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

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IEEE 802.3 Ethernet Working Group

# CFI Panel Members

Chair and Presenter:

Supporters and experts for the Question and Answer session

# Supporters - Page 1

# Supporters - Page 2

# 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
  - Create a standard or specification

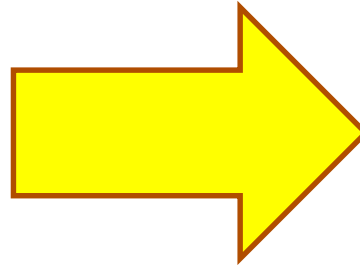
# Agenda

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

# **Industrial Networking Market Need**

# Vision

- Multidrop
  - RS-485
  - HART modem
  - CAN
  - Proprietary/custom
- Point-point
  - 4-20mA
  - HART modem
  - RS-232
  - Proprietary/custom
- New whitespace applications
  - Enabled through new capabilities



IEEE 802.3



# Industrial Automation Landscape

## ■ Factory Automation

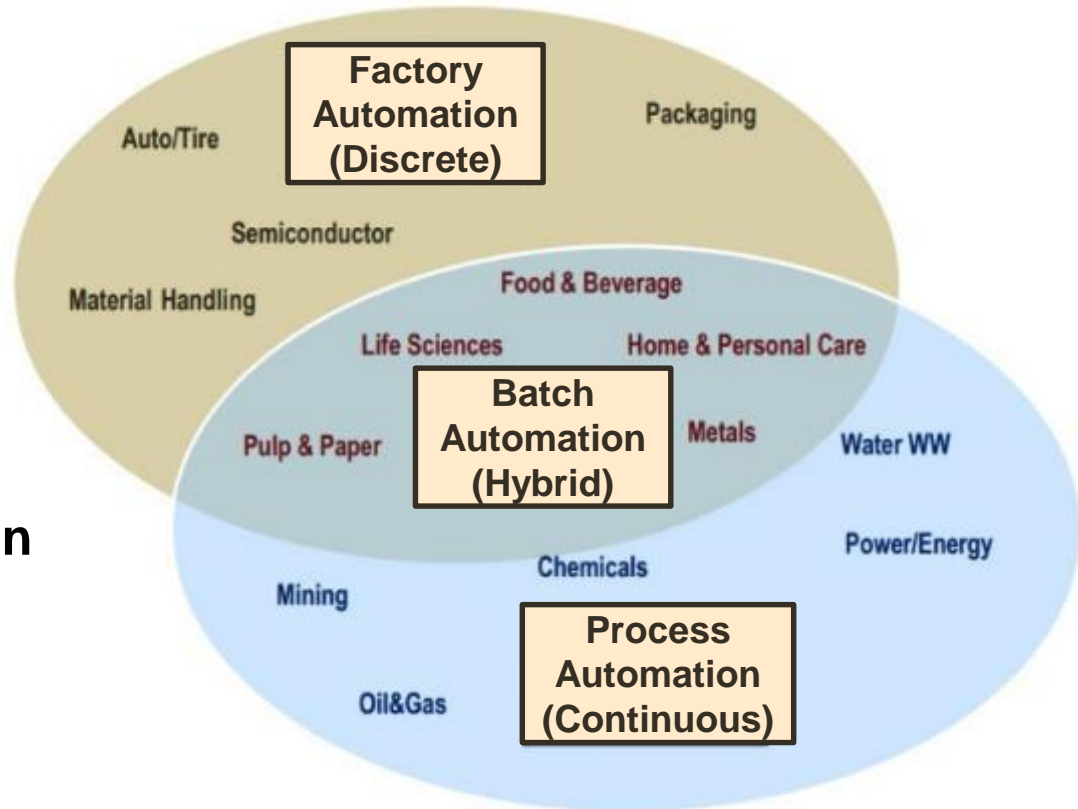
- Discrete units of output
- Rapid operations

