10Mb/s Extended Reach Single Twisted Pair Ethernet PHY Call for Interest

IEEE 802.3 Ethernet Working Group

CFI Panel Members

Chair and Presenter:

Supporters and experts for the Question and Answer session

Supporters - Page 1

Ludwig Winkel, Siemens AG (Industrial Automation)

Klaus Wächter, Siemens AG (Building automation)

Chris DiMinico, (Cable)

Mick McCarthy, Analog Devices (Semiconductor supplier)

Matthias Fritsche, HARTING Electronics (Industrial Automation)

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Supporters - Page 2

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Claude Gauthier, OmniPhy (PHY vendor)

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Alan Flatman, LAN Technologies (Cable)

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Supporters - Page 3

Rubén Pérez de Aranda, KDPOF (PHY vendor)

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Mr. Harald Mueller, Endress+Hauser (Industrial Automation)

Robert Hall, Johnson Controls (Building Automation)

Steve Carlson, High Speed Design

George Zimmerman, CME Consulting

CFI Objective

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

10Mb/s Extended Reach Single Twisted Pair Ethernet PHY

- This meeting will NOT:
  - Fully explore the problem
  - Debate strengths and weaknesses of solutions
  - Choose a solution
  - Create a PAR or 5 Criteria **[CSD?]**
  - Create a standard or specification

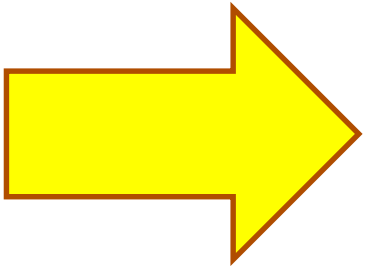
Agenda

- **Industrial Networking Market Need**
- **Solution Requirements**
- **Target Markets**
- **Market Potential**
- **Technical Feasibility**
- **CFI Proposal**
- **Q&A**
- **Straw Polls**

