Network + Section 5 - Media and Cabling Distribution

Copper Media

- Coaxial

Coaxial cable

Outside insulation — Insulation — Copper mesh — Copper wire
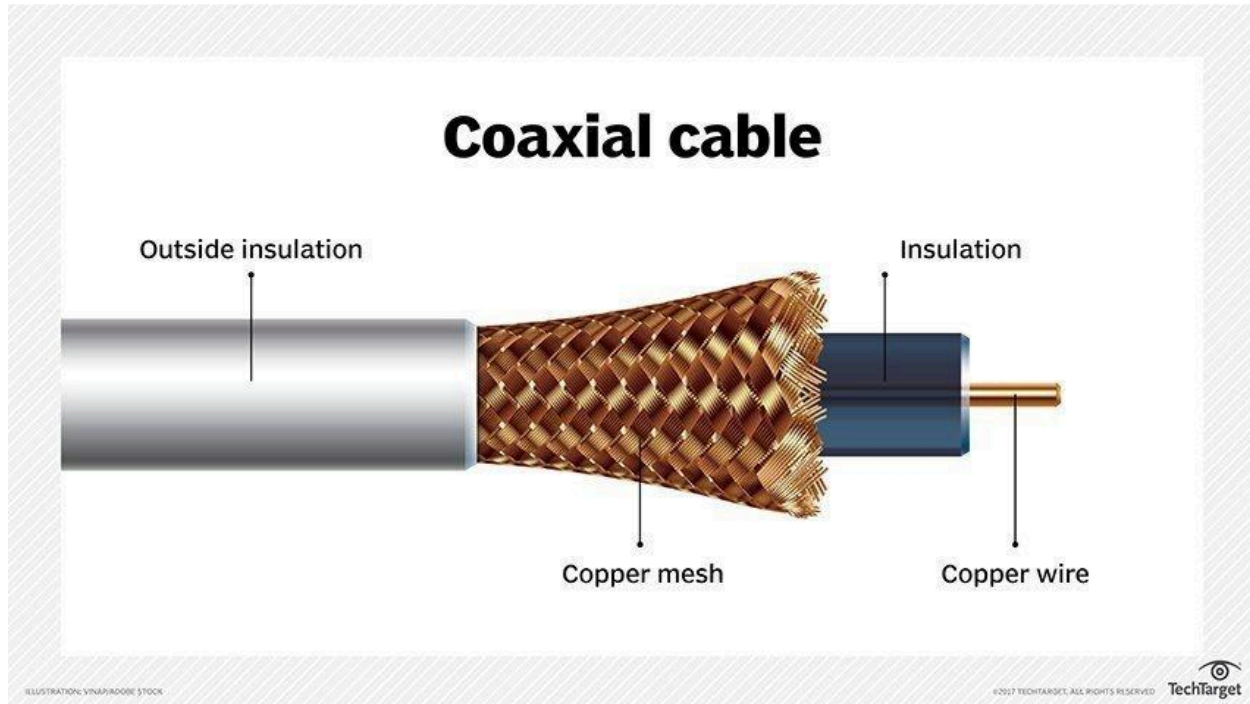
- ○ Braided Metal Shield helps shield it from any data transmission leakage. Coming from inside the cable outward.
  - ○ Center core all data will pass through.
  - ○ Where might coaxial cables be in modern networks?
    - ■ RG-6 - normally used by cable companies to connect their service to your home.
    - ■ RG-59 - going to carry composite video between two nearby devices or connect outlet to a cable modem. (Cable TV, or Satellite TV).
      - ● How do coaxial cables connect?
        - ○ F-Type - Screw on type of connector.
        - ○ BNC (Bayonet Neil Concelman connector, British Naval Connector) - used to be used heavily in early networking days. (10Base-2 or 10Base-5)
- Twinaxial Cable - Similar to coaxial cable but uses two inner conductors to carry the data instead of just one. Used for short range high speed connection.Not common in the workplace.
- Serial Cable - terminated with a DB-9 or DB-25 connector, Pins. Also known as RS-232. These cables are old, not common. May see if working with external ISDN modem, or a T1 or an E1 modem connection.

