THE REYNOLDS COMPANY
ELECTRICAL SUPPLY

Tech Talk

Fiber Optic Cable Selection
February 24, 2021

Our Guest Panelists

Joe Belaschky
Automation/Network Specialist
Houston

Mike Masterson
Automation Specialist
Houston

2021 Online Events - Register to receive a calendar invite

- **Tech Talks**
- **Building Faceplates in View ME/SE**

  March 10th @ 10 AM
- **HART and Highly Integrated HART**

  March 24th @ 10 AM

- **User Groups**
- **Networking Update with Panduit**

  ~~February 17th~~ Rescheduled TBD @ 10 AM
- **Scalable OEE**

  March 17th @ 10 AM

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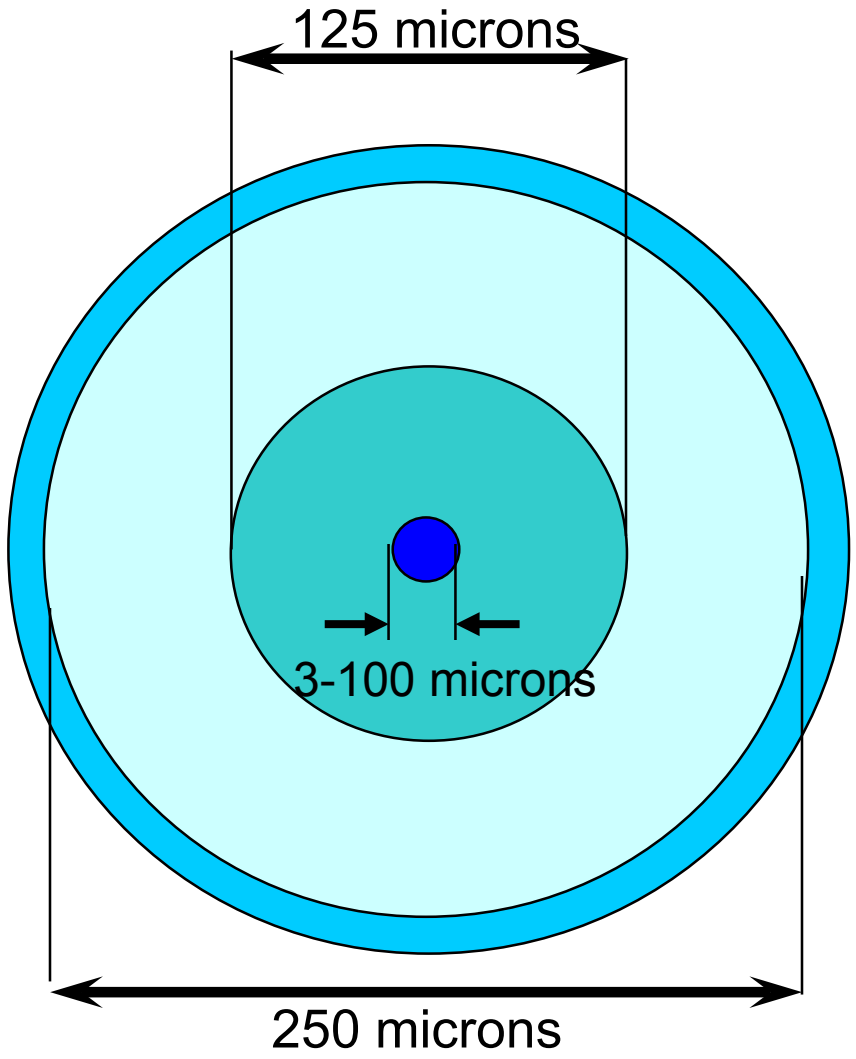
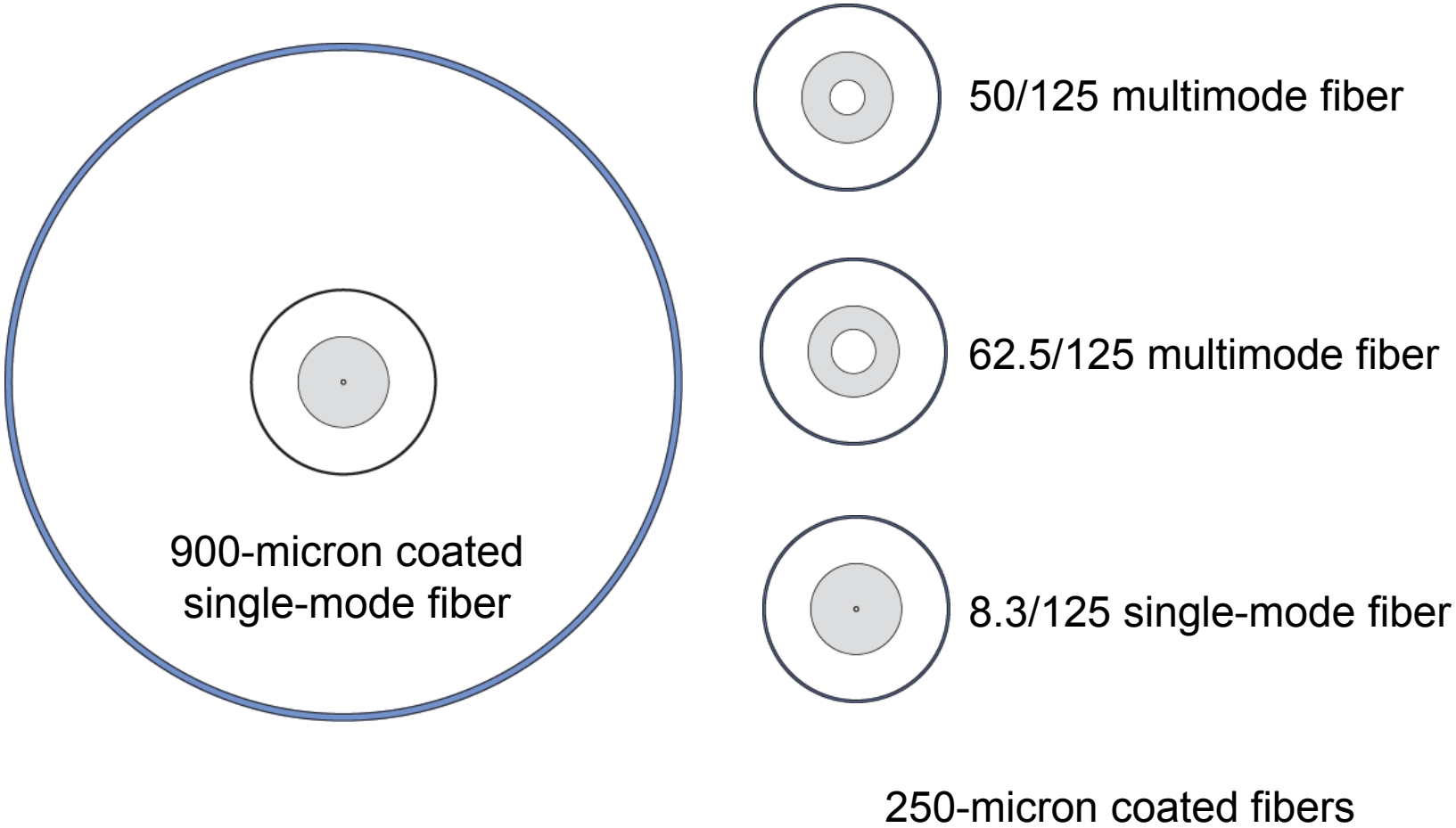
Fiber Structure

