# 10 Gigabit Ethernet Transmission and Field Testing

BICSI May, 2000

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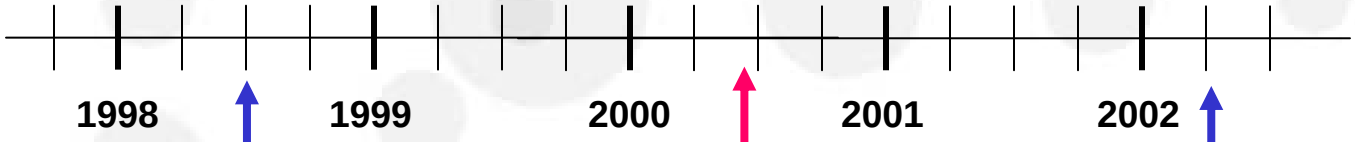
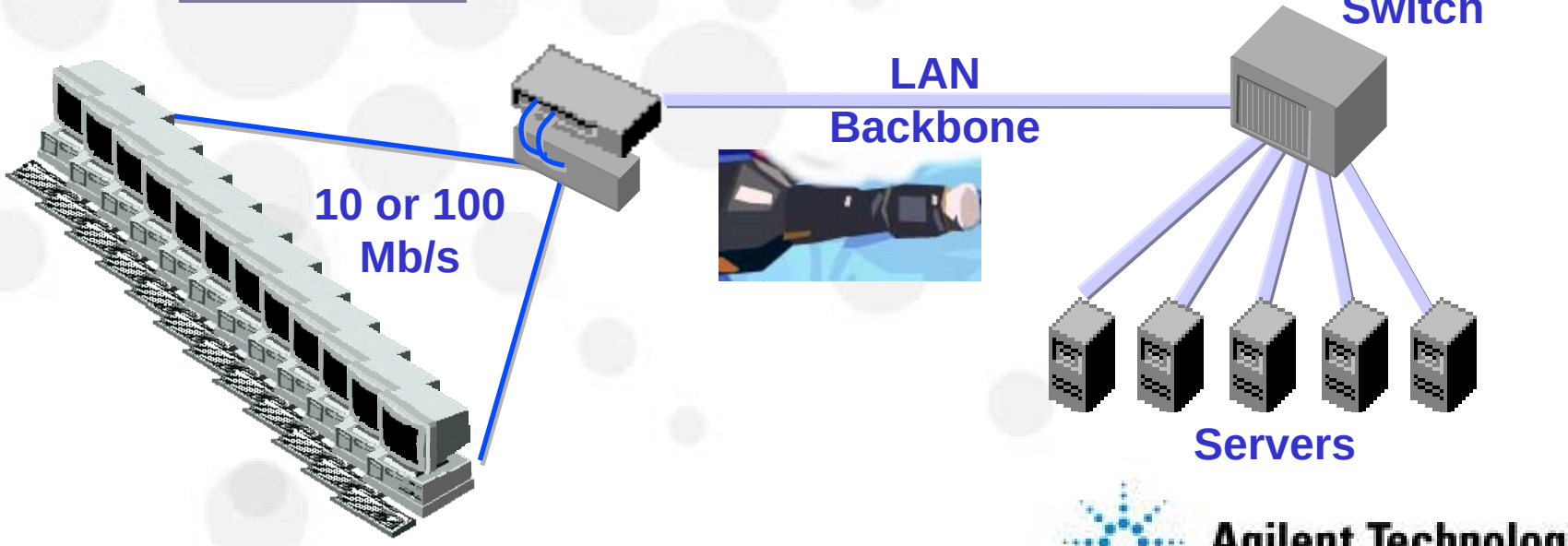
# The Need for Speed




June 1998
IEEE 802.3z
**1 Gb/s**

we are here

March 2002
IEEE 802.3ae
**10 Gb/s**

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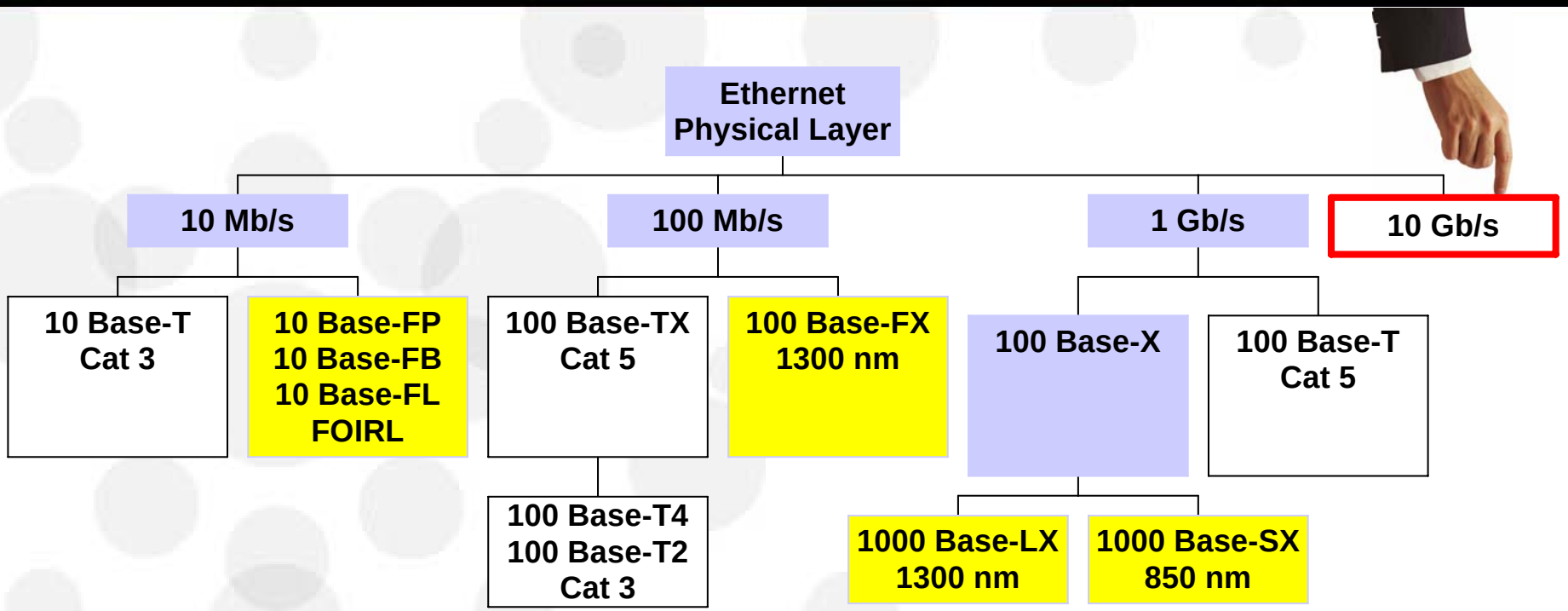
# Ethernet Physical Layer (PHY) Interfaces




