

# Single-Pair Cabling's Emergence into Enterprise Automation and IoT Networks



Valerie Maguire, BSEE

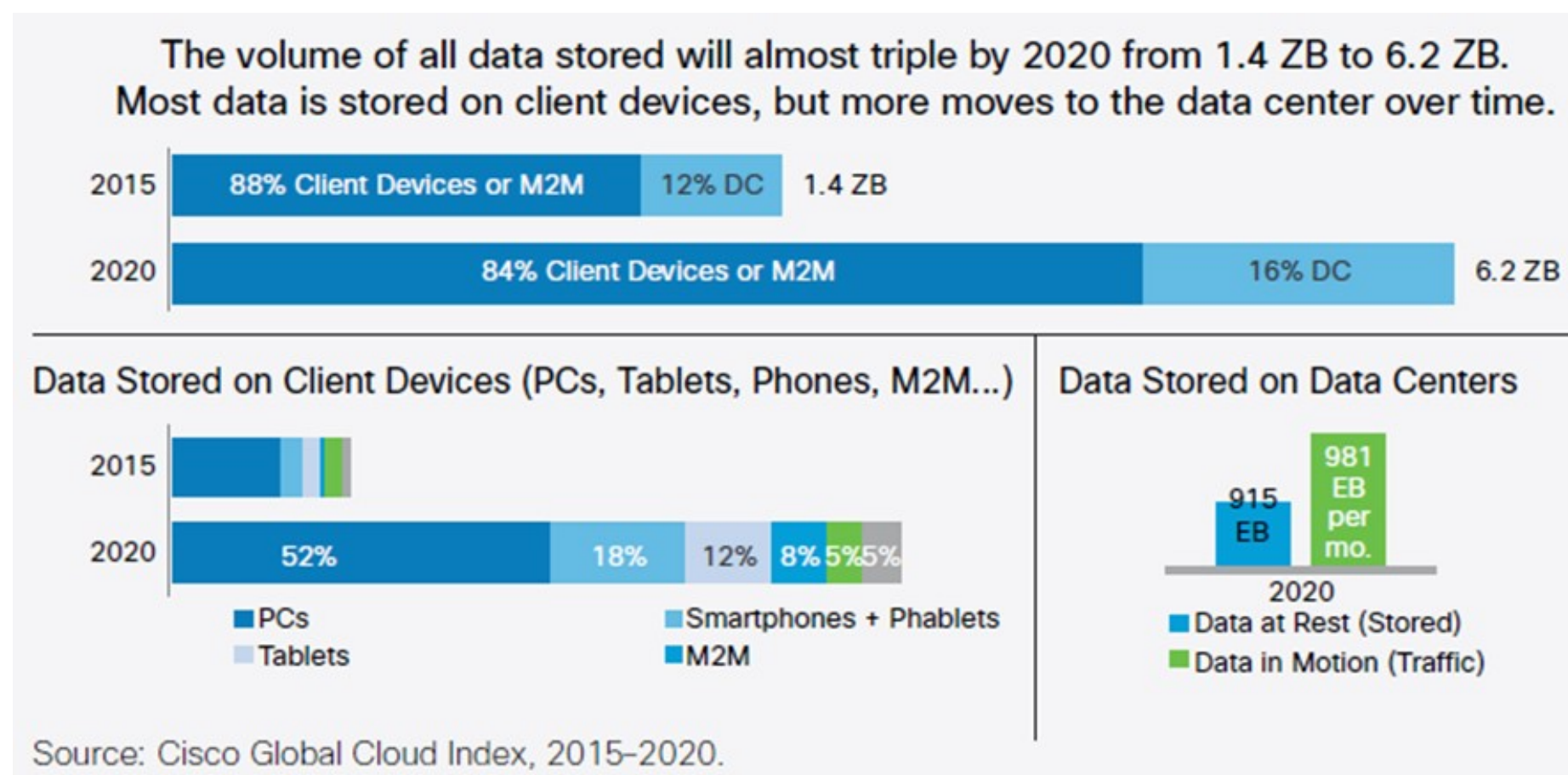
# Agenda

- Introduction to single-pair devices and systems
- Legacy building automation system communication protocols
- Single-pair Ethernet Standards
- TIA and ISO/IEC initiatives to develop single-pair cabling specifications
  - Mechanical and electrical specifications of single-pair cabling, cables, and connectors



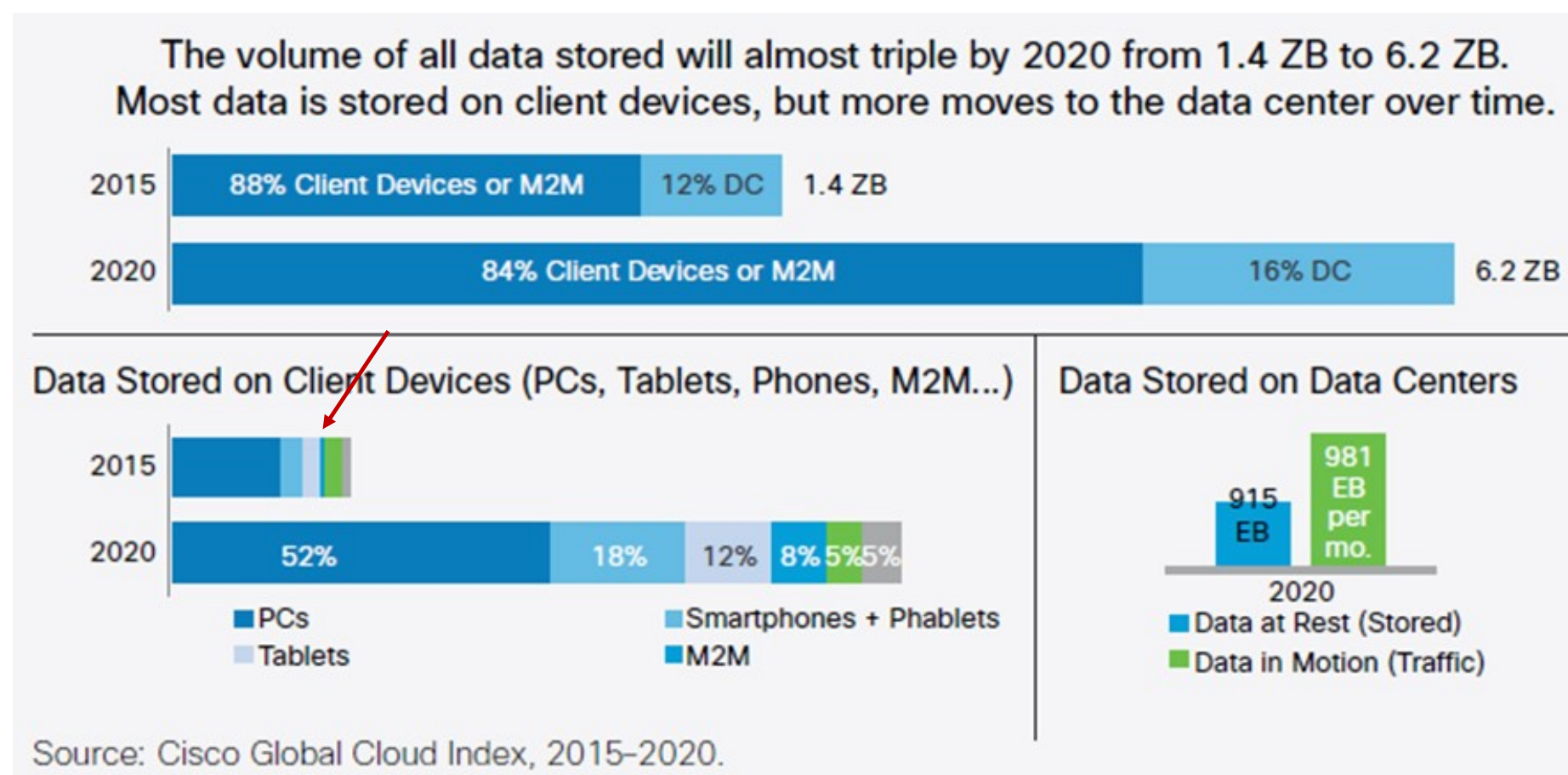
# M2M (machine-to-machine)

“Stored data associated with M2M grows at a faster rate than any other device”



