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Eric Rivard

Cisco CCENT ICND1 100-101

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Cisco Press
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Dedications

I dedicate this edition to my beloved family: my beautiful wife, Tammy, and my children, Ellie, Collin, Reegin, Averie, and Sadie. I am the man I am today because of you. You are my everything! Tammy, I could not have found a more perfect partner to spend my life and all eternity with. I am deeply in love with you. Thank you for your support, understanding, love, and patience. To my children, you are such a blessing to your mother and me, and we love you more than you will ever know. Always remember how special you are. Always choose the right path and help others. I love you so much!

Finally, I would like to dedicate this edition to my father-in-law, Paul M. Hatch. Thank you for your love, support, and righteous example through the years. I feel so blessed to be called your son. We love you. God be with you until we meet again.

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Contents

Introduction ix

Section 1 Exploring the Functions of Networking 2

Section 2 Introducing Local-Area Networks 38

Section 3 Understanding Ethernet and Switch Operations 98

Section 4 Understanding TCP/IP 130

Section 5 Routing 172

Section 6 Managing Traffic Using Access Lists 208

Section 7 Enabling Internet Connectivity 230

Section 8 Managing Network Device Security 246

Section 9 Implementing VLANs and Trunks 280

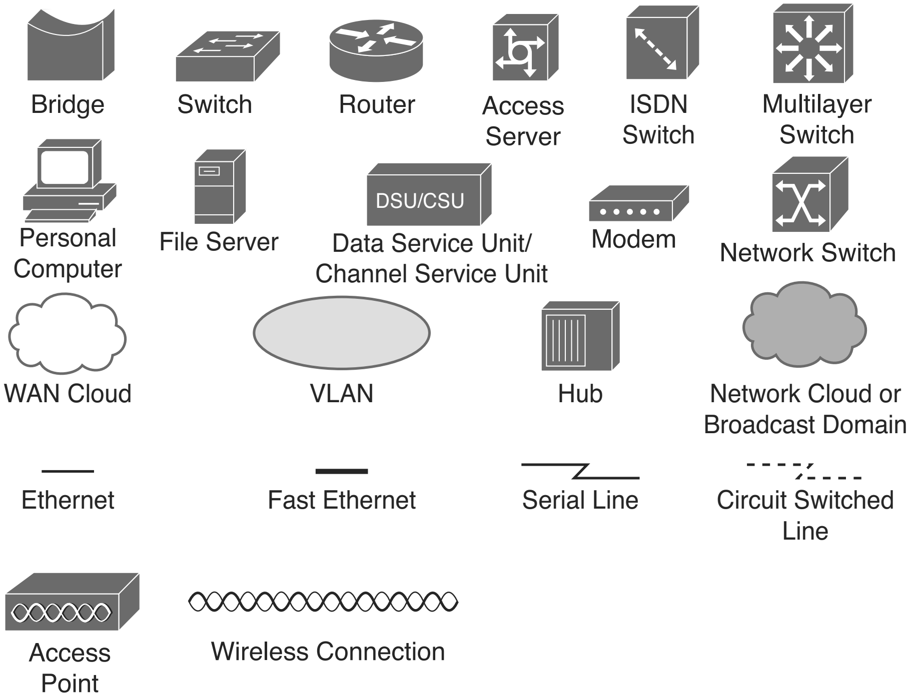
Section 10 WAN Technologies 310

Section 11 Implementing OSPF 332

Section 12 Introducing IPv6 350

ICND1 Quick Reference Guide 376

Icons



Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally, as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a **show** command).
- *Italics* indicate arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets [ ] indicate optional elements.
- Braces { } indicate a required choice.
- Braces within brackets [{ }] indicate a required choice within an optional element.

Introduction

Since the Cisco career certification programs were announced in 1998, they have been the most sought-after and prestigious certifications in the networking industry. For many, passing the ICND exams is crucial in building a rewarding career in networking or obtaining career advancement.

Notorious as being some of the most difficult certifications in the networking industry, Cisco exams can cause much stress to the ill-prepared. Unlike other certification exams, the Cisco exams require that students truly understand the material instead of just memorizing answers. This pack is best used after you have used another, primary method of study for the CCENT certification and need a mode of self-assessment and review to bring you confidently to test day.

The Purpose of Flash Cards

For years, flash cards have been recognized as a quick and effective study aid. They have been used to complement classroom training and significantly boost memory retention.

The flash cards in this pack serve as a final preparation tool for the CCENT exam. They work best when used in conjunction with official study aids for the CCENT exam. They might also be useful to you as a quick desk- or field-reference guide.

Who These Flash Cards Are For

These flash cards are designed for network administrators, network engineers, Cisco Networking Academy Program students, and any professional or student looking to advance his or her career through achieving Cisco CCENT certification.

How to Use These Flash Cards

Review one section at a time, reading each flash card until you can answer it correctly on your own. When you can correctly answer every card in a given section, move on to the next.

