A Preview of the Computer Networking for Broadcast Engineers Course

About the Author

This course was written for SBE by Paul Claxton, CPBE, CBNT. Mr. Claxton is a retired US Navy Master Chief Petty Officer and has been an SBE member for more than ten years. He is active in the Society as current and past SBE chapter 131 chairperson and certification chairperson for his chapter. He holds certifications from Novell, Microsoft, CompTIA, and SANS in various computer networking, security, and administration areas and has presented IT subject papers at the NAB's engineering sessions. Currently, Mr. Claxton is employed at the American Forces Network Broadcast Center in Riverside, California as an IT management specialist and project engineer.

Course Description

The purpose of this course is to give the student an introduction to the fundamental concepts of computer networking. The course will cover computer topologies (both physical and logical), media types, the OSI model, and local area networking. It will cover some legacy material but is primarily about Ethernet, TCP/IP and other current computer networking protocols. Hardware such as switches and routers will be covered and software such as VLAN, VPN, and NAT as well. Some basic troubleshooting, security, and administrative procedures will also be reviewed. The course is meant as an introduction, covering many subjects at a high level in order to assist the broadcaster in passing the Certified Broadcast Networking Technologist exam. There are several quiz questions at the end of each chapter to help the student ensure he/she understands the material.

Course Content

1. Introduction
2. Physical Media: Copper, Wiring Standards Fiber, Optic, RF and Connectors
3. Physical Network Topologies: Bus, Ring, Star, Mesh, Cellular and Hybrid
4. Logical Network Topologies: Bus and Ring and Connection Types
5. The Open Systems Interconnection Model and Data Encapsulation
6. Introduction to Network Devices: Repeaters, Transceivers, Hubs, Switches, Routers and Spanning Tree Protocol
7. Ethernet and Network Interface Cards
8. Internet Protocols (IP), Addressing and Subnetting, and DNS Servers
9. Routing and Route Discovery, and Network Address Translation
10. Troubleshooting Procedures, Hardware and Software Tools and Equipment
11. Virtual Local Area Networks (VLANs) and Virtual Private Networks (VPNs)
12. Security Principles
13. Data Backup
14. Documentation
15. Glossary

SBE Recertification Credit

The completion of a course through SBE University qualifies for 1 credit, identified under Category I of the Recertification Schedule for SBE Certifications.

Enrollment Information

SBE Member Price:	$99
Non-Member Price:	$169

Physical Media: Copper, Wiring Standards Fiber, Optic, RF, and Connectors

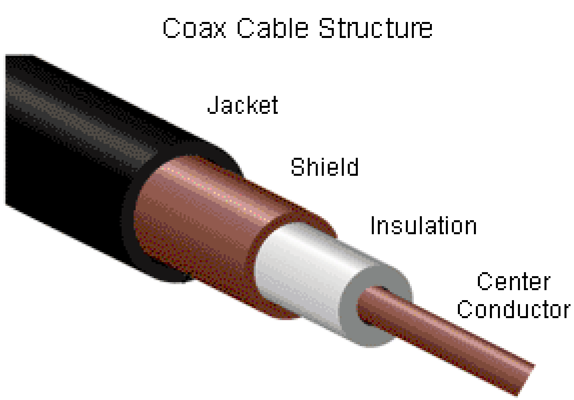
The fundamental purpose of a network is to link computer nodes together so that they can communicate and share information with each other. Copper wire, fiber optic cable, and radio frequency waves can be used to connect the many different types of nodes together. Copper cables come in many types including coaxial, twisted pair, USB, serial, and parallel types.

There are several types of connectors used and a couple of wiring standards in use which will be covered. Network signals are sent at radio frequencies so many of the principles of RF cable are used in networking.

Physical Media: Copper

Coaxial Cable

Coaxial cable is one of the oldest methods of connecting computer network nodes together. The network cables are similar in construction to video cables but are of 50 ohm construction. Either RG-58A/U or RG-8 cable is used in thinnet and thicknet applications. Like other types of copper cables the outside plastic jacket can be constructed of PVC or Teflon-type covering. PVC cabling is not plenum rated and where that is a concern the low smoke Teflon-type or other plenum rated cabling must be used. Coax cable is relatively rugged but its larger and can be more difficult to work with than other types of copper cables. The standard connector for coax cable is a BNC. Coax cable networks sizes are limited due to the high cable losses. One caution broadcasters that still use coaxial cable for networking is to avoid mixing the computer network's 50 ohm cable and connectors with RF's 75 ohm cable and connectors.