Industrial Networking Market Need

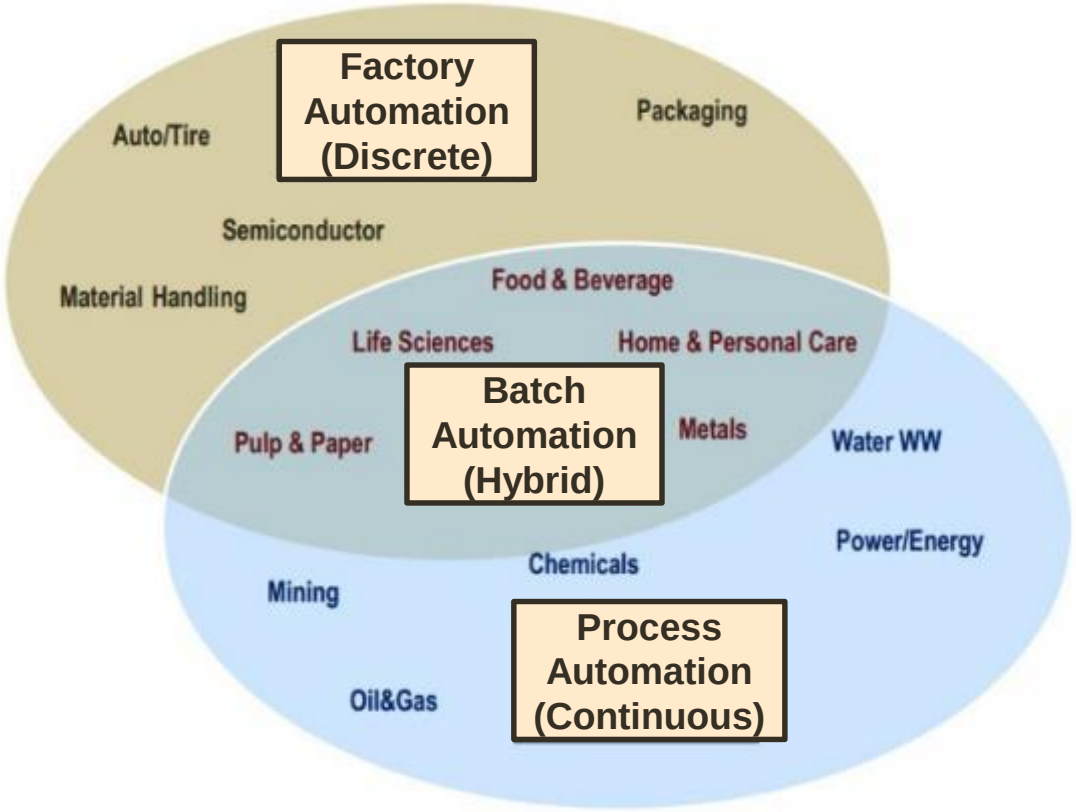
Vision

- Multi-drop
  - RS-485
  - HART modem
  - CAN
  - Proprietary/custom
- Point-point
  - 4-20mA
  - HART modem
  - RS-232
  - Proprietary/custom
- New applications
  - Enabled through this proposed PHY development



New
IEEE 802.3
Standard

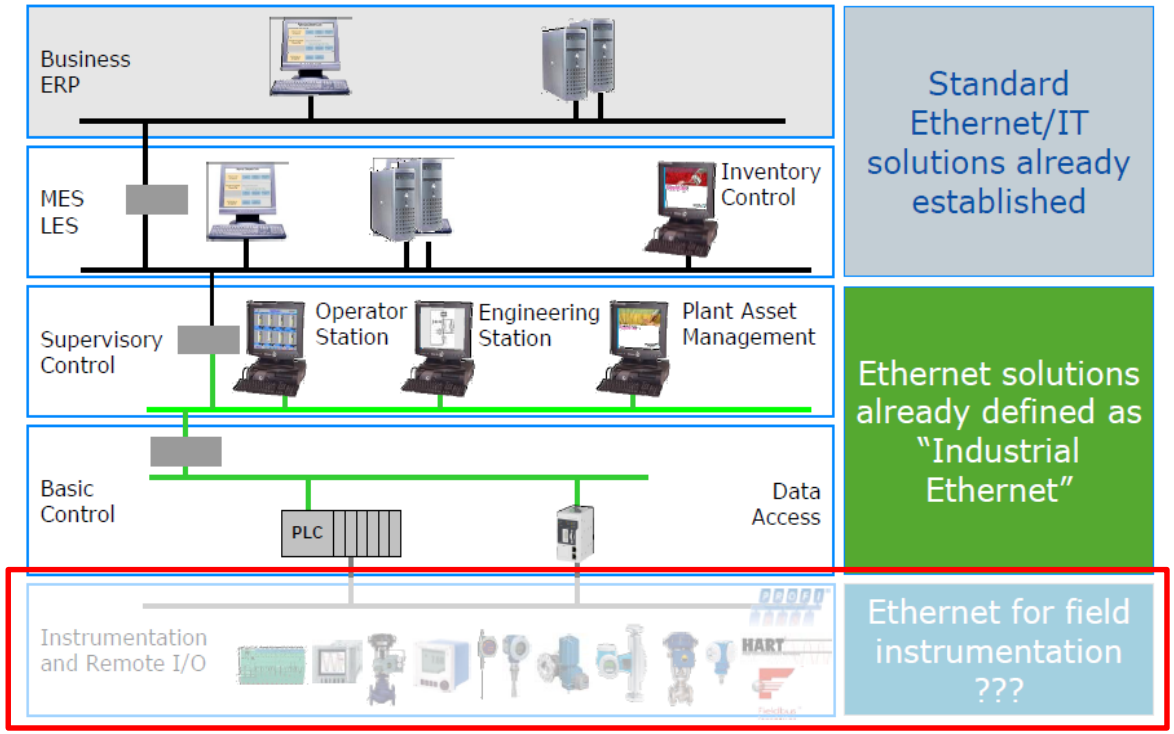
Industrial Automation Landscape



Ethernet Gap in Industrial Networking

- Desire to converge on **one** network type
- Ethernet adoption is happening where technically possible
- Non-Ethernet *fieldbuses* still required to complete communications to the edge
  - Challenges: Combined reach & rate, special environments, cost