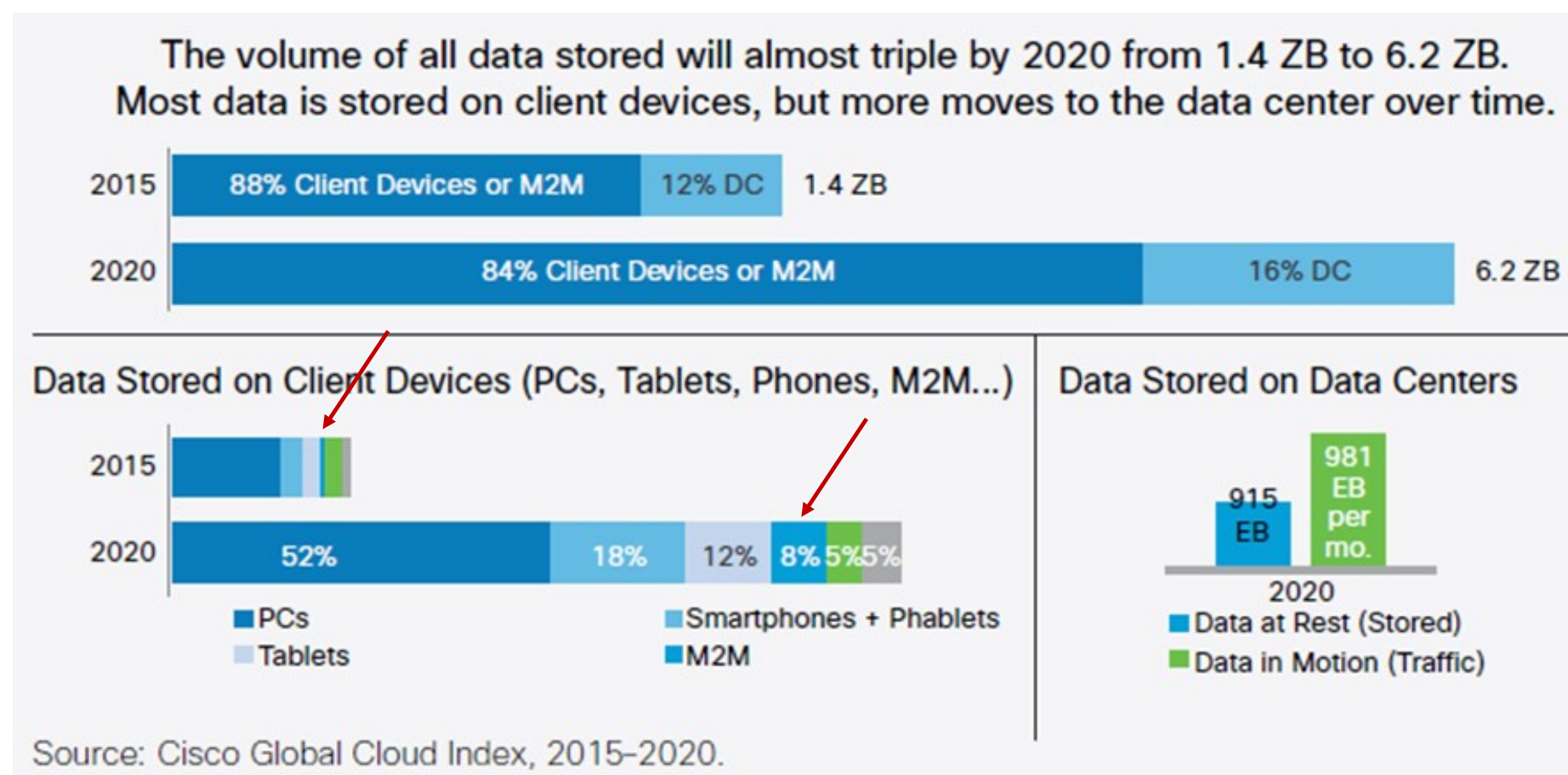
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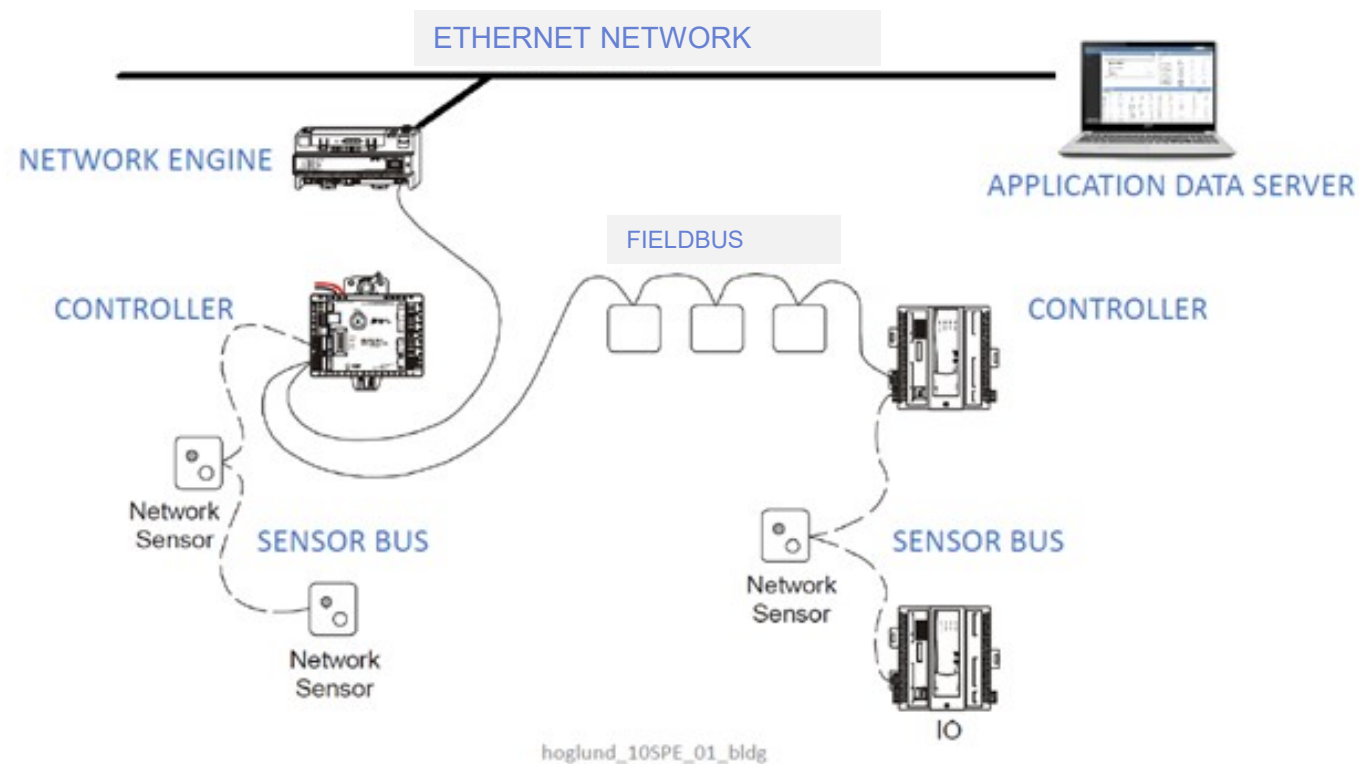
# Machine-generated data



- Application, server and business process logs, call detail records, and sensor data
- Internet clickstream data and website activity logs
- Automotive and industrial
- Elevator, lighting control, and security
- Fieldbus applications
- Monitoring applications such as building energy management systems that analyze HVAC, sensor, occupancy, and other data to improve efficiency

# Building automation communication

- Buildings are often managed by a large number of sensors and actuators connected to controllers and a centralized user interface



# Today's building automation physical layer

## Example Cables

- 1-pair or 2-pair 18-24AWG shielded, solid or stranded
- 1-pair, 16-18AWG unshielded
- Category 5 UTP
- Lengths can vary from 100m to 1,400m



## Example Connectors

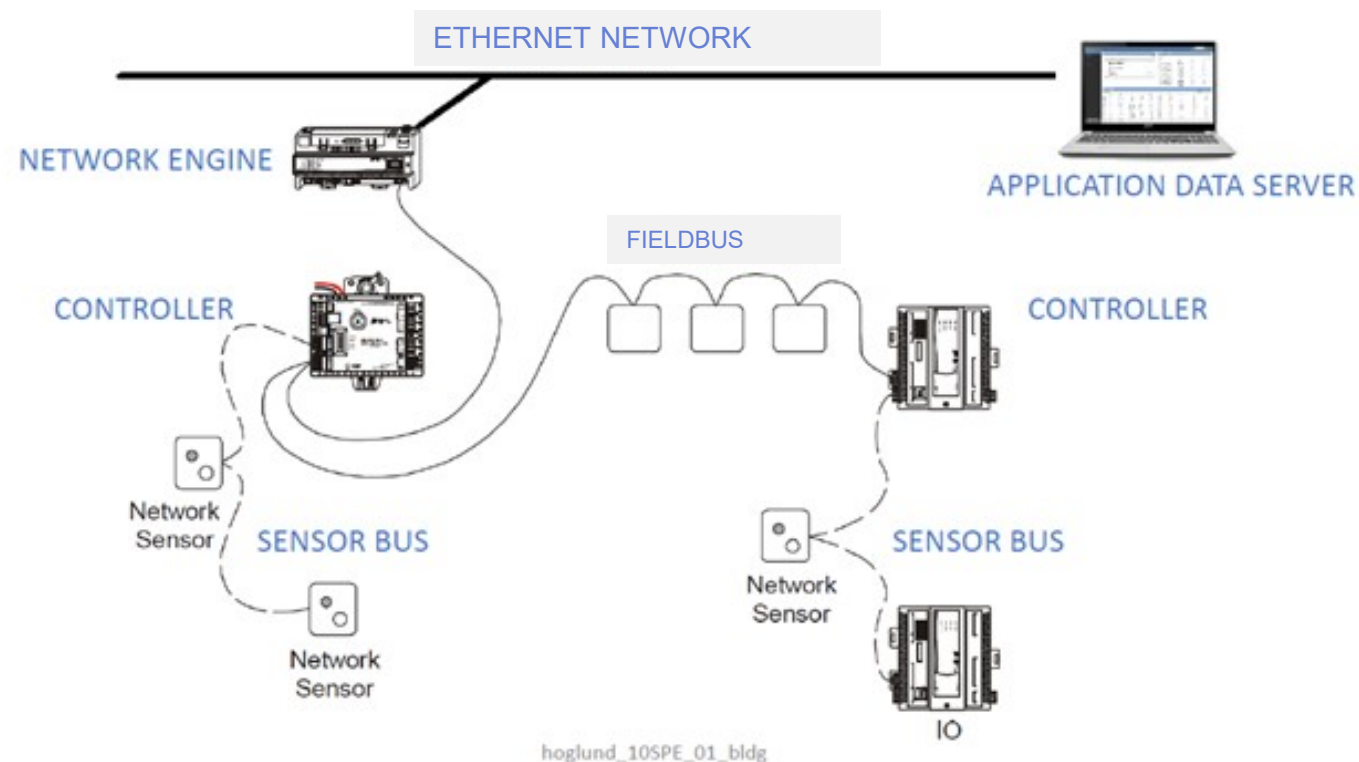
- Terminal block connection
- LONWORKS® FTT termination module
- RJ-45





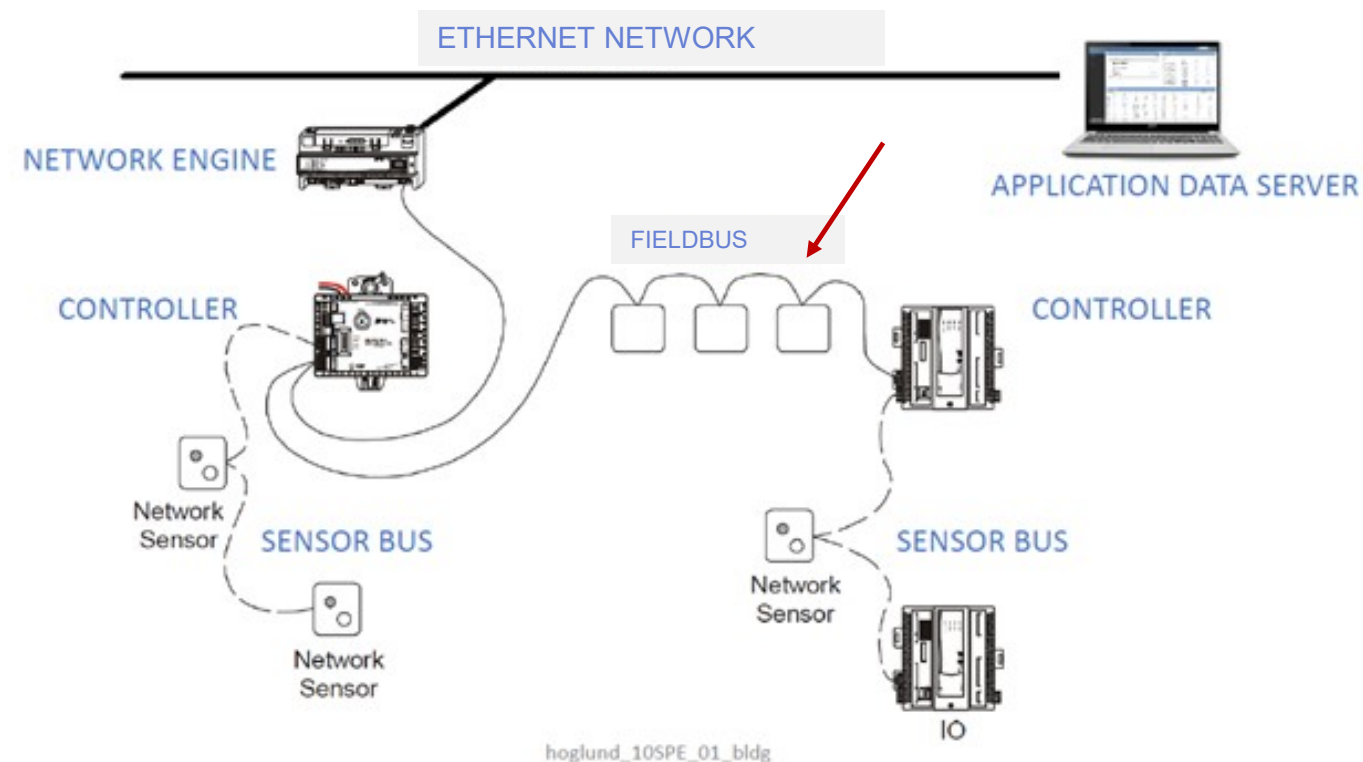
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- Ethernet can be as a replacement for Fieldbus (controller-to-controller) and Sensor Bus (controller-to-sensor) communication