## ■ Process Automation

- Continuous output
- Expansive applications
- Often hazardous

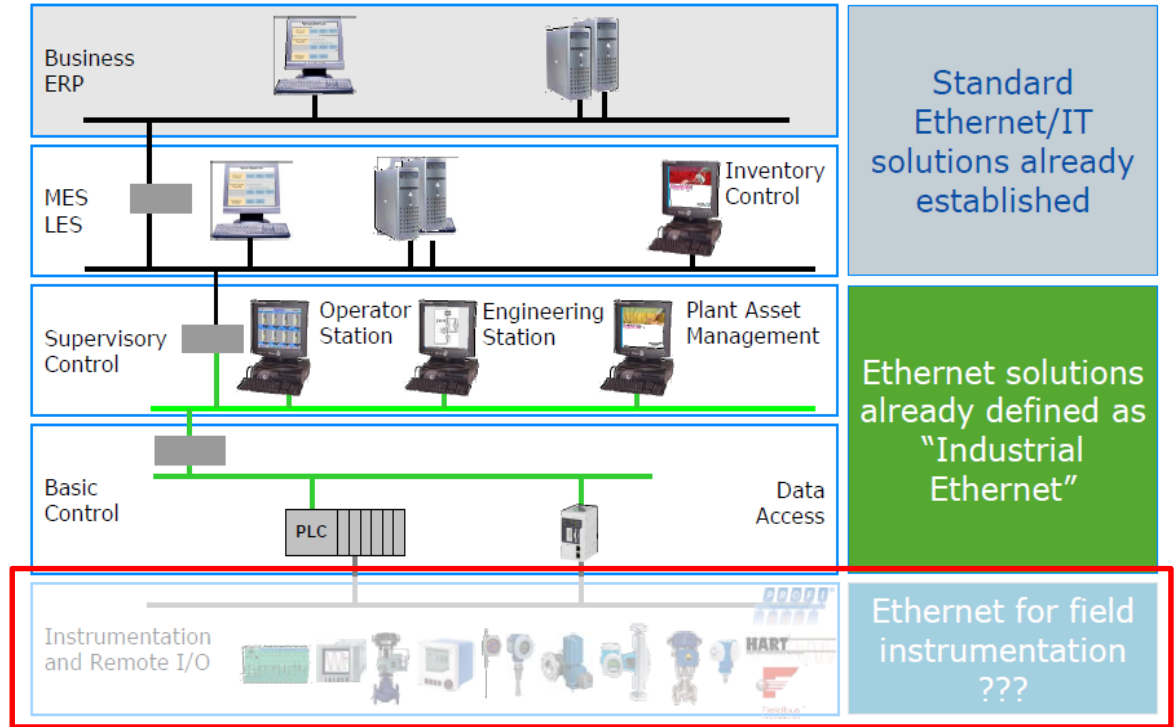
## ■ Batch/Hybrid Automation

- Batch output
  - Combination of both continuous and discrete



# Ethernet Conversion Gap in Industrial Networking

- Ethernet is propagating
- Desire to converge on **one** network type
- Non-Ethernet *fieldbuses* still required to complete communications to the edge
  - Challenges: Cost, reach, special environments

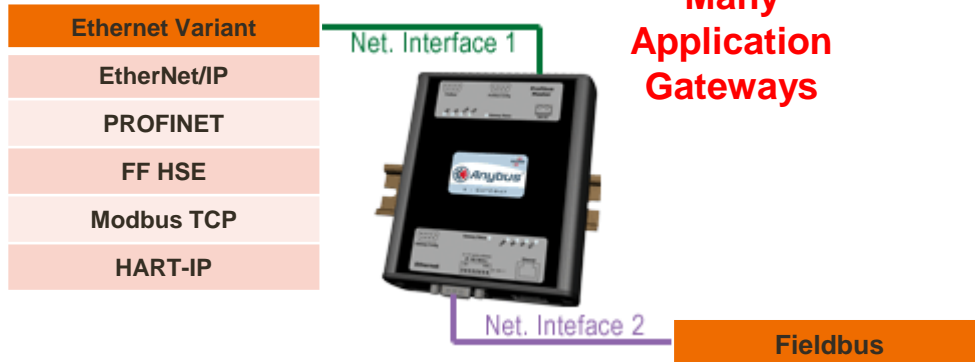


**Ethernet Gap** →

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

# Too Many Fieldbus Variants

- Big challenges for end users
  - Labor skills
  - Installation complexity
  - Maintenance complexity
  - Interoperation issues



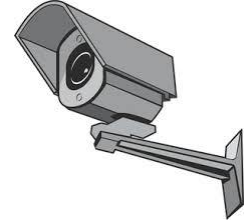
## Partial list...