Ethernet Gap at the 'Edge'



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

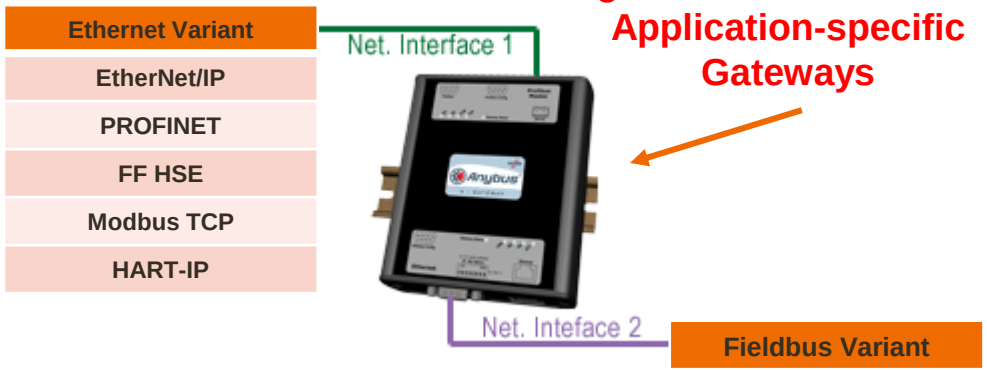
Existing Market Fragmentation

Too Many Fieldbus Variants

- **Big challenges for end users**
  - **Sourcing appropriately qualified labor**
  - **Installation complexity**
  - **Maintenance complexity**
  - **Interoperability issues**

Partial list…

Fieldbus Variants	
FOUNDATION Fieldbus H1	PROFIBUS DP
PROFIBUS PA	DeviceNet
HART	CANOpen
IO-Link	Modbus
CompoNet	CC-Link
AS-Interface	INTERBUS



Fragmentation forces use of Application-specific Gateways

New Requirement: Higher Rates at the Edge

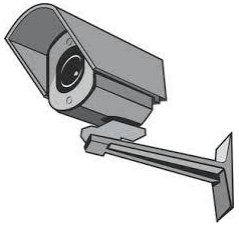
- IIoT, Big Data, and Analytics
  - High-speed data logging
    - Production details, equipment conditions, environment state, energy consumption,…
  - Optimization, maintenance, safety, compliance,…

PLATTFORM INDUSTRIE 4

industrial internet CONSORTIUM

- Embedded web servers
  - Installation and maintenance

- Video
  - Reduced footsteps
  - Safety
  - Product quality sensor
  - Security



Solution Requirements:

Why 10Mb/s Extended Reach Single Twisted Pair Ethernet PHY?

Why Ethernet to the Edge?

- **Single network paradigm**
  - **Transparent connectivity**
    - **Reduces complex gateways**
  - **Leverages of economy of scale**
  - **More rapid commissioning**
  - **More rapid fault diagnosis and repair**
- **Well-known installation, maintenance and management processes**

- **Ethernet Ecosystem**
  - **Protocols**
  - **Security**
  - **Existing switching technology**
  - **…**

Why 10Mb/s and Extended Reach?