- Twisted Pair Cable - There are two variations
  - UTP - Unshielded twisted pair - Cheaper, no metal to cover the twisted pair.
  - STP - Shielded twisted pair - It's going to be wrapped in metal foil. This minimizes the EMI (Electromagnetic Interference) between the inner twisted pair.
  - STP and UTP operate about the same. Both have distance limitations.
- There are two types of connectors. RJ45 and RJ11
  - RJ45 is a plastic eight pin connector. Ethernet based network CAT 5, CAT6, CAT7. Reserved for data networks.
    - If you're using RJ45 with CAT5 it's only going to use four of the eight pins, reserved for power over ethernet.
  - RJ11 is a six pin connector. 2 pins are only going to be used. For phone networks.
- Registered Jack (RJ) - Used to carry voice or data which specifies the standards a device needs to meet to connect to the phone or data network. Telecommunication.
- Bandwidth - Theoretical measure of how much data could be transferred from a source to its destination.
- Throughput - Actual measure of how data transferred from a source to its destination.
  - Categories of twisted pair cabling
    - CAT3
    - CAT5 - TX stands for twisted pair, fast ethernet, only twisted pair network
    - CAT5e
    - CAT6
    - CAT6a
    - CAT7 - Can use RJ45 traditional style connector or different connector known as TERA.
    - CAT8

CAT 3 (Ethernet)	CAT 5 (Fast Ethernet)	CAT 5e (Gigabit Ethernet)
10BASE-T	100BASE-TX	1000BASE-T
10 Mbps	100 Mbps	1000 Mbps (1 Gbps)
100 meters	100 meters	100 meters

CAT 6	
1000BASE-T	10GBASE-T
1000 Mbps (1Gbps)	10 Gbps
100 meters	55 meters

CAT 6a
10GBASE-T
10 Gbps
100 meters

CAT 7
10GBASE-T
10 Gbps
100 meters

CAT 8
40GBASE-T
40 Gbps
30 meters

CATEGORY	STANDARD	BANDWIDTH	DISTANCE
CAT 3	10BASE-T	10Mbps	100 meters
CAT 5	100BASE-TX	100 Mbps	100 meters
CAT 5e	1000BASE-T	1000 Mbps	100 meters
CAT 6	1000BASE-T/ 10-GBASE-T	1000/Mbps/10 Gbps	100 meters/ 55 meters
CAT 6a	10GBASE-T	10 Gbps	100 meters
CAT 7	10GBASE-T	10 Gbps	100 meters
CAT 8	40GBASE-T	40 Gbps	30 meters

- Keep cable runs under 70 meters from the IDF to the office.
- On the exam
  - Able to troubleshoot common cable connectivity issues using the appropriate tools.

