunk (300…500m max. cable length TBD) and Spur (200 m max. cable length)

IEEE SPE Bandwidth Enhancement

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

Bandwith: 100 Mbps ? TBD



Max. (300..500 m) TBD

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)

IEEE SPE Bandwidth Enhancement - Cable

Parameter	Cable Category			
	I	II	III	IV
Cable length trunk [m]	≤ 250	≤ 500	≤ 750	≤ 1000
Cable length spur [m]	≤ 50	≤ 100	≤ 150	≤ 200
Coupling attenuation [dB]	≥ 60 (f is frequency in MHz; 0,1 ≤ f ≤ 20)			
Return loss [dB]	≥ 15 + 8 x f (f is frequency in MHz; 0,1 ≤ f ≤ 0,5)			
	≥ 19 (f is frequency in MHz; 0,5 ≤ f ≤ 20)			
Insertion loss [dB] / 100 m (f is frequency in MHz; 0.1 ≤ f ≤ 20)	$\leq 4{,}92 \times \sqrt{f} + 0{,}04 \times f + 0{,}8/\sqrt{f}$	$\leq 2{,}46 \times \sqrt{f} + 0{,}02 \times f + 0{,}4/\sqrt{f}$	$\leq 1{,}64 \times \sqrt{f} + 0{,}0133 \times f + 0{,}267/\sqrt{f}$	$\leq 1{,}23 \times \sqrt{f} + 0{,}01 \times f + 0{,}2/\sqrt{f}$
	0,1 ≤ f ≤ 20; f is frequency in MHz			
Cross talk [dB], (PSANEXT/PSAFEXT wire pair to wire pair) for multi core cables	≥ 60 (f is frequency in MHz; 0,1 ≤ f ≤ 20)			

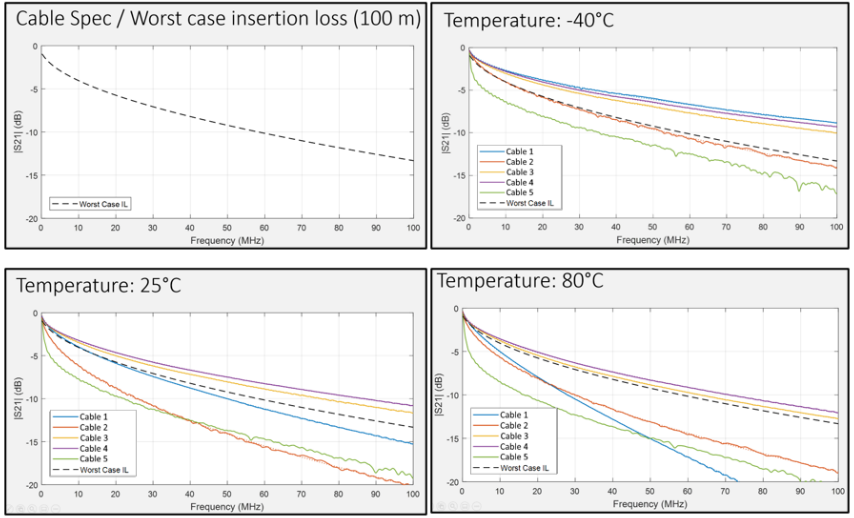
NOTE 1 The values in Table 16 apply for single pair and multi pair cables.

NOTE 2 Insertion loss and return loss shall be measured with a reference cable length of 500 m.

NOTE 3 The AC link segment requirements may also be verified using TIA SP1-1000 and ISO/IEC T1-A-1000 channel definitions, which might exclude IEC 61158 type A fieldbus cables from being compliant to these definitions.

10BASE-T1L
APL cable specification, according IEEE802.3CG

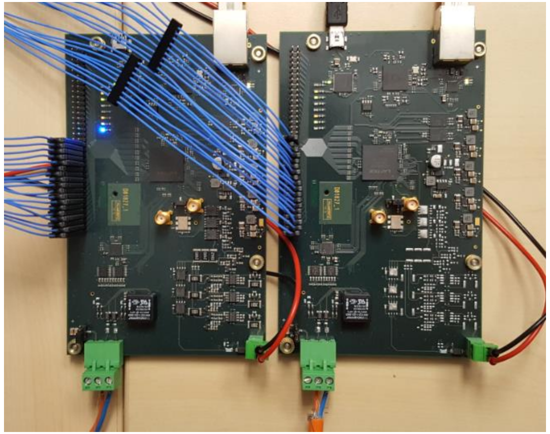
SPE Bandwidth Enhancement: APL Project Phase 2:
For this purpose, detailed cable measurements of Fieldbus Cable Type A cables, which are already widely used in the industry, were first carried out. Figure 3 shows the results of insertion loss measurements for various shielded twisted-pair cables.

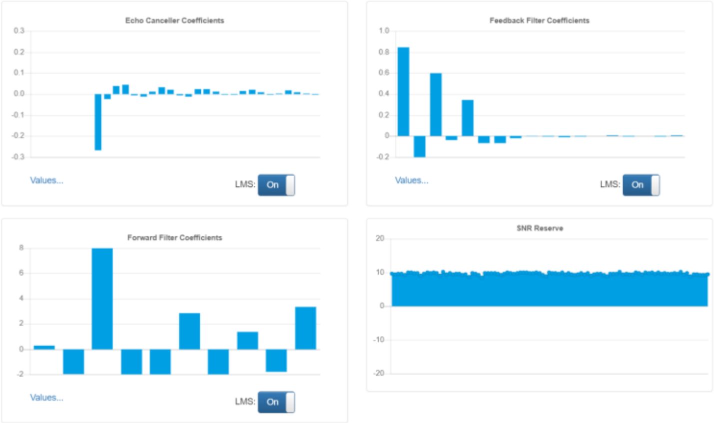


Re-Use existing Fieldbus Type A cable !