⑦Data rates increase as a power of 10

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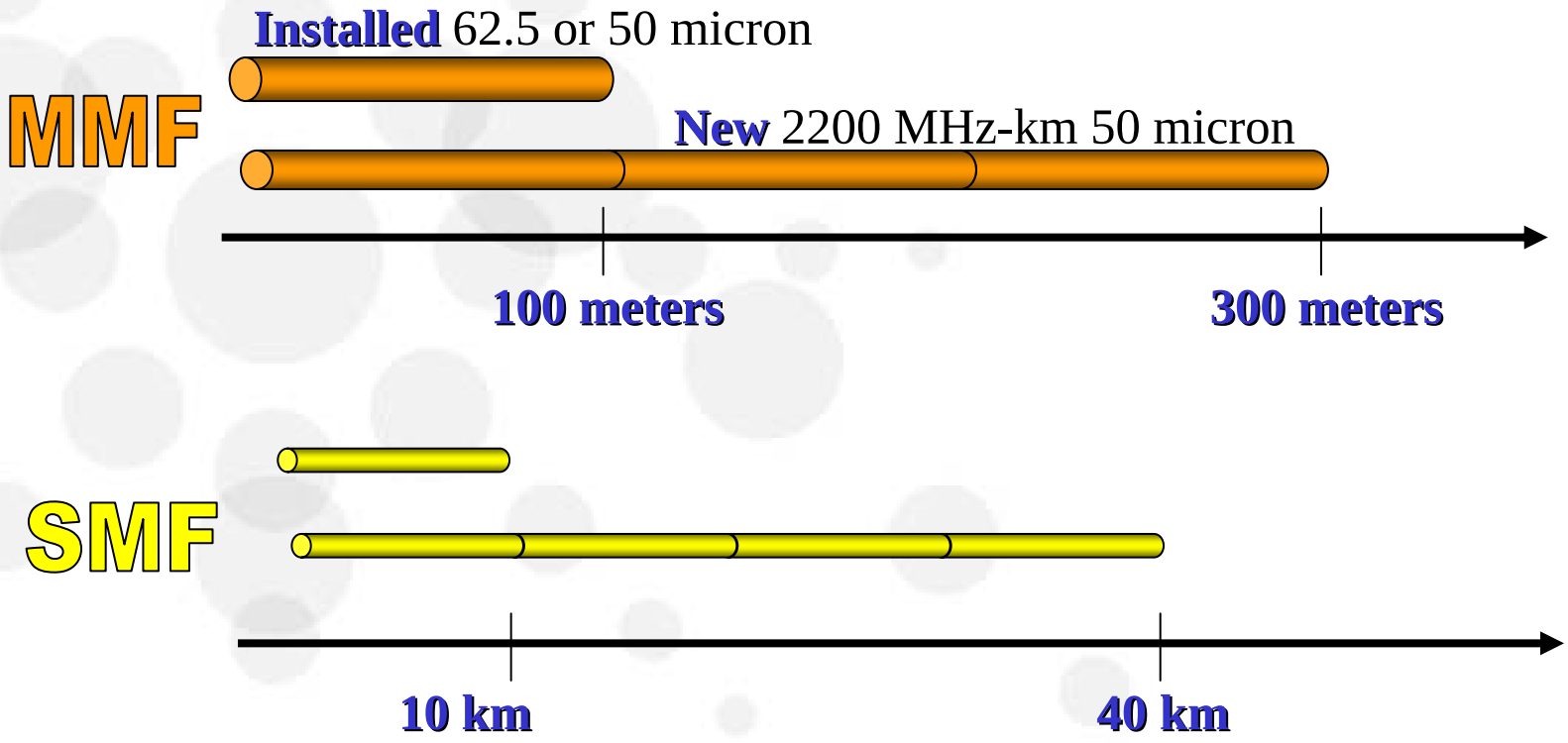
# Objectives of IEEE 802.3ae 10 Gb/s Ethernet Working Group