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

# Cannot Meet New Application Needs: Higher Rates from the Edge

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

- **Embedded web servers**
  - Installation and maintenance
- **Video**
  - Reduced footsteps
  - Safety
  - Product quality sensor
  - Security



# **Industrial Networking Solution Requirements:**

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

# Why Ethernet to the Edge?

- **Single network paradigm**
  - Leverages of economy of scale
  - Reduces complex gateways
  - More rapid commissioning
  - More rapid fault diagnosis and repair
- **Larger pool of talent to install, manage and maintain**
- **Join & benefit from Ethernet Ecosystem**
  - Protocols
  - Security
  - ...



# Why 10Mb/s and Extended Reach?

- **Common fieldbuses reach 400-5000m**
  - **1200m believed to address 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?

- **Large install base of similar cabling**
  - Single Twisted Pair is most common – usually shielded
  - Certain cables are certified
- **Desire to maximise cable reuse**
  - Lengthy fieldbus cables are expensive to run (often in conduit)
  - End nodes are easier to replace
  - Similar efforts with 2.5G/5G
- **Some devices require power over the same pair**
  - Enhancement of PoDL for extended reach to be considered

Enhanced Cable Reuse Value

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



# Why Single Twisted Pair?

- **Expected benefits:**
  - Less complex to install
  - Lower cost
  - Smaller size & lower weight
- **Benefits enable a large volume of small and cost-sensitive Factory Automation components to migrate to Ethernet**
  - Previously un-networked discrete devices
  - Low end fieldbus devices



# 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
- **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 future need for 100Mb/s
- **Establishes credibility in Ethernet as true consolidated fieldbus replacement**

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

- Desire to have one network type throughout facility/factory/plant
  - Alternative to **hugely** fragmented Fieldbus landscape using single pair
  - Single pair essential
    - Weight, cost, mechanical benefits
    - Ease of installation – lower skilled labour force
  - Ease of maintenance
    - Availability of Ethernet knowledge and networking configuration
  - Lower Total Cost of Ownership
- Greater bandwidth required to support Industry 4.0 / Smart Factory / IIoT
  - Enabling new use cases with higher throughput, lower latency
  - Sensors running web servers!
  - Improved efficiencies
- Existing Ethernet standards not addressing needs

# Target Markets

# Potential Markets

- **Industrial Automation**
  - The dominant driving market for this CFI
  - Landscape breakdown described previously:
    - Process Automation
    - Factory Automation
    - Hybrid
  - Large market potential (i.e. port count)

A 10Mb/s Extended Reach Single Twisted Pair Ethernet PHY anticipates significant leverage across other segments including:

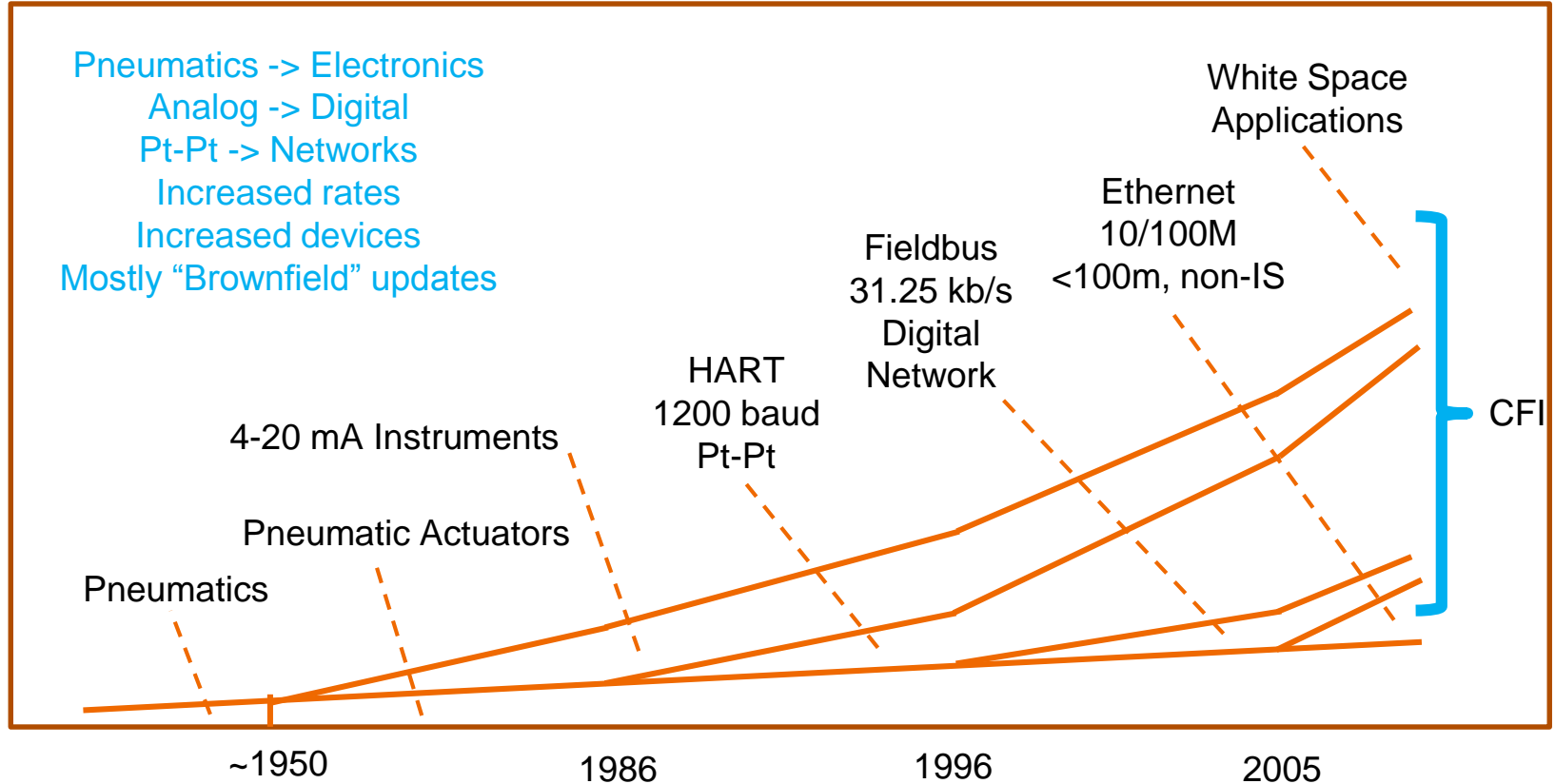
- **Building Automation**
- **Lighting Systems**

(Reference July 2014 IEEE 802 BoF “I Feel the Need... for Low Speed” (Carlson/Kennedy))

# Markets Summary

- **Process Automation**
  - Sensors (flow, level, pressure, temp, ...), actuators, drive applications (closed loop)
  - Redundancy through ring topology
- **Factory Automation**
  - Sensors, HMI, motors, actuators
- **Building Automation**
  - Temperature, humidity, light, occupancy sensors
  - Mechanical actuators: HVAC, shades/blinds
  - Controllers, meters, access control

