

NET 363

Introduction to LANs

Transmission Media

Greg Brewster
DePaul University

Ethernet Physical Standards

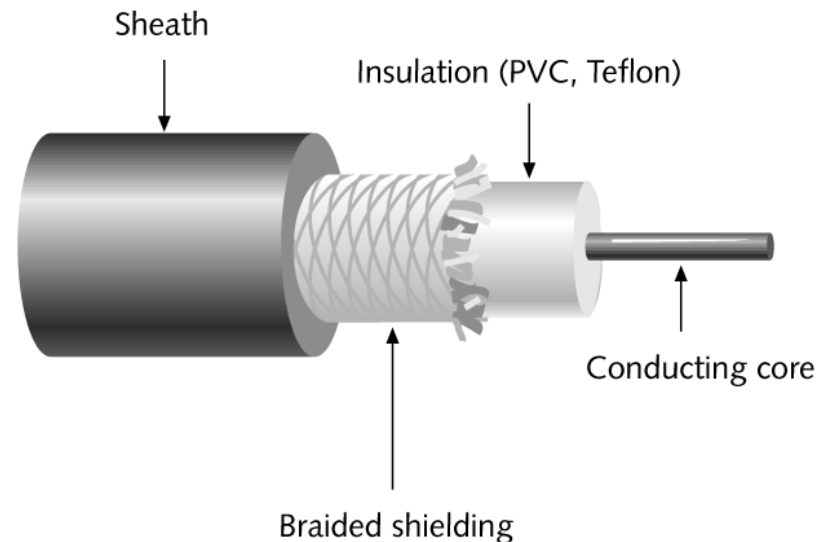
- Wired Ethernet can run over different types of physical cables (copper wire, coaxial cable, optical fiber) at various transmission rates (10 Mbps, 100 Mbps, 1 Gbps, 10 Gbps, 100 Gbps, 400 Gbps)
 - For each (cable type, data rate) pair, there is a unique Physical Ethernet standard defined by the IEEE 802.3 committee
- Wireless (Wi-Fi) Ethernet can run over 2 different frequency bands (2.4 GHz and 5 GHz) at various transmission rates as defined by the IEEE 802.11 committee.

Wired Ethernet Cabling

- Coaxial Cable
 - Widely used in 1980s, but not today
 - Expensive, difficult to manage
- Twisted Copper Pair
 - Least expensive
 - Limited distance - typically max. 100 meters (330 feet)
 - Susceptible to electromagnetic noise
- Fiber Optic Cable
 - Most expensive
 - Longest distance – possibly up to 60 miles
 - Highest bandwidth

Network Cabling

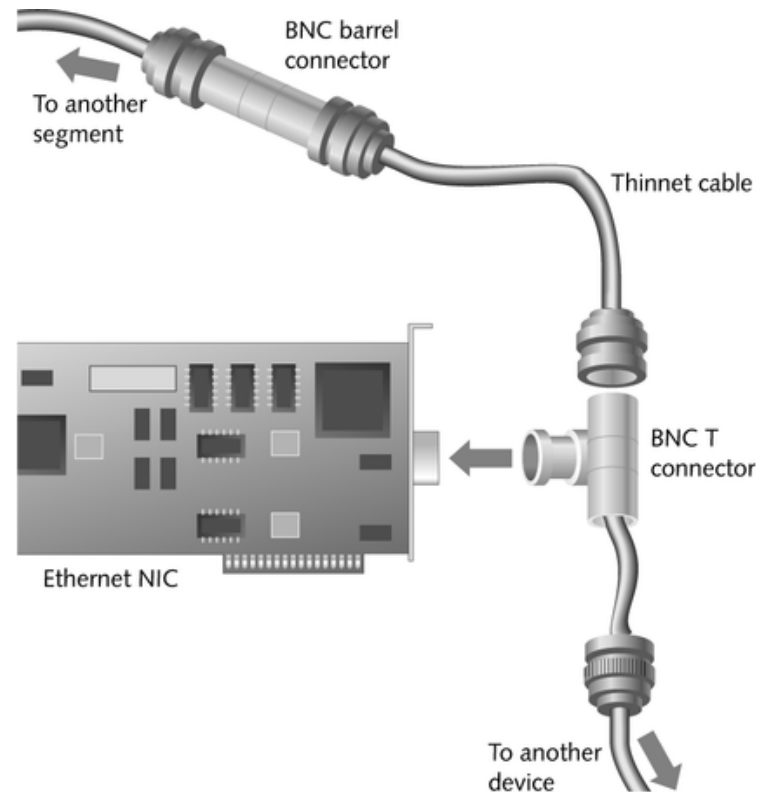
- Coaxial Cable
 - Central copper core surrounded by an insulator
 - **Braiding** insulates coaxial cable
 - **Sheath** is the outer cover of a cable
 - Foundation for Ethernet network in the 1980s