⑦ **Link distances**

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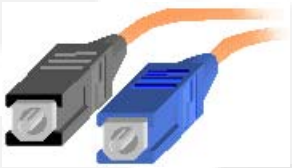
# Objectives of IEEE 802.3ae 10 Gb/s Ethernet Working Group

⑦ **Support fiber media selected from the second edition of ISO/IEC 11801**



| | Bandwidth | |
|---|---|---|
| | **At 850 nm** | **At 1300 nm** |
| **MMF 62.5 μm** | 160 MHz•km | 500 MHz•km |
| **MMF 62.5 μm** | 200 MHz•km | 500 MHz•km |
| **MMF 50 μm** | 500 MHz•km | 500 MHz•km |
| **MMF 50 μm** | 2200 MHz•km | 500 MHz•km |
| **SMF** | | |

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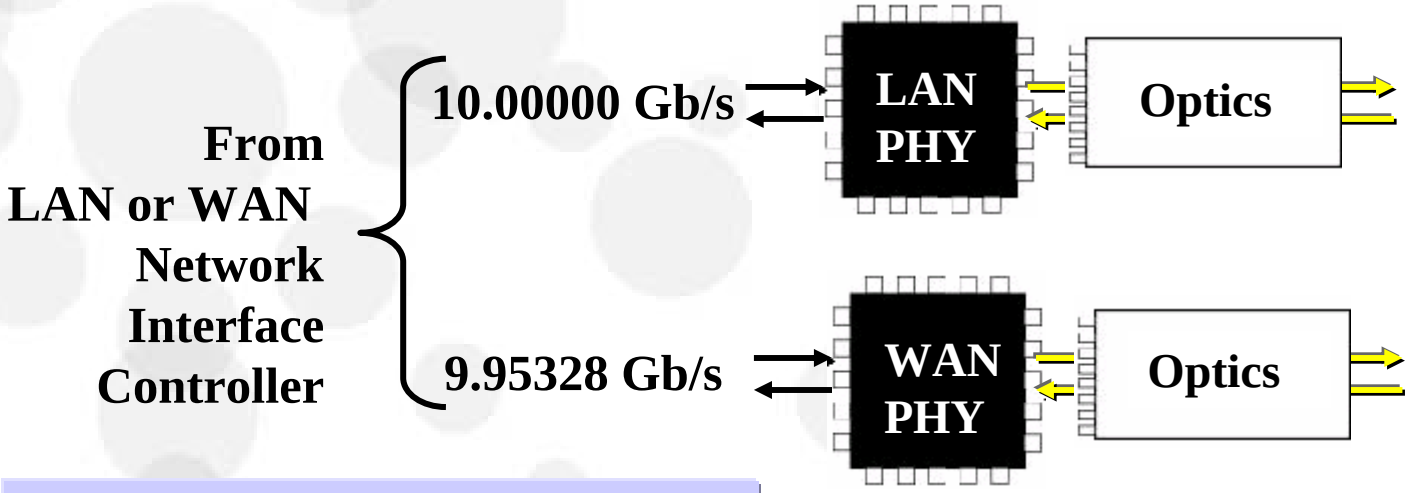
# Objectives of IEEE 802.3ae 10 Gb/s Ethernet Working Group

⑦ **Define two families of PHYs**

- A LAN PHY operating at a data rate of 10 Gb/s
- A WAN PHY operating at the OC-192 data rate of 9.95328 Gb/s




