Networking

Networking Fundamentals

1.3.2 - Fiber-Optic Cables

What is a fiber optic cable and what are the different standards and connectors?

Overview

The student will be able to summarize the types of cables and connectors and explain which is the appropriate type for a solution

Grade Level(s)

10, 11, 12

Cyber Connections

- Threats & Vulnerabilities
- Networks & Internet
- Hardware & Software

This content is based upon work supported by the US Department of Homeland Security's Cybersecurity & Infrastructure Security Agency under the Cybersecurity Education Training and Assistance Program (CETAP).

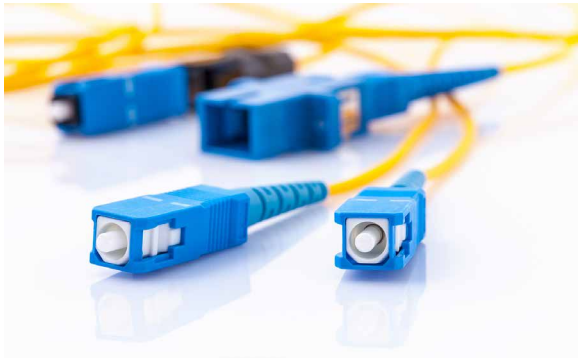
Teacher Notes:

CompTIA N10-008 Network+ Objectives

Objective 1.3

- Summarize the types of cables and connectors and explain which is the appropriate type for a solution
    - Fiber
        - Single-mode
        - Multimode
    - Ethernet Standards
        - Fiber
            - 100BASE-FX
            - 100BASE-SX
            - 1000BASE-SX
            - 1000BASE-LX
            - 10GBASE-SR
            - 10GBASE-LR
            - Coarse wavelength division multiplexing (CWDM)
            - Dense wavelength division multiplexing (DWDM)
            - Bidirectional wavelength division multiplexing (WDM)

Fiber-Optic Cables



A fiber-optic cable/connector

Fiber-optic cables and twisted pair ethernet cables are common networking cables but fiber-optic cables can transmit data at higher speeds and over longer distances. A ***fiber-optic cable*** transmits data via a digital light impulse rather than electrical currents (like a twisted pair cable). While a twisted pair cable has a copper core, fiber-optic cables have a glass or plastic core that reflect the light through the cable.

Teacher Notes:

Inside of a fiber-optic cable
Notice the glass core where the digital light impulses travel

While fiber-optics can transmit at higher speeds and for longer distances, there are drawbacks to them which is why twisted pair cables are still used. For example, fiber-optic cables are more expensive than twisted pair cables, especially if the core of the cable is made of glass. They are also more difficult to install and repair than twisted pair cables, and the equipment to install/repair is also more expensive, thus leading to the use twisted pair cables.

Single-Mode vs. Multimode

If the cable has 1 mode of light to propagate, this is known as a ***single-mode*** fiber-optic cable (SMF). ***Multimode*** fiber-optic cables (MMF) have multiple cores for multiple paths through the cable. While multimode has a higher bandwidth, since there are more paths and communication occurring, single-mode cables are more expensive since their cores are made from glass and they can transmit data at a faster rate. Single-mode cables are typically used in long transmissions since their signal can travel up to 50 times further than the multimode cables. Multimode cables still transmit further than twisted pair cables, but they are limited to around 400m.

One important note about single-mode and multimode cables is that they cannot interchange. Single-mode cables cannot interact with multimode cables and the same is true for the connectors.

Fiber-Optic Standards

Like the Ethernet Cable Standards set by the IEEE, there are also Fiber-Optic Standards set under the IEEE 802.3. Here are the 6 standards covered by CompTIA's Network+ exam:

Teacher Notes:

100BASE-FX – Standard set in 1995, the 100 signifies that data can travel up to 100 Mbps. This standard works with multimode fiber cables and can travel up to 2 km.

100BASE-SX – Standard set in 2000 with speeds up to 100 Mbps and works with multimode cables.

1000BASE-SX – Standard set in 1998 and has speeds up to 1 Gbps (1000 Mbps). This uses multimode cables and can travel up to 500 m.

1000BASE-LX – Standard set in 1998 with speeds up to 1 Gbps (1000 Mbps). This can use either single-mode or multimode cables where single-mode cables can travel up to 2,000 m and multimode cables up to 550 m.

10GBASE-SR – Standard set in 2002, can transmit data up to 10 Gbps. This uses multimode cables and can travel up to 300 m.

10GBASE-LR – Standard set in 2002 with data speeds up to 10 Gbps. This uses single-mode cables and can travel up to 10 kilometers (km).

Multiplexing

Bidirectional wavelength division multiplexing (WDM) is the ability to send multiple data/digital signals down one strand of fiber-optic cables by using different light wavelengths (aka different colors). This allows more data to be transmitted using one cable, thus reducing the number of cables needed to run between locations. Below is a chart that lists the two main WDM methods.

Multiplexing Method	Number of Channels	Max Distance	Wavelength Separation
Course Wavelength-Division Multiplexing (CWDM)	Up to 18	70 km	20nm apart
Dense Wavelength-Division Multiplexing (DWDM.	Up to 80	1000 m	0.8nm apart