- **Single solution required to simultaneously match both reach and rate**
- **Existing solutions have varied capabilities. Study group will not cover all extremes/outliers**
  - **Common fieldbuses reach 400-5000m**
    - **1200m addresses most fieldbus applications**
  - **Common fieldbuses have rates up to 12Mb/s**
    - **10Mb/s addresses most fieldbus applications**
      - **Enables a standard MAC**

Fieldbus	Longest Reach	Highest Rate
PROFIBUS DP	9.6kb/s @ 1200m	12Mb/s @ 100m
CANopen	10kb/s @ 5000m	1Mb/s @ 20m
Modbus RTU	100kb/s @ 1200m	2Mb/s @ 50m
CC-Link	156kb/s @ 1200m	10Mb/s @ 100m
HART	1200 baud @ 1524m (24AWG) 1200 baud @ 3048m (20AWG)	No enhanced rate
DeviceNet	125kb/s @ 500m	500kb/s @ 100m
ControlNet	5Mb/s @ 1000m	No enhanced rate
INTERBUS	500kb/s @ 400m	No enhanced rate
FOUNDATION H1	31.25kb/s @ 1900m	No enhanced rate
PROFIBUS PA	31.25kb/s @ 1900m	No enhanced rate

Why Single Twisted Pair?

- **Installed base**
  - **Single Twisted Pair is most common – usually shielded**
  - **Certain cables are certified**
- **Maximize cable reuse**
  - **Lengthy fieldbus cables are expensive to run (often in conduit)**
  - **End nodes are easier to replace**
  - **Similar efforts within 2.5G/5GBASE-T Task Force**

High Cable Reuse Value

Fieldbus	Cable Type	Cable Power
FOUNDATION H1	FF-844 specified	Yes
HART	Various	Yes
PROFIBUS PA	IEC 61158 Type A	Yes
4-20mA	SP-50 instrumentation cable	Yes
CANopen	EIA-485	Yes
Modbus RTU	EIA-485	No
CC-Link	CC-Link, Ver.1.10 specified Shielded, 3- & 5-core	No
DeviceNet	ODVA DeviceNet specified (5-core, various classes)	Yes
ControlNet	RG-6/U Coaxial	No
INTERBUS	3 / 6 no. twisted pairs, various	Yes
PROFIBUS DP	IEC 61158 Type A (22AWG?)	No

Why Single Twisted Pair?

- **Enables simple and cost-sensitive edge factory automation elements to migrate to Ethernet**
  - **Large volumes**
  - **Low-end fieldbus devices**
  - **Previously hard-wired discrete devices**
- **Expected benefits:**
  - **Less complex to install**
  - **Lower cost**
  - **Smaller size, lower weight, more flexible, tighter bend radius, …**

Common size 22.5mm
Similar to Euro coin

Examples

What about Power?

- Low power operation is required
- Many devices require power delivery over the same pair
  - Enhancement of PoDL for extended reach to be considered
- Existing sensor solutions are often ‘loop powered’
  - Powered from analog current loop/fieldbus cable, e.g. ISA/SP50 Type A
    - Multiple gauges available: 18 AWG sample cable → 43.6 Ohms/km max loop resistance
  - Limited power availability today (~3.2mA @ 18Vdc = ~58mW)
  - Complex Process devices expected to not exceed 500mW total power budget

Power Considerations – Intrinsic Safety

- Industrial Automation has stringent safety standards applied
- Required where some safety and mission critical systems involved
- Specific needs for explosion proof systems – Intrinsic Safety
  - Out of IEEE 802 scope
  - Certification is of the networked equipment – not of the IEEE PHY
  - The PHY should not preclude the design of IS networked equipment
    - Usually involves limitation of current, voltage and energy storage capabilities
    - Energy stored in 10/100 transformer exceeds limits

Why Limit this CFI to 10Mb/s?

- **Preference for this CFI is to include one PHY development**
  - **Satisfies immediate pull from market addressing ‘sweet spot’**
  - **Reduces complexity & minimises time to completion**
- **Establishes credibility in Ethernet as true consolidated fieldbus replacement**
- **Future CFI(s) can consider efforts at different rates**
  - **Address certain applications that would benefit from higher rate (>10Mb/s), extended reach, single pair solutions**
    - **Distance of existing single pair standards not long enough for some use cases**
    - **NAMUR and Industry vendors body (APL) agree on <u>future</u> (> 5 years) need for 100Mb/s**