**OC-192 rate = OC-1 x 192**
**or**
**51.84 Mb/s * 192 = 9.95328 Gb/s**

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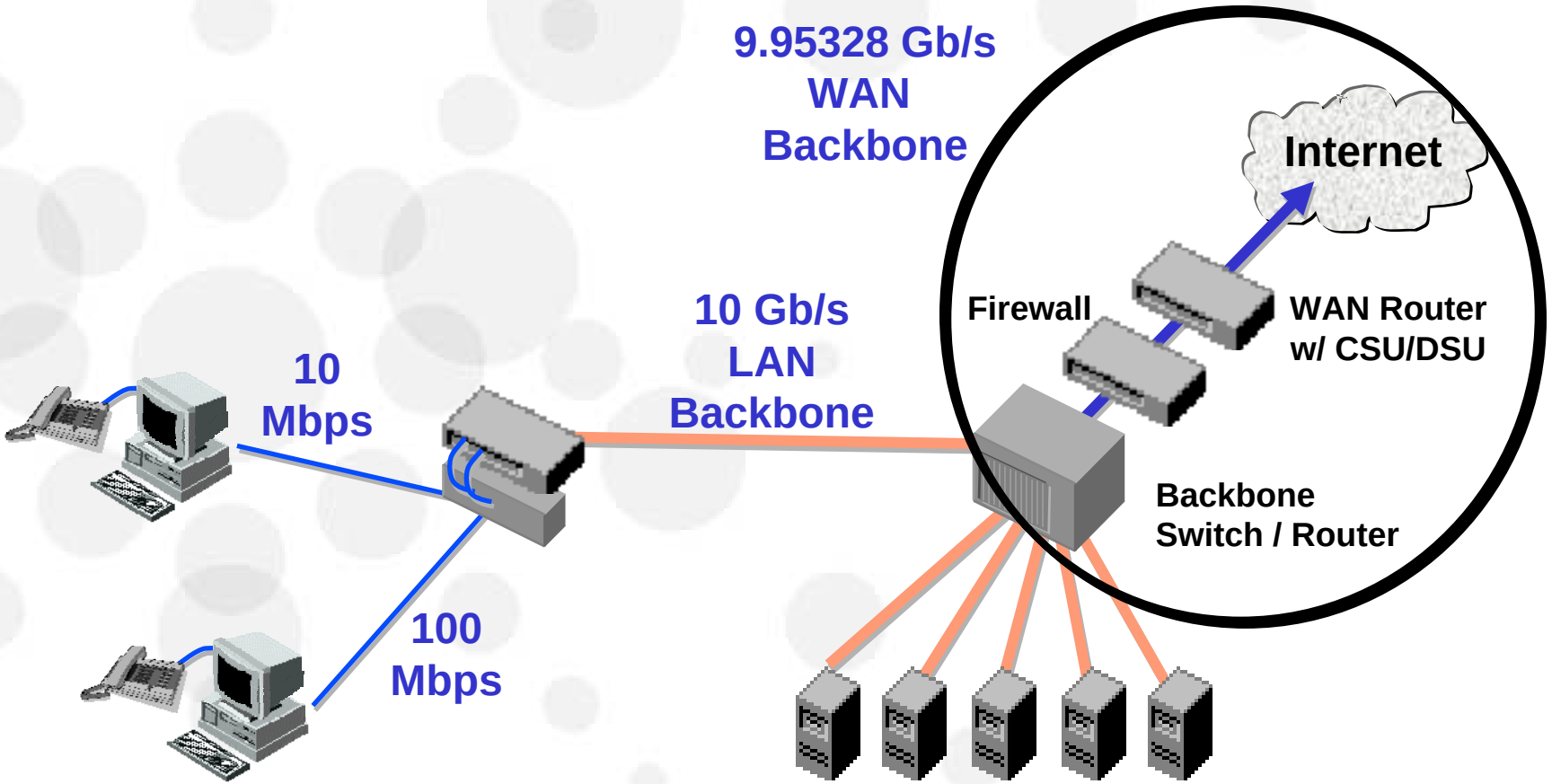
# World-Wide Ethernet ?

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# Three Notable Schemes Under Consideration

- **1310 nm WWDM (Wide Wavelength Division Multiplexing)**
  - Supports 300 m over installed 62.5 µm and 50 µm fiber
  - Supports at least 10 km over SMF
  - Requires the use of an offset patch cord just like 1000Base-LX
- **850 nm VCSEL (Vertical Cavity Surface Emitting Laser)**
  - Supports 300 m over new 2200 MHz-km 50 µm fiber but less than 100 m over installed 62.5 µm fiber
  - No SMF support
- **1310 nm DFB (distributed feedback) laser**
  - Cooled version supports 40 km
  - Uncooled version supports 10 km
  - Candidate for supporting dual data rate communications - 10 Gb/s for the LAN environment and OC-192 data rates for the WAN environment

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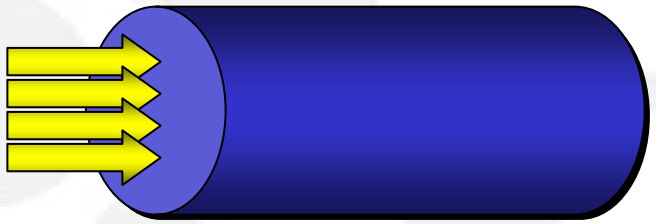
# WWDM Transmission

***Use 4 wavelengths around 1310 nm***

***1280***
***1300***
***1320***
***1340***
***nm***



***Each Wavelength carries 1/4 of the data rate***

4 x 3.125 Gbd = 12.5 Gbd

- Wide Wavelength Division Multiplexing
  - 300 meters over MMF
  - 10 km over SMF
- Widely applicable

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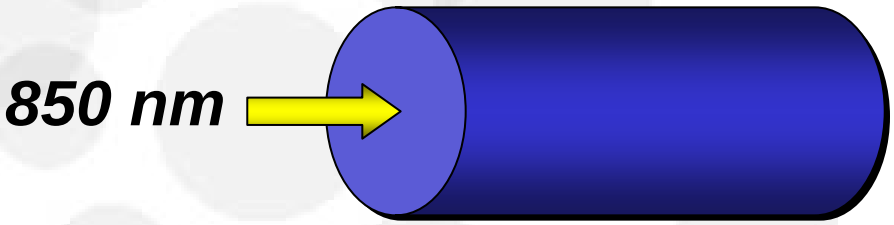
# 850 nm VCSEL Transmission

***Uses serial transmission***




***Requires 2200 MHz-km 50 micron fiber***

- 300 meters over new 2200 MHz-km MMF
- Less than 100 meters over installed MMF
- No SMF support
- New installations