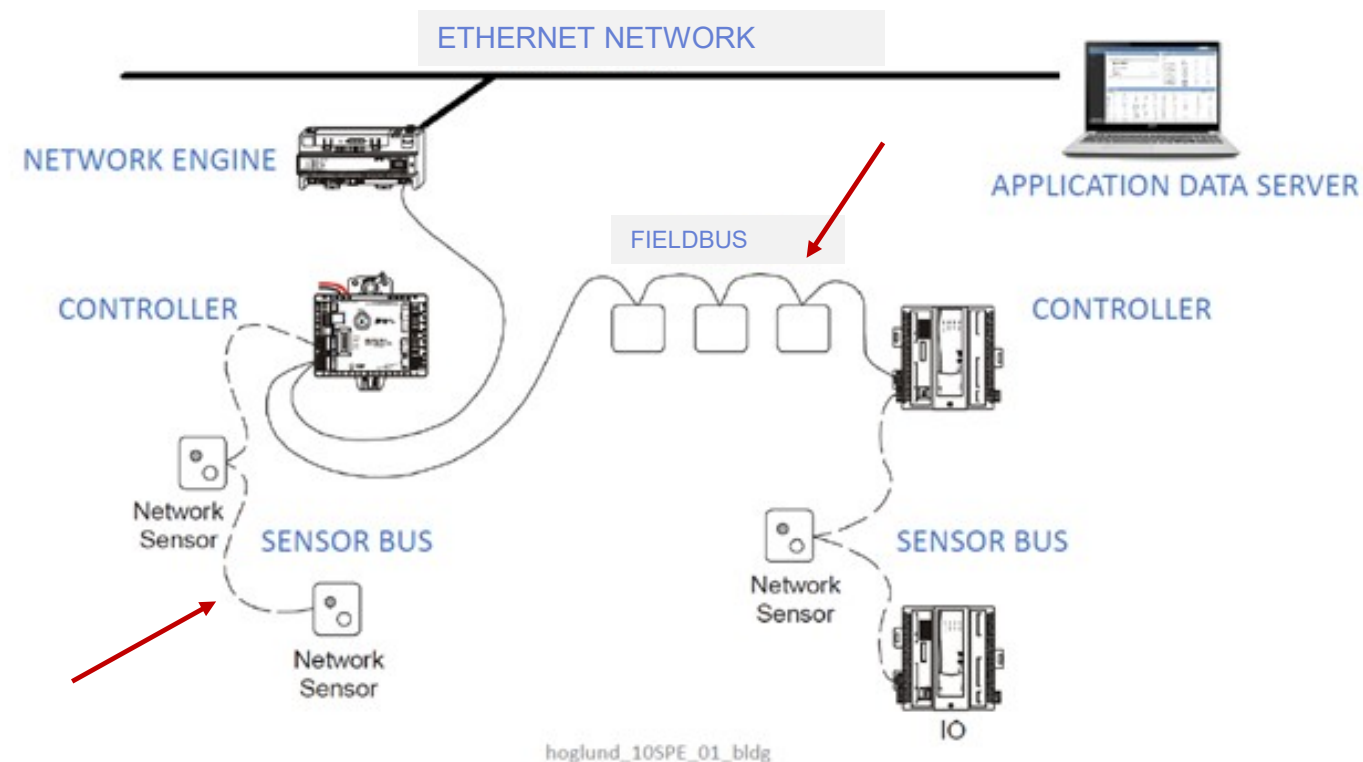
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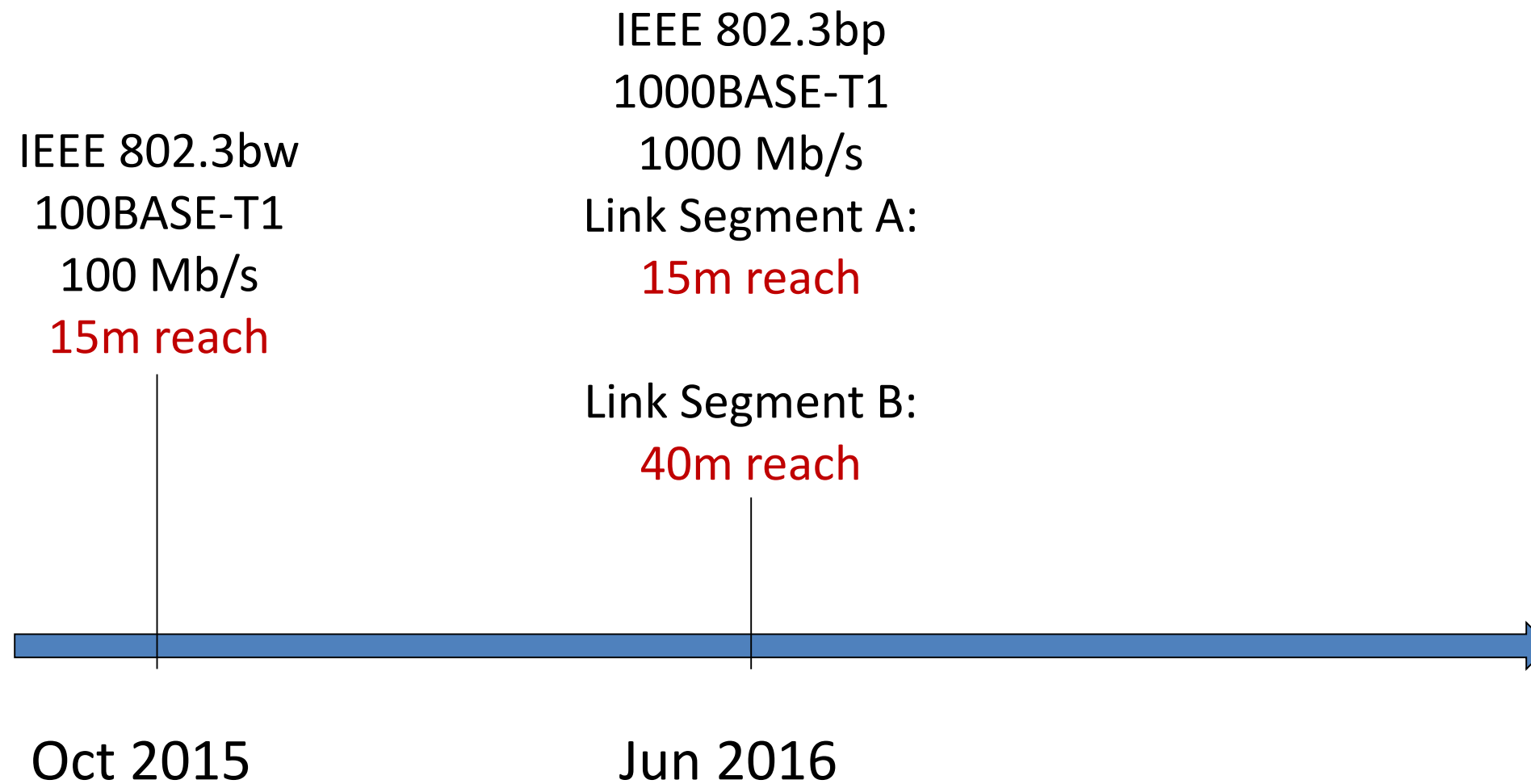


