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# **Link Segment IEEE 802.3 10 Mb/s Single Twisted Pair Ethernet Study Group**

**Chris DiMinico  
MC Communications/Panduit  
cdiminico@ieee.org**

# Purpose

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- **Scope**

- **Initiate discussion(s) on 10 Mb/s Single Twisted Pair Ethernet Link Segment Specifications**

- **Automotive**
    - **Industrial Automation**

- **Rationale**

- **Link segment characteristics enables considerations for PHY (e.g., signaling)**

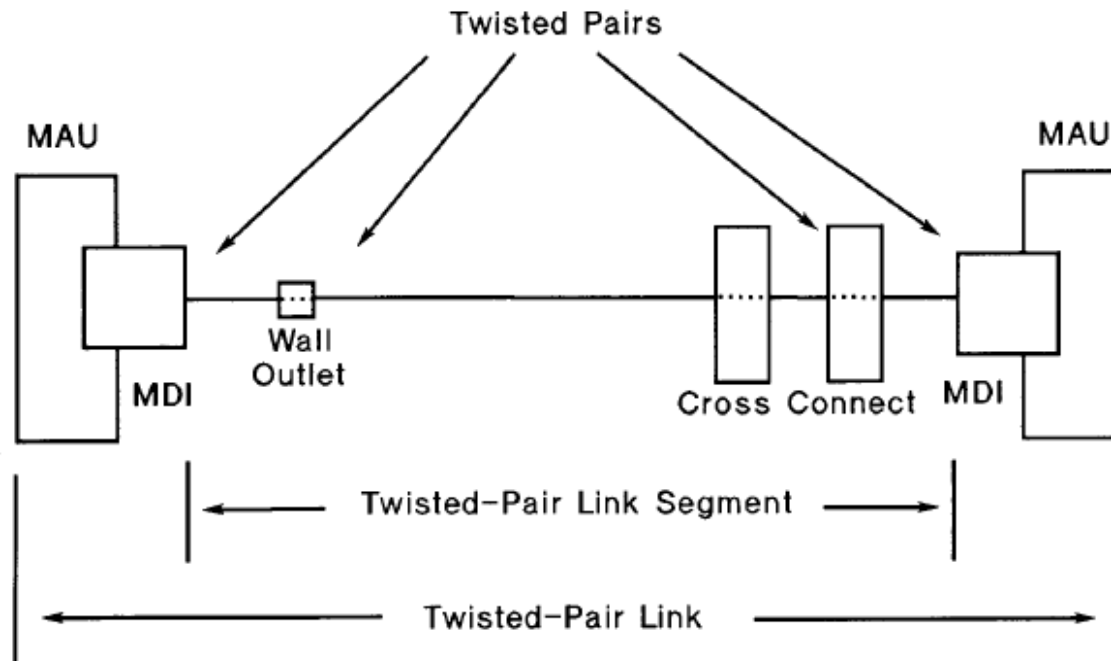
- **Link Segment**

- **Developed in conjunction with the automotive/Industrial networking industries**

# Link Segment

**1.4.242 link segment:** The point-to-point full-duplex medium connection between two and only two Medium Dependent Interfaces (MDIs).