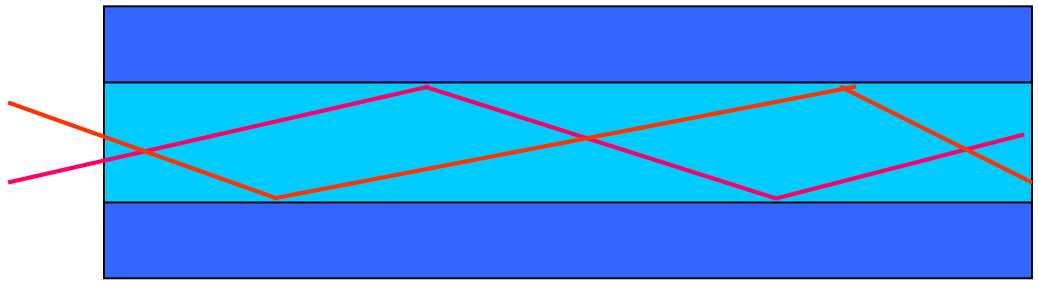
- Core—center of an optical fiber and contains dopants to change speed of light
- Cladding—outer layer of glass to contain light with different refractive index
- Coating—cushions and protects fibers (primary buffer)



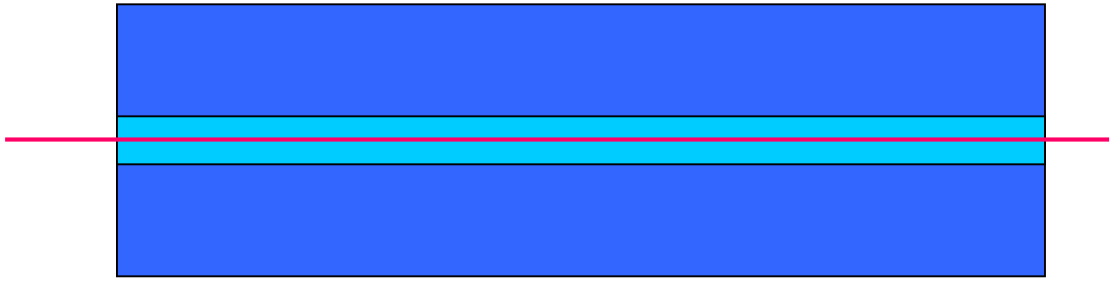
Fiber Comparison



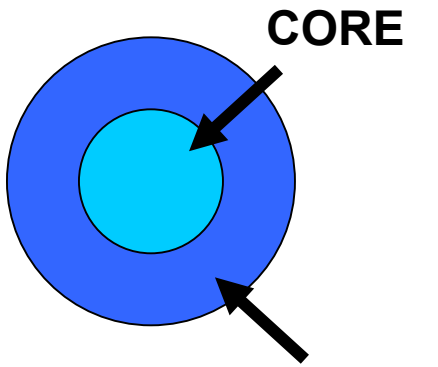
Light Path Within Optical Fiber

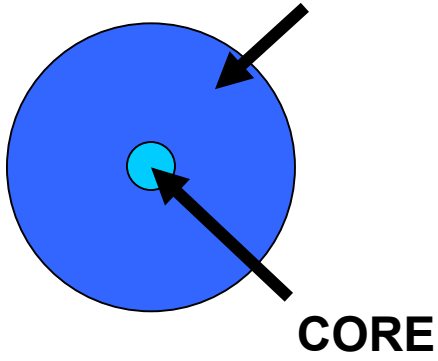


Multimode Optical Fiber

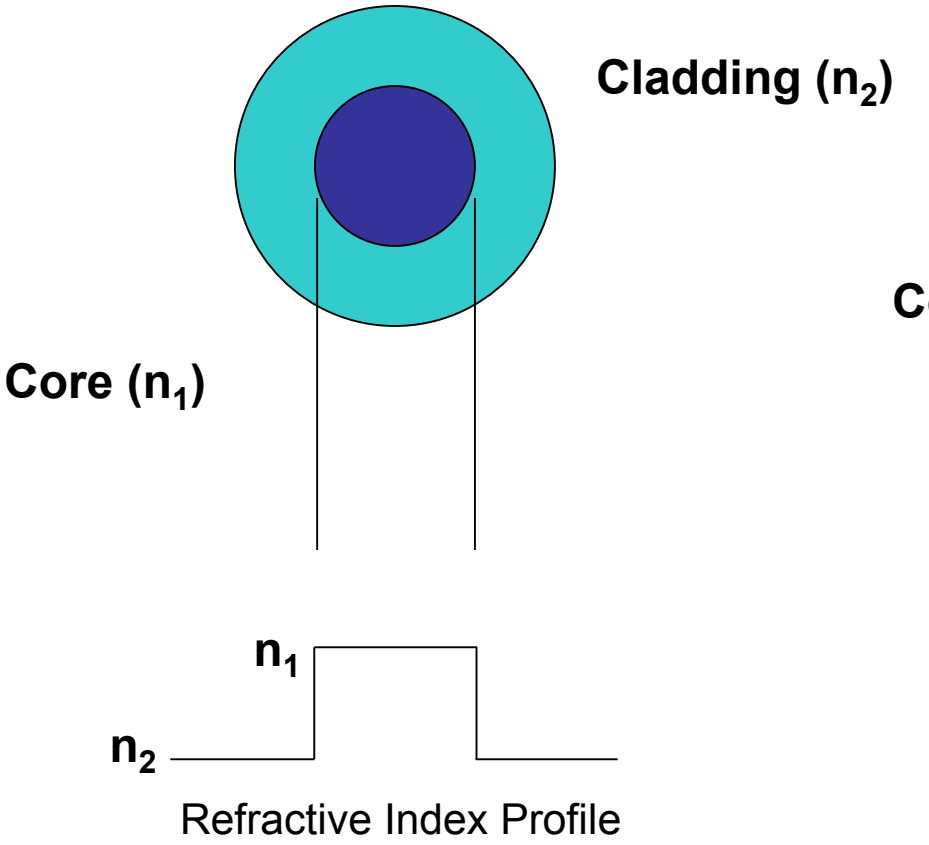


Single-mode Optical Fiber

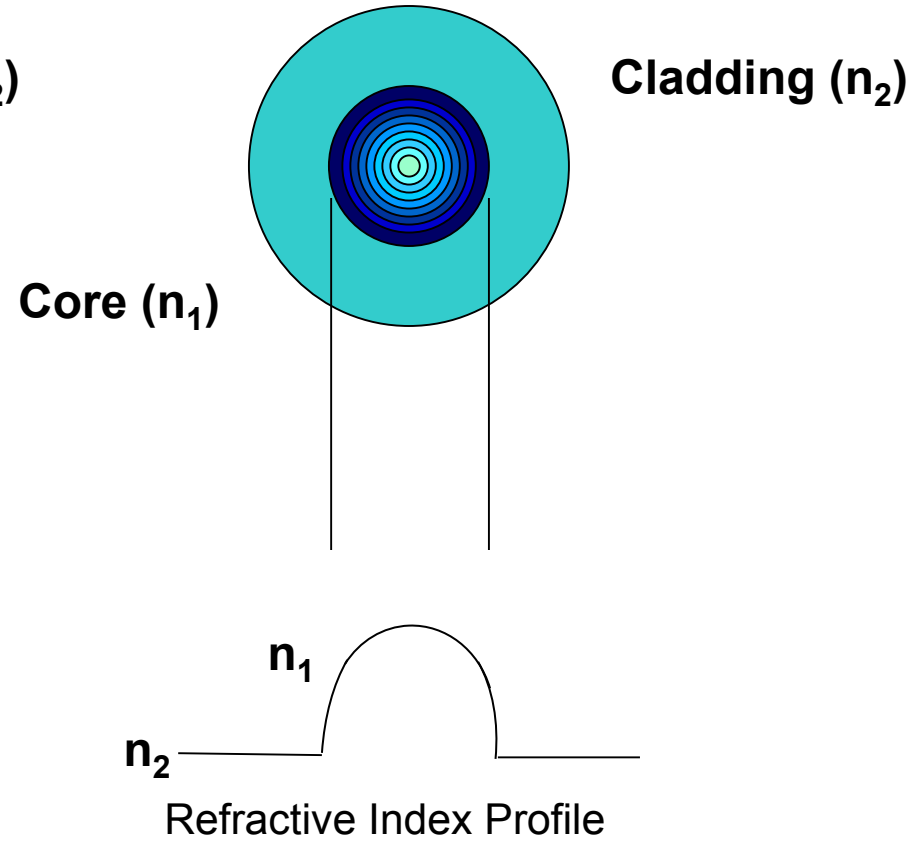




Index Profile of Multimode Fibers