These flash cards are a condensed form of study and review. Don’t rush to move through each section. The amount of time you spend reviewing the cards directly affects how long you’ll be able to retain the information needed to pass the test. A couple of days before your exam, review each section as a final refresher. Although these flash cards are designed to be used as a final-stage study aid (30 days before the exam), they can also be used in the following situations:

- **Pre-study evaluation:** Before charting out your course of study, read one or two questions at the beginning and end of every section to gauge your competence in the specific areas.
- **Reinforcement of key topics:** After you complete your study in each area, read through the answer cards (on the left side of the pages) to identify key topics and to reinforce concepts.

- **Identify areas for last-minute review:** In the days before an exam, review the study cards and carefully note your areas of weakness. Concentrate your remaining study time on these areas.
- **Post-study quiz:** By flipping through this book at random and viewing the questions on the right side of the pages, you can randomize your self-quiz to be sure that you're prepared in all areas.
- **Desk reference or field guide to core concepts (Quick Reference Guide section only):** Networking professionals, sales representatives, and help-desk technicians alike can benefit from a handy, simple-to-navigate book that outlines the major topics aligned with the CCENT certification.

Quick Reference Guide

After the flash cards, you will find the Quick Reference Guide, which can serve as both a study guide for the CCENT exam and as a companion reference to the text. For readers who seek CCENT certification, this Quick Reference Guide is well suited to reinforce the concepts learned in the text rather than as a sole source of information. For readers who have either already obtained CCENT certification or simply need a basic overview, the study sheets in this guide can serve as a standalone reference.

What Is Included on the CD-ROM

The CD-ROM included with this book provides you with access to the Pearson IT Certification Practice Test (PCPT) software as well as the Pearson IT Certification Flash Cards Online application.

The PCPT software comes complete with more than 150 exam-realistic practice test questions that help you assess your knowledge and exam readiness. The software is fully customizable, enabling you to focus on individual topic areas or take completed, timed exams. You can work in study mode, which allows you to review answers and full explanations, or in practice exam mode, which simulates the actual exam experience. You can take notes on questions or bookmark questions to create your own custom question databases. This powerful assessment engine also tracks your performance and provides feedback on a chapter-by-chapter basis, laying out a complete assessment of your knowledge to help you focus your study where it is needed most.

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Section 3

Understanding Ethernet and Switch Operations

Ethernet is the technology of choice for today's LANs. It is fast, has low costs, and is easy to maintain. Today's Ethernet standards support speeds of 10 Mbps, 100 Mbps, 1 Gbps, 10 Gbps, and 40 Gbps.

Ethernet functions at Layers 1 and 2 of the Open Systems Interconnection (OSI) model. As such, Ethernet standards specify cabling, signaling, and data link layer addressing.

Because most LANs use Ethernet as the primary Layer 2 technology, most switches today are Ethernet switches. This section covers the fundamentals of Ethernet technologies and describes how switches operate.

Question 1

What does BASE mean in 100BASE-T and 1000BASE-T?

Question 2

What is carrier sense multiple access collision detect (CSMA/CD)?

Question 3

What is UTP cabling?

Answer 1

BASE in 100BASE-T and 1000BASE-T refers to the baseband signaling method. Baseband is a network technology in which only one carrier frequency is used. This means that when a device transmits, it uses the entire bandwidth on the wire and does not share it during the single time interval.

Answer 2

CSMA/CD describes the Ethernet access method.

In CSMA/CD, many stations can transmit on the same cable, and no station has priority over any other. Before a station transmits, it listens on the wire (carrier sense) to make sure that no other station is transmitting. If no other station is transmitting, the station transmits across the wire. If a collision occurs, the transmitting stations detect the collision and run a random backoff algorithm. The random backoff algorithm is a random time that each station waits before retransmitting.

Answer 3

Unshielded twisted-pair (UTP) cabling is a type of twisted-pair cable that relies solely on the cancellation effects produced by the twisted wire pairs to limit electromagnetic interference (EMI) and radio frequency interference (RFI).

UTP cable is often installed using an RJ-45 connector, and UTP cabling must follow precise specifications dictating how many twists are required per meter of cable. The advantages of UTP are ease of installation and low cost. A disadvantage of UTP is that it is more prone to EMI than other types of media.

Question 4

What is the maximum cable length for UTP?

Question 5

What is a straight-through Ethernet cable, and when would you use it?

Question 6

What is a crossover Ethernet cable, and when would you use it?

Answer 4

The maximum length is 100 meters or 328 feet.

Answer 5

A straight-through Ethernet cable is wired the same way at both ends. This cable uses pins 1, 2, 3, and 6. The send and receive wires are not crossed.

You should use a straight-through Ethernet cable when connecting dissimilar devices (for example, data terminal equipment [DTE] to data communications equipment [DCE]). Examples include connecting PCs (DTE) to switches or hubs (DCE) or a router (DTE) to a switch or a hub (DCE).

Answer 6

A crossover Ethernet cable is a cable that has the send and receive wires crossed at one of the ends. In a Category 5 cable, the 1 and 3 wires are switched and the 2 and 6 wires are switched at one end of the cable.

You should use a crossover cable when connecting similar devices (DCE to DCE or DTE to DTE), such as connecting a router to a router, a switch to a switch or hub, a hub to a hub, or a PC to a PC.