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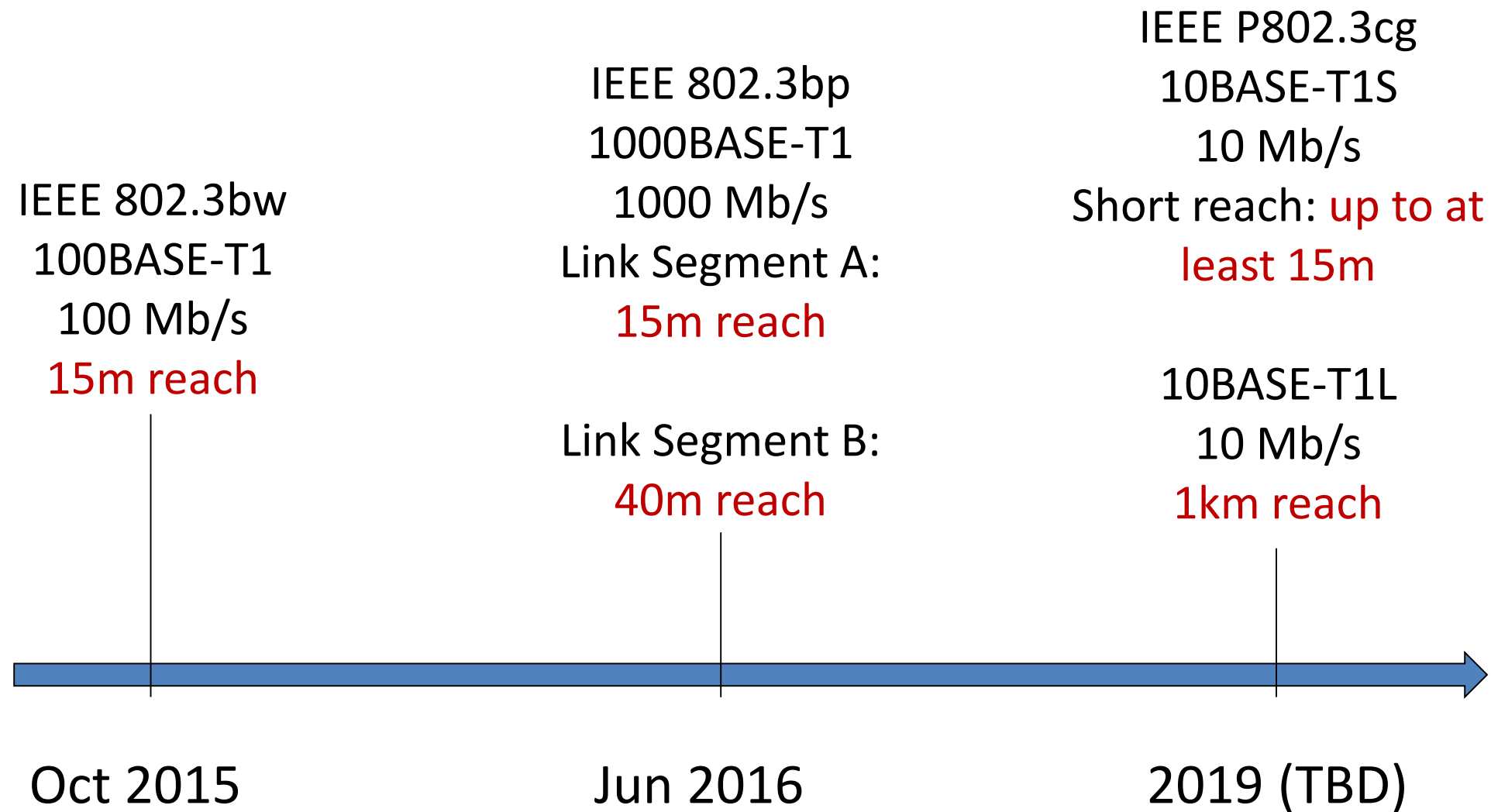
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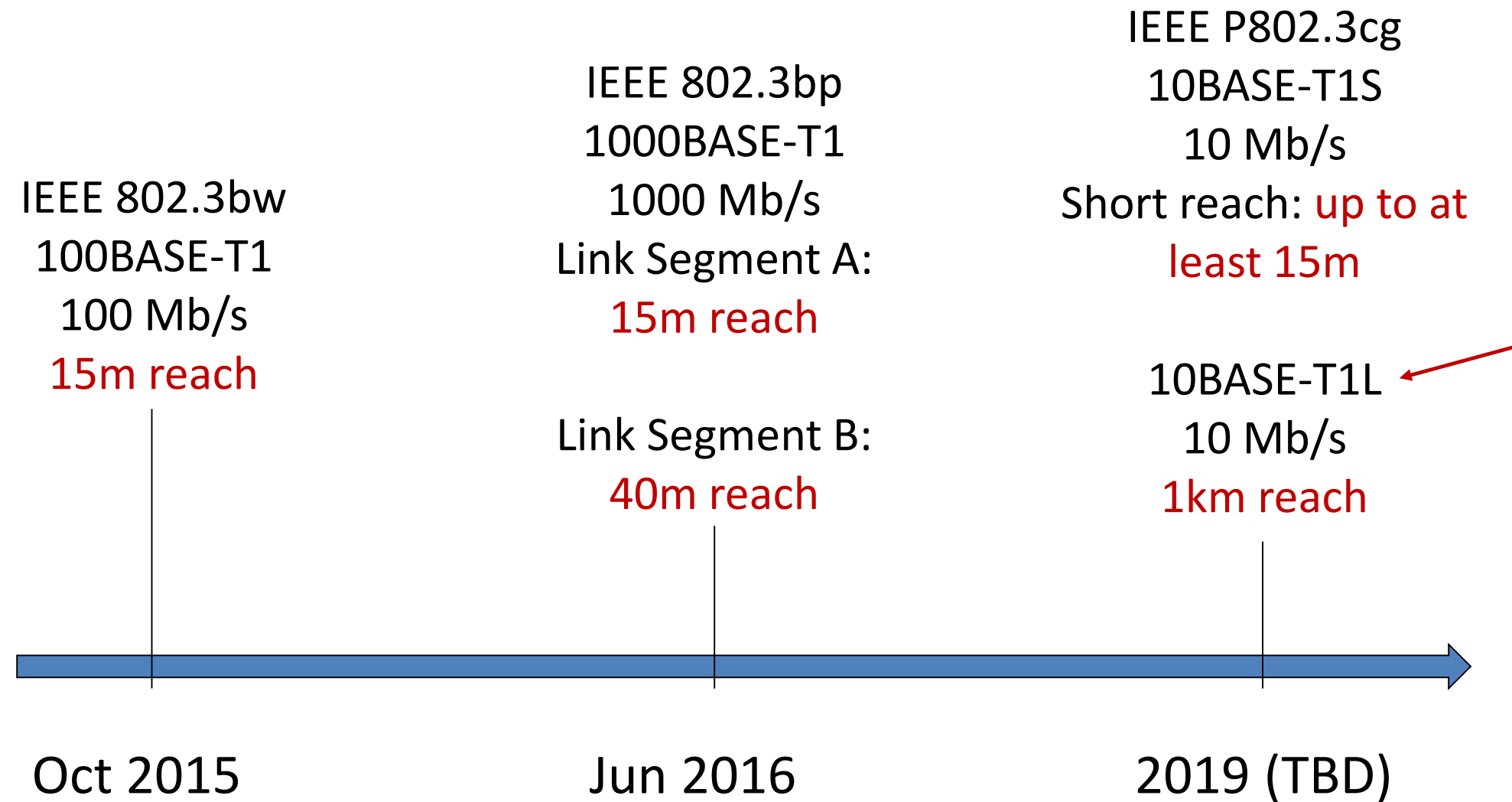
# Single-pair Ethernet Standards (BASE-T1)



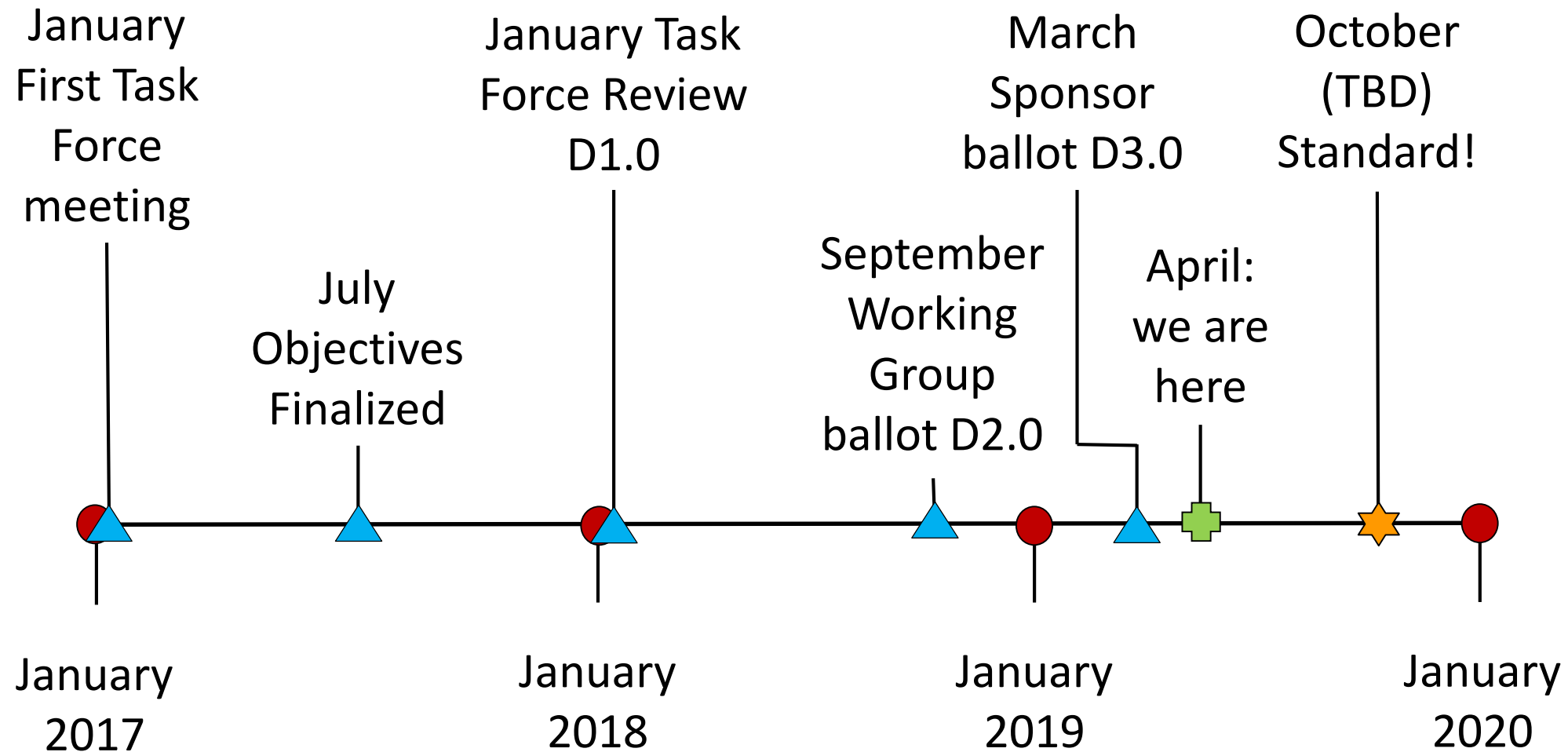
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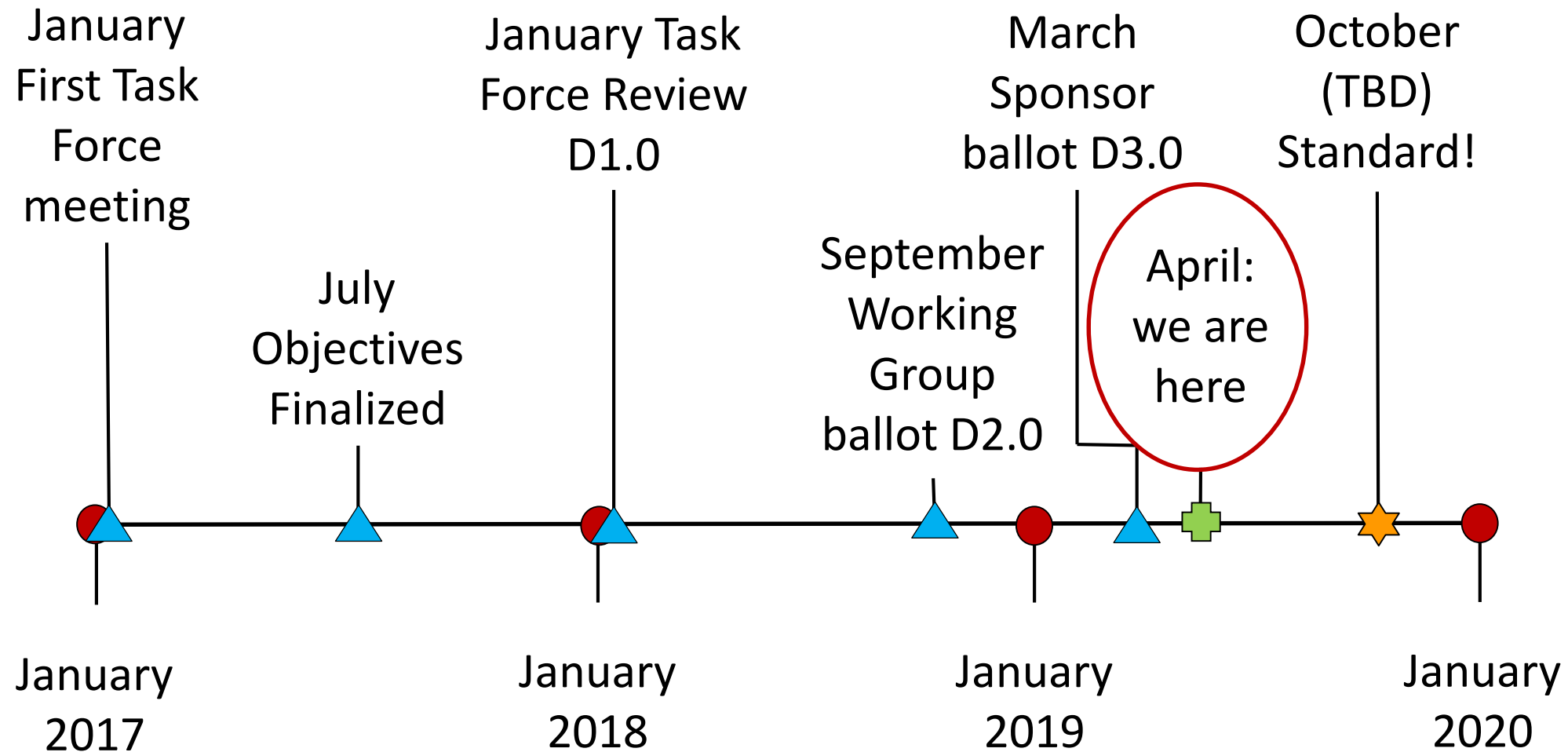
# Single-pair Ethernet Standards (BASE-T1)