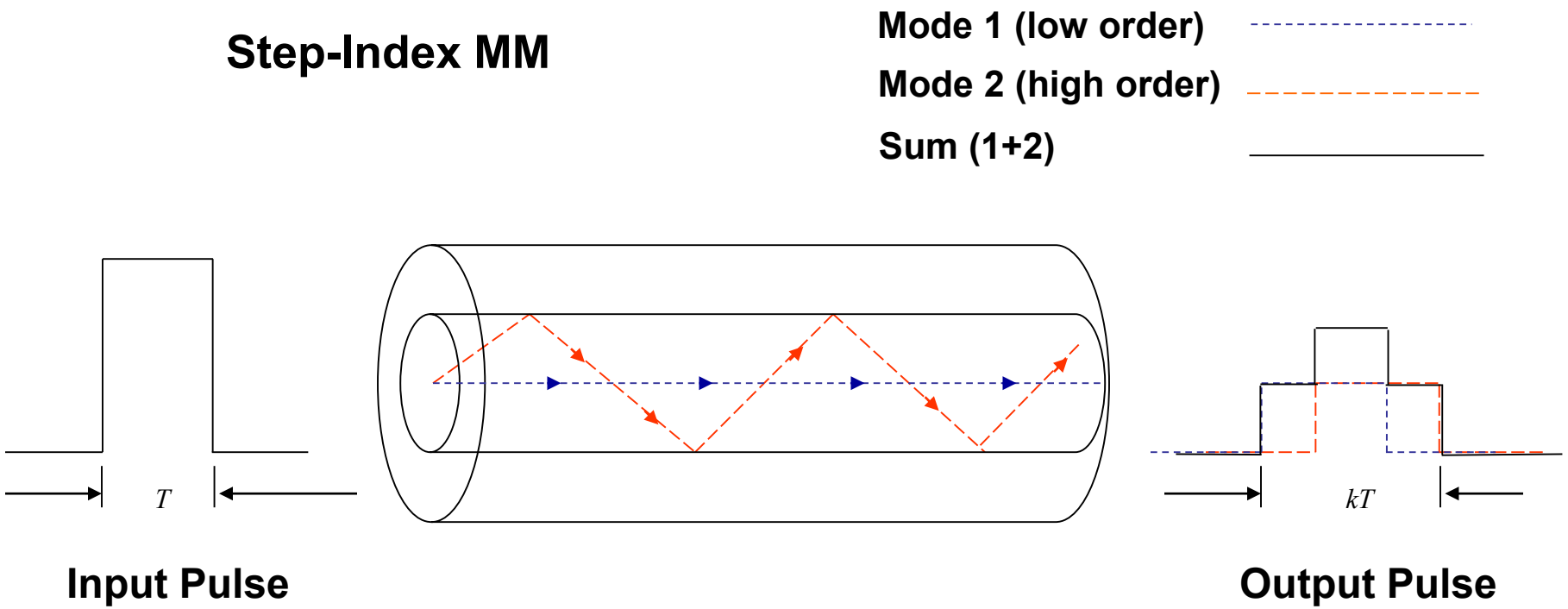


Stepped Index MM



Graded Index MM

Index Profile of Multimode Fibers



The modes in a step-index multimode fiber arrive at different times causing pulse spreading.

Note: In multimode fibers, there may be as many as 1,000 modes.

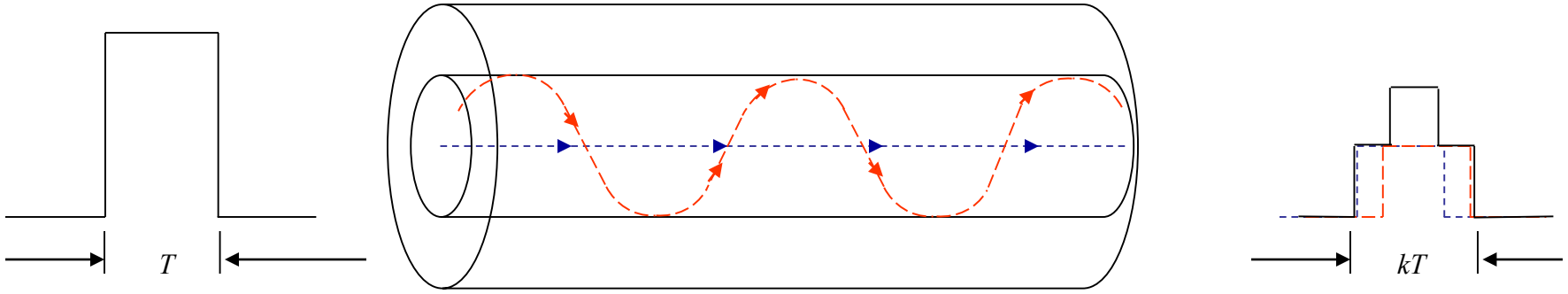
Index of Multimode Fibers

Graded-Index MM

Mode 1 (low order)

Mode 2 (high order)

Sum (1+2)



Input Pulse

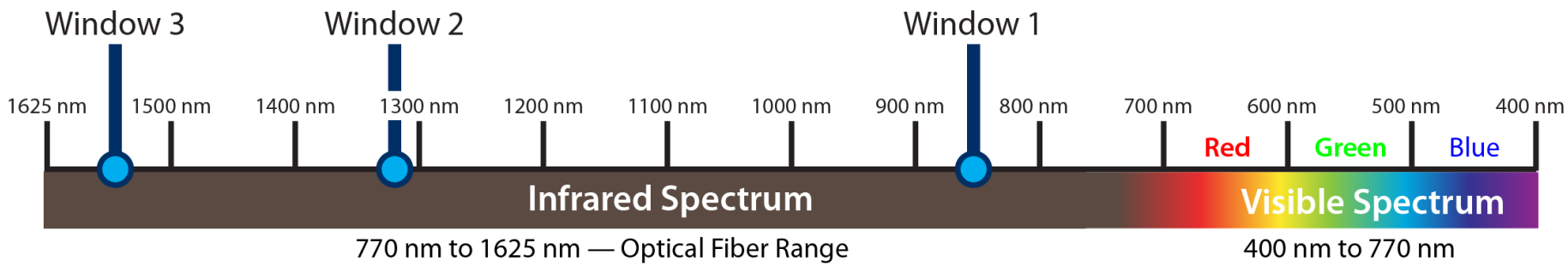
Output Pulse

The modes in a graded-index multimode fiber arrive at different times causing pulse spreading but not as sever as stepped-index.

