

Chapter 2

Figure 2-3 shows a conceptual view of a typical enterprise LAN in a three-story building. Each floor has an Ethernet LAN switch and a wireless LAN AP. To allow communication between floors, each per-floor switch connects to one centralized distribution switch. For example, PC3 can send data to PC2, but it would first flow through switch SW3 to the first floor to the distribution switch (SWD) and then back up through switch SW2 on the second floor.

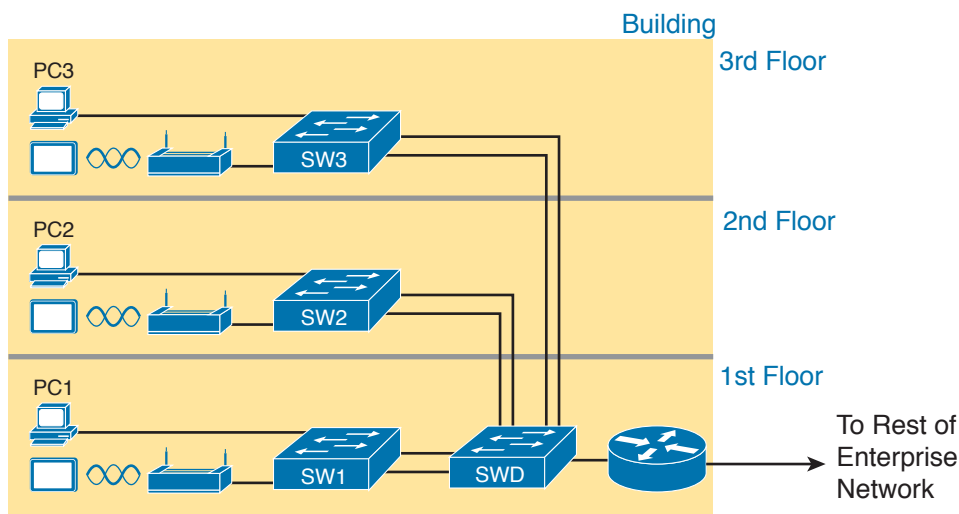


Figure 2-3 *Single-Building Enterprise Wired and Wireless LAN*

Table 2-2 lists a few Ethernet physical layer standards. First, the table lists enough names so that you get a sense of the IEEE naming conventions.

Table 2-2 Examples of Types of Ethernet

Speed	Common Name	Informal IEEE Standard Name	Formal IEEE Standard Name	Cable Type, Maximum Length
10 Mbps	Ethernet	10BASE-T	802.3	Copper, 100 m
100 Mbps	Fast Ethernet	100BASE-T	802.3u	Copper, 100 m
1000 Mbps	Gigabit Ethernet	1000BASE-LX	802.3z	Fiber, 5000 m
1000 Mbps	Gigabit Ethernet	1000BASE-T	802.3ab	Copper, 100 m
10 Gbps	10 Gig Ethernet	10GBASE-T	802.3an	Copper, 100 m

10BASE-T and 100BASE-T use two pairs of wires in a UTP cable, one for each direction, as shown in Figure 2-9. The figure shows four wires, all of which sit inside a single UTP cable that connects a PC and a LAN switch. In this example, the PC on the left transmits using the top pair, and the switch on the right transmits using the bottom pair.

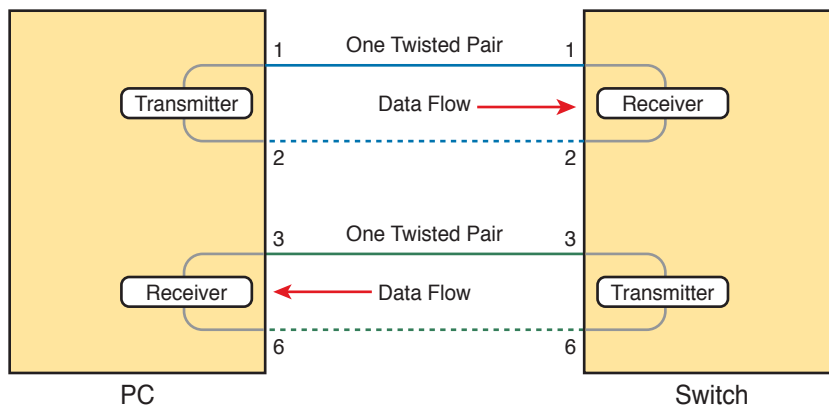


Figure 2-9 *Using One Pair for Each Transmission Direction with 10- and 100-Mbps Ethernet*