# Process Automation Networking History, Trends & Growth

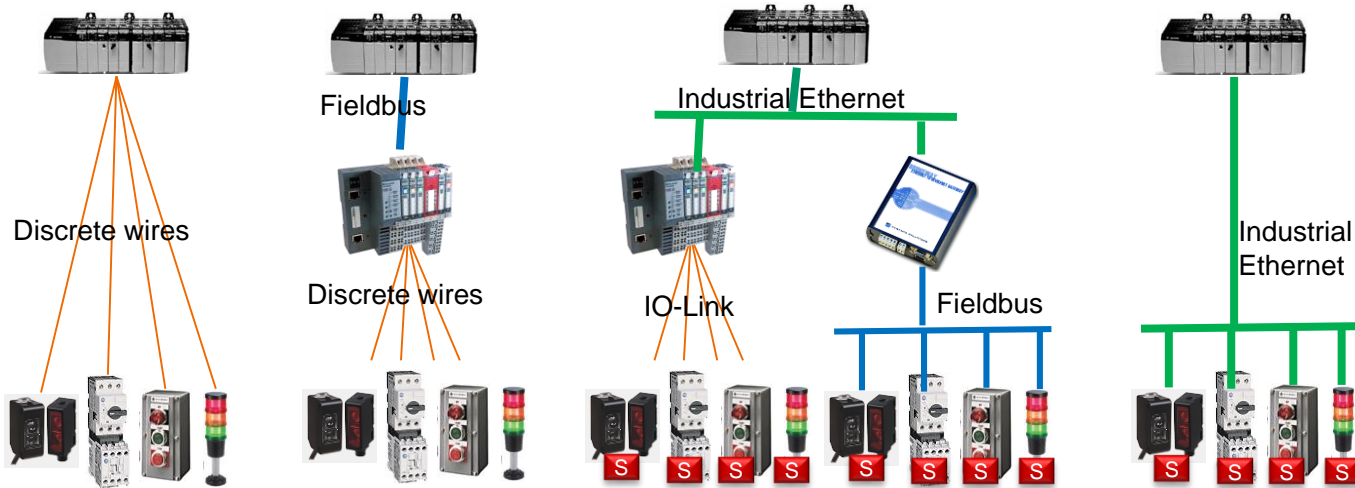


# Process Automation Intrinsic Safety

- Industrial Automation has stringent safety standards applied
  - Some safety and mission critical systems involved
- “Intrinsic safety (IS) is a protection technique for safe operation of electrical equipment in hazardous areas by limiting the energy, electrical and thermal, available for ignition” - Wikipedia
- Requirement within Industrial Process and Batch/Hybrid
- Certification is of the networked equipment – not of the IEEE PHY
- The PHY should not preclude the design of IS networked equipment



# Discrete Automation: Networking History & Trends



Local I/O  
discrete wires,  
Dumb devices

Remote I/O  
Fieldbus,  
Dumb devices

Industrial Ethernet for  
control, fieldbus/IO-Link  
for **smart devices**

Industrial Ethernet for  
**both** control and field  
smart devices?

1980s

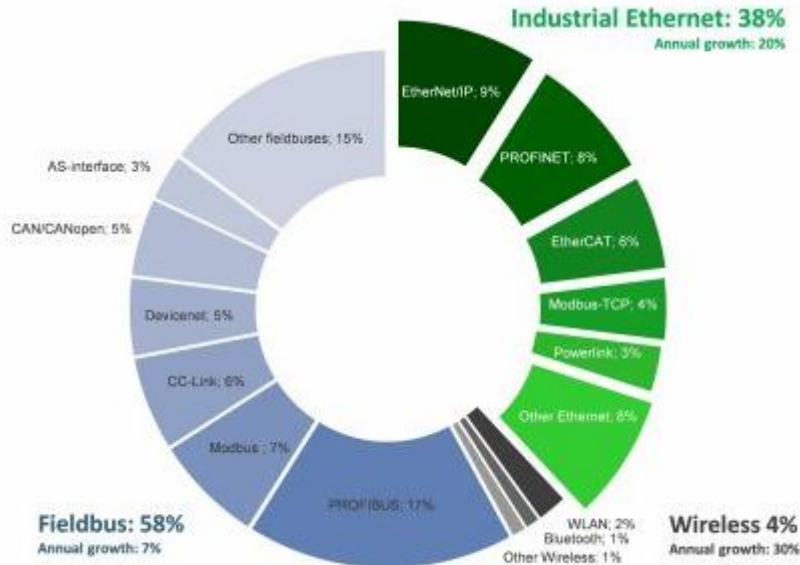
1990s

2000s-2010s

2020s?