# Projected P802.3cg timeline



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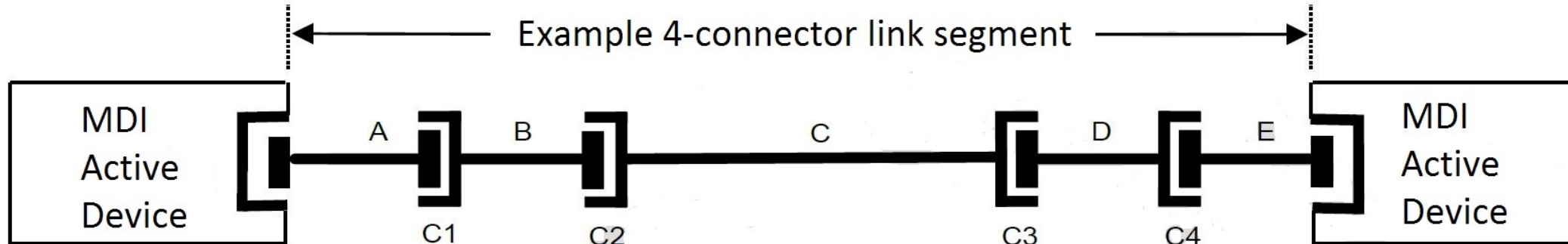
# Definitions

**10BASE-T1S:** 10 Mb/s Ethernet over short reach single balanced twisted-pair cabling up to at least 15m with an allowance of up to **four** in-line connectors

**10BASE-T1L:** 10 Mb/s Ethernet over long reach single balanced twisted-pair cabling up to at least 1,000m with an allowance of up to **ten** in-line connectors

# 10BASE-T1L link segment

- 10BASE-T1L will operate over a cabling channel referred to as a link segment in IEEE P802.3cg
- A link segment can be a point-to-point connection or structured cabling
- Structured cabling specifications are currently under development by TIA TR-42 and ISO/IEC JTC1 SC25/WG3



## Legend

### Cables and cords

Cord ..... A, E  
Cable ..... B, C, D

### Connecting hardware

Connectors C1 through C4

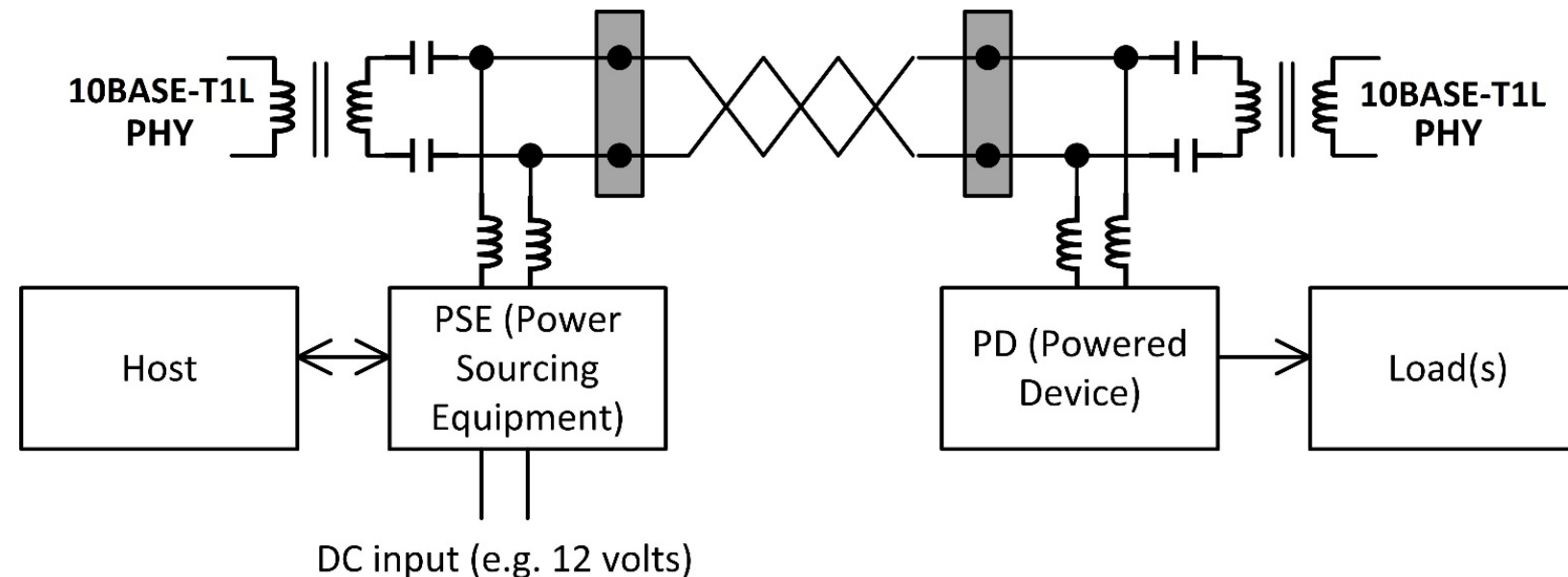
# 10BASE-T1L mixing segment



- A mixing segment (or multidrop) is a new configuration recognized in the P802.3cg amendment
- A mixing segment can support more than two devices (or nodes)
- Possible 10BASE-T1L mixing segment opportunities include:
  - Elevator control
  - Ultra-low voltage lighting and control (e.g., DALI™)
- May be an engineered system supported by machine or appliance style wiring

# Power over Data Lines (PoDL)

- 10BASE-T1L will support optional remote power provisioning with six classes of new Type E power sourcing equipment (PSE)
- Type E will be specified to deliver up to a minimum of 8.9 W to the PD over 1000m of 18 AWG single-pair cabling or 14.3 W over 300m of 24 AWG cabling
- PoDL is a 1-pair remote power delivery technology and is not inherently compatible with 2- and 4-pair PoE technology



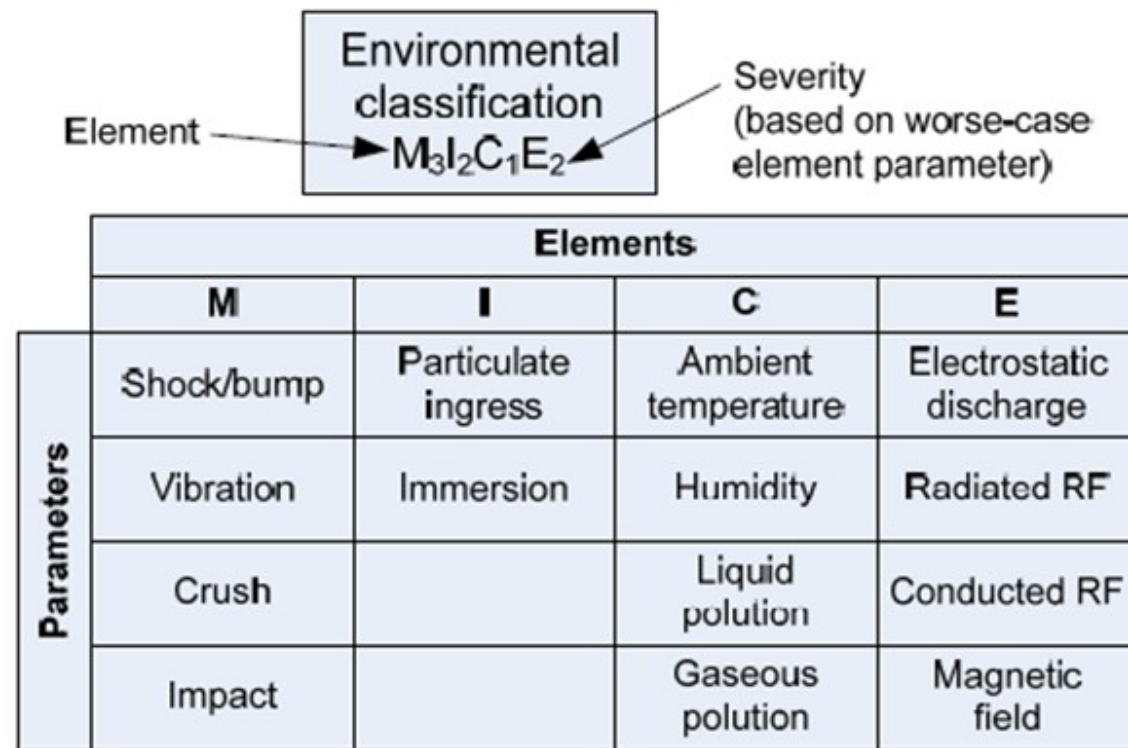
# 10BASE-T1L operating environments

$M_1I_1C_1E_1$

- Enterprise
- LAN cable and connectors

Up to  $M_3I_3C_3E_3$

- Factory, industrial, automation
- Ruggedized cable and connectors



# TIA Standards initiatives

- TR-42.1 Premises
  - TIA-568.0-D-2, “Single Balanced Twisted-Pair Use Cases and Topology” (draft 0.5)
- TR-42.1 Premises
  - TIA-862-B-2, “Single Balanced Twisted-Pair Use Cases and Topology” (draft 0.1)
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  - TIA-568.5, “Single Balanced Twisted-Pair Cabling and Components Standard” (draft 0.8b)

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  - TIA-1005-A-4, “Single Balanced Twisted-Pair Use Cases and Topology for Industrial Premises” (first draft pending)

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# TIA-568.0-D-2 key specifications

- New definitions developed
  - Intelligent building systems
  - Internet of things
  - Machine to machine
  - Single-pair conversion point
- New acronyms
  - IBS
  - IoT
  - M2M
  - SPCP



- Placeholders for single-pair cabling installation requirements

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# TIA-862-B-2 key specifications

- Very early draft
- Will amend text in parent document
- Topology
  - Coverage area cabling using single balanced twisted-pair cabling can be configured as generic cabling in a star topology
- Adds single-pair cabling as a recognized media