Target Markets

Target Markets

- **Industrial Automation (**The dominant driving market for this CFI)
  - Process Automation
  - Factory Automation

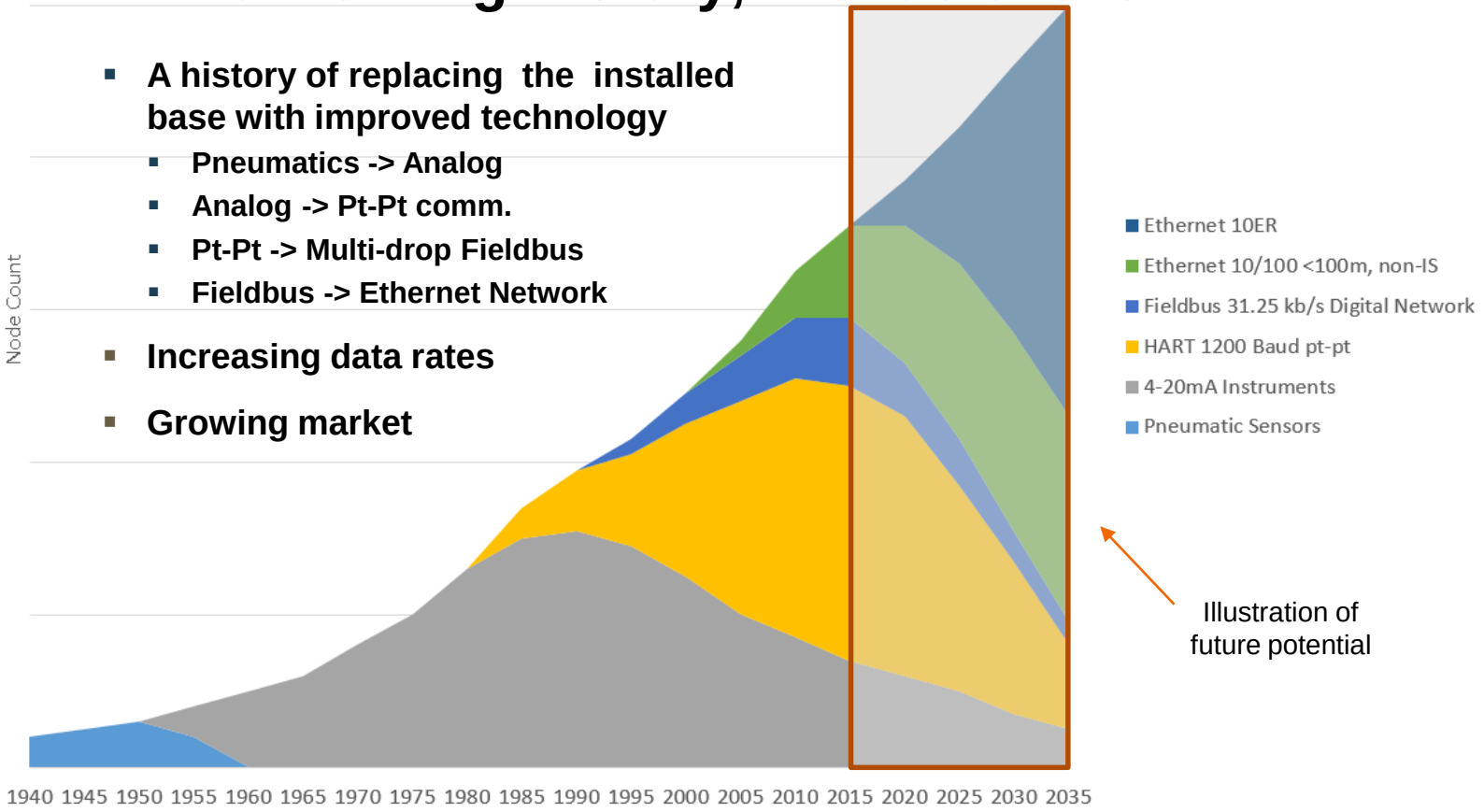
- **Building Automation[1]**
  - Lighting Systems
  - HVAC
  - Security
  - Fire
  - Residential