Figure 3: Insertion loss measured at different temperatures for various Fieldbus Type A cables

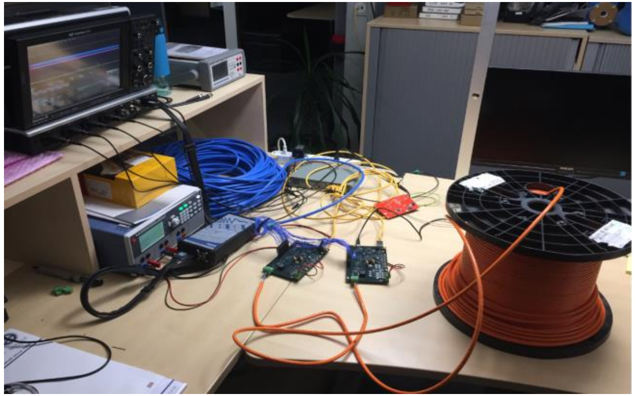
Technical Feasibility Implementations

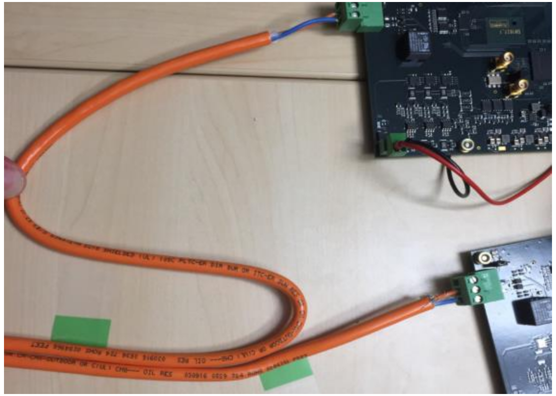


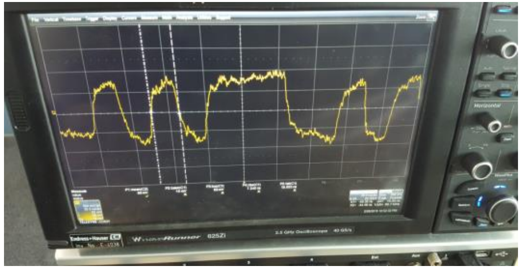


APL Phase2 Project :

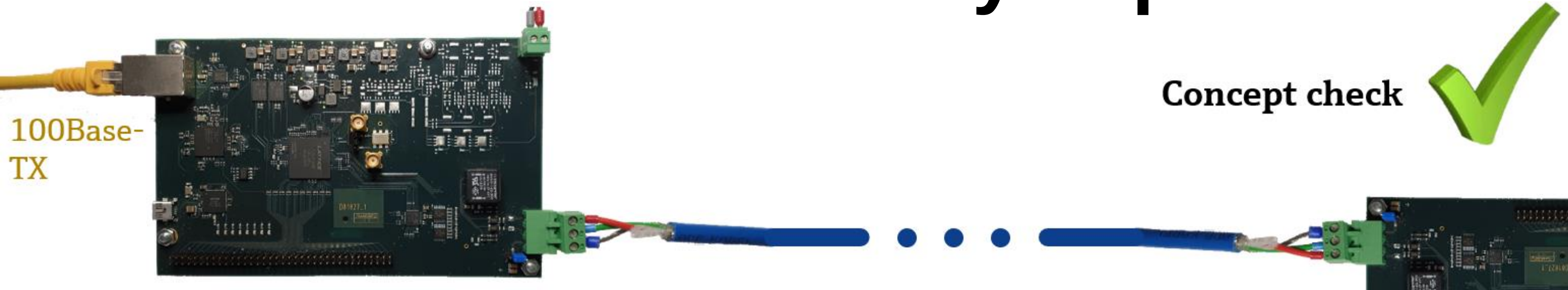
Working Prototype 200 m Fieldbus Type A Cable @ 100Mbps / PAM 3







Technical Feasibility Implementations



- 10 Mbps: 10BASE-T1L
  - Backward compatibly with 10 Mbps at least 800 m using 0.5 V transmit amplitude (1 V pp)

- 100 Mbps:
  - 300 m cable by using 1 V transmit amplitude (2 V pp), without bit error
  - 220 m cable by using 0.5 V transmit amplitude (1 V pp), without bit error
  - 3B2T encoding was tested for 100Mbps and achieved the same maximum reach -> 4B3T is more applicable for intrinsic safety applications due to its disparity observing encoding

Summary

- Support Bandwidth 100 Mbps
- Support more than 300 m cable length, Wish length max. 500 m
- Support re-use of Fieldbus Type A cable
- Support low power consumption (less than TBD mW) (wish less than 200 mW PHY-IC consumption)
- Backward compatibly with 10 Mbps 10BASE-T1L => Support of auto negotiation IEEE802.3cg 10BASE-T1L
- Do not preclude intrinsically safety use case (use inside EX-Area)
  - DC-free signal coding 4B3T
  - optional external termination resistor
  - limitation of max. transmit voltage (1 V pp)

Thank you!