Industrial  
IoT

# TIA Standards initiatives

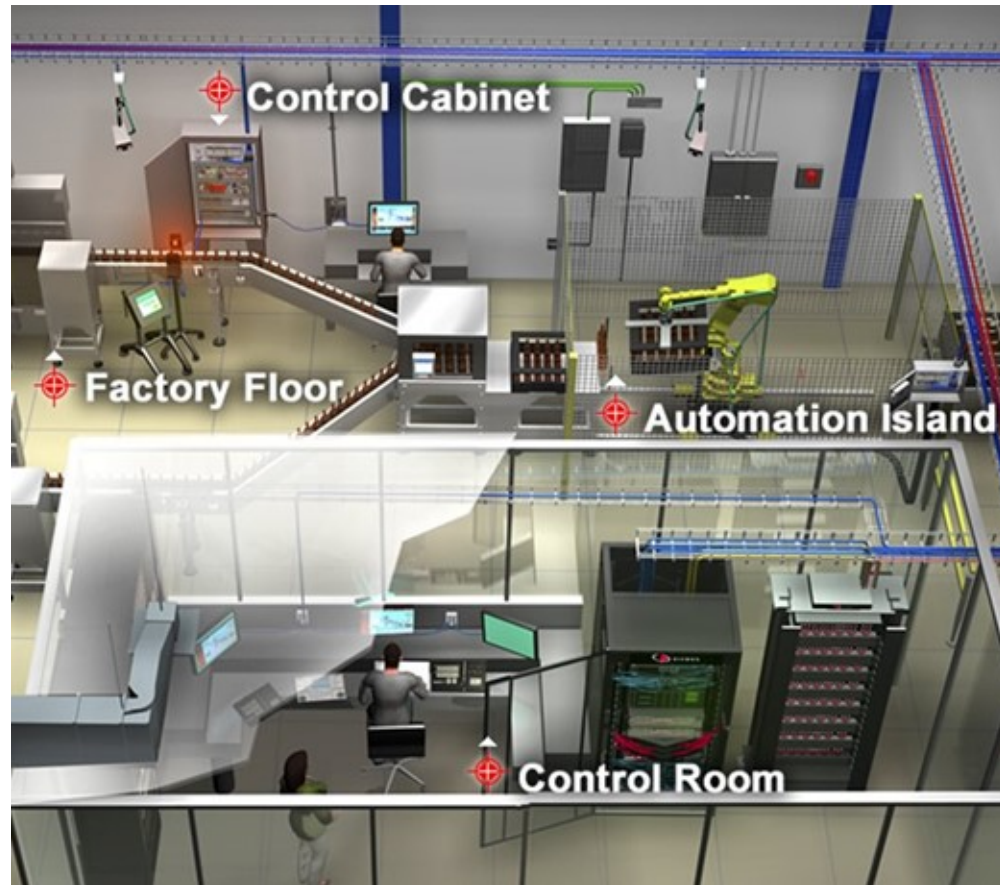
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# TIA-568.5 key specifications



- Mechanical requirements
  - 18 AWG to 26 AWG (TBD) cables
- Transmission requirements
- Component and cabling test procedures
- Modeling configurations and length scaling
- Application support considerations
  - Adaption to four pair cabling

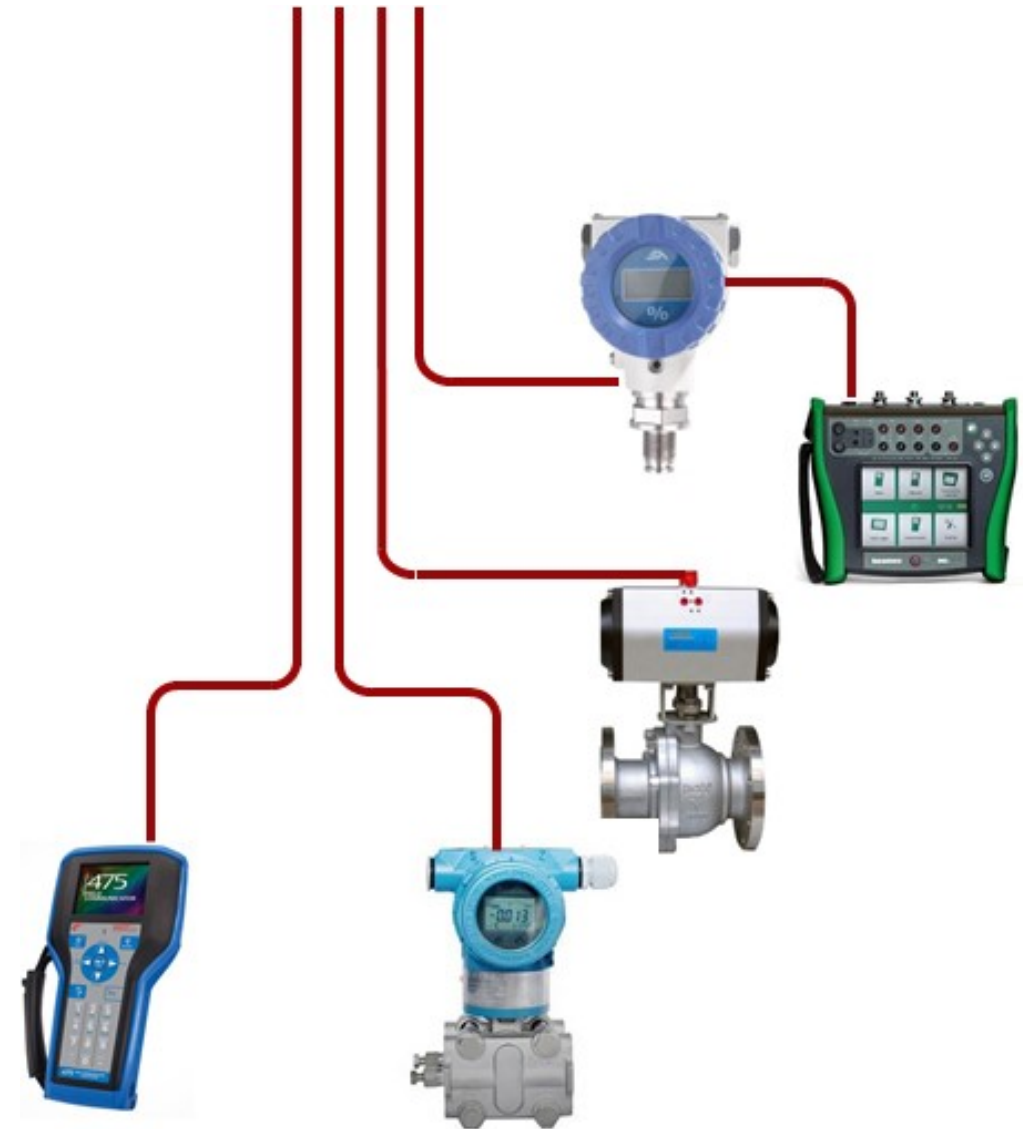
# TIA-568.5 transmission specifications



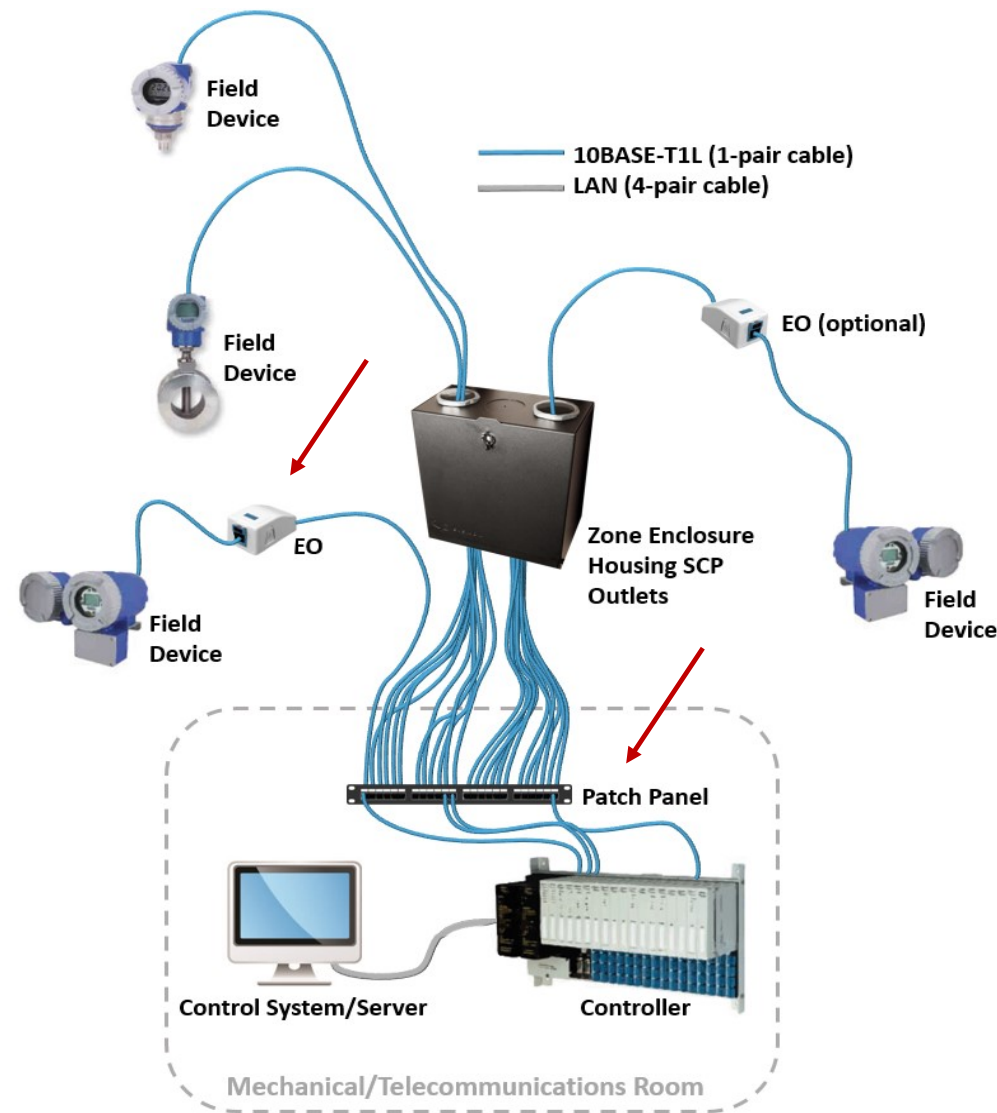
- Specifications are developed with the intent of being able to support 10/100/1000BASE-T1 applications
- Specified bandwidth is 0.1 to 600 MHz for higher performing single-pair cabling
  - Note: Category 6A cables and connectors are specified from 1 MHz to 500 MHz
- Single-pair media will not be referred to by a category number (e.g., “category 9”)

# Four TIA-568.5 channel models

- **1000m:** 18 AWG solid or stranded cable plus up to 10 connectors
- **100m:** (90m 23 AWG solid cable and 10m 24 AWG or 8m 26 AWG cords) plus up to 4 connectors
- **40m:** (30m 22 AWG cable and 10m 22AWG cord) plus up to 4 connectors
- **15m:** (11m 26 AWG cable and 4m 26 AWG cord) plus up to 4 connectors