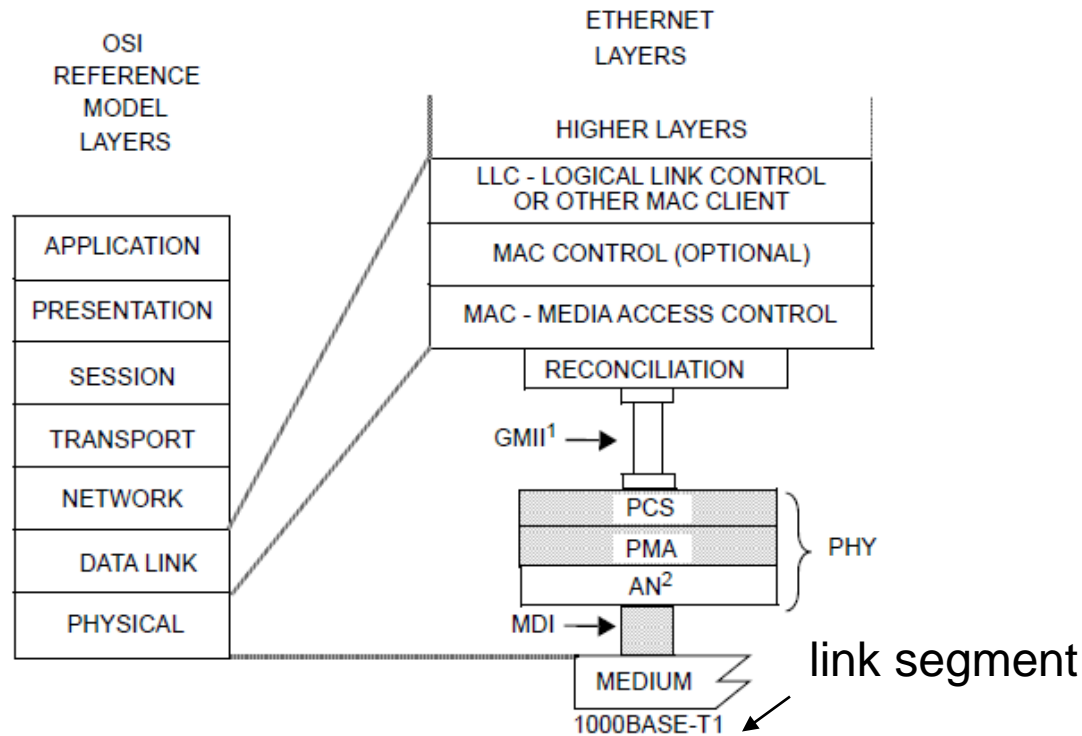
- **10BASE-T**



(b)

Figure 14-2—Twisted-pair link

# 1000BASE-T1 Link Segment



MDI = MEDIUM DEPENDENT INTERFACE  
GMII = TEN GIGABIT MEDIA INDEPENDENT INTERFACE

NOTE 1—GMII is optional  
NOTE 2—Auto-Negotiation is optional

PCS = PHYSICAL CODING SUBLAYER  
PMA = PHYSICAL MEDIUM ATTACHMENT  
PHY = PHYSICAL LAYER DEVICE  
AN = AUTO-NEGOTIATION

# Automotive wiring system

## Automotive wiring system example

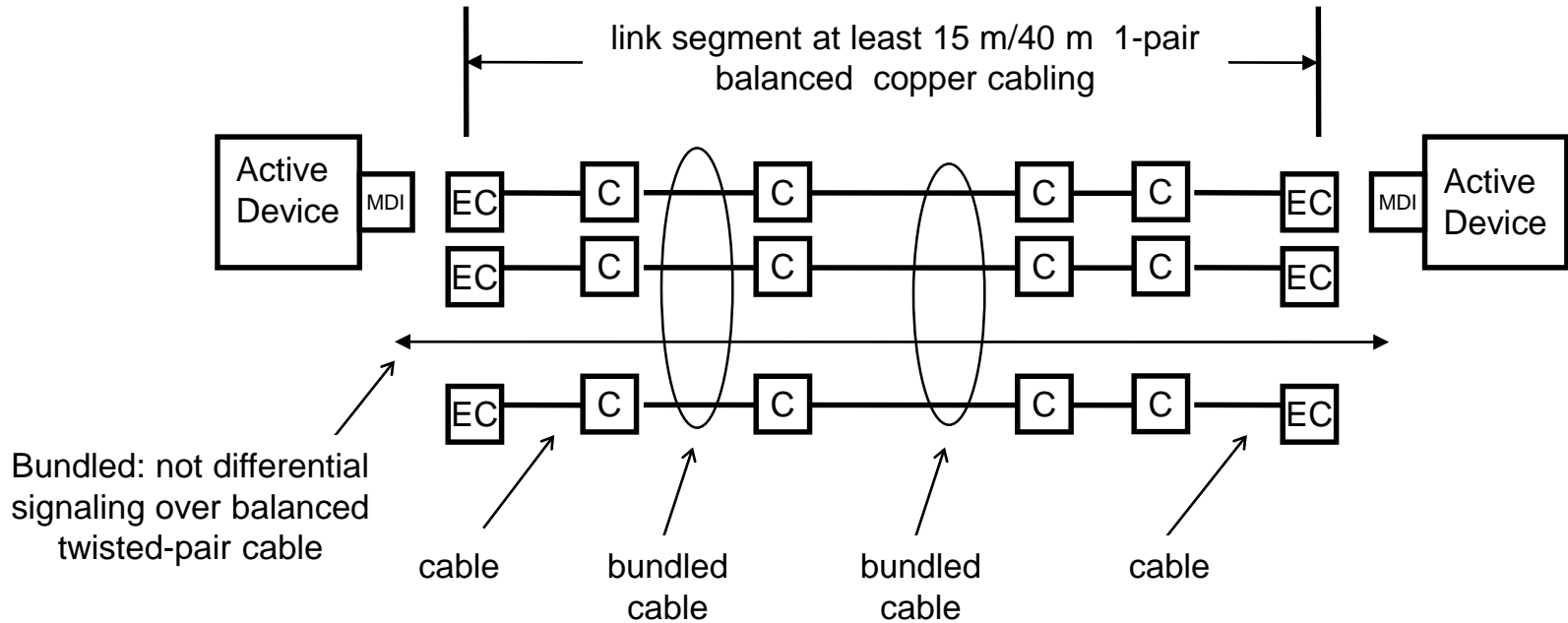
- Length of cable: more than 3 km
- Number of single cables : up to 1,500
- Number of contacts: up to 3,000
- Weight: up to 50 kg