- Straight-Through Cable (Patch Cable) - Contains the exact same pinout on both ends of the cable.
    - 568B are cables normally used for wiring jacks inside your building.
    - If counting pins from one to eight, orange white, orange, green white, blue, blue white, green, brown white, brown.
    - These patch cables are used to connect a DTE to a DCE.
        - Data Terminal Equipment (DTE) - "Endpoint" devices that connect to a piece of data communications equipment or DCE (e.g. laptops, desktops, servers, and routers).
        - Data Communications Equipment (DCE) - Includes things like switches, modems, hubs, and bridges.
        - Straight-through, DTE to DCE, DCEto DTE
        - Crossover, DTE to DTE, DCE to DCE
- Crossover Cable - Swaps the send and receive pins on the other end of the cable when the connector and its pinout are created.
    - On one end 568A on the other end 568B.
    - Used to connect workstation to workstation, or switch to switch.
    - For the exam, a switch to a switch connection requires a crossover cable.
    - Most modern switches use something known as MDIX medium dependent interface crossover.
        - Medium Dependant Interface Crossover (MDIX) - An Automated way to electronically stimulate a crossover cable connector even if using a straight-through patch cable.
        - For exam, If a switch doesn't support MDIX, use a crossover cable to make them talk.
- 568B is the standard we use for all interior wiring.
- For crossover cable it'll be 568B on one end and 568A on the other.
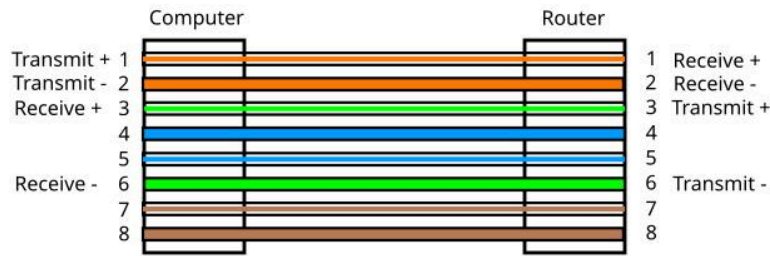
Straight Through Cable
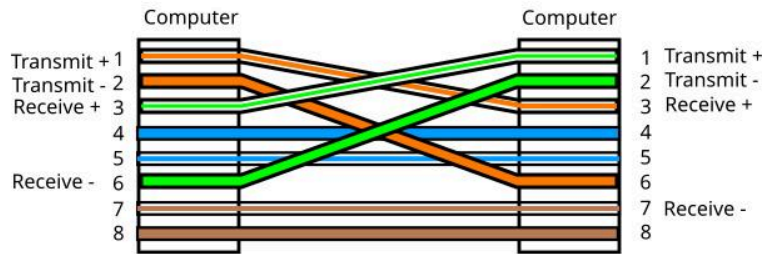
Crossover Cable

- Plenum Cable - A special coating put on a UTP or an STP cable that provides a fire-retardant chemical layer to the outer insulating jacket.
  - For exam, Plenum cables are for ceilings, walls, raised floors, or air ducts.

Fiber Media

- Fiber Optic Cable - Uses light from a light-emitting diode (LED) or laser to transmit information through a thin glass fiber.
  - Immune to electromagnetic interference (EMI).
  - Can travel wide distances, hundreds of miles, not much attenuation or signal loss.
  - Greater usable range.
  - Greater data capacity. Terabits per second.
- Drawbacks of working Fiber
  - Expensive. Costs 10 to 5 times more than copper cable.
  - Difficult to work with. Requires special tools and training to work with.
- Categorize fiber optic cables
  - Single Mode Fiber (SMF) - Used for longer distances and has smaller core size which allows for only a single mode of travel for the light signal.
    - SMF's core size is 8.3-10 microns in diameter.
    - More precise signal transmission.
  - Multimode Fiber (MMF) - Used for shorter distances and has larger core size which allows for multiple modes of travel for the light signal.
    - MMF's core size is 50-100 microns in diameter.
    - Up to 2kms or less. Shorter distance.

| MMF	SMF
Larger core size	Smaller core size
Covers shorter distances	Covers longer distances
Less expensive	More expensive

- There are 4 different types of connectors to plug them into your devices. SC, ST, LC, MTRJ.
  - SC - Subscriber Connector - "Stick and Click". Square connector. When connected into a network jack or wall jack going to hear a click.

- ST - Straight Tip Connector "Stick and Twist". ST is the older type. SC, it has a transmit and receiver cable. Insert it and half twist to the right until it locks in place.