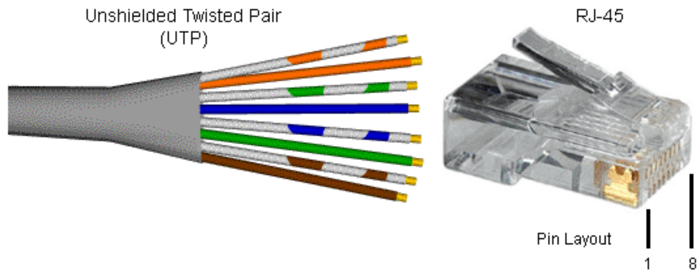


Twisted Pair

A second type of copper cable is twisted pair where individual wires are twisted together at a precise rate and bundled together inside a common cable. There are shielded twisted pair (STP) and unshielded twisted pair (UTP) varieties. Advances in cable technology have allowed for speed increases across twisted pair cables. The original speed of cable was 10 megabits per second and now 100 megabit and 1000 megabit (gigabit) twisted cables are common with distances limited to 100 meters. Twisted pair is expected to suit 10 Gbit/s rates over short distances. Twisted pair can support Ethernet, token ring, ISDN, and ATM. There is a 100 meter limit on distances between active nodes. The standard connector for twisted pair cable is an RJ-45.

The IEEE has set standards of twisted cable which are often referred to their category name with category 5 and 6 in common use today.

- Category 1 - Pre-1983 not suited for network
- Category 2 - 4 Mbps
- Category 3 - 4 twisted pairs for 10 Mbps
- Category 4 - 20 MHz
- Category 5 - 100 Mbps
- Category 5e (enhanced) - Gigabit Ethernet
- Category 6 - Gigabit Ethernet

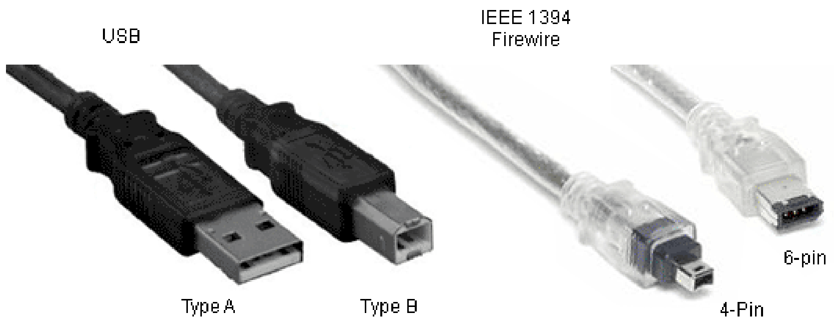


With category 5 and 6 cabling special care must be taken when handling and "pulling" cable to not put excessive stress or kinks into the cabling. No network cable should be abused but gigabit Ethernet is especially sensitive and cable should be laid into place rather than pulled whenever possible. Maintaining the twist ratios throughout the entire length of the cable is required including inside the connector and connector boot. As an example with category 5 twisted cables there can be no more than half an inch of untwisted wire. Current installation techniques avoid the use of traditional wire ties and hook-and-loop straps are used instead.

Twisted pair cable is cheap, easy to work with, and fast making it commonly used in broadcasting network applications. Network interface cards for twisted pair are commonly included on motherboards by manufacturers. The cables are susceptible to radio frequency interference (RFI) so they should be installed with distance between them and power or other signal cables. Shielded twisted pair cables include a foil shielding to help reduce EMI/RFI and cross-talk concerns but are more expensive and slightly more difficult to install.