Network Cabling

Thinnet (10Base2)

- Also known as thin Ethernet, was most popular medium for Ethernet LANs in the 1980s



Network Cabling

- Twisted-Pair (TP) Cable
 - Consists of color-coded pairs of insulated copper wires twisted around each other and encased in plastic coating
 - Twists help reduce effects of **crosstalk**, interference caused by signals traveling on nearby wire pairs infringing on another pair's signals

Ethernet Cabling

- Twisted pair copper wire cables used for Ethernet always contain 8 wires twisted into 4 pairs. The wire colors are standardized as shown.

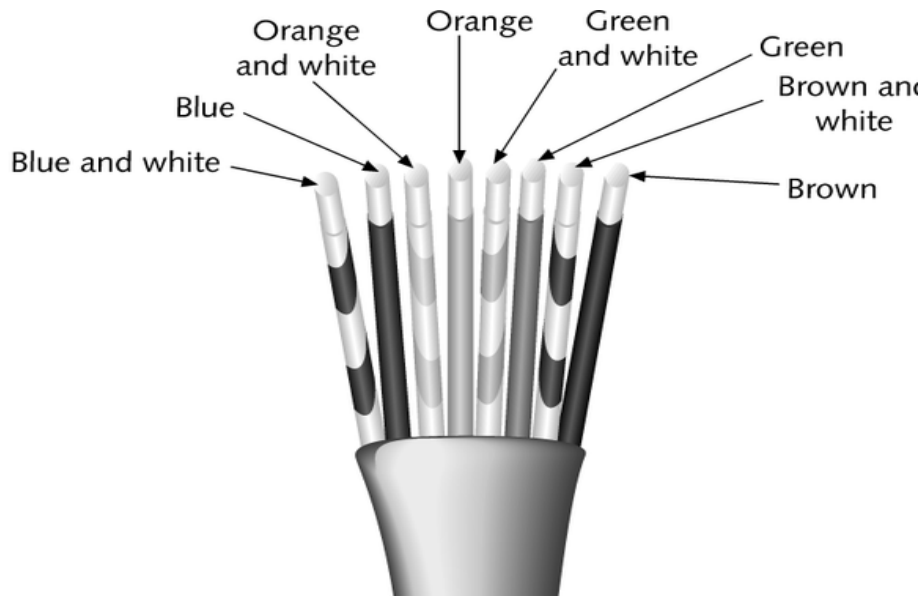
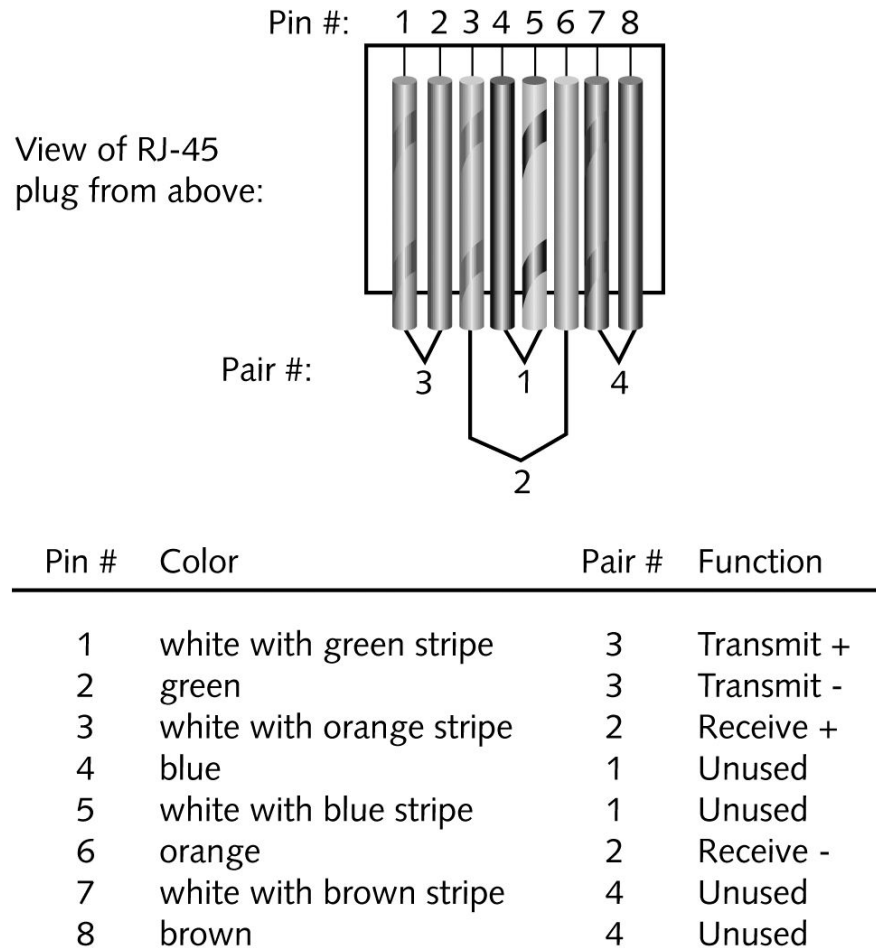