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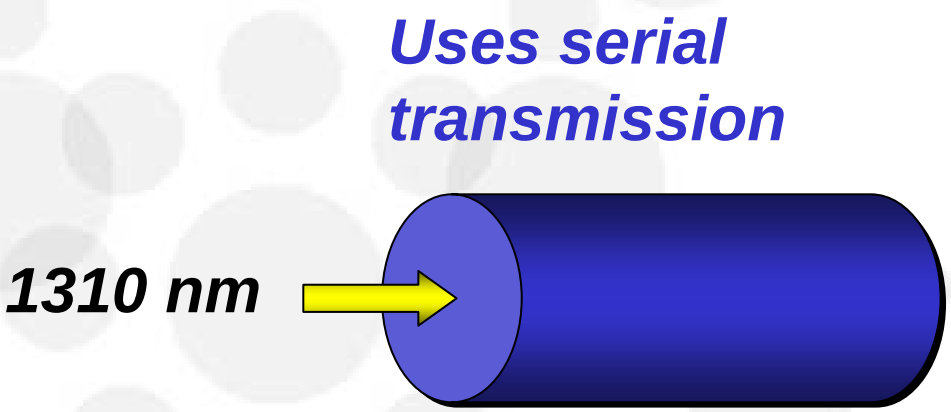
# 1310 DFB Laser Transmission




- **1310 nm DFB (distributed feedback) laser**
  - Cooled version supports 40 km
  - Uncooled version supports 10 km
- Optimized for SMF long distance transmission

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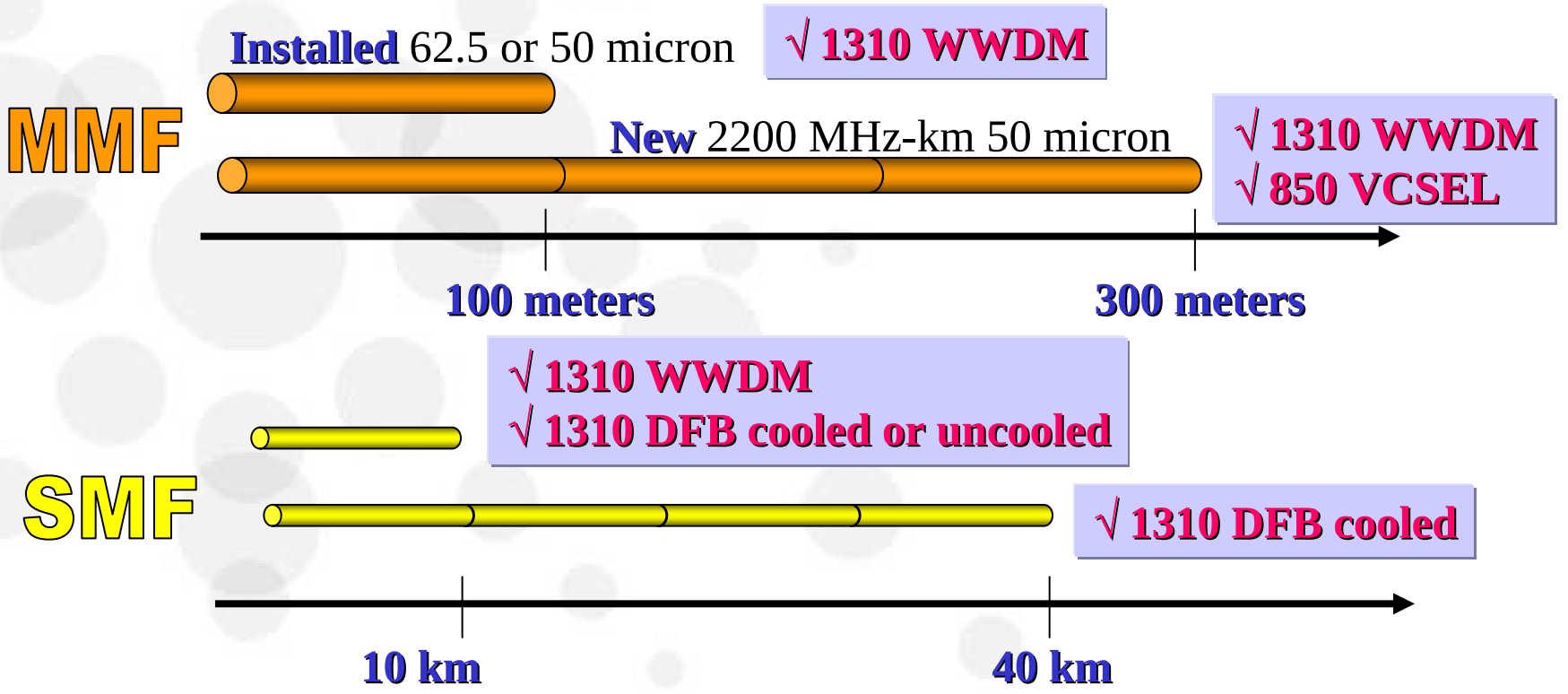
# Possible 10 Gb/s Ethernet PHYs to be Standardized

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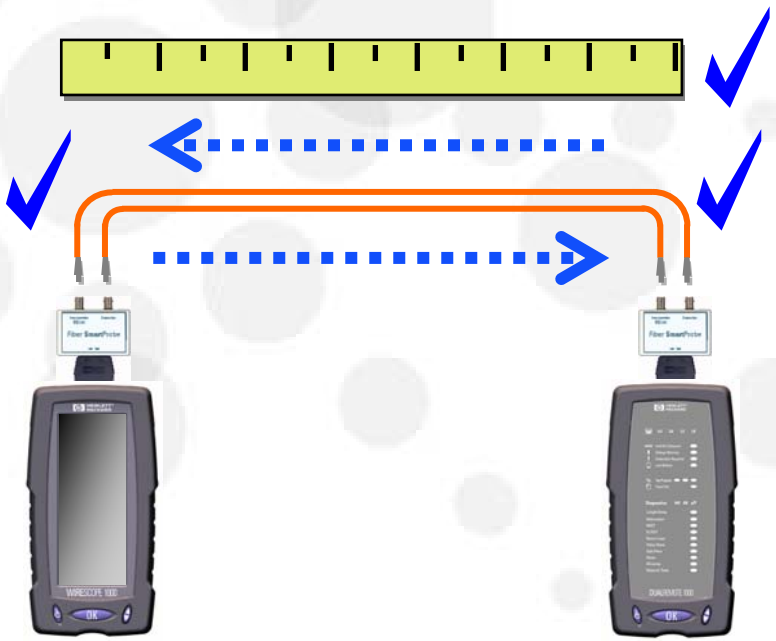
# Field testing