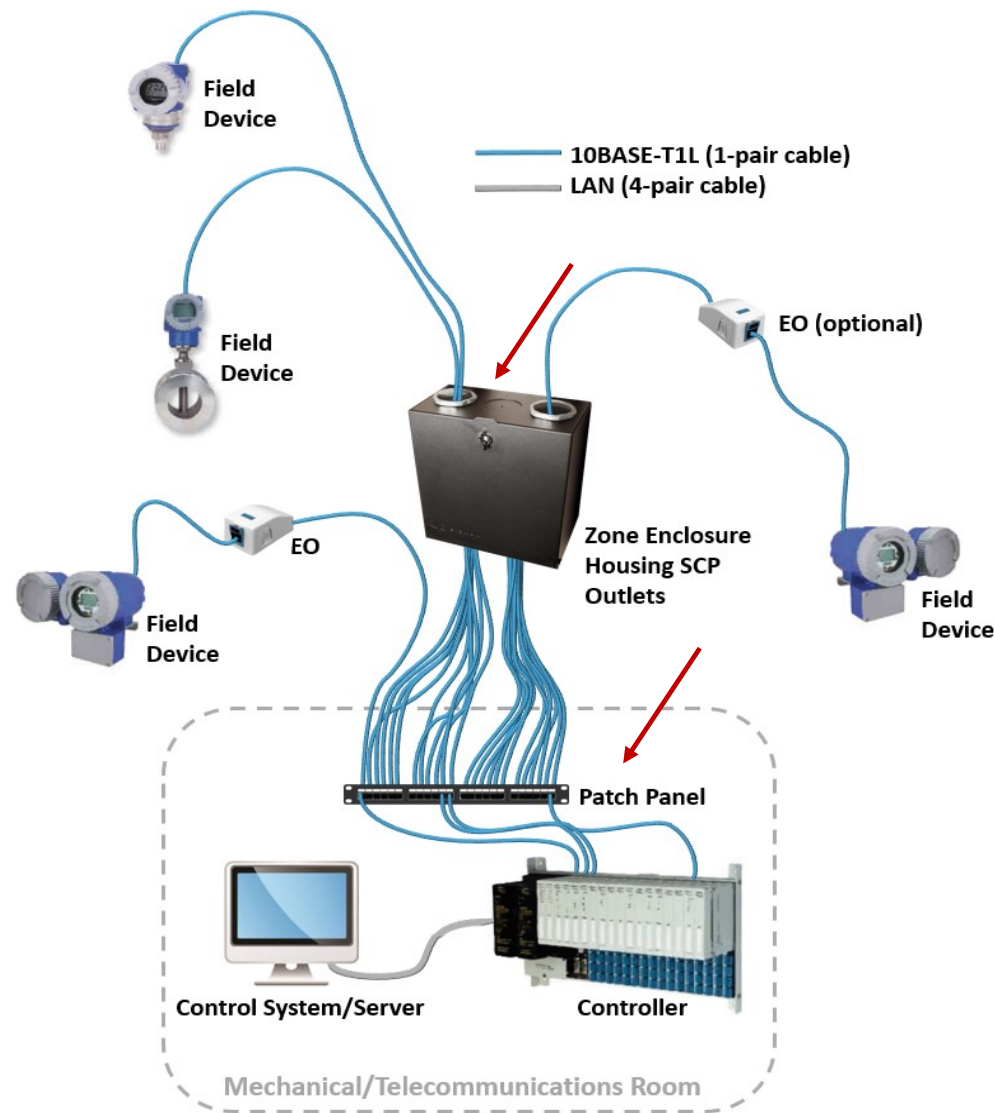
# Typical channel configurations



1. a patch panel in the MR/TR and an equipment outlet (EO) at the device

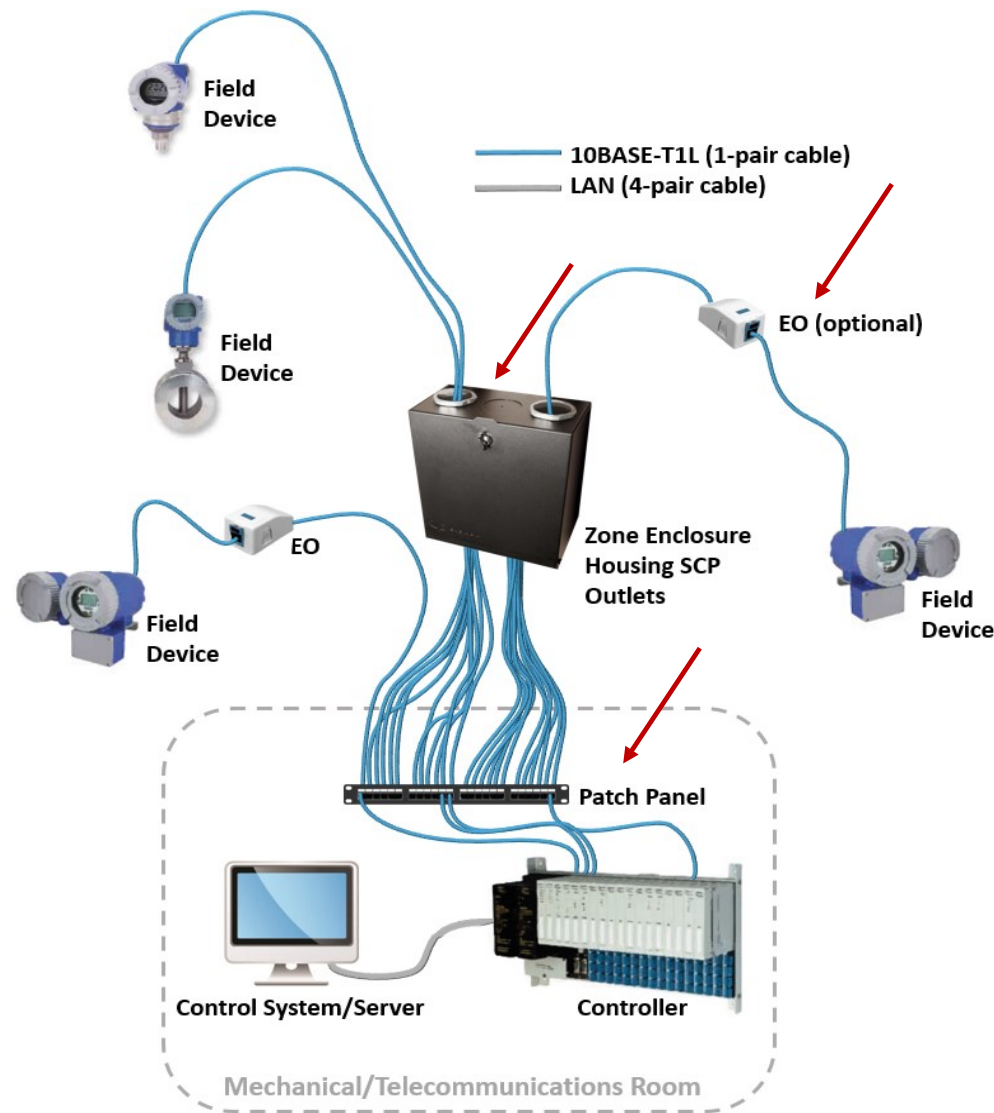


# Typical channel configurations



1. a patch panel in the MR/TR and an equipment outlet (EO) at the device
2. a patch panel in the MR/TR and a zone enclosure housing service concentration points (SCP outlets) serving multiple devices

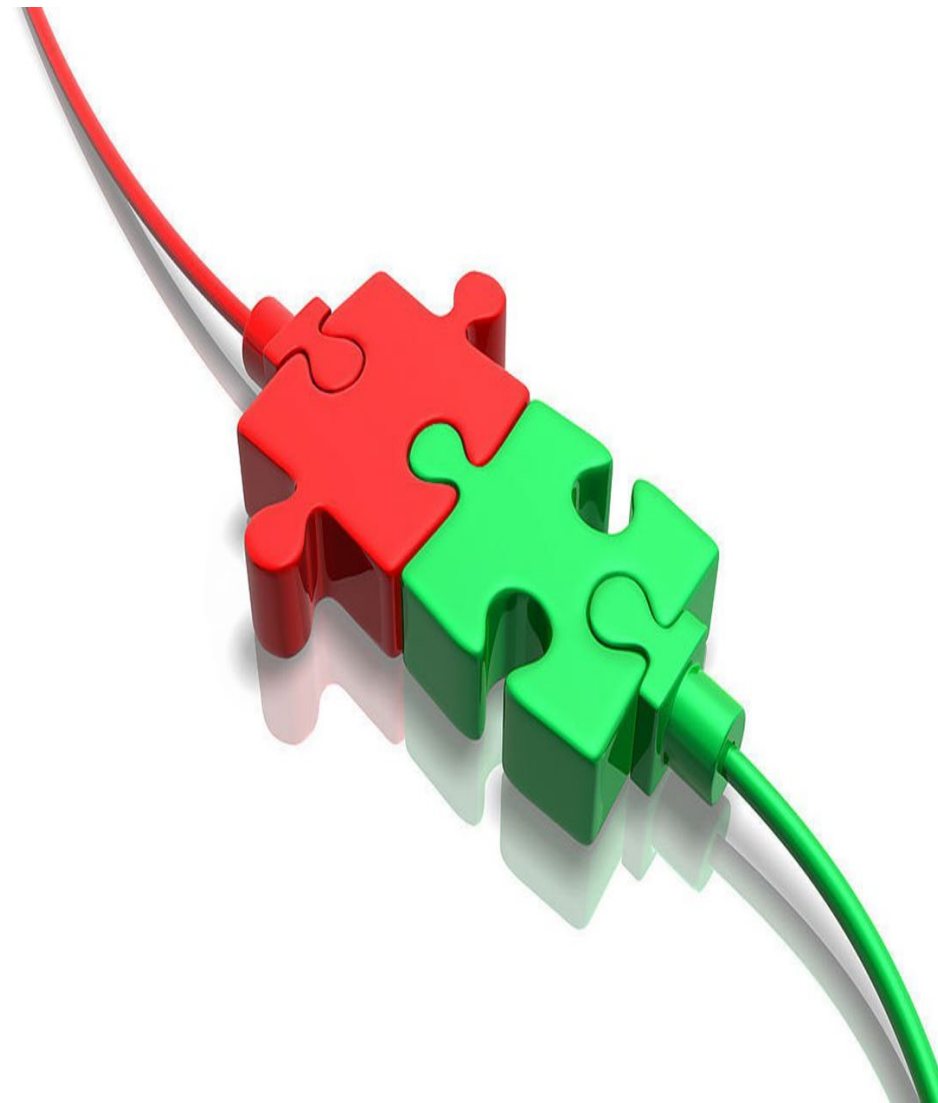
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3. a patch panel in the MR/TR, a zone enclosure housing SCP outlet serving multiple devices, and an EO at the device

# Benefits of structured cabling

- Device interoperability and elimination of proprietary cables and interfaces
- Ability to pre-cable for future applications
- Generic support of a wide range of applications
- Simplified labeling and administration
- Accessibility for testing
- Ability to provide data and power over the same conductors