NOTE In today's networks, most Catalyst switches have auto-mdix, which can automatically detect the type of cable connected to the interface and automatically configure the connection appropriately.

Question 7

What are the different UTP categories?

Question 8

What is the difference between single-mode fiber (SMF) and multimode fiber (MMF)?

Question 9

What are three ways that LAN traffic is transmitted?

Answer 7

The categories of UTP cable are as follows:

- **Category 1:** Used for telephone communications.
- **Category 2:** Capable of data transmission speeds of up to 4 Mbps.
- **Category 3:** Used in 10BASE-T networks. Speeds up to 10 Mbps.
- **Category 4:** Used in Token Ring networks. Speeds up to 16 Mbps.
- **Category 5:** Capable of data transmission speeds of up to 100 Mbps.
- **Category 5e:** Supports speeds of up to 1 Gbps.
- **Category 6:** Consists of four pairs of 24-gauge copper wires. Speeds up to 1 Gbps.
- **Category 6a:** Supports speeds up to 10 Gbps.

Answer 8

The primary difference between SMF and MMF is the ability of the fiber to send light for a long distance at high bit rates. In general, MMF supports shorter distances than SMF.

Answer 9

LAN traffic is transmitted one of the following three ways:

- **Unicast:** Unicasts are the most common type of LAN traffic. A unicast frame is a frame intended for only one host.
- **Broadcast:** Broadcast frames are intended for all hosts within a broadcast domain. Stations view broadcast frames as public service announcements. All stations receive and process broadcast frames.
- **Multicast:** Multicasts are traffic in which one transmitter tries to reach only a subset, or group, of the entire segment.

Question 10

How many bits are in an Ethernet address?

Question 11

What portion of the MAC address is vendor specific?

Question 12

What portion of the MAC address is vendor assigned?

Answer 10

Also called a MAC address, an Ethernet address is the Layer 2 address associated with the Ethernet network adapter. Typically burned into the adapter, the MAC address is usually displayed in a hexadecimal format, such as 00-0d-65-ac-50-7f.

Answer 11

The first half or first 24 bits of the MAC address are vendor specific.

A MAC address is 48 bits and is displayed in hexadecimal. The first half of the address identifies the vendor or manufacturer of the card. This is called the Organizational Unique Identifier (OUI). The last half of the address identifies the card address.

Answer 12

The last 24 bits are vendor assigned.

Question 13

What are the first 24 bits in a MAC address called?

Question 14

What is an example of a Layer 2 address?

Question 15

What is an example of a Layer 3 address?

Answer 13

These bits are the Organizational Unique Identifier (OUI).

Answer 14

An example is a MAC address.

Answer 15

An example is an IP address.

Question 16

If a sending device does not know the MAC address of the destination device, what protocol is used to find the MAC address of the receiving device?

Question 17

Host A wants to send data to host B. Host B is on a different segment from host A. The two segments are connected to each other through a router. What will host B see as the source MAC address for all frames sent from host A?

Question 18

Switching uses a process outlined by the IEEE as transparent bridging. What are the five processes transparent bridges use for determining what to do with a frame?

Answer 16

Address Resolution Protocol (ARP) is used to find the MAC address of the receiving device.

ARP is a local broadcast sent to all devices on the local segment to find the MAC address of a host.

Answer 17

Because host B is on a different segment that is separated by a router, the MAC address of all frames sent from host A will be the MAC address of the router. Anytime a frame passed through a router, a router rewrites the MAC address to the MAC address of the router's exit interface for the segment and then sends the frame to the local host.

In this case, the router will change the source MAC address of the frame sent from host A with the MAC address of its interface connecting to the segment host B is on. Host B will see that the frame came from the MAC address of the router with the IP address of host A.

Answer 18

The five processes of transparent bridging as defined in IEEE 802.1d are

1. Learning
2. Flooding
3. Filtering
4. Forwarding
5. Aging

Question 19

What is the transparent bridging learning process?

Question 20

What is the transparent bridging flooding process?

Question 21

What is the transparent bridging filtering process?

Answer 19

When a frame enters a switch, the switch adds the source Ethernet MAC address and source port into its MAC address table. The process of recording the source MAC address and the source port in the table whenever a switch sees a frame is called the learning process.

Answer 20

When a switch receives a unicast frame and it does not have the destination MAC address and port in its bridging table, or a broadcast or multicast frame, the switch will forward this frame out all ports, except the port it received the unicast frame on. This is called the flooding process.

Answer 21

The filtering process occurs when a switch receives a frame and the source and destination hosts reside on the same interface. When this occurs, the switch filters or discards the frame.

Question 22

What is the transparent bridging forwarding process?

Question 23

What is the transparent bridging aging process?

Question 24

For what two purposes does the Ethernet protocol use physical addresses?

Answer 22

A switch forwards a frame when the destination address is in the switch's MAC address table and the source and destination are on different interfaces. This is the forwarding process.

Answer 23

When a switch learns a source address, it time-stamps the entry in the MAC address table. Every time the switch sees a frame from the same source, the timestamp is updated. The aging process occurs when the switch does not see a frame from the source before the aging timer expires. When this happens, the switch removes the entry from the MAC address table.