# Market Potential

# Current Industrial Network Share



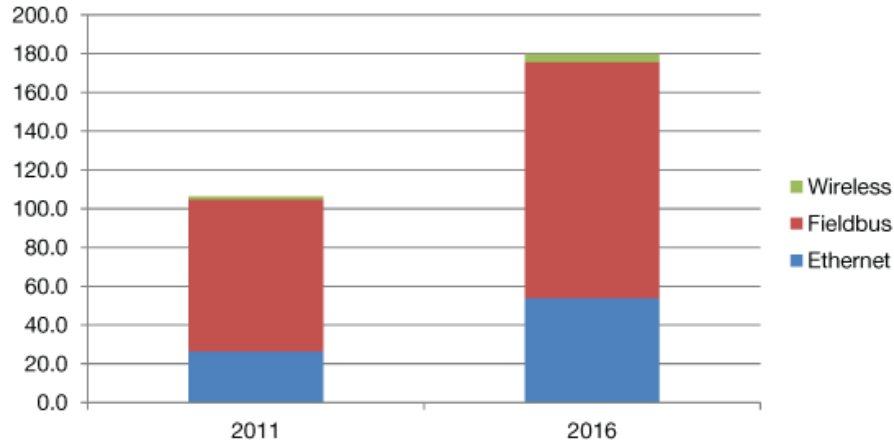
- Growth of networked nodes
  - Fieldbus (58%), 7% growth
  - Ethernet (38%), **20% growth**
  - Limited wireless adoption
- Significant number of protocols
  - Ethernet protocols can share common hardware
  - Fieldbuses have unique hardware

Source: HMS Networks, March 2016

# Industrial Networking Market Size - High

## Fieldbus Fades as Ethernet Excels

Worldwide growth in industrial networking by technology 2011-2016 by millions of new node connections.

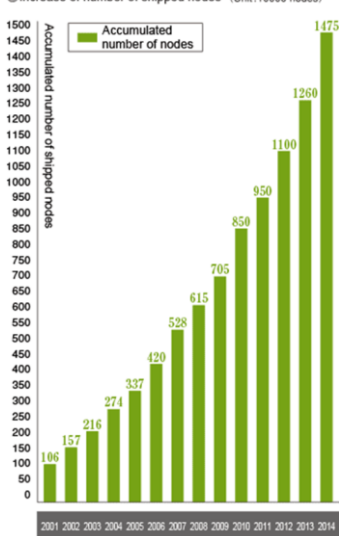


Source: IHS, March 2013

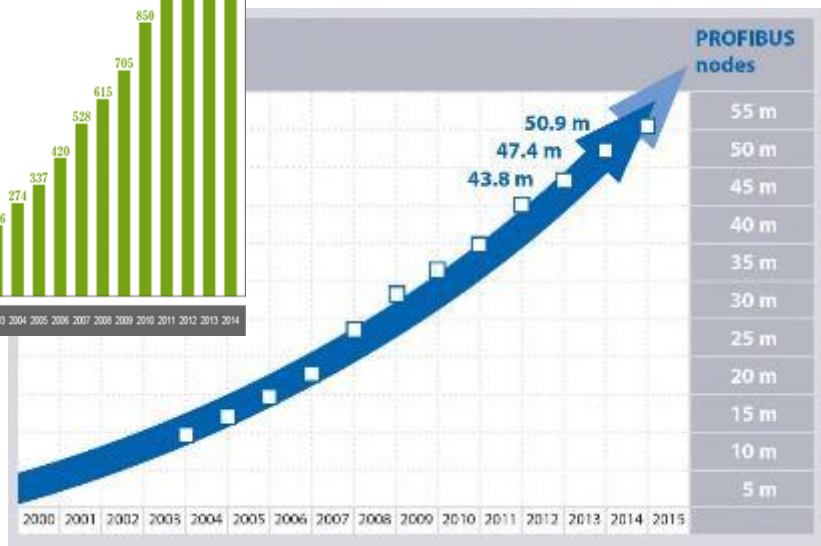
- IHS report also showing growth profile
- Some discrepancies with previous market share summaries
  - Earlier data (IHS 2013)
  - Projected lower Ethernet adoption
- Indicates
  - 55M new Ind. Ethernet ports/yr
  - 120M new Fieldbus ports/yr

# Industrial Networking Market Size - Low

○ Increase of number of shipped nodes (Unit: 10000 nodes)