- LC Lucent Connector "Love Connector". Newer version of SC connector. Uses a stick and click connection. It transmits and receives sides attached side-by-side like lovers.
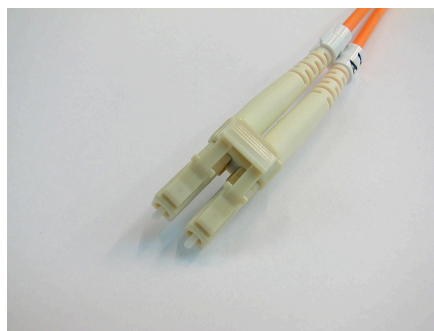
- MTRG Mechanical Transfer Registered Jack. It's a fiber optic connector. Widely used from networking devices. Smaller form factor. Each MTRJ connector is going to have both the transmit and receive pins terminate inside a single target connector. Half the size of all the other connectors. Can be used in a fiber switch panel. On the other side of the connection it will convert to an LC, ST, SC.
- Angled Physical Contact (APC) Connector - The fiber end face is posted at an eight degree angle. Light is reflected light into an angle into the clouding of the cable. Better signal with less noise. SC will use this. Green connector APC.
- Ultra Physical Contact (UPC) Connector - No angling. Instead it has more of a curvature for better core alignment. Reflected light is going to be reelected straight back down and towards the light source and creates more noise and causes a bit of signal loss. MTRJ will use UPC. Clue connector UPC.
- Wavelength Division Multiplexing (WDM) - Combines multiple signals into one signal and sends over a single fiber optic strand using different wavelengths of the laser light source.
  - Allows multiple signals to be combined into one signal, then sent over a single fiber optic strand using different wavelengths for the laser light source.
  - MUX Multiplexer, DEMUX Demultiplexer.

wavelength-division multiplexing (WDM)
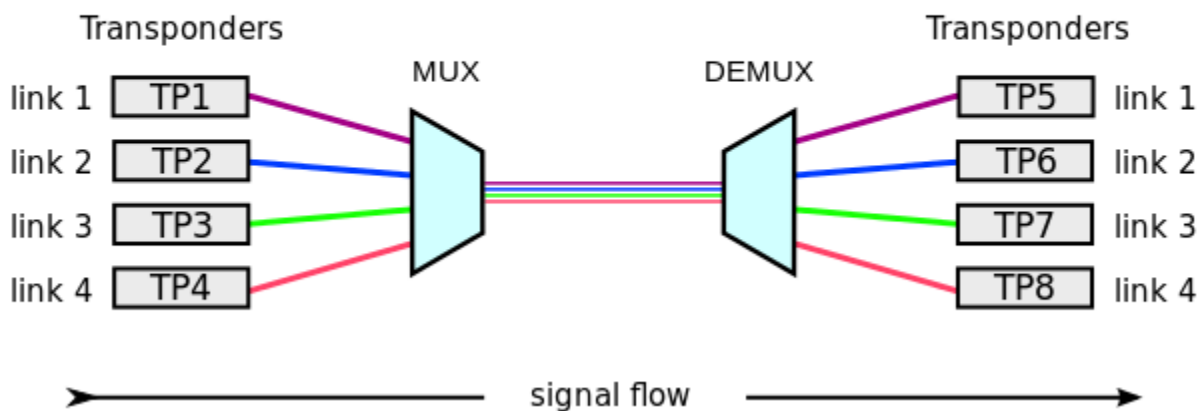
- Run over single mode fibers. There are a few WDM that can run over multimode.
- There are two types of WDM.
  - CWDM - Coarse Wavelength Division Multiplexing. Shorter distances, 40 kilometers up to 70 kilometers. 10 gigabits per second ethernet up to 16 gigabits per second for fiber channel. Sometimes used to connect routers and switches, using GBIC and SFF transceivers.
  - DWDM - Dense Wavelength Division Multiplexing. Over a single fiber. Used to transport data over longer distances. Connections get amplified going across cable. Major IPSs and Telecommunication service providers use this. SONET systems.