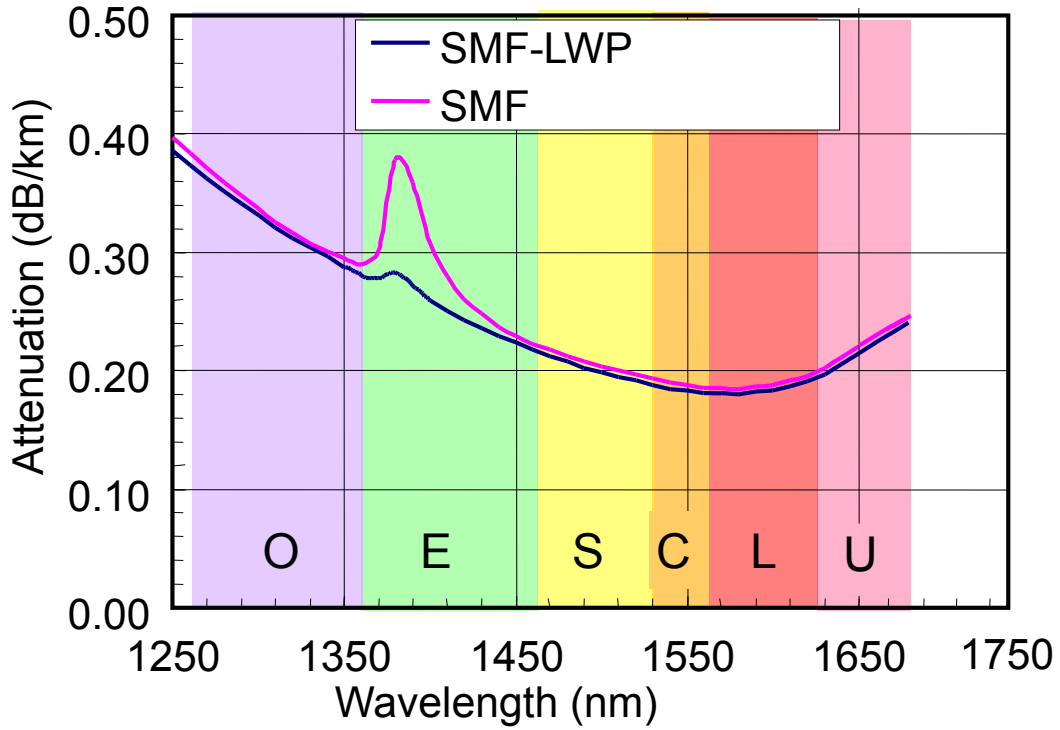
Standard Wavelengths

- Single-mode fiber
  - 1310 nm and 1550 nm
- Multimode fiber
  - 850 nm and 1300 nm

Note: All transmission wavelengths for optical fiber operate in the infrared spectrum of light. Thus, the light is not visible.



Single-mode Wavelength Bands

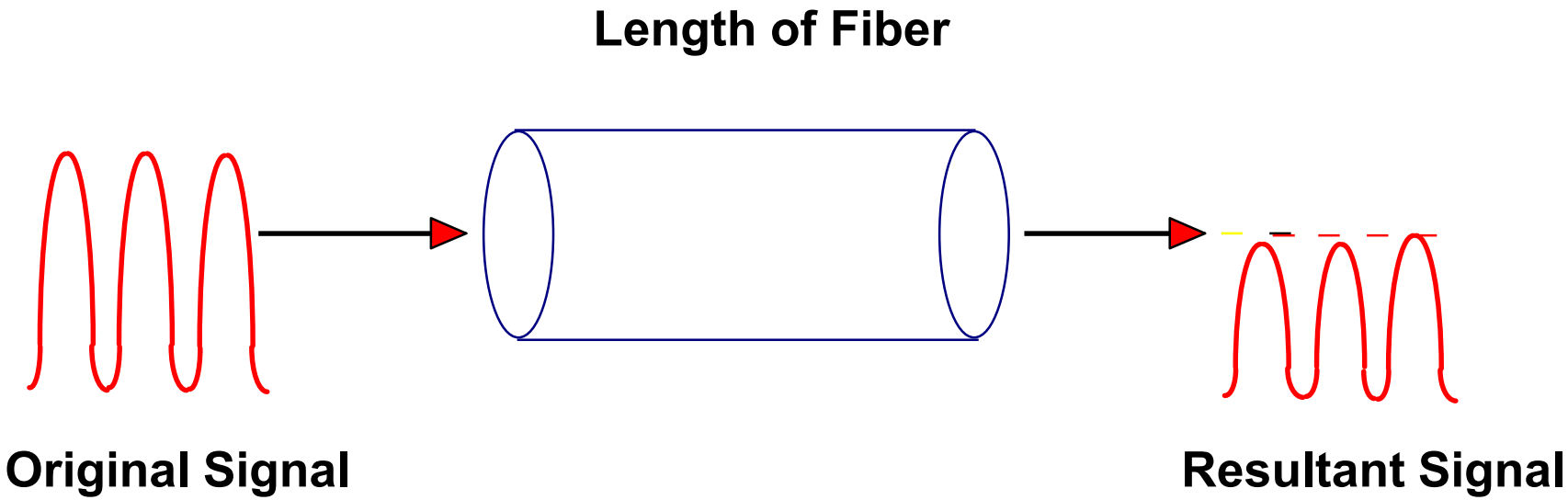


O band	original	1260–1360 nm
E band	extended	1360–1460 nm
S band	short wavelengths	1460–1530 nm
C band	conventional (“erbium window”)	1530–1565 nm
L band	long wavelengths	1565–1625 nm
U band	ultra long wavelengths	1625–1675 nm

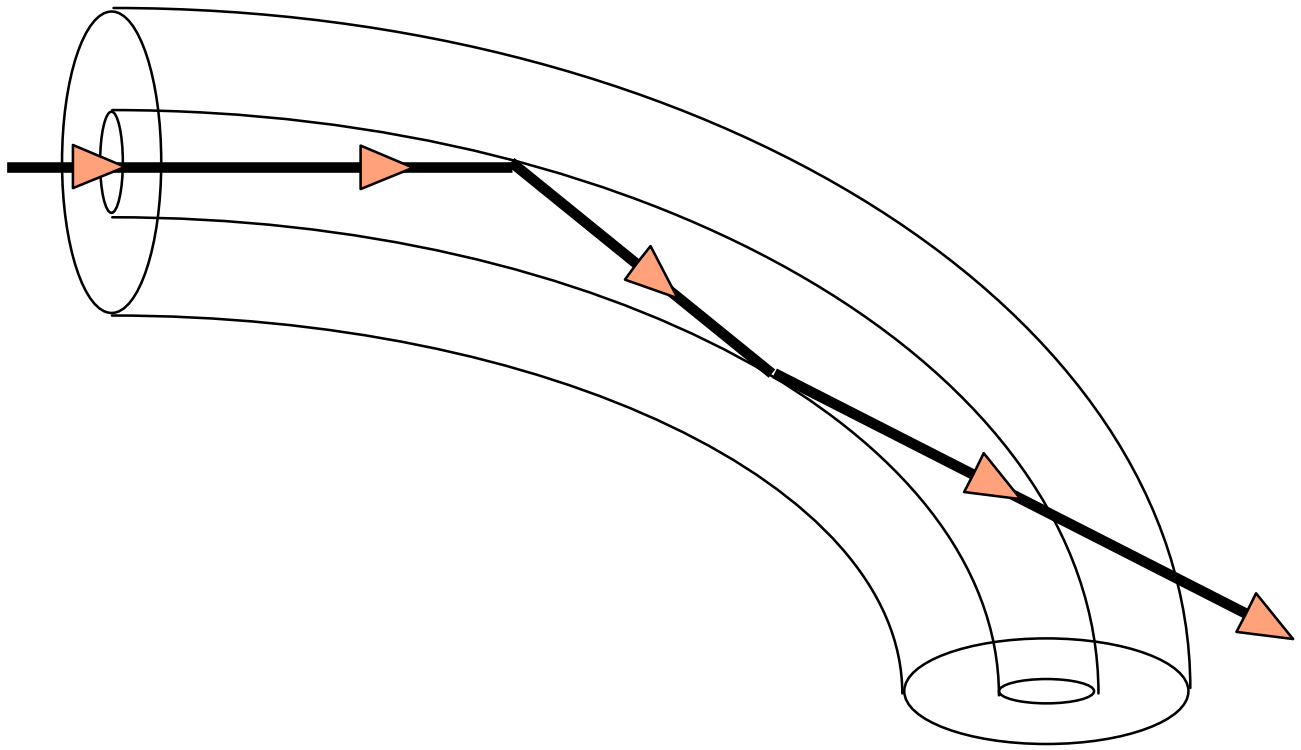
Attenuation

- Decrease in optical power
- Measured in decibels (dB)
- Limits the distance the signal travels
- Some attenuation inherent in glass
- Some attenuation can be induced by people and environment