Answer 24

Ethernet uses physical addresses to

- Uniquely identify devices at Layer 2
- Allow communication between different devices on the same Layer 2 network

Question 25

What will an Ethernet switch do if it receives a unicast frame with a destination MAC that is listed in the switch table?

Question 26

Under what conditions would a switch flood a frame?

Answer 25

The switch will forward the frame to a specific port.

Switches use the transparent bridging process to determine how to handle frames. The process is as follows:

1. A frame is received.
2. If the destination is a broadcast or multicast, the switch will forward the frame to all ports except to the port the frame was received.
3. If the destination is a unicast and the address is not in the MAC address table, the switch forwards the frame to all ports except the receiving port.
4. If the destination is a unicast, the address is in the MAC address table, and the associated interface in the MAC address table is not the receiving interface, the switch forwards the frame to the correct interface.
5. If the above rules do not occur, filter the frame.

Answer 26

A switch will flood a frame if the MAC address table is full, if the destination MAC address has not been learned by the switch, or if the frame is a broadcast or multicast frame.

Question 27

What is the switch MAC address table used for?

Question 28

Describe full-duplex transmission.

Answer 27

The switch MAC address table forwards traffic out the appropriate interface.

Because switches operate at Layer 2 of the OSI model, they switch traffic by MAC address. Instead of flooding traffic out all interfaces, a switch learns the MAC address of devices on each interface and only forwards traffic destined to the host on the interface. The learned MAC addresses are stored in the switch's MAC address table.

Answer 28

Full-duplex transmission is achieved by setting switch interfaces, router ports, and host NICs to full duplex. Microsegmentation, where each network device has its own dedicated segment to the switch, ensures that full duplex will work properly. Because the network device has its own dedicated segment, it does not have to worry about sharing the segment with other devices. With full-duplex transmission, the device can send and receive at the same time, effectively doubling the amount of bandwidth between nodes.

Three points to remember about the operation of full-duplex communication are

- There are no collisions in full-duplex mode.
- A dedicated switch port is required for each full-duplex node.
- The host network card and the switch port must be capable of operating in full-duplex mode.

Question 29

What are the advantages of using full-duplex Ethernet instead of half-duplex?

Question 30

How does replacing a hub with a switch affect CSMA/CD behavior in an Ethernet network?

Answer 29

Full-duplex provides faster data transfer by being able to send and receive simultaneously and operates without collisions.

NOTE By enabling full-duplex on a port, you are disabling CSMA/CD on the segment.

Answer 30

It effectively eliminates collisions.

Replacing a hub with a switch effectively eliminates collisions because each switch port is a separate collision domain. One device per switch port and configured for full-duplex operation eliminates the need for CSMA/CD.

Question 31

What command allows you to view the duplex and speed settings configured for a switch port?

Question 32

Can a network hub be connected to a switch port in full-duplex mode?

Answer 31

To view the duplex and speed setting configured for a switch port, enter the **show interface** *interface-id* command, as follows:

```
Cat2960# show interface f0/1
FastEthernet0/1 is up, line protocol is up
  Hardware is Fast Ethernet, address is 0019.e81a.4801
    (bia 0019.e81a.4801)
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Auto-duplex, Auto-speed, media type is 10/100BaseTX
  input flow-control is off, output flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
```

Answer 32

No. Because a hub shares access to the segment, it must connect to a switch port in half-duplex mode to be able to detect collisions.

NOTE CSMA/CD is not enforced when full-duplex is configured.

Question 33

When troubleshooting a switch interface operating in full-duplex mode, which error condition can be immediately ruled out?

Question 34

An end user complains of slow access to the network. You issue the show interface **command on the port the end user is connected to and you see a lot of collisions and runts on the interface. What is most likely the cause of the problem?**

Question 35

An end user complains of slow access to the network. You issue the show interface **command on the port the user is connected to and you see a lot of collisions and cyclic redundancy check (CRC) errors on the interface. What can be several causes for the problem?**

Answer 33

Collisions can be ruled out.

Remember, collisions occur only on half-duplex links. There are no collisions on full-duplex links.

Answer 34

A duplex mismatch is most likely the cause.

Although there are many things that can cause network slowness, the key here is when you issue the **show interface** command, you see many collisions and runts. A duplex mismatch will not only cause the end user to experience network slowness but also cause many collisions and runts on the switch interface.

Answer 35

The most likely causes of the problem are a bad network cable, damaged media, or EMI.

Excessive collisions and CRC errors usually indicate a problem with the network cable attached to the port, or outside interference.

Question 36

You connect two switches using a straight-through UTP Cat 6 cable. The port link lights between the switches are not coming on. What is the problem?

Question 37

You have a port on your switch that is not working properly. You enter the show interface **command on the faulty port and the port status says "errDisable." What are some possible causes for this error?**

Question 38

Traffic between two switches is slow. You issue the show interface **command on the uplink between the two switches and you see the following:**

```
!output omitted!
0 input packets with dribble condition detected
     180749 packets output, 8004302 bytes, 0 underruns
     0 output errors, 45345 collisions, 0 interface resets
     0 babbles, 45345 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
```

What are several possibilities for this problem?