Other Copper Cables

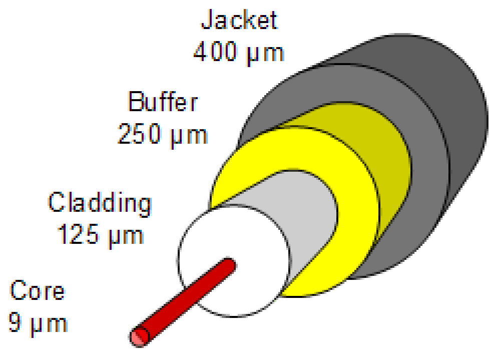
Other copper cables found in use include serial and parallel cables, USB, and IEEE 1394 "FireWire". Serial cables often use the RS-232 standard and D-subminiature 9-pin or 25-pin connectors to interconnect devices together. Parallel cables use DB-25 or 36-pin "Centronics" connectors and were often used to connect personal computers to printers. The parallel port is considered legacy in most applications having been replaced by the Universal Serial Bus (USB). USB cables use several different connectors of various sizes with the type A, type B, and their mini- and mico- types being the most popular. USB comes in four speeds: 1.5 Mbit/sec, 12 Mbit/sec, 480 Mbit/sec, and 4.8 Gbit/sec with the 480 Mbit/sec USB 2.0 being the most popular. IEEE 1394 "FireWire" use two different connectors and have data rates of 400 Mbit/sec, 800 Mbit/sec, 1.6 Gbit/sec, and 3.2 Gbit/sec.



Physical Media: Fiber Optics (or Fibre Optics)

Fiber optic cable uses very thin strands of special glass to send visible or infrared colors of light signals between nodes. Fiber optic cables allow the transmission of signals over great distances due to low losses which can be as low as 0.3 dB per kilometer or 0.5 dB per mile. Another benefit of fiber optic cable is that it is immune to both RFI and EMI interference. Fiber optic cable comes in two broad types: single mode and multi-mode. Single mode fiber cables have finer core diameters and are generally used for longer runs runs. Multi-mode cables have larger core diameters and are generally used for shorter cable runs. Often multiple strands of fibers are bundled together inside a protective jacket.

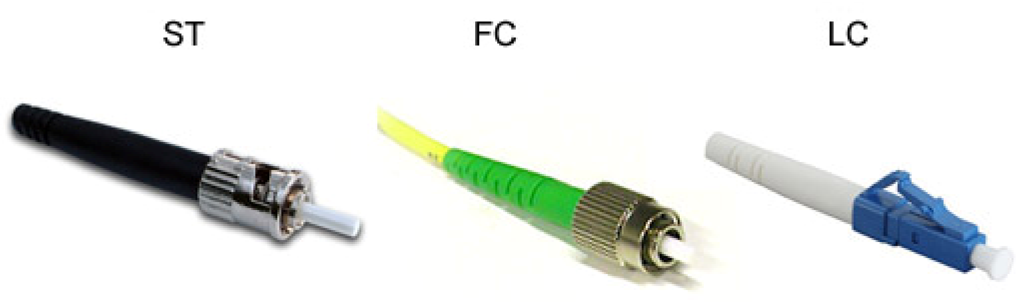
Typical Single Mode Fiber Structure



Caution must be used when working with fiber optic cables as their bending radius is limited so sharp turns, bends, and kinks must be avoided. It is common practice to run fiber optic cables inside of protective innerduct when running cables through a plant or even between equipment racks. The laser light sources for single mode cable can be very powerful and care must be taken to avoid exposing the unprotected eye to the light source. Never look into the end of a single mode fiber optic cable. When preparing connectors care must be taken with the very sharp glass core which can penetrate the skin or eye.

There are many types of fiber optic connectors with about 12 of them in common use including the common ST, SC, FC, LC, FDDI, MT-RJ, and Opti-jack connectors.

Fiber Optic Connectors



Fiber optic cables allow for sending signals great distances and provide good security. The initial expense of the cable and installation can be higher than with copper as fiber optic network cards are normally added in as riser cards to the motherboards in personal computers. Test equipment is more expensive and terminating and splicing for fiber optic cables is more expensive and time consuming than the copper cable counterparts.

Which physical media offers high speeds over the longest distances?

- [ ] Coax
- [ ] Twisted Pair
- [ ] Fiber Optic
- [ ] RF

Which physical media is normally not found in the production or automation system?

- [ ] Coax
- [ ] Twisted Pair
- [ ] Fiber Optic
- [ ] RF