## Automotive versus LAN cabling

- Topology (identification of link segment)
- Temperature ratings (engine compartments)
- Jacketing and insulation materials (resistant to oil, gasoline, hydraulic fluids etc.)
- Mechanical properties



# 802.3bp Link Segment Representation

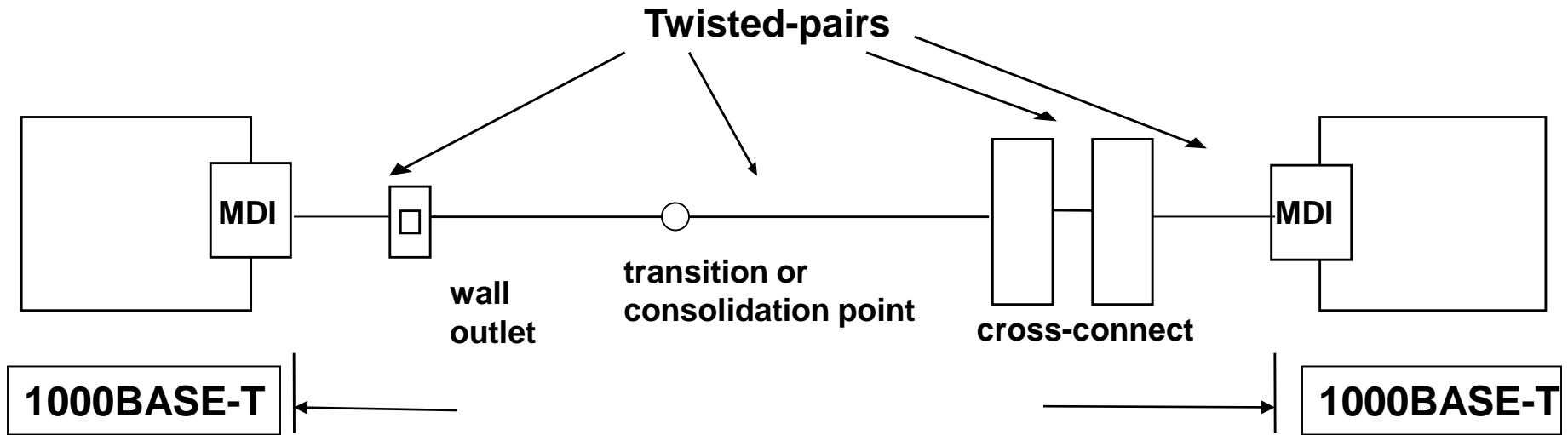


The IEEE 802.3 nomenclature is bracketed to identify relationship to the IEEE 802.3 definitions.

Length objective [EC] to [EC] at least 15 m/40 m  
Number of inline connectors [C] = 4

- [C] = inline connector
- [EC] = connection to equipment
- [MDI] = Active electronics connector [Medium dependent interface (MDI)]

# Twisted Pair Link Segment



## Structured cabling ISO/IEC, TR42

### 1000BASE-T Link transmission and coupling parameters

- Insertion loss, Return loss
- NEXT, FEXT, Multiple Disturber Crosstalk

# 1000BASE-T1 Link Segment

## 97.6 Link segment characteristics

1000BASE-T1 is designed to operate over a single twisted-pair copper cable that meets the requirements specified in this subclause. The single twisted-pair copper cable supports an effective data rate of 1 Gb/s in each direction simultaneously. The term “link segment” used in this clause refers to a single twisted-pair copper cable operating in full duplex.

Two link segments are specified:

- a) A link segment optimized for use in automotive applications that supports up to four in-line connectors using a single twisted-pair copper cable for up to at least 15 m. This link segment is referred to as *link segment type A*.
- b) An *optional link segment* supporting up to four in-line connectors using a single twisted-pair copper cable for up to at least 40 m to support applications requiring additional physical reach, such as industrial and automation controls and transportation (aircraft, railway, bus and heavy trucks). This link segment is referred to as *link segment type B*.



# 1000BASE-T1 Link Segment

- 97.6 Link segment characteristics
  - 97.6.1 Link transmission parameters for link segment type A
    - 97.6.1.1 Insertion loss
    - 97.6.1.2 Differential characteristic impedance
    - 97.6.1.3 Return loss
    - 97.6.1.4 Differential to common mode conversion
    - 97.6.1.5 Maximum link delay
  - 97.6.2 Link transmission parameters for link segment type B
    - 97.6.2.1 Insertion loss
    - 97.6.2.2 Differential characteristic impedance
    - 97.6.2.3 Return loss
    - 97.6.2.4 Maximum link delay
    - 97.6.2.5 Coupling attenuation

# 1000BASE-T1 Link Segment

- **Between Link Segments (Alien)**

- 97.6.3 Coupling parameters between type A link segments
  - 97.6.3.1 Multiple disturber alien near-end crosstalk (MDANEXT) loss
  - 97.6.3.2 Multiple disturber power sum alien near-end crosstalk (PSANEXT) loss
  - 97.6.3.3 Multiple disturber alien far-end crosstalk (MDAFEXT) loss
  - 97.6.3.4 Multiple disturber power sum alien attenuation crosstalk ratio far-end (PSAACRF)
- 97.6.4 Coupling parameters between type B link segments
  - 97.6.4.1 Multiple disturber alien near-end crosstalk (MDANEXT) loss
  - 97.6.4.2 Multiple disturber power sum alien near-end crosstalk (PSANEXT) loss
  - 97.6.4.3 Multiple disturber alien far-end crosstalk (MDAFEXT) loss
  - 97.6.4.4 Multiple disturber power sum alien attenuation crosstalk ratio far-end (PSAACRF)

# Link segment/PHY - Considerations

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- Topology
- Transmission and coupling parameters
- Environmental
  
- Topology
  - Length (up to at least x meters)
  - Number of connectors (x)
  
- Transmission and coupling parameters
  - Insertion loss
  - Link segment noise
    - o Noise within link segment –
      - ✓ return loss
      - ✓ mode conversion (balance)
    - o Noise coupling between link segments
      - ✓ Alien crosstalk - ANEXT, AFEXT and multiple disturber ANEXT and AFEXT
    - o Mode conversion (balance)

# Link segment/PHY - Considerations

- 10 Mb/s Single-Pair PHY electromagnetic environment
  - Susceptibility levels
    - o Sources of interference from the environment (TBD)...
      - Emission levels External noise - noise from signaling or power in adjacent wire pairs from non-10 Mb/s Single-Pair PHYs
    - oThe twisted-pair link segment shall comply with applicable local and national codes for the limitation of electromagnetic.
- 10 Mb/s Single-Pair PHY operating environmental
  - Specific requirements for temperature, humidity and values for these parameters are considered to be beyond the scope of the 10 Mb/s Single-Pair PHYs specification. (informative annex?)
  - Specific requirements for physical stress (such as shock and vibration) and values for these parameters are considered to be beyond the scope of the 10 Mb/s Single-Pair PHYs (informative annex?)
- 10 Mb/s Single-Pair PHY MDI specifications
  - MDI electrical specifications (TBD)
  - Mechanical interface (non-objective (?))

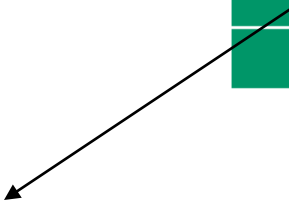
# IA Twisted Pair Link Segment

- Enables cable reuse
  - Installed base of Single Twisted Pair, usually shielded
  - Certain cables are certified
  - Lengthy fieldbus cables are expensive to install (often in filled conduit)
  - End nodes are easier to replace
  - Similar value proposition to 2.5G/5GBASE-T Task Force
- Enables constrained form factor applications (sensors etc.)
  - Reduced size and cost

High 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



## Link segment/PHY - Considerations

# Summary

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- **Discussion on link segment characteristics for 10 Mb/s Single Twisted Pair Ethernet**
- **Differentiating LAN cabling from automotive and IA cabling; topology and cabling characteristics.**