Figure 4-13
CAT5 UTP
cable

Twisted Pair wire terminations



End-user equipment (PCs, servers, printers, etc) and routers transmit on pins 1-2 and receive on pins 3-6

Hubs and switches transmit on pins 3-6 and receive on pins 1-2.

Figure 3-34 TIA/EIA 568A standard terminations

UTP Cable Types

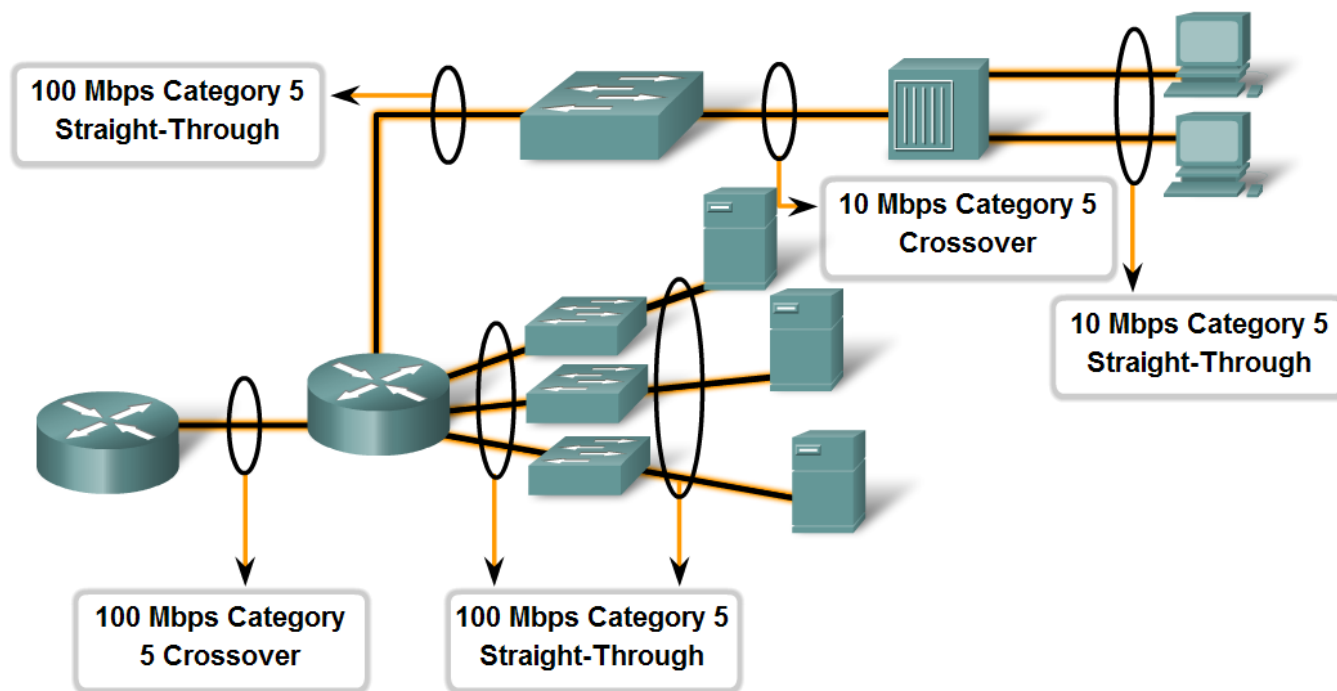
- There are 3 types of unshielded twisted pair cable:
 - **Straight-Through Cable:** Each pin (1-8) on one end is connected through to same pin on other end.
 - **Crossover Cable:** Pins 1,2 on each end are connected to Pins 3,6 on other end (T / R crossover)
 - **Rollover Cable:** Pins 1-8 on one end connected to pins 8-1 on the other end (reversed).
- Straight-Through Cable used to connect a hub or switch to anything else (i.e. PC to hub, router to switch, printer to switch, etc.)
- Crossover Cable used for other connections (switch-switch, hub-switch, PC-router, router-router, etc.)
- Rollover Cable used to connect a PC to Console port on Cisco equipment (to access CLI)

UTP Cable Types in a LAN

- See the cable to use in connecting intermediate and end devices in a LAN.

Making LAN Connections

Identify the correct UTP cable type and likely category to connect different intermediate and end devices in a LAN.



Serial Cables in a WAN