# TIA-568.5 applications matrix

Distance	1000m	100m	40m	15m
Possible Names	SP1	SP2	SP3	SP4

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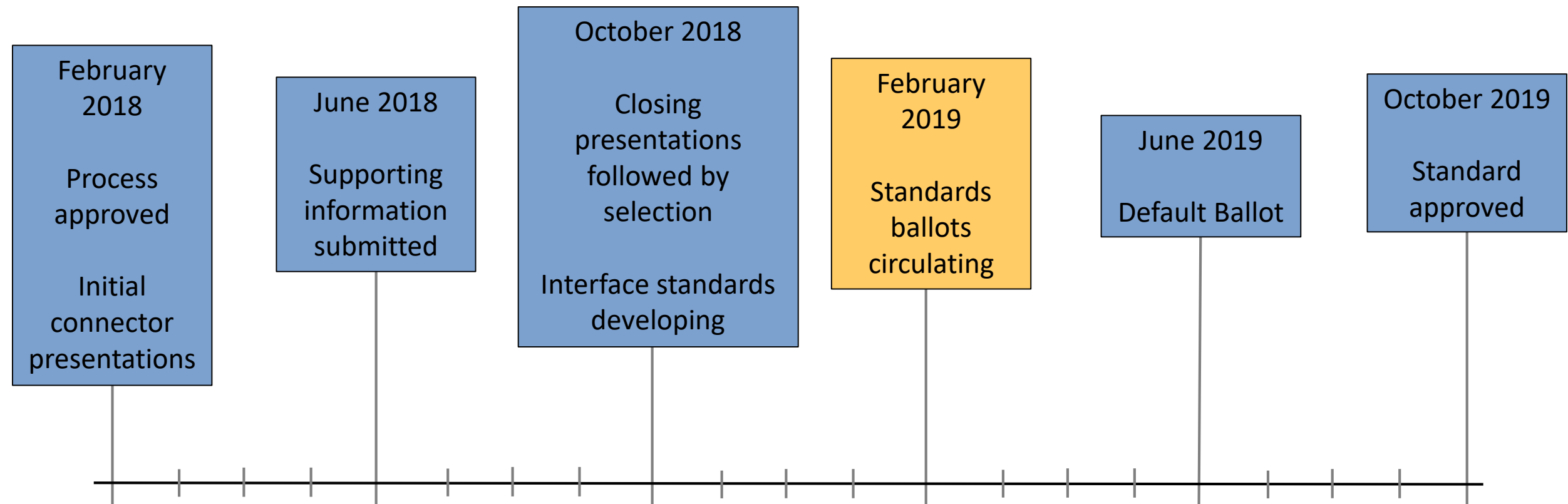
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100BASE-T1	8	4 (15m max)	4 (15m max)	4
1000BASE-T1	8	4 (40m max)	4	4



# Single-pair connector - M<sub>1</sub>I<sub>1</sub>C<sub>1</sub>E<sub>1</sub> timeline



# TIA-568.5 M<sub>1</sub>I<sub>1</sub>C<sub>1</sub>E<sub>1</sub> connector variants

Variant 1	Variant 2	Variant 3	Variant 4
			

## Required features:

1. Mechanical size and fit into bulkhead, equipment, and outlet mounting openings
2. Low complexity to manufacture and easy usability
3. Usability by applications as an MDI connector
4. Robust consistent performance electrical performance
5. Robust consistent performance mechanical performance
6. Reliability including remote powering support (1.36 A per conductor and withstand un-mating under load)

# What is ISO/IEC JTC 1/SC 25 doing?

- ISO/IEC TR 11801-9906 will define performance of application specific one pair channels
- Amendments to the ISO/IEC 11801-X series will describe cable, component, and cabling requirements in both generic and premise specific environments
- ISO/IEC Working Group completed their evaluation of single-pair connector specifications for  $M_1I_1C_1E_1$  and  $M_3I_3C_3E_3$  environments before TIA TR-42 did

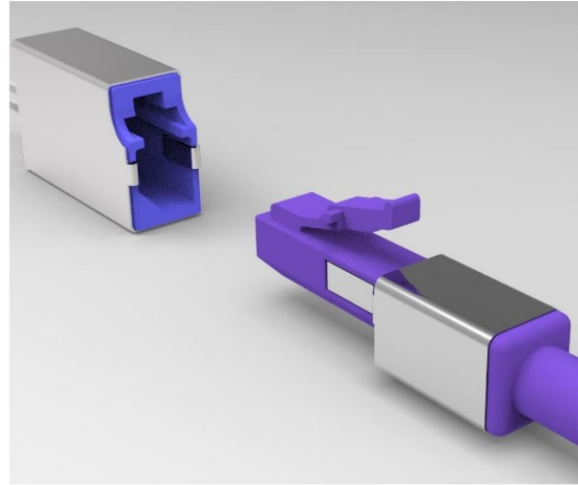


International  
Organization for  
Standardization



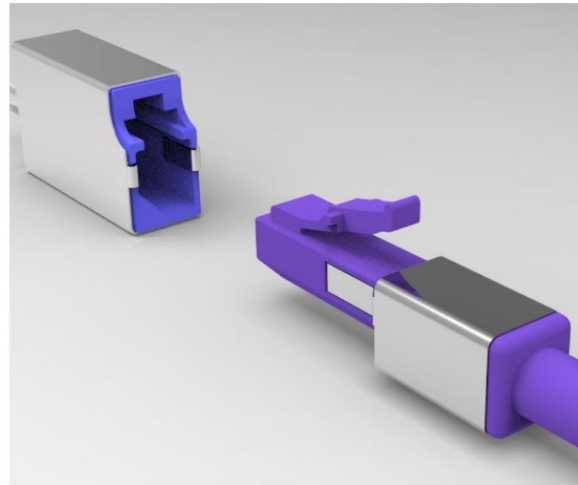
INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

# ISO/IEC JTC 1/SC 25 form factors selected



- The form factor specified in IEC 63171-1 based on the LC optical fiber form factor has been selected for use in enterprise and intelligent building ( $M_1I_1C_1E_1$ ) environments
- The ruggedized form factor specified in IEC 60176-3-125 has been specified for use in light and heavy industrial environments

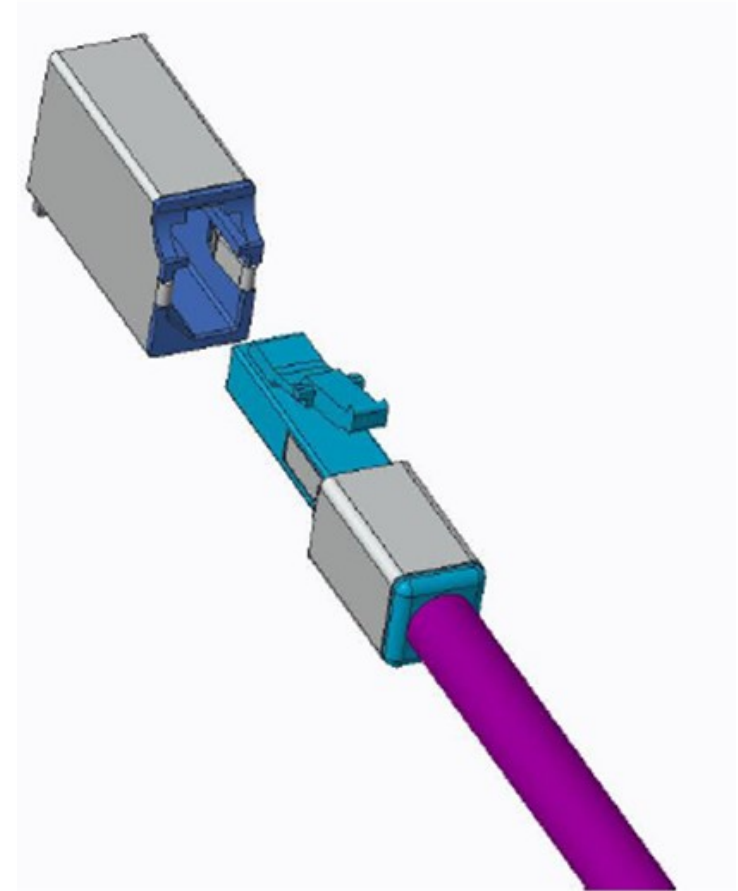
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- TIA harmonized their interface selections with ISO/IEC

# IEEE P802.3cg update

- Draft 3.0 is circulating for Sponsor ballot
- The following text has been added to the 10BASE-T1L MDI connectors clause:
  - “Specific systems or applications can use connectors or terminals, in addition to those listed below...”
  - “Connectors meeting the requirements of IEC 63171-1 or IEC 61076-3-125 may be used as the mechanical interface to the balanced cabling.”
- Informational figures showing the connector and pin assignments are included



# Closing thoughts

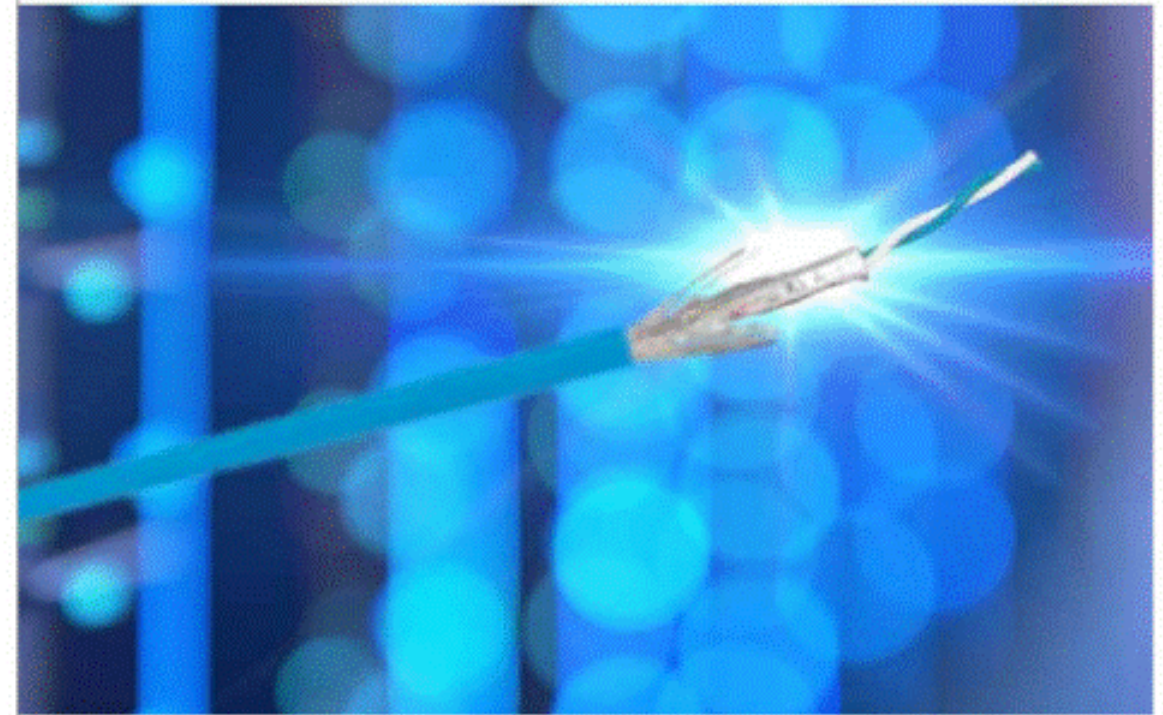


- One balanced pair is sufficient to provide power and data to many automation controllers, sensors, and M2M devices
- BASE-T1 Ethernet and structured cabling offers opportunities to eliminate proprietary interfaces and protocols and facilitate networking a wide range of building and automation devices
- Single-pair cabling Standards will facilitate deployment of generic infrastructure to support future IoT devices and technology

# Learning more...

- Refer to the article entitled, “The Emerging Role of Single-Pair Cabling in Enterprise Networks” in the September/October issue of *ICT Today* for more information
- Article link:  
[http://www.nxtbook.com/nxtbooks/bicsi/icttoday\\_20180910/index.php#/14](http://www.nxtbook.com/nxtbooks/bicsi/icttoday_20180910/index.php#/14)

By Valerie Maguire, BSEE



## The Emerging Role of Single-Pair Cabling in Enterprise Networks