Attenuation

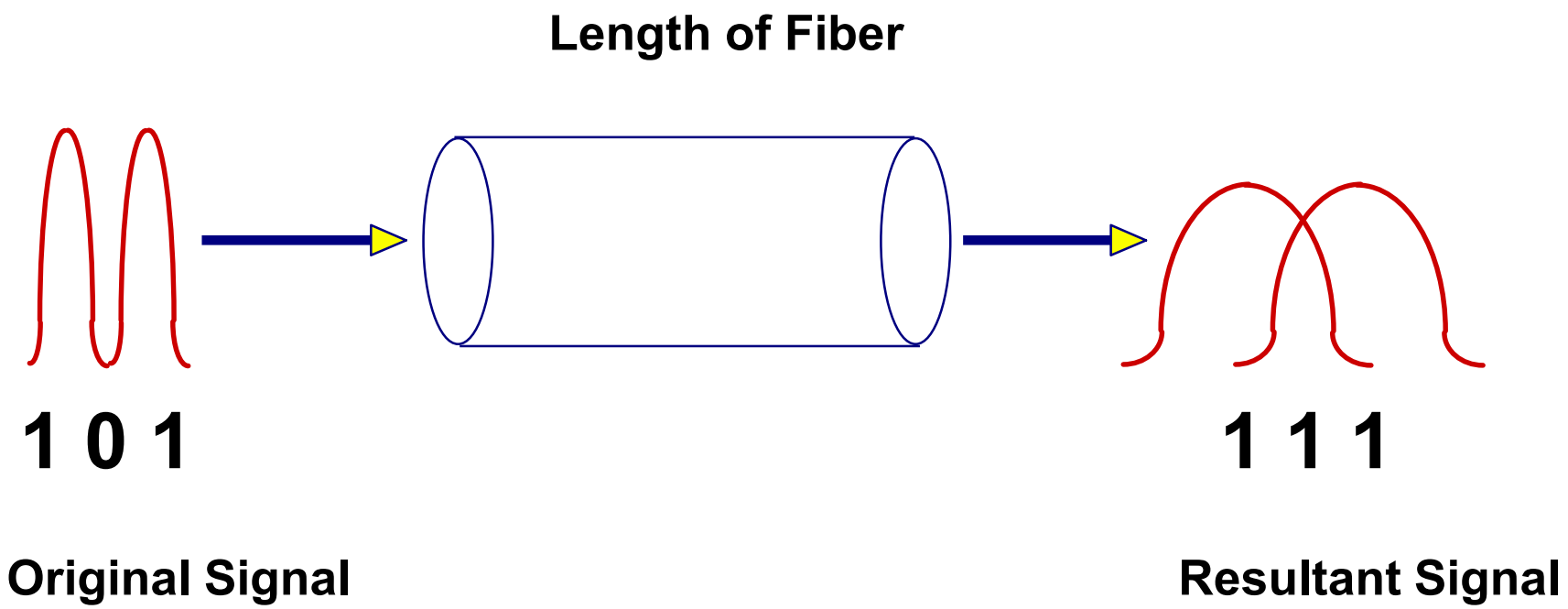


Extrinsic Attenuation—Macro-bend

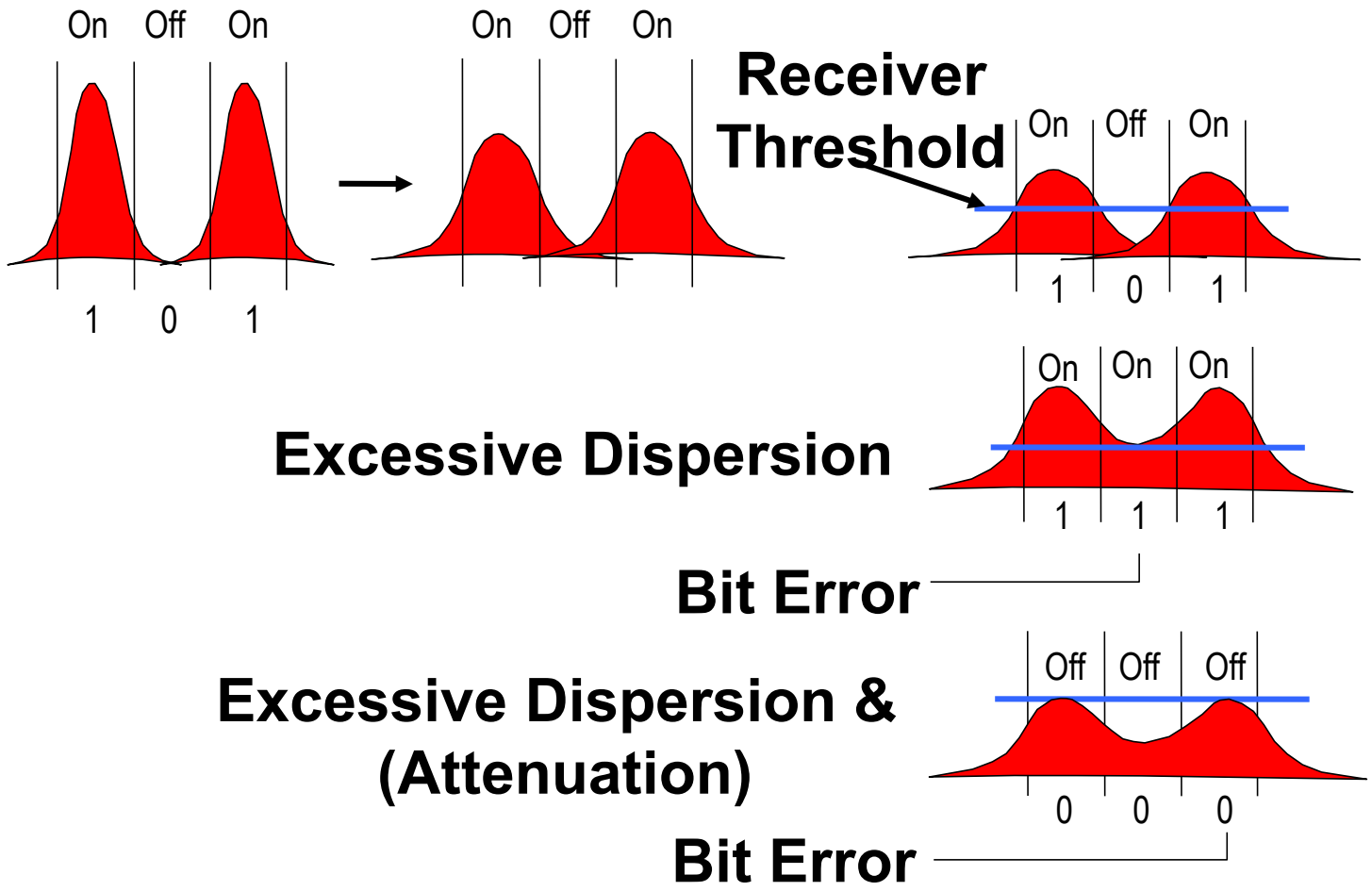


Dispersion

- Dispersion—Pulse spreading over distance

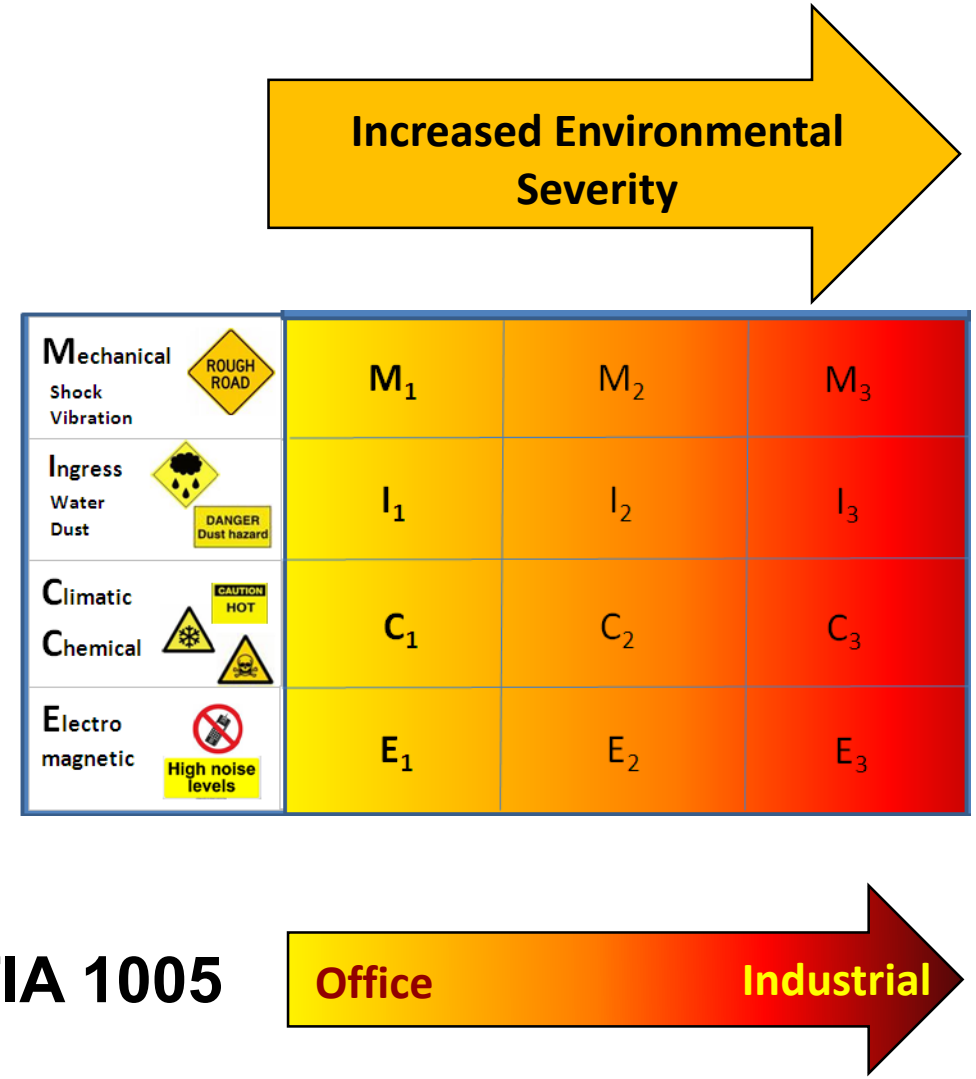


(Simplified) Signal Transmission



Environmental Focus – M.I.C.E.

OSI Layer 1- Physical Layer



- M.I.C.E. provides a method of categorizing the environmental classes for each plant Cell/Area Zone.
- The MICE environmental classification is a measure of product robustness:
  - Specified in ISO/IEC 24702
  - Part of TIA-1005 and ANSI/TIA-568-C.0 standards
- This provides for determination of the level of "hardening" required for the network media, connectors, pathways, devices and enclosures.
- Examples of rating:
  - 1585 Industrial Ethernet Media : $M_3I_3C_3E_3$
  - M12: $M_3I_3C_3E_3$
  - RJ-45: $M_1I_1C_2E_2$

Select best media for your needs

OSI Layer 1- Physical Layer

UTP vs. STP	**Unshielded Twisted Pair (UTP)**	**Shielded Twisted Pair (STP)**
	Costs less	Excellent immunity from EMI and RFI noise
	Installs faster	Can locate cable close to source of noise
	Smaller diameter, more flexible	Well suited for more rigorous environments
CAT5e vs. CAT6a	**CAT5e**	**CAT6a**
	Costs Less	Higher signal to noise ration; performance margins
	Suitable for speeds of less than a Gbps	Designed to deliver Gbps performance
Copper vs. Fiber	**Copper**	**Fiber**
	Termination and installation is faster	Cost of fiber transceivers is higher
	Less fragile	Use when excessive EMI noise is present
	Distances of less than 100m	Use when distance is a factor (over 100m)
Multi-mode vs. Single-mode Fiber	**Multi-mode**	**Single-mode**
	For distances of up to 550m @ 1Gbps and 2km @ 100 Mbps	Longer distances (up to 40km)
	Lower cost transceivers, connectors and installation	High bandwidth capabilities
	Higher fiber cost, but lower total system cost	Lower fiber cost, but higher total system cost