- A different class of cables is used to connect WANs, and the cables, standards and ports are different than those in use by LANs.

Types of WAN Connections

Cisco HDLC	PPP	Frame Relay	DSL Modem	Cable Modem
EIA/TIA-232 EIA/TIA-449 X.21V.24 V.35 High Speed Serial Interface (HSSI)			RJ-11 Note: Works over telephone line	F Note: Works over Cable TV line



Router: Male Smart Serial



Network: Male Winchester Block Type

Cable “Categories”

- Over the past 20 years, copper wire cable manufacturing has improved steadily such that modern cables can carry data at much higher data rates than older cables.
- All copper-wire cables are now marked with a “category number” that indicates the data-carrying capacity of that cable.

Cable Category Standards

Standard	Max. Data Rate	Length	Notes
Category 3	10 Mbps	100 meters	
Category 5	100 Mbps	100 meters	
Category 5e	1000 Mbps (1G)	100 meters	
Category 6	1000 Mbps (1G) 10000 Mbps (10G)	100 meters 35 meters	
Category 6a	10000 Mbps (10G)	100 meters	Thicker Conductors (23 AWG)
Category 7	10000 Mbps (10G) 40000 Mbps (40G)	100 meters 10 meters MAX	Thicker Conductors (23 AWG)
Category 8	10000 Mbps (10G) 25000 Mbps (25G) 40000 Mbps (40G)	100 meters 30 meters MAX 30 meters MAX	Designed to support 25G/40G Thicker Conductors (22 AWG)