- **New Applications**

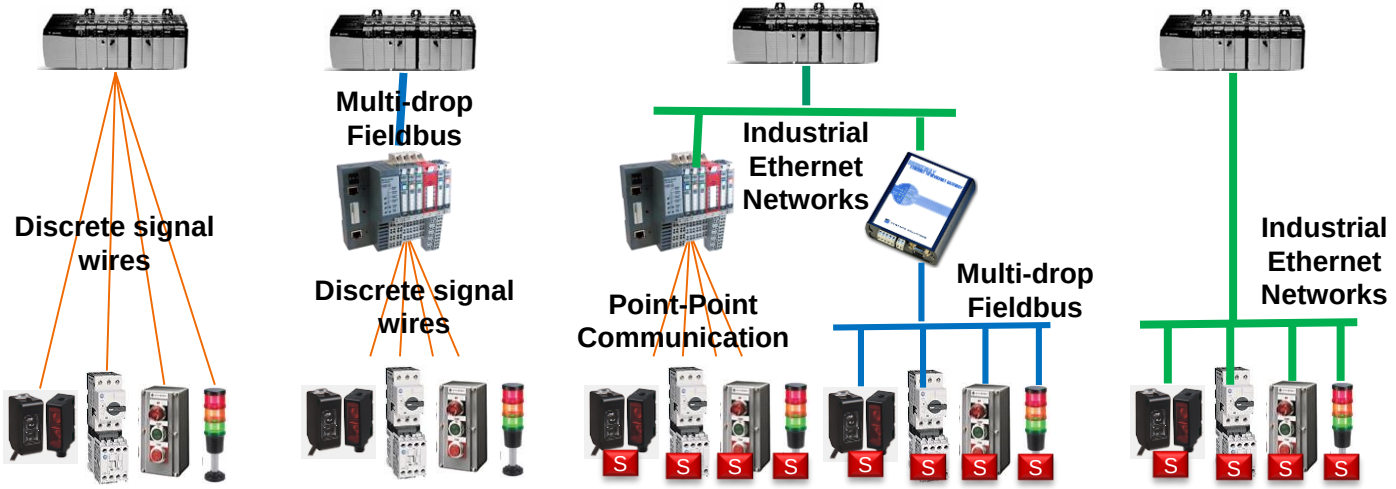
[1]Further information see: July 2014 IEEE 802 BoF “I Feel the Need… for Low Speed” (Carlson/Kennedy)

Process Automation
Networking History, Trends & Growth

- **A history of replacing the installed base with improved technology**
  - **Pneumatics -> Analog**
  - **Analog -> Pt-Pt comm.**
  - **Pt-Pt -> Multi-drop Fieldbus**
  - **Fieldbus -> Ethernet Network**
- **Increasing data rates**
- **Growing market**