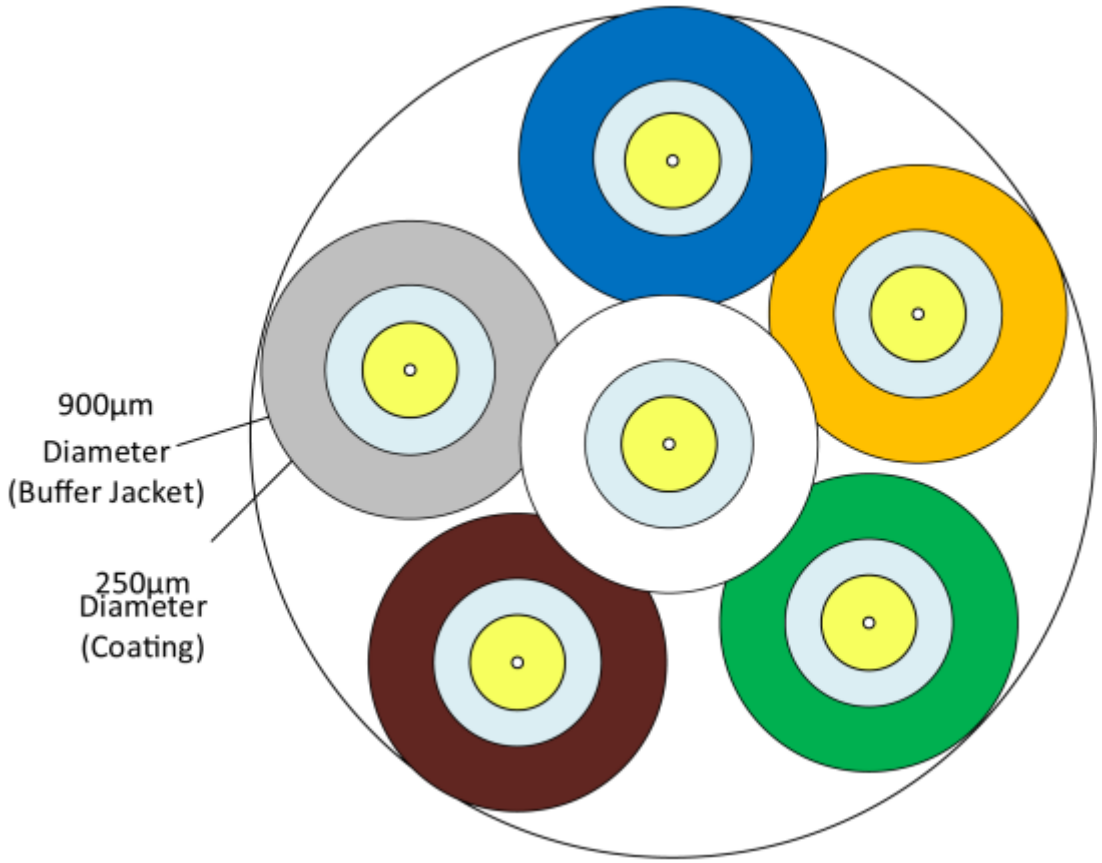
Fiber Types

Table 1 Maximum Distance for Currently Used Fiber Types and Designations

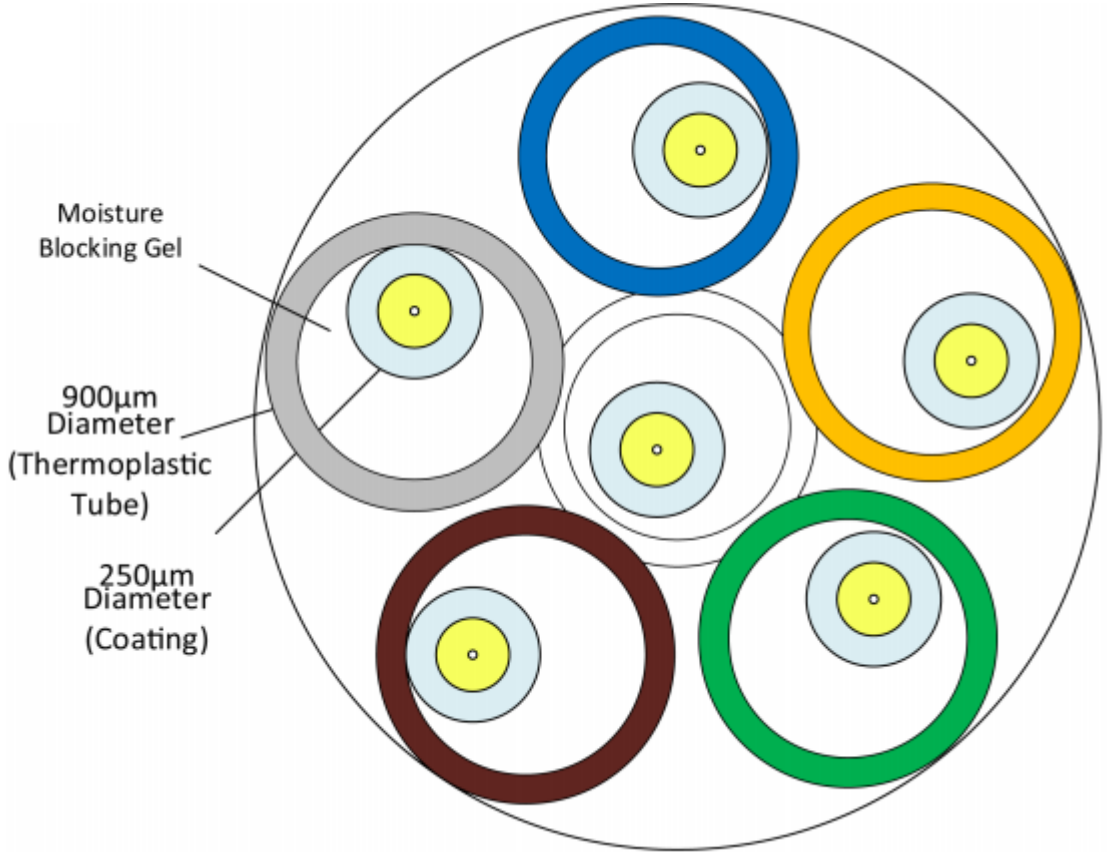
Designation	Core/Cladding Diameter	Fiber Type	100 Mbps Maximum Distance	1 Gbps Maximum Distance
OM1	62.5/125µm	Multimode	2000m	220m
OM2	50/125µm	Multimode	2000m	275m
OM3	50/125µm	Multimode	>2000m	500m
OM4	50/125µm	Multimode	>2000m	550m
OS2	9/125µm	Singlemode	10km	10km