RJ-45 Connector

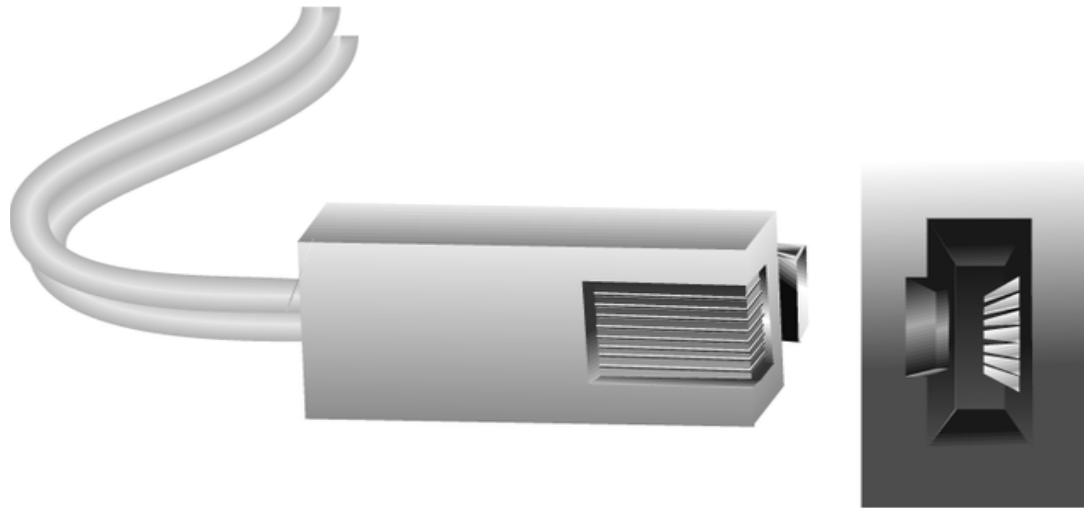
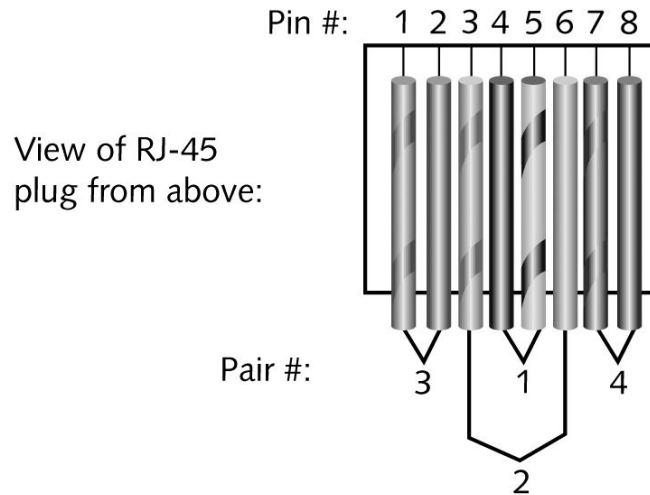


FIGURE 4-14 RJ-45 connector, used by both STP and UTP

Twisted Pair Layout



Pin #	Color	Pair #	Function
1	white with green stripe	3	Transmit +
2	green	3	Transmit -
3	white with orange stripe	2	Receive +
4	blue	1	Unused
5	white with blue stripe	1	Unused
6	orange	2	Receive -
7	white with brown stripe	4	Unused
8	brown	4	Unused

Figure 3-34 TIA/EIA 568A standard terminations

Network Cabling

- Fiber-Optic Cable
 - High Throughput
 - High Cost
 - Connector
 - Good Noise immunity
 - Size and scalability
- Wavelength-Division Multiplexing (WDM)
 - Allows multiple light data signals to be sent over single fiber