Answer 36

The problem is with the cable. A straight-through cable is used to connect data terminal equipment (DTE) devices to data communications equipment (DCE) devices. A switch is considered a DCE device, and so are hubs. DTE devices include computers, printers, servers, and routers. For two like devices to connect to each other, a crossover cable is needed. In this case, replacing the cable with a crossover cable will fix the problem.

Answer 37

If you are having connectivity issues and the port state shows "errDisable," the following issues can be causing this error:

- EtherChannel misconfiguration.
- Duplex mismatch.
- Bridge protocol data unit (BPDU) port guard has been enabled on the port.
- Unidirectional Link Detection (UDLD).
- A native VLAN mismatch.

Answer 38

The switch port is receiving a lot of late collisions. The problem can be a duplex mismatch or a faulty port, or the distance between the two switches might exceed the cable specifications.

NOTE Duplex mismatches occur when the connecting ends are set to different duplex modes, or when one end's duplex is configured and the other end is set to autonegotiation.

Question 39

What is the cause of multiple collisions on a port?

Question 40

While troubleshooting a switched network, you see the following on a switch interface that is having connectivity problems:

```
!output omitted!
  5 minute input rate 10000 bits/sec, 8 packets/sec
  5 minute output rate 10000 bits/sec, 7 packets/sec
     1476671 packets input, 363178961 bytes, 0 no buffer
     Received 20320 broadcasts (12683 multicast)
     2345 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
```

What could be the cause of the problem?

Answer 39

Multiple collisions are the number of times the transmitting port had more than one collision before successfully transmitting a frame. If you experience multiple collisions on a port, the problem usually lies with an oversaturated medium.

Answer 40

The switch is receiving a lot of runts. Runts are frames smaller than 64 bytes with a bad frame check sequence (FCS). Bad cabling or inconsistent duplex settings usually cause runts.

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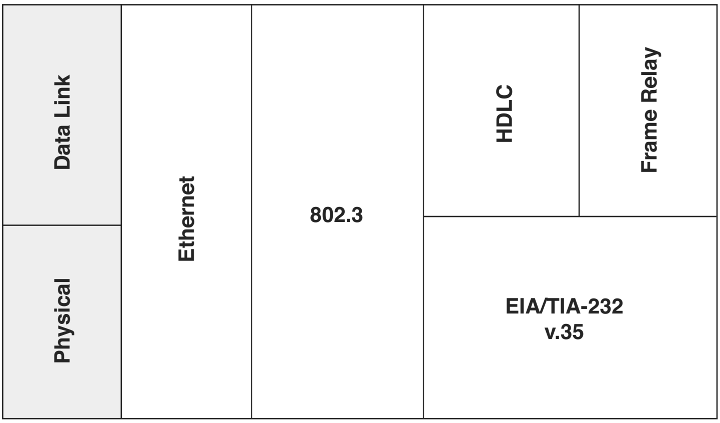
Section 3
Understanding Ethernet and Switch Operations

Ethernet was developed in the 1970s by Digital Equipment Corporation (DEC), Intel, and Xerox. Later, the IEEE defined new standards for Ethernet called Ethernet 802.3. 802.3 is the standard that is in use today.

Ethernet

Ethernet is one of the most widely used LAN standards. As Figure 3-1 shows, Ethernet operates at Layers 1 and 2 of the OSI model.

Figure 3-1 *Physical and Data Link Layers*



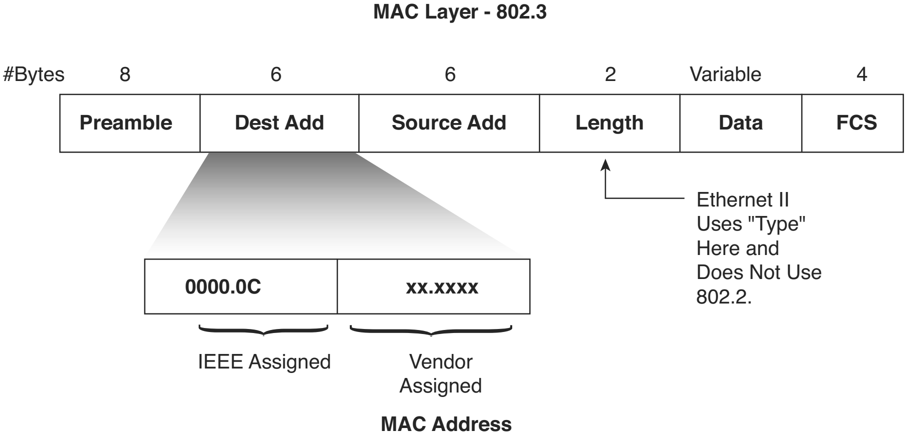
The physical layer (Layer 1) defines cabling, connection specifications, and topology.

The data link layer (Layer 2) has the following functions:

- Provides physical addressing
- Provides support for connection-oriented and connectionless services
- Provides frame sequencing and flow control

One sublayer performs data-link functions: the MAC sublayer. Figure 3-2 shows the Media Access Control (MAC) sublayer (802.3). The MAC sublayer is responsible for how data is sent over the wire. The MAC address is a 48-bit address expressed as 12 hex digits.