Buffer Type

Tight Buffered

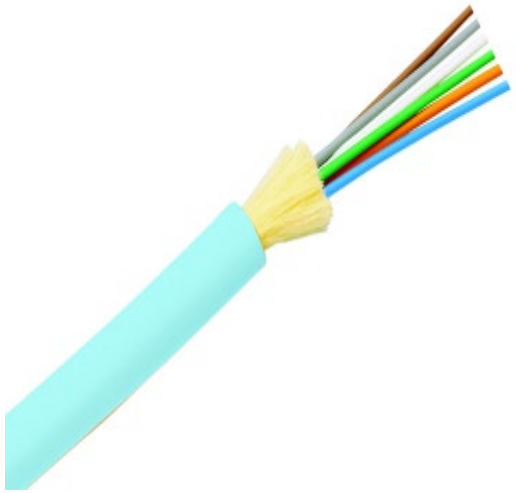


Loose Tube



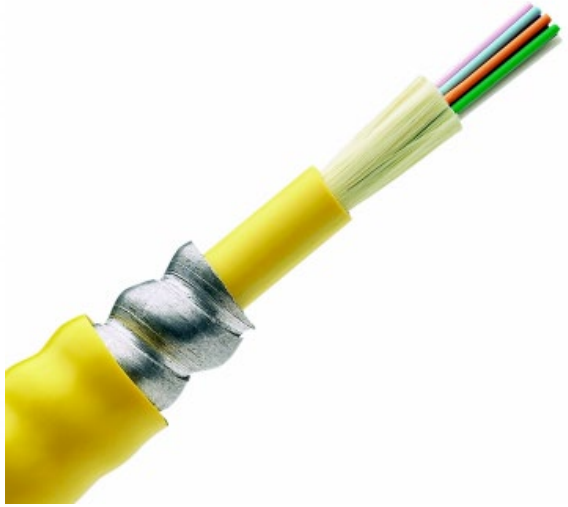
Multi Fiber Types

Distribution Fiber Optic Cabling



IP-rated Fiber Optic Cabling

Armored Fiber Optic Cabling



Dielectric Conduited Fiber Optic Cabling

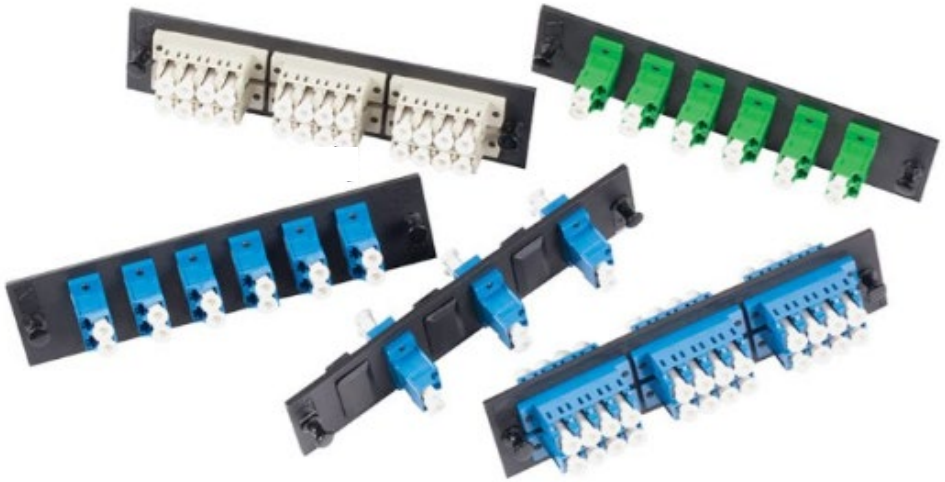
Loose Tube Fan-Out

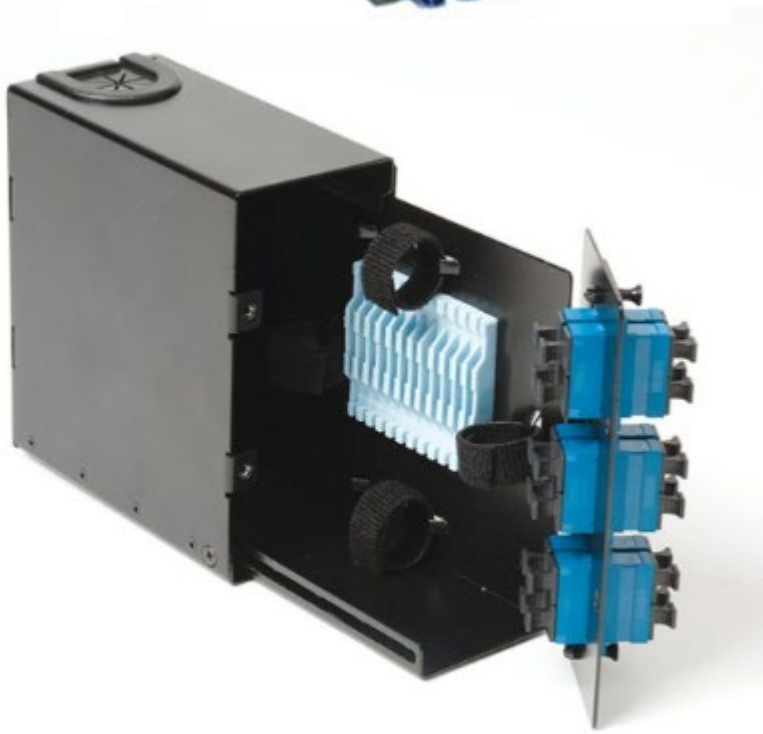
Used to terminate high density, small OD cables into multiple terminations

Connectors

	LC	SC	ST
Image			
Connector Name	Lucent or Little (LC)	Square or Subscriber (SC)	Straight Tip (ST)
Coupling Type	Snap	Snap (Push-Pull)	Bayonet
Connector Outside Dimensions, mm	4.5 x 4.5	9.0 x 8.3	Diameter 8.6
Ferrule size, mm	1.25	2.5	2.5
TIA Standard	TIA-604/FOCIS - 10	TIA-604/FOCIS - 3	TIA-604/FOCIS -2
IEC Standard	IEC 61754-20	IEC 61754-4	IEC 61754-2
Duplex Type	Yes, with duplexing clip	Yes. Connector can mate	No

Patching

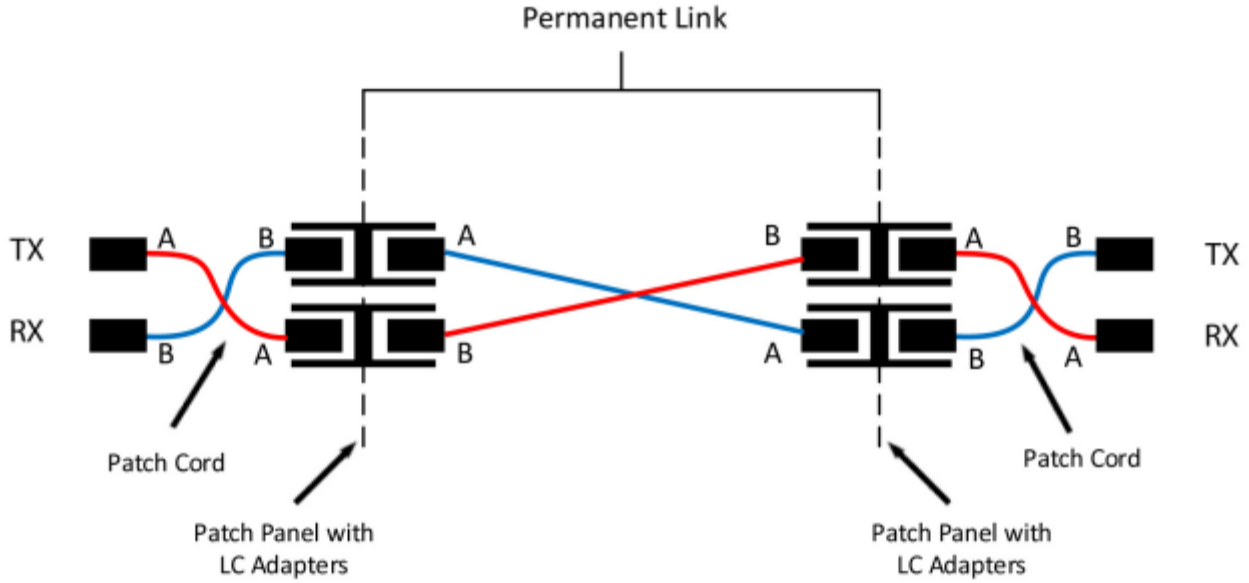




Connection Options

- Direct patch cable
  - Select a cable to connect directly to each end device

- Patch cable to patch panel
  - Select a patch cable to connect to first end device and the local patch panel
  - Select the bulk cable to connect the patch panels together
  - Select a patch cable to connect the second end device to the other patch panel



What is the limiting factor

Deciding factors on fiber patch cable selection

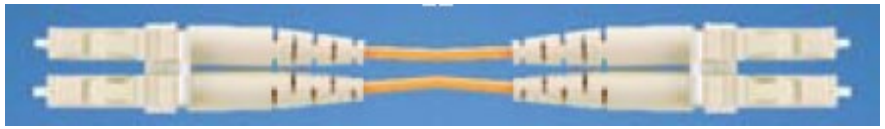
- Speed
- Length
- Embedded SFP (sets speed/fiber type/wavelength)
- Available fiber type in patch panel

Deciding factors on fiber back haul cable selection

- Speed
- Length
- End Device limitations
- Available fiber type in patch panel
- Environment that the fiber will be passing through
- Conduit, fiber duct, direct exposure

Examples

Etap to Stratix Switch



Etap
- Multimode
- LC
- 1310nm
- 100mb

Fiber
- LC on both ends
- Multimode

SFP
- LC

Must also match
- Multimode
- 1310nm
- 100mb

Examples

Etap to Stratix Switch
With patch panel

Fiber
- Existing OM3

Fiber
- LC on Etap end
- Multimode
- OM3

Fiber
- LC on SFP end
- Multimode
- OM3

SFP
- LC

Must also match
- Multimode
- 1310nm
- 100mb

Etap
- Multimode
- LC
- 1310nm
- 100mb

Patch panels
- Connection type can be various
- OM3 rating is required based on existing cable

Testing

Don’t assume

Post install tests

1. Visual with magnification
2. Visible light
3. Measure loss
4. OTDR

Our Partners made this presentation possible

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