Discrete Automation: Networking History & Trends



Local I/O **discrete wires,** Dumb devices

Remote I/O **Fieldbus**, Dumb devices

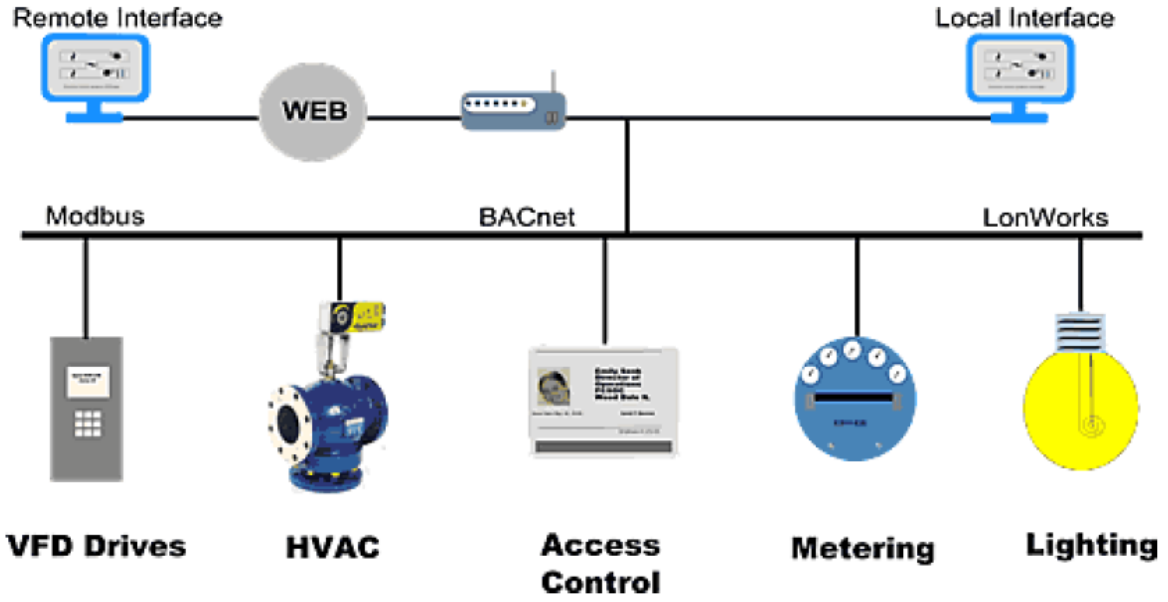
Industrial Ethernet interconnecting multi-drop Fieldbus and point-point for **smart devices**

Native Industrial Ethernet smart devices?

1980s 1990s 2000s-2010s 2020s?

S = Smart Device

Building Automation Architecture

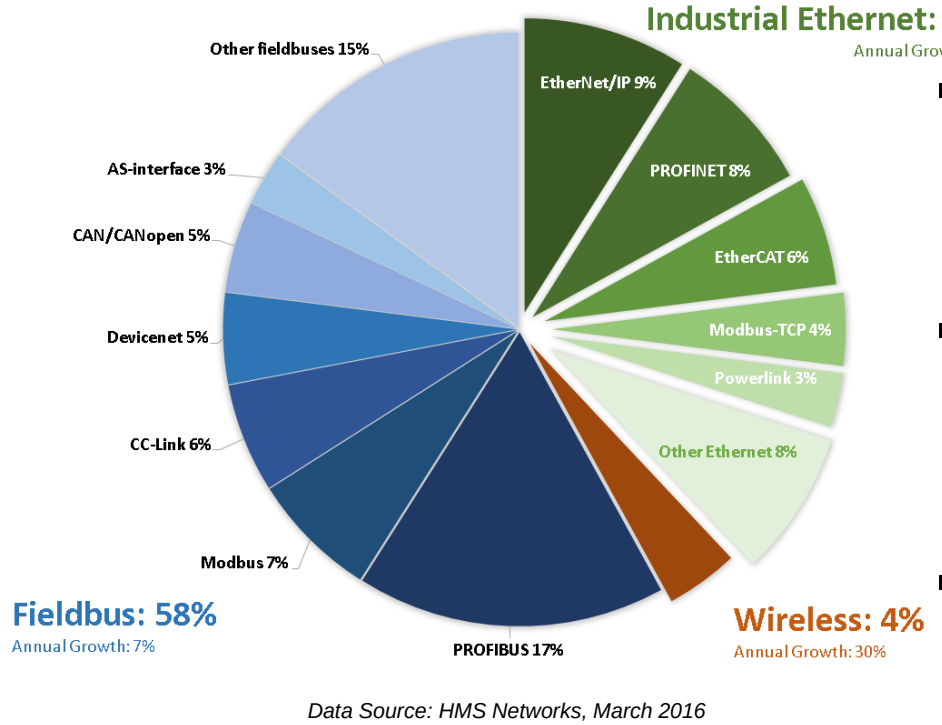


Credit: Steve Carlson/Lynn Kennedy, IEEE 802 BoF, July 2014.

- Fragmentation…
  - Modbus: RS232/485
  - BACnet: RS485
  - LonWorks: Proprietary
- Multiple gateways needed
- Desire to converge on **one** network type

Market Potential

Current Industrial Network Share



Data Source: HMS Networks, March 2016

- Entire market is growing
  - Fieldbus (58%), 7% growth
  - Ethernet (38%), **20% growth**
  - Limited wireless adoption
- Despite greater growth rate today, Ethernet will hit a roadblock
  - Without this CFI, existing Ethernet cannot match key Fieldbus capabilities
- Significant number of protocols
  - Ethernet protocols can share common hardware
  - Fieldbuses have unique hardware

Industrial Networking Market Size

- Converged data is challenging to align
  - Various reporting techniques
    - May or may not include analog only solutions
  - Varying vintage of information
    - May not fully capture recent growth trajectory of Ethernet
  - Potential biases of representative organisations

Source	Vintage	Ports/Year Estimate
IHS	2013	175M
PNO	2015	52M
CLPA	2013	72M
IHS/ARC	2012/2015	136M
	Mean	109M

Building Automation Market Size

- **Placeholder**
  - Placeholder

Target Market Size – Summary

- Based on current port count without projected growth, mid-range estimate could suggest [100M + **BA number**] ports/year.
- Estimate 50-60% can be served by new Ethernet PHY
- Potential market of **50M + xxx** ports/year and growing
- New Ethernet-based technology (CFI subject) can provide greater growth through additional application enablement

Technical Feasibility

Related Implementations

- **Proprietary PHYs**
  - **Pepperl + Fuchs demonstrator**
    - http://www.pepperl-fuchs.com/global/downloads_ENU/PR-2016-23023PA-ENG.pdf
  - **BroadR-Reach ®**
    - https://community.broadcom.com/docs/DOC-1274
- **Relevant past generation IEEE PHYs**
  - **10PASS-TS (IEEE Std 802.3, Clause 61 & Clause 62)**
    - **10 Mb/s, 750 meters, single copper pair, variable rate**
  - **2BASE-TL (IEEE Std 802.3, Clause 61 & Clause 63)**
    - **2 Mb/s, 2.7 km, full-duplex, voice-grade copper wiring, variable rate**
- **ITU-T G.992.2 VDSL2**

® BroadR-Reach is a registered trademark of Broadcom Ltd.

CFI Proposal

High Level Summary

- Clear demand for complete Ethernet-based solution throughout facility/factory/plant
  - Multi-drop fieldbuses and point-to-point digital and analog links need an Ethernet replacement
- 10Mb/s Extended Reach Single Pair Ethernet meets the need
  - Consolidate hugely fragmented fieldbus market to unified Ethernet-based solution
  - Enable Industrial IoT applications and new markets – e.g. big data analytics, smart sensors, streaming video
  - Single pair for ease of install and enabling cable reuse
  - Power delivery
- Large market potential for 10Mb/s extended reach single pair Ethernet
  - 50M+ ports/yr for industrial automation
  - **TBD** for building automation
- Technical feasibility demonstrated

Why Now and Why in IEEE 802.3?

- The industry is requesting it
- It’s Ethernet – it belongs in IEEE 802.3
  - IEEE 802.3 is recognized as the international standard for Ethernet
  - Responsible for Ethernet physical layers
- The effort should start now to meet the industry adoption timeline
  - Late 2019 for product introduction to market

10Mb/s Extended Reach Single Twisted Pair Ethernet PHY Q&A

15 Minutes

Straw Polls

Straw Poll

xxx Number of people in the room

__xx_ Individuals who would attend and contribute to a

10Mb/s Extended Reach Single Twisted Pair Ethernet PHY Study Group

__xx_ Companies that support the formation of a

10Mb/s Extended Reach Single Twisted Pair Ethernet PHY Study Group

Thank you!