Figure 3-2 *MAC Sublayer*



The MAC sublayer defines the following:

- Physical addressing
- Network topology
- Line discipline
- Error notification
- Orderly delivery of frames
- Optional flow control

Ethernet LAN Connection Media

The term *Ethernet* encompasses several LAN implementations. Physical layer implementations vary, and all support various cabling structures. The following four main categories of Ethernet exist:

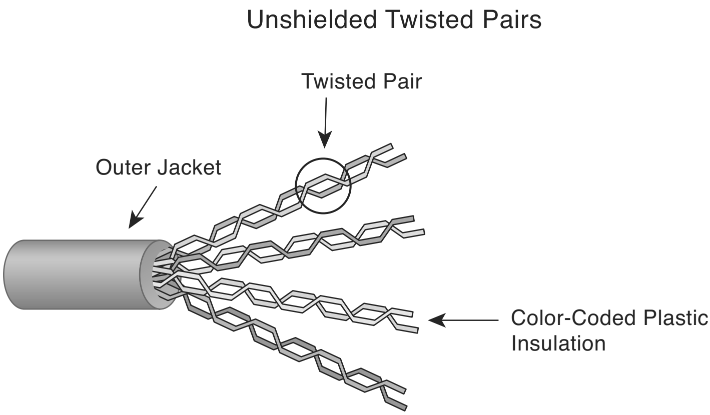
- **Ethernet (DIX) and IEEE 802.3:** Operate at 10 Mbps over coaxial cable, unshielded twisted-pair (UTP) cable, or fiber. The standards are referred to as 10BASE2, 10BASE5, 10BASE-T, and 10BASE-F.
- **Fast Ethernet or 100-Mbps Ethernet:** Operates over UTP or fiber.
- **Gigabit Ethernet:** An 802.3 extension that operates over fiber and copper at 1000 Mbps, or 1 gigabit per second (Gbps).
- **10-Gigabit Ethernet:** Defined in 802.3ae, runs in full-duplex mode only, over fiber.

Network Media Types

Network media refers to the physical path that signals take across a network. The most common types of media are as follows:

- **Twisted-pair cable:** Used for telephony and most Ethernet networks. Each pair makes up a circuit that can transmit signals. The pairs are twisted to prevent interference (crosstalk). The two categories of twisted-pair cables are unshielded twisted-pair (UTP) and shielded twisted-pair (STP). UTP cable is usually connected to equipment with an RJ-45 connector. UTP (see Figure 3-3) has a small diameter that can be an advantage when space for cabling is at a minimum. It is prone to electrical noise and interference because of the lack of shielding. Examples of categories of UTP cable exist: CAT 1, CAT 2, CAT 3, CAT 4, CAT 5, CAT 5e, CAT 6, CAT 6a, CAT 7, and so on.

Figure 3-3 *UTP*

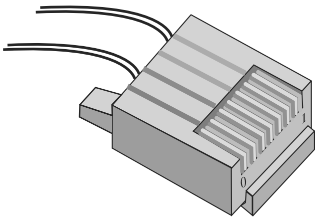


- **Fiber-optic cable:** Allows the transmission of light signals. This offers better support in bandwidth over other types of cables. The two types of fiber-optic cables are multimode and single-mode, defined as follows:
  - **Multimode:** With this type of fiber, several modes (or wavelengths) propagate down the fiber, each taking a slightly different path. Multimode fiber is used primarily in systems with transmission distances less than 2 km.
  - **Single-mode:** This type of fiber has only one mode in which light can propagate. Single-mode fiber is typically used for long-distance and high-bandwidth applications.

UTP Implementation

An RJ-45 connector is used with UTP cabling. Figure 3-4 shows an RJ-45 connector and its pin connections, following the T568B standards.

Figure 3-4 *RJ-45 Connector*

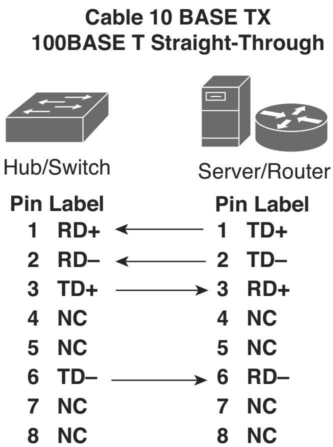


The RJ-45 Connector

Pin	Wire Pair T is Tip R is Ring
1	Pair 2 T2
2	Pair 2 R2
3	Pair 3 T3
4	Pair 1 R1
5	Pair 1 T1
6	Pair 3 R3
7	Pair 4 T4
8	Pair 4 R4

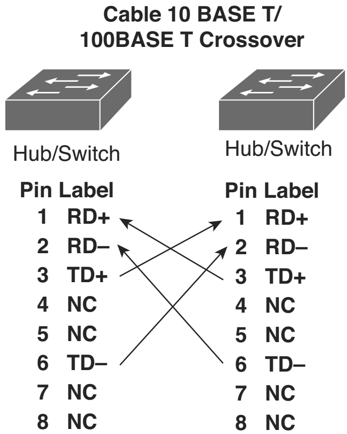
The two types of Ethernet cables are straight-through and crossover. Straight-through cables are typically used to connect different devices (data terminal equipment [DTE] to data communications equipment [DCE]), such as switch-to-router connections. Figure 3-5 shows the pins for a straight-through cable.