⑦What guidance do generic cabling standards provide?



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# Fiber Loss Limits

| *Optical fiber cable type* | *Wavelength (nm)* | *Maximum attenuation (dB/km)* |
|---|---|---|
| 50/125 μm | 850 | 3.5 |
| | 1300 | 1.5 |
| 62.5/125 μm | 850 | 3.5 |
| | 1300 | 1.5 |
| Singlemode | 1310 | 1.0 |
| inside plant cable | 1550 | 1.0 |
| Singlemode | 1310 | 0.5 |
| outside plant cable | 1550 | 0.5 |

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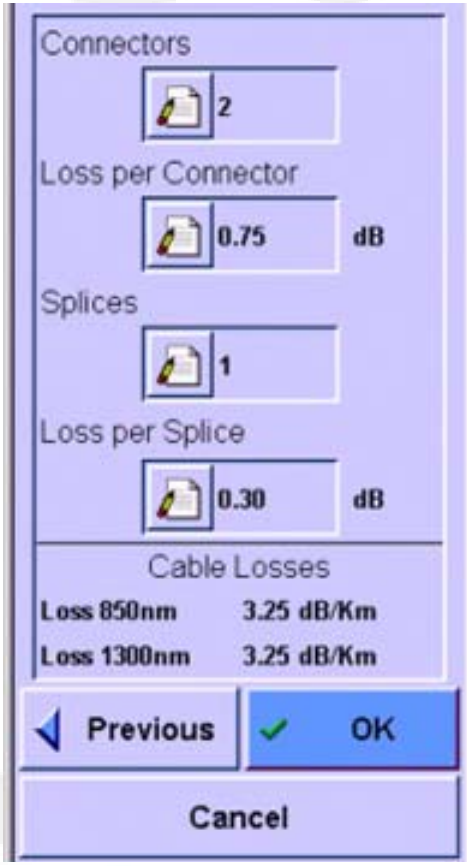
# Connection Loss Limits

|  | Attenuation (dB) |
|---|---|
| Splice | 0.3 |
| Connection, TIA | 0.75 |
| Connection, ISO | 0.5 |
| | |

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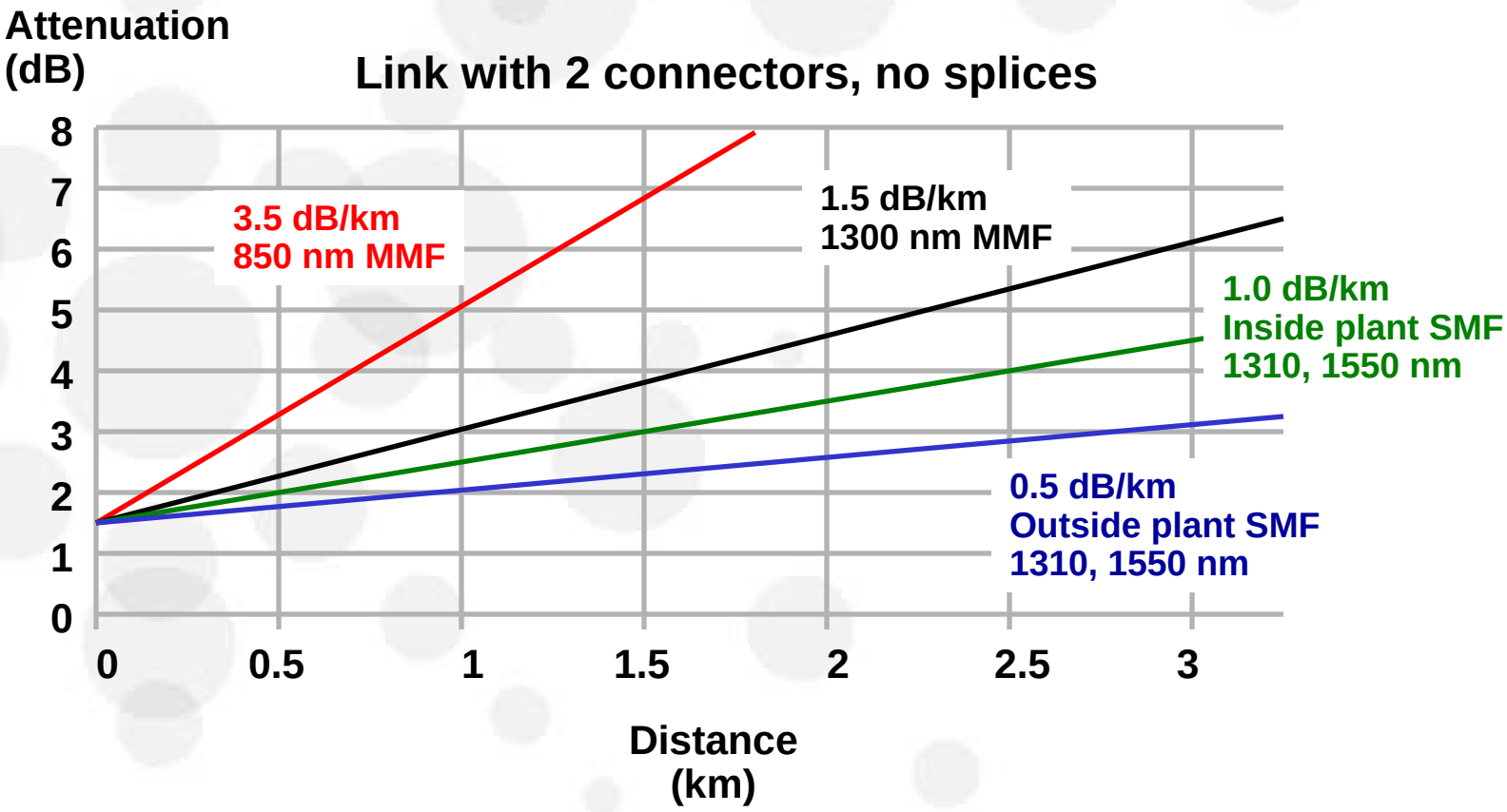
# TIA 568-A Link Budget