	Coarse WDM	Dense WDM (DWDM)
Wavelength Channels	Up to 18 channels	Up to 80 channels
Channel Distance	20nm	0.8nm
Speed	Up to 10 Gbps (Ethernet) Up to 16 Gbps (Fiber)	Up to 8 Tbps (100 Gbps/channel)

Transceivers

- Four main areas of copper fiber.
    - Bandwidth
    - Distance
    - EMI immunity
    - Security
- Fiber optic cables can go at least 40+ kms and can carry speeds of 60 or 70 Tbps or more.
- Copper cables can only go up to 100 meters and can carry speeds up to 10 Gbps. Newer cables can reach up to 25 - 45 gigabits per second but can only go 30 meters.
- The benefits of using fiber outweighs copper cabling's limitations.
- Media Converter/Transceiver - Converts media from one format to another. Layer 1 device.
    - They conduct Layer one to Layer one conversions.
    - Fiber to copper or coaxial the fiber or fiber to coaxial or any other layer one to layer one conversion.
- Bidirectional - Knows as half-duplex communication where devices must take turns to communicate. Think of a walkie talkie.
- Duplex - Known as full duplex communication where devices are able to communicate at the same time.
- GBIC - Standard Hot-pluggable gigabit Ethernet transceiver that can take in copper or fiber as its connector.
- SFP - Small Form-factor Pluggable - smaller module than a GBIC, and it's compact and hot pluggable using an optical module that can be used with fiber connections. SFP can also be called GBIC.

Transciever	Speed
Small form-factor pluggable (SFP)	Up to 4.2 Gbps
SFP+	Up to 16 Gbps
Quad small form-factor pluggable (QSFP)	Up to 40 Gbps
QSFP+	Up to 41.2 Gbps

QSFP28	Up to 100 Gbps
QSFP56	Up to 200 Gbps

Cable Distribution

- Cable Distribution System - An organized system that connects the network's backbone in the MDF to the IDF and finally to the end user's wall jacks.
    - Should be hierarchical in structure.
- Demarcation Point - Where the Internet service provider's connection ends and your network begins.
- Backbone Switch - Connects to everything on the network.
    - Example - 24 port switch.
    - Edge switches are closer to the end-users and are going to connect up-stream back to the backbone switch.
- Main Distribution Frame (MDF) - A telecommunications closet which serves as the main starting point for all interior cabling.
- Cable Tray - A unit or assembly of units that form a rigid structural system to securely support the cables and raceways.
    - Cables move horizontally and vertically and this is done in cable trays.
    - Usually located inside of a drop ceiling or under a raised floor.
    - Minimize the number of cables that have to cross floors vertically.
    - Should be used for trunk cables to connect the main distribution frame and it's backbone router and switch.
- Intermediate Distribution Frame (IDF) - Contains an edge switch, a patch panel, and other associated equipment to support the floor and offices nearest to it.
    - Small to medium sized offices may contain one IDF but larger organization may contain multiple IDFs per floor.
- Punch down blocks - Usually located in your MDF.
    - 66 Block (M Block) - Used in older analog telephone systems and older CAT3 networks and supports a 25-pair cable that would run to the MDF or IDF.
    - 110 Block - Supports high speed data networks for CAT 5 and above and include the use of insulation displacement contract connectors.
        - Exclusively used in American style networks and patch panels.
        - Supports high speed cabling, CAT 5 and above.
        - Specialized punch down tool is used for punch blocks. Blade is used to push twisted pair cable down onto the teeth of the block and then cut off excess cable.
    - Krone Block - Proprietary European alternative to 110 block.
        - Developed by a German telecommunications company.
        - Requires specific tools.

- ○ BIX Block - Another proprietary punch down block which is available in various sizes.
    - ■ Requires specific tool.
- ○ You will usually see 110 block.
- ● Patch Panel - Keeps a data center or server room organized by making it easy to move, add, or change a cable distribution infrastructure.
    - ○ Patch panel will have 2 sides. One with network jacks, and the other you will find 110 block punch down blocks.
    - ○ Patch panels are inexpensive.
    - ○ Good for network management and prevents damage to more expensive equipment like switches.
    - ○ Fiber distribution panels convert fiber connections from one type to another.
        - ■ No punch down block for fiber. Use fiber connectors like LC, ST, SC, and MTRJ.