Figure 3-5 *Straight-Through Wiring*



Crossover Ethernet cables are typically used to connect similar devices (DTE to DTE or DCE to DCE), such as switch-to-switch connections. Exceptions to this rule are switch-to-hub connections or router-to-PC connections, which use a crossover cable. Figure 3-6 shows the pins for a crossover cable.

Figure 3-6 *Crossover Wiring*



Role of CSMA/CD in Ethernet

All stations on an Ethernet segment are connected to the same media. Therefore, all devices receive all signals. When devices send signals at the same time, a collision occurs. A scheme is needed to detect and compensate for collisions. Ethernet uses a method called carrier sense multiple access collision detect (CSMA/CD) to detect and limit collisions.

In CSMA/CD, many stations can transmit on the Ethernet media, and no station has priority over any other. Before a station transmits, it listens to the network (carrier sense) to make sure that no other station is transmitting. If no other station is transmitting, the station transmits across the media. If a collision occurs, the transmitting stations detect the collision and run a backoff algorithm. The backoff algorithm computes a random time that each station waits before retransmitting.

Ethernet LAN Traffic

Three major types of network traffic exist on a LAN:

- **Unicasts:** The most common type of LAN traffic. A unicast frame is a frame intended for only one host.
- **Broadcasts:** Intended for all hosts. Stations view broadcast frames as public service announcements. All stations receive and process broadcast frames.
- **Multicasts:** Traffic in which one transmitter tries to reach only a subset, or group, of the entire segment.

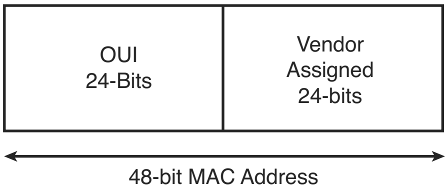
Ethernet Addresses

The Ethernet address, or MAC address, is the Layer 2 address of the network adapter of the network device. Typically burned into the adapter, the MAC address is usually displayed in a hexadecimal format such as 00-0d-65-ac-50-7f.

As shown in Figure 3-7, the MAC address is 48 bits and consists of the following two components:

- **Organizational Unique Identifier (OUI):** 24 bits. This is IEEE assigned and identifies the manufacturer of the card.
- **Vendor-assigned:** 24 bits. Uniquely identifies the Ethernet hardware.

Figure 3-7 *MAC Addresses*



Switching Operation

Ethernet switches perform four major functions when processing packets: learning, forwarding, filtering, and flooding.

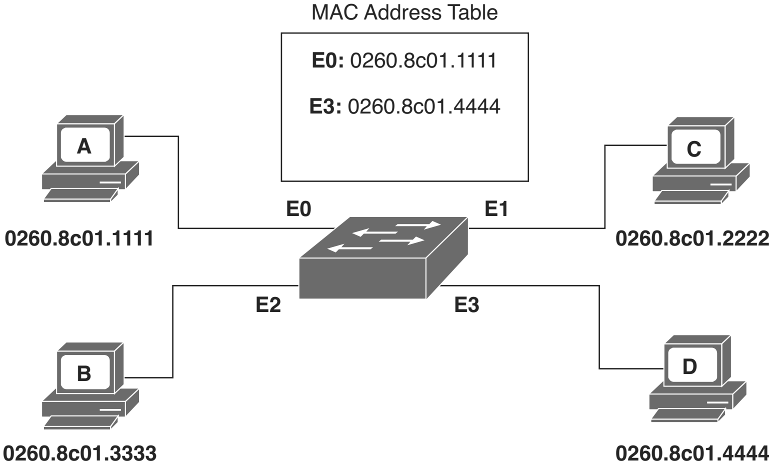
Switches perform these functions by the following methods:

- **MAC address learning:** Switches learn the MAC addresses of all devices on the Layer 2 network. These addresses are stored in a MAC address table.
- **Forwarding and filtering:** Switches determine which port a frame must be sent out to reach its destination. If the address is known, the frame is sent only on that port, filtering other ports from receiving the frame. If it's unknown, the frame is flooded to all ports except the one it originated from.
- **Flooding:** Switches flood all unknown frames, broadcasts, and some multicasts to all ports on the switch except the one it originated from.

A switch uses its MAC address table when forwarding frames to devices. When a switch is first powered on, it has an empty MAC address table. With an empty MAC address table, the switch must learn the MAC addresses of attached devices. This learning process is outlined as follows using Figure 3-8:

1. Initially, the switch MAC address table is empty.

Figure 3-8 *Frame Forwarding by a Switch*



2. Station A with the MAC address 0260.8c01.1111 sends a frame to station C. When the switch receives this frame, it does the following:
   a. Because the MAC table is empty, the switch must flood the frame to all other ports (except E0, the interface the frame was received).
   b. The switch notes the source address of the originating device and associates it with port E0 in its MAC address table entry.
3. The switch continues to learn addresses in this manner, continually updating the table. As the MAC table becomes more complete, the switching becomes more efficient, because frames are forwarded to specific ports rather than being flooded out all ports.