To allow a PC NIC to communicate with a switch, the UTP cable must also use a *straight-through cable pinout*. The term *pinout* refers to the wiring of which color wire is placed in each of the eight numbered pin positions in the RJ-45 connector. An Ethernet straight-through cable connects the wire at pin 1 on one end of the cable to pin 1 at the other end of the cable; the wire at pin 2 needs to connect to pin 2 on the other end of the cable; pin 3 on one end connects to pin 3 on the other, and so on, as seen in Figure 2-10. Also, it uses the wires in one wire pair at pins 1 and 2, and another pair at pins 3 and 6.

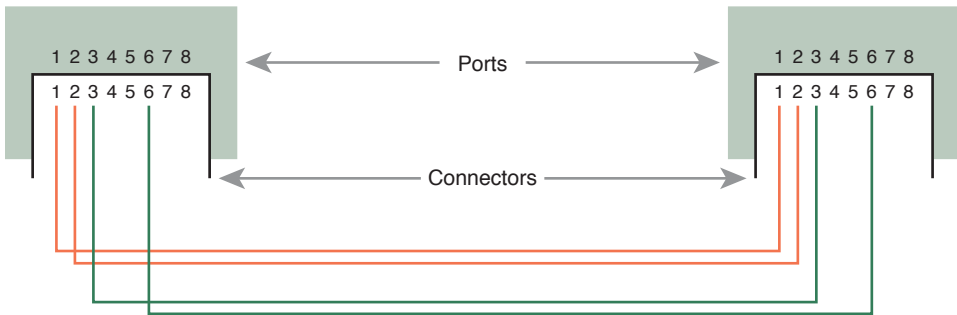


Figure 2-10 10BASE-T and 100BASE-T Straight-Through Cable Pinout

The figure shows what happens on a link between two switches. The two switches both transmit on the pair at pins 3 and 6, and they both receive on the pair at pins 1 and 2. So, the cable must connect a pair at pins 3 and 6 on each side to pins 1 and 2 on the other side, connecting to the other node's receiver logic. The top of the figure shows the literal pinouts, and the bottom half shows a conceptual diagram.

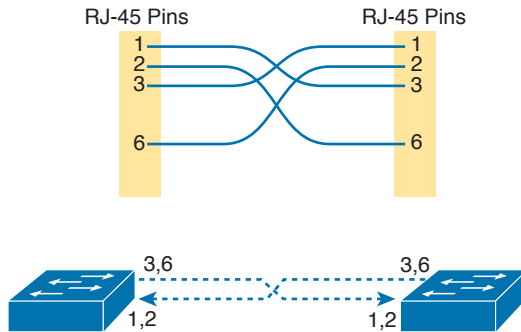


Figure 2-12 *Crossover Ethernet Cable*

For the exam, you should be well prepared to choose which type of cable (straight-through or crossover) is needed in each part of the network. The key is to know whether a device acts like a PC NIC, transmitting at pins 1 and 2, or like a switch, transmitting at pins 3 and 6. Then, just apply the following logic:

Crossover cable: If the endpoints transmit on the same pin pair

Straight-through cable: If the endpoints transmit on different pin pairs

Table 2-3 lists the devices and the pin pairs they use, assuming that they use 10BASE-T and 100BASE-T.

Table 2-3 10BASE-T and 100BASE-T Pin Pairs Used

Transmits on Pins 1,2	Transmits on Pins 3,6
PC NICs	Hubs
Routers	Switches
Wireless access point (Ethernet interface)	—

For example, Figure 2-13 shows a campus LAN in a single building. In this case, several straight-through cables are used to connect PCs to switches. In addition, the cables connecting the switches require crossover cables.