Fiber-optic connector

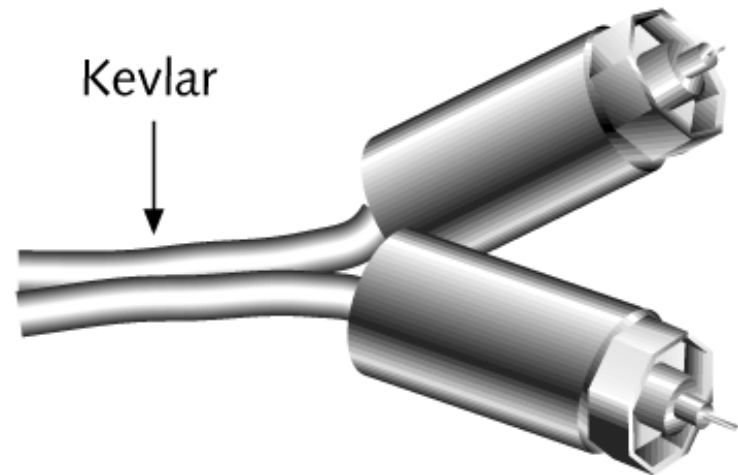


FIGURE 4-17 SMA fiber connector

Fiber Optic Cable

- Fiber-Optic Cable
 - Contains one or several glass fibers at its **core**
 - **Cladding** is the glass shield around the core

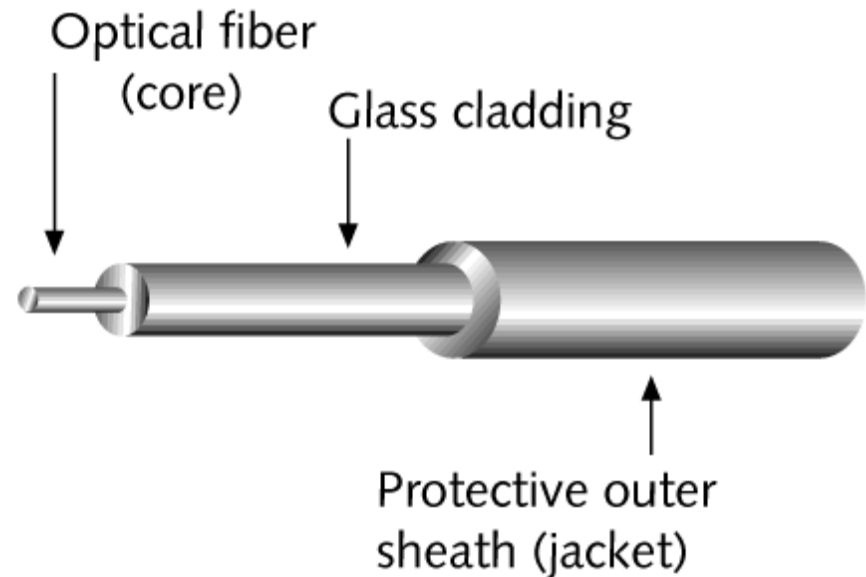


FIGURE 4-15 Fiber-optic cable

Fiber Optic Cable

- Single-Mode Fiber
 - Carries single path of light to transmit data
 - More expensive, higher data rates (to 40 Gbps and beyond)
- Multimode Fiber
 - Carries many paths of light over a single or many fibers
 - Less expensive, but lower data rates / shorter distances allowed due to timing differences between different paths (up to 1-10 Gbps)

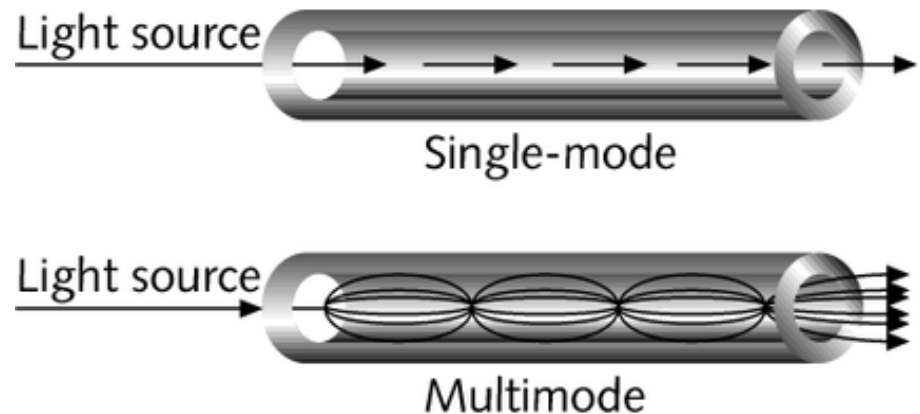


FIGURE 4-16 Single-mode and multimode fiber-optic cables