Maximizing the Benefits of Switching

Microsegmentation

Microsegmentation is a network design (functionality) where each workstation or device on a network gets its own dedicated segment (collision domain) to the switch. Each network device gets the full bandwidth of the segment and does not have to share the segment with other devices. Microsegmentation reduces and can even eliminate collisions because each segment is its own collision domain.

Microsegmentation is implemented by installing LAN switches. Benefits of microsegmentation are as follows:

- Collision-free domains from one larger collision domain
- Efficient use of bandwidth by enabling full-duplex communication
- Low latency and high frame-forwarding rates at each interface port

Duplex Communication

Duplexing is the mode of communication in which both ends can send and receive information. With full-duplex, bidirectional communication can occur at the same time. Half-duplex is also bidirectional communication, but signals can flow in only one direction at a time. Table 3-1 provides a comparative summary of full-duplex and half-duplex.

Table 3-1 *Full-Duplex and Half-Duplex*

Full-Duplex	Half-Duplex
Can send and receive data at the same time.	Can send and receive, but not simultaneously.
Collision-free.	The Ethernet segment is susceptible to collisions.
Point-to-point connection only.	Multipoint and point-to-point attachments.
Uses a dedicated switched port with separate circuits.	The medium is considered shared.
Efficiency is rated at 100 percent in both directions.	Efficiency is typically rated at 50 to 60 percent.
Both ends must be configured to run in full-duplex mode.	The duplex setting must match on devices sharing a segment.

Configuring and Verifying Port Duplex

The default port settings on a Catalyst 2960 switch are as follows:

- **Duplex:** auto
- **Speed:** auto

The default auto setting means that the switch will automatically try to negotiate the duplex and speed of connected interfaces.

To change the default settings, use the following commands:

```
Switch(config)# interface g0/1
Switch(config-if)# duplex {auto | full | half}
Switch(config-if)# speed {10 | 100 | 1000 | auto}
```

To view duplex and speed settings, use the **show interface** *interface-id* command, as follows:

```
Cat2960# show interface f0/1
FastEthernet0/1 is up, line protocol is up
  Hardware is Fast Ethernet, address is 0019.e81a.4801 (bia
    0019.e81a.4801)
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Auto-duplex, Auto-speed, media type is 10/100BaseTX
  input flow-control is off, output flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
```

Troubleshooting Common Switch Issues

When troubleshooting switch issues, remember the following:

- Switches operate at Layer 2 of the OSI model.
- Switches provide an interface to the physical media.
- Problems generally are seen at Layer 1 and Layer 2.
- Layer 3 issues could be regarding IP connectivity to the switch for management purposes.

Identifying and Resolving Media Issues

Common switch Layer 1 issues include the following:

- Bad wires or damaged wires.
- EMI is introduced.
- Malfunctioning equipment.

Bad wiring and EMI commonly show up as excessive collisions and noise. This is displayed by excessive collisions and runts when issuing the **show interface** command, as follows:

```
SwitchA# show interface g0/1
GigabitEthernet0/1 is up, line protocol is up (connected)
  Hardware is Gigabit Ethernet Port, address is 000d.65ac.5040
   (bia 000d.65ac.5040)
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
     reliability 255/255, txload 1/255, rxload 1/255
<Text-Ommited>
  5 minute output rate 10000 bits/sec, 7 packets/sec
```

```
1476671 packets input, 363178961 bytes, 0 no buffer
Received 20320 broadcasts (12683 multicast)
542 runts, 0 giants, 0 throttles
3 input errors, 3 CRC, 0 frame, 0 overrun, 0 ignored
0 input packets with dribble condition detected
1680749 packets output, 880704302 bytes, 0 underruns
8 output errors, 1874 collisions, 15 interface resets
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
```

Identifying and Resolving Access Port Issues

Common port access issues are as follows:

- Media-related issues
- Duplex mismatch
- Speed mismatch

Media-Related Issues

Media-related issues might be reported as an access issue; for example, a user might say that she cannot access the network. Media issues should be isolated and identified as indicated in the previous topic.

Duplex Issues

The following items can create duplex issues:

- One end set to full-duplex and the other set to half-duplex results in a duplex mismatch.
- One end set to full-duplex and auto-negotiation on the other:
  - Auto-negotiation can fail, and the end reverts to half-duplex.
  - Results in a duplex mismatch.
- One end set to half-duplex and auto-negotiation on the other:
  - Auto-negotiation can fail, and the end reverts to half-duplex.
  - Both ends set to half-duplex causes no mismatch.

Speed Issues

The following items can create speed issues:

- One end set to one speed and the other set to another results in a mismatch.
- One end set to a higher speed and auto-negotiation on the other:
  - Auto-negotiation will fail, and the end will revert to a lower speed.
  - Results in a mismatch.