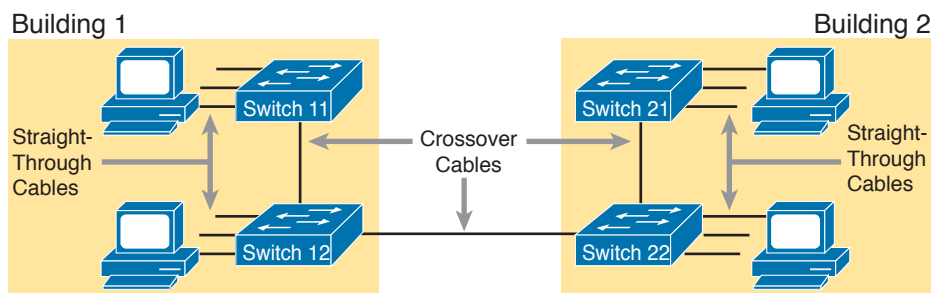


Figure 2-13 *Typical Uses for Straight-Through and Crossover Ethernet Cables*

The three outer layers of the cable protect the interior of the cable and make the cables easier to install and manage, while the inner *cladding* and *core* work together to create the environment to allow transmission of light over the cable. A light source, called the *optical transmitter*, shines a light into the core. Light can pass through the core; however, light reflects off the cladding back into the core. Figure 2-16 shows an example with a light emitting diode (LED) transmitter. You can see how the cladding reflects the light back into the core as it travels through the core.

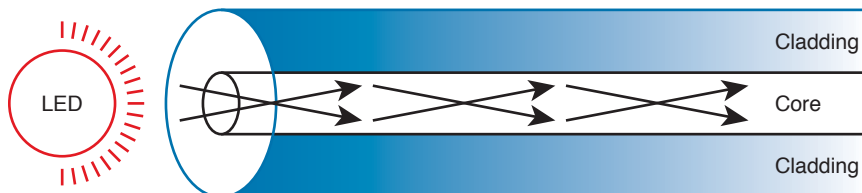


Figure 2-16 *Transmission on Multimode Fiber with Internal Reflection*

Although distance might be the first criterion to consider when thinking about whether to use UTP or fiber cabling, a few other tradeoffs exist as well. UTP wins again on cost, because the cost goes up as you move from UTP, to multimode, and then to single-mode, due to the extra cost for the transmitters like the SFP and SFP+ modules. UTP has some negatives, however. First, UTP might work poorly in some electrically noisy environments such as factories, because UTP can be affected by electromagnetic interference (EMI). Also, UTP cables emit a faint signal outside the cable, so highly secure networks may choose to use fiber, which does not create similar emissions, to make the network more secure. Table 2-5 summarizes these tradeoffs.

Table 2-5 Comparisons Between UTP, MM, and SM Ethernet Cabling

Criteria	UTP	Multimode	Single-Mode
Relative Cost of Cabling	Low	Medium	Medium
Relative Cost of a Switch Port	Low	Medium	High
Approximate Max Distance	100m	500m	40km
Relative Susceptibility to Interference	Some	None	None
Relative Risk of Copying from Cable Emissions	Some	None	None

Figure 2-20 shows the structure of the unicast MAC address, with the OUI.

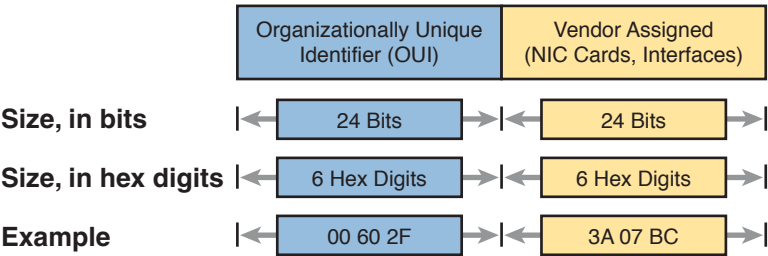


Figure 2-20 *Structure of Unicast Ethernet Addresses*

Full duplex means that the NIC or switch port has no half-duplex restrictions. So, to understand full duplex, you need to understand half duplex, as follows:

Half duplex: The device must wait to send if it is currently receiving a frame; in other words, it cannot send and receive at the same time.

Full duplex: The device does not have to wait before sending; it can send and receive at the same time.

Figure 2-24 shows an example, with full-duplex links on the left and a single LAN hub on the right. The hub then requires SW2's F0/2 interface to use half-duplex logic, along with the PCs connected to the hub.

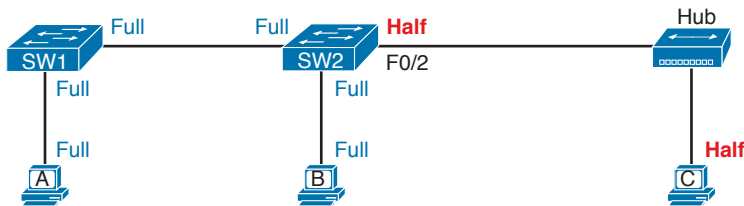


Figure 2-24 *Full and Half Duplex in an Ethernet LAN*