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# Generic Cabling Limits for Fiber

⑦How are generic fiber limits used to verify whether high speed Ethernet will work?

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# Length and Attenuation Limits for 1 Gb/s Ethernet

| Gigabit Ethernet Specification | Type of Fiber | Wave-length (nm) | Fiber Core Size (microns) | Modal Bandwidth (MHz * km) | Maximum Distance (m) | Attenuation (dB) |
|---|---|---|---|---|---|---|
| 1000Base-SX | MMF | 850 | 50 | 400 | 500 | 3.37 |
| | | | | 500 | 550 | 3.56 |
| | | | 62.5 | 160 | 220 | 2.38 |
| | | | | 200 | 275 | 2.60 |
| 1000Base-LX | MMF | 1310 | 50 | 400, 500 | 550 | 2.35 |
| | | | 62.5 | 500 | 550 | 2.35 |
| | SMF | 1310 | 10 | | 5,000 | 4.57 |

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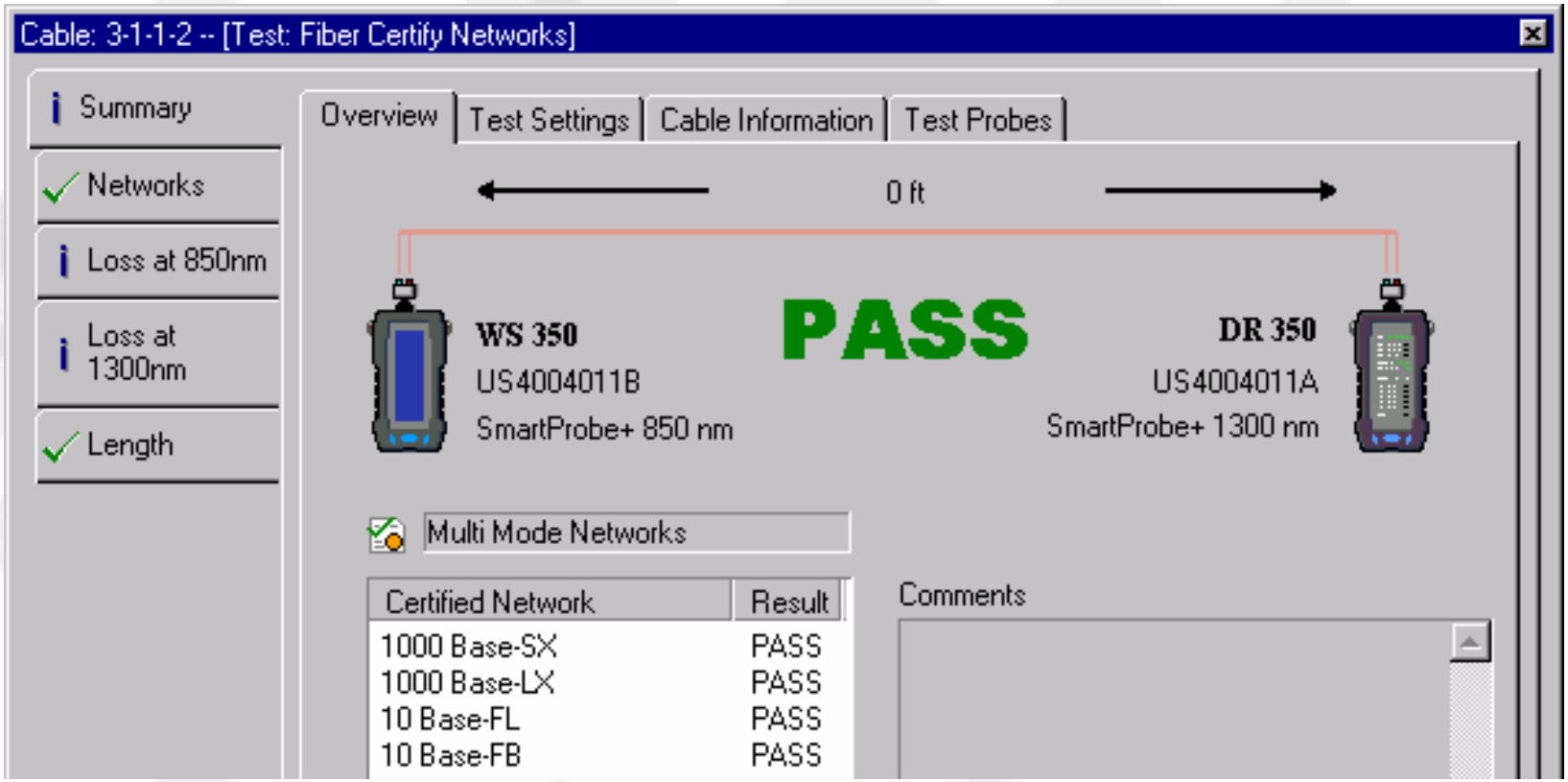
# Automated Field Testing