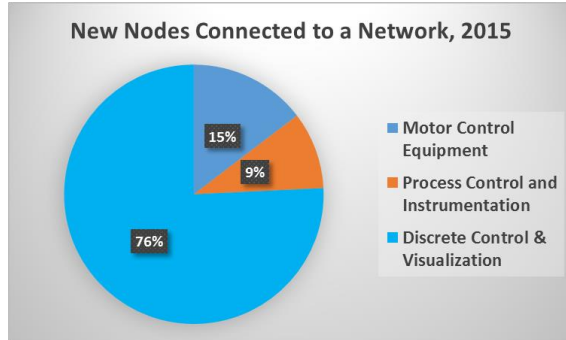
Source: cc-link.org, undated (pre-2013)



Source: Profibus and Profinet International, April 2015

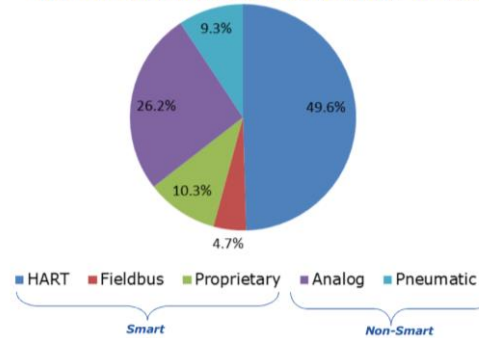
- CC-Link
  - Showing ~2.15M nodes/yr
  - 6% market share (per HMS)
  - Infers market of 36M ports/yr
  
- Profibus
  - 3.6M/yr Profibus DP
  - 800k/yr Profibus PA
  - 17% market share combined
  - Infers market of 26M ports/yr

# Industrial Networking Market Size – Process



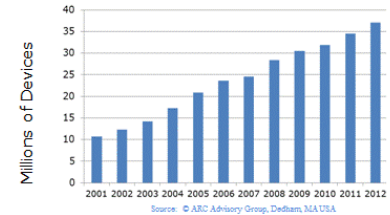
Source: IHS, *The World Market for Industrial Ethernet & Fieldbus Technologies – 2013 Edition*

**74.8 Million Installed Field Devices in 2012**



Source: Uwe Grundmann, ARC Advisory Group, ARC Industry Forum, Tokyo 2015.

**Installed Base of HART Devices**



**2012 HART Installed Base 37.1 Million Devices**



Target Market for Manufacturing & Service Sectors

ARC Advisory Group

Source: [http://en.hartcomm.org/hcf/developer/developer\\_mktpos.html](http://en.hartcomm.org/hcf/developer/developer_mktpos.html)

- Process Automation makes up 9% of overall market
- HART enjoys ~50% share of this subset
- Growing at 3M devices/yr
- Infers 68M devices/yr -> 136M ports/yr

# Industrial Networking Market Size – Summary

- 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
- Based on current solutions, mid-range estimate could suggest **80 – 100M** ports/year – not including Building Automation!
- New enabling technology (CFI subject) can enable greater growth and enables additional whitespace applications

# Technical Feasibility



# Related Implementations

- **Proprietary PHYs**
  - **Advanced Physical Layer (APL) prototype shown publically at Automation Fair and other venues**
  - **BroadR-Reach**
- **Relevant IEEE PHYs**
  - **10PASS-TS**
    - **10 Mb/s, 750 meters, single copper pair, variable rate**
  - **2BASE-TL**
    - **2 Mb/s, 2.7 km, full-duplex, voice-grade copper wiring, variable rate**

# CFI Proposal

# High Level Summary

- Clear demand for 10Mbps Extended Reach Single Pair Ethernet
  - Consolidate fragmented fieldbus market to unified Ethernet-based solution
  - Convert existing/legacy analog links to modern higher speed digital systems
  - Enable Industrial IoT applications – e.g. big data analytics, smart sensors, streaming video
  - Single pair for ease of install and enabling cable reuse
- Large market potential for 10Mbps extended reach single pair Ethernet
  - 80M+/yr for industrial automation
  - Xxx for building automation
  - Xxx for other potential market segments
- Technical feasibility demonstrated
  - Advanced Physical Layer
  - BroadR-Reach over home access network

# Why Now and Why in IEEE 802.3?

- The industry is requesting it
- **It's Ethernet---** it belongs in IEEE 802.3
  - IEEE802.3 is recognized as the international standard for Ethernet
- Responsible for Ethernet physical layers
- **The effort should start now to meet the industry adoption timeline**

# 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!**