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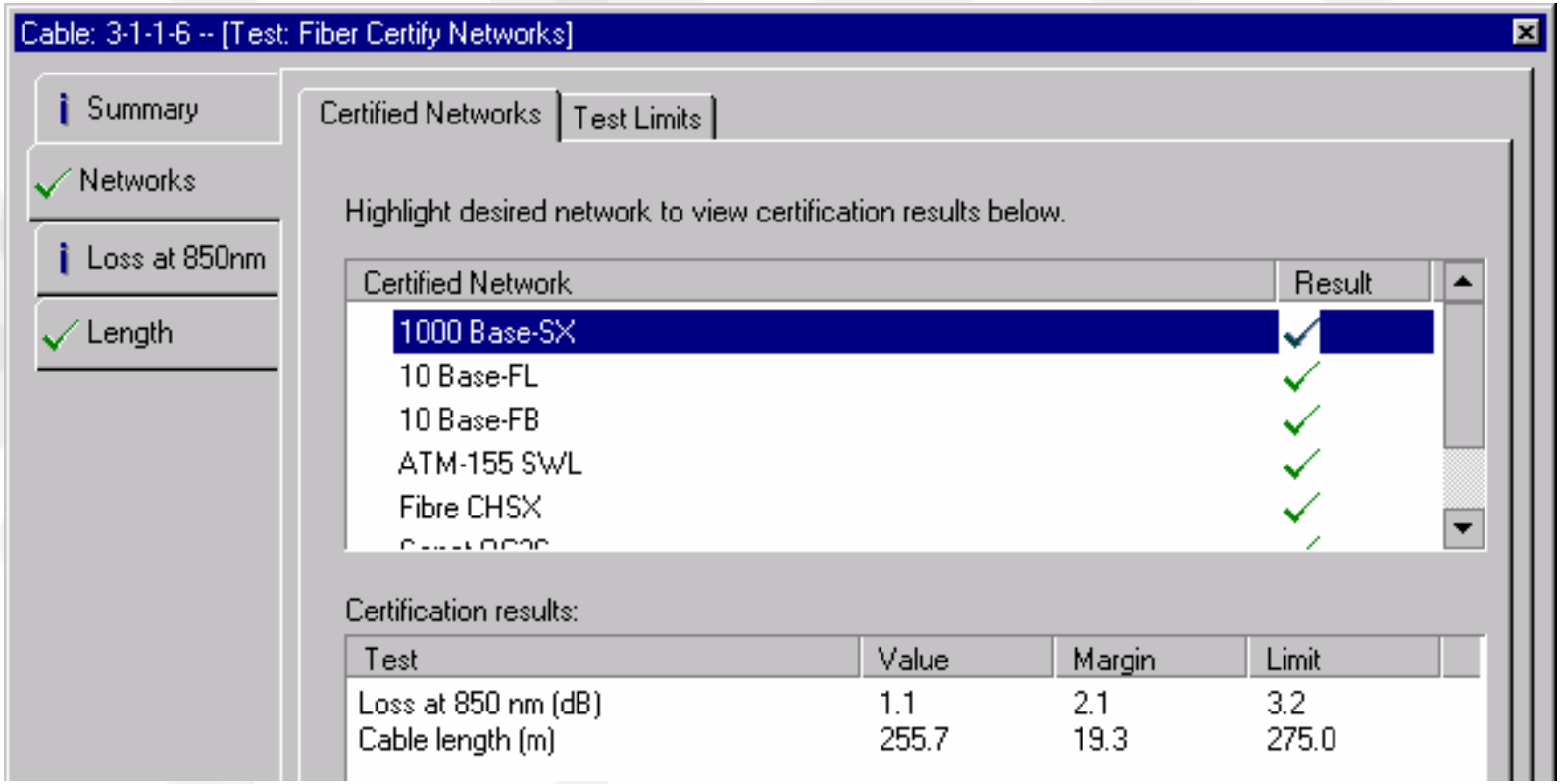
# Automated Field Testing

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# Field Testing Complexity


- 7 different limits for 1 Gb/s Ethernet
- Probably more limits for 10 Gb/s Ethernet
  - 4 distance targets
  - 5 different fiber types
  - ? 3 transceiver schemes
- Important to automate due to increased complexity

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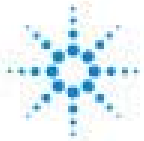
# For more information…

